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TEST REPORT
SHAMS DUBAI - DRRG Standards Version 2.0
STANDARDS FOR DISTRIBUTED RENEWABLE RESOURCES GENERATORS CONNECTED TO THE DISTRIBUTION NETWORK

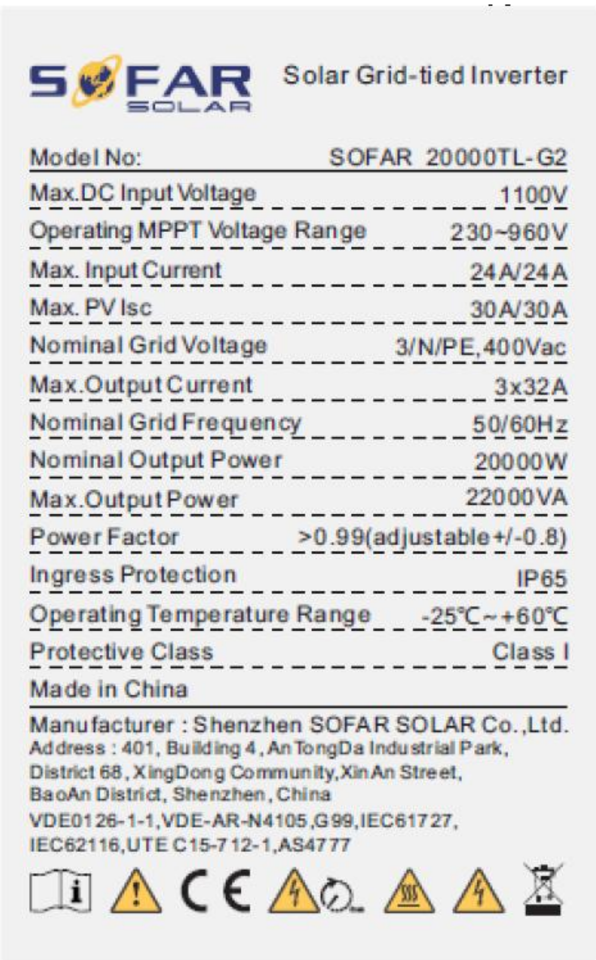
Report Number. .... :	190819062GZU-001
Tested by (name + signature)......... :	Jason Fu Technical Team Leader
Approved by (name + signature)..... :	Tommy Zhong Technical Manager
Date of issue .... :	30 Oct 2019
Total number of pages..................	176 Pages
Testing Laboratory .... :	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Address .... :	Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China
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 .... :	SHAMS DUBAI - DRRG Standards Version 2.0 March 2016
Test procedure............................ :	Type test
Non-standard test method .... :	N/A
Test Report Form No..................... :	TTRF_ SHAMS DUBAI - DRRG Standards Version 2.0 _a
Test Report Form(s) Originator.... :	Intertek Guangzhou
Master TRF .... :	Dated 2017-08
Test item description .... :	Solar Grid-tied Inverter
Trade Mark...................................... :	SOFAR SOLAR
Manufacturer .... :	Same as applicant
Model/Type reference .... :	SOFAR 20000TL-G2, SOFAR 25000TL-G2, SOFAR 30000TL-G2, SOFAR 33000TL-G2

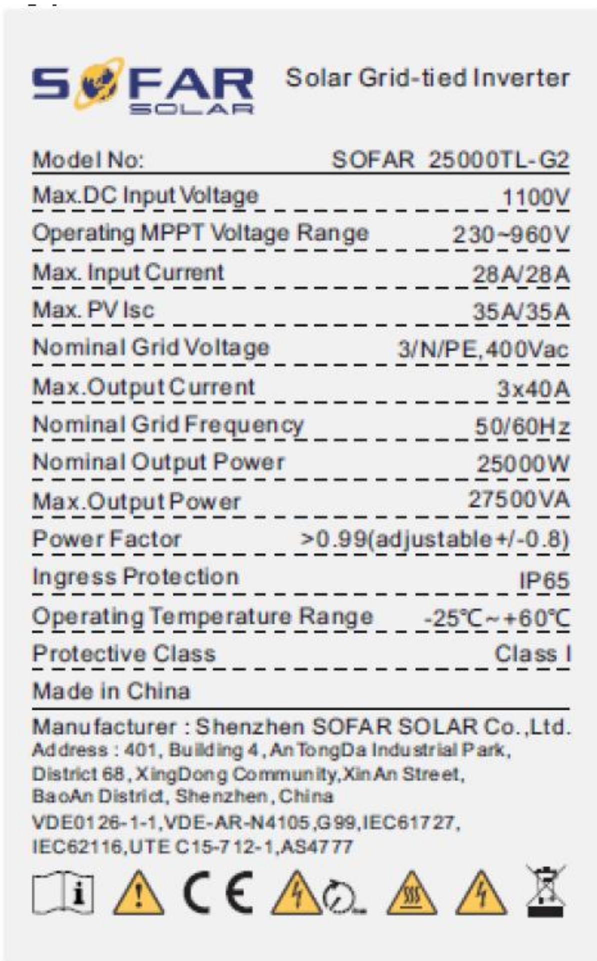
Ratings ....

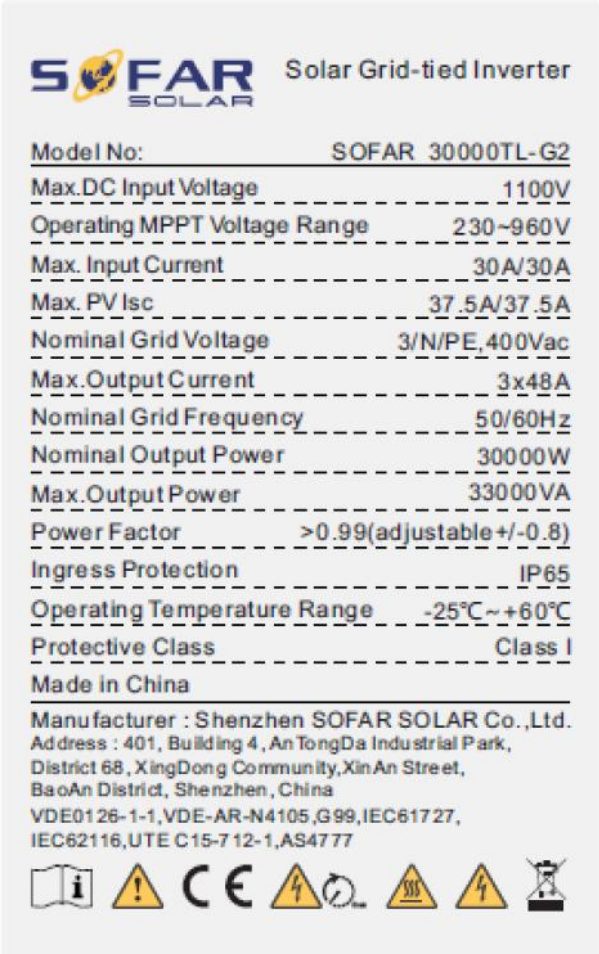
Model	SOFAR 20000TL-G2	SOFAR 25000TL-G2	SOFAR 30000TL-G2	SOFAR 33000TL-G2
Max. DC input Voltage	1100Vdc			
Operating MPPT voltage range	230Vdc – 960Vdc			
Max. Input current	24A/24A	28A/28A	30A/30A	30A/30A
PV Isc	30A*2	35A*2	37.5A*2	37.5A*2
Nominal AC output voltage	3/N/PE 230Vac/400Vac			
Nominal AC 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	V3.00			

Summary of testing:	
Tests performed (name of test and test clause): **All applicable tests**	**Testing location:** **Intertek Testing Services Shenzhen Ltd. Guangzhou Branch** **Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China**

Copy of marking plate:



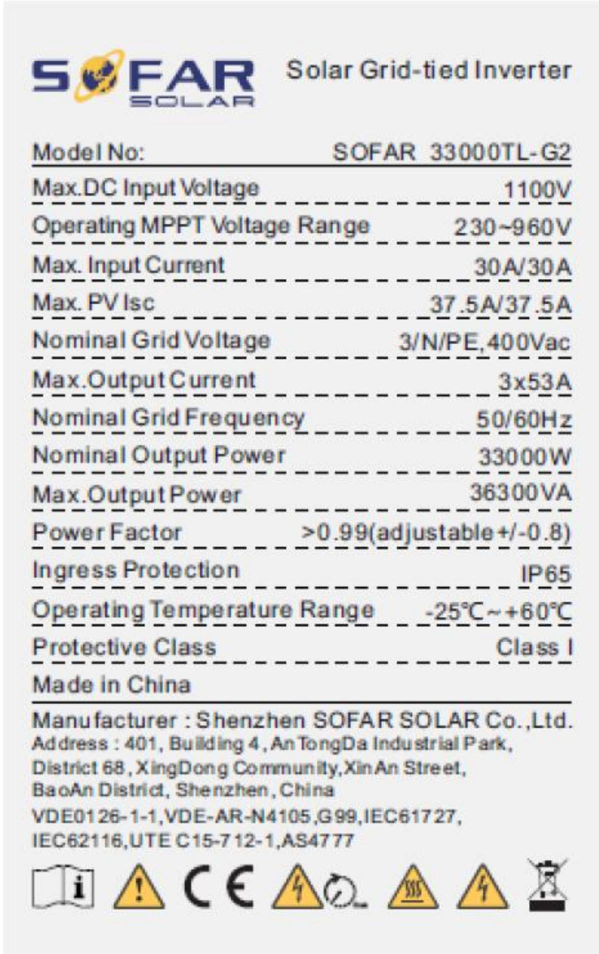




SOFAR SOLAR Solar Grid-tied Inverter

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
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 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
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

Note:

1. 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.
2. Label is attached on the side surface of enclosure and visible after installation

Possible test case verdicts:	
- test case does not apply to the test object..........:	N/A
- test object does meet the requirement................:	P (Pass)
- test object was not evaluated for the requirement...:	N/E
- test object does not meet the requirement..........:	F (Fail)
Testing ....:	
Date of receipt of test item....................................:	19 Aug 2019
Date (s) of performance of tests ....:	20 Aug 2019-29 Oct 2019

General remarks:

"(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 ☐ comma / ☒ point is used as the decimal separator.

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

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The test report only allows to be revised only within the report defined retention period unless standard or regulation was withdrawn or invalid.

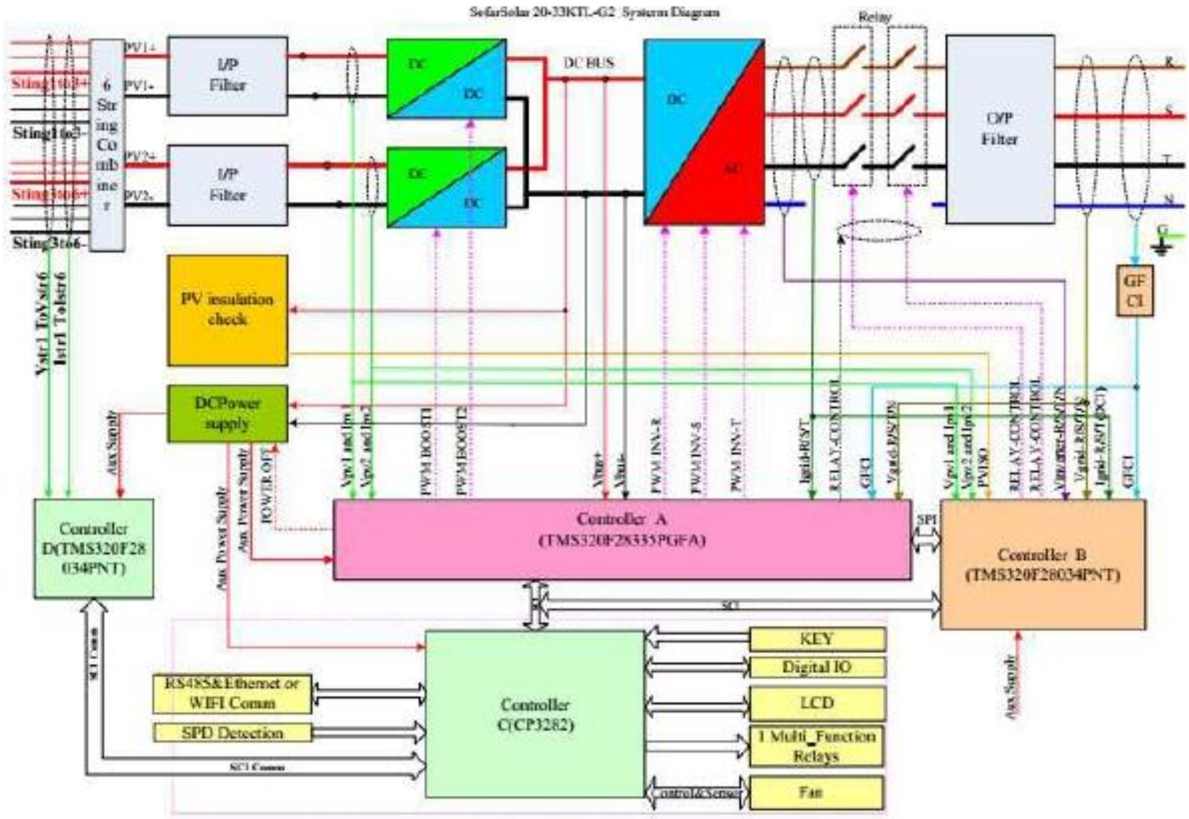
Name and address of factory:

Dongguan SOFAR SOLAR Co., Ltd

1F-6F, Building E, No.1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City

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.
The inverter must be connected a circuit which provides with external interface protection system (external IPS)



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: V3.00

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

The tests had been performed on the SOFAR 33000TL-G2 is valid for the SOFAR 20000TL-G2, SOFAR 25000TL-G2, SOFAR 30000TL-G2.

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Clause	Requirement – Test	Result – Remark	Verdict

2	**TECHNICAL REQUIREMENTS**		--
2.1	General Rules		P
	The following general rules shall hold for photovoltaic plants:		P
	1. The limit to the P_{MC} under a contract account is defined by DEWA as part of the Conditions complementing the regulatory framework set by the Executive Council Resolution No. (46) of 2014 Concerning the Connections of the Generators of Electricity from Solar Energy to the Power Distribution System in the Emirate of Dubai”.		P
	2. PV arrays for installation on buildings shall not have maximum voltages greater than 1,000 Vdc, as calculated at the minimum outdoor temperature of 0 ° C. All the equipment (PV modules, inverter, and cables) shall withstand the maximum voltage of the array.	This report is only covered the inverter.	N/A
	3. Arrays with voltages which exceed the above mentioned value of 1,000 Vdc (but not exceeding 1,500 Vdc) may be allowed only for ground mounted solutions, canopies, urban design and any other solutions that does not involve the installation of PV modules, inverters or other related equipment on buildings. In any case, all the equipment must withstand the maximum voltage reached for the system, as calculated at the minimum outdoor temperature of 0 ° C.		N/A
	4. The inverters shall be provided with an IP65 enclosure for outdoor application and IP54 enclosure for indoor application. In this latter case, lower protection grades shall only be permitted if the characteristics of the room will be properly conceived to protect the equipment. The inverter shall be able to withstand the maximum temperatures with effective heating dispersion and with a power derating smaller than or equal to 25 % of its rated power as determined for an ambient temperature of 50 ° C at the DC design voltage. This temperature is to be considered the maximum outdoor value at which all equipment, apparatus, materials and accessories used in electrical installations must be capable of operating with satisfactory performance in the climatic conditions of the Emirate of Dubai. In addition, provisions which prevent the increase of the internal heating of the inverters shall be taken for outdoor installation (e.g. protections against direct exposition to the sun). For those inverters which do not comply with the above set rule, a placement in cooled room or	IP65	P

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Clause	Requirement – Test	Result – Remark	Verdict
	enclosures with effective ventilation shall be required, inside which the ambient temperature will be kept below the value which determines a power derating equal to 25 % of the inverter rated power at the DC design voltage.		
	5. For Safety Issues also refer to 2.6.		P
2.2	Earthing and Protection Schemes	Shall be considered in the end installation	N/A
2.2.1	Protections required at the Connection Point		N/A
2.2.1.1	GENERAL REQUIREMENTS		N/A
	The protection system is of considerable importance for secure and reliable operation of the network and of the electric facilities (both passive and active). According to DEWA rules, automatic installations must be provided for short-circuit clearing in electric facilities, which must also be selective with the upstream protections ruled by DEWA. The Producer is responsible for the reliable protection of his plants (e.g. short-circuit, earth-fault and overload protection). An accredited Consultant will properly design the installation and an accredited Contractor shall install an adequate amount of protection equipment. For plants capable of injection of power in the Distribution Network, these protections need also to guarantee that the plant does not contribute to sustain a fault in the network itself.		N/A
2.2.1.2	PROTECTION SYSTEM FOR RRGPs	Shall be considered in the end installation	N/A
	1. The following protections shall be adopted by the Producer:		N/A
	- General Overcurrent Protection at the main incomer at the connection point	.	N/A
	- Interface Protection to separate the production plant from the network	External IPS	N/A
	Other protections may be required for each RRGU (Generator protection) (see 2.2.1.3).		N/A
	2. For the General Overcurrent Protection, two different situations may be met, according to the voltage level:		N/A
	- for LV connections, the incomer protection shall be chosen and installed according to the criteria and rules set by the standards of the series IEC 60364 as well as to “DEWA Regulations for electrical installations”	Shall be considered in the end installation	N/A
	- for MV connections, the standards IEC 60255,		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	IEC 61936-1 as well as the “General Conditions / requirements for providing direct 11 kV supply” shall apply		
	3. An Interface Protection shall be installed with the purpose to separate the production plant (which could be just a portion of an installation) thus ensuring that the connection of a RRGU or a RRGP will not impair the integrity or degrade the safety of the Distribution System. Therefore, this protection will intervene, disconnecting the RRGU / RRGP from the Distribution Network, any time a problem with this latter is sensed (usually for a fault, where the RRGP has to be disconnected in order to prevent from feeding it).	Shall be considered in the end installation	N/A
	3.1 The Interface Protection shall be located:		P
	- in a separate unit for RRGP with a Maximum Capacity ≥ 10 kW, or	External IPS	P
	- in a separate unit or, in case the number of inverters does not exceed 3, integrated into the Inverter for RRGP with a Maximum Capacity < 10 kW.		N/A
	In the former case, an intervention of the protection will determine the tripping of the Interface Switch (see Connection Schemes in Appendix A), whereas in the latter the devices within the control of the RRGU (typically integrated in the Inverter) will act to disconnect the unit from the network. Tripping through integrated protection relays must not be delayed by other functions of the control system.	Shall be considered in the end installation	N/A
	The loss of the auxiliary voltage of either the protection equipment or the plant’s control system must lead to an instantaneous tripping of the interface switch.	Shall be considered in the end installation	N/A
	DEWA shall be responsible for ensuring through the design that the voltage and frequency at the Connection Point remain within statutory limits. The Interface Protection settings have to be chosen to allow for voltage rise or drop within the Producer’s Installation and to allow the RRGU to continue to operate outside of the statutory frequency range as required.	Shall be considered in the end installation	N/A
	The protection functions required in the Interface Protection are the following: Table 3 – Protection functions required		N/A
	3.2 With the exceptation of functions 78 and 81R, at least 2 thresholds for each of the above listed functions shall be required, in order to avoid nuisance tripping setting long time delays for smaller excursions and allow a faster tripping time in case of greater excursions. The thresholds to be		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	activated will be defined in the following. Some of the required ones may be for future use.		
	One of the main goals of the Interface Protection is to prevent the RRGU / RRGP supporting an islanded section of the Distribution Network, when it would or could pose a hazard to the Network itself or to the customers connected to it. In order to ensure this, functions 78 (Vector shift) and 81R (ROCOF), known as Loss Of Mains (LOM) protections, must be both implemented in the Interface Protection. These functions have to be available in the interface protection, but they shall be activated only on explicit demand of DEWA.		N/A
	3.3 The number and position in the installation of this Interface Protection is indicated in the Connection Schemes (see Appendix A). The Interface Protection will act on an Interface Switch with the purpose:		N/A
	- to separate the generating part of the plant from the network;		N/A
	- to prevent the RRGU not being synchronised with the network in case of reclosure of circuit breakers made by DEWA in the Distribution Network.		N/A
	When implemented in the MV side of the plant, the Interface Switch shall consist of:	Shall be considered in the end installation	N/A
	- three-polar withdrawable automatic circuit breaker operated by an undervoltage release, or		N/A
	- three-polar automatic circuit breaker operated by an undervoltage release along with an isolator (either upstream or downstream the circuit breaker).		N/A
	When implemented in the LV side of the plant, the Interface Switch shall consist of:		N/A
	- automatic circuit breaker or switch disconnector operated by an undervoltage release, or		N/A
	- omnipolar AC3 contactor.		N/A
	3.4 In case of a RRGP with a Maximum Capacity ⩾ 10 kW, as a rule only one Interface Protection and one Interface Switch are installed.		N/A
	Alternatively, in extended plants, it is possible to install more than one Interface Protections, each one which controls a single Interface Switch. However, in this case an OR logic shall be adopted between the protections, in order to open all the Interface Switches once one of the protections has detected an abnormal condition of the grid. This circuital condition shall be evaluated and preliminary approved by DEWA.	.	N/A

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	3.5 For RRGPs with a Maximum Capacity > 20 kW a backup switch to the Interface Switch shall be provided. This may also consist of an already existing switch, e.g. a main incomer, in any case a device which will be able to separate the RRGUs from the network in case of failure of the Interface Switch.	Shall be considered in the end installation.	N/A
	The backup may be achieved:	Shall be considered in the end installation	N/A
	- by sending the opening command, as elaborated by the Interface Protection, to both the Interface Switch and the backup switch, or - by sending the opening command, as elaborated by the Interface Protection, to the Interface Switch and, in case of failure (monitored by the protection through a dry contact from the Interface Switch), by sending the opening command to the backup switch at most after 0.5 s. The opening release on the backup switch shall be reliable, in order to ensure the separation from the network. Only manual reclosing of the backup switch shall be permitted.		N/A
	3.6 For the three-phase systems, both for LV and MV connections, the protection functions:	Shall be considered in the end installation	N/A
	- Under and Overvoltage shall be fed by voltages proportional to the 3 line voltages		N/A
	- Under and Overfrequency shall be fed by voltages proportional to at least one line voltage		N/A
	In case of voltage sensing at the MV side, these voltages will be obtained by means of VTs. The connection of the Interface Protection at the LV side, with direct sensing of the line voltages, is however always allowed.		N/A
	3.7 Automatic reclosure of the Interface Switch: the opening of the Interface Switch shall occur for either a fault or a disturbance on the distribution network, whose duration exceeds the Interface Protection setting times, or as an effect of a remote tripping command. After these disturbances will have been cleared by the network protections or the remote tripping command will have been withdrawn, the automatic reclosure of the Interface Switch shall be made possible. The Interface Protection will have to sense a healthy network condition and give the consensus to the closing of the Interface Switch. The following provisions shall then apply:		N/A
	- the voltages which feed the Interface Protection shall always be sensed in order to measure them at the network side (see Connection Schemes in		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	Appendix A);		
	- in case the Interface Switch consists of an automatic circuit breaker, this shall be motorized. The undervoltage release which operates the switch shall be fed by an auxiliary voltage derived from the network side and not from the producing plant side.		N/A
	3.8 The Interface Protection shall include the ability to receive signals with protocol IEC 61850, finalised to remote tripping.		N/A
	3.9 In accordance with established practice it is the Producer's responsibility to install, own and maintain these protections.		N/A
	4. The protection system of the Renewable Resource Generating Plant, including connection installations to the Network, shall be able to eliminate faults inside the installation and, in backup, faults outside the installation, within the time given in Table 4.	Shall be considered in the end installation	N/A
2.2.1.3	PRODUCER RESPONSIBILITY		P
	The Producer shall be responsible for the protection of the generating plant or the generating units, respectively. Consequently, the protection concept described in these Standards needs to be adequately extended. However, intrinsic protection must not undermine the requirements described in these Standards regarding steady-state voltage control and dynamic network support of the RRGP or RRGUs.		P
2.2.2	Short-circuit contribution of the Renewable Resources Generating Units and Plants	Shall be considered in the end installation	N/A
	1. Requirements related to the neutral earthing and the coupling of the transformer and to the 1-phase short-circuit current contribution will be provided by DEWA. As regards the 1-phase to earth values for the different voltage levels of the Distribution Network, refer to point 2.2.3.		N/A
	2. Maximum admissible short-circuit current		N/A
	Due to the operation of a RRGP, the short-circuit current is increased by its contribution, particularly in the vicinity of the connection point. Therefore, information about the anticipated short-circuit currents of the RRGP at the network connection point has to be provided together with the application for connection to the network.		N/A
	To ensure correct calculations, the impedances between the RRGP and the connection point (MV/LV transformer, lines, etc.) need to be taken into consideration.	Shall be considered in the end installation	N/A
	If a short-circuit current increase above the rated		N/A

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	values (see next 2.2.3) occurs in the network because of RRGP, DEWA and the Producer shall agree upon appropriate measures, such as limitation of the short-circuit current from the RRGP (e.g. by using series reactors or other means).		
2.2.3	Equipment rating, characteristics and Insulation of the installation at the Connection Point		P
2.2.3.1	EQUIPMENT RATINGS AND INSULATION OF INSTALLATION		P
	1. The equipment rating and the insulation values of the RRGPs, including connection installations to the Network, shall be designed to withstand at least the Network side currents and voltages defined in Table 5.		P
	2. The single phase to earth short circuit currents in the MV networks, as deriving from the state of the neutral, and to be used for the design of the earthing system for the generation plant, are defined in Table 6.		N/A
2.2.3.2	OTHER CHARACTERISTICS FOR MV PANELS	Shall be considered in the end installation	N/A
	In addition to the above, when a direct MV supply is necessary for a RRGP and the MV panel is provided by the Producer, the following specified conditions have to be complied:		N/A
	1. The incomer protection relays shall comply with standard IEC60255 (or equivalent) and will be supported by a type test and guaranteed routine manufacturer's works test certificates. A certificate confirming that the relays have been duly type tested shall be produced by the Producer.		N/A
	2. The overcurrent relay shall operate correctly for the fault currents up to the values specified in 2.2.3.1.		N/A
	3. The instrument transformers shall comply with standard IEC60044 and IEC 61869 (or equivalent) and be supported by type test and guaranteed routine manufacturer's works test certificates. A certificate confirming that the transformers have been duly type tested shall be produced by the Producer.		N/A
	4. The incomer current transformer shall be dimensioned so that the protection scheme will operate effectively for the fault currents up to the values specified in 2.2.3.1.		N/A
2.3	Power quality (Phase unbalance, harmonics and flicker) and Electromagnetic compatibility		P
2.3.1	General Requirements		P
	1. RRGPs may also be made of single-phase units		N/A

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	connected to the LV network, provided that the Maximum Capacity of a plant at the point of connection is lower than or equal to 10 kW per line conductor, and that the total capacity of the units is well balanced amongst the three phases, without exceeding the maximum permissible imbalance of 5 kW. Therefore, it shall be possible to connect in single-phase units, distributed amongst three line conductors, at maximum capacity of 3x10 kW.		
	In the case of the above limits are exceeded at the point of connection, the additional extension shall be three phase connected.		N/A
	2. The maximum permissible phase power imbalance of 5 kW shall apply for each network connection. The power imbalance is calculated as the difference between the DRRG generated power in the most and the least loaded phases. Whenever a power imbalance larger than 5 kW takes place proper provisions shall be adopted in order to limit it. Therefore, an automatic system shall be installed for this purpose. Such system will act to reduce the imbalance among the phases below 5 kW, within 1 min. Conversely, if the maximum acceptable imbalance is not reached by the specified time, the automatic system shall disconnect the whole RRGP from the network.		N/A
	In case of Producers with a single-phase connection to the LV network, the maximum power (P_{MC}) of 5 kW and the use of single-phase inverters shall be allowed for each single connection point, provided the balance of the load along the feeder is possible. DEWA will verify this feasibility at the Application stage.	Three phases	N/A
	3. The RRGP equipment emissions created in the grid shall be lower than the limits specified by DEWA. These individual emission levels for each grid user are compliant with the international standards and technical reports as specified hereinafter.		P
	4. The RRGP equipment immunity to grid disturbances shall be higher than DEWA commitment to provide a voltage in line with standard EN 50160, which describes the level of disturbances that should be expected during normal operation.		P
	The mean value of the fundamental frequency measured over 10 s shall be within a range of:		P
	- 50 Hz ± 1 % (i.e. 49,5 Hz... 50,5 Hz) during 99,5 % of a year;		P
	- 50 Hz + 4 % / - 6 % (i.e. 47 Hz... 52 Hz) during 100 % of the time.		N/A

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	Under normal operating conditions excluding the periods with interruptions, supply voltage variations should not exceed ± 5 % of the nominal voltage Un for MV network and ± 6 % of the nominal voltage Un for LV network, as per DEWA regulations. These values may rise to ±10% in particular and transitorily periods (Contingencies).		P
	Supply voltage unbalance: Under normal operating conditions, during each period of one week, 95 % of the 10 min mean r.m.s. values of the negative phase sequence component (fundamental) of the supply voltage shall be within the range 0 % to 2 % of the positive phase sequence component (fundamental).	I	N/A
	Under normal operating conditions, during each period of one week, 95 % of the 10 min mean r.m.s. values of each individual harmonic voltage shall be less than or equal to the values given in EN50160. Resonances may cause higher voltages for an individual harmonic.		P
	Unless differently specified, the THD of the supply voltage (including all harmonics up to the order 40) shall be less than or equal to 8% for LV network and 6.5 % for MV network.		P
	To demonstrate that a RRGP does not contribute to exceed the above mentioned limits at the point of connection, a harmonic study might be required by DEWA, particularly at the planning stage.		P
	If statistics are collected, voltage dips/swells shall be measured and detected according to IEC 61000-4-30, using as reference the nominal supply voltage. The voltage dips/swells characteristics of interest for this standard are residual voltage (maximum r.m.s. voltage for swells) and duration (In this standard, values are expressed in percentage terms of the reference voltage).		P
	Typically, on MV networks, the line to line voltages shall be considered.		P
	On LV networks, for four-wire three phase systems, the line to neutral voltages shall be considered; for three-wire three phase systems the line to line voltages shall be considered; in the case of a single phase connection, the supply voltage (line to line or line to neutral, according to the network user connection) shall be considered.		P
	Conventionally, the dip start threshold is equal to 90 % of the nominal voltage; the start threshold for swells is equal to the 110 % of the nominal voltage. The hysteresis is typically 2 %; reference rules for hysteresis are given in 5.4.2.1 of IEC 61000-4-30.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	Evaluation of voltage swells shall be in accordance with IEC 61000-4-30. The method of analyzing the voltage swells (post treatment) depends on the purpose of the evaluation.		P
	Typically, on LV networks:		P
	- if a three phase system is considered, polyphase aggregation shall be applied; polyphase aggregation consists of defining an equivalent event characterized by a single duration and a single maximum r.m.s. voltage;		P
	- time aggregation applies; time aggregation consists of defining an equivalent event in the case of multiple successive events; the method used for the aggregation of multiple events can be set according to the final use of data; some reference rules are given in IEC/TR 61000-2-8.		P
	Typically, on MV networks:		P
	- polyphase aggregation is applied; polyphase aggregation consists in defining an equivalent event characterized by a single duration and a single residual voltage;		P
	- time aggregation applies; time aggregation consists of defining an equivalent event in the case of multiple successive events; the method used for aggregation of multiple events can be set according to the final use of data; some reference rules are given in IEC/TR 61000-2-8.		P
2.3.2	Low voltage connections		P
	For RRGU with an output current I ≤ 16 A per phase, the harmonic components of the current produced and measured at the output terminals shall comply with the standard IEC 61000-3-2. The limitation of voltage changes, voltage fluctuations and flicker shall comply with the standard IEC 61000-3-3.		N/A
	For RRGU with an output current 16 < I ≤ 75 A per phase, the harmonic components of the current produced and measured at the output terminals shall comply with the standard IEC 61000-3-12. The limits specified in the same standard, may be reasonably extended to RRGU with output current > 75 A. The limitation of voltage changes, voltage fluctuations and flicker shall comply with the standard IEC 61000-3-11.		P
	For all the RRGP connected to the LV grid, the detriment of the RRGP to the voltage quality measured at the Point of Connection shall be in accordance with IEC 61000-2-2 and IEC/TR 61000-3-14.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	The following aspects shall be addressed:		P
	- voltage fluctuation and flicker;	(See the appendix table)	P
	- harmonics and interharmonics up to 50th;	(See the appendix table)	P
	- voltage distortion at higher frequencies (above 50th harmonic);		N/A
	- voltage dips and short supply interruptions;		P
	- voltage unbalances;		N/A
	- transient overvoltages;		P
	- d.c. components;		P
	- mains signalling.		N/A
	The contribution of other disturbances on the grid shall be taken into consideration in the calculations, in order not to impute them to the operation of the RRGP.		P
	According to the type of installation, the following standards shall be applied:		P
	- IEC 61000-6-1 and IEC 61000-6-3 for residential, commercial and light-industrial environments;		N/A
	- IEC 61000-6-2 and IEC 61000-6-4 for industrial environments;	(Refer to the EMC report)	P
	If a transformer between the DC section(s) and the AC section of the RRGU is not present, a suitable protection shall be used in order to avoid any relevant DC injection into the grid (see Point 2.4.6).		P
2.3.3	Medium voltage connections		P
	For all the RRGP connected to MV grid (6.6 kV, 11 kV, and 33 kV), the detriment of the RRGP to the voltage quality measured at the Point of Connection shall concern the following aspects and standards:		P
	- voltage fluctuation and flicker – IEC/TR 61000-3-7;		P
	- harmonics and interharmonics – IEC/TR 61000-3-6 (see table 7);		P
	- voltage unbalances – IEC 61000-3-13.		P
	At the network assessment stage, a special harmonic evaluation will be performed by DEWA to verify that a MV connected RRGP does not contribute to exceed the harmonic content limits at the Point of Connection.		P
	The contribution of other disturbances on the grid shall be taken into consideration in the calculations, in order not to impute them to the operation of the RRGP.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	It is assumed that DC section(s) in the RRGP are separated from MV AC section by an MV/LV transformer. Therefore no DC currents injection shall be possible from DC/AC converters to the MV grid.		P
2.4	Normal and Emergency mode of operation		P
2.4.1	Mode of operation		P
	1. A RRGU shall connect to the Distribution Network only when the grid is assumed to be in undisturbed operating conditions; this means that the grid frequency is within the range [49.9-50.1Hz] and grid voltage in the range +/-5% of grid rated value.		P
	2. The connection of the RRGU (or RRGP) to the Network shall not create transient voltage variation of more than 4% of rated value.		P
	3. During start-up/shutdown phases, the RRGU shall not vary its power output at a rate greater than 20%/min of Maximum Capacity.		P
2.4.2	Ability to stay connected - Voltage/Frequency/Change of frequency ranges		P
	1. With regard to Frequency ranges, a RRGU / RRGP shall be capable of staying connected to the Distribution Network and operating within the Frequency ranges and time periods specified here:		P
	- Unlimited time operation without disconnection is required within the range 47.5-52.5 Hz		P
	- Outside these limits, the intervention time shall be defined by DEWA.		P
	Possible frequency and time settings are defined in Table 8:		P
	The power in feed shall be maintained within the limits specified in section 2.4.3 (Active power limitation).		P
	2. Any rate of change of frequency up to 2 Hz/s shall be withstood by the Renewable Resource Generating Unit without disconnection from the network other than triggered by loss of mains protection. The frequency shall be measured using 100 ms average.		P
	3. All the RRGUs / RRGPs shall be capable of staying connected to the Distribution Network and operating within the ranges of the Network Voltage at the Connection Point and time periods specified here, expressed in terms of the nominal voltage Vn:		P
	- Unlimited time operation without disconnection is required within the range 85% Vn ⩽ V ⩽ 110% Vn		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- Outside these limits, the intervention time shall be defined by DEWA.		P
	Possible voltage and time settings are defined in Table 9a, for RRGP connected to the LV network, and 9b for RRGP connected to MV network:		P
	The LOM protection functions can be set according to values suggested by the international practice, i.e. as indicated in Table 9c, for any voltage level.		P
	4. Steady-state stability of a Generating Unit is required for any operating point in the P-Q-Capability Diagram in case of power oscillations.		P
2.4.3	Ability to predict the behaviour - Frequency behaviour		P
	1. In case of deviation of the Network frequency from its nominal value above 52.5Hz, the Renewable Resource Generating Unit shall be disconnected from the network.		P
	2. In case of deviation of the Network frequency from its nominal value below 47.5Hz, the Renewable Resource Generating Unit shall be disconnected from the network.		P
	3. Following the disconnection stated in previous paragraphs (1 & 2), the Renewable Resource Generating Unit shall not be reconnected to the Network before the Network frequency is within the range 49.9 Hz – 50.1 Hz during a minimum of 60 seconds. The Active Power Output shall not be recovered with a gradient above 20% of the Maximum Capacity per minute.		P
	4. In case of deviation of the Network frequency from its nominal value, due to a deviation within the frequency ranges and time periods given in 2.4.2, the Renewable Resource Generating Unit, for whatever voltage level the RRGP is connected to (MV and LV), shall have a predicable behaviour in terms of active power output:		P
	a) Due to over-frequency deviations, the ratio between the Active Power Output and the Maximum Active Power Output of the Renewable Resource Generating Plant available at the time the frequency exceeds 50.3 Hz, shall not be changed for frequencies below 50.3 Hz and shall be decreased linearly by a minimum of 45.5 % (droop = 4.4%) of nominal active power per Hertz until 52.5Hz, as illustrated in Figure 2.		P
	b) In the frequency range between 47.5 Hz and 50.3 Hz, the RRGPs provided with Non-Synchronously-Connected Renewable Resource Generating Units shall produce the maximum allowable active power.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	5. The Active Power output of the Renewable Resource Generating Unit connected to the Network shall be controllable. For this purpose, the Renewable Resource Generating Plant control system shall be capable of receiving an Instruction containing a required Set point, given orally, manually or through automatic remote control system by DEWA.		P
	6. The accuracy of frequency measurements for Active Power Frequency Response must be better than 10 mHz.		P
2.4.4	Ability to predict the behaviour - Steady State Voltage behaviour		P
	All the Renewable Resources Generation Units connected to either MV or LV Distribution Network have to participate to voltage control by means of production and absorption of reactive power. The purpose of this is the limitation of over and undervoltages caused by the RRGUs themselves, due to the injection of active power to the grid.		P
	1. In LV and MV networks, in case of deviation of the Voltage at the Connection Point from its nominal value above 110% of nominal voltage, the Renewable Resource Generating Unit shall be disconnected from the network with a delay consistent with settings indicated in Tables 9a and 9b.		P
	2. Following the disconnection stated in paragraph 1, the Renewable Resource Generating Unit shall not be reconnected to the Network before the Voltage at the Connection Point is within the range 95% - 105% of nominal Voltage during a minimum of 60 seconds. The Active Power Output shall not be recovered with a gradient above 20% of the Maximum Capacity per minute.		P
	3. The RRGUs will be allowed to operate in parallel with the LV and MV Distribution Network if complying with the following requirements:		P
	- Non-Synchronously-Connected Renewable Resource Generating Units as part of Renewable Resources Generating Plants with Maximum Capacity < 10 kW, which shall be able to maintain their power factor in the range [0.98 leading (underexcited operation), 0.98 lagging (overexcited operation)] for nominal Voltage if the active power output is above 20% of rated power. No deviations from these ranges due to voltage deviation are accepted. The acceptable range of operation for nominal voltage is illustrated by the hatched areas in the capability curve in Figure 3;		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- Non-Synchronously-Connected Renewable Resource Generating Units as part of Renewable Resources Generating Plants with Maximum Capacity ⩾ 10 kW and ⩽ 400 kW, which shall be able to provide a reactive power as a function of the active power according to a semi-circular capability curve as in Fig. 4. They shall mandatorily keep their power factor in the range [0.9 leading (underexcited operation), 0.9 lagging (overexcited operation)] for nominal voltage, whereas the ability to provide reactive power within the remaining part of the capability curve will be optional.		P
	For a low produced power (S⩽10% Sn), due to the uncertainty of the inverter behaviour there are no particular requirements in terms of reactive power provision.		P
	4. The Maximum Capacity limits shall be referred to the RRGP, which is the maximum capacity of the overall set of RRGUs connected to the network.		P
	5. The RRGUs will be allowed to operate in parallel with the MV Distribution Network if compliant with the following requirements:		P
	- Non-Synchronously-Connected Renewable Resource Generating Units as part of Renewable Resources Generating Plants with Maximum Capacity larger than 400 kW and then connected to the MV Distribution Network, which shall be able to provide a reactive power as a function of the active power according to a semicircular capability curve as in Fig. 5. The acceptable range of operation for nominal voltage is illustrated by the hatched area in the capability curve in Figure 5.		P
	For a low produced power (S⩽10% Sn), due to the uncertainty of the inverter behaviour there are no particular requirements in terms of reactive power provision.		N/A
	6. To achieve this ability of voltage regulation for RRGUs connected either to MV or LV (only for P_{MC} ⩾ 10 kW) Distribution Network, the provision of reactive power shall be automatic, with a local logic, according to one of these two methods:		P
	- power factor fixed and settable (see Fig. 6, curve type a);		P
	- power factor as a function of the produced active power P, according to a curve defined by three points A, B, C (see Fig. 6, curve type b)		P
	This control logic, according to DEWA request, shall be activated either locally or from remote control through a proper interface. This possible choice between local and remote control shall be		P

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Clause	Requirement – Test	Result – Remark	Verdict
	adjustable inside the inverter.		
	In particular, this provision of reactive power shall be based on the ratio P/Pn (where Pn is the rated active power of the inverter), in a way that the RRGU must absorb lagging reactive power above 50 % of its nominal power in order to reduce the voltage:		P
	- A: P = 0,2 Pn; cos φ = 1		P
	- B: P = 0,5 Pn; cos φ = 1		P
	- C: P = Pn; cos φ = 0.9		P
	(for P<0.2 Pn the reactive power contribution is not required and a cos φ around the unity, e.g. 0.98 lead-lag, may be kept).		P
	Moreover, the voltage at the inverter terminals shall also be discriminating, making this contribution possible only when the voltage exceeds a lock-in voltage adjustable in the range 1.0 Vn - 1.1 Vn and stopping it when the voltage goes below a lock-out voltage settable in the range 0.9 Vn – 1.0 Vn, being Vn the nominal voltage at the inverter terminals. The following processes shall then apply for the activation (Fig. 7a) and De-activation (Fig. 7b) of reactive power control:		P
2.4.4.1	DISCLAIMER		P
	The requirement of provision of reactive power by the RRGUs, with the rules and ranges set above, must be carefully taken into account by the Customer's appointed consultants when sizing the inverters. In order for an inverter to provide both active and reactive power, with active power equal to 100 % of the maximum input power at the DC side of the inverter (depending on the PV array characteristics and working condition) and a cos φ = 0.9, it must be considered that the inverter itself has to be oversized to 111 % of the photovoltaic generator capacity.		P
2.4.5	Ability to predict the behaviour – Transient Voltage behaviour		P
2.4.5.1	GENERAL RULES		P
	To avoid the disconnection of a Non-Synchronously-Connected Renewable Resource Generating Unit in the occurrence of voltage dips due to faults on the higher voltage level networks, a RRGU being part of a RRGP shall be able to ride through, that is:		P
	- not to disconnect from the network in the event of network faults		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- not to extract from the network to which the RRGP is connected after fault clearance more inductive reactive power than prior to the occurrence of the fault		P
	These requirements apply to all types of short circuits (i.e. to single-phase, two-phase and three-phase short circuits); whatever the voltage level considered (MV or LV).		P
2.4.5.2	REQUIREMENTS FOR RRGUS CONNECTED TO LV DISTRIBUTION NETWORK		P
	1. Low Voltage Ride Through (LVRT) capability shall be possible for RRGUs being part of a RRGP with Maximum Capacity $P_{MC} \geqslant$ 10kW. This capability is illustrated by the curve of Figure 8.		P
	2. The following functional requirements shall be satisfied:		P
	- in the non-hatched area the RRGU shall not disconnect from the network. Performance with a zero voltage for 200 ms shall be endured. The temporary interruption of the production of active and reactive power is in this case allowed; - in the hatched area the RRGU may be disconnected; - within 200 ms from the restoring of a network voltage included in the range 85 % Vn $\leqslant$ V $\leqslant$ 110 % Vn (grey shaded area), the RRGU will restore the export of active and reactive power to the network as it was before the fault occurrence, with a maximum tolerance of ±10% of the RRGU rated power. If the voltage is restored, but it remains in the range 0.85 Vn $\leqslant$ V $\leqslant$ 0.9 Vn a reduction in the produced power is admissible; - the LVRT curve shall be coordinated with the settings of the undervoltage function (V<, 27) in the Interface Protection.		P
	3. The compliance tests to verify these requirements will be carried out in accordance to the methods described in Appendix D.		P
2.4.5.3	REQUIREMENTS FOR RRGUs CONNECTED TO MV DISTRIBUTION NETWORK		P
	1. Low Voltage Ride Through (LVRT) capability shall be possible for all the RRGUs being part of a RRGP connected to the MV Distribution Network. This capability is illustrated by the curve of Figure 9.		P
	2. The following functional requirements shall be satisfied:		P
	- a RRGU shall not disconnect from the network in the event of voltage drops to 0% Vn of a duration		P

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Clause	Requirement – Test	Result – Remark	Verdict
	⩽ 200ms. This will allow a fault clearing in base time in the HV network;		
	- a RRGU shall not disconnect from the network any time during which the voltage is in the non-hatched area. The temporary interruption of the production of active power is in this case allowed;		P
	- in the hatched area the RRGU may be disconnected;		P
	- within 400 ms from the restoring of a network voltage included in the range 0.85 Vn ⩽ V ⩽ 1.1 Vn, the RRGU will restore the export of active and reactive power to the network as it was before the fault occurrence, with a maximum tolerance of ± 10% of the RRGU rated power. If the voltage is restored, but it remains in the range 0.85 Vn ⩽ V ⩽ 0.9 Vn a reduction in the produced power is admissible;		P
	- the LVRT curve shall be coordinated with the settings of the undervoltage function (V<, 27) in the Interface Protection.		P
	3. The performance as per Figure 9 shall be granted for a dip in any of the phase voltages.		P
	4. The compliance tests to verify these requirements will be carried out in accordance with the methods described in Appendix D.		P
2.4.6	Injection of a DC component in the current		P
	In the RRGU, a system to avoid, at steady state, the injection of currents with DC components > 0.5 % of the inverter rated current shall be foreseen.		P
	The tests described in Appendix D shall be required to demonstrate this.		P
	However, this requirement shall be achieved by means of either:		P
	- a separating transformer (operating at mains frequency); or		N/A
	- a protection function which can sense the DC component injected to the network, embedded into the inverter.		P
	This protection function shall act to trip the RRGU circuit breaker:		P
	- at most in 200 ms if the DC component exceeds 1 A; or		P
	- at most in 1s if the DC component exceeds 0.5 % of the inverter rated current.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	Irrespective of the presence of this protection feature in the inverter, for RRGPs with relevant Maximum Capacity (typically above 100 kW) the provision of a separating transformer between the generation and the load section of the installation is always advisable. In fact, particularly in case of use of string inverters, which do not need a transformer to be connected to the 0.4 kV network, each inverter may be compliant with the above DC current injection requirement, however the sum of the injected DC currents may still be detrimental for the rest of the equipment in the installation.	Compliant with the above DC current injection requirement	P
2.4.7	Monitoring, remote control and information exchange	It should be completed by the end system	P
2.4.7.1	GENERAL RULES		P
	The RRGUs and RRGPs shall be provided with all the necessary facilities for monitoring, remote control and information exchange.		P
	The remote control shall be required for RRGPs with Maximum Capacity larger or equal than 10 kW, whereas the remote monitoring shall be required for RRGPs with Maximum Capacity larger than 100 kW.		P
	Other requirements related to monitoring, remote control (communication with other protection relays, substations and the Supervisory Control and Data Acquisition) and information exchange will be provided by DEWA.		P
2.4.7.2	REQUIREMENTS FOR RRGUs CONNECTED TO LV DISTRIBUTION NETWORK		P
	1. The RRGUs as part of a RRGP with a Maximum Capacity 10 kW ⩽ P_{MC} ⩽ 400 kW connected to the LV Distribution Network shall be capable of:		P
	- providing reactive power support to the network as per curve in Figure 6 (cos φ = f(P)) rather than with a fixed power factor within the admissible range as defined by curve in Figure 4, as a consequence of the receiving of a set-point signal sent from a remote control centre;		P
	- receiving a remote signal to reduce active power production. If the produced power will already be below the DEWA's request, the power production shall not change. Conversely, the required power production shall be reached within 1 minute from the receiving of the request signal, with a tolerance of ±2,5% P_{MC}. In case of a request for reduction to a power below 10% P_{MC}, the disconnection of the inverter from the network shall be admissible.		P
	2. The Interface Protection of RRGP with a	External IPS	N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	Maximum Capacity 10 kW ⩽ P_{MC} ⩽ 400 kW connected to the LV Distribution Network shall be remotely controllable, in case a rapid disconnection of the plant from the network is needed by DEWA.		
2.4.7.3	REQUIREMENTS FOR RRGUs CONNECTED TO MV DISTRIBUTION NETWORK		P
	1. The RRGUs as part of a RRGP connected to the MV Distribution Network shall be capable of:		P
	- providing reactive power support to the network as per curve in Figure 6 (cos φ = f(P)) rather than with a fixed power factor within the admissible range as defined by curve in either Figure 4 or 5 depending on the maximum capacity of the RRGP, as a consequence of the receiving of a set-point signal sent from a remote control centre;		P
	- receiving a remote signal to reduce active power production. If the produced power will already be below the DEWA's request, the power production shall not change. Conversely, the required power production shall be reached within 1 minute from the receiving of the request signal, with a tolerance of ±2,5% P_{MC}. In case of a request for the reduction to a power below 10% P_{MC}, the disconnection of the inverter from the network shall be admissible.		P
	2. The Interface Protection of a RRGP connected to the MV Distribution Network shall be remotely controllable, in case a rapid disconnection of the plant from the network is needed by DEWA.		N/A
2.4.7.4	COMMUNICATION PROTOCOL		P
	Remote control of the RRGUs and RRGPs shall comply with Smart Grid specifications.		P
	The preferred communication protocols shall be suggested or required by DEWA.		P
2.4.7.5	REMOTE MONITORING		N/A
	1. With the purpose of a future implementation of the DEWA forecasting system, the RRGP with Maximum Capacity > 100 kW connected to both LV and MV network shall be required to provide measurements of:		N/A
	- Solar Irradiance		N/A
	- external air temperature,		N/A
	- wind speed, and		N/A
	- PV module's temperature (as measured on the back of a meaningful number of panels).		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	2. It is also recommended that the internal temperature of the inverters to be monitored by the Producer, particularly when these are not installed in air conditioned rooms.		N/A
	3. The following measurements will also be made available at the connection point, from the meter:		N/A
	- Voltage,		N/A
	- Active power, and		N/A
	- Reactive power.		N/A
	4. The minimum communication requirements for MV connected units are:		N/A
	- The meter data should be transmitted through secure wireless or optical fibre communication to the DEWA metering facility;		N/A
	- The communication channels should be capable of handling multiple applications over the same infrastructure;		N/A
	- The communication protocols should be tunnelling through MPLS (MultiProtocol Label Switching) or transport over other IP infrastructure;		N/A
	- The metering protocols should be interoperable with DEWA remote metering system.		N/A
2.5	Metering	It should be completed by the end system	N/A
	A dedicated metering system is required for the RRGPs. This shall include the “Main Electricity Metering System” and the “RRGP Electricity Metering System”.		N/A
	The “Main Electricity Metering System” will measure the net energy at the Point of Connection (POC).		N/A
	The “RRGP Electricity Metering System” will measure the energy produced by the local generator(s) connected to the POC.		N/A
	The characteristics of the components of these metering systems are described hereinafter. These apply for LV and MV connections, although, with some proper adjustments they can suit also for HV connections.		N/A
2.5.1	Meter, CT and VT Requirements		N/A
2.5.1.1	EQUIPMENT REQUIRED		N/A
2.5.1.1.1	Meters		N/A
	Electricity Metering Systems shall include the “Main Electricity Metering System” and the		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	"RRGP Electricity Metering System".		
	The "Main Electricity Metering System" will measure the net energy of the Point of Connection (POC).		N/A
	The "RRGP Electricity Metering System" will measure the energy produced by the local generator(s) connected to the POC.		N/A
	"Main Electricity Metering System" and "RRGP Electricity Metering System" equipment shall keep the same levels of accuracy and functionality at all relevant times.		N/A
	Both the "Main Electricity Meter" and "RRGP Electricity Meter" shall measure the quantities defined below.		N/A
	"Main Electricity Meter" and "RRGP Electricity Meter" shall be installed, operated and maintained so as to comply at all relevant times with the standards and accuracy classes indicated in Appendix B.1 ("Accuracy of electricity metering system").		N/A
	Both types of Electricity Meters must measure bi-directional flow of energy.		N/A
	For each separate Metering Point, a Main Electricity Metering System shall be installed, operated and maintained to measure the following parameters:		N/A
	1. Positive and Negative Active Energy		N/A
	2. Positive and Negative of Reactive Energy		N/A
	Conventionally the energy is considered "positive" when it enters in the meters towards the output connections of the meters itself; the energy is defined "negative" when it flows from the output of the meter towards the input of the meter itself.		N/A
	DEWA shall configure "Main Electricity Meter" and "RRGP Electricity Meter" such that active energy is measured by the number of measuring elements equal to or one less than the number of primary system conductors. These include the neutral and/or earth conductor where system configurations enable the flow of energy in such conductors.		N/A
	The "Main Electricity Meter" and the "RRGP Electricity Meter" shall be labelled by DEWA or otherwise be readily identifiable in accordance with Appendix B.2 ("Labelling of meters").		N/A
	The Electricity Metering Systems shall meter the		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	quantities on a continuous basis and the information shall be shown on a display and must be permanently stored in a non-volatile Meter Register. The Meter Registers shall not pass through zero to zero more than once within the normal meter reading cycle and their contents cannot be modified or altered by any means and by anyone, including even the meter Manufacturer.		
	DEWA will provide Electricity Metering Systems with "Outstations" which have an output for retrieving data related to each measured quantity.		N/A
	DEWA will provide two "Outstations" one for the use of DEWA and one for the Producer.		N/A
	By means of the Outstations the metering data related to the measured quantities shall be retrieved locally and, in the future, remotely, using the communication channels.		N/A
	DEWA shall provide Test terminals for "Main Electricity Meter" and "RRGP Electricity Meter" to facilitate on-site tests. These terminals shall be in close proximity to the "Main Electricity Meter" and "RRGP Electricity Meter" and shall be capable of providing suitable means for accessing current and voltage signals, injecting test quantities, connecting test Meters, and replacing "Main Electricity Meter" and "RRGP Electricity Meter" without a circuit outage.		N/A
	The Test terminal must be protected by any tampering action and unauthorized use.		N/A
2.5.1.1.2	Current Transformers		N/A
	When necessary, DEWA shall provide current transformers in accordance with the standards and accuracy classes indicated in Appendix B.1 ("Accuracy of electricity metering system").		N/A
	DEWA shall provide two sets of current transformers.		N/A
	The first set of current transformers will supply exclusively the Main Electricity Meter.		N/A
	The second set of current transformers will supply exclusively the RRGP Electricity Meter.		N/A
	The current transformer windings, the cables connecting such windings to the Electricity Meters shall be dedicated exclusively for such purposes; cables and connections shall be securely sealed.		N/A
	No interconnections or sharing of connections among the two sets of transformers are allowed.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	The total burden on each current transformer shall not exceed the rated burden of such current transformer. No other burden shall be connected to these current transformers.		N/A
	Current transformer test certificates showing errors at the overall working burden or at burdens which allow the error at working burden to be calculated shall be made available by DEWA, wherever possible, for inspection by the relevant parties.		N/A
2.5.1.1.3	Voltage Transformers		N/A
	When necessary, DEWA shall provide voltage transformers in accordance with standards and accuracy classes indicated in Appendix B.1 (“Accuracy of electricity metering system”).		N/A
	DEWA shall provide one voltage transformer with two or more secondary windings.		N/A
	The voltage transformer winding supplying “Main Electricity Meter” shall be dedicated to that purpose and such windings and connections shall be securely sealed.		N/A
	The voltage transformer winding supplying “RRGP Electricity Meter” shall be dedicated to that purpose and such windings and connections shall be securely sealed.		N/A
	No other burden shall be connected to these voltage transformer secondary windings.		N/A
	Separately fused voltage transformer supplies shall be provided by DEWA for the “Main Electricity Meter” and the “RRGP Electricity Meter” . The fuses shall be located as close to the voltage transformer as possible.		N/A
	The connections of meters and Measurement (Current and Voltage) Transformers are clearly visible in Appendix A.		N/A
2.5.1.2	ACCURACY REQUIREMENTS		N/A
2.5.1.2.1	Overall Accuracy		N/A
	The accuracy of the various items of measuring equipment comprising the “Electricity Metering Systems” shall conform to the relevant IEC standards. Standards relevant are listed in Appendix B.1 (“Accuracy of electricity metering system”).		N/A
	Where relevant standards change from time to time, DEWA will review such changes and recommend to the Regulatory Authority the extent to which any such changes should be implemented.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	The Measurement Transformers must be chosen belonging to the appropriate class of accuracy, in order to guarantee the final accuracy of the metering system.		N/A
	No compensation should be necessary. Only the transformer ratio can be set in the Meters, in order to allow the use of different Measurement transformers, in accordance with the power of the Plant.		N/A
2.5.1.3	METER APPROVAL AND CERTIFICATION		N/A
	Only types of Meters belonging to the DEWA's list of approved meters can be installed.		N/A
	The meters shall be provided by DEWA.		N/A
2.5.1.4	OPERATION AND MAINTENANCE		N/A
	Electricity Metering Systems shall be operated and maintained in accordance with the manufacturer's recommendations or as otherwise necessary for DEWA to comply with its obligations under these Standards.		N/A
2.5.2	Meter Constructional and Mechanical requirements		N/A
2.5.2.1	Safety		N/A
	Electricity Meters shall comply with the relevant standards specified under reference standards. Meters shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially:		N/A
	a) Personnel safety against electric shock.		N/A
	b) Personnel safety against effects of excessive temperature.		N/A
	c) Safety against spread of fire.		N/A
	d) All parts and surfaces which are subject to corrosion under normal working conditions shall be effectively protected.		N/A
	The meter shall have adequate mechanical strength and shall withstand the elevated temperature, which is likely to occur in normal working conditions.		N/A
	The electrical connections in the meter shall be resistant to tampering. These shall be made so as to prevent their opening from outside the meter bases/ cover accidentally or deliberately without breaking the seals.		N/A
	The construction of the meter shall be such as to minimize the risks of short-circuiting of the insulation between live parts and accessible		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	conducting parts due to accidental loosening or unscrewing of the wiring screws, etc.		
	The meter shall substantially constructed of good material in good workmanship manner, with the objective of attaining stability of performance and sustained accuracy over wide range of operating conditions.		N/A
2.5.2.2	Degree of Protection		N/A
	The meter shall be minimum IP53/54 compliant and shall prevent from vermin and dust ingress.		N/A
	Meter electronics shall be sealed by a water, dust and vermin resistant layer of special coating. Coating shall also give high humidity resistance performance.		N/A
2.5.3	Meter Terminal Block and Cover		N/A
	All terminals shall be arranged in one terminal block and be suitable for front connections having adequate insulating properties and mechanical strength. The manner of fixing the conductors to the terminals shall ensure adequate and durable contact so that there is no risk of loosening or undue heating of the conductors or the terminals.		N/A
	The terminals shall permit the connection of both solid and stranded Copper/Aluminium Conductor of cross sectional area of not less than 50sq.mm for 3ph. meters (up to 120 Amps) and 25sq.mm for 1ph. Meters (up to 100 Amps).		N/A
	Terminals executions should comply with IEC standards (asymmetrical execution) and connection scheme should be clearly highlighted underneath the terminal cover.		N/A
	Barriers shall be provided to prevent possible short-circuiting of the adjacent terminals of same or different potentials under normal operating conditions.		N/A
	The terminals, the conductor fixing screws or the external or internal conductors shall not be liable to come into contact with metal parts. The screw shall have a slot on the head for only flat screwdriver. Each terminal shall have at least two screws to ensure proper tightening of the conductor.		N/A
	The terminals shall have a separate polycarbonate cover, which can be sealed independently of the meter cover. The cover fixing screws shall be of the captive type and shall be able to accommodate wire seals.		N/A
	The sealing screws shall be strong enough to withstand all types of forces applied on these during fastening and opening. These screws shall be properly protected against harsh environmental		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	conditions.		
2.5.3.1	Sealing – Intrusion Detection		N/A
	Provision shall be made and seals shall be provided for the sealing of meter electronics housing and terminal cover. Active part of the meter shall be factory sealed. It shall not be possible to remove or open the meter without irreparable damage of the seals.		N/A
	Main cover and terminal cover shall be equipped with opening detectors (tamper switch).		N/A
2.5.4	Meter Communication and remote capability		N/A
2.5.4.1	Local communication		N/A
	Meter configuration shall be able via optical head or the electrical output with software package to be supplied under the project. Manufacturer shall inform about security provided to prevent and track unauthorized resetting and reconfiguration of the meter.		N/A
	Basic data of the meter (year of manufacture, type, serial number, total kWh cumulative counter and total kVArh cumulative counter) shall not be changeable.		N/A
	Optical head / terminal shall ensure connection with HHU (Hand Held Unit) or Laptop. In this regard, the meter optical head shall have a magnetic ring on the port so that optical head can stands on it without affecting the proper operation of the meter.		N/A
2.5.4.2	Remote communication		N/A
	The meters installed on the field should be able to communicate at any time on a remote basis, all stored data and therefore have a reliable and recognized open communication protocol and appropriate port for connection of communication module.		N/A
2.5.4.3	Communication flexibility		N/A
	In order to ensure flexibility for future communication such as wired and /or wireless system, modular communication architecture shall be adopted (for WAN/LAN and HAN infrastructures)		N/A
2.5.5	Metering System Calibration and Testing		N/A
2.5.5.1	INITIAL CALIBRATION		N/A
	All new “Main Electricity Meter” and “RRGP Electricity Meter” shall undergo relevant certification tests in accordance with Good Industry Practice and with the relevant IEC standards.		N/A
	All initial calibration of “Main Electricity Meter” and “RRGP Electricity Meter” shall be performed		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	by the meter manufacturer. DEWA will apply a "certification seal" following initial calibration.		
	The integrity of the "certification seal" of the "Main Electricity Meter" and "RRGP Electricity Meter" will grant the certified status. No person shall break the seal unless properly authorised by DEWA, which is responsible for ensuring that "Main Electricity Meter" and "RRGP Electricity Meter" certification is carried out for compliance with the provisions of these Standards.		N/A
	"Main Electricity Meter" and "RRGP Electricity Meter" removed from service must be re-certified before reconnection for use under these Standards. It will be possible to apply a new "certification seal" to a meter only after being recertified will successful result		N/A
	New voltage transformers and current transformers shall be tested prior to installation on any site. The test will prove the compliance with the declared accuracy class. DEWA shall provide manufacturers' test certificates to show compliance with the accuracy classes.		N/A
	In case that the testing will show the not compliance with the Manufacturer's certificate, the component will be discarded. No calibration is required or possible.		N/A
2.5.5.2	COMMISSIONING		N/A
	Commissioning tests shall be carried out on all new Electricity Metering Systems providing Metering Data before the connection is made live and in accordance with Good Industry Practice. Commissioning tests shall also be carried out before reconnection where a replacement Electricity Metering System is fitted as part of existing Electricity Metering System. No connection or reconnection shall be permitted unless the tests are passed.		N/A
	The "Main Electricity Meter", "RRGP Electricity Meter" and "Measurement Transformers" shall be tested by DEWA for accuracy in accordance with Good Industry Practice, the Connection Guidelines and DEWA procedures for Commissioning, to be defined with the meter manufacturer.		N/A
2.5.6	Meter and Data Security and Registration		N/A
2.5.6.1	METER ACCESS AND SEALING		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	All Electricity Metering Systems and associated communications equipment shall be located in secure metering cabinets located in an area that is readily accessible, free from obstructions and well lit by artificial light. The cabinets shall include, as a minimum, effective protection from moisture and dust ingress and from physical damage, including vibration. Appropriate temperature controls shall be provided. The cabinets must be lockable and capable of being sealed to prevent unauthorised access.		N/A
	DEWA shall seal the “Main Electricity Meter” and “RRGP Electricity Meter” in the presence of the Producer. The meters shall include data collection and communication means and protocols according DEWA’s requirement. Only DEWA’s personnel shall break such seals. The Producer shall be given at least forty-eight (48) hours' advance notice of the breaking of any seals. No such notice will be necessary when the breaking of a seal is necessitated by the occurrence of an emergency.		N/A
	Neither DEWA nor the Producers shall tamper or otherwise interfere with any part of the Electricity Metering System in any way. Should be an Electricity Metering System found to have been tampered or interfered with, then one of the two following corrective actions should be taken, until such tampering or interference has been rectified:		N/A
	- If a secondary metering system, not damaged, can measure and record the quantities initially measured by the tampered meter, then the measures will be considered as valid.		N/A
	- If no other relevant working Metering system is available, the quantity shall be estimated by DEWA considering the records of measures registered in the previous periods.		N/A
	Where the Producer requires the right of access or to deal in some other way with a Meter or Electricity Metering System for the purposes of these Standards, all such necessary rights shall be granted by DEWA. All such rights should be set down in the relevant contracts.		N/A
	The right of access provided for in these Standards includes the right to bring into DEWA’s property any vehicles, plant, machinery and maintenance or other materials as shall be reasonably necessary for the purposes of performance of obligations under these Standards.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	DEWA and the Producer shall ensure that all reasonable arrangements and provisions are made and/or revised from time to time as and when necessary or desirable in accordance with Good Industry Practice to facilitate the safe exercise of any right of access.		N/A
2.5.6.2	METER REGISTRATION		N/A
	Electricity Metering Systems shall be registered in a central database, the Meter Registration System, which is to be operated and maintained by DEWA in accordance with Good Industry Practice. The purpose of the Meter Registration System is to provide a complete, accurate and up to date central database of all Meter Data and to ensure an auditable trail to demonstrate compliance with these standards. The Meter Registration System shall contain, as a minimum, specific information at each Actual Metering Point as indicated in Appendix B.4 ("Meter registration data").		N/A
	DEWA is responsible for ensuring that data relating to all changes to DEWA's Electricity Metering System including any changes to the types of data set out in Appendix B.4 is promptly reported in writing, to the Meter Registration System.		N/A
	The Meter Registration System shall maintain the specified information for a minimum of seven years after the replacement or disconnection of a Meter.		N/A
	Any data held in the Meter Registration System (a) shall be the intellectual property of DEWA and (b) may be viewed, on request, by the Producer.		N/A
2.5.6.2.1	Meter Records		N/A
	DEWA shall label all "Main Electricity Meter" and "RRGP Electricity Meter" with a unique "identification number". The lists of "identification numbers" must be maintained by DEWA.		N/A
	DEWA shall ensure that complete and accurate records of the calibration and operation of the Electricity Metering System are maintained. These records shall include, but not be limited to the dates and results of any tests, readings, adjustments or inspection carried out and the dates on which any seal was applied or broken. The reasons for any seal being broken and the Persons, and their affiliations, attending any such tests, readings, inspections or sealing shall be recorded.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	DEWA shall ensure that the pertinent data (Appendix B.4 "Meter registration data") is promptly entered into the Meter Registration System. Such data shall be kept up to date. DEWA shall also provide any other Electricity Metering System data requested by other involved parties.		N/A
2.6	Safety issues		P
	Where the maximum PV array voltage, as calculated at the minimum outdoor temperature of 0 ° C, exceeds 1,000 Vdc, the entire PV array and associated wiring and protection, shall have access restricted to competent persons only. PV arrays for installation on buildings shall not have maximum voltages greater than 1,000 Vdc.		P
2.6.1	Protection against electric shock and overcurrent		P
	Protection against electric shocks		P
	For protection against electric shock, the requirements of IEC 60364-4-41 shall apply. PV module exposed metal earthing and bonding shall be according to applicable standards.		P
	Protection against overcurrent	Overcurrent protect device shall be installed in the end system.	P
	Overcurrent within a PV array can result from earth faults in array wiring or from fault currents due to short circuits in modules, in junction boxes, PV array combiner boxes or in module wiring.	Not PV array	N/A
	PV modules are current limited sources but can be subjected to overcurrents because they can be connected in parallel and also connected to external sources. The overcurrents can be caused by the sum of currents from:	Not PV modules	N/A
	- multiple parallel adjacent strings		N/A
	- some types of inverters to which they are connected and/or		N/A
	- external sources.		N/A
	Overcurrent protection shall be provided in accordance with applicable standards and with PV module manufacturer's requirements.		N/A
	Overcurrent protection devices required for the protection of PV modules and/or wiring shall be selected to reliably and consistently operate within 2 h when an overcurrent of 135 % of the nominal device current rating is applied.		N/A
	PV string overcurrent protection		N/A
	String overcurrent protection shall be used if:		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	$[(S_A - 1) \times I_{SC\_MOD}] > I_{MOD\_MAX\_OCPR}$		N/A
	Where fuses are applied, these fuses need to meet the requirements as described in IEC 60269-6 (Type "gPV")".		N/A
	Where string overcurrent protection is required, either (see Figure 10):		N/A
	a) each PV string shall be protected with an overcurrent protection device (e.g. fuse or circuit breaker), where the nominal overcurrent protection rating of the string overcurrent protection device shall be In where:		N/A
	$I_n > 1.5 \times I_{SC\_MOD}$ and $I_n < 2.4 \times I_{SC\_MOD}$ and $I_n \leqslant I_{MOD\_MAX\_OCPR}$ Or		N/A
	b) strings may be grouped in parallel under the protection of one overcurrent device provided:		N/A
	$I_n > 1.5 \times S_G \times I_{SC\_MOD}$ and $I_n < I_{MOD\_MAX\_OCPR} - ((S_G - 1) \times I_{SC\_MOD})$		N/A
	In some PV module technologies I_{SC_MOD} is higher than the nominal rated value during the first weeks or months of operation. This should be taken into account when establishing overcurrent protection and cable ratings.		N/A
	PV sub-array overcurrent protection		N/A
	The nominal rated current (In) of overcurrent protection devices for PV sub-arrays shall be determined with the following formula:		N/A
	$I_n > 1.35 \times I_{SC\ S\text{-}ARRAY}$ and $I_n \leqslant 2.4 \times I_{SC\ S\text{-}ARRAY}$		N/A
	The nominal rated current (In) of overcurrent protection devices for PV arrays shall be determined with the following formula:		N/A
	$I_n > 1.35 \times I_{SC\ S\text{-}ARRAY}$ and $I_n \leqslant 2.4 \times I_{SC\ S\text{-}ARRAY}$		N/A
	The 1.35 multiplier used here instead of the 1.5 multiplier used for strings is to allow designer flexibility but also taking into account of the heightened irradiance.		N/A
	PV arrays with direct functional earth connections		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	PV arrays that have one conductor directly connected to a functional earth (i.e. not via a resistance) shall be provided with a functional earth fault interrupter which operates to interrupt earth fault current if an earth fault occurs in the PV array. This may be achieved by interruption of the functional earth of the array. The nominal overcurrent rating of the functional earth fault interrupter is shown in Table 10.		N/A
	The functional earth fault interrupter shall not interrupt the connection of exposed metal parts to earth.		N/A
2.6.2	Array insulation resistance detection	(Refer to IEC 62109-2 report)	P
	In a non-isolated inverter connected to the mains, an array earth fault will result in potentially hazardous current flow as soon as the inverter connects to the earthed circuit. In an isolated inverter, if an earth fault in a floating or functionally earthed PV array goes undetected, a subsequent earth fault can cause hazardous current to flow. The detection and indication of the original earth fault is required.		P
	A means shall be provided to measure the insulation resistance from the PV array to earth before starting operation and at least once every 24 h.		P
	The action on fault required is dependent on the type of inverter in use, as follows:		P
	- for isolated inverters, it shall indicate a fault (operation is allowed); the fault indication shall be maintained until the array insulation resistance has recovered to a value higher than the limit above;		N/A
	- for non-isolated inverters, it shall indicate a fault and shall not connect to the mains; the device may continue to make the measurement, may stop indicating a fault and may allow connection to the output circuit if the array insulation resistance has recovered to a value higher than the limit.		P
2.6.3	Protection by residual current monitoring system	(Refer to IEC 62109-2 report)	P
	Where required, residual current monitoring shall be provided. The residual current monitoring means shall measure the total (both AC and DC components) RMS residual current.		P
	Detection shall be provided to monitor for excessive continuous residual current, and excessive sudden changes in residual current according to the applicable standards.		P
2.6.4	Earth fault protection on AC side		P

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Clause	Requirement – Test	Result – Remark	Verdict
	PV systems with at least simple separation between DC side and AC side do not need any specific earth fault protection on AC side.	RCD used	N/A
	Without at least a simple separation between DC side and AC side a RCD Class B shall be inserted downstream the output side of the inverter. If the inverter, by construction, cannot inject DC current on AC side also in case of fault, a RCD Class A or Class B shall be inserted downstream the output side of the inverter.		P
2.6.5	Protection against effects of lightning and overvoltage	It should be considered in the end system	N/A
	The installation of a PV array on a building often has a negligible effect on the probability of direct lightning strikes; therefore it does not necessarily imply that a lightning protection system should be installed if none is already present.		N/A
	However, if the physical characteristics or prominence of the building do change significantly due to the installation of the PV array, it is recommended that the need for a lightning protection system be assessed and installed in accordance with applicable standards.		N/A
	If a lightning protection system (LPS) is already installed on the building, the PV system should be integrated into the LPS as appropriate.		N/A
	All DC cables should be installed so that positive and negative cables of the same string and the main array cable should be bundled together, avoiding the creation of loops in the system.		N/A
	Long cables (e.g. PV main DC cables over about 50 m) should be either:		N/A
	- installed in earthed metallic conduit or trunking,		N/A
	- be buried in the ground (using appropriate mechanical protection),		N/A
	- be cables incorporating mechanical protection which will provide a screen, or		N/A
	- be protected by a surge protective device (SPD).		N/A
	These measures will act to both shield the cables from inductive surges and, by increasing inductance, attenuate surge transmission. Be aware of the need to allow any water or condensation that may accumulate in the conduit or trunking to escape through properly designed and installed vents.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	To protect the DC system as a whole, surge protective devices can be fitted between active conductors and between active conductors and earth at the inverter end of the DC cabling and at the array. To protect specific equipment, surge protective devices may be fitted as close as is practical to the device.		N/A
	The need for surge protective devices should be assessed according to applicable standards and appropriate protective measures implemented.		N/A
2.6.6	Emergency system of disconnection		N/A
	In case of buildings for which the hazard is classified as either Ordinary or High, a manual emergency system (manual call point) for the disconnection of the PV modules from the internal electric plant of the building shall be present. Electrical disconnection may be made either on the DC side (typically when inverters are placed inside the building) or on AC side (typically when inverters are placed outside the building or in an outer cabinet or shelter). The disconnector (DC or AC) can be placed either outdoor or indoor if a fire-compartment area exists.		N/A
	The manual call point is not necessary in case of One-and-Two-Family Dwelling.		N/A
	The conveyance of cables from PV modules inside the building before the disconnector is allowed, provided that inside the building they are placed in a tray / trunk with a fire-rated protection of at least 30 minutes.		N/A
	When required, the manual call point shall be installed at the height of 1.1 – 1.4 m above floor level and in a plain, accessible, well lit and free from hindrance location. The manual call point shall be close to an external access in order to be easily operated by personnel or firefighters.		N/A
	The manual call point shall be in accordance with NFPA 72 and a proper label shall indicate that it actuates the disconnection of the PV plant.		N/A
2.6.7	Building Integrated PV not installed in fire compartments		N/A
	In case of Building Integrated PV not installed in fire compartment areas, which is in case where the BIPV is directly accessible from inside the area, it is necessary to adopt one of the following further measures:		N/A
	− The manual call point also disconnects or short-circuits separately each module or groups of modules each of them having an open circuit voltage at STC not greater than 120 Vdc.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	− Installation of an Arc Fault Circuit Interrupter (AFCI) to protect the DC side from series arcs. When AFCI detects a failure it disconnects the DC side of the PV plant and generates an audible signal.		N/A
2.6.8	Equipment marking		P
	All electrical equipment shall be marked according to the requirements for marking in IEC or to local standards and regulations when applicable. Markings should be in Arabic & English or use appropriate local warning symbols.		P
2.6.9	System labelling and warning signs		N/A
2.6.9.1	Requirements for signs		P
	All signs shall:		P
	a) comply with British Standards (BS 5499 and other related standards) and with applicable International Standards		P
	b) be indelible;		P
	c) be legible from at least 0.8 m unless otherwise specified in the relevant clauses;		P
	d) be constructed and affixed to remain legible for the life of the equipment it is attached or related to;		P
	e) be understandable by the operators;		P
	f) be in Arabic and English.	Only English was checked, and it should also provide Arabic	P
2.6.9.2	Identification of a PV installation		P
	For reasons of safety of the various operators (maintenance, personnel, inspectors, public distribution DEWA, emergency aid services, etc.), it is essential to indicate the presence of a photovoltaic installation on a building.		P
	Moreover, due to the presence of multiple supplies, as typical for a PV plant, a warning notice must also be affixed along with the above mentioned sign.		P
	1. A switchboard sign such as shown in figure 2.6.7.2 shall be fixed:	It should be considered by the end system	N/A
	- at the origin of the electrical installation,		N/A
	- at the metering position, if remote from the origin,		N/A
	- at the consumer unit or distribution board to which the supply from the inverter is connected,		N/A
	- at all points of isolation of all sources of supply.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
2.6.9.3	Labelling of PV array and PV string combiner boxes		N/A
	A sign as shown in figure 2.6.7.3 shall be attached to PV array and PV string combiner boxes as well as labels indicating “live during daylight” to d.c. combiner boxes and switches.		N/A
2.6.9.4	Labelling of disconnection devices		P
	Disconnection devices shall be marked with an identification name or number according to the PV array wiring diagram.		N/A
	All switches shall have the ON and OFF positions clearly indicated.	It has DC switch	P
	The PV array d.c. switch disconnector shall be identified by a sign affixed in a prominent location adjacent to the switch disconnector.		P
	Where multiple disconnection devices are used that are not ganged, signage shall be provided warning of multiple d.c. sources and the need to turn off all switch disconnectors to safely isolate equipment.		N/A
2.7	Compliance		P
2.7.1	General provisions		P
	1. Responsibility of the Producer:		P
	a) The Producer shall ensure that the RRGUs and the RRGP are compliant with these Standards. This compliance shall be maintained throughout the lifetime of the facility.		P
	2. Rights of DEWA:		P
	a) DEWA shall have the right to request that the Producer carries out compliance tests and simulations not only during the operational notification procedure, but repeatedly throughout the lifetime of the RRGP and more specifically after any failure, modification or replacement of any equipment that may have impact on the RRGUs compliance with these Standards.		P
	b) DEWA shall have the right to request that the Producer submits recordings from available measurements, covering the period for which such data is available.		P
	3. When DEWA’s participation is needed to perform tests, DEWA will provide the Producer with an offer for the cost of the tests.		P
2.7.2	Compliance Testing		P

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Clause	Requirement – Test	Result – Remark	Verdict
	Compliance testing is defined according to the actual power of the plant being connected to the grid. The tests described can be referred to the whole RRGP or to each single RRGU's equipment (inverter) depending from the actual design of the plant.		P
2.7.2.1	General Rules for Compliance Testing		P
	1. The proof of compliance of the RRGPs with these Standards requires the successful completion of several tests. These tests are divided into three categories:		P
	a) Laboratory testing:		P
	i. These tests are required for all RRGUs as part of RRGPs, with the rules and criteria set in Appendix D3 and D4 of these Standards.		P
	ii. DEWA is entitled to provide a description of the tests and the criteria of fulfilment. Alternatively, and upon DEWA's approval, the laboratory may provide DEWA with the list of tests and fulfilment criteria for approval and validation.		P
	iii. These tests are to be performed by laboratories on request of a manufacturer. These laboratories have to be accredited EA or ILAC according to the standard ISO/IEC 17025, with an accreditation valid also for the tests required in this document. If the tests are successful, a Manufacturer's Data and Performance Type Certificate (MD&PTC) of compliance with DEWA standards shall be provided by the manufacturer to DEWA, for the tested equipment to be included among the accepted ones on the website. An applicant will be entitled to propose to DEWA some equipment which is not in the list of the eligible one, provided a certificate of testing is submitted at the Design Approval stage. The manufacturer will then be required to support the applicant for the retrieval of the needed documentation.		P
	iv. These tests are required to certify that the equipment, meant to be sold in large quantities to DEWA grid users, is compliant with these Standards.		P
	b) Simulations and field testing:		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	i. For Renewable Resource Generating Plants having Maximum Capacity above 400 kW, DEWA is entitled to require the Producer to provide simulation models, that properly reflect the behaviour of the RRGUs in both steady-state and dynamic simulations (50 Hz component). The models shall be verified against the results of laboratory compliance tests. The main purpose of the simulations is to control that a RRGP made of different RRGUs in compliance with these Standards, is still compliant with these Standards, taking into account the particular design of the plant and its location in the grid. In any case, DEWA may grant the permission to use MD&PTC of the single RRGU instead of part or all of the simulations and field tests.		N/A
	ii. DEWA is entitled to provide a description of the tests and the criteria of fulfilment, unless otherwise agreed between DEWA and the grid user.		N/A
	iii. These tests are to be performed by the Producer (or a third party on behalf of the Producer), unless otherwise agreed between DEWA and the grid user.		N/A
	2. The Producer is advised to check with DEWA at an early stage of a project what parts, if any, are acceptable in lieu of the full compliance process and how to proceed to make use of this facility.		P
2.7.2.2	Required Tests for Compliance		P
	1. The list of the required tests used to prove to DEWA compliance of the Generating Units with these Standards is provided in Appendix D: compliance tests.		P
	2. The Producer shall also refer to what specified in the Connection Guidelines.		P
2.7.3	Compliance Monitoring		N/A
	1. Data from the monitoring and measurement devices, as required by these Standards, shall be made available by the Producer upon request from DEWA for the sole use of Compliance monitoring.		N/A
	2. The term Compliance monitoring shall include verification of the continuous compliance of the Renewable Resource Generating Units and Plants with both the requirements that were tested in the process of Compliance Testing and the requirements that were not tested in the process of Compliance Testing.		N/A
APPENDIX	CONNECTION SCHEMES		P

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Clause	Requirement – Test	Result – Remark	Verdict

A			
APPENDIX B	ELECTRICITY METERING SYSTEM		N/A
APPENDIX C	LIST OF STANDARDS FOR EQUIPMENT		P
C.1	Preliminary considerations		P
	The main standards to be used as a reference in the development of PV applications are summarized hereinafter.		P
	For each standard a short comment and its importance from a 3-level scale are added.		P
	The meaning of the “stars” is the following:		P
	★ Useful document ★★ Important document ★★★ Fundamental document		P
C.2	PV modules		N/A
C.3	Inverters	The relative standards should be considered	P
C.4	EMC (Electro Magnetic Compatibility)	(Refer to the EMC report)	P
C.5	Cables and connectors		N/A
C.6	LV switchgears and controlgear		N/A
C.7	HV switchgears and controlgear		N/A
C.8	Transformers		N/A
C.9	Electrical installation		N/A
C.10	PV mounting system		N/A
C.11	Grid connection	The relative standards should be considered	P
APPENDIX D	COMPLIANCE TESTS		P
D.0	General Rules		P
	This Appendix describes the procedures to test the Interface Protection System (IPS) and Inverters as a part of Non-Synchronously-Connected Renewable Resource Generating Units.		P
	The Interface Protection system may be:		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- built-in in the inverter: this is allowed for RRGUs as part of a RRGP which has a Maximum Capacity P_{MC} < 10 kW and when the number of inverters does not exceed three;		N/A
	- external in all the other cases.		P
	The Appendix on IPS shows characteristics and methods to test the Interface Protection System. The rules to be applied are based on IEC 60255-1 and related series standards. The specification of the characteristics and of the test methods is essential, given the significant need for reliability and tripping speed that the interface device must ensure in case of faults external to the RRGP, to eliminate the contribution to the fault.		N/A
	With the only exception of the functional tests, the remaining tests mentioned in the following paragraphs must be performed only at a laboratory accredited according to ISO/IEC 17025 that has in its scope of accreditation the required tests. To ensure the validity and acceptance of related certificates in countries other than that of issuance, the accreditation of the laboratory has to be issued by the local institution.		P
	This Appendix is organized such that:		P
	- The characteristics and tests for IPS in Low Voltage RRG Units / Plants are described in D.1		P
	- The characteristics and tests for IPS in Medium Voltage RRG Units / Plants are described in D.2		P
	- The characteristics and tests for Inverters in Low Voltage RRG Units / Plants are described in D.3		P
	- The characteristics and tests for Inverters in Medium Voltage RRG Units / Plants are described in D.4		P
D.1	Interface Protection System for Low Voltage connected RRGUs		N/A
D.1.0	Definitions		Info.
D.1.1	Types of test		N/A
	The tests to be run on the Interface Protection System (IPS) and on the inverter in case of built-in IPS, are the following:		N/A
	- type tests		P
	- on site tests (both at commissioning and under operation), as required by DEWA.		N/A
	The type tests must be performed on a specimen identical to those marketed.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	Type tests include those listed in D.1.3, D.1.4. According to the results obtained, the relevant documentation as required in D.1.4 shall be issued.		P
	The type tests on a built-in IPS must be carried out using the required apparatus (see D.2.4.1). A built-in IPS is a set of software functions implemented within the same board on which the inverter control is built (or other electronic board inserted into the inverter), which performs the protection functions.		N/A
	The on-site tests on non-integrated IPS must be carried out with the equipment referred to in D.2.5.1 and shall include those A) and D) of D.1.4.3.1, A) and D) of D.1.4.3.2, and those of D.1.4.3.4.2, D.1.4.3.4.3.		P
	The on-site tests on the built-in IPS must be performed with the equipment referred to in D.2.5.1 or through the selftest function as per D.1.4.4 and must include those A) and D) of D.1.4.3.1, A) and D) of D.1.4.3.2, and those of D.1.4.3.4.2.		N/A
	The on-site tests should concern the continuity of the circuit between the IPS, the related electronic devices and voltage measurement circuits. In the case of built-in IPS these verifications are made through a self-test function.		N/A
	Errors detected during on-site tests and at commissioning must not exceed the limit error increased by the change of the limit error inferred according to type test ε (1+ $\Delta \varepsilon$).		N/A
D.1.2	IPS characteristics		N/A
	The IPS must provide the following functions and performance:		N/A
	- Undervoltage (27, with two thresholds)		N/A
	- Overvoltage (59, with two thresholds)		N/A
	- Overfrequency (81> with two thresholds)		N/A
	- Underfrequency (81< with two thresholds)		N/A
	- Loss Of Mains (LOM) functions (81R ,78)		N/A
	- a remote tripping function		N/A
	- a backup function (if required depending on the maximum capacity of the plant)		N/A
	- signal processing of communication signal availability		N/A
	- a watchdog function		N/A
	- self-test function (in case of built-in IPS inside inverter installed in plant with overall Maximum Capacity smaller than 10 kW)		N/A
	- any transducers aimed at the acquisition of the voltage signals		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	- an opening circuit of the interface device		N/A
	- only for not built-in, IPS auxiliary power system which in the absence of power from mains allows IPS operation for at least 5 s. Such power supply must get to shut-down condition without any malfunction or without the need of further manual reset. The auxiliary power system must be suitably sized to allow IPS operation, the command to keep closed the interface device, and of any additional device at least for the time defined above. It is intended that when mains is back, the relay checks the network parameters (voltage and frequency) before allowing reclosing of interface device.		N/A
	The voltage and nominal frequency of the power grid to be considered as a reference for all the protection functions are:		N/A
	- Rated Voltage: (230-400) V		N/A
	- Rated Frequency: 50 Hz		N/A
D.1.3	Setting ranges of the IPS		N/A
	The thresholds and trip times must be available for setting at the instance of DEWA, therefore the IPS must be programmed with "default" thresholds and trip times as per Table 8 and Table 9a, but it must always be allowed to modify thresholds and trip time according to steps/ranges in the followings paragraphs.		N/A
D.1.3.1	Minimum phase or line voltage protection [27]		N/A
	The undervoltage protection can be single phase or three phase with two thresholds. The following setting ranges are envisaged (Maximum allowed calibration steps):		N/A
	Threshold 27-1 (0.20 ÷ 1) Vn adjustable in steps of 0.05 Vn		N/A
	Tripping time 27-1 (0.05 ÷ 5) s adjustable in steps of 0.05 s		N/A
	Threshold 27-2 (0.05 ÷ 1) Vn adjustable in steps of 0.05 Vn		N/A
	Tripping time 27-2 (0.05 ÷ 5) s adjustable in steps of 0.05 s		N/A
D.1.3.2	Maximum phase or line voltage protection [59]		N/A
	The overvoltage protection can be single phase or three phase with two thresholds. The following setting ranges are envisaged (Maximum allowed calibration steps):		N/A
	Threshold 59-Av (1.0 ÷ 1.20) Vn adjustable in steps of 0.01 Vn		N/A
	Tripping delay 59-Av ⩽ 3 s		N/A

Clause	Requirement – Test	Result – Remark	Verdict
	Threshold 59-1 (1.0 ÷ 1.20) Vn adjustable in steps of 0.01 Vn		N/A
	Tripping delay 59-1 ≤ 100s		N/A
	Threshold 59-2 (1.0 ÷ 1.30) Vn adjustable in steps of 0.01 Vn		N/A
	Tripping time 59-2 (0.05 ÷ 1)s adjustable in steps of 0.05 s		N/A
	59-Av protection must be based on the calculation of an average value of 10 minutes in accordance with standard IEC 61000-4-30. At least once every 3 s, a new average value of the 10 previous minutes must be created, to be compared with the setting value for the protection 59-Av in Table 9a. As an alternative, another overvoltage stage 59-1 (additional to 59-2) can be accepted in place of 59-Av in the protection, provided this stage can be set in the same voltage range as per 59-Av and the tripping delay can be adjusted to 90 s.		N/A
D.1.3.3	Underfrequency protection [81<]		N/A
	The underfrequency protection must be minimum single phase with two thresholds. The following setting ranges are envisaged (Maximum allowed calibration steps):		N/A
	Threshold 81<-1 (47.0 ÷ 50.0) Hz adjustable in steps of 0.1 Hz		N/A
	Tripping time 81<-1 (0.05 ÷ 5) s adjustable in steps of 0.05 s		N/A
	Threshold 81<-2 (47.0 ÷ 50.0) Hz adjustable in steps of 0.1 Hz		N/A
	Tripping time 81<-2 (0.05 ÷ 5) s adjustable in steps of 0.05 s		N/A
	Protection must be insensitive to transients of frequency with duration smaller than or equal to 40 ms.		N/A
	The protection must correctly operate in the voltage range in input included between 0.2 Vn and 1.15 Vn and must be inhibited for input voltages smaller than 0.2 Vn.		N/A
D.1.3.4	Overfrequency protection [81>]		N/A
	The overfrequency protection must be minimum single phase with two thresholds. The following setting ranges are at least envisaged (Maximum allowed calibration steps):		N/A
	Threshold 81> -1 (50.0 ÷ 53.0) Hz adjustable in steps of 0.1 Hz		N/A
	Tripping time 81> -1 (0.05 ÷ 5) s adjustable in steps of 0.05 s		N/A
	Threshold 81> -2 (50.0 ÷ 53.0) Hz adjustable in		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	steps of 0.1 Hz		
	Tripping time 81> -2 (0.05 ÷ 5) s adjustable in steps of 0.05 s		P
	Protection must be insensitive to transients of frequency with duration minor or equal to 40 ms.		P
	The protection must correctly operate in the voltage range in input included between 0.2 Vn and 1.15 Vn and must be inhibited for input voltages smaller than 0.2 Vn.		P
D.1.3.5	Loss of Mains		N/A
	The Loss of Mains protection must be able to detect the loss of a single phase of the supply network. If the LOM protection function is realised by means of Rate of Change of Frequency (ROCOF – 81R) and Vector Shift (78), to be used alternatively at the instance of DEWA, the following setting ranges are envisaged:		N/A
	Threshold 81R (0.01 ÷ 5.0) Hz/s adjustable in steps of 0.01 Hz/s Threshold 78 (1 ÷ 50) ° adjustable in steps of 1 °		N/A
	Inhibition of the LOM protection functions shall be possible in the IP.		N/A
	Both ROCOF and Vector Shift will use a measurement of the period of the mains voltage cycle to detect either a rapid change in frequency or a shift in the voltage vector.		N/A
D.1.4	Checks and type tests on the IPS		N/A
	The Interface Protection System (IPS) must be submitted to the following type tests:		N/A
	- Functional (see D.1.4.3 and in particular D.1.4.4 in case of self-test)		N/A
	- EMC (see D.1.4.5)		N/A
	- Environmental compatibility (see D.1.4.6)		N/A
	- Insulation (see D.1.4.7)		N/A
	- Overloading of measuring circuits (see D.1.4.8)		N/A
	With the exception of only the functional tests, the remaining tests must be executed only at a laboratory accredited according to EN ISO/IEC 17025.		N/A
	The functional tests may be alternatively performed either:		N/A
	- at the above mentioned accredited laboratory, or		N/A
	- at the laboratories of the manufacturer, or non-accredited laboratories.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	In this second case, the tests must be carried out under the supervision and responsibility of appropriate certifying body that meets the requirements of EN ISO/IEC 17065:2012 or, alternatively, under the supervision and responsibility of the accredited laboratory where EMC tests were performed.		N/A
	As a prerequisite it must always be possible to verify the correct operation of any IP or built-in IPS according to the thresholds and settled times.		N/A
	In case of a built-in IPS, dropout ratios and the dropout times are not to be checked.		N/A
	The test is passed when the IPS tripping takes place within the following error limits for at least 3 consecutive tests (1 test if on-site):		N/A
	- ⩽ 5 % for the tripping voltage thresholds		N/A
	- ± 20 mHz for the tripping frequency thresholds		N/A
	- ⩽ 3 % ± 20 ms for trip time		N/A
	- ⩽ 5 % for the dropout voltage thresholds		N/A
	- ± 20 mHz for the dropout frequency thresholds		N/A
	- variation of the error during the repetition of tests		N/A
	• ⩽ 2 % for the voltages		N/A
	• ± 20 mHz for the frequency thresholds		N/A
	• ⩽ 1 % ± 20 ms for the trip times		N/A
	The dropout ratio and the dropout time are not applicable for the overvoltage function 59-Av and for LOM functions.		N/A
	The verification of the correct operation of the IPS must be performed by interfacing the IPS either to a relay test set with the features listed below, or to an appropriate generator designed to simulate the actual conditions of a lowvoltage network and which is set to simulate variations in voltage and frequency so as to detect the trip of the IPS.		N/A
D.1.4.1	Characteristics of the relay test set		N/A
	Relay test sets suitable for type tests shall be used. The minimum requirements of such sets are given in D.2.4.1.		N/A
	For on-site tests (typically at the Commissioning), the requirements for relay test sets are less restrictive as explained in D.2.5. Test sets suitable for type tests may then be used also for on-site tests, conversely test sets having the minimum requirements as specified for on-site tests may not be used for type tests.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
D.1.4.2	Characteristics of the LV network simulator		N/A
	The built-in IPS must be tested by interfacing the converter to a suitable generator, able to reproduce the network conditions necessary to check the IPS.		N/A
	The simulator consists of:		N/A
	- a variable DC power source to feed the inverter;		N/A
	- an AC power source adjustable both in voltage and frequency with adequate power to provide to the inverter the reference of the network values;		N/A
	- an AC load necessary for the inverter to deliver the highest power.		N/A
	The accuracies required by the AC source in terms of voltage and frequency must be at least equal to those of the IPS and therefore:		N/A
	- Voltage ± 5%		N/A
	- Frequency ± 20 mHz		N/A
	The harmonic distortion introduced by the power source (network simulator) must not be higher than the standard limit, i.e. for that power source (network simulator), those indicated by IEC 61000-3-2 and IEC 61000-3-12.		N/A
D.1.4.3	Functional Tests		N/A
	The tests for checking the functions and for the measurement of accuracies are listed below:		N/A
	a) check of all functions		N/A
	b) measure threshold accuracy		N/A
	c) measure trip time accuracy		N/A
	d) measure dropout ratio accuracy (not required in case of built-in IPS up to 10 kW)		N/A
	e) measure the dropout time accuracy (not required in case of built-in IPS up to 10 kW)		N/A
	f) test on Loss of Mains functions		N/A
	All of the above tests must be performed with working equipment and with the reference conditions shown in Table D1.		N/A
	For the tests on built-in IPS, reference will be given to the overall power of the RRGP, not to the power of each single inverter.		N/A
	The verification of the protection functions must be carried out for both voltage and frequency thresholds according to the test procedures described below.		N/A
	The checks must be performed on each threshold, and therefore during the verification of the single threshold all the thresholds that may possibly interfere must be inhibited / excluded.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
D.1.4.3.1	Test procedure for overvoltage and overfrequency functions		N/A
	The functions of overvoltage and overfrequency must be verified according to the following procedure, by repeating each test 3 times (1 time if on-site) in order to verify the variability of errors that must stay within the provisions of D.1.4.		N/A
	A) Measurement of the accuracy of the trip threshold		N/A
	1. Apply to IPS an input a voltage equal to 0.9 times the actual tripping setting and a frequency equal to 0.99 times the actual tripping setting.		N/A
	2. Gradually increase the voltage/frequency input to IPS with a maximum step size of 10 mHz for frequency and 5 V for voltage up to test the trip value.		N/A
	B) Measurement of the dropout time		N/A
	1. From the final condition of above point A) bring instantly, that is by a step function, the voltage/frequency to the value of the actual setting decreased by 10 % for the voltage and 1 % for the frequency.		N/A
	2. Measure the dropout time as the time interval between the point A) and the instant the command was sent to the interface device.		N/A
	C) Measurement of the dropout ratio		N/A
	1. Supply the IPS with a voltage equal to 1.08 times the actual tripping setting and with a frequency equal to 1.01 times the actual tripping setting.		N/A
	2. Gradually decrease the voltage/frequency input to IPS with a maximum step size of 10 mHz for frequency and 5 V for voltage up to test the dropout value. Evaluate the dropout ratio as the ratio Vdropout / Vtripping.		N/A
	D) Measurement of the tripping time		N/A
	1. Apply to IPS an input a voltage equal to 0.9 times the actual tripping setting and with a frequency equal to 0.99 times the actual tripping setting.		N/A
	2. Increase instantly that is by a step function, the voltage/frequency of IPS supply, to the value of the voltage tripping setting increased by 8% and to the value of the frequency tripping setting increased by 1%.		N/A
D.1.4.3.2	Test procedure for undervoltage and underfrequency functions		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	The functions of minimum voltage and minimum frequency must be verified according to the following procedure, by repeating each test 3 times (1 time if on-site) in order to verify the variability of errors that must stay within the provisions of D.1.4.		N/A
	A) Measurement of the accuracy of the trip threshold		N/A
	1. Apply to IPS an input a voltage equal to 1.1 times the related actual tripping setting and a frequency equal to 1.01 times the related actual tripping setting.		N/A
	2. Gradually decrease the voltage/frequency input to IPS with a maximum step size of 10 mHz for frequency and 5 V for voltage up to test the trip value.		N/A
	B) Measurement of the dropout time		N/A
	1. From the final condition of above point A) bring instantly, that is by a step function, the voltage/frequency to the value of the trip threshold increased by 10 % for the voltage and 1% for the frequency.		N/A
	2. Measure the dropout time as the time interval between the point A) at the instant the command was sent to the interface device.		N/A
	C) Measurement of the dropout ratio		N/A
	1. Supply the IPS with a voltage equal to 0.92 times the actual tripping setting and with a frequency equal to 0.99 times the actual tripping setting.		N/A
	2. Gradually decrease the voltage/frequency input to IPS with a maximum step size of 10 mHz for frequency and 5 V for voltage up to test the dropout value. Evaluate the dropout ratio as the ratio Vinitial / Vfinal		N/A
	D) Measurement of tripping time		N/A
	1. Apply to IPS a voltage input equal to 1.1 times the actual tripping setting and a frequency input equal to 1.01 times the actual tripping setting.		N/A
	2. Decrease instantly that is by a step function, the voltage/frequency of IPS supply, to the value of the trip threshold increased by 10% for voltage and by 1% for frequency.		N/A
D.1.4.3.3	Test procedure for Loss of Mains functions		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	Type tests on Loss of Mains protection functions on built-in IPS are to be carried out at three levels of output power (10 %, 55 %, 100 % of the nominal power of the equipment under test), or alternatively, at the conditions set by IEC 62116. The time from the switch opening (disconnection from AC source) until the protection disconnection occurs is to be measured and must comply with the value required by DEWA.		N/A
D.1.4.3.4	Additional prescriptions for functional tests		N/A
D.1.4.3.4.1	Insensitivity to harmonics of the frequency relay		N/A
	For frequency relays, the insensitivity to harmonics, as listed in Table D2 must be checked when simultaneously applied with phase angles in quadrature with respect to the fundamental, relatively to:		N/A
	- measurement of the accuracy of the thresholds		N/A
	- measurement of the precision of the trip times.		N/A
D.1.4.3.4.2	Check the remote trip		N/A
	It must be checked that the IPS issues the tripping signal within 50 ms from the receipt of the remote trip signal at the dedicated input.		N/A
D.1.4.3.4.3	IPS on-site tests		N/A
	As part of the on-site commissioning tests, it is also a good practice to carry out a functional check of the IPS, for example by removing the supply from the grid and checking that the IP correctly operates on the IS to disconnect the RRGU.		N/A
D.1.4.4	Self-test		N/A
	In case the IPS functions are built into the inverter, this latter shall be provided with a self-test system that checks the functions of maximum / minimum frequency and maximum / minimum voltage in the IPS as described below:		N/A
	- for each protection function of frequency and voltage, change linearly up or down the trip threshold with a ramp ⩽ 0.05 Hz / s or ⩽ 0.05 Vn / s respectively for frequency and voltage protections;		N/A
	- the above process, at a certain point of the test, brings to the coincidence between the threshold and the value current of the controlled quantity (frequency or voltage) and therefore the trip of the protection and the consequent opening of the interface device.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	For each test the values of the quantities and trip times must be readable by the test executor as well as the actual value of voltage and frequency detected by the inverter.		N/A
	The tests must measure:		N/A
	- accuracy of trip thresholds;		N/A
	- accuracy of tripping times.		N/A
	At the end of each test, the inverter must exit the test mode, reset the settings normally used and automatically reconnect to the network in the presence of the allowing conditions.		N/A
	The procedure must be initiated by any user and must be clearly described in the inverter's user manual.		N/A
D.1.4.5	EMC compatibility tests		N/A
D.1.4.6	Tests of environmental compatibility		N/A
	For the purposes of acceptance, during the environmental (climatic) tests the following functions must be checked:		N/A
	- all the protective functions,		N/A
	- the measurement of the accuracy of the tripping thresholds,		N/A
	- the measurement of the accuracy of the tripping times.		N/A
D.1.4.7	Insulation tests		N/A
D.1.4.8	Overloading tests of the measuring circuits		N/A
	For voltage circuits, the overload must be:		N/A
	- Permanent $\geqslant$ 1.3 Vn;		N/A
	- Transient (1 s) $\geqslant$ 1.5 Vn.		N/A
D.1.4.9	Compliance of the equipment		N/A
	The fulfilment to the conditions listed above must be certified by the "Declaration of conformity "of the equipment. The Declaration of Conformity must be issued by and responsibility of the manufacturer, in the form of selfcertification by the manufacturer himself, prepared in accordance to the applicable laws, and delivered to DEWA at the time of connection.		N/A
	The Declaration of Conformity that testifies the tests were passed (test reports) must be kept securely by the manufacturer for 20 years after the last production. The documentation must however be available to DEWA through the manufacturer website.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
D.1.4.10	Automation to avoid current imbalances in production		N/A
	The following tests should be performed only if the entire plant can work with imbalances of power greater than 5 kW.		N/A
	When the system is completed and before the final connection in parallel to the grid, the following test condition must be checked:		N/A
	- plant in operation at its nominal conditions;		N/A
	- create a permanent artificial imbalance exceeding 5 kW;		N/A
	- check either reduction of this imbalance within 1 min or disconnection of the entire plant after this time has elapsed.		N/A
D.2	Interface Protection Systems for Medium Voltage Connected RRGPs		N/A
D.3	Inverters for Low Voltage connected RRGUs		P
	This section contains test protocols to be applied to static generators, typically for photovoltaic grid-connected systems. This section is for equipment and plants to be connected to LV distribution network.		P
D.3.1	Scope		P
	This section describes the compliance tests on inverters for Low Voltage photovoltaic applications.		P
D.3.2	Tests on inverters for low voltage connected RRGUs		P
	The tests on such static generators are typically carried out at a laboratory accredited according to ISO/IEC 17025.		P
	The device must be certified and labelled in order to demonstrate the compliance with all the safety standards in force in UAE (like for example the European “CE” mark, which is a guarantee of compliance with applicable directives LV, EMC, …). In addition, the same shall have successfully passed the following tests (in parentheses indicates the reference for the tests to be performed):		P
	a) harmonic emission limits for Class A (IEC 61000-3-2 or IEC 61000-3-12); they should be repeated in 3 sessions (33%, 66% and 100 % of the nominal power);	(See the appendix table)	P

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Clause	Requirement – Test	Result – Remark	Verdict
	b) for devices with phase currents above 75 A it is possible to carry out the tests of harmonic emission, with the same criteria of the IEC 61000-3-12;		P
	c) limits of voltage fluctuations and flicker (IEC 61000-3-3 or IEC 61000-3-11); they should be repeated in 3 sessions (33%, 66% and 100 % of the nominal power);	(See the appendix table)	P
	d) method of connection, reconnection and gradual supply of power, as described below in D.3.2.1;		P
	e) reactive power supply, as described in D.3.2.2;		P
	f) active power limitation, as described in D.3.2.3;		P
	g) verification of DC component on the output current, as described in D.3.2.4;		P
	h) Verification of insensitivity to voltage dips, as described in D.3.2.5;		P
	i) verification of the absence of damage in case of automatic reclosing, as described below in D.3.2.6.		P
	The tests referred to in points a), b), c), g) must be performed on the device at Reference conditions shown in Table D8 and Table D9. The remaining tests can be performed only under the conditions specified in Table D8.		P
	The inverters must comply with IEC 61000-6-3 for application in residential, commercial and light-industrial environments. In case of industrial environment the inverters must comply with IEC 61000-6-4.	(Refer to the EMC report)	P
	If the requirements referred to in points a), b), c) and g) above are met in a range of temperature stated by the manufacturer other than that indicated in Table D9, the Manufacturer must prevent the operation of the device outside of the said operating range. This feature must be verified by appropriate evidence.		P
D.3.2.1	Conditions of connection, reconnection and gradual power delivery		P
D.3.2.1.1	Verifying connection and reconnection	(See the appendix table)	P
	In order to prevent perturbations to the network, the parallel of generators of any type must only happen when the frequency and voltage measured at the output terminals remain within the following limits for a time of 300 s (or not less than 60 s):		P
	- voltage between 95 % and 105 % Vn; frequency between 49.9 Hz and 50.1 Hz (default setting, adjustment range between 49 Hz and 51 Hz).		P

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Clause	Requirement – Test	Result – Remark	Verdict
	In addition the power delivery for production plants indirectly connected must be gradual, with a transition from the initial no load conditions at the instant the parallel is operated, to the value of available power with a maximum positive gradient not exceeding 20% per minute of the maximum capacity.		P
	The verification of compliance to these requirements is envisaged by the circuit of Figure D2.		P
	a) switch the inverter ON with AC voltage respectively less than 95% and greater than 105% of the nominal value Vn (while the frequency must be between 49.9 Hz and 50.1 Hz), and check that the unit prevents the parallel with the grid – no power output according to network analyzer.		P
	b) After at least 30 s from the time of start of the test referred to in point a), check the persistence of the state "open", i.e. absence of output power. At this point bring the voltage within the limits - 95 % Vn < V <105 % Vn - and simultaneously disable the inverter. In these conditions then proceed to rearm, while checking that the parallel with the network and the start of the power delivery does not take place before at least 60 s from the time the inverter is enabled.		P
	c) At this point it is necessary to simulate with the converter in operation a disconnection due to the voltage being respectively higher and lower than overvoltage and undervoltage thresholds, in order to verify that, when voltage is restored within the expected range 95 % Vn < V < 105 % Vn , the time before reconnection is at least 300 s.		P
	d) Repeat the test described in a) with voltage - 95 % Vn < V <105 % Vn – and frequency respectively less than 49.9 Hz and greater than 50.1 Hz, checking that the unit prevents the parallel with the network - no power output according to network analyzer.		P
	e) After at least 60 s from the time of start of the test referred to in paragraph d) check the persistence of the state "open", i.e. the absence of output power. At this point bring frequency f within the limits - 49.9 Hz < f < 50.1 Hz and simultaneously disable the inverter. In these conditions, then proceed to rearm, while checking that the parallel with the network and the start of the power delivery does not take place before at least 60 s from the activation of the inverter.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	f) As for point c), it is necessary to simulate with the inverter in operation a detachment due to the frequency being higher and lower respectively than overfrequency and underfrequency thresholds, in order to verify that, when frequency is restored within the expected range 49.9 Hz < f < 50.1 Hz, the time before reconnection is at least 300 s.		P
	The test may be carried out alternatively with a network simulator capable of changing the parameters of frequency and voltage available at the output terminals of the inverter, or directly to the electricity grid. In this case, test performance is allowed by adjusting the parameters that control frequency and voltage in grid connected conditions (of parallel) so that they fall outside the allowed values. To check the minimum delay before connection (start) or reconnection after the intervention of protections, the range of allowed V and f must be reset to default (95 % Vn < V < 105 % Vn, 49.9 Hz < f < 50.1 Hz). In any case the DC power source must be set to provide a power equal to the DC rated power of the inverter.		P
D.3.2.1.2	Verification of step release of the active power		P
	The verification of delivery with gradual ramp up from no load up to the nominal value in at least 300 s is performed by recording with the network analyzer, during the test sequences b), c), e) and f), the average value of the parameters of the inverter output every 200 ms (5 samples/s). The samples recorded soon after the inverter exceeds a level of power delivery equal to 5 % the rated power Pn, when shown on a graph, must be all below the limit curve P < 0.333% Pn/s with a maximum positive deviation of +2.5% × Pn.	(See the appendix table)	P
D.3.2.2	Exchange of reactive power		P
D.3.2.2.1	Verification of constructional requirements: reactive power capability		P
	Static converters used in power plants with power exceeding 10 kW prepared for applications under continuous operation in parallel to the network, must be able to work with power factor different from 1. The reactive power exchange with the network can be performed upon request of DEWA in the following cases:		P
	- if there are needs for network management, in particular in order to contribute to the limitation of the voltage at the output terminals or on the LV line on which also other DG sources may be connected;		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- with the aim of providing a network service; such requirement only applies to plants with total power exceeding 10 kW and according to the regulatory conditions that may be issued by the competent Authority.		P
	The tests referred to in this paragraph are intended to verify the "capability" of reactive power of static converters as a function of the active power, to ensure compliance of the minimum construction requirements, that is:		P
	a) for all inverters in plants with maximum capacity smaller than 10 kW,		N/A
	• an instantaneous power factor between cos φ = 0.98 in absorption of reactive (inductive behaviour) and cos φ = 0.98 in the provision of reactive (capacitive behaviour);		N/A
	b) for all inverters in plants of maximum capacity equal to or larger than 10 kW,		P
	• an instantaneous power factor between cos φ = 0.90 in absorption of reactive (inductive behaviour) and cos φ = 0.90 in the provision of reactive (capacitive behaviour) , according to the capability curve shown in Figure D3. In that case the reactive exchange is aimed at the limitation of mains overvoltage or undervoltage caused by the power plant releasing its active power;	(See the appendix table)	P
	• absorption or delivery of a reactive power up to 48.43 % of the rated active power, for any instantaneous value of the active power delivered , according to the capability curve shown in Figure D3, aimed at the supply of a network service requested by DEWA, at the conditions subject to specific regulations issued by the competent Authority.		P
	For the purposes of this test (minimum requirements), the manufacturer shall indicate and set the regulation of maximum reactive power available when the active power output changes, with the aim of allowing the characterization of the maximum capability of the conversion system (since devices of smaller size could also be used on systems of maximum capacity equal to or larger than 10 kW).		P
D.3.2.2.2	Mode of execution and registration of the test results		P
	With reference to the test circuit of Figure D2, the following requirements are defined.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- The inverter must be set so that it can respectively absorb (inductive behaviour) and deliver (capacitive behaviour) the maximum reactive power available at each level of the active power delivered according to its capability.		P
	- Set the DC source in such a way that the converter can deliver in a sequence the active power included in the 10 bins [0-10]%; [10-20]%; ... ; [90-100]% of the nominal apparent power (average values at 1 min calculated on the basis of the values measured to the fundamental frequency on a time window of 200 ms).		P
	- For each of the 10 levels of active power report at least 3 average values for inductive and 3 for capacitive reactive power, calculated at 1 min on the basis of the measurements at the fundamental frequency on a time window of 200 ms.		P
	- In addition to the measurements taken to limit values for reactive power setting, record the measured values by setting the reactive power supplied to 0 (cos φ = 1).		P
	The maximum capability of absorption (Qmin) and delivery (Qmax) of reactive power resulting from the sequence of the above measures and the measures for Q = 0 must be reported in a tabular form showing, for each level of active power output between 0 % and 100% of nominal power, the corresponding level of reactive power consumption (and delivery), both in absolute terms and in terms of cos φ. The test is passed according to the conditions settled in D.3.2.2.2.1 or D.3.2.2.2.2.		P
D.3.2.2.2.1	Inverter in plants with maximum capacity up to 10 kW		N/A
	The value of the instantaneous power factor resulting in each of the 10 measuring points is equal to or less than 0.98 in both modes of absorption (inductive behaviour) and delivery (capacitive behaviour) of reactive power.		N/A
D.3.2.2.2.2	Inverter in plants with maximum capacity larger than 10 kW		P
	The value of the reactive power absorption (inductive behaviour) and delivery (capacitive behaviour) resulting in each of the 10 measurement points is external or at least coincident with the perimeter of the capability curve in Figure D3.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	The test report must contain the results of measurements of the maximum reactive power absorbed (Qmin) and delivered (Qmax) from the converter also in the form of graph P vs. Q as a function of the active power fed into the grid. See the examples in Figure D4 (inverter in plants up to 10 kW) and Figure D5 (inverters for plants of total power larger than 10 kW).	(See the appendix table)	P
D.3.2.2.3	Exchange of reactive power according to an assigned level		P
	The DRRG power plants must participate in the control of the voltage of the grid. For inverters in plants of maximum capacity equal to or exceeding 10 kW the possibility of implementing a strategy of centralized control via remote control signal is envisaged.		P
	The tests covered in this section are required only for inverters in power plants with maximum capacity larger than or equal to 10 kW.		P
	The purpose of the test is to verify the ability of the inverter control system to perform the command for adjusting the level of reactive power within the maximum limits of capability both in absorption and in delivery of reactive power, and to verify the adjustment accuracy.		P
	In the absence of a protocol defined to exchange control commands, it is left to the manufacturer to determine how to perform the commands for setting the point of work of reactive power, both as regards the physical signal (analog, on serial protocol, etc.) and for the adopted control parameter (setting according an absolute value of the reactive power Q or as a cos φ value).		P
D.3.2.2.3.1	Mode of execution and registration of the test results (assuming Q regulation)		P
	- Set the DC source so that the inverter delivers about 50% of the active power nominal Pn.		P
	- Using the methods and the control parameter specified by the manufacturer, vary the reactive power supplied by the inverter, switching from the maximum inductive value (at least equal to Qmin ⩽ -0.4843 Pn) directly to zero (Q = 0), and then go from zero to the maximum capacitive value (equal to Qmax ⩾ 0.4843 Pn).		P
	- Maintain each of the 3 set-point limit for a time of 180 s.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- Calculate the mean values at 1 minute of reactive power on the basis of the values measured on a time window of 200 ms at the fundamental frequency. The calculation of the 1 minute averaged value must start from samples taken after 30 s from the command of the new set-point of the reactive power, this to ensure that the system has reached steady state.		P
	The test is passed successfully if the maximum deviation between the level assigned and the current value measured for the reactive power is equal to:		P
	- $\Delta Q \leqslant \pm$ 2.5% of the rated active power of the converter (direct setting of level of reactive power)		P
	- $\Delta \cos \varphi \leqslant \pm$ 0.01 (set via the power factor)		P
	The test shall be documented both in tabular and graphic form, as shown in the examples of Table D13 and Figure D13.	(See the appendix table)	P
D.3.2.2.4	Time response to a step change in the level assigned		P
	In addition to the requirements covered by the tests referred to in paragraph D.3.2.2.3, relative to the control of the network voltage through the supply of reactive power, it is necessary not only to verify the accuracy of the control system of the converters, but also their response time when a step change in the level of reactive power requested via an external command is applied.		P
	As per the requirements of the preceding paragraph, in this case the tests are required for inverters installed in power plants with maximum capacity larger than or equal to 10 kW, which must be able to implement a strategy of centralized control via signal remote control. It remains to the manufacturer's option to voluntarily carry out the tests also for inverters of smaller size.		P
	The purpose of the test is to measure the response time of the inverter to a step applied to the command of reactive power delivery, passing from one level to another level with the process described below and illustrated in Figure D7.		P
	- According to the results of the capability tests referred to in paragraph D.3.2.2.1, detect the values of + Qmax and - Qmin of the maximum capacitive and inductive reactive power that can be delivered by the converter respectively at 50% and 100% of the nominal active power.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- Put in a graph similar to the template of Figure D7 the values measured as a 0.2 s average of the reactive power during the execution of commands for adjusting the reactive power with a step change when the inverter is providing an active power equal to 50% (Test 1) and 100% of the nominal active power Pn (Test 2).		P
	- Detect the response time (Tr = settling time in the graph of Figure D7), that is equivalent to the time that elapses from the instant of application of the new set-point to the instant in which the reactive power reaches a value in a range included within a band of ± 5 % of the new set value.		P
	- As shown in Figure D7, the response time has to be detected at a variation of the set-point from zero to – Qmin (step 1), from - Qmin to +Qmax (step 2), and from + Qmax to zero (step 3).		P
	The values of the response time must be documented in the test report, which must also indicate the values of + Qmax, - Qmin, the AC test voltage and the method used to send the control command of the set-point of the reactive power.	(See the appendix table)	P
	The test is passed if the maximum response time reported is less than 10 seconds in all the measurement conditions.		P
D.3.2.2.5	Automatic delivery of reactive power according to a characteristic curve cos φ = f (P)		P
	All static converters in plants with maximum capacity larger than or equal to 10 kW must be able to absorb reactive power in an automatic and autonomous (local control) logic according to a characteristic curve of the power factor vs. active power = f (P).		P
	The test aims to verify that the inverter follows the procedures for automatic delivery of the reactive power according to the characteristic curve standard cos φ = f (P) below defined (curve of type b).		P
	The standard curve is defined uniquely by the linear interpolation of the three characteristic points:		P
	A: P = 0.2 Pn; cos φ = 1		P
	B: P = 0.5 Pn; cos φ= 1		P
	C: P = Pn; cos φ = cos φ_max		P
	where cos φ_max is equal to 0.98 (inductive) for converters up to 10 kW and 0.90 (inductive) for converters of size exceeding 10 kW.	0.90 (inductive) for converters of size exceeding 10 kW	P

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Clause	Requirement – Test	Result – Remark	Verdict
	The control according to the characteristic curve is enabled when the voltage measured at the output terminals exceeds the "critical" lock-in value (e.g. set to V = 1.05 Vn).		P
	The value of voltage lock-in that enables the delivery mode automatic power reactive and that during the tests must be set to 1.05 Vn (the "default" also for the production of the series) shall be adjustable between Vn and 1.1 × Vn with intervals 0.01 Vn.		P
	The value required for the lock-in voltage should be specified in the Connection Agreement.		P
	It must be borne in mind that the setting time to the new maximum value of reactive power on the characteristic curve have to be adjusted automatically by the inverter within 10 s (see the tests on the trip time in D.3.2.2.4).		P
	The automated adjustment mode is disabled when:		P
	- the active power P output falls below 50% of Pn (point B), defined as the power lock-out, independent of the voltage at the terminals, or:		P
	- the voltage read at the output terminals of the converter falls below the lock-out limit, to be set to a default value equal to Vn, but that must be adjustable in the range of 0.9 Vn and Vn with Vn intervals of 0.01.		P
D.3.2.2.5.1	Verification of compliance with the rules for the application of the characteristic curve		P
	With reference to Figure D8, for the verification of compliance to the rules for application of the characteristic curve, type b), proceed as follows.		P
	a) Connect the inverter as shown in the test circuit of Figure D2 (directly to AC mains, provided this is adjustable from 0.9 Vn up to 1.1 Vn, or through a network simulator).		P
	b) Enable the type b) curve by acting on the converter according to the manufacturer's instructions.		P
	c) Set the DC source so that the active power supplied by the converter is equal to 20% of the nominal power P = 0.2 Pn (point A), with voltage at the output terminals Vn equal to or not exceeding 1.04 Vn (assuming that the lock-in parameter is set to 1.05 Vn).		P
	d) Measure active power, reactive power and power factor cos φ as averages over 0.2 s, report such values in a table (see Table D12) and in a graph similar to Figure D8.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	e) Repeat the measure referred to at above point D) by increasing the active power delivered by steps of 10 % of rated power, from 20% Pn up to 60% Pn. Check at the same time during this test, the AC voltage to output terminals does not exceed the limit value V = 1.04 Vn.		P
	f) Report in Table D12 the values of the active power, reactive power and cos φ detected during the measurements performed at 5 levels of active power output from 20% to 60 % of rated power. In these conditions, being AC voltage at the output terminals less than 1.05 Vn, the inverter must NOT enable the delivery of reactive power.		P
	g) At this point, with the AC power still delivering at the last level reached before (P = 0.6 Pn), increase the network voltage (or by the simulator), so as this is equal to 1.06 Vn when at the limit "critical" V = 1.05 Vn.		P
	h) Repeat the measure referred to in above point D) by increasing the delivered active power by steps of 10 % of rated power, from 60% Pn up to 100% Pn (always with AC voltage read at the output terminals higher than 1.05 V = Vn).		P
	i) Report in the Table the values of active power, reactive power and cos φ detected during the measurements carried out at 5 levels of active power delivered from 60% to 100 % of the nominal power. In these conditions, being the AC voltage to output terminals greater than 1.05 Vn, the inverter must enable the delivery of reactive power following the characteristic standard curve.		P
	j) With the inverter in full supply of active power, AC voltage output higher than 105% Vn and therefore reactive power output equal to the maximum limit (cos φ = 0.90 for powers higher than 10 kW in reactive absorption), reduce the ac voltage bringing it to the rated value, and check that the reactive power remains attached to the maximum limit value. This is to verify that, once exceeded the value of Lock-In "critical" voltage, the inverter remains in the mode of reactive power delivery according to the characteristic standard curve, maintaining this behaviour for all the output voltage values exceeding the Lock- Out threshold (default threshold set to Vn).		P
	For each operating point, the maximum deviation of cos φ compared to the expected value according to the characteristic standard curve must be less than $\Delta \cos \varphi\_max \leqslant \pm 0.01$.	(See the appendix table)	P

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Clause	Requirement – Test	Result – Remark	Verdict
	For this reason, the manufacturer, in addition to an in factory pre-setting of the control system according to the "Standard" curve of the type described in this paragraph subject to verification by tests, must parameterize the curve to make it adjustable by varying only the 3 points A, B and C.		P
	Consequently, the so-called "fixed cosφ" control method (type a) curve), does not require verification, as it can be derived from the characteristic curve cosφ = f (P) in a consistent manner by setting the parameters of adjustment of points A , B and C as follows:		P
	A = B: P = 0.05; cos φ = 1 C: P = Pn; cos φ = cos_max		P
D.3.2.3	Active Power Limitation		P
	The tests to be performed on the active power limitation mode will address both the automated mode as a function of frequency and that based on a centralized logic by remote control.		P
D.3.2.3.1	Control of active power in the presence of transients on the transmission network		P
	The purpose of the test is to check the function of automated reduction of active power in case of overfrequency, through the extrapolation of a graph of P as a function of frequency.		P
	Two sets of measurements have to be performed: starting from 100 % of rated power (sequence A) and starting from 50 % (sequence B).		P
	For each measurement sequence gradually increase the frequency and measure the value of power (average values of 0.2 s). The test can be performed either by means of a network simulator capable of changing frequency parameters available at the output terminals of the inverter, or directly on mains. In this case it is allowed to adjust the frequency parameters that control the power regulation system in the case of overfrequency, so as to simulate the progressive increase in the frequency and the subsequent coming back around the nominal value.		P
	At the end of each sequence the frequency shall be reset to a value close to the nominal one , in order to verify that time requirements are fulfilled for the gradual restoration of the power delivered before the transition frequency (i.e. before exceeding the limit of 50.3 Hz).		P
D.3.2.3.1.1	Performance of the tests		P
	- Connect the device to be tested according to the instructions provided by the manufacturer.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- Fix all the parameters of the simulated network to the respective values of normal operation.		P
	- Bring all the parameters of the equipment under test to the respective values of normal operation, so that the AC power at the inverter output is equal to the maximum AC power deliverable for the sequence A, or 50% in the case of sequence B.		P
	- Perform the measurements on 7 points (the frequency value will have an uncertainty of maximum ± 10 mHz) according to the following time sequence:		P
	1) f = 47.51 Hz (t1 for the sequence A, t'1 for the sequence B)		P
	2) f = 50 Hz + 0.2 Hz (t2 for the sequence A, t'2 for the sequence B)		P
	3) f = 50 Hz + 0.40 Hz (t3 for the sequence A, t'3 for the sequence B)		P
	4) f = 50 Hz + 0.60 Hz (t4 for the sequence A, t'4 for the sequence B)		P
	5) f = 50 Hz + 2.49 Hz (t5 for the sequence A, t'5 for the sequence B)		P
	6) f = 50 Hz + 0.11 Hz (t6 for the sequence A, t'6 for the sequence B) At this point perform step 7) by bringing the frequency back to the nominal value for the check of the gradual recovery of the maximum delivery (Sequence A) or 50% of the maximum power (sequence B):		P
	7) f = 50 Hz (t7 for the sequence A, t'7 for the sequence B).		P
D.3.2.3.1.2	Results of tests	(See the appendix table)	P
	The results are to be presented in a table and a graphic trend extrapolated on the basis of these (with two curves representing respectively Sequence A and Sequence B, as shown from example in Figure D9). Expected performance for the sequence A and sequence B must also be represented in the chart.		P
	The test is passed if the following conditions are fulfilled for both sequences A and B:		P
	- for each of the 6 points from t1 (t'1) to t6 (t'6) the difference between the expected value of active power and that measured falls within a tolerance of ± 2.5% Pn, where Pn is the rated power of the inverter;		P

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement – Test	Result – Remark	Verdict
	- when mains frequency is restored to the nominal value (step 7 of the sequences in D.3.2.3.1.1), the inverter must keep the minimum level of power attained during the previous frequency increase, for a minimum waiting time equal to 5 minutes, after which it will have to gradually restore the supply with a positive maximum gradient not exceeding 20% / minute of the power supplied before the increase in frequency (stored value).		P
D.3.2.3.2	Active Power Limitation upon external command		P
	The ability to reduce the active power generated as a result of a signal received from a remote control centre must be tested, by agreeing in advance with the inverter manufacturer the mode of signal collection and processing.		P
	The procedure described hereinafter will be used.		P
	- Set the inverter to produce 100% of the nominal power.		P
	- After 1 minute of operation reduce the power to 90%.		P
	- Give 1-minute time for the inverter to run the command, and then measure the value of active power (averaged over 1 minute). The deviation from the set point in the minute of measurement shall be within ± 2.5% Pn, to consider the test valid and passed.		P
	- Afterward, reduce the power of a further 10%, keep that value for 2 more minutes, and repeat until the value of 0 % Pn is reached.		P
	In the measurement related to the set point Pn 10% check in accordance to the standards requirements, and then the measured power must be in the range between 12.5% Pn and 0, to consider the test valid and passed.		P
	The test results shall be tabled like in D15	(See the appendix table)	P
	In addition, the results shall be reported on a graph containing the trend of the set-point, of the measured average power values as well as their tolerances with reference to the set-point.		P
	The chart below shows an example of the performance of the set-point (black) and of the average power (red) for each measurement, which must all be within the grey areas of tolerance, in order to consider the test successfully passed.		P
D.3.2.4	DC component in the output current		P
D.3.2.4.1	Verification of emission of a DC component	(See the appendix table)	P
	The test is to be performed as follows:		P

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Clause	Requirement – Test	Result – Remark	Verdict
	1. The voltage (or simulator) must be initially set to a value equal to the nominal voltage ± 1 % (frequency of 50 ± 0.2 Hz). The total voltage distortion (THD) must be less than 2.5% (inverter switched off). In case a simulator is used, it must produce a sinusoidal voltage with negligible DC offset (<0.1 %).		P
	2. The input DC source must be adjusted so that the voltage is equal to the nominal MPPT stated by the manufacturer (or average of minimum and maximum MPPT values, if the nominal value is not declared) and the AC power of inverter output, measured in volt-ampere, is equal to (33 ± 5)% of the nominal value declared by the manufacturer.		P
	3. The system will be left to work in the conditions mentioned in the previous paragraph for at least 5 minutes or the time required to stabilize the inverter internal temperature.		P
	4. At this point measure the DC component of the current injected into the grid (frequency < 1 Hz) on each of the output phases. The measurement should be taken by averaging the measured variable on a time window of up to 1 sec, by recording the performance for a minimum period of 5 minutes and collecting a minimum number of samples equal to the reciprocal of the time window over which the parameter was averaged (in the case of 1 sec, at least 300 samples). With the same procedures measure and record the rms current and rms voltage output of the inverter.		P
	5. Repeat steps 2), 3) and 4) with the converter operating respectively at (66 ± 5) %, and (100 ± 5) % of the nominal power, measured in volt-ampere.		P
	For each power level:		P
	a) calculate the average value of the rms current and rms voltage on each phase. For each parameter the average must be calculated considering all samples taken during the measurement period.		P
	b) Check that the average value of the rms current of each phase as calculated in step a) is within 5% of the set value (respectively 33% , 66% and 100 % of the nominal value).		P
	c) Check that the average value of the rms voltage of each phase as calculated in step a) is within 5% of the nominal value.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	d) Compute the average value of the DC component of the current on each phase. The average is to be calculated by considering the absolute value (i.e. without sign) of the value of each sample recorded during each observation period of 5 minutes (for the 3 power levels).		P
	e) For each phase, divide the average value of the DC component calculated in step d) by the nominal value of the output current of the inverter and multiply this ratio by 100. The calculated values represent the percentage of DC current fed into the grid for each phase, as compared to the nominal current of the inverter.		P
	f) The DC component measured in accordance with this procedure has to be within the specified limits. For indicative purposes Table D16 shows an example of representation of the test results.		P
D.3.2.4.2	Verification of protections to prevent the injection of a DC component	(See the appendix table)	P
	The test shall be performed as follows:		P
	1. The inverter is connected to a test circuit similar to that shown in Figure D11.		P
	2. Mains voltage (or in the simulator) must be maintained within a value equal to nominal voltage ± 1 % (frequency of 50 ± 0.2 Hz). The total voltage distortion (THD) shall be less than 2.5% (inverter off). In case a simulator is used, it must produce a sinusoidal voltage with negligible DC offset (<0.1 %).		P
	3. The DC source input must be adjusted so that the voltage is equal to the nominal MPPT stated by the manufacturer (or average of the minimum and maximum MPPT values, if the nominal value is declared) and the AC power of inverter output, measured in volt-ampere, is equal to (33 ± 5) % of the value declared by the manufacturer.		P
	4. The check that the inverter shuts down when the first protection threshold Idc > (> 0.5% In) is exceeded, can be made alternatively as described in points a) and b):		P
	a) Through a simulation of the drift of the symmetry control of the converter, with modalities to be agreed with the manufacturer and likely to induce an offset on Idc larger than 0.5% of the nominal current. Shutdown must occur within 1 second from the instant of application of the offset.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	b) In the measurement device of the DC component (e.g. current transformer or resistance) a DC current greater than 0.5% of the nominal current is impressed. Shutdown must occur within 1 second from the instant of application of the current imbalance.		P
	5. The check that the inverter shuts down, when exceeding the second protection threshold Idc >> (> 1 A) is carried out alternatively as described in paragraphs c) in case the protection is built into the control system of the converter, or d) for external protections:		P
	a) Through a simulation of the fault, by a measurement, carried in a manner to be agreed with the manufacturer, it must be assessed whether an abnormal plant operation due to a DC component on the current injected into the network exceeding 1 A, brings to the shutdown within 0.2 s after the simulated fault condition is triggered.		P
	b) In the measurement device of the DC component (e.g. current transformer or resistance) a DC current greater than 1 A is impressed. The shutdown must occur within 0.2 s after the fault current is impressed.		P
	6. Repeat steps 2), 3) and 4) with the converter operating respectively at (66 ± 5) %, and (100 ± 5) % of the nominal power, measured in VA.		P
D.3.2.5	Verification of insensitivity to voltage dips (LVRT capability)		P
	These tests have the purpose to verify that the inverter, if used in plants of maximum capacity larger than or equal to 10 kW, is insensitive to voltage dips according to the voltage-time profile shown in Figure 8. In particular, the tests aim to verify that the following functional requirements are met:		P
	- in the non-hatched area the RRGU shall not disconnect from the network. Performance with a zero voltage for 200 ms shall be endured. The temporary interruption of the production of active and reactive power is in this case allowed;		P
	- in the hatched area the RRGU may be disconnected;		P

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Clause	Requirement – Test	Result – Remark	Verdict
	- within 200 ms from the restoring of a network voltage included in the range 85 % Vn ⩽ V ⩽ 110 % Vn (grey shaded area), the RRGU will restore the export of active and reactive power to the network as it was before the fault occurrence, with a maximum tolerance of ±10% of the RRGU rated power. If the voltage is restored, but it remains in the range 0.85 Vn ⩽ V ⩽ 0.9 Vn a reduction in the produced power is admissible.		P
	The verification of compliance with the requirements for immunity to voltage dips is made according to the test sequences reported in Table D17, to be performed with the equipment under test working respectively:		P
	a) between 10% and 30% of the nominal power and		P
	b) above 90% of the nominal power.		P
	For each of the sequences a) and b) the system has to operate under the set conditions for at least 5 minutes or the time necessary for the internal temperature of the converter to stabilize.		P
	The interface protection must be disabled or adjusted to avoid nuisance tripping during the test run.		P
	The fault simulation system must produce the voltage dip profile as reported in Table D17 and Figure 8 both at no load operating condition and when connected to the equipment under test. The result of each sequence must be documented as follows:		P
	- Time behaviour of active power P, reactive power Q and the phase voltages at the output terminals L1, L2, L3, as moving average of rms values computed in a cycle (20 ms) and updated every half a cycle (10 ms), on a time window that begins 100 ms before the test begins and ends at least 400 ms after the end of the transient voltage (in order to monitor the restoration of active and reactive power). The voltage transient ends when the voltage is more than 85 % of the rated voltage.		P
	- In the same observation period, oscillograms of voltages and of the phase currents (possibly with enlarged detail of the trend during the rising edges and falling voltage) shall be recorded.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	The tests can be performed using, for example, the test circuit shown in Figure D12. Voltage dips are reproduced by a circuit that simulates a short circuit connecting either the three or the two phases to ground via impedance (Z2), or connecting either three or two phases together via the same impedance. Switches S1 and S2 will allow the definition of the time profiles of individual test sequences.	Use alternative network simulator	N/A
	For the sizing of the test circuit, the following considerations apply:		N/A
	- The impedance Z1 is used to limit the effect of the short circuit on the power grid that feeds the test circuit (short circuit current limitation). The sizing of Z1 must be in a way to allow a maximum short circuit current of 800 A per phase (in particular in the worst case, that is with 5 % residual voltage Vn).		N/A
	- A bypass switch S1 is usually employed to prevent overheating of the series impedance Z1 before and after the execution of each sequence.		N/A
	- The voltage drop is created by connecting the impedance Z2 to ground or to another phase, via the switch S2. The value of Z2 must be calculated to produce a voltage at its terminals equal to the values of residual voltage specified in Table D17 (no-load conditions).		N/A
	- As AC network it has to be intended the low voltage three-phase network. Laboratories are not allowed to connect directly to a public LV network. Hence, the testing laboratory shall be provided with a MV connection and a MV/LV transformer.		N/A
	- The closing and opening of switch S2 determines the duration of the event when the voltage drops, therefore its control must be accurate in simulations of both two-phase and three-phase faults. The switch can be for example a contactor of suitable size.		N/A
	- In the absence of the generator, the test circuit must ensure that the envelope of the voltage during the simulation corresponds to that of the graph of Figure D4. The duration of the transient voltage drop must be measured from the instant of closure to that of reopening of switch S2. The tolerances dashed in Figure D13 take into account the deviations and delays in closing and opening of S2 and the gradient of voltage drop and rise. Any deviations from the chart below should be adequately documented and justified in the test report.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	Use of alternative test circuits is allowed and, in particular, of network simulators (Figure D14).		P
	When using a network simulator, this must:		P
	1. ensure the possibility of independent control of the amplitude and phase angle of the three voltages		P
	2. be built with adjustable impedances Z1, Z2 and Z3, ZN parameters in order to reproduce the typical network parameters.		P
	With reference to the list of Table D14, the voltage drops here tested are actually caused by faults in the low, medium or high voltage networks. The types of fault considered include:		P
	1. three-phase symmetrical fault (Table D17 Tests No. 1 and 2)		P
	2. phase-to-phase (2-phase) asymmetrical faults (Table D17, Tests No. 3 and No. 4)		P
	Fault in MV, which causes in LV a change not only in amplitude but also of the phase relationships between voltages (the case considered foresees the presence of a Dy transformer in a secondary substation).		P
	During the phase-to-phase asymmetrical fault, the residual amplitude of the 3 voltages and the shifts between phases must comply with the values in the following Table.		P
	3. Asymmetrical phase-to-phase (2-phase) fault in the LV network (Table D17, Test No. 5 and No.6)		P
	These voltage variations propagate along the low voltage distribution network lines with amplitude of individual voltages and phase angles that are dependent on the characteristics of the transformers in the distribution substations, in particular on their vector group and impedance.		P
	Therefore, in order to correctly simulate the effects of two-phase faults on the low voltage side of the line, the conditions that arise on the LV lines when the fault is induced on the MV portion of the distribution line are to be reproduced through the simulator, including the phase shifts due to the presence of asymmetric two-phase faults.		P
D.3.2.6	Verification of insensitivity to automatic reclosing under phase mismatching		P
	This type of test can be performed in two ways:		P
	1. with inverter connected to a simulated network (D.3.2.6.1)		P
	2. with inverter connected to distribution network (D.3.2.6.2 and D.3.2.6.3 alternatively).		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	The generator must not be damaged as a result of the tests. The shutdown and the protection intervention are however allowed.		P
D.3.2.6.1	Test on simulated network		P
	With reference to the diagram in Figure D9 - Use of the simulated network:		P
	- The network simulator must be able to produce phase jumps of the inverter output voltage of 90° and 180° respectively;		P
	- Generator: inverter working at rated power with unity power factor (cos φ=1);		P
	- VR: voltage of the simulated network.		P
	The generator shall be brought into operation at rated power. The system will be left to work in the set conditions for at least 5 minutes or the time required to stabilize the inverter internal temperature.		P
	Two tests shall then be performed, inducing a transient which suddenly introduces a phase shift on the simulated network voltage VR equal to 180° and 90° respectively.		P
	The test report shall include:		P
	- the angle between the voltages measured before and after the phase jump by means of an instrument having a precision of 1° ;		P
	- the current of the generator, measured on a time window which lasts from 20 ms before the simulated network voltage phase jump to at least 200 ms after this phase jump.		P
D.3.2.6.2	Test on the distribution network via a coupling transformer		N/A
	With reference to the diagram shown in Figure D15 - Circuit for the verification of insensitivity to the automatic reclosure with phase mismatch via network simulator – this test envisage the use of a coupling transformer:		N/A
	- TR: transformer with open columns, to configure YYn or DYn as a function of the test to be performed		N/A
	- Generator: inverter working at rated power with unity power factor (cos φ = 1)		N/A
	- Rc: resistive ballast load, power equal to the nominal power of the inverter		N/A
	- VR: voltage of distribution network		N/A
	- VR': voltage with 90° and 180° phase mismatch with respect to the distribution network, as a function of the test to be performed		N/A
	- VG: voltage applied to the generator.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	The contactor CB is closed, the contactor CB' is open.		N/A
	The generator shall be brought into operation at rated power. The system will be left to work in the set conditions for at least 5 minutes or the time required to stabilize the inverter internal temperature.		N/A
	Check that, for at least 1 minute, the current through the circuit breaker CB is less than the 2%. The measured value shall be reported in the test report.		N/A
	Then open the contactor CB and close contactor CB', in a coordinated way and simultaneously (neglecting the time difference on opening and closing times). The ballast resistance attenuates electrical transients at the inverter output and prevents the inverter disconnection from the network.		N/A
	The generator shutdown or the protection tripping can only occur afterwards the complete closure of the contactor CB'.		N/A
	Two tests shall be performed, with phase angle at closure equal to 180° and at 90° respectively. To this purpose the vector group of the transformer TR must be reconfigured in appropriate way.		N/A
	The test report shall include:		N/A
	- the angle between the two measured voltages by means of an instrument having a precision of 1°;		N/A
	- the current of the generator as a result of the closure, measured on a time window which lasts from 20 ms before the mains voltage phase jump to at least 200 ms after this phase jump.		N/A
D.3.2.6.3	Test on the distribution network, simulation of the frequency drift		N/A
	With reference to the diagram in Figure D17:		N/A
	- CB: controlled switch or contactor. The making capacity for both, must be adequate. The closing time must be known and stable		N/A
	- Generator: inverter working at rated power with unity power factor (cosφ = 1)		N/A
	- Rc: Resistive ballast load, with size equal to inverter rated power		N/A
	- Zc: Drifting reactive load. Zc will be sized to absorb reactive current of the order of 1% as compared the nominal current of the inverter. The actual value and the nature of this impedance (either inductive or capacitive) shall be agreed with the inverter manufacturer and reported in the test report.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	- VR: voltage of distribution network		N/A
	- VG: voltage of generator in islanding condition on the ballast load.		N/A
	The generator shall be brought into operation at rated power. The system will be left to work in the set conditions for at least 5 minutes or the time required to stabilize the inverter internal temperature.		N/A
	Because the islanding operation is not expected on grid connected inverters, for the execution of this test it may be necessary to alter certain parameters of control and regulation.		N/A
	The MPPT algorithm is to be disabled.		N/A
	For static generators, any internal protection against the loss of mains other than those described in this rule, e.g. based on the measurement of the impedance, phase shift, etc., should be excluded, as well as the protections and controls in frequency that can disconnect the generator.		N/A
	Check that, for at least 1 minute, the current through the circuit breaker CB is less than 2%. The measured value should be reported in the test report.		N/A
	At this point the frequency of the inverter drifts with a dynamic dependent on the parameters and the technology of the inverter being tested. The load Zc contributes to make the system unstable and may be not necessary for the performance of the test.		N/A
	The setup should ensure that the frequency drift is sufficiently slow to allow the observation of the phase difference between VR and VG through an oscilloscope with isolated channels.		N/A
	Two tests shall be performed, with phase angle at closure equal to 180° and at 90° respectively.		N/A
	The generator must not be damaged as a result of the tests. The off-service and the intervention of any protections are allowed.		N/A
	The test report shall include:		N/A
	- the angle between the two measured voltages with a tool having error of 1° ;		N/A
	- the current of the generator as a result of the closure, measured on a time window that runs from 20 ms before to at least 200 ms after the phase jump of mains voltage.		N/A
D.4	Inverters for Medium Voltage connected RRGUs		P
D.4.3	Measurements to assess the quality of the voltage		P
D.4.4	Check the operating range of voltage and frequency		P

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Clause	Requirement – Test	Result – Remark	Verdict
D.4.5	Verification of conditions for synchronization and load pickup		P
D.4.6	Verification of constructional requirements for reactive power exchange		P
D.4.7	Verification of constructional requirements for active power control		P
D.4.8	Verification of insensitivity to voltage dips (LVRT capability)		P
D.4.9	Verification of insensitivity to automatic reclosing while in phase mismatching		P
D.5	Simulations and Testing		N/A
D.5.1	On-site testing (and inspection) of a RRGP		N/A

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Clause	Requirement + Test	Result - Remark	Verdict

D.3.2 a)	TABLE: Harmonic emission	P

SOFAR 20000TL-G2								
Normal ambient (EN 61000-3-12) Output power 33%								
Watts(kW)				2,198/ 2,198/ 2,192				
Vrms(V)				230,07/ 230,01/ 230,00				
Arms(A)				9,554/ 9,557/ 9,532				
Frequency(Hz)				50,00				
THD* (33% output power)				0,604%/ 0,575%/ 0,627%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	9,554	9,556	9,532	--	--	--	Three Phase	--
2nd	0,008	0,009	0,007	0,080	0,094	0,079	Three Phase	8,000
3rd	0,027	0,009	0,014	0,281	0,094	0,148	Three Phase	21,600
4th	0,008	0,01	0,009	0,087	0,102	0,090	Three Phase	4,000
5th	0,015	0,027	0,018	0,158	0,281	0,186	Three Phase	10,700
6th	0,01	0,008	0,01	0,101	0,080	0,101	Three Phase	2,667
7th	0,012	0,011	0,015	0,121	0,118	0,157	Three Phase	7,200
8th	0,008	0,006	0,007	0,079	0,068	0,076	Three Phase	2,000
9th	0,023	0,008	0,015	0,239	0,082	0,159	Three Phase	3,800
10th	0,004	0,005	0,004	0,042	0,050	0,043	Three Phase	1,600
11th	0,007	0,014	0,012	0,072	0,143	0,128	Three Phase	3,100
12th	0,004	0,004	0,005	0,042	0,045	0,051	Three Phase	1,333
13th	0,008	0,01	0,017	0,088	0,107	0,183	Three Phase	2,000
14th	0,003	0,003	0,004	0,035	0,030	0,040	Three Phase	8,000
15th	0,009	0,006	0,012	0,096	0,067	0,130	Three Phase	N/A
16th	0,003	0,003	0,003	0,030	0,030	0,030	Three Phase	N/A
17th	0,013	0,013	0,019	0,131	0,132	0,198	Three Phase	N/A
18th	0,003	0,003	0,003	0,031	0,034	0,036	Three Phase	N/A
19th	0,009	0,014	0,017	0,096	0,151	0,179	Three Phase	N/A
20th	0,003	0,003	0,002	0,027	0,028	0,026	Three Phase	N/A
21th	0,006	0,004	0,007	0,063	0,045	0,078	Three Phase	N/A
22th	0,002	0,003	0,002	0,025	0,027	0,025	Three Phase	N/A
23th	0,016	0,017	0,018	0,171	0,174	0,193	Three Phase	N/A
24th	0,003	0,003	0,003	0,033	0,028	0,035	Three Phase	N/A
25th	0,013	0,013	0,015	0,140	0,138	0,158	Three Phase	N/A
26th	0,003	0,003	0,003	0,027	0,031	0,028	Three Phase	N/A
27th	0,003	0,003	0,004	0,030	0,032	0,044	Three Phase	N/A
28th	0,003	0,002	0,002	0,027	0,025	0,026	Three Phase	N/A
29th	0,011	0,013	0,01	0,112	0,136	0,102	Three Phase	N/A
30th	0,003	0,003	0,003	0,027	0,028	0,028	Three Phase	N/A
31th	0,01	0,01	0,008	0,110	0,101	0,087	Three Phase	N/A
32th	0,002	0,002	0,002	0,024	0,025	0,026	Three Phase	N/A
33th	0,004	0,003	0,006	0,038	0,035	0,066	Three Phase	N/A
34th	0,002	0,002	0,002	0,024	0,025	0,025	Three Phase	N/A
35th	0,01	0,009	0,006	0,108	0,098	0,065	Three Phase	N/A
36th	0,003	0,003	0,003	0,029	0,031	0,030	Three Phase	N/A
37th	0,006	0,009	0,006	0,065	0,089	0,061	Three Phase	N/A
38th	0,002	0,002	0,002	0,023	0,024	0,024	Three Phase	N/A
39th	0,003	0,003	0,004	0,029	0,036	0,042	Three Phase	N/A
40th	0,002	0,002	0,002	0,033	0,031	0,028	Three Phase	N/A

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Clause	Requirement + Test	Result - Remark	Verdict

Normal ambient (EN 61000-3-12) Output power 66%								
Watts(kW)					4,424/ 4,412/ 4,400			
Vrms(V)					230,09/ 230,04/ 230,02			
Arms(A)					19,229/ 19,180/ 19,129			
Frequency(Hz)					50,00			
THD* (66% output power)					0,459%/0,518%/0,468%			
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	19,229	19,180	19,129	--	--	--	Three Phase	--
2nd	0,008	0,012	0,010	0,042	0,061	0,052	Three Phase	8,000
3rd	0,013	0,043	0,038	0,069	0,226	0,199	Three Phase	21,600
4th	0,010	0,011	0,011	0,052	0,058	0,056	Three Phase	4,000
5th	0,052	0,040	0,018	0,272	0,208	0,097	Three Phase	10,700
6th	0,011	0,009	0,012	0,057	0,047	0,061	Three Phase	2,667
7th	0,028	0,040	0,024	0,144	0,211	0,124	Three Phase	7,200
8th	0,009	0,008	0,008	0,046	0,042	0,041	Three Phase	2,000
9th	0,019	0,023	0,014	0,100	0,122	0,072	Three Phase	3,800
10th	0,005	0,007	0,006	0,026	0,035	0,029	Three Phase	1,600
11th	0,022	0,038	0,035	0,115	0,200	0,184	Three Phase	3,100
12th	0,006	0,004	0,007	0,031	0,023	0,039	Three Phase	1,333
13th	0,035	0,021	0,020	0,181	0,107	0,104	Three Phase	2,000
14th	0,005	0,004	0,005	0,027	0,019	0,024	Three Phase	8,000
15th	0,005	0,023	0,021	0,026	0,120	0,109	Three Phase	N/A
16th	0,004	0,005	0,004	0,021	0,025	0,018	Three Phase	N/A
17th	0,011	0,018	0,026	0,055	0,092	0,135	Three Phase	N/A
18th	0,004	0,003	0,004	0,020	0,017	0,019	Three Phase	N/A
19th	0,025	0,006	0,024	0,130	0,030	0,123	Three Phase	N/A
20th	0,003	0,003	0,003	0,016	0,016	0,016	Three Phase	N/A
21th	0,010	0,010	0,018	0,054	0,053	0,096	Three Phase	N/A
22th	0,003	0,003	0,003	0,015	0,015	0,015	Three Phase	N/A
23th	0,006	0,017	0,016	0,030	0,088	0,085	Three Phase	N/A
24th	0,003	0,003	0,003	0,017	0,014	0,016	Three Phase	N/A
25th	0,015	0,005	0,015	0,080	0,024	0,077	Three Phase	N/A
26th	0,003	0,003	0,003	0,015	0,016	0,015	Three Phase	N/A
27th	0,005	0,009	0,012	0,027	0,048	0,063	Three Phase	N/A
28th	0,003	0,003	0,003	0,013	0,013	0,014	Three Phase	N/A
29th	0,004	0,012	0,013	0,022	0,061	0,067	Three Phase	N/A
30th	0,003	0,002	0,003	0,013	0,013	0,013	Three Phase	N/A
31th	0,012	0,004	0,009	0,060	0,019	0,049	Three Phase	N/A
32th	0,002	0,002	0,003	0,013	0,012	0,014	Three Phase	N/A
33th	0,005	0,008	0,011	0,025	0,040	0,057	Three Phase	N/A
34th	0,003	0,003	0,003	0,014	0,014	0,014	Three Phase	N/A
35th	0,004	0,008	0,009	0,020	0,044	0,045	Three Phase	N/A
36th	0,003	0,003	0,003	0,014	0,015	0,014	Three Phase	N/A
37th	0,010	0,004	0,010	0,052	0,021	0,051	Three Phase	N/A
38th	0,002	0,002	0,002	0,013	0,013	0,013	Three Phase	N/A
39th	0,004	0,006	0,007	0,019	0,033	0,034	Three Phase	N/A
40th	0,002	0,002	0,002	0,012	0,012	0,012	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Normal ambient (EN 61000-3-12) Output power 100%								
Watts				6,735/ 6,713/ 6,700				
Vrms				230,12/ 230,06/ 230,05				
Arms				29,271/ 29,181/ 29,127				
Frequency				50,00				
THD				0,447%/ 0,462%/ 0,597%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	29,271	29,181	29,126	--	--	--	Three Phase	--
2nd	0,014	0,015	0,012	0,048	0,053	0,041	Three Phase	8,000
3rd	0,021	0,049	0,062	0,073	0,169	0,212	Three Phase	21,600
4th	0,009	0,013	0,013	0,032	0,044	0,045	Three Phase	4,000
5th	0,069	0,027	0,056	0,235	0,093	0,191	Three Phase	10,700
6th	0,012	0,010	0,011	0,040	0,035	0,038	Three Phase	2,667
7th	0,044	0,074	0,062	0,151	0,253	0,213	Three Phase	7,200
8th	0,008	0,010	0,009	0,026	0,034	0,032	Three Phase	2,000
9th	0,045	0,025	0,026	0,155	0,085	0,090	Three Phase	3,800
10th	0,005	0,005	0,007	0,017	0,019	0,023	Three Phase	1,600
11th	0,024	0,061	0,074	0,083	0,210	0,255	Three Phase	3,100
12th	0,006	0,004	0,006	0,022	0,014	0,020	Three Phase	1,333
13th	0,054	0,023	0,051	0,184	0,079	0,174	Three Phase	2,000
14th	0,005	0,005	0,007	0,018	0,018	0,024	Three Phase	8,000
15th	0,011	0,024	0,035	0,039	0,082	0,120	Three Phase	N/A
16th	0,004	0,006	0,004	0,015	0,021	0,014	Three Phase	N/A
17th	0,026	0,029	0,049	0,089	0,099	0,169	Three Phase	N/A
18th	0,005	0,005	0,003	0,016	0,017	0,011	Three Phase	N/A
19th	0,033	0,020	0,043	0,113	0,068	0,147	Three Phase	N/A
20th	0,003	0,005	0,004	0,011	0,016	0,014	Three Phase	N/A
21th	0,014	0,008	0,022	0,048	0,028	0,077	Three Phase	N/A
22th	0,004	0,004	0,003	0,013	0,015	0,011	Three Phase	N/A
23th	0,009	0,027	0,029	0,031	0,093	0,101	Three Phase	N/A
24th	0,003	0,003	0,004	0,011	0,011	0,012	Three Phase	N/A
25th	0,022	0,012	0,027	0,077	0,041	0,094	Three Phase	N/A
26th	0,004	0,004	0,003	0,012	0,014	0,010	Three Phase	N/A
27th	0,008	0,009	0,018	0,026	0,031	0,061	Three Phase	N/A
28th	0,003	0,003	0,003	0,011	0,012	0,009	Three Phase	N/A
29th	0,012	0,020	0,023	0,039	0,067	0,079	Three Phase	N/A
30th	0,003	0,003	0,003	0,009	0,012	0,009	Three Phase	N/A
31th	0,021	0,011	0,023	0,072	0,038	0,078	Three Phase	N/A
32th	0,003	0,003	0,003	0,009	0,011	0,009	Three Phase	N/A
33th	0,006	0,006	0,012	0,022	0,021	0,042	Three Phase	N/A
34th	0,004	0,004	0,004	0,012	0,013	0,012	Three Phase	N/A
35th	0,010	0,018	0,019	0,034	0,061	0,065	Three Phase	N/A
36th	0,003	0,003	0,003	0,010	0,011	0,009	Three Phase	N/A
37th	0,016	0,009	0,018	0,053	0,032	0,061	Three Phase	N/A
38th	0,002	0,003	0,002	0,009	0,009	0,009	Three Phase	N/A
39th	0,004	0,007	0,010	0,015	0,023	0,035	Three Phase	N/A
40th	0,002	0,002	0,002	0,009	0,008	0,008	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Minimum ambient rating or -25°C (EN 61000-3-12) Output power 33%								
Watts(kW)				2,200/ 2,199/ 2,193				
Vrms(V)				230,07/ 230,02/ 230,00				
Arms(A)				9,562/ 9,563/ 9,537				
Frequency(Hz)				50,00				
THD* (33% output power)				0,640%/ 0,587%/ 0,586%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	9,562	9,562	9,536	--	--	--	Three Phase	--
2nd	0,007	0,009	0,007	0,072	0,097	0,074	Three Phase	8,000
3rd	0,026	0,011	0,015	0,270	0,117	0,157	Three Phase	21,600
4th	0,008	0,009	0,007	0,080	0,090	0,078	Three Phase	4,000
5th	0,025	0,027	0,014	0,261	0,278	0,148	Three Phase	10,700
6th	0,008	0,008	0,009	0,086	0,080	0,091	Three Phase	2,667
7th	0,018	0,011	0,012	0,187	0,116	0,129	Three Phase	7,200
8th	0,006	0,006	0,006	0,066	0,060	0,065	Three Phase	2,000
9th	0,020	0,010	0,017	0,206	0,107	0,176	Three Phase	3,800
10th	0,004	0,005	0,004	0,041	0,050	0,041	Three Phase	1,600
11th	0,010	0,015	0,010	0,103	0,152	0,110	Three Phase	3,100
12th	0,003	0,004	0,004	0,035	0,046	0,045	Three Phase	1,333
13th	0,011	0,007	0,014	0,115	0,076	0,148	Three Phase	2,000
14th	0,003	0,003	0,003	0,033	0,029	0,036	Three Phase	8,000
15th	0,007	0,008	0,012	0,071	0,084	0,122	Three Phase	N/A
16th	0,003	0,003	0,003	0,028	0,030	0,030	Three Phase	N/A
17th	0,013	0,011	0,017	0,136	0,115	0,174	Three Phase	N/A
18th	0,003	0,003	0,003	0,029	0,036	0,033	Three Phase	N/A
19th	0,009	0,016	0,017	0,092	0,165	0,181	Three Phase	N/A
20th	0,003	0,003	0,002	0,026	0,028	0,025	Three Phase	N/A
21th	0,006	0,003	0,006	0,062	0,036	0,065	Three Phase	N/A
22th	0,002	0,003	0,002	0,025	0,027	0,024	Three Phase	N/A
23th	0,017	0,019	0,018	0,177	0,195	0,192	Three Phase	N/A
24th	0,003	0,003	0,003	0,030	0,029	0,032	Three Phase	N/A
25th	0,014	0,014	0,015	0,151	0,148	0,157	Three Phase	N/A
26th	0,003	0,003	0,003	0,027	0,030	0,028	Three Phase	N/A
27th	0,003	0,004	0,005	0,031	0,038	0,053	Three Phase	N/A
28th	0,003	0,002	0,002	0,027	0,025	0,026	Three Phase	N/A
29th	0,010	0,013	0,009	0,109	0,138	0,095	Three Phase	N/A
30th	0,003	0,003	0,003	0,027	0,029	0,029	Three Phase	N/A
31th	0,010	0,010	0,007	0,108	0,100	0,075	Three Phase	N/A
32th	0,002	0,002	0,003	0,024	0,025	0,027	Three Phase	N/A
33th	0,004	0,004	0,007	0,041	0,038	0,073	Three Phase	N/A
34th	0,002	0,002	0,002	0,024	0,024	0,025	Three Phase	N/A
35th	0,010	0,008	0,006	0,104	0,084	0,061	Three Phase	N/A
36th	0,003	0,003	0,003	0,030	0,033	0,030	Three Phase	N/A
37th	0,005	0,008	0,006	0,055	0,087	0,062	Three Phase	N/A
38th	0,002	0,002	0,002	0,023	0,024	0,023	Three Phase	N/A
39th	0,003	0,004	0,004	0,030	0,037	0,045	Three Phase	N/A
40th	0,002	0,002	0,002	0,023	0,022	0,023	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Minimum ambient rating or -25°C (EN 61000-3-12) Output power 66%								
Watts(kW)				4,433/ 4,414/ 4,403				
Vrms(V)				230,09/ 230,04/ 230,03				
Arms(A)				19,270/ 19,187/ 19,142				
Frequency(Hz)				50,00				
THD* (66% output power)				0,724%/0,856%/0,654%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	19,269	19,186	19,142	--	--	--	Three Phase	--
2nd	0,010	0,012	0,008	0,052	0,063	0,043	Three Phase	8,000
3rd	0,023	0,072	0,054	0,121	0,376	0,283	Three Phase	21,600
4th	0,009	0,010	0,010	0,046	0,054	0,051	Three Phase	4,000
5th	0,088	0,073	0,033	0,458	0,380	0,174	Three Phase	10,700
6th	0,010	0,009	0,010	0,051	0,049	0,052	Three Phase	2,667
7th	0,057	0,080	0,044	0,298	0,416	0,229	Three Phase	7,200
8th	0,009	0,009	0,007	0,048	0,044	0,036	Three Phase	2,000
9th	0,039	0,045	0,012	0,200	0,233	0,064	Three Phase	3,800
10th	0,005	0,005	0,005	0,028	0,029	0,026	Three Phase	1,600
11th	0,023	0,064	0,057	0,118	0,334	0,300	Three Phase	3,100
12th	0,006	0,004	0,005	0,029	0,020	0,027	Three Phase	1,333
13th	0,057	0,030	0,033	0,298	0,157	0,171	Three Phase	2,000
14th	0,005	0,004	0,005	0,025	0,019	0,026	Three Phase	8,000
15th	0,009	0,030	0,033	0,044	0,155	0,171	Three Phase	N/A
16th	0,005	0,006	0,003	0,028	0,033	0,017	Three Phase	N/A
17th	0,012	0,022	0,031	0,063	0,116	0,161	Three Phase	N/A
18th	0,004	0,005	0,005	0,022	0,024	0,025	Three Phase	N/A
19th	0,029	0,007	0,029	0,149	0,036	0,150	Three Phase	N/A
20th	0,003	0,003	0,003	0,017	0,018	0,014	Three Phase	N/A
21th	0,014	0,010	0,022	0,073	0,050	0,117	Three Phase	N/A
22th	0,003	0,003	0,003	0,014	0,018	0,014	Three Phase	N/A
23th	0,006	0,021	0,017	0,030	0,111	0,090	Three Phase	N/A
24th	0,003	0,003	0,004	0,015	0,017	0,020	Three Phase	N/A
25th	0,017	0,004	0,015	0,089	0,022	0,079	Three Phase	N/A
26th	0,003	0,003	0,003	0,017	0,018	0,016	Three Phase	N/A
27th	0,006	0,011	0,013	0,029	0,056	0,070	Three Phase	N/A
28th	0,003	0,003	0,002	0,013	0,013	0,013	Three Phase	N/A
29th	0,004	0,011	0,013	0,020	0,060	0,066	Three Phase	N/A
30th	0,002	0,003	0,003	0,013	0,016	0,015	Three Phase	N/A
31th	0,012	0,003	0,010	0,060	0,017	0,052	Three Phase	N/A
32th	0,003	0,003	0,003	0,013	0,013	0,013	Three Phase	N/A
33th	0,006	0,008	0,012	0,031	0,040	0,063	Three Phase	N/A
34th	0,003	0,002	0,003	0,014	0,013	0,013	Three Phase	N/A
35th	0,004	0,009	0,008	0,021	0,046	0,043	Three Phase	N/A
36th	0,003	0,003	0,003	0,014	0,015	0,014	Three Phase	N/A
37th	0,011	0,003	0,010	0,059	0,018	0,052	Three Phase	N/A
38th	0,002	0,002	0,002	0,012	0,013	0,012	Three Phase	N/A
39th	0,004	0,007	0,008	0,022	0,037	0,040	Three Phase	N/A
40th	0,002	0,002	0,002	0,012	0,012	0,012	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Minimum ambient rating or -25°C (EN 61000-3-12) Output power 100%									
Watts						6,716/ 6,686/ 6,676			
Vrms						230,11/ 230,06/ 230,05			
Arms						29,186/ 29,061/ 29,021			
Frequency						50,00			
THD						0,643%/ 0,716%/0,749%			
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	29,185	29,060	29,021	--	--	--	Three Phase	--
2nd	0,017	0,016	0,009	0,059	0,056	0,032	Three Phase	8,000
3rd	0,039	0,077	0,077	0,134	0,264	0,265	Three Phase	21,600
4th	0,008	0,012	0,010	0,028	0,040	0,036	Three Phase	4,000
5th	0,105	0,071	0,077	0,360	0,243	0,266	Three Phase	10,700
6th	0,009	0,011	0,010	0,032	0,037	0,034	Three Phase	2,667
7th	0,079	0,120	0,086	0,271	0,414	0,295	Three Phase	7,200
8th	0,008	0,009	0,007	0,029	0,032	0,026	Three Phase	2,000
9th	0,065	0,050	0,021	0,221	0,171	0,072	Three Phase	3,800
10th	0,005	0,006	0,006	0,016	0,019	0,021	Three Phase	1,600
11th	0,029	0,088	0,099	0,100	0,303	0,340	Three Phase	3,100
12th	0,005	0,005	0,004	0,018	0,017	0,015	Three Phase	1,333
13th	0,075	0,033	0,068	0,256	0,115	0,235	Three Phase	2,000
14th	0,005	0,005	0,005	0,016	0,019	0,018	Three Phase	8,000
15th	0,019	0,024	0,041	0,063	0,083	0,143	Three Phase	N/A
16th	0,005	0,007	0,004	0,017	0,024	0,014	Three Phase	N/A
17th	0,028	0,042	0,056	0,097	0,144	0,193	Three Phase	N/A
18th	0,004	0,005	0,005	0,014	0,018	0,018	Three Phase	N/A
19th	0,039	0,027	0,051	0,134	0,092	0,174	Three Phase	N/A
20th	0,004	0,004	0,003	0,014	0,014	0,010	Three Phase	N/A
21th	0,019	0,006	0,025	0,064	0,020	0,085	Three Phase	N/A
22th	0,003	0,004	0,003	0,012	0,014	0,010	Three Phase	N/A
23th	0,009	0,032	0,032	0,030	0,111	0,111	Three Phase	N/A
24th	0,003	0,004	0,004	0,011	0,012	0,015	Three Phase	N/A
25th	0,024	0,014	0,030	0,083	0,047	0,104	Three Phase	N/A
26th	0,004	0,004	0,003	0,013	0,014	0,010	Three Phase	N/A
27th	0,009	0,008	0,019	0,032	0,029	0,064	Three Phase	N/A
28th	0,003	0,003	0,003	0,010	0,011	0,009	Three Phase	N/A
29th	0,013	0,023	0,025	0,046	0,078	0,087	Three Phase	N/A
30th	0,003	0,003	0,003	0,009	0,012	0,010	Three Phase	N/A
31th	0,023	0,013	0,025	0,079	0,046	0,086	Three Phase	N/A
32th	0,003	0,003	0,002	0,009	0,010	0,009	Three Phase	N/A
33th	0,007	0,006	0,013	0,026	0,020	0,045	Three Phase	N/A
34th	0,004	0,004	0,004	0,013	0,013	0,013	Three Phase	N/A
35th	0,010	0,020	0,021	0,036	0,070	0,071	Three Phase	N/A
36th	0,003	0,003	0,003	0,010	0,011	0,010	Three Phase	N/A
37th	0,018	0,010	0,020	0,060	0,035	0,067	Three Phase	N/A
38th	0,003	0,003	0,002	0,009	0,009	0,008	Three Phase	N/A
39th	0,005	0,006	0,011	0,019	0,022	0,037	Three Phase	N/A
40th	0,003	0,003	0,002	0,009	0,009	0,008	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Maximum ambient rating or +55°C (EN 61000-3-12) Output power 33%								
Watts(kW)				2,197/2,197/2,191				
Vrms(V)				230,07/230,01/230,00				
Arms(A)				9,552/9,554/9,529				
Frequency(Hz)				50,00				
THD* (33% output power)				0,608%/0,575%/0,614%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	9,551	9,553	9,529	--	--	--	Three Phase	--
2nd	0,007	0,009	0,007	0,077	0,099	0,079	Three Phase	8,000
3rd	0,026	0,009	0,014	0,274	0,099	0,147	Three Phase	21,600
4th	0,009	0,010	0,009	0,092	0,106	0,089	Three Phase	4,000
5th	0,018	0,026	0,016	0,190	0,273	0,166	Three Phase	10,700
6th	0,009	0,008	0,010	0,099	0,087	0,109	Three Phase	2,667
7th	0,013	0,011	0,014	0,134	0,111	0,147	Three Phase	7,200
8th	0,007	0,006	0,007	0,078	0,066	0,076	Three Phase	2,000
9th	0,022	0,008	0,015	0,227	0,086	0,157	Three Phase	3,800
10th	0,004	0,005	0,004	0,044	0,056	0,046	Three Phase	1,600
11th	0,007	0,014	0,012	0,077	0,142	0,122	Three Phase	3,100
12th	0,004	0,005	0,005	0,040	0,049	0,051	Three Phase	1,333
13th	0,009	0,009	0,017	0,090	0,098	0,176	Three Phase	2,000
14th	0,003	0,003	0,004	0,035	0,032	0,040	Three Phase	8,000
15th	0,008	0,007	0,012	0,085	0,072	0,126	Three Phase	N/A
16th	0,003	0,003	0,003	0,030	0,033	0,032	Three Phase	N/A
17th	0,013	0,012	0,019	0,133	0,126	0,195	Three Phase	N/A
18th	0,003	0,004	0,003	0,030	0,038	0,036	Three Phase	N/A
19th	0,009	0,015	0,017	0,093	0,154	0,181	Three Phase	N/A
20th	0,003	0,003	0,003	0,028	0,029	0,027	Three Phase	N/A
21th	0,006	0,004	0,007	0,061	0,043	0,075	Three Phase	N/A
22th	0,002	0,003	0,002	0,026	0,028	0,026	Three Phase	N/A
23th	0,016	0,017	0,018	0,172	0,175	0,192	Three Phase	N/A
24th	0,003	0,003	0,003	0,031	0,030	0,035	Three Phase	N/A
25th	0,013	0,013	0,015	0,140	0,139	0,156	Three Phase	N/A
26th	0,003	0,003	0,003	0,027	0,033	0,029	Three Phase	N/A
27th	0,003	0,003	0,004	0,030	0,032	0,046	Three Phase	N/A
28th	0,003	0,002	0,003	0,028	0,026	0,027	Three Phase	N/A
29th	0,011	0,013	0,009	0,112	0,134	0,100	Three Phase	N/A
30th	0,003	0,003	0,003	0,027	0,030	0,030	Three Phase	N/A
31th	0,010	0,010	0,008	0,109	0,101	0,084	Three Phase	N/A
32th	0,002	0,002	0,003	0,024	0,026	0,028	Three Phase	N/A
33th	0,004	0,003	0,006	0,039	0,035	0,067	Three Phase	N/A
34th	0,002	0,002	0,002	0,024	0,025	0,025	Three Phase	N/A
35th	0,010	0,009	0,006	0,107	0,093	0,063	Three Phase	N/A
36th	0,003	0,003	0,003	0,034	0,036	0,035	Three Phase	N/A
37th	0,006	0,009	0,006	0,065	0,092	0,064	Three Phase	N/A
38th	0,002	0,002	0,002	0,024	0,025	0,023	Three Phase	N/A
39th	0,003	0,003	0,004	0,028	0,035	0,042	Three Phase	N/A
40th	0,002	0,002	0,002	0,023	0,022	0,023	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Maximum ambient rating or +55°C (EN 61000-3-12) Output power 66%								
Watts(kW)					4,423/ 4,411/ 4,399			
Vrms(V)					230,09/230,04/230,02			
Arms(A)					19,222/19,175/19,124			
Frequency(Hz)					50,00			
THD* (66% output power)					0,457%/0,522%/0,458%			
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	19,222	19,175	19,124	--	--	--	Three Phase	--
2nd	0,009	0,012	0,010	0,045	0,065	0,053	Three Phase	8,000
3rd	0,014	0,044	0,037	0,073	0,228	0,192	Three Phase	21,600
4th	0,011	0,012	0,011	0,057	0,064	0,055	Three Phase	4,000
5th	0,051	0,039	0,018	0,267	0,206	0,096	Three Phase	10,700
6th	0,011	0,010	0,013	0,057	0,054	0,066	Three Phase	2,667
7th	0,029	0,042	0,024	0,152	0,220	0,128	Three Phase	7,200
8th	0,009	0,008	0,008	0,047	0,044	0,041	Three Phase	2,000
9th	0,020	0,024	0,014	0,104	0,125	0,073	Three Phase	3,800
10th	0,006	0,008	0,006	0,029	0,040	0,029	Three Phase	1,600
11th	0,021	0,037	0,034	0,109	0,196	0,177	Three Phase	3,100
12th	0,006	0,005	0,007	0,029	0,025	0,034	Three Phase	1,333
13th	0,034	0,021	0,019	0,178	0,109	0,100	Three Phase	2,000
14th	0,004	0,004	0,004	0,023	0,020	0,021	Three Phase	8,000
15th	0,005	0,023	0,020	0,027	0,119	0,106	Three Phase	N/A
16th	0,004	0,005	0,003	0,022	0,024	0,017	Three Phase	N/A
17th	0,011	0,017	0,025	0,055	0,088	0,132	Three Phase	N/A
18th	0,004	0,003	0,004	0,020	0,018	0,020	Three Phase	N/A
19th	0,024	0,006	0,023	0,127	0,031	0,120	Three Phase	N/A
20th	0,003	0,003	0,003	0,016	0,016	0,015	Three Phase	N/A
21th	0,010	0,010	0,018	0,053	0,052	0,093	Three Phase	N/A
22th	0,003	0,003	0,003	0,015	0,015	0,014	Three Phase	N/A
23th	0,006	0,017	0,016	0,031	0,087	0,084	Three Phase	N/A
24th	0,003	0,003	0,003	0,017	0,015	0,017	Three Phase	N/A
25th	0,015	0,005	0,015	0,080	0,024	0,076	Three Phase	N/A
26th	0,003	0,003	0,003	0,015	0,016	0,015	Three Phase	N/A
27th	0,005	0,009	0,012	0,026	0,048	0,062	Three Phase	N/A
28th	0,003	0,003	0,003	0,013	0,013	0,013	Three Phase	N/A
29th	0,004	0,011	0,013	0,021	0,060	0,066	Three Phase	N/A
30th	0,003	0,003	0,003	0,013	0,014	0,014	Three Phase	N/A
31th	0,011	0,004	0,009	0,060	0,019	0,048	Three Phase	N/A
32th	0,002	0,002	0,003	0,013	0,013	0,013	Three Phase	N/A
33th	0,005	0,008	0,011	0,025	0,040	0,057	Three Phase	N/A
34th	0,003	0,003	0,003	0,015	0,014	0,014	Three Phase	N/A
35th	0,004	0,008	0,008	0,020	0,043	0,043	Three Phase	N/A
36th	0,003	0,003	0,003	0,014	0,015	0,014	Three Phase	N/A
37th	0,010	0,004	0,009	0,051	0,020	0,049	Three Phase	N/A
38th	0,002	0,002	0,002	0,013	0,013	0,013	Three Phase	N/A
39th	0,004	0,006	0,006	0,019	0,033	0,034	Three Phase	N/A
40th	0,002	0,002	0,002	0,013	0,012	0,012	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Maximum ambient rating or +55°C (EN 61000-3-12) Output power 100%								
Watts				6,727/6,708/6,694				
Vrms				230,11/230,07/230,05				
Arms				29,234/29,158/29,099				
Frequency				50,00				
THD				0,391%/0,390%/0,5455				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	29,234	29,158	29,098	--	--	--	Three Phase	--
2nd	0,015	0,017	0,012	0,052	0,058	0,040	Three Phase	8,000
3rd	0,018	0,040	0,055	0,062	0,136	0,191	Three Phase	21,600
4th	0,011	0,013	0,012	0,036	0,046	0,040	Three Phase	4,000
5th	0,058	0,018	0,052	0,199	0,063	0,179	Three Phase	10,700
6th	0,011	0,010	0,011	0,038	0,036	0,039	Three Phase	2,667
7th	0,035	0,058	0,053	0,118	0,199	0,182	Three Phase	7,200
8th	0,008	0,008	0,009	0,027	0,029	0,031	Three Phase	2,000
9th	0,038	0,018	0,027	0,130	0,061	0,092	Three Phase	3,800
10th	0,005	0,007	0,006	0,018	0,023	0,022	Three Phase	1,600
11th	0,023	0,052	0,066	0,080	0,180	0,227	Three Phase	3,100
12th	0,007	0,006	0,005	0,025	0,019	0,017	Three Phase	1,333
13th	0,046	0,019	0,045	0,156	0,066	0,154	Three Phase	2,000
14th	0,004	0,007	0,007	0,015	0,023	0,023	Three Phase	8,000
15th	0,011	0,022	0,033	0,036	0,077	0,112	Three Phase	N/A
16th	0,005	0,007	0,004	0,015	0,024	0,015	Three Phase	N/A
17th	0,025	0,025	0,046	0,085	0,087	0,158	Three Phase	N/A
18th	0,005	0,006	0,004	0,016	0,020	0,013	Three Phase	N/A
19th	0,030	0,017	0,039	0,104	0,059	0,135	Three Phase	N/A
20th	0,003	0,005	0,004	0,011	0,018	0,014	Three Phase	N/A
21th	0,012	0,009	0,021	0,041	0,031	0,072	Three Phase	N/A
22th	0,004	0,005	0,003	0,014	0,017	0,011	Three Phase	N/A
23th	0,009	0,025	0,028	0,031	0,085	0,095	Three Phase	N/A
24th	0,003	0,004	0,004	0,011	0,014	0,014	Three Phase	N/A
25th	0,022	0,011	0,026	0,074	0,038	0,089	Three Phase	N/A
26th	0,004	0,005	0,003	0,013	0,016	0,011	Three Phase	N/A
27th	0,007	0,009	0,017	0,024	0,031	0,060	Three Phase	N/A
28th	0,003	0,004	0,003	0,011	0,013	0,009	Three Phase	N/A
29th	0,011	0,019	0,022	0,037	0,064	0,075	Three Phase	N/A
30th	0,003	0,004	0,003	0,009	0,013	0,010	Three Phase	N/A
31th	0,021	0,010	0,022	0,070	0,035	0,074	Three Phase	N/A
32th	0,003	0,003	0,003	0,009	0,011	0,009	Three Phase	N/A
33th	0,006	0,006	0,012	0,020	0,022	0,041	Three Phase	N/A
34th	0,004	0,004	0,004	0,012	0,013	0,012	Three Phase	N/A
35th	0,010	0,017	0,018	0,033	0,058	0,063	Three Phase	N/A
36th	0,003	0,003	0,003	0,010	0,011	0,010	Three Phase	N/A
37th	0,015	0,009	0,017	0,050	0,030	0,059	Three Phase	N/A
38th	0,003	0,003	0,002	0,009	0,009	0,008	Three Phase	N/A
39th	0,004	0,007	0,010	0,015	0,023	0,034	Three Phase	N/A
40th	0,003	0,003	0,002	0,009	0,009	0,008	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

SOFAR 33000TL-G2								
Normal ambient (EN 61000-3-12) Output power 33%								
Watts(kW)				3,579/3,557/3,556				
Vrms(V)				230,19/229,55/230,05				
Arms(A)				15,552/15,495/15,461				
Frequency(Hz)				50,00				
THD* (33% output power)				0,908%/0,892%/0,776%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	15,552	15,495	15,461	99,996	99,996	99,997	Three Phase	--
2nd	0,029	0,015	0,027	0,186	0,099	0,173	Three Phase	8,000
3rd	0,037	0,046	0,063	0,235	0,297	0,408	Three Phase	21,600
4th	0,030	0,011	0,026	0,193	0,071	0,170	Three Phase	4,000
5th	0,071	0,059	0,025	0,456	0,379	0,164	Three Phase	10,700
6th	0,026	0,010	0,022	0,167	0,064	0,145	Three Phase	2,667
7th	0,055	0,064	0,034	0,353	0,413	0,221	Three Phase	7,200
8th	0,018	0,010	0,013	0,119	0,064	0,086	Three Phase	2,000
9th	0,025	0,033	0,021	0,162	0,216	0,137	Three Phase	3,800
10th	0,011	0,011	0,010	0,068	0,069	0,063	Three Phase	1,600
11th	0,027	0,051	0,030	0,175	0,328	0,192	Three Phase	3,100
12th	0,009	0,007	0,007	0,058	0,046	0,047	Three Phase	1,333
13th	0,038	0,028	0,013	0,246	0,184	0,083	Three Phase	2,000
14th	0,009	0,008	0,008	0,057	0,050	0,055	Three Phase	8,000
15th	0,012	0,026	0,024	0,077	0,170	0,154	Three Phase	N/A
16th	0,009	0,007	0,007	0,057	0,048	0,046	Three Phase	N/A
17th	0,008	0,016	0,018	0,050	0,103	0,114	Three Phase	N/A
18th	0,007	0,007	0,006	0,048	0,043	0,041	Three Phase	N/A
19th	0,015	0,008	0,014	0,096	0,050	0,094	Three Phase	N/A
20th	0,008	0,007	0,006	0,050	0,044	0,042	Three Phase	N/A
21th	0,010	0,010	0,021	0,067	0,063	0,135	Three Phase	N/A
22th	0,007	0,006	0,006	0,047	0,042	0,039	Three Phase	N/A
23th	0,009	0,011	0,012	0,055	0,069	0,075	Three Phase	N/A
24th	0,007	0,007	0,006	0,048	0,043	0,041	Three Phase	N/A
25th	0,010	0,008	0,011	0,063	0,050	0,068	Three Phase	N/A
26th	0,007	0,007	0,007	0,048	0,043	0,043	Three Phase	N/A
27th	0,008	0,012	0,010	0,050	0,078	0,065	Three Phase	N/A
28th	0,007	0,006	0,006	0,047	0,042	0,039	Three Phase	N/A
29th	0,010	0,007	0,009	0,066	0,045	0,058	Three Phase	N/A
30th	0,007	0,007	0,006	0,046	0,042	0,038	Three Phase	N/A
31th	0,008	0,009	0,009	0,050	0,059	0,061	Three Phase	N/A
32th	0,007	0,006	0,006	0,047	0,042	0,041	Three Phase	N/A
33th	0,007	0,007	0,010	0,046	0,048	0,066	Three Phase	N/A
34th	0,007	0,007	0,006	0,048	0,042	0,039	Three Phase	N/A
35th	0,010	0,007	0,008	0,064	0,048	0,052	Three Phase	N/A
36th	0,008	0,007	0,006	0,048	0,044	0,040	Three Phase	N/A
37th	0,010	0,009	0,012	0,063	0,055	0,076	Three Phase	N/A
38th	0,008	0,007	0,006	0,049	0,044	0,040	Three Phase	N/A
39th	0,007	0,009	0,007	0,046	0,057	0,048	Three Phase	N/A
40th	0,007	0,006	0,006	0,047	0,041	0,038	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Normal ambient (EN 61000-3-12) Output power 66%								
Watts(kW)				7,289/7,242/7,249				
Vrms(V)				230,31/229,72/230,20				
Arms(A)				31,652/31,528/31,495				
Frequency(Hz)				50,00				
THD* (66% output power)				0,622%/0,592%/0,764%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	31,652	31,528	31,494	99,998	99,998	99,997	Three Phase	--
2nd	0,036	0,029	0,031	0,114	0,092	0,098	Three Phase	8,000
3rd	0,053	0,041	0,097	0,167	0,131	0,307	Three Phase	21,600
4th	0,037	0,015	0,032	0,115	0,048	0,101	Three Phase	4,000
5th	0,093	0,055	0,098	0,294	0,176	0,311	Three Phase	10,700
6th	0,025	0,011	0,024	0,078	0,036	0,077	Three Phase	2,667
7th	0,082	0,111	0,093	0,259	0,351	0,297	Three Phase	7,200
8th	0,018	0,014	0,016	0,057	0,043	0,050	Three Phase	2,000
9th	0,059	0,035	0,026	0,187	0,110	0,082	Three Phase	3,800
10th	0,011	0,012	0,010	0,036	0,039	0,031	Three Phase	1,600
11th	0,029	0,079	0,092	0,090	0,252	0,293	Three Phase	3,100
12th	0,011	0,009	0,007	0,035	0,027	0,022	Three Phase	1,333
13th	0,061	0,023	0,060	0,191	0,074	0,190	Three Phase	2,000
14th	0,007	0,010	0,010	0,024	0,031	0,032	Three Phase	8,000
15th	0,024	0,017	0,039	0,076	0,055	0,125	Three Phase	N/A
16th	0,009	0,009	0,007	0,030	0,029	0,023	Three Phase	N/A
17th	0,026	0,038	0,051	0,083	0,121	0,161	Three Phase	N/A
18th	0,008	0,007	0,006	0,024	0,024	0,020	Three Phase	N/A
19th	0,033	0,028	0,045	0,104	0,087	0,144	Three Phase	N/A
20th	0,008	0,008	0,006	0,025	0,026	0,020	Three Phase	N/A
21th	0,020	0,008	0,025	0,063	0,025	0,080	Three Phase	N/A
22th	0,008	0,007	0,006	0,024	0,024	0,019	Three Phase	N/A
23th	0,014	0,033	0,033	0,045	0,104	0,105	Three Phase	N/A
24th	0,007	0,007	0,006	0,023	0,022	0,018	Three Phase	N/A
25th	0,023	0,014	0,030	0,074	0,046	0,096	Three Phase	N/A
26th	0,007	0,007	0,006	0,023	0,023	0,019	Three Phase	N/A
27th	0,013	0,010	0,019	0,040	0,030	0,060	Three Phase	N/A
28th	0,007	0,007	0,005	0,023	0,021	0,017	Three Phase	N/A
29th	0,011	0,020	0,023	0,035	0,063	0,073	Three Phase	N/A
30th	0,007	0,006	0,005	0,021	0,019	0,017	Three Phase	N/A
31th	0,021	0,013	0,024	0,066	0,041	0,077	Three Phase	N/A
32th	0,007	0,006	0,006	0,023	0,021	0,018	Three Phase	N/A
33th	0,010	0,008	0,014	0,030	0,026	0,045	Three Phase	N/A
34th	0,007	0,006	0,005	0,022	0,020	0,017	Three Phase	N/A
35th	0,011	0,020	0,019	0,035	0,065	0,061	Three Phase	N/A
36th	0,007	0,007	0,006	0,023	0,022	0,019	Three Phase	N/A
37th	0,014	0,009	0,017	0,045	0,030	0,052	Three Phase	N/A
38th	0,007	0,007	0,006	0,022	0,021	0,018	Three Phase	N/A
39th	0,008	0,008	0,010	0,025	0,027	0,031	Three Phase	N/A
40th	0,007	0,006	0,005	0,022	0,020	0,017	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Normal ambient (EN 61000-3-12) Output power 100%								
Watts(kW)				11,043/10,972/10,980				
Vrms(V)				230,31/229,69/230,10				
Arms(A)				47,951/47,773/47,724				
Frequency(Hz)				50,00				
THD* (100% output power)				0,633%/0,624%/0,567%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	47,950	47,772	47,724	99,998	99,998	99,998	Three Phase	--
2nd	0,124	0,087	0,076	0,258	0,181	0,158	Three Phase	8,000
3rd	0,057	0,054	0,094	0,120	0,113	0,197	Three Phase	21,600
4th	0,066	0,047	0,037	0,138	0,099	0,077	Three Phase	4,000
5th	0,060	0,075	0,066	0,124	0,157	0,139	Three Phase	10,700
6th	0,043	0,013	0,035	0,090	0,028	0,073	Three Phase	2,667
7th	0,178	0,198	0,114	0,371	0,415	0,240	Three Phase	7,200
8th	0,052	0,017	0,042	0,108	0,036	0,088	Three Phase	2,000
9th	0,095	0,077	0,018	0,198	0,161	0,038	Three Phase	3,800
10th	0,027	0,011	0,023	0,056	0,024	0,047	Three Phase	1,600
11th	0,058	0,112	0,126	0,121	0,235	0,264	Three Phase	3,100
12th	0,019	0,010	0,012	0,039	0,021	0,025	Three Phase	1,333
13th	0,070	0,032	0,069	0,147	0,067	0,145	Three Phase	2,000
14th	0,014	0,013	0,007	0,030	0,027	0,014	Three Phase	8,000
15th	0,024	0,025	0,026	0,051	0,052	0,055	Three Phase	N/A
16th	0,017	0,012	0,008	0,035	0,025	0,016	Three Phase	N/A
17th	0,022	0,038	0,046	0,046	0,080	0,097	Three Phase	N/A
18th	0,014	0,011	0,006	0,029	0,023	0,012	Three Phase	N/A
19th	0,039	0,038	0,056	0,081	0,079	0,118	Three Phase	N/A
20th	0,009	0,007	0,007	0,018	0,015	0,014	Three Phase	N/A
21th	0,028	0,009	0,018	0,057	0,019	0,038	Three Phase	N/A
22th	0,007	0,006	0,007	0,015	0,012	0,014	Three Phase	N/A
23th	0,024	0,039	0,034	0,049	0,082	0,072	Three Phase	N/A
24th	0,007	0,006	0,005	0,014	0,012	0,011	Three Phase	N/A
25th	0,023	0,018	0,029	0,047	0,037	0,061	Three Phase	N/A
26th	0,006	0,006	0,005	0,014	0,012	0,011	Three Phase	N/A
27th	0,014	0,006	0,017	0,029	0,013	0,036	Three Phase	N/A
28th	0,007	0,006	0,005	0,014	0,013	0,011	Three Phase	N/A
29th	0,014	0,023	0,023	0,029	0,049	0,048	Three Phase	N/A
30th	0,006	0,006	0,005	0,013	0,012	0,011	Three Phase	N/A
31th	0,024	0,020	0,028	0,049	0,042	0,058	Three Phase	N/A
32th	0,006	0,006	0,005	0,013	0,012	0,010	Three Phase	N/A
33th	0,010	0,006	0,010	0,021	0,013	0,020	Three Phase	N/A
34th	0,006	0,006	0,005	0,013	0,012	0,010	Three Phase	N/A
35th	0,018	0,027	0,025	0,038	0,056	0,051	Three Phase	N/A
36th	0,006	0,006	0,005	0,013	0,012	0,010	Three Phase	N/A
37th	0,016	0,012	0,017	0,034	0,026	0,036	Three Phase	N/A
38th	0,006	0,005	0,005	0,013	0,011	0,010	Three Phase	N/A
39th	0,007	0,006	0,008	0,015	0,012	0,016	Three Phase	N/A
40th	0,006	0,005	0,005	0,013	0,011	0,010	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Minimum ambient rating or -15°C (EN 61000-3-12) Output power 33%								
Watts(kW)				3,659/3,645/3,634				
Vrms(V)				230,09/230,04/230,02				
Arms(A)				15,902/15,844/15,799				
Frequency(Hz)				50,00				
THD* (33% output power)				0,674%/0,857%/0,543%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	15,902	15,843	15,798	99,998	99,996	99,999	Three Phase	--
2nd	0,008	0,010	0,005	0,050	0,062	0,032	Three Phase	8,000
3rd	0,025	0,063	0,041	0,155	0,398	0,257	Three Phase	21,600
4th	0,007	0,005	0,004	0,044	0,029	0,028	Three Phase	4,000
5th	0,063	0,062	0,015	0,399	0,390	0,092	Three Phase	10,700
6th	0,004	0,005	0,005	0,022	0,031	0,031	Three Phase	2,667
7th	0,047	0,056	0,023	0,293	0,356	0,148	Three Phase	7,200
8th	0,005	0,005	0,003	0,030	0,031	0,020	Three Phase	2,000
9th	0,026	0,039	0,015	0,167	0,248	0,098	Three Phase	3,800
10th	0,004	0,006	0,003	0,026	0,037	0,018	Three Phase	1,600
11th	0,022	0,051	0,032	0,140	0,324	0,204	Three Phase	3,100
12th	0,004	0,003	0,005	0,028	0,019	0,031	Three Phase	1,333
13th	0,044	0,031	0,013	0,278	0,198	0,082	Three Phase	2,000
14th	0,003	0,002	0,003	0,018	0,012	0,016	Three Phase	8,000
15th	0,009	0,031	0,028	0,057	0,194	0,180	Three Phase	N/A
16th	0,002	0,003	0,001	0,015	0,017	0,008	Three Phase	N/A
17th	0,007	0,012	0,019	0,046	0,078	0,121	Three Phase	N/A
18th	0,002	0,001	0,002	0,011	0,009	0,015	Three Phase	N/A
19th	0,017	0,007	0,017	0,108	0,044	0,109	Three Phase	N/A
20th	0,001	0,001	0,001	0,007	0,009	0,008	Three Phase	N/A
21th	0,012	0,009	0,021	0,077	0,059	0,130	Three Phase	N/A
22th	0,001	0,001	0,001	0,009	0,008	0,007	Three Phase	N/A
23th	0,004	0,009	0,010	0,027	0,057	0,061	Three Phase	N/A
24th	0,002	0,002	0,003	0,011	0,010	0,016	Three Phase	N/A
25th	0,010	0,005	0,012	0,062	0,030	0,075	Three Phase	N/A
26th	0,002	0,002	0,002	0,010	0,011	0,013	Three Phase	N/A
27th	0,004	0,010	0,012	0,027	0,061	0,076	Three Phase	N/A
28th	0,001	0,001	0,001	0,007	0,006	0,009	Three Phase	N/A
29th	0,006	0,004	0,010	0,037	0,028	0,062	Three Phase	N/A
30th	0,001	0,001	0,002	0,008	0,009	0,011	Three Phase	N/A
31th	0,005	0,006	0,011	0,030	0,041	0,069	Three Phase	N/A
32th	0,001	0,001	0,002	0,007	0,007	0,011	Three Phase	N/A
33th	0,004	0,006	0,010	0,027	0,039	0,064	Three Phase	N/A
34th	0,001	0,001	0,001	0,007	0,007	0,008	Three Phase	N/A
35th	0,006	0,004	0,009	0,037	0,027	0,054	Three Phase	N/A
36th	0,001	0,001	0,002	0,008	0,009	0,010	Three Phase	N/A
37th	0,006	0,005	0,011	0,040	0,032	0,069	Three Phase	N/A
38th	0,001	0,001	0,001	0,006	0,006	0,008	Three Phase	N/A
39th	0,003	0,004	0,006	0,019	0,028	0,039	Three Phase	N/A
40th	0,001	0,001	0,001	0,006	0,005	0,006	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Minimum ambient rating or -15°C (EN 61000-3-12) Output power 66%								
Watts(kW)				7,317/7,286/7,276				
Vrms(V)				230,14/230,07/230,06				
Arms(A)				31,797/31,669/31,628				
Frequency(Hz)				50,00				
THD* (66% output power)				0,648%/0,720%/0,765%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	31,796	31,668	31,627	99,998	99,997	99,997	Three Phase	--
2nd	0,016	0,014	0,008	0,051	0,044	0,024	Three Phase	8,000
3rd	0,056	0,080	0,083	0,177	0,252	0,261	Three Phase	21,600
4th	0,006	0,009	0,008	0,019	0,029	0,026	Three Phase	4,000
5th	0,109	0,076	0,087	0,343	0,241	0,276	Three Phase	10,700
6th	0,007	0,009	0,006	0,020	0,027	0,021	Three Phase	2,667
7th	0,085	0,130	0,093	0,269	0,411	0,294	Three Phase	7,200
8th	0,007	0,010	0,004	0,023	0,031	0,014	Three Phase	2,000
9th	0,074	0,056	0,023	0,234	0,176	0,073	Three Phase	3,800
10th	0,003	0,004	0,004	0,011	0,013	0,013	Three Phase	1,600
11th	0,029	0,098	0,110	0,092	0,309	0,347	Three Phase	3,100
12th	0,004	0,004	0,003	0,014	0,012	0,010	Three Phase	1,333
13th	0,079	0,035	0,074	0,249	0,112	0,234	Three Phase	2,000
14th	0,004	0,004	0,004	0,012	0,013	0,013	Three Phase	8,000
15th	0,023	0,023	0,046	0,074	0,074	0,146	Three Phase	N/A
16th	0,005	0,007	0,003	0,015	0,023	0,010	Three Phase	N/A
17th	0,032	0,047	0,062	0,101	0,150	0,196	Three Phase	N/A
18th	0,003	0,004	0,006	0,009	0,014	0,018	Three Phase	N/A
19th	0,043	0,032	0,057	0,134	0,102	0,181	Three Phase	N/A
20th	0,004	0,003	0,001	0,011	0,008	0,004	Three Phase	N/A
21th	0,021	0,005	0,026	0,067	0,014	0,081	Three Phase	N/A
22th	0,002	0,003	0,002	0,007	0,011	0,005	Three Phase	N/A
23th	0,010	0,036	0,035	0,032	0,114	0,111	Three Phase	N/A
24th	0,002	0,003	0,004	0,006	0,010	0,012	Three Phase	N/A
25th	0,023	0,015	0,032	0,071	0,048	0,101	Three Phase	N/A
26th	0,003	0,003	0,002	0,009	0,010	0,006	Three Phase	N/A
27th	0,012	0,007	0,019	0,037	0,022	0,059	Three Phase	N/A
28th	0,002	0,002	0,002	0,006	0,008	0,005	Three Phase	N/A
29th	0,012	0,023	0,026	0,039	0,072	0,082	Three Phase	N/A
30th	0,001	0,002	0,003	0,003	0,007	0,009	Three Phase	N/A
31th	0,022	0,014	0,027	0,071	0,046	0,085	Three Phase	N/A
32th	0,001	0,002	0,001	0,004	0,005	0,004	Three Phase	N/A
33th	0,009	0,005	0,013	0,027	0,016	0,042	Three Phase	N/A
34th	0,001	0,001	0,001	0,005	0,004	0,004	Three Phase	N/A
35th	0,010	0,022	0,022	0,033	0,070	0,070	Three Phase	N/A
36th	0,001	0,002	0,002	0,004	0,006	0,007	Three Phase	N/A
37th	0,017	0,011	0,021	0,053	0,035	0,066	Three Phase	N/A
38th	0,001	0,002	0,001	0,003	0,005	0,004	Three Phase	N/A
39th	0,006	0,006	0,012	0,020	0,018	0,037	Three Phase	N/A
40th	0,002	0,001	0,001	0,005	0,004	0,003	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Minimum ambient rating or -15°C (EN 61000-3-12) Output power 100%								
Watts(kW)				11,043/11,001/10,986				
Vrms(V)				230,18/230,10/230,09				
Arms(A)				47,977/47,811/47,749				
Frequency(Hz)				50,00				
THD* (100% output power)				0,681%/0,692%/0,580%				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	47,976	47,809	47,748	99,998	99,998	99,998	Three Phase	--
2nd	0,135	0,086	0,090	0,281	0,180	0,189	Three Phase	8,000
3rd	0,038	0,062	0,066	0,079	0,131	0,139	Three Phase	21,600
4th	0,097	0,056	0,065	0,202	0,117	0,136	Three Phase	4,000
5th	0,090	0,099	0,042	0,187	0,207	0,087	Three Phase	10,700
6th	0,034	0,019	0,016	0,070	0,039	0,034	Three Phase	2,667
7th	0,188	0,207	0,107	0,392	0,433	0,224	Three Phase	7,200
8th	0,049	0,010	0,047	0,101	0,021	0,097	Three Phase	2,000
9th	0,098	0,098	0,008	0,205	0,206	0,016	Three Phase	3,800
10th	0,033	0,020	0,034	0,068	0,043	0,071	Three Phase	1,600
11th	0,051	0,132	0,152	0,106	0,277	0,317	Three Phase	3,100
12th	0,019	0,014	0,007	0,039	0,029	0,015	Three Phase	1,333
13th	0,095	0,056	0,081	0,198	0,117	0,171	Three Phase	2,000
14th	0,019	0,005	0,014	0,039	0,010	0,030	Three Phase	8,000
15th	0,012	0,032	0,034	0,025	0,066	0,070	Three Phase	N/A
16th	0,008	0,009	0,004	0,016	0,020	0,008	Three Phase	N/A
17th	0,037	0,038	0,036	0,078	0,080	0,076	Three Phase	N/A
18th	0,007	0,007	0,014	0,015	0,014	0,029	Three Phase	N/A
19th	0,030	0,050	0,061	0,062	0,104	0,128	Three Phase	N/A
20th	0,007	0,006	0,010	0,015	0,012	0,021	Three Phase	N/A
21th	0,019	0,011	0,010	0,039	0,022	0,021	Three Phase	N/A
22th	0,008	0,007	0,005	0,017	0,015	0,010	Three Phase	N/A
23th	0,016	0,043	0,038	0,033	0,090	0,080	Three Phase	N/A
24th	0,010	0,006	0,005	0,021	0,012	0,010	Three Phase	N/A
25th	0,030	0,017	0,032	0,063	0,036	0,067	Three Phase	N/A
26th	0,006	0,005	0,002	0,012	0,010	0,004	Three Phase	N/A
27th	0,012	0,003	0,011	0,025	0,005	0,023	Three Phase	N/A
28th	0,003	0,002	0,003	0,007	0,005	0,006	Three Phase	N/A
29th	0,015	0,023	0,019	0,032	0,048	0,040	Three Phase	N/A
30th	0,002	0,002	0,004	0,005	0,004	0,007	Three Phase	N/A
31th	0,018	0,018	0,025	0,038	0,038	0,052	Three Phase	N/A
32th	0,002	0,002	0,002	0,003	0,004	0,004	Three Phase	N/A
33th	0,009	0,003	0,007	0,019	0,005	0,015	Three Phase	N/A
34th	0,002	0,003	0,002	0,004	0,005	0,004	Three Phase	N/A
35th	0,016	0,023	0,021	0,033	0,048	0,043	Three Phase	N/A
36th	0,002	0,002	0,002	0,004	0,005	0,004	Three Phase	N/A
37th	0,014	0,011	0,018	0,029	0,023	0,038	Three Phase	N/A
38th	0,002	0,002	0,002	0,004	0,004	0,003	Three Phase	N/A
39th	0,007	0,002	0,008	0,014	0,004	0,016	Three Phase	N/A
40th	0,002	0,002	0,001	0,004	0,004	0,002	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Maximum ambient rating or +55°C (EN 61000-3-12) Output power 33%								
Watts(kW)				3,649/3,642/3,631				
Vrms(V)				230,09/230,04/230,02				
Arms(A)				15,861/15,834/15,789				
Frequency(Hz)				50,00				
THD* (33% output power)				0,401/0,493/0,405				
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	15,861	15,833	15,788	99,999	99,999	99,999	Three Phase	--
2nd	0,009	0,012	0,007	0,054	0,078	0,046	Three Phase	8,000
3rd	0,017	0,032	0,027	0,107	0,199	0,172	Three Phase	21,600
4th	0,009	0,009	0,004	0,056	0,054	0,026	Three Phase	4,000
5th	0,030	0,036	0,018	0,188	0,227	0,114	Three Phase	10,700
6th	0,006	0,009	0,006	0,040	0,060	0,038	Three Phase	2,667
7th	0,023	0,021	0,013	0,147	0,133	0,081	Three Phase	7,200
8th	0,007	0,009	0,005	0,045	0,060	0,031	Three Phase	2,000
9th	0,009	0,018	0,017	0,054	0,117	0,110	Three Phase	3,800
10th	0,006	0,009	0,005	0,036	0,060	0,029	Three Phase	1,600
11th	0,019	0,026	0,013	0,118	0,167	0,081	Three Phase	3,100
12th	0,005	0,006	0,006	0,034	0,037	0,037	Three Phase	1,333
13th	0,024	0,020	0,006	0,150	0,125	0,036	Three Phase	2,000
14th	0,003	0,004	0,002	0,018	0,023	0,013	Three Phase	8,000
15th	0,005	0,021	0,018	0,031	0,134	0,113	Three Phase	N/A
16th	0,003	0,003	0,002	0,016	0,019	0,010	Three Phase	N/A
17th	0,004	0,011	0,013	0,025	0,066	0,082	Three Phase	N/A
18th	0,003	0,002	0,002	0,017	0,010	0,014	Three Phase	N/A
19th	0,014	0,007	0,012	0,088	0,047	0,077	Three Phase	N/A
20th	0,002	0,001	0,001	0,010	0,008	0,009	Three Phase	N/A
21th	0,009	0,010	0,017	0,060	0,062	0,107	Three Phase	N/A
22th	0,001	0,001	0,001	0,008	0,009	0,008	Three Phase	N/A
23th	0,004	0,006	0,007	0,023	0,036	0,046	Three Phase	N/A
24th	0,002	0,001	0,002	0,013	0,009	0,014	Three Phase	N/A
25th	0,008	0,005	0,010	0,047	0,029	0,066	Three Phase	N/A
26th	0,001	0,002	0,002	0,009	0,011	0,012	Three Phase	N/A
27th	0,004	0,008	0,011	0,027	0,050	0,069	Three Phase	N/A
28th	0,001	0,001	0,002	0,009	0,007	0,010	Three Phase	N/A
29th	0,005	0,004	0,009	0,035	0,027	0,057	Three Phase	N/A
30th	0,001	0,002	0,002	0,007	0,010	0,012	Three Phase	N/A
31th	0,004	0,005	0,009	0,026	0,033	0,056	Three Phase	N/A
32th	0,001	0,001	0,002	0,008	0,007	0,010	Three Phase	N/A
33th	0,004	0,006	0,010	0,022	0,040	0,062	Three Phase	N/A
34th	0,002	0,002	0,002	0,011	0,011	0,012	Three Phase	N/A
35th	0,006	0,002	0,007	0,040	0,013	0,046	Three Phase	N/A
36th	0,001	0,002	0,002	0,009	0,010	0,011	Three Phase	N/A
37th	0,005	0,005	0,009	0,029	0,033	0,059	Three Phase	N/A
38th	0,001	0,001	0,001	0,007	0,006	0,008	Three Phase	N/A
39th	0,003	0,004	0,005	0,016	0,028	0,034	Three Phase	N/A
40th	0,001	0,001	0,001	0,006	0,005	0,007	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Maximum ambient rating or +55°C (EN 61000-3-12) Output power 66%								
Watts(kW)					7,288/7,269/7,254			
Vrms(V)					230,14/230,06/230,05			
Arms(A)					31,668/31,596/31,532			
Frequency(Hz)					50,00			
THD* (66% output power)					0,343%/0,329%/0,526%			
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	31,668	31,596	31,531	99,999	99,999	99,999	Three Phase	--
2nd	0,011	0,012	0,008	0,035	0,038	0,026	Three Phase	8,000
3rd	0,027	0,029	0,057	0,085	0,093	0,181	Three Phase	21,600
4th	0,006	0,007	0,008	0,018	0,023	0,024	Three Phase	4,000
5th	0,043	0,023	0,055	0,136	0,073	0,175	Three Phase	10,700
6th	0,007	0,006	0,005	0,022	0,019	0,016	Three Phase	2,667
7th	0,033	0,047	0,053	0,105	0,149	0,167	Three Phase	7,200
8th	0,004	0,006	0,005	0,013	0,018	0,017	Three Phase	2,000
9th	0,034	0,014	0,031	0,109	0,043	0,098	Three Phase	3,800
10th	0,003	0,005	0,004	0,010	0,015	0,012	Three Phase	1,600
11th	0,025	0,048	0,065	0,078	0,152	0,207	Three Phase	3,100
12th	0,006	0,004	0,003	0,018	0,012	0,011	Three Phase	1,333
13th	0,042	0,014	0,042	0,131	0,045	0,133	Three Phase	2,000
14th	0,003	0,005	0,005	0,008	0,015	0,015	Three Phase	8,000
15th	0,014	0,022	0,037	0,045	0,069	0,116	Three Phase	N/A
16th	0,003	0,005	0,003	0,010	0,017	0,008	Three Phase	N/A
17th	0,026	0,025	0,047	0,081	0,078	0,149	Three Phase	N/A
18th	0,004	0,004	0,002	0,011	0,014	0,006	Three Phase	N/A
19th	0,030	0,018	0,041	0,096	0,056	0,131	Three Phase	N/A
20th	0,002	0,004	0,003	0,005	0,012	0,008	Three Phase	N/A
21th	0,014	0,010	0,024	0,046	0,031	0,076	Three Phase	N/A
22th	0,003	0,004	0,001	0,009	0,011	0,004	Three Phase	N/A
23th	0,009	0,026	0,029	0,029	0,082	0,093	Three Phase	N/A
24th	0,002	0,003	0,003	0,007	0,010	0,009	Three Phase	N/A
25th	0,019	0,011	0,026	0,062	0,033	0,082	Three Phase	N/A
26th	0,002	0,003	0,002	0,007	0,010	0,005	Three Phase	N/A
27th	0,009	0,010	0,018	0,028	0,030	0,058	Three Phase	N/A
28th	0,002	0,002	0,001	0,005	0,007	0,004	Three Phase	N/A
29th	0,009	0,017	0,021	0,027	0,052	0,068	Three Phase	N/A
30th	0,001	0,002	0,002	0,003	0,007	0,007	Three Phase	N/A
31th	0,019	0,009	0,022	0,061	0,029	0,070	Three Phase	N/A
32th	0,001	0,002	0,001	0,005	0,006	0,004	Three Phase	N/A
33th	0,006	0,007	0,013	0,020	0,022	0,041	Three Phase	N/A
34th	0,001	0,001	0,001	0,004	0,004	0,003	Three Phase	N/A
35th	0,008	0,017	0,019	0,026	0,055	0,060	Three Phase	N/A
36th	0,001	0,002	0,002	0,004	0,005	0,005	Three Phase	N/A
37th	0,013	0,008	0,017	0,042	0,025	0,055	Three Phase	N/A
38th	0,001	0,002	0,001	0,004	0,005	0,004	Three Phase	N/A
39th	0,005	0,007	0,011	0,015	0,022	0,036	Three Phase	N/A
40th	0,001	0,001	0,001	0,004	0,003	0,003	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Maximum ambient rating or +55°C (EN 61000-3-12) Output power 100%								
Watts(kW)					11,002/10,970/10,951			
Vrms(V)					230,15/230,10/230,09			
Arms(A)					47,807/47,676/47,596			
Frequency(Hz)					50,00			
THD* (100% output power)					0,508%/0,501%/0,436%			
Harmonics	Current Magnitude (A)			% of Fundamental			Phase	Harmonic Current Limits (%)
	L1	L2	L3	L1	L2	L3		
1st	47,806	47,675	47,596	99,999	99,999	99,999	Three Phase	--
2nd	0,105	0,073	0,068	0,219	0,154	0,142	Three Phase	8,000
3rd	0,027	0,052	0,057	0,056	0,109	0,119	Three Phase	21,600
4th	0,067	0,040	0,045	0,140	0,083	0,094	Three Phase	4,000
5th	0,064	0,051	0,044	0,134	0,107	0,092	Three Phase	10,700
6th	0,022	0,008	0,016	0,046	0,016	0,035	Three Phase	2,667
7th	0,127	0,146	0,073	0,266	0,307	0,154	Three Phase	7,200
8th	0,037	0,015	0,029	0,077	0,031	0,061	Three Phase	2,000
9th	0,082	0,070	0,017	0,172	0,146	0,035	Three Phase	3,800
10th	0,028	0,016	0,025	0,058	0,033	0,053	Three Phase	1,600
11th	0,040	0,094	0,103	0,083	0,196	0,217	Three Phase	3,100
12th	0,016	0,010	0,008	0,034	0,021	0,017	Three Phase	1,333
13th	0,064	0,033	0,052	0,133	0,070	0,110	Three Phase	2,000
14th	0,016	0,015	0,004	0,034	0,031	0,009	Three Phase	8,000
15th	0,018	0,030	0,021	0,037	0,062	0,044	Three Phase	N/A
16th	0,014	0,013	0,003	0,030	0,028	0,007	Three Phase	N/A
17th	0,020	0,027	0,041	0,042	0,058	0,087	Three Phase	N/A
18th	0,013	0,011	0,003	0,027	0,023	0,006	Three Phase	N/A
19th	0,040	0,034	0,051	0,083	0,072	0,108	Three Phase	N/A
20th	0,008	0,005	0,006	0,017	0,011	0,012	Three Phase	N/A
21th	0,021	0,008	0,013	0,044	0,018	0,028	Three Phase	N/A
22th	0,006	0,003	0,007	0,012	0,006	0,014	Three Phase	N/A
23th	0,025	0,041	0,035	0,053	0,086	0,075	Three Phase	N/A
24th	0,003	0,003	0,004	0,006	0,006	0,008	Three Phase	N/A
25th	0,022	0,017	0,026	0,046	0,036	0,055	Three Phase	N/A
26th	0,003	0,002	0,003	0,005	0,004	0,006	Three Phase	N/A
27th	0,009	0,003	0,012	0,019	0,007	0,026	Three Phase	N/A
28th	0,002	0,003	0,002	0,005	0,006	0,003	Three Phase	N/A
29th	0,010	0,016	0,018	0,022	0,034	0,038	Three Phase	N/A
30th	0,002	0,003	0,002	0,005	0,006	0,004	Three Phase	N/A
31th	0,018	0,013	0,021	0,037	0,028	0,045	Three Phase	N/A
32th	0,002	0,002	0,002	0,004	0,005	0,003	Three Phase	N/A
33th	0,005	0,002	0,006	0,011	0,005	0,013	Three Phase	N/A
34th	0,002	0,002	0,001	0,004	0,004	0,003	Three Phase	N/A
35th	0,013	0,020	0,018	0,026	0,041	0,037	Three Phase	N/A
36th	0,002	0,002	0,002	0,003	0,005	0,003	Three Phase	N/A
37th	0,013	0,008	0,014	0,027	0,017	0,030	Three Phase	N/A
38th	0,001	0,002	0,001	0,003	0,004	0,003	Three Phase	N/A
39th	0,004	0,004	0,008	0,009	0,008	0,016	Three Phase	N/A
40th	0,002	0,002	0,002	0,004	0,005	0,003	Three Phase	N/A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.3.2 c)	**Voltage fluctuations and flicker (IEC 61000-3-11)**			P
Flicker measurement under ambient condition 20˚C				
100% rating power condition:				
P_{bin}(%)	Limit	L1 Phase	L2 Phase	L3 Phase
PST	≤ 1	0.34	0.31	0.30
PLT	≤ 0.65	0.33	0.30	0.29
dc	≤ 3.30%	0.00%	0.00%	0.00%
dmax	4%	0.88%	0.90%	0.90%
66% rating power condition:				
P_{bin}(%)	Limit	L1 Phase	L2 Phase	L3 Phase
PST	≤ 1	0.28	0.26	0.25
PLT	≤ 0.65	0.27	0.25	0.25
dc	≤ 3.30%	0.00%	0.00%	0.00%
dmax	4%	0.78%	0.95%	0.95%
33% rating power condition:				
P_{bin}(%)	Limit	L1 Phase	L2 Phase	L3 Phase
PST	≤ 1	0.27	0.28	0.30
PLT	≤ 0.65	0.27	0.27	0.29
dc	≤ 3.30%	0.00%	0.00%	0.0%
dmax	4%	0.72%	0.78%	0.74%
Flicker measurement under ambient condition -10˚C				
100% rating power condition:				
P_{bin}(%)	Limit	L1 Phase	L2 Phase	L3 Phase
PST	≤ 1	0.29	0.26	0.30
PLT	≤ 0.65	0.26	0.25	0.29
dc	≤ 3.30%	0.00%	0.00%	0.00%
dmax	4%	0.88%	0.90%	0.90%
66% rating power condition:				
P_{bin}(%)	Limit	L1 Phase	L2 Phase	L3 Phase
PST	≤ 1	0.29	0.26	0.25
PLT	≤ 0.65	0.28	0.25	0.25
dc	≤ 3.30%	0.00%	0.00%	0.00%
dmax	4%	0.78%	0.95%	0.95%

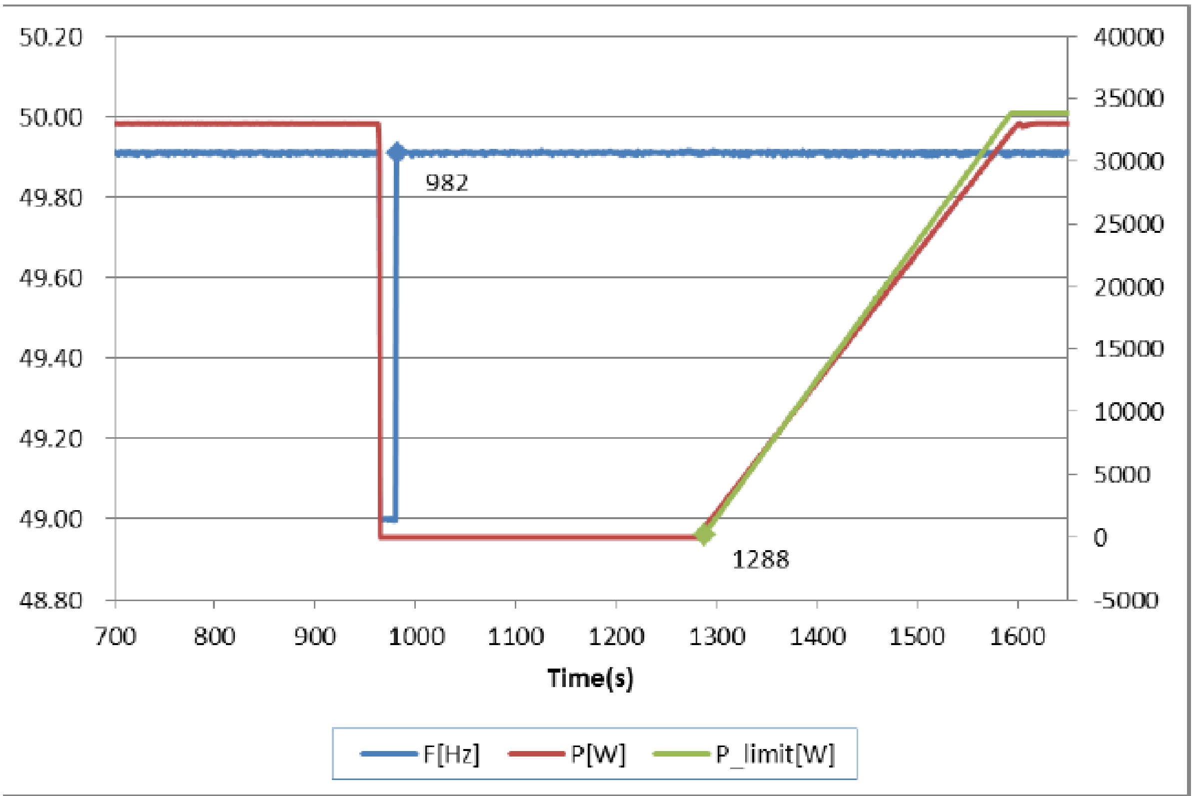
SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

33% rating power condition:				
P_{bin}(%)	Limit	L1 Phase	L2 Phase	L3 Phase
PST	≤ 1	0.27	0.26	0.30
PLT	≤ 0.65	0.27	0.25	0.29
dc	≤ 3.30%	0.00%	0.00%	0.0%
dmax	4%	0.72%	0.78%	0.74%
Flicker measurement under ambient condition 55˚C				
100% rating power condition:				
P_{bin}(%)	Limit	L1 Phase	L2 Phase	L3 Phase
PST	≤ 1	0.29	0.26	0.30
PLT	≤ 0.65	0.26	0.25	0.29
dc	≤ 3.30%	0.00%	0.00%	0.00%
dmax	4%	0.88%	0.90%	0.90%
66% rating power condition:				
P_{bin}(%)	Limit	L1 Phase	L2 Phase	L3 Phase
PST	≤ 1	0.29	0.26	0.25
PLT	≤ 0.65	0.28	0.25	0.25
dc	≤ 3.30%	0.00%	0.00%	0.00%
dmax	4%	0.78%	0.95%	0.95%
33% rating power condition:				
P_{bin}(%)	Limit	L1 Phase	L2 Phase	L3 Phase
PST	≤ 1	0.25	0.26	0.30
PLT	≤ 0.65	0.24	0.25	0.29
dc	≤ 3.30%	0.00%	0.00%	0.0%
dmax	4%	0.72%	0.78%	0.74%

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.3.2.1.1	Verifying connection and reconnection		P
Condition	Result		Limit
a) < 95% Vn and > 105% Vn (49.9 Hz < f < 50.1 Hz)	No power output	☒ Yes, ☐ No	--
b) 95% Vn < V <105% Vn	Connection delay time (s)	65	≥ 60 s
c) 95% Vn < V < 105% Vn	Reconnection delay time (s)	307	≥ 300 s
d) < 49.9 Hz and > 50.1 Hz (95% Vn < V <105% Vn)	No power output	☒ Yes, ☐ No	--
e) 49.9 Hz < f < 50.1 Hz	Connection delay time (s)	65	≥ 60 s
f) 49.9 Hz < f < 50.1 Hz	Reconnection delay time (s)	306	≥ 300 s

D.3.2.1.2	Verification of step release of the active power		P
Condition	Output power gradient (W/s)	Output power gradient/ Pn (% Pn/s)	Limit (% Pn/s)
Test sequences b)	107.49	0.326	0.333
Test sequences c)	106.45	0.322	
Test sequences e)	106.46	0.323	
Test sequences f)	98.80	0.299	



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.3.2.2.2	Mode of execution and registration of the test results	P

Inductive reactive power absorbation				
Power-BIN	Active power [kW]	Reactive power [kVar]	Power factor (cos φ)	DC power [kW]
0% -10%	3,060	-16,266	0,1849	3,438
	3,060	-16,262	0,1849	3,438
	3,061	-16,261	0,1850	3,440
10% -20%	6,598	-16,646	0,3685	7,020
	6,597	-16,645	0,3685	7,020
	6,598	-16,644	0,3685	7,021
20% -30%	9,925	-16,806	0,5085	10,400
	9,925	-16,807	0,5085	10,400
	9,923	-16,808	0,5084	10,398
30% -40%	13,216	-16,877	0,6165	13,757
	13,218	-16,877	0,6166	13,760
	13,223	-16,875	0,6168	13,758
40% -50%	16,498	-16,903	0,6985	17,112
	16,496	-16,902	0,6985	17,110
	16,497	-16,903	0,6984	17,111
50% -60%	19,838	-16,907	0,7611	20,550
	19,840	-16,908	0,7611	20,551
	19,839	-16,906	0,7611	20,550
60% -70%	23,095	-16,924	0,8066	23,910
	23,094	-16,924	0,8066	23,911
	23,090	-16,927	0,8065	23,910
70% -80%	26,402	-16,568	0,8470	27,339
	26,402	-16,567	0,8470	27,338
	26,482	-16,565	0,8477	27,422
80% -90%	29,692	-16,587	0,8730	30,757
	29,691	-16,589	0,8730	30,758
	29,756	-16,591	0,8734	30,831
90% -100%	32,825	-16,645	0,8919	34,038
	32,828	-16,646	0,8919	34,043
	32,824	-16,645	0,8919	34,040

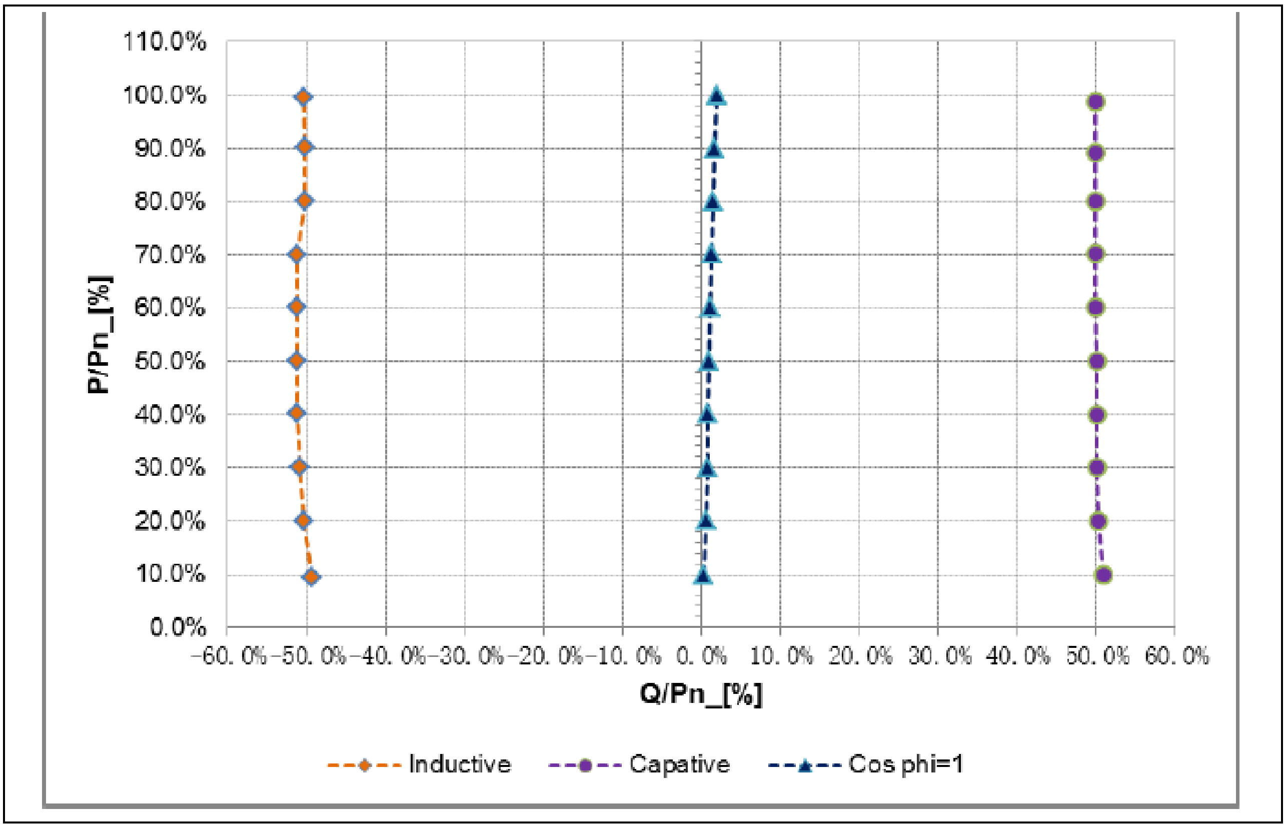
SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Capacitive reactive power supply				
Power-BIN	Active power [kW]	Reactive power [kVar]	Power factor (cos φ)	DC power [kW]
0% -10%	3,280	16,836	0,1913	3,641
	3,283	16,839	0,1914	3,643
	3,284	16,833	0,1915	3,642
10% -20%	6,609	16,561	0,3706	7,000
	6,610	16,567	0,3706	7,000
	6,609	16,562	0,3706	7,000
20% -30%	9,904	16,513	0,5143	10,344
	9,901	16,510	0,5143	10,340
	9,903	16,515	0,5143	10,343
30% -40%	13,206	16,506	0,6247	13,708
	13,179	16,510	0,6238	13,683
	13,180	16,503	0,6240	13,681
40% -50%	16,532	16,510	0,7076	17,112
	16,532	16,503	0,7077	17,112
	16,532	16,505	0,7076	17,112
50% -60%	19,837	16,491	0,7689	20,508
	19,818	16,497	0,7685	20,489
	19,819	16,495	0,7686	20,490
60% -70%	23,148	16,473	0,8147	23,916
	23,141	16,476	0,8146	23,913
	23,141	16,477	0,8146	23,913
70% -80%	26,455	16,483	0,8487	27,339
	26,454	16,484	0,8487	27,338
	26,453	16,481	0,8487	27,339
80% -90%	28,776	16,500	0,8668	29,750
	29,746	16,496	0,8745	30,761
	29,741	16,492	0,8745	30,758
90% -100%	32,585	16,496	0,8922	33,740
	32,604	16,492	0,8923	33,759
	32,602	16,491	0,8923	33,760

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

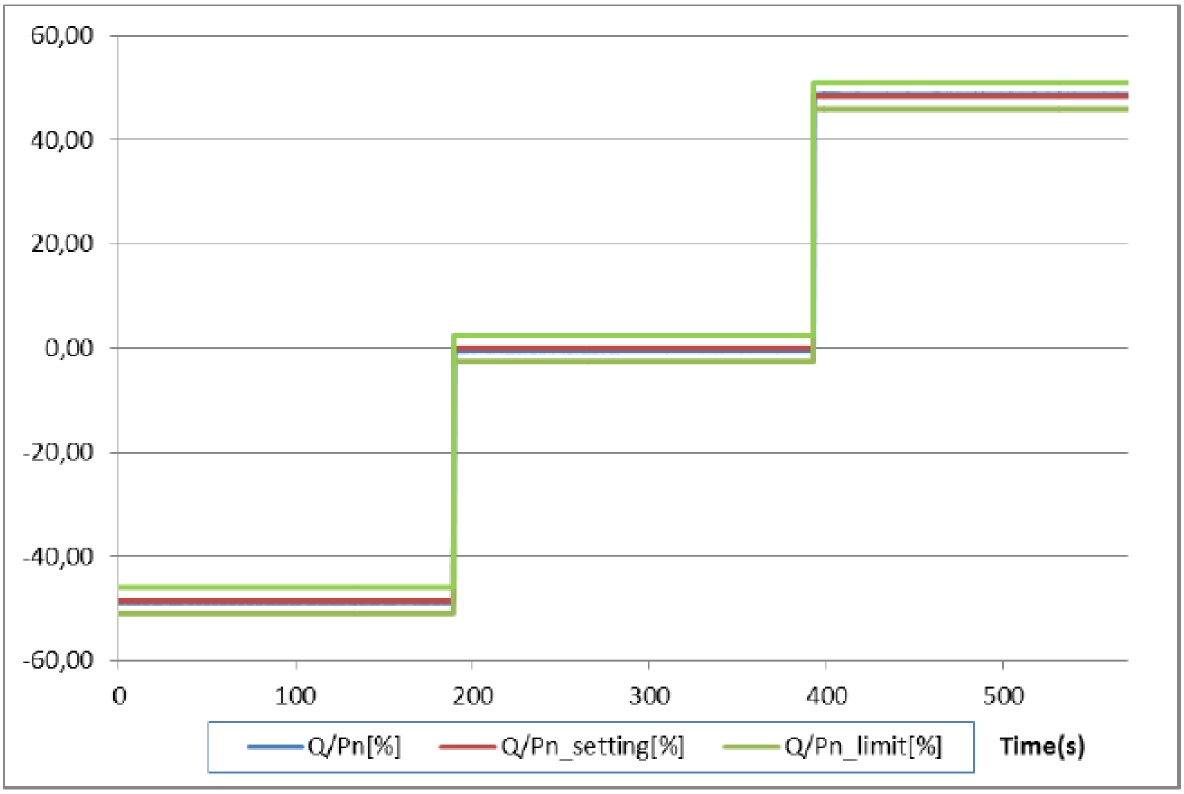
Reactive power supply with set point Q=0				
Power-BIN	Active power [kW]	Reactive power [kVar]	Power factor (cos φ)	DC power [kW]
0% -10%	3,299	0,071	0,9976	3,411
	3,299	0,071	0,9976	3,413
	3,299	0,071	0,9976	3,411
10% -20%	6,641	0,236	0,9994	6,815
	6,638	0,234	0,9994	6,813
	6,639	0,236	0,9994	6,814
20% -30%	9,942	0,252	0,9997	10,186
	9,939	0,251	0,9997	10,184
	9,937	0,253	0,9997	10,184
30% -40%	13,240	0,289	0,9998	13,565
	13,229	0,287	0,9998	13,555
	13,230	0,283	0,9998	13,555
40% -50%	16,545	0,332	0,9998	16,959
	16,545	0,333	0,9998	16,960
	16,543	0,330	0,9998	16,958
50% -60%	19,848	0,380	0,9998	20,363
	19,846	0,380	0,9998	20,362
	19,847	0,384	0,9998	20,363
60% -70%	23,140	0,436	0,9998	23,766
	23,141	0,439	0,9998	23,768
	23,141	0,443	0,9998	23,770
70% -80%	26,426	0,502	0,9998	27,176
	26,426	0,506	0,9998	27,176
	26,424	0,506	0,9998	27,175
80% -90%	29,696	0,573	0,9998	30,578
	29,693	0,573	0,9998	30,577
	29,690	0,571	0,9998	30,576
90% -100%	33,025	0,653	0,9998	34,064
	33,033	0,656	0,9998	34,076
	33,036	0,647	0,9998	34,080

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

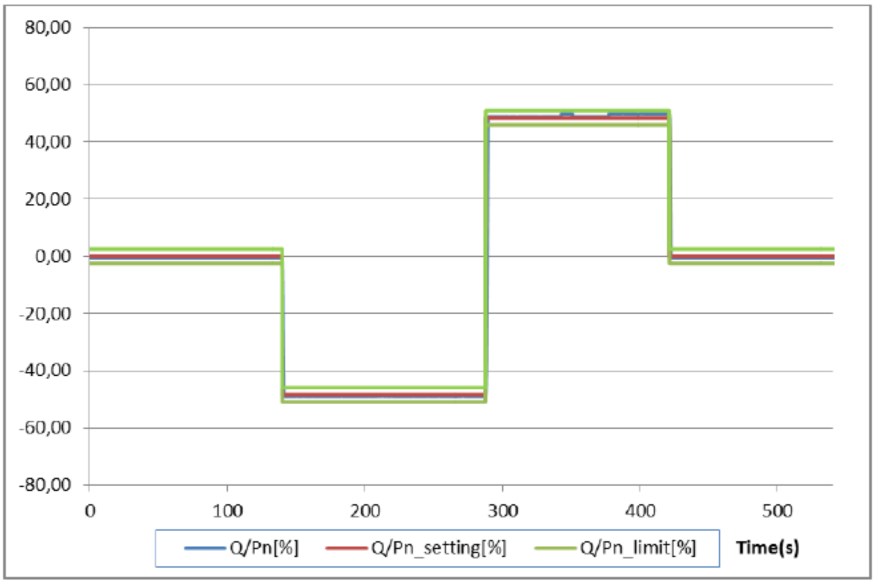
D.3.2.2.3	Exchange of reactive power according to an assigned level		P
	Set-point reactive power Q / Pn [%]	Measured reactive power Q / Pn [%]	Deviation from set point ΔQ / Pn [%]
Qmax[ind]	-48.43	-48.87	-0.44
0	0	-0.40	-0.40
Qmax[cap]	+48.43	48.74	0.31
Limit			± 2.5



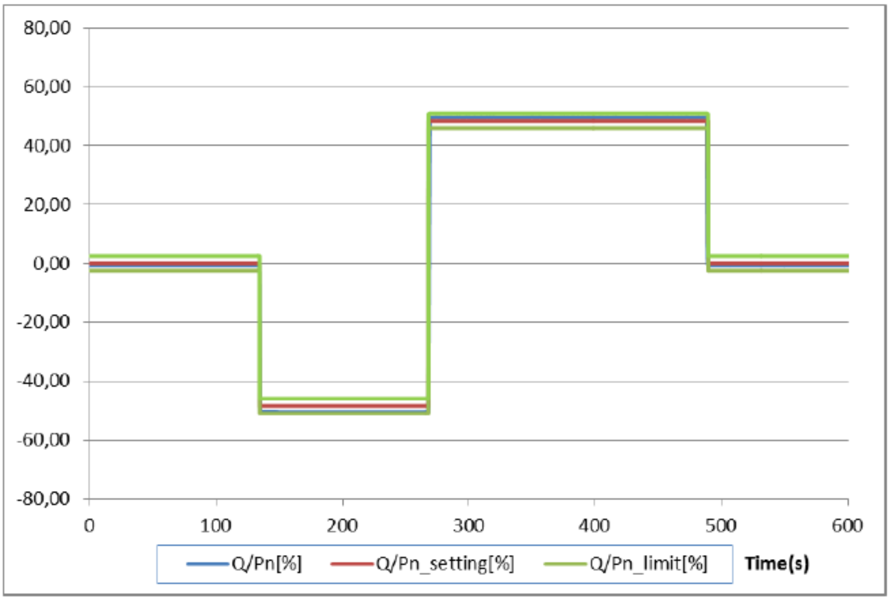
SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.3.2.2.4	**Time response to a step change in the level assigned**	P

Reactive power set point	Maximum response time (s)	
	50% of rated active power	100% of rated active power
Zero to -Qmin	1.2	0.6
-Qmin to +Qmax	2.0	1.0
+Qmax to zero	1.0	0.8
Limit	10	



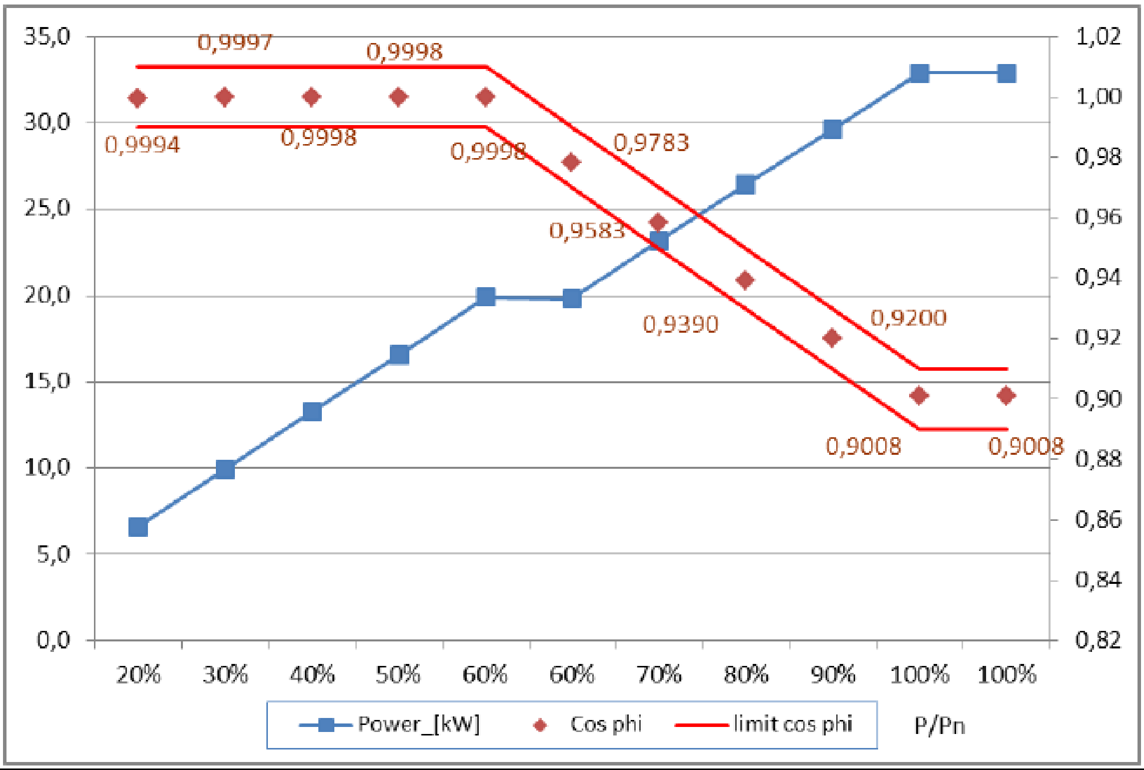
50% of rated active power



100% of rated active power

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.3.2.2.5	**Automatic delivery of reactive power according to a characteristic curve cos φ = f (P)**				P
Lock-in parameter is set to 1.05Vn = 241.5Vac					
P / Pn [%]	P [KW]	Q [KVar]	Cos φ Measured	Cos φ Expected	∆ Cos φ
Voltage at the output terminals ≤ 1.05 Vn = 239.2Vac					
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	0.398	0.9998	1.00	-0.0002
Increase the network voltage to 1.06 Vn = 243.8Vac					
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	0.00
100%	32.877	-15.846	0.9008	0.90	0.0008
Remark: ∆cos φ_max ≤ ± 0.01					



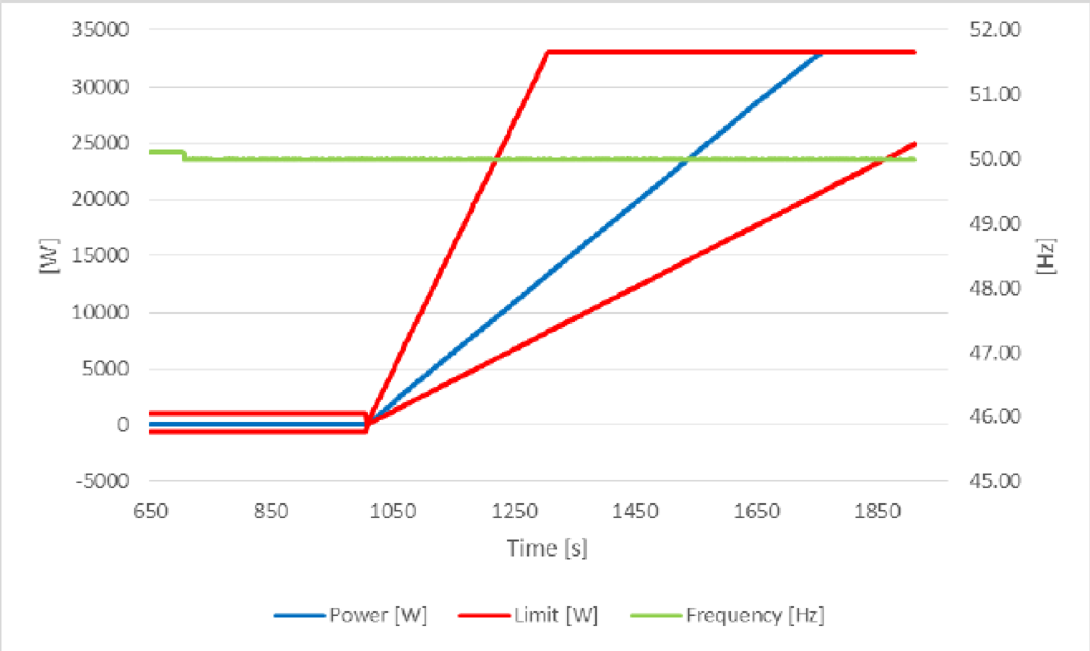
SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.3.2.3.1	Control of active power in the presence of transients on the transmission network					P
Frequency	Sequences A (50% Pn) (W)			Sequences B (100% Pn) (W)		
	Output power (measured)	Output power (expected)	Deviation	Output power (measured)	Output power (expected)	Deviation
47.51 Hz	16665	16500	165	33099	33000	99
50.2 Hz	16682	16500	182	33099	33000	99
50.4 Hz	15914	15749	165	31384	31499	-115
50.6 Hz	13895	14248	-353	27770	28496	-726
52.49 Hz	23	59	-36	28	117	-89
50.11 Hz	13	59	-46	20	117	-97
50 Hz	18	59	-41	25	117	-92
Limit	--	--	±825	--	--	±825

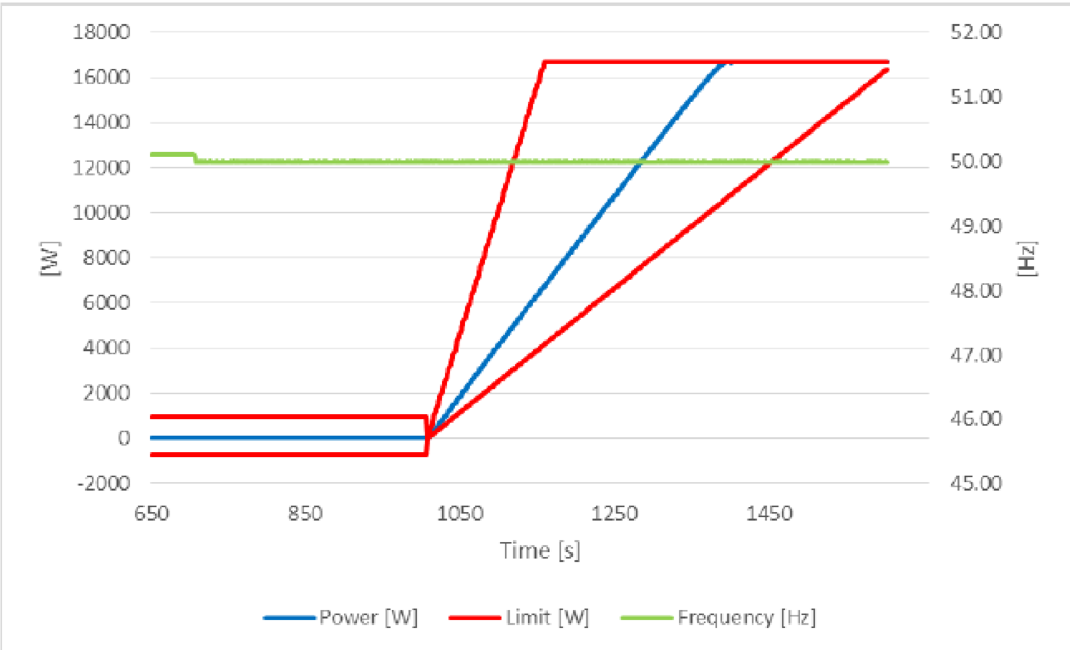
50 Hz	Waiting time (s)	Positive gradient of output power (W/ min.)	Waiting time (s)	Positive gradient of output power (W/ min.)
	347	2828.58	350	2828.57
Limit	300	3300	300	6600

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Graph of Measurement 2.: Power gradient 100% P_{nom}

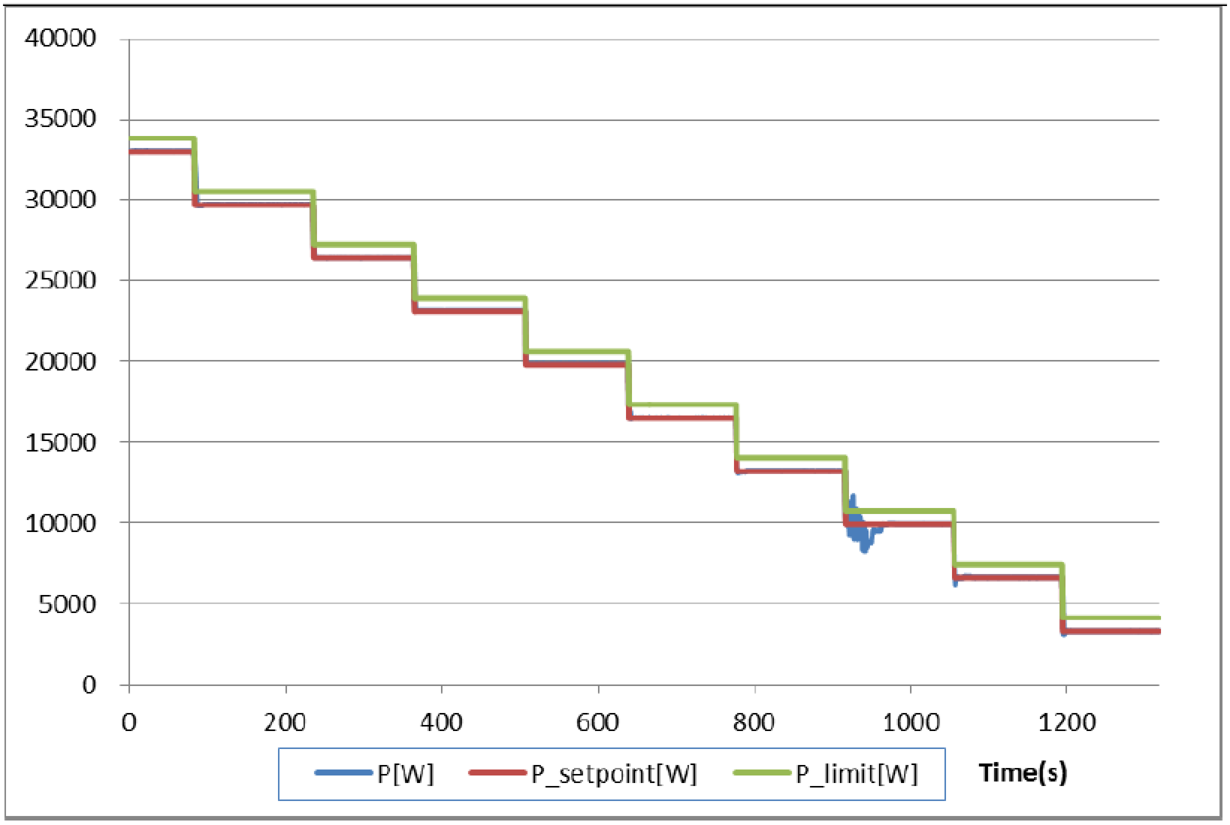


Graph of Measurement 2.: Power gradient 50% P_{nom}



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.3.2.3.2	Active Power Limitation upon external command			P
Set point P [P / Pn]	Set point P [KW]	Measured P [KW]	Accuracy [%]	Limit [%
100%	33.000	33.036	0.109	±2.5
90%	29.700	29.740	0.121	±2.5
80%	26.400	26.409	0.027	±2.5
70%	23.100	23.149	0.148	±2.5
60%	19.800	19.848	0.145	±2.5
50%	16.500	16.511	0.033	±2.5
40%	13.200	13.252	0.158	±2.5
30%	9.900	9.923	0.070	±2.5
20%	6.600	6.629	0.088	±2.5
10%	3.300	3.302	0.006	+2.5%~ 0
0%	0	0.198	0.600	+2.5%~ 0



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.3.2.4.1	Verification of emission of a DC component	P

Test result: SOFAR 20000TL-G2

Power Level	(33 ± 5)%	(66 ± 5)%	(100 ± 5)%
	Ambient (Phase1)		
Watt (kW)	2,210	4,425	6,701
Vrms (V)	230,07	230,10	230,11
Arms (A)	9,601	19,228	29,120
PF	0,9998	0,9999	0,9999
Cosφ	0,9998	0,9999	0,9999
DC (mA)	-0,086	-0,087	-0,074
DC (%)	-0,297	-0,300	-0,255
	Ambient (Phase2)		
Watt (kW)	2,210	4,411	6,681
Vrms (V)	230,02	230,04	230,06
Arms (A)	9,604	19,180	29,039
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,053	-0,054	-0,054
DC (%)	-0,183	-0,186	-0,186
	Ambient (Phase3)		
Watt (kW)	2,201	4,400	6,667
Vrms (V)	230,00	230,02	230,05
Arms (A)	9,579	19,131	28,984
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,068	-0,076	-0,063
DC (%)	-0,235	-0,262	-0,217
	-25°C (Phase1)		
Watt (kW)	2,199	4,434	6,718
Vrms (V)	230,07	230,09	230,11
Arms (A)	9,561	19,273	29,194
PF	0,9998	0,9999	0,9999
Cosφ	0,9998	0,9999	0,9999
DC (mA)	-0,015	-0,021	-0,019
DC (%)	-0,052	-0,072	-0,066
	-25°C (Phase2)		
Watt (kW)	2,199	4,412	6,685
Vrms (V)	230,01	230,04	230,08
Arms (A)	9,562	19,181	29,057
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,036	-0,039	-0,053
DC (%)	-0,124	-0,135	-0,183
	-25°C (Phase3)		
Watt (kW)	2,193	4,434	6,675
Vrms (V)	229,99	230,09	230,05
Arms (A)	9,535	19,273	29,019
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,034	-0,028	-0,027
DC (%)	-0,117	-0,097	-0,093

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Clause	Requirement + Test	Result - Remark	Verdict

	+60°C (Phase1)		
Watt (kW)	2,214	4,419	6,700
Vrms (V)	230,07	230,09	230,14
Arms (A)	9,625	19,198	29,114
PF	0,9998	0,9999	0,9999
Cosφ	0,9998	0,9999	0,9999
DC (mA)	-0,049	-0,035	-0,020
DC (%)	-0,169	-0,121	-0,069
	+60°C (Phase2)		
Watt (kW)	2,215	4,409	6,678
Vrms (V)	230,02	230,04	230,07
Arms (A)	9,629	19,158	29,025
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,050	-0,048	-0,048
DC (%)	-0,173	-0,166	-0,166
	+60°C (Phase3)		
Watt (kW)	2,210	4,395	6,663
Vrms (V)	230,00	230,02	230,04
Arms (A)	9,604	19,105	28,965
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,055	-0,042	-0,034
DC (%)	-0,190	-0,145	-0,117

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Diagram of permanent DC-Injection (ambient)

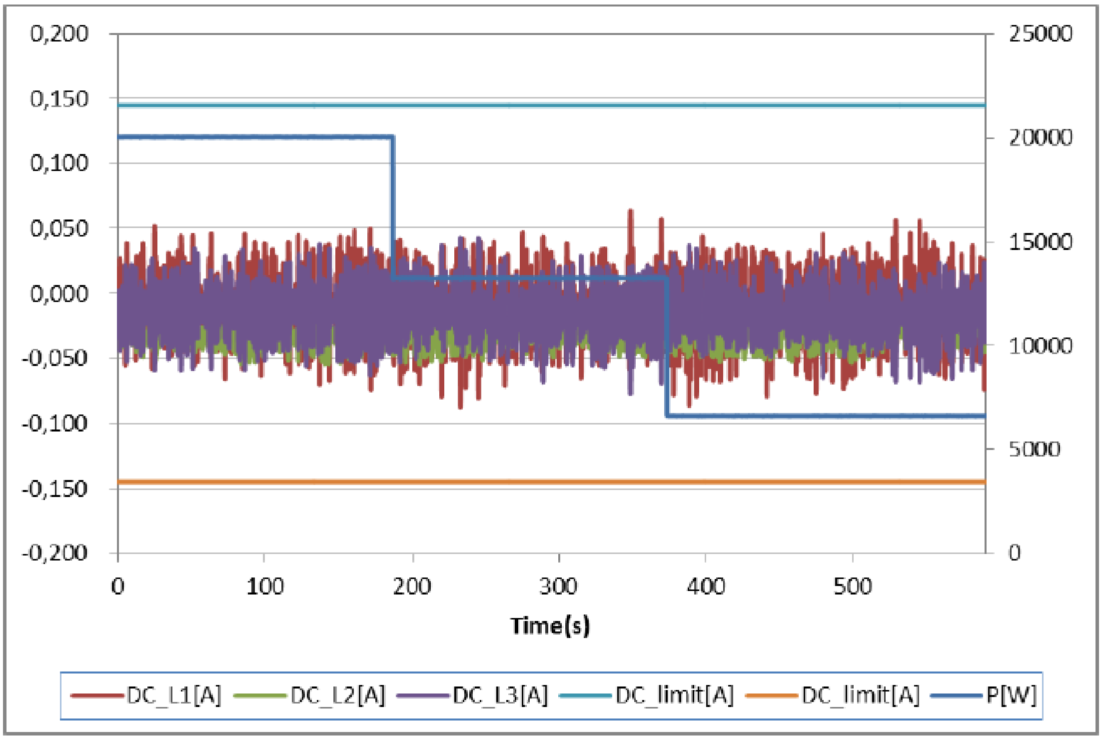
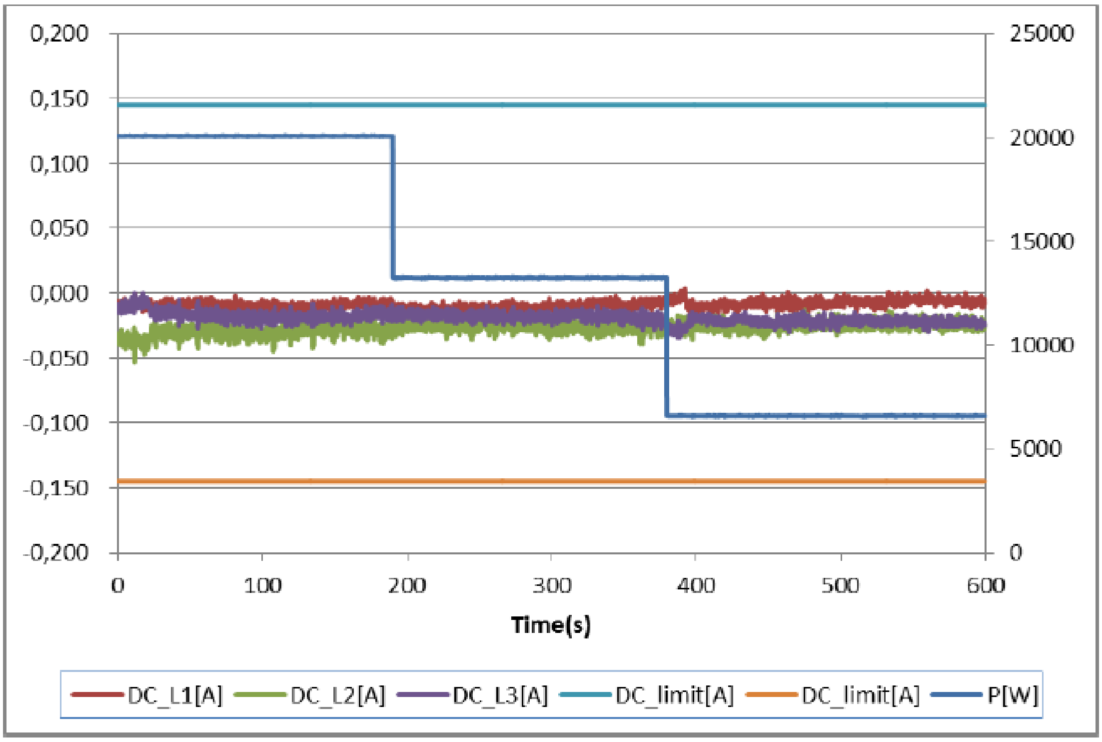
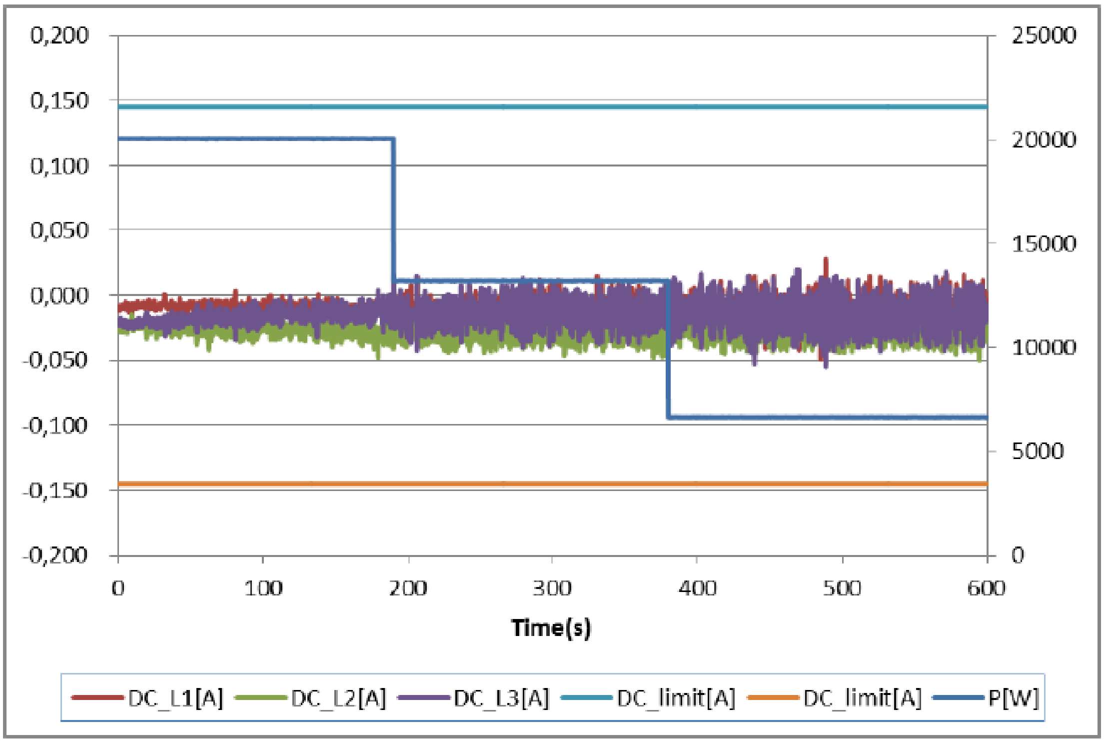


Diagram of permanent DC-Injection (-25°C)



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Diagram of permanent DC-Injection (+60°C)



Test result: SOFAR 33000TL-G2			
Power Level	(33 ± 5)%	(66 ± 5)%	(100 ± 5)%
	Ambient at normal (L1 Phase)		
Watt (kW)	3,579	7,289	11,043
Vrms (V)	230,19	230,31	230,31
Arms (A)	15,552	31,652	47,951
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	0,078	0,062	0,046
DC (%)	0,163	0,130	0,096
	Ambient at normal (L2 Phase)		
Watt (kW)	3,557	7,242	10,972
Vrms (V)	229,55	229,72	229,69
Arms (A)	15,495	31,528	47,773
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	0,031	-0,030	-0,062
DC (%)	0,065	-0,063	-0,130
	Ambient at normal (L3 Phase)		
Watt (kW)	3,556	7,249	10,980
Vrms (V)	230,05	230,20	230,10
Arms (A)	15,461	31,495	47,724
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,073	-0,067	-0,077
DC (%)	-0,153	-0,140	-0,161
	Ambient at -25°C (L1 Phase)		
Watt (kW)	3,659	7,317	11,043
Vrms (V)	230,09	230,14	230,18
Arms (A)	15,902	31,797	47,977
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,043	0,039	0,046
DC (%)	-0,090	0,082	0,096
	Ambient at -25°C (L2 Phase)		
Watt (kW)	3,645	7,286	11,001
Vrms (V)	230,04	230,07	230,10
Arms (A)	15,844	31,669	47,811
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	0,021	-0,027	-0,034
DC (%)	0,044	-0,056	-0,071
	Ambient at -25°C (L3 Phase)		
Watt (kW)	3,634	7,276	10,986
Vrms (V)	230,02	230,06	230,09
Arms (A)	15,799	31,628	47,749
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	0,037	0,036	-0,021
DC (%)	0,077	0,075	-0,044
	Ambient at +60°C (L1 Phase)		
Watt (kW)	3,649	7,288	11,002
Vrms (V)	230,09	230,14	230,15
Arms (A)	15,861	31,668	47,807
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,072	-0,065	-0,061

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

DC (%)	-0,151	-0,136	-0,128
	Ambient at +60°C (L2 Phase)		
Watt (kW)	3,642	7,269	10,970
Vrms (V)	230,04	230,06	230,10
Arms (A)	15,834	31,596	47,676
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	-0,027	-0,026	-0,039
DC (%)	-0,056	-0,054	-0,082
	Ambient at +60°C (L3 Phase)		
Watt (kW)	3,631	7,254	10,951
Vrms (V)	230,02	230,05	230,09
Arms (A)	15,789	31,532	47,596
PF	0,9999	0,9999	0,9999
Cosφ	0,9999	0,9999	0,9999
DC (mA)	0,055	0,048	0,048
DC (%)	0,115	0,100	0,100

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Diagram of permanent DC-Injection (ambient)

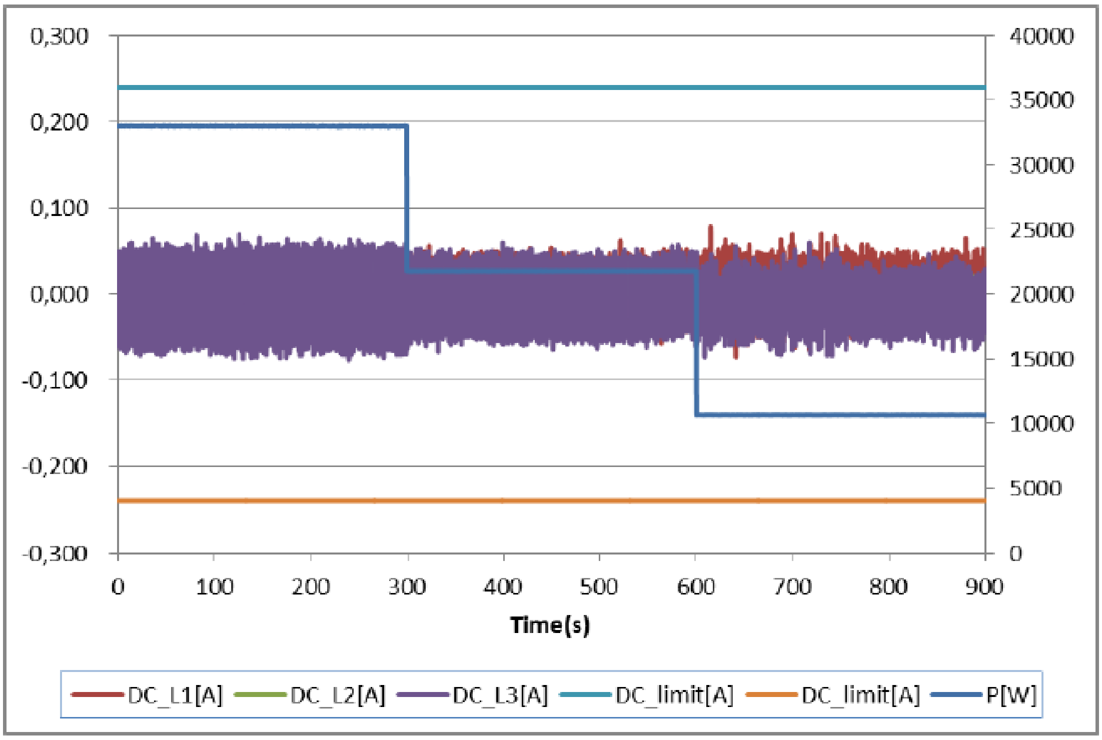
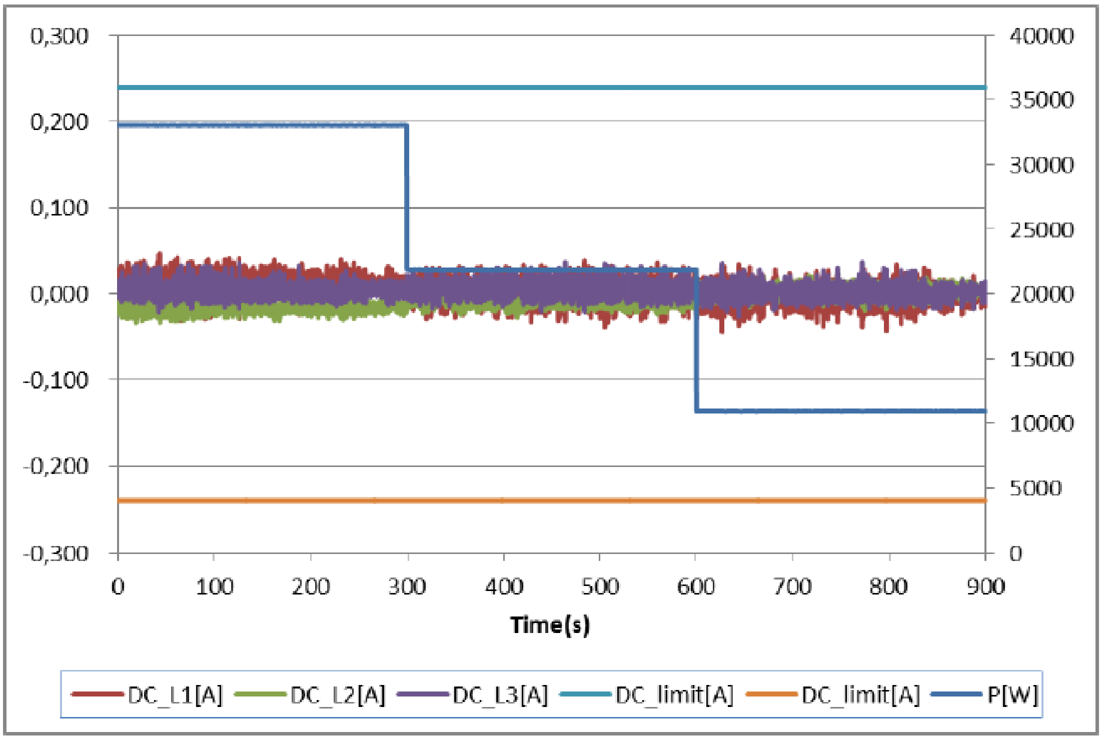
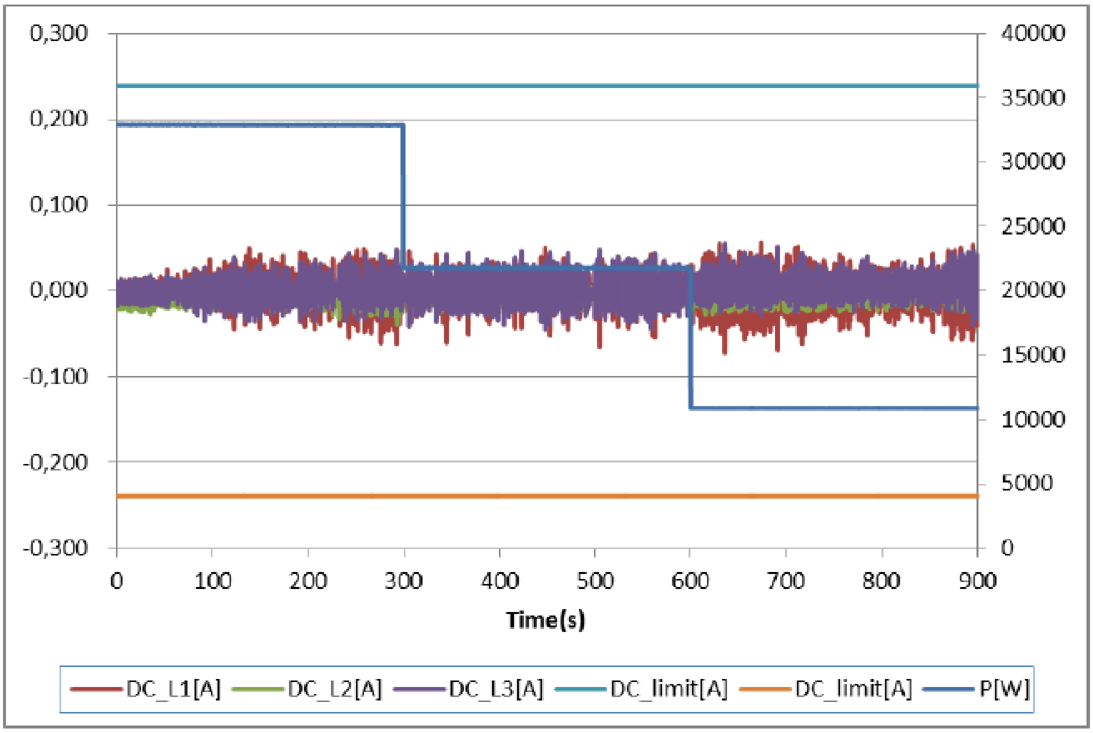


Diagram of permanent DC-Injection (-25°C)



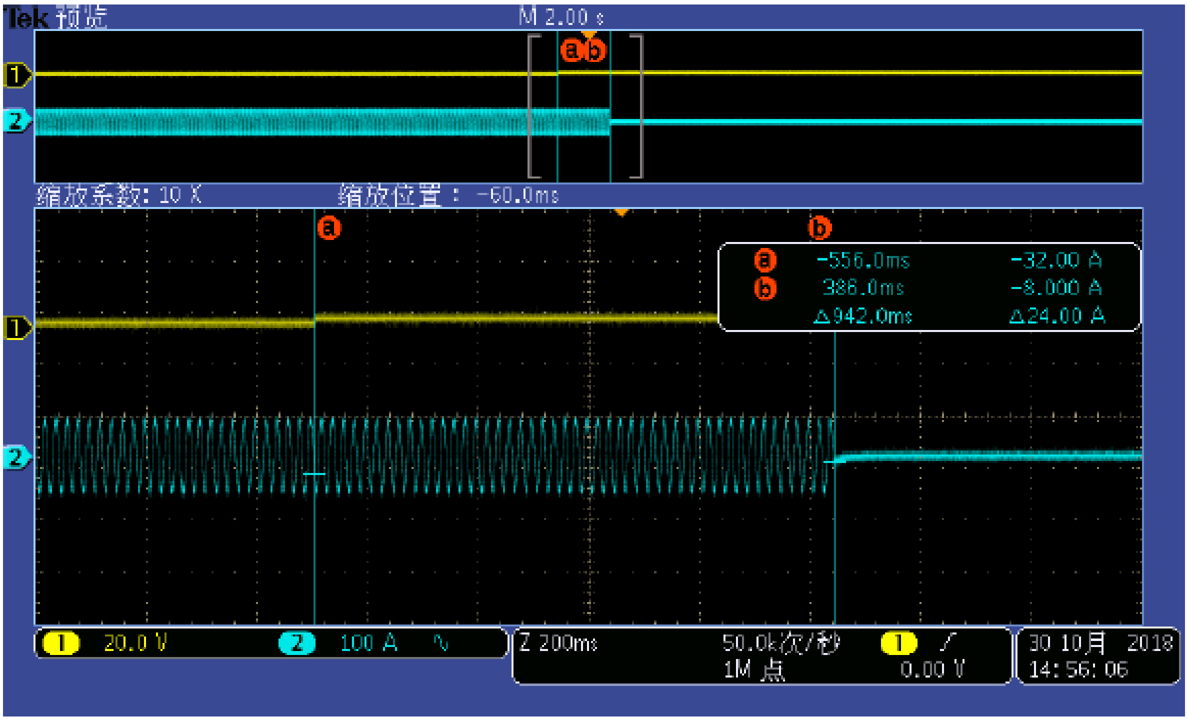
SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Diagram of permanent DC-Injection (+60°C)



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.3.2.4.2	**Verification of protections to prevent the injection of a DC component**			P
DC component	Trip time (s)			
Idc> (> 0.5% In)	(33 ± 5) % Pn	(66 ± 5) % Pn	(100 ± 5) % Pn	Limit
> 0.239A	0.942	0.906	0.942	1
Idc>> (> 1 A)	(33 ± 5) % Pn	(66 ± 5) % Pn	(100 ± 5) % Pn	Limit
> 1 A	0.179	0.160	0.180	0.2

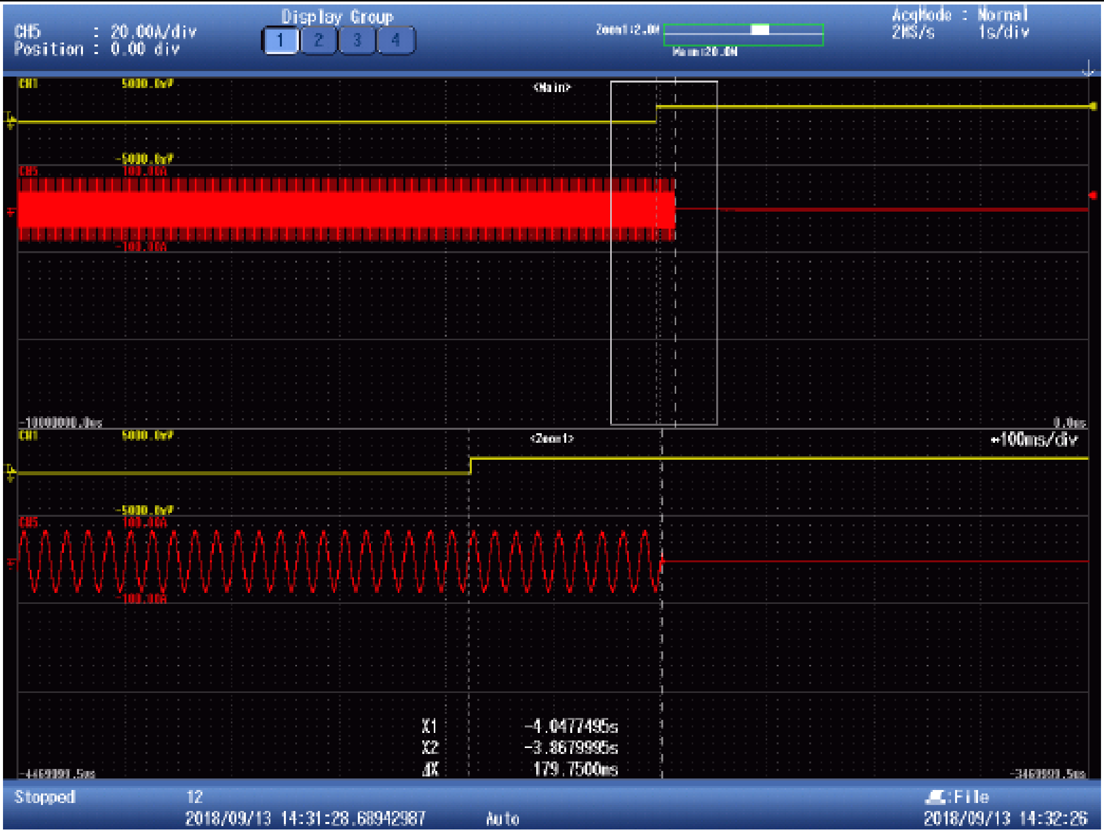


DC-Injection 0.5%

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

DC-Injection 1A

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

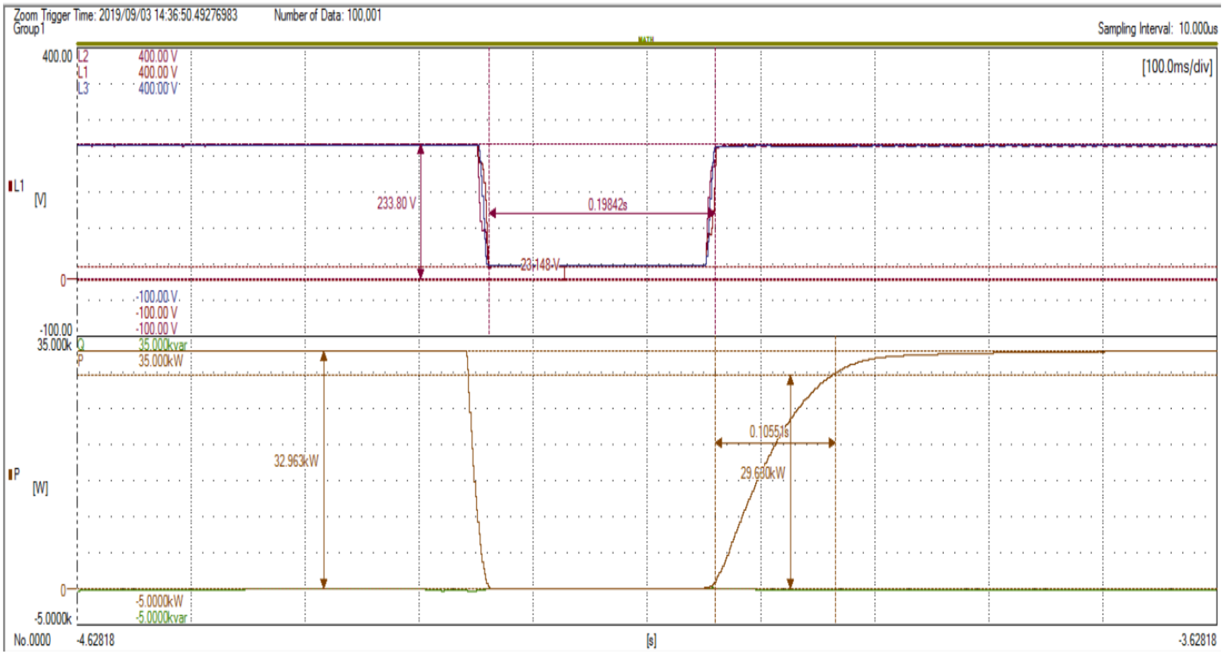


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

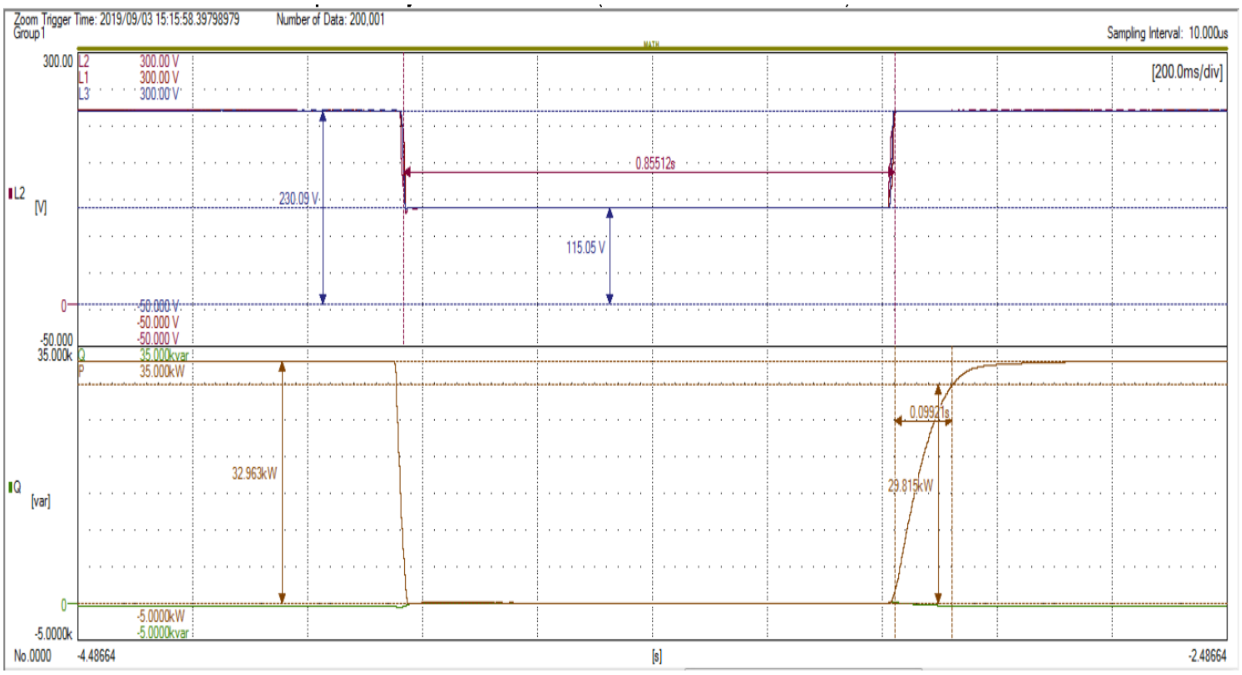
D.3.2.5	**Table: Verification of insensitivity to voltage dips (LVFRT capability)**								**P**
Output power: 33KW	Limits: >90% Pnom,								
	R	S	T	R	S	T	**Duration**	**Recovery time**	**Limits of recovery time**
	U/Unom	U/Unom	U/Unom	φ1	φ2	φ3	[ms]	[ms]	[ms]
1 - three-phase symmetrical fault	0.05	0.05	0.05	0°	-120°	120°	200± 20	105.51	<200
2 - three-phase symmetrical failure	0.45	0.45	0.45	0°	-120°	120°	400± 20	99.20	<200
3 - two-phase asymmetric failure	0.86	0.86	0.05	27°	-147°	113°	200± 20	107.09	<200
4 - two-phase asymmetric failure	0.88	0.88	0.45	15°	-135°	115°	400± 20	107.08	<200
5 – asymmetric two-phase fault in LV	0.05	0.05	1.000	0°	-120°	120°	200 ± 20	92.92	<200
6 – asymmetric two-phase fault in LV	0.45	0.45	1.00	0°	-120°	120°	400 ± 20	102.23	<200

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Test 1: three-phase symmetrical fault

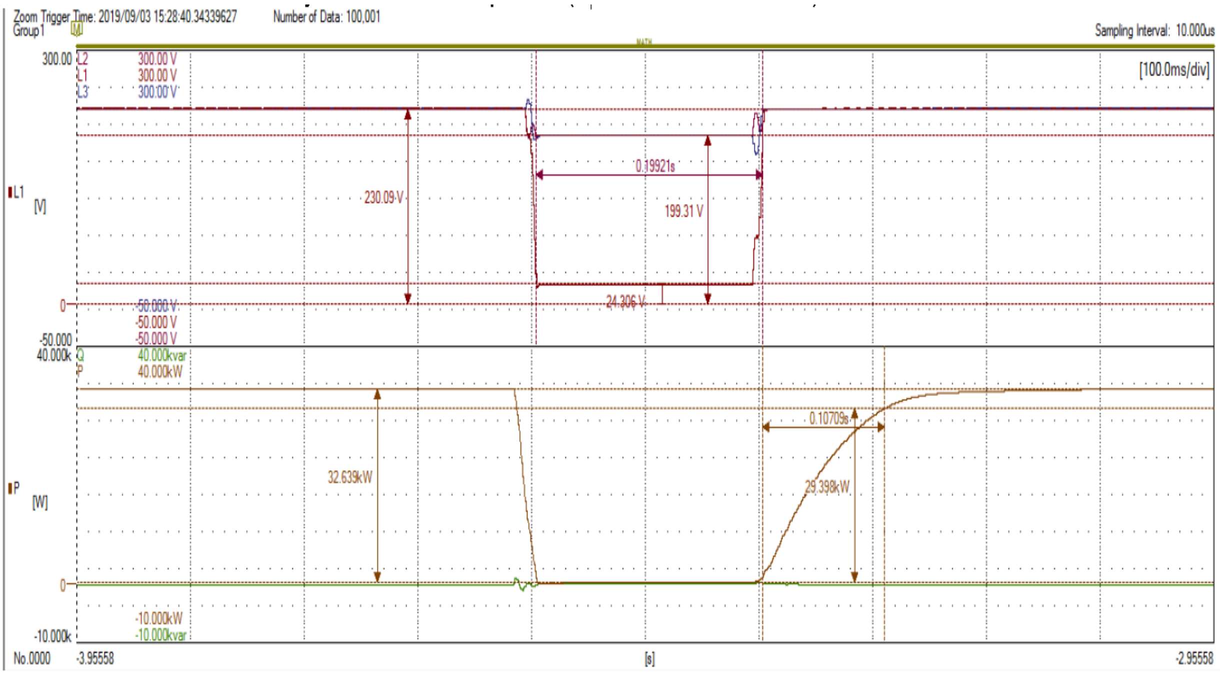


Test 2: three-phase symmetrical failure

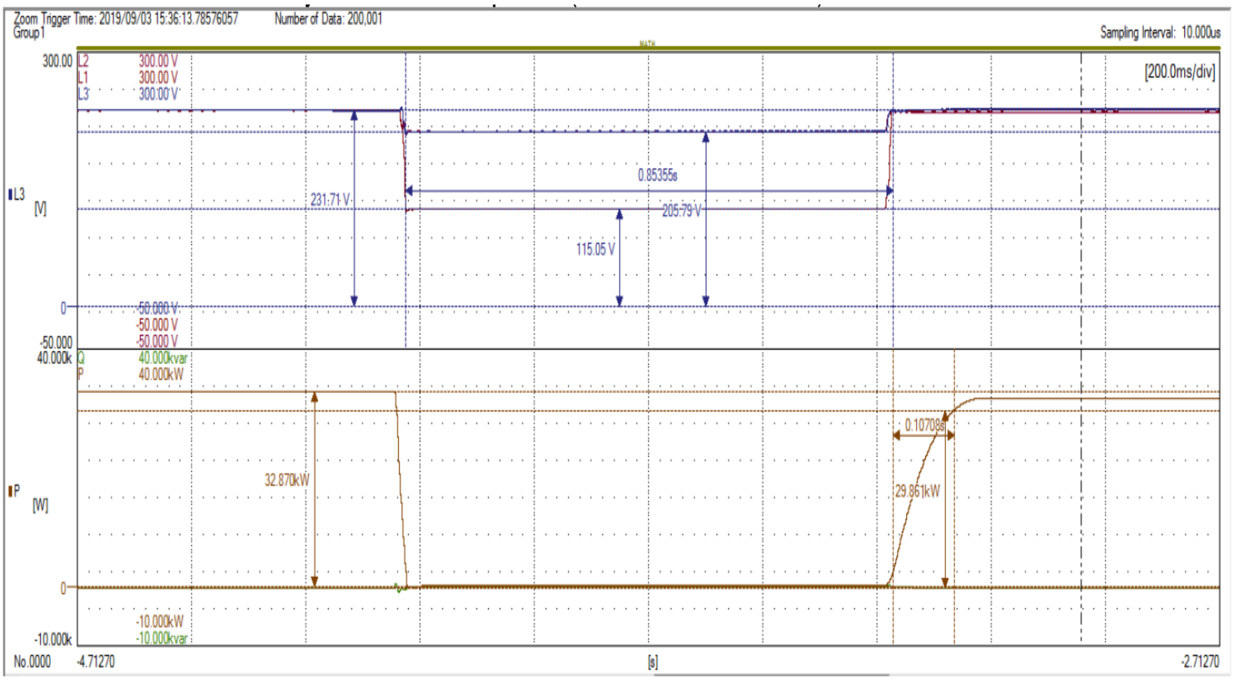


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Test 3: two-phase asymmetric failure

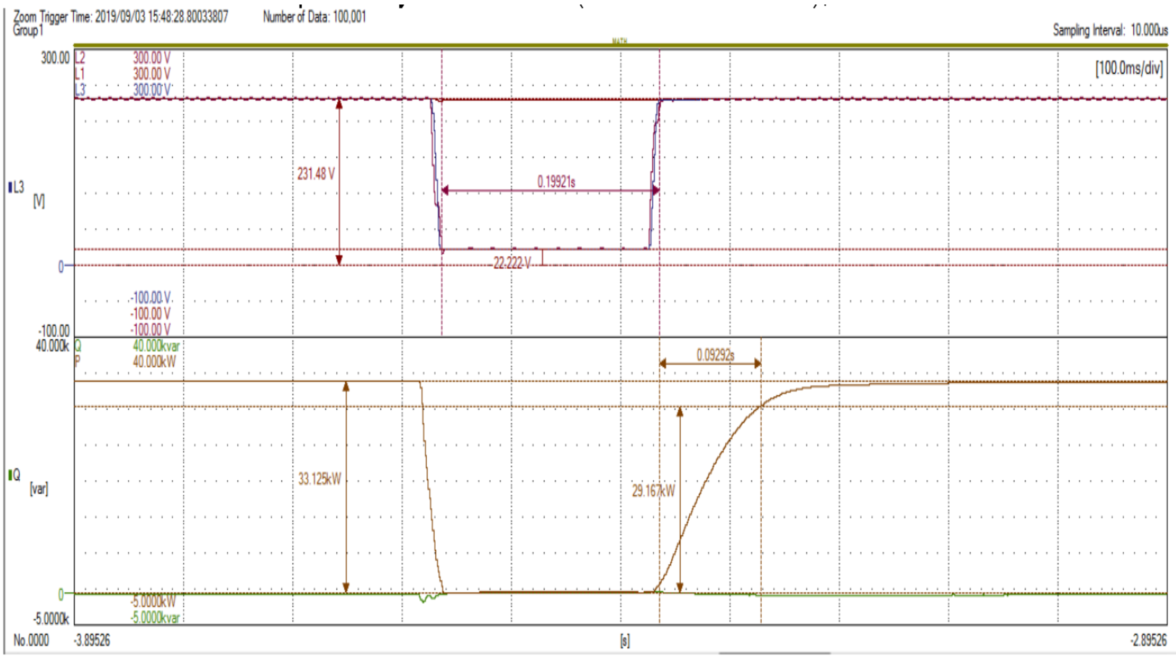


Test 4: two-phase asymmetric failure

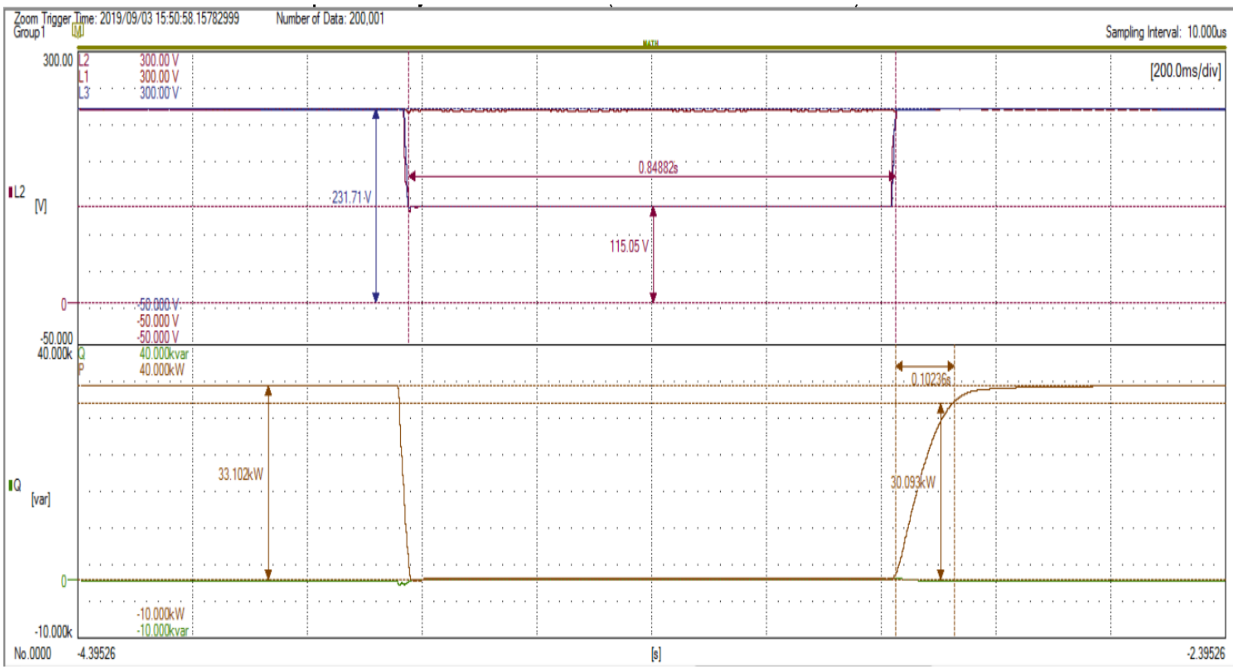


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Test 5: asymmetric two-phase fault in LV



Test 6: asymmetric two-phase fault in LV

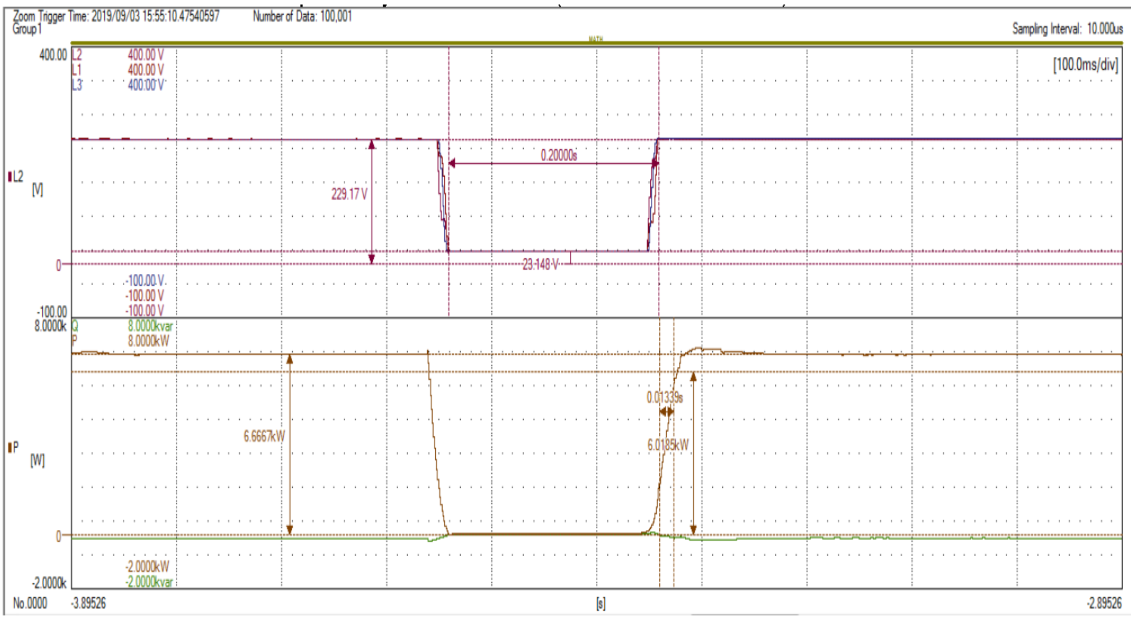


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

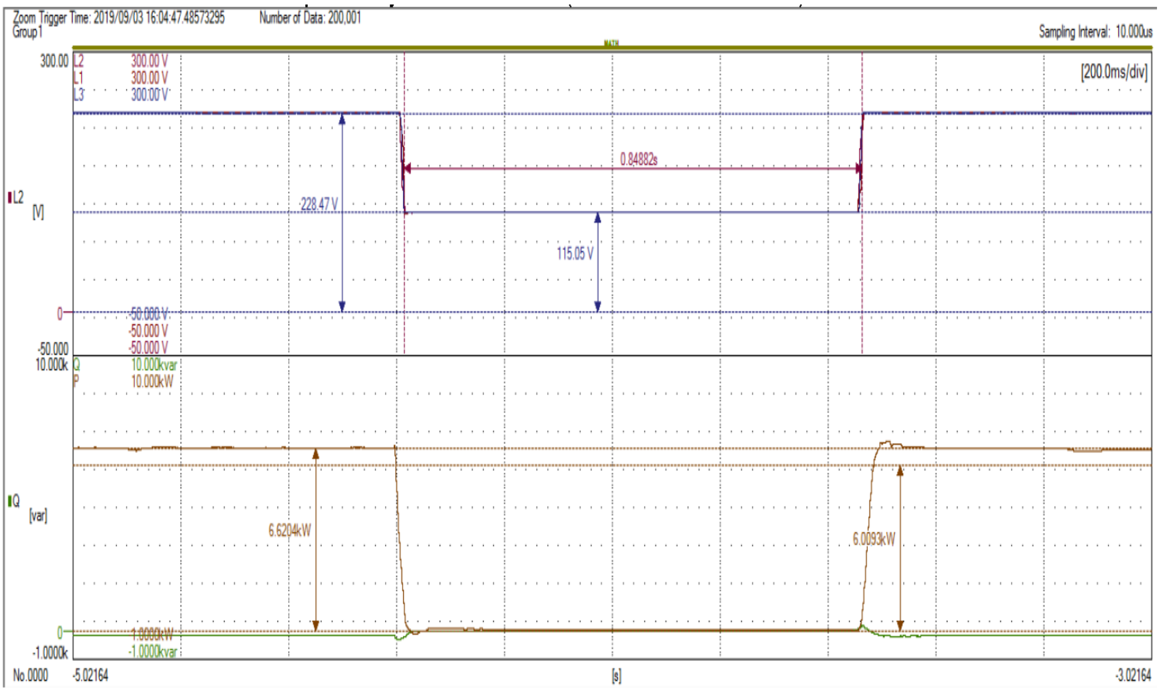
D.3.2.5	Table: Verification of insensitivity to voltage dips (LVFRT capability)								P
Output power: 6.6KW	Limits: 10%-30% Pnom,								
	R	S	T	R	S	T	**Duration**	**Recovery time**	**Limits of recovery time**
	U/Unom	U/Unom	U/Unom	φ1	φ2	φ3	[ms]	[ms]	[ms]
1 - three-phase symmetrical fault	0.05	0.05	0.05	0°	-120°	120°	200± 20	13.39	<200
2 - three-phase symmetrical failure	0.45	0.45	0.45	0°	-120°	120°	400± 20	21.20	<200
3 - two-phase asymmetric failure	0.86	0.86	0.05	27°	-147°	113°	200± 20	21.26	<200
4 - two-phase asymmetric failure	0.88	0.88	0.45	15°	-135°	115°	400± 20	17.08	<200
5 – asymmetric two-phase fault in LV	0.05	0.05	1.000	0°	-120°	120°	200 ± 20	22.06	<200
6 – asymmetric two-phase fault in LV	0.45	0.45	1.00	0°	-120°	120°	400 ± 20	20.16	<200

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Test 1: three-phase symmetrical fault

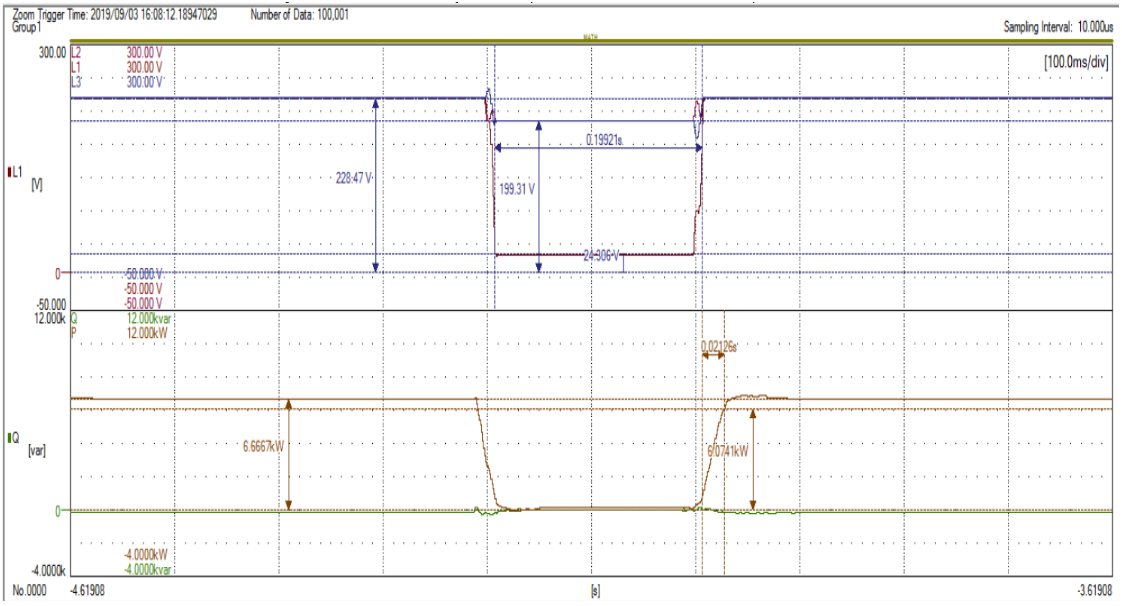


Test 2: three-phase symmetrical failure

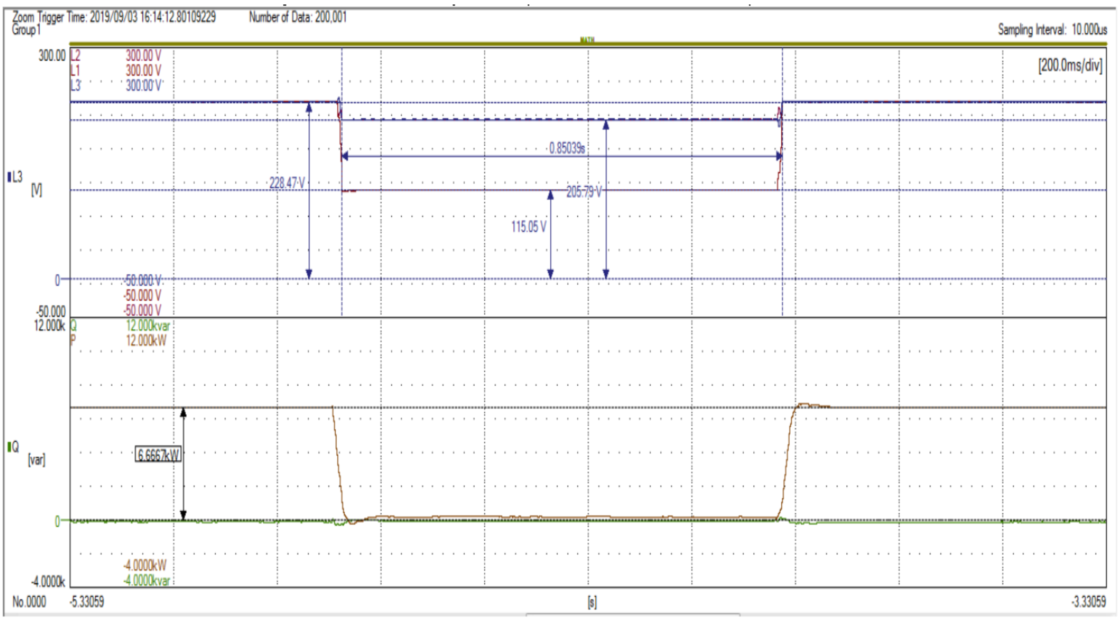


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Test 3: two-phase asymmetric failure

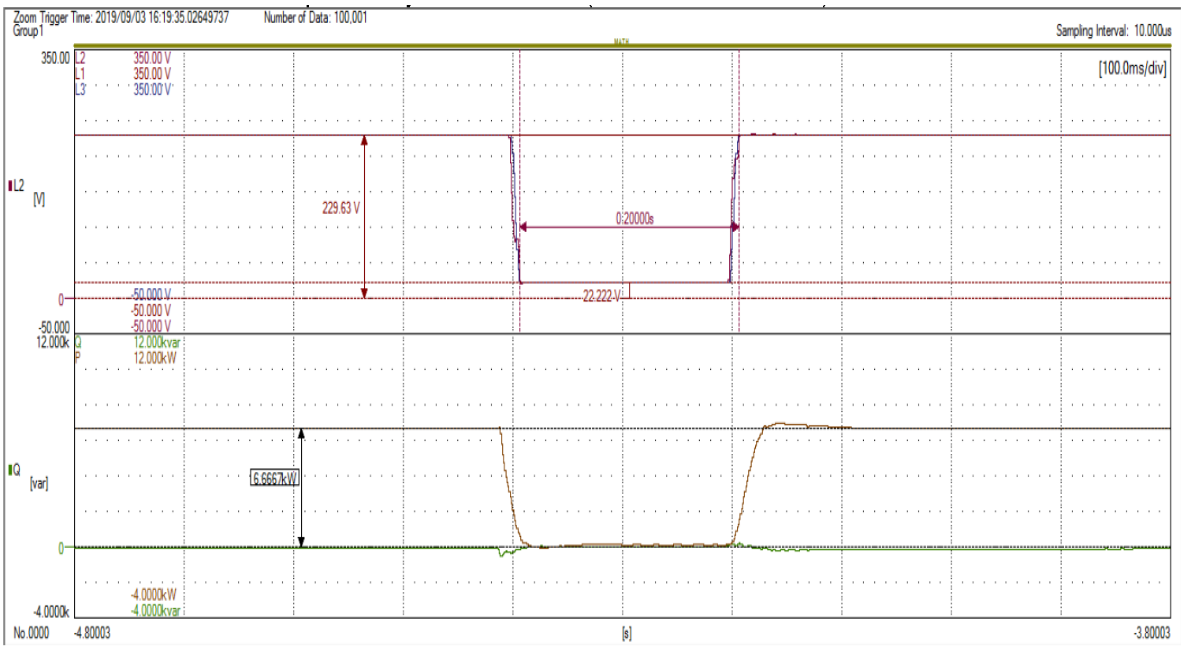


Test 4: two-phase asymmetric failure

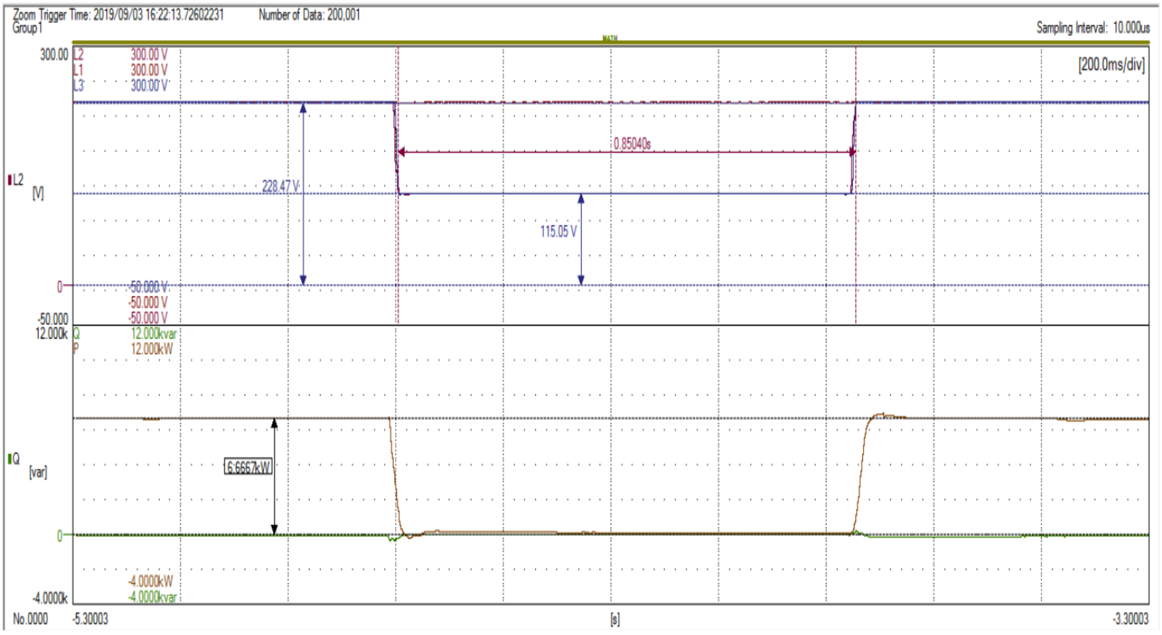


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Test 5: asymmetric two-phase fault in LV



Test 6: asymmetric two-phase fault in LV



D.3.2.6	**Table: Verification of insensitivity to automatic reclosing under phase mismatching**			**P**
Setoff	Angle before the setoff	Angle after the setoff	Current at 20 ms before to at least 200 ms after the setoff	Result
+90º	0º	+90º	L1:49.83A L2:47.83A L3:48,76A	No damage
-90 º	0º	-90º	L1:49.52A L2:47.39A L3:48.10A	No damage
+180º	0º	+180º	L1:19.06A L2:18.55A L3:19.24A	No damage Inverter disconnected
-180º	0º	-180º	L1:17.60A L2:17.55A L3:19.46A	No damage Inverter disconnected

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

90º phase shift

180º phase shift

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.4.3.1	Harmonics current	P

Reference standard:

IEC 61400-21:2008-08 Ed.2 (§. 7.4)

Wind turbines

Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines

Harmonics (SOFAR 20000TL-G2)

P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
Order	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
1	3,011	11,782	19,320	30,051	38,344	48,043	62,132	67,361	76,996	86,681	96,243
2	0,059	0,060	0,047	0,044	0,047	0,051	0,057	0,058	0,067	0,070	0,074
3	0,329	0,167	0,124	0,104	0,108	0,141	0,182	0,198	0,221	0,244	0,274
4	0,065	0,074	0,049	0,040	0,041	0,046	0,054	0,057	0,062	0,065	0,063
5	0,429	0,219	0,081	0,080	0,098	0,157	0,216	0,230	0,251	0,274	0,299
6	0,042	0,049	0,045	0,038	0,036	0,038	0,042	0,044	0,043	0,043	0,042
7	0,282	0,212	0,073	0,068	0,079	0,145	0,202	0,233	0,243	0,276	0,321
8	0,048	0,043	0,039	0,032	0,033	0,033	0,036	0,038	0,038	0,037	0,035
9	0,140	0,104	0,101	0,079	0,074	0,087	0,108	0,108	0,124	0,150	0,176
10	0,050	0,035	0,039	0,032	0,037	0,038	0,038	0,038	0,037	0,038	0,034
11	0,253	0,282	0,136	0,063	0,078	0,135	0,172	0,184	0,200	0,239	0,274
12	0,055	0,034	0,040	0,033	0,033	0,036	0,038	0,039	0,041	0,041	0,040
13	0,212	0,233	0,102	0,065	0,066	0,101	0,135	0,149	0,163	0,177	0,201
14	0,035	0,031	0,033	0,029	0,028	0,031	0,033	0,034	0,035	0,035	0,036
15	0,062	0,052	0,038	0,045	0,062	0,077	0,078	0,084	0,097	0,111	0,120
16	0,033	0,035	0,030	0,029	0,027	0,030	0,033	0,033	0,033	0,034	0,032
17	0,080	0,213	0,114	0,076	0,038	0,046	0,083	0,098	0,123	0,144	0,157
18	0,038	0,032	0,028	0,028	0,028	0,028	0,029	0,029	0,029	0,029	0,028
19	0,135	0,172	0,083	0,071	0,051	0,041	0,068	0,085	0,110	0,127	0,145
20	0,032	0,029	0,029	0,029	0,029	0,030	0,030	0,030	0,031	0,030	0,031
21	0,071	0,037	0,043	0,033	0,044	0,060	0,075	0,080	0,083	0,082	0,083
22	0,031	0,029	0,029	0,027	0,028	0,027	0,027	0,028	0,027	0,027	0,026
23	0,060	0,133	0,048	0,068	0,058	0,042	0,053	0,067	0,089	0,099	0,104
24	0,033	0,028	0,028	0,027	0,027	0,028	0,028	0,027	0,026	0,026	0,025
25	0,122	0,128	0,046	0,063	0,056	0,043	0,045	0,054	0,077	0,089	0,093
26	0,031	0,027	0,028	0,027	0,026	0,027	0,027	0,027	0,027	0,027	0,027
27	0,043	0,039	0,031	0,033	0,030	0,040	0,045	0,049	0,056	0,063	0,065
28	0,033	0,029	0,028	0,028	0,027	0,028	0,028	0,028	0,026	0,026	0,027
29	0,087	0,133	0,055	0,050	0,054	0,046	0,043	0,051	0,068	0,075	0,079
30	0,028	0,026	0,027	0,027	0,026	0,028	0,028	0,028	0,027	0,026	0,026
31	0,048	0,134	0,057	0,043	0,055	0,045	0,035	0,040	0,057	0,067	0,076
32	0,029	0,029	0,028	0,027	0,027	0,027	0,027	0,027	0,027	0,027	0,027
33	0,038	0,034	0,029	0,038	0,028	0,033	0,040	0,046	0,050	0,051	0,050
34	0,030	0,030	0,028	0,028	0,027	0,029	0,027	0,027	0,026	0,026	0,026
35	0,079	0,110	0,053	0,050	0,054	0,045	0,036	0,034	0,049	0,057	0,062
36	0,028	0,027	0,027	0,026	0,027	0,027	0,027	0,027	0,026	0,026	0,025
37	0,077	0,077	0,049	0,043	0,040	0,052	0,042	0,041	0,053	0,059	0,060
38	0,027	0,027	0,027	0,026	0,026	0,027	0,026	0,026	0,026	0,026	0,026
39	0,033	0,028	0,027	0,032	0,027	0,030	0,034	0,034	0,035	0,037	0,037
40	0,029	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,027

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Interharmonics at continuous operation (SOFAR 20000TL-G2)

P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
f [Hz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
75	0,063	0,075	0,069	0,071	0,064	0,073	0,076	0,064	0,068	0,069	0,069
125	0,063	0,080	0,077	0,080	0,071	0,072	0,071	0,067	0,070	0,069	0,068
175	0,054	0,069	0,070	0,074	0,071	0,074	0,074	0,069	0,072	0,068	0,068
225	0,057	0,064	0,065	0,065	0,064	0,066	0,068	0,063	0,064	0,061	0,061
275	0,066	0,058	0,059	0,060	0,060	0,061	0,064	0,063	0,064	0,064	0,063
325	0,065	0,061	0,059	0,061	0,057	0,057	0,060	0,059	0,060	0,058	0,059
375	0,061	0,055	0,054	0,053	0,052	0,053	0,053	0,052	0,053	0,051	0,050
425	0,054	0,057	0,058	0,060	0,060	0,063	0,068	0,070	0,073	0,080	0,087
475	0,052	0,051	0,049	0,050	0,049	0,051	0,052	0,052	0,051	0,050	0,051
525	0,058	0,055	0,054	0,056	0,055	0,056	0,060	0,063	0,067	0,074	0,081
575	0,055	0,050	0,048	0,048	0,048	0,048	0,048	0,048	0,047	0,046	0,045
625	0,054	0,050	0,048	0,047	0,047	0,047	0,047	0,046	0,045	0,046	0,044
675	0,054	0,051	0,049	0,049	0,048	0,047	0,046	0,045	0,046	0,045	0,043
725	0,049	0,048	0,047	0,048	0,047	0,046	0,046	0,045	0,045	0,044	0,043
775	0,051	0,052	0,050	0,050	0,050	0,049	0,049	0,047	0,047	0,046	0,045
825	0,049	0,048	0,047	0,047	0,046	0,045	0,044	0,044	0,044	0,044	0,044
875	0,051	0,048	0,047	0,045	0,045	0,045	0,045	0,044	0,044	0,043	0,042
925	0,053	0,048	0,047	0,047	0,045	0,046	0,046	0,044	0,044	0,042	0,043
975	0,054	0,049	0,049	0,048	0,047	0,047	0,046	0,045	0,045	0,044	0,044
1025	0,048	0,048	0,047	0,047	0,047	0,046	0,046	0,046	0,045	0,044	0,043
1075	0,050	0,048	0,048	0,047	0,047	0,046	0,046	0,045	0,045	0,043	0,042
1125	0,048	0,048	0,046	0,046	0,046	0,045	0,044	0,043	0,044	0,043	0,042
1175	0,050	0,047	0,046	0,046	0,045	0,045	0,045	0,045	0,044	0,043	0,043
1225	0,050	0,048	0,046	0,045	0,046	0,044	0,043	0,044	0,043	0,042	0,042
1275	0,049	0,047	0,046	0,046	0,046	0,045	0,044	0,044	0,045	0,044	0,044
1325	0,046	0,045	0,045	0,045	0,044	0,045	0,045	0,044	0,043	0,043	0,042
1375	0,049	0,048	0,049	0,048	0,048	0,048	0,048	0,047	0,046	0,045	0,045
1425	0,048	0,046	0,045	0,045	0,044	0,046	0,046	0,045	0,045	0,043	0,042
1475	0,049	0,049	0,047	0,048	0,048	0,047	0,047	0,046	0,046	0,045	0,045
1525	0,048	0,047	0,046	0,045	0,045	0,044	0,043	0,043	0,042	0,041	0,040
1575	0,049	0,047	0,048	0,047	0,046	0,047	0,045	0,043	0,044	0,043	0,043
1625	0,047	0,046	0,045	0,045	0,045	0,043	0,043	0,043	0,042	0,042	0,041
1675	0,047	0,047	0,047	0,047	0,046	0,047	0,048	0,046	0,044	0,043	0,042
1725	0,049	0,047	0,046	0,046	0,047	0,049	0,049	0,048	0,046	0,046	0,044
1775	0,047	0,046	0,046	0,045	0,044	0,047	0,047	0,046	0,045	0,044	0,043
1825	0,047	0,047	0,046	0,045	0,045	0,044	0,044	0,044	0,042	0,042	0,040
1875	0,048	0,047	0,046	0,046	0,045	0,045	0,044	0,043	0,043	0,042	0,042
1925	0,047	0,046	0,046	0,046	0,045	0,045	0,044	0,043	0,043	0,042	0,042
1975	0,048	0,047	0,048	0,047	0,046	0,046	0,044	0,044	0,044	0,045	0,043

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Higher Frequencies components (SOFAR 20000TL-G2)											
P/P$_n$ [%]	5	10	20	30	40	50	60	70	80	90	100
f [kHz]	I$_h$ [%]	I$_h$ [%]	I$_h$ [%]	I$_h$ [%]	I$_h$ [%]	I$_h$ [%]	I$_h$ [%]	I$_h$ [%]	I$_h$ [%]	I$_h$ [%]	I$_h$ [%]
2,1	0,349	0,315	0,365	0,369	0,372	0,380	0,041	0,039	0,056	0,062	0,064
2,3	0,470	0,401	0,287	0,469	0,371	0,377	0,037	0,032	0,044	0,051	0,053
2,5	0,342	0,982	1,015	0,558	0,558	0,554	0,032	0,026	0,038	0,042	0,041
2,7	0,575	0,433	0,396	0,352	0,335	0,326	0,042	0,031	0,044	0,048	0,051
2,9	0,683	2,095	2,131	0,971	1,092	0,859	0,042	0,021	0,031	0,042	0,045
3,1	0,560	0,861	1,347	0,916	0,723	1,110	0,057	0,065	0,067	0,055	0,044
3,3	0,261	0,374	0,408	0,347	0,356	0,361	0,041	0,055	0,071	0,079	0,081
3,5	0,428	0,515	1,078	0,475	0,691	0,651	0,025	0,028	0,036	0,063	0,071
3,7	0,213	0,381	0,342	0,285	0,177	0,195	0,017	0,015	0,023	0,046	0,057
3,9	0,213	0,260	0,238	0,226	0,210	0,209	0,017	0,016	0,020	0,035	0,051
4,1	0,248	0,578	0,548	0,260	0,231	0,242	0,014	0,015	0,015	0,017	0,018
4,3	0,194	0,292	0,334	0,255	0,209	0,210	0,012	0,013	0,013	0,013	0,015
4,5	0,184	0,219	0,228	0,239	0,217	0,211	0,016	0,016	0,016	0,013	0,014
4,7	0,300	0,191	0,219	0,273	0,227	0,225	0,015	0,015	0,015	0,013	0,010
4,9	0,167	0,170	0,187	0,207	0,135	0,133	0,014	0,012	0,013	0,012	0,012
5,1	0,149	0,146	0,177	0,221	0,198	0,182	0,018	0,018	0,017	0,015	0,013
5,3	0,142	0,131	0,163	0,384	0,186	0,195	0,016	0,015	0,015	0,013	0,011
5,5	0,095	0,099	0,123	0,159	0,141	0,132	0,017	0,013	0,013	0,012	0,012
5,7	0,102	0,107	0,123	0,138	0,149	0,144	0,020	0,018	0,017	0,015	0,013
5,9	0,072	0,102	0,098	0,113	0,104	0,164	0,018	0,015	0,017	0,014	0,011
6,1	0,075	0,083	0,115	0,095	0,102	0,121	0,018	0,015	0,015	0,013	0,012
6,3	0,146	0,113	0,124	0,181	0,109	0,105	0,019	0,020	0,018	0,016	0,014
6,5	0,052	0,055	0,067	0,094	0,252	0,373	0,027	0,028	0,022	0,016	0,016
6,7	0,060	0,066	0,085	0,079	0,078	0,080	0,017	0,018	0,028	0,029	0,032
6,9	0,062	0,064	0,064	0,064	0,067	0,073	0,020	0,022	0,019	0,015	0,016
7,1	0,053	0,061	0,058	0,058	0,057	0,057	0,021	0,022	0,019	0,013	0,012
7,3	0,058	0,071	0,073	0,067	0,068	0,069	0,018	0,019	0,017	0,014	0,013
7,5	0,435	0,438	0,437	0,442	0,444	0,454	0,030	0,030	0,027	0,019	0,016
7,7	0,085	0,082	0,086	0,082	0,074	0,073	0,037	0,033	0,029	0,022	0,016
7,9	0,127	0,112	0,108	0,109	0,100	0,115	0,041	0,045	0,037	0,024	0,020
8,1	0,436	0,439	0,442	0,447	0,446	0,453	0,077	0,067	0,057	0,037	0,026
8,3	0,178	0,187	0,159	0,105	0,086	0,080	0,076	0,079	0,071	0,052	0,033
8,5	0,108	0,147	0,142	0,114	0,096	0,084	0,097	0,098	0,091	0,068	0,048
8,7	0,086	0,103	0,112	0,119	0,082	0,063	0,070	0,074	0,069	0,062	0,054
8,9	0,055	0,072	0,076	0,078	0,077	0,071	0,071	0,059	0,043	0,042	0,045
Voltage of defined MPP [V]								700			
Current of defined MPP [A]								28,57			

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Harmonics (SOFAR 25000TL-G2)

P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
Order	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
1	2,871	9,422	19,028	28,662	38,701	47,986	57,595	67,176	76,805	86,305	95,906
2	0,048	0,047	0,040	0,037	0,039	0,040	0,043	0,059	0,061	0,066	0,067
3	0,232	0,150	0,082	0,087	0,117	0,143	0,172	0,195	0,220	0,244	0,255
4	0,049	0,068	0,038	0,034	0,042	0,048	0,051	0,091	0,097	0,098	0,096
5	0,291	0,190	0,064	0,074	0,131	0,170	0,201	0,220	0,237	0,260	0,276
6	0,039	0,041	0,031	0,030	0,030	0,033	0,035	0,035	0,035	0,035	0,038
7	0,217	0,167	0,055	0,055	0,121	0,168	0,190	0,220	0,256	0,297	0,350
8	0,043	0,039	0,026	0,026	0,026	0,027	0,029	0,040	0,043	0,048	0,046
9	0,092	0,086	0,071	0,056	0,073	0,089	0,094	0,117	0,143	0,172	0,191
10	0,033	0,031	0,027	0,030	0,031	0,032	0,030	0,040	0,039	0,042	0,041
11	0,122	0,204	0,079	0,056	0,111	0,136	0,154	0,185	0,219	0,255	0,282
12	0,046	0,032	0,028	0,027	0,028	0,030	0,028	0,029	0,030	0,029	0,029
13	0,154	0,166	0,063	0,048	0,084	0,108	0,128	0,139	0,159	0,174	0,188
14	0,028	0,025	0,024	0,024	0,025	0,025	0,026	0,031	0,033	0,033	0,034
15	0,066	0,042	0,029	0,044	0,061	0,063	0,073	0,086	0,094	0,101	0,106
16	0,025	0,026	0,024	0,024	0,026	0,026	0,026	0,028	0,027	0,026	0,026
17	0,102	0,146	0,074	0,043	0,038	0,062	0,088	0,112	0,125	0,141	0,143
18	0,030	0,027	0,023	0,023	0,023	0,024	0,025	0,025	0,024	0,023	0,023
19	0,098	0,114	0,056	0,047	0,035	0,050	0,080	0,099	0,115	0,130	0,139
20	0,024	0,026	0,023	0,025	0,025	0,025	0,025	0,026	0,029	0,029	0,028
21	0,057	0,045	0,028	0,032	0,047	0,059	0,069	0,068	0,067	0,070	0,069
22	0,027	0,025	0,023	0,023	0,022	0,022	0,022	0,022	0,022	0,021	0,023
23	0,079	0,081	0,045	0,052	0,034	0,039	0,064	0,078	0,083	0,093	0,097
24	0,025	0,024	0,022	0,022	0,022	0,023	0,022	0,021	0,021	0,021	0,021
25	0,059	0,081	0,040	0,049	0,035	0,033	0,054	0,071	0,073	0,079	0,086
26	0,023	0,022	0,021	0,022	0,022	0,021	0,021	0,022	0,022	0,021	0,021
27	0,034	0,034	0,026	0,024	0,032	0,036	0,043	0,049	0,053	0,053	0,055
28	0,026	0,025	0,023	0,023	0,023	0,022	0,022	0,023	0,022	0,021	0,022
29	0,083	0,094	0,040	0,046	0,037	0,032	0,049	0,060	0,063	0,067	0,067
30	0,023	0,022	0,022	0,022	0,022	0,022	0,022	0,022	0,022	0,022	0,022
31	0,080	0,105	0,040	0,045	0,037	0,025	0,039	0,053	0,061	0,069	0,071
32	0,023	0,022	0,022	0,022	0,021	0,021	0,021	0,023	0,021	0,022	0,021
33	0,027	0,024	0,023	0,023	0,027	0,032	0,038	0,041	0,040	0,040	0,040
34	0,025	0,024	0,023	0,023	0,023	0,023	0,022	0,021	0,021	0,021	0,021
35	0,035	0,095	0,039	0,042	0,036	0,025	0,033	0,045	0,049	0,059	0,064
36	0,023	0,023	0,022	0,023	0,023	0,022	0,022	0,022	0,021	0,021	0,021
37	0,061	0,075	0,030	0,031	0,042	0,030	0,037	0,047	0,048	0,051	0,053
38	0,022	0,021	0,022	0,021	0,021	0,022	0,021	0,022	0,021	0,021	0,021
39	0,026	0,023	0,022	0,022	0,025	0,027	0,028	0,029	0,029	0,030	0,030
40	0,023	0,023	0,022	0,022	0,024	0,023	0,023	0,023	0,022	0,022	0,023

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Interharmonics at continuous operation (SOFAR 25000TL-G2)

P/Pn [%]	5	10	20	30	40	50	60	70	80	90	100
f [Hz]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]
75	0,052	0,053	0,059	0,055	0,056	0,049	0,056	0,054	0,052	0,052	0,053
125	0,052	0,062	0,064	0,063	0,058	0,054	0,055	0,054	0,050	0,047	0,046
175	0,044	0,054	0,059	0,058	0,057	0,054	0,055	0,054	0,054	0,047	0,044
225	0,046	0,048	0,050	0,051	0,053	0,051	0,053	0,053	0,049	0,045	0,045
275	0,056	0,049	0,050	0,049	0,049	0,050	0,051	0,049	0,051	0,052	0,047
325	0,053	0,049	0,048	0,047	0,045	0,045	0,048	0,049	0,046	0,046	0,045
375	0,045	0,043	0,041	0,040	0,039	0,039	0,040	0,040	0,041	0,044	0,039
425	0,045	0,047	0,048	0,049	0,050	0,053	0,057	0,063	0,071	0,083	0,093
475	0,041	0,040	0,040	0,041	0,042	0,041	0,041	0,040	0,040	0,042	0,043
525	0,049	0,046	0,045	0,044	0,045	0,047	0,052	0,059	0,066	0,078	0,089
575	0,045	0,042	0,038	0,038	0,038	0,038	0,038	0,038	0,037	0,036	0,037
625	0,045	0,042	0,038	0,039	0,039	0,038	0,038	0,036	0,037	0,036	0,037
675	0,043	0,040	0,038	0,037	0,036	0,036	0,036	0,036	0,034	0,033	0,034
725	0,040	0,040	0,038	0,038	0,038	0,037	0,038	0,037	0,036	0,035	0,035
775	0,041	0,040	0,040	0,040	0,040	0,039	0,038	0,037	0,036	0,036	0,035
825	0,042	0,039	0,038	0,038	0,037	0,036	0,036	0,035	0,034	0,034	0,032
875	0,040	0,039	0,038	0,037	0,036	0,036	0,035	0,034	0,035	0,033	0,032
925	0,041	0,040	0,039	0,039	0,038	0,037	0,037	0,035	0,036	0,034	0,034
975	0,041	0,041	0,038	0,037	0,037	0,036	0,036	0,035	0,035	0,034	0,033
1025	0,039	0,039	0,038	0,038	0,038	0,038	0,037	0,036	0,036	0,036	0,034
1075	0,039	0,038	0,037	0,038	0,038	0,037	0,037	0,037	0,036	0,035	0,034
1125	0,040	0,039	0,038	0,038	0,037	0,036	0,036	0,034	0,035	0,034	0,034
1175	0,040	0,038	0,037	0,036	0,036	0,035	0,035	0,034	0,034	0,033	0,033
1225	0,040	0,038	0,036	0,036	0,035	0,035	0,035	0,034	0,034	0,033	0,033
1275	0,038	0,036	0,036	0,037	0,037	0,036	0,035	0,035	0,035	0,035	0,034
1325	0,037	0,037	0,037	0,037	0,037	0,037	0,035	0,034	0,036	0,035	0,033
1375	0,039	0,039	0,039	0,039	0,039	0,038	0,038	0,036	0,036	0,035	0,033
1425	0,039	0,039	0,037	0,037	0,037	0,037	0,037	0,036	0,035	0,034	0,033
1475	0,038	0,037	0,038	0,038	0,038	0,037	0,037	0,035	0,036	0,034	0,033
1525	0,037	0,036	0,036	0,036	0,036	0,035	0,034	0,033	0,033	0,032	0,031
1575	0,038	0,038	0,037	0,037	0,037	0,036	0,035	0,035	0,035	0,035	0,035
1625	0,038	0,037	0,037	0,035	0,034	0,035	0,035	0,035	0,035	0,033	0,032
1675	0,039	0,040	0,038	0,038	0,037	0,037	0,035	0,035	0,034	0,034	0,033
1725	0,040	0,039	0,039	0,039	0,039	0,039	0,038	0,037	0,037	0,036	0,034
1775	0,039	0,039	0,037	0,037	0,038	0,037	0,036	0,036	0,035	0,035	0,034
1825	0,038	0,037	0,036	0,036	0,036	0,035	0,035	0,035	0,035	0,033	0,033
1875	0,038	0,038	0,038	0,037	0,036	0,035	0,035	0,034	0,034	0,034	0,033
1925	0,037	0,036	0,036	0,037	0,035	0,035	0,034	0,033	0,034	0,033	0,032
1975	0,038	0,037	0,038	0,037	0,036	0,035	0,035	0,034	0,035	0,035	0,034

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Higher Frequencies components (SOFAR 25000TL-G2)

P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
f [kHz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
2,1	0,061	0,076	0,023	0,030	0,042	0,028	0,038	0,056	0,173	0,072	0,218
2,3	0,044	0,059	0,019	0,029	0,040	0,023	0,031	0,051	0,194	0,071	0,210
2,5	0,042	0,050	0,024	0,026	0,032	0,022	0,025	0,047	0,229	0,051	0,213
2,7	0,039	0,032	0,021	0,042	0,043	0,027	0,030	0,049	0,173	0,064	0,181
2,9	0,038	0,028	0,028	0,044	0,043	0,026	0,021	0,044	0,173	0,066	0,174
3,1	0,031	0,027	0,032	0,031	0,028	0,048	0,056	0,066	0,233	0,051	0,160
3,3	0,027	0,029	0,022	0,024	0,020	0,030	0,047	0,066	0,190	0,071	0,150
3,5	0,018	0,024	0,024	0,022	0,019	0,019	0,024	0,056	0,530	0,081	0,224
3,7	0,020	0,022	0,018	0,015	0,015	0,013	0,013	0,046	0,304	0,078	0,255
3,9	0,024	0,015	0,032	0,017	0,016	0,012	0,014	0,035	0,153	0,080	0,204
4,1	0,015	0,016	0,032	0,015	0,013	0,012	0,012	0,022	0,144	0,029	0,329
4,3	0,015	0,016	0,025	0,015	0,012	0,010	0,011	0,017	0,108	0,032	0,136
4,5	0,020	0,024	0,026	0,014	0,014	0,012	0,012	0,018	0,095	0,027	0,109
4,7	0,016	0,027	0,019	0,013	0,012	0,012	0,012	0,017	0,094	0,019	0,114
4,9	0,013	0,022	0,016	0,013	0,013	0,010	0,010	0,015	0,069	0,022	0,077
5,1	0,016	0,022	0,022	0,012	0,015	0,014	0,014	0,016	0,072	0,022	0,073
5,3	0,018	0,013	0,014	0,011	0,014	0,013	0,012	0,014	0,073	0,018	0,085
5,5	0,012	0,013	0,011	0,009	0,014	0,013	0,011	0,014	0,061	0,019	0,063
5,7	0,016	0,014	0,011	0,012	0,013	0,016	0,015	0,016	0,058	0,019	0,064
5,9	0,017	0,018	0,016	0,012	0,011	0,015	0,013	0,014	0,058	0,016	0,070
6,1	0,014	0,017	0,013	0,013	0,011	0,014	0,012	0,015	0,058	0,018	0,060
6,3	0,018	0,019	0,022	0,015	0,011	0,016	0,015	0,016	0,047	0,017	0,058
6,5	0,017	0,016	0,023	0,017	0,013	0,019	0,020	0,019	0,082	0,016	0,072
6,7	0,016	0,018	0,022	0,014	0,010	0,013	0,013	0,029	0,229	0,032	0,180
6,9	0,019	0,016	0,028	0,019	0,012	0,016	0,016	0,017	0,049	0,019	0,088
7,1	0,022	0,030	0,032	0,023	0,017	0,017	0,017	0,016	0,040	0,015	0,055
7,3	0,028	0,030	0,031	0,022	0,015	0,015	0,014	0,016	0,041	0,018	0,051
7,5	0,030	0,039	0,042	0,030	0,023	0,023	0,024	0,026	0,187	0,017	0,169
7,7	0,061	0,055	0,047	0,038	0,033	0,028	0,025	0,021	0,048	0,018	0,054
7,9	0,107	0,098	0,072	0,051	0,035	0,032	0,032	0,024	0,061	0,022	0,068
8,1	0,085	0,093	0,088	0,074	0,062	0,060	0,053	0,040	0,189	0,022	0,166
8,3	0,149	0,129	0,110	0,071	0,062	0,057	0,064	0,048	0,047	0,026	0,054
8,5	0,089	0,126	0,124	0,081	0,054	0,080	0,079	0,062	0,054	0,036	0,052
8,7	0,063	0,076	0,074	0,062	0,043	0,055	0,057	0,053	0,056	0,043	0,050
8,9	0,043	0,056	0,049	0,046	0,049	0,061	0,047	0,034	0,045	0,046	0,060
Voltage of defined MPP [V]								700			
Current of defined MPP [A]								35,71			

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Harmonics (SOFAR 30000TL-G2)

P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
Order	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
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

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Interharmonics at continuous operation (SOFAR 30000TL-G2)											
P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
f [Hz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
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

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Higher Frequencies components (SOFAR 30000TL-G2)

P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
f [kHz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
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
Voltage of defined MPP [V]								700			
Current of defined MPP [A]								42,86			

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Harmonics (SOFAR 33000TL-G2)

P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
Order	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
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
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
39	0,024	0,026	0,024	0,025	0,025	0,027	0,027	0,028	0,027	0,026	0,024
40	0,025	0,026	0,027	0,027	0,025	0,025	0,024	0,023	0,022	0,022	0,022

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Clause	Requirement + Test	Result - Remark	Verdict

Interharmonics at continuous operation (SOFAR 33000TL-G2)

P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
f [Hz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
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

Higher Frequencies components (SOFAR 33000TL-G2)											
P/P_n [%]	5	10	20	30	40	50	60	70	80	90	100
f [kHz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
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
Voltage of defined MPP [V]								700			
Current of defined MPP [A]								47,14			

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.4.3.2	**Voltage fluctuactions caused by Switching operations**	**P**

Reference standard:
IEC 61400-21:2008-08 Ed.2 (§. 7.3)
Wind turbines
Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines

Table: Voltage fluctuactions caused by switching operations				
Case of switching operation	**Cut-in at 10% of rate power**			
Network impedance phase angle, k (°)	**30**	**50**	**70**	**85**
Flick step factor, $K_f(\psi_k)$	0.03	0.02	0.02	0.02
Voltage change factor, $Ku(\psi_k)$	0.18	0.24	0.20	0.28
Maximum inrush current factor k_{imax}	0.05			
Case of switching operation	**Cut-in at 100% of rate power**			
Network impedance phase angle, k (°)	**30**	**50**	**70**	**85**
Flick step factor, $K_f(\psi_k)$	0.07	0.04	0.03	0.03
Voltage change factor, $Ku(\psi_k)$	0.23	0.34	0.31	0.26
Maximum inrush current factor k_{imax}	0.02			
Case of switching operation	**Service disconnection at rated power**			
Network impedance phase angle, k (°)	**30**	**50**	**70**	**85**
Flick step factor, $K_f(\psi_k)$	0.01	0.01	0.01	0.01
Voltage change factor, $Ku(\psi_k)$	0.35	0.14	0.14	0.06
Maximum inrush current factor k_{imax}	0.16			
Worst case over all switching operations, k_{imax}	0.16			

D.4.3.3	**Measurement of voltage fluctuations (flicker) in continuous operating conditions**	P

Reference standard:
IEC 61400-21:2008-08 Ed.2 (§. 7.3.3)
Wind turbines
Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines

Network impedance phase angle, k (°)	**30**	**50**	**70**	**85**
Flick coefficient, c(ψ_k)	3.06	2.01	1.63	1.53
Short-term flick, P_{st}	0.18	0.12	0.10	0.09

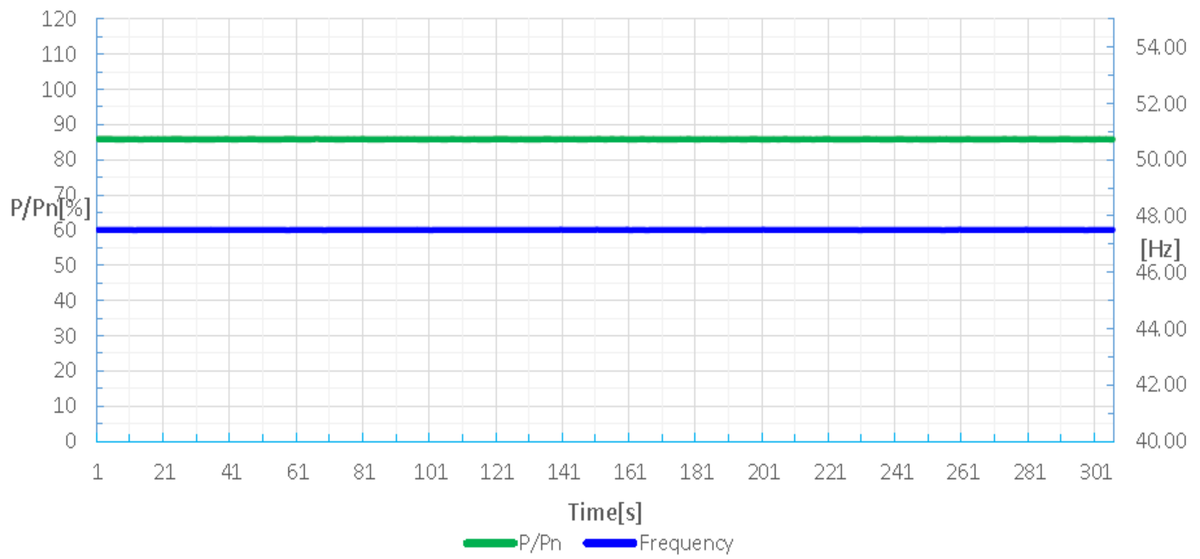
SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.4.4.1.1	**Tests at full power on the simulated network**	P

Normal working range:		85%Vn ≤ V ≤ 110%Vn 47.5 Hz ≤ f ≤ 52.5 Hz	
Grid frequency f [Hz]:		50	
Grid voltage U_n [V]:		230/400	
Set Value	**Limit Value**	**Time [min,]**	**Result**
196,5 V (85,4%Vn)	85%Vn	5	Pass
251.4 V (109,2%Vn)	110%Vn	5	Pass
47.5 Hz	47.5 Hz	5	Pass
52.5 Hz	52.5 Hz	5	Pass

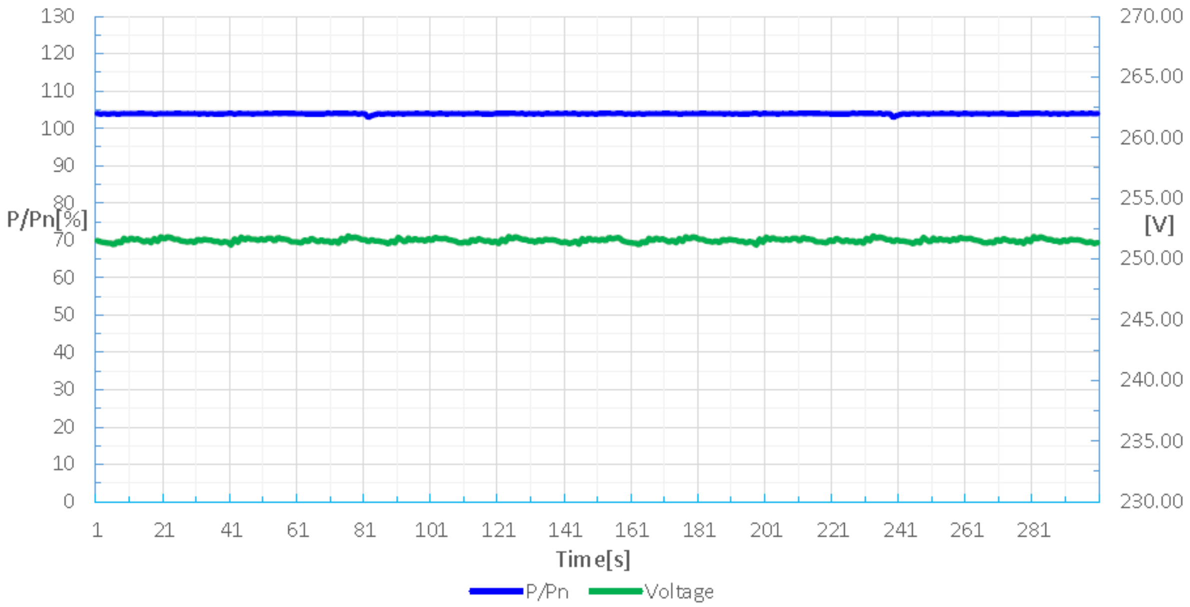
Test 1

Setting value: V=85%Vn; f=47,5Hz; P=100%*Sn; Cosϕ=1
*EUT is allowed to operate at reduced power, equal to the maximum output for limit reached maximum output current (P≥85% * Sn)



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

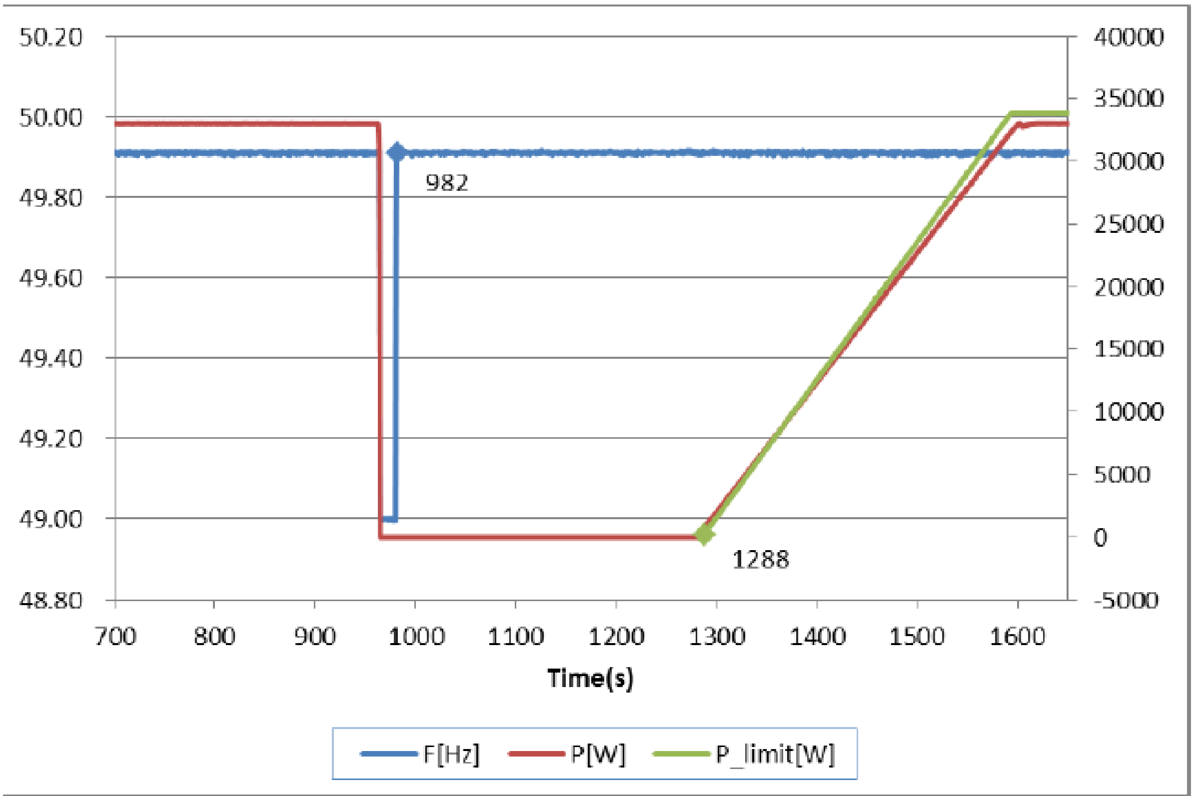
Test 2
Setting value: V=110%Vn; f=51,5Hz; P=100%*Sn; Cosφ=1
Disable the automatic power reduction in case of overfrequency



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

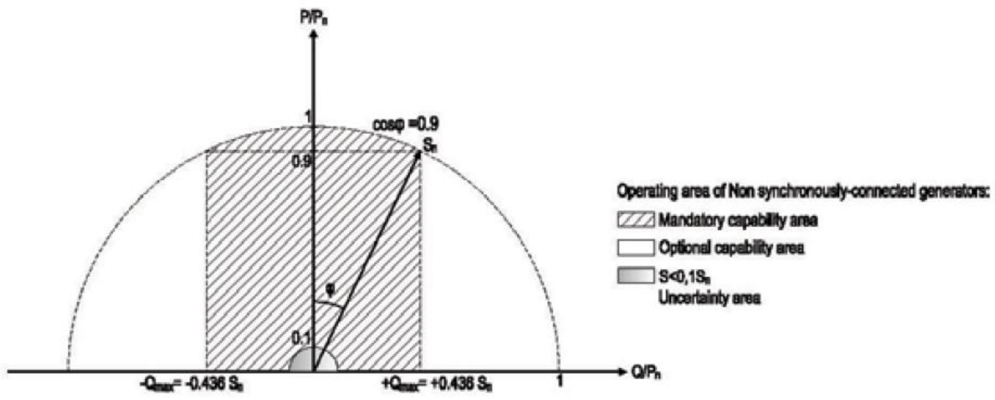
D.4.5.1.1	**Table: Tests at full power on the simulated network**		P
Condition	Result		Limit
a) < 95% Vn and > 105% Vn (49.9 Hz < f < 50.1 Hz)	No power output	☒ Yes, ☐ No	--
b) 95% Vn < V <105% Vn	Connection delay time (s)	65	≥ 60 s
c) 95% Vn < V < 105% Vn	Reconnection delay time (s)	307	≥ 300 s
d) < 49.9 Hz and > 50.1 Hz (95% Vn < V <105% Vn)	No power output	☒ Yes, ☐ No	--
e) 49.9 Hz < f < 50.1 Hz	Connection delay time (s)	65	≥ 60 s
f) 49.9 Hz < f < 50.1 Hz	Reconnection delay time (s)	306	≥ 300 s

D.4.5.2	**Verification of step release of the active power (load pickup)**		P
Condition	Output power gradient (W/s)	Output power gradient/ Pn (% Pn/s)	Limit (% Pn/s)
Test sequences b)	107.49	0.326	0.333
Test sequences c)	106.45	0.322	
Test sequences e)	106.46	0.323	
Test sequences f)	98.80	0.299	



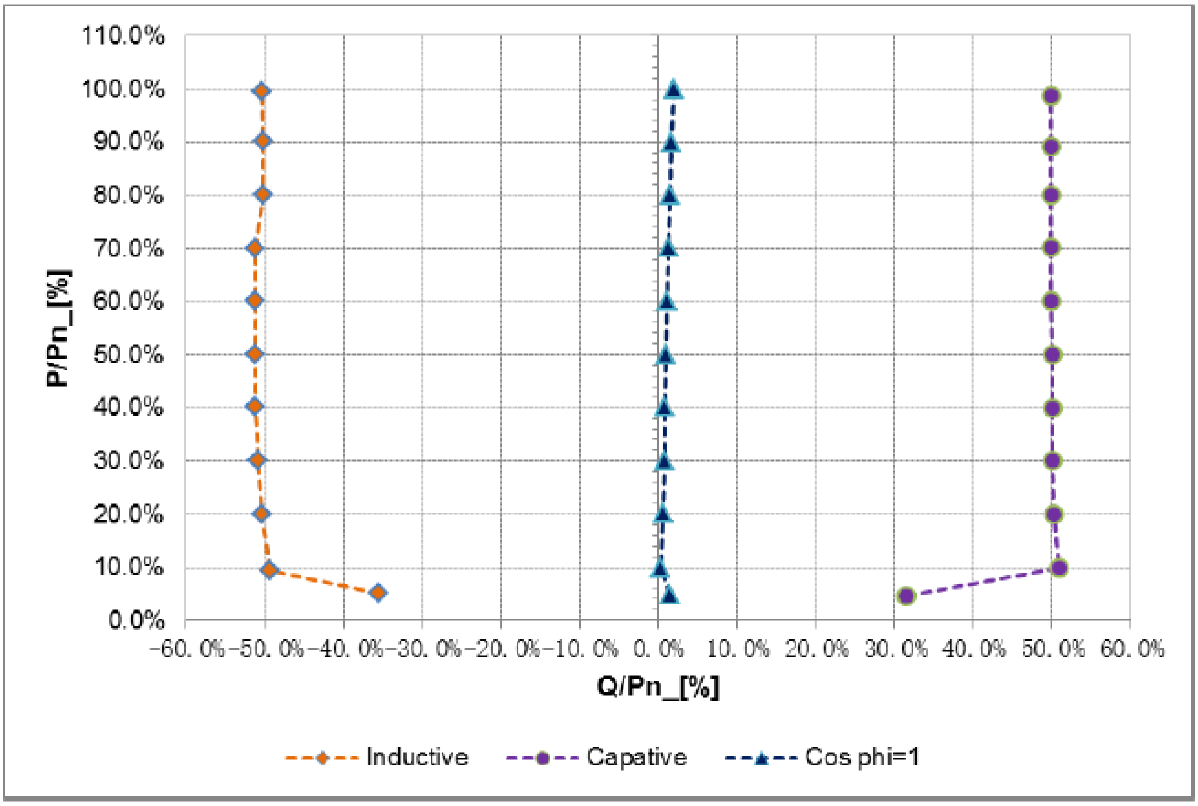
SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.4.6	Table: Verification of constructional requirements for reactive power exchange	P



Capability for static generators in plants with power < 400 kW (limited semi-circular characteristic)

Graph of capability curves valid for inverter : SOFAR 33000TL-G2

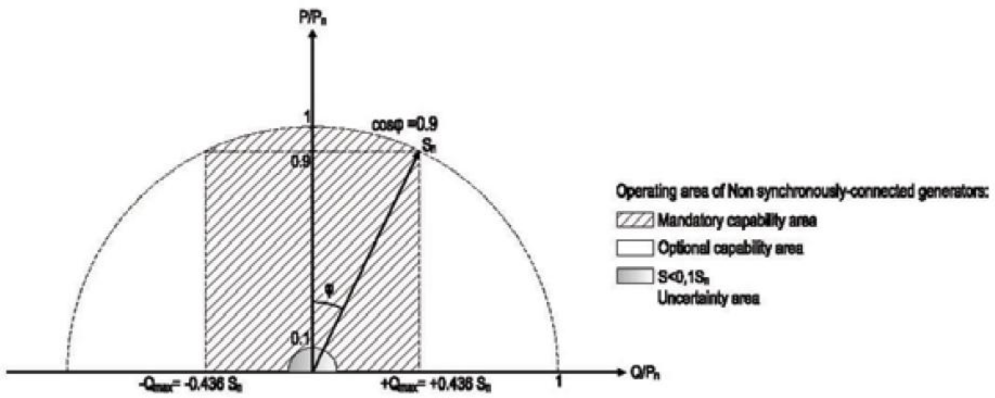


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

-Qmax (inductive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% ±5%	1,674	0,051	-11,716	-0,355	1,827	0,055	0,1414
10% ±5%	3,060	0,093	-16,263	-0,493	3,438	0,104	0,1849
20% ±5%	6,598	0,200	-16,645	-0,504	7,020	0,213	0,3685
30% ±5%	9,924	0,301	-16,807	-0,509	10,399	0,315	0,5085
40% ±5%	13,219	0,401	-16,876	-0,511	13,758	0,417	0,6166
50% ±5%	16,497	0,500	-16,903	-0,512	17,111	0,519	0,6985
60% ±5%	19,839	0,601	-16,907	-0,512	20,550	0,623	0,7611
70% ±5%	23,093	0,700	-16,925	-0,513	23,911	0,725	0,8066
80% ±5%	26,429	0,801	-16,567	-0,502	27,366	0,829	0,8473
90% ±5%	29,713	0,900	-16,589	-0,503	30,782	0,933	0,8731
100% ±5%	32,826	0,995	-16,645	-0,504	34,041	1,032	0,8919
+Qmax (capacitive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% ±5%	1,491	0,045	10,397	0,315	1,606	0,049	0,1419
10% ±5%	3,283	0,099	16,836	0,510	3,642	0,110	0,1914
20% ±5%	6,610	0,200	16,563	0,502	7,000	0,212	0,3706
30% ±5%	9,903	0,300	16,513	0,500	10,342	0,313	0,5143
40% ±5%	13,188	0,400	16,506	0,500	13,691	0,415	0,6242
50% ±5%	16,532	0,501	16,506	0,500	17,112	0,519	0,7076
60% ±5%	19,825	0,601	16,494	0,500	20,496	0,621	0,7687
70% ±5%	23,143	0,701	16,475	0,499	23,914	0,725	0,8146
80% ±5%	26,454	0,802	16,483	0,499	27,339	0,828	0,8487
90% ±5%	29,421	0,892	16,496	0,500	30,423	0,922	0,8719
100% ±5%	32,597	0,988	16,493	0,500	33,753	1,023	0,8923
Q=0							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% ±5%	1,611	0,049	0,484	0,015	1,631	0,049	0,9574
10% ±5%	3,299	0,100	0,071	0,002	3,412	0,103	0,9976
20% ±5%	6,640	0,201	0,236	0,007	6,814	0,206	0,9994
30% ±5%	9,939	0,301	0,252	0,008	10,185	0,309	0,9997
40% ±5%	13,233	0,401	0,286	0,009	13,558	0,411	0,9998
50% ±5%	16,545	0,501	0,332	0,010	16,959	0,514	0,9998
60% ±5%	19,847	0,601	0,381	0,012	20,363	0,617	0,9998
70% ±5%	23,141	0,701	0,439	0,013	23,768	0,720	0,9998
80% ±5%	26,425	0,801	0,504	0,015	27,176	0,824	0,9998
90% ±5%	29,693	0,900	0,572	0,017	30,577	0,927	0,9998
100% ±5%	33,031	1,001	0,652	0,020	34,074	1,033	0,9998

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

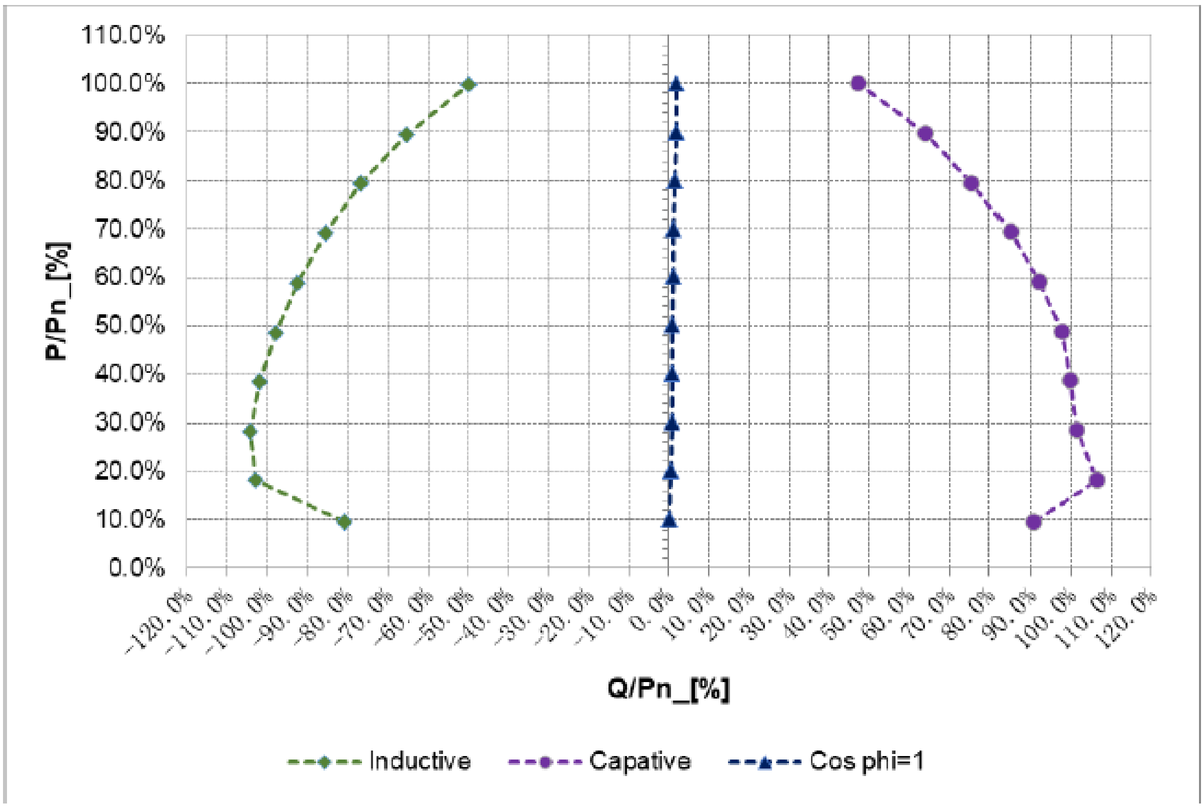
D.4.6	**Table: Verification of constructional requirements for reactive power exchange**	**P**



1:

Capability for static generators in plants with power < 400 kW (limited semi-circular characteristic)

Graph of capability curves valid for inverter :



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

-Qmax (inductive)

Power-BIN	Active power [kW]	Active power p.u.	Reactive power [kVA]	Reactive power p.u.	DC power [kW]	DC power p.u.	Power factor (cos φ)
0% ±5%	0,202	0,006	-0,915	-0,028	0,332	0,010	0,2158
10% ±5%	3,107	0,094	-26,680	-0,808	3,350	0,102	0,4189
20% ±5%	5,957	0,181	-33,944	-1,029	6,774	0,205	0,1731
30% ±5%	9,302	0,282	-34,429	-1,043	10,154	0,308	0,2608
40% ±5%	12,668	0,384	-33,661	-1,020	13,528	0,410	0,3522
50% ±5%	16,043	0,486	-32,306	-0,979	16,907	0,512	0,4448
60% ±5%	19,433	0,589	-30,499	-0,924	20,301	0,615	0,5374
70% ±5%	22,814	0,691	-28,198	-0,854	23,682	0,718	0,6290
80% ±5%	26,190	0,794	-25,345	-0,768	27,063	0,820	0,7186
90% ±5%	29,569	0,896	-21,594	-0,654	30,444	0,923	0,8076
100% ±5%	32,943	0,998	-16,514	-0,500	33,822	1,025	0,8940

+Qmax (capacitive)

Power-BIN	Active power [kW]	Active power p.u.	Reactive power [kVA]	Reactive power p.u.	DC power [kW]	DC power p.u.	Power factor (cos φ)
0% ±5%	0,206	0,006	-0,897	-0,027	0,338	0,010	0,2238
10% ±5%	3,120	0,095	29,888	0,906	3,385	0,103	0,4040
20% ±5%	6,032	0,183	35,089	1,063	6,773	0,205	0,1704
30% ±5%	9,424	0,286	33,519	1,016	10,156	0,308	0,2711
40% ±5%	12,786	0,387	32,960	0,999	13,529	0,410	0,3617
50% ±5%	16,138	0,489	32,225	0,977	16,906	0,512	0,4478
60% ±5%	19,520	0,592	30,315	0,919	20,297	0,615	0,5414
70% ±5%	22,896	0,694	28,029	0,849	23,680	0,718	0,6326
80% ±5%	26,267	0,796	24,979	0,757	27,061	0,820	0,7247
90% ±5%	29,615	0,897	21,190	0,642	30,421	0,922	0,8132
100% ±5%	32,993	1,000	15,642	0,474	33,818	1,025	0,9036

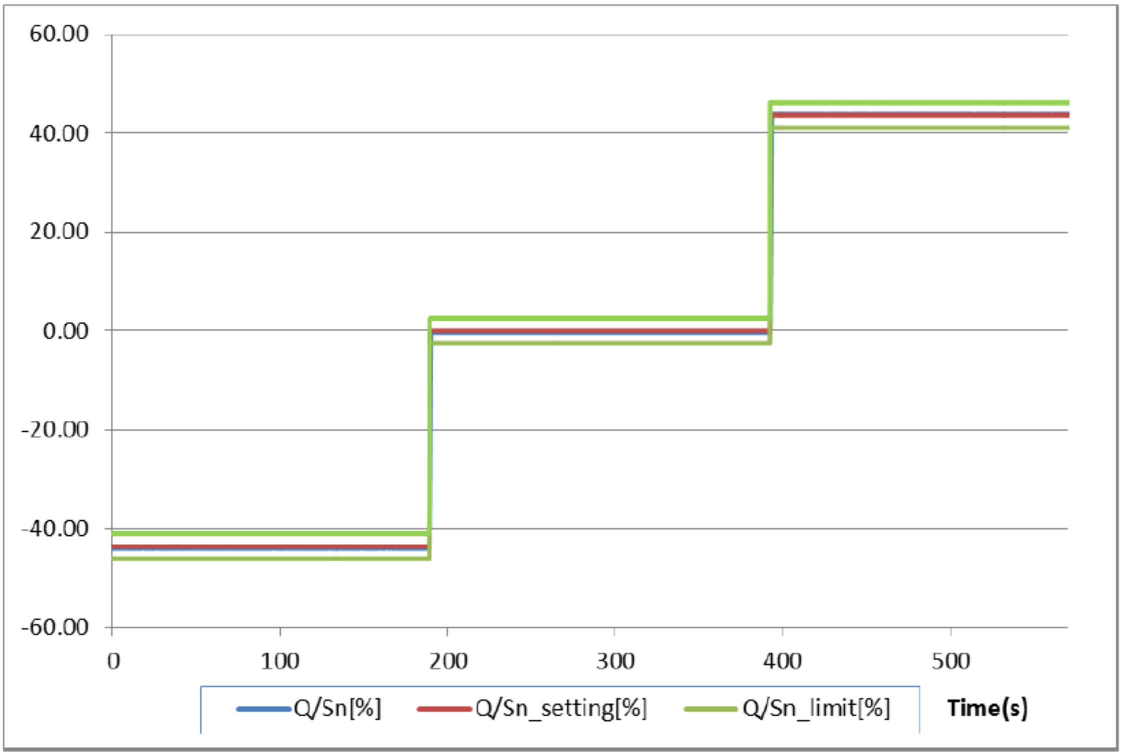
Q=0

Power-BIN	Active power [kW]	Active power p.u.	Reactive power [kVA]	Reactive power p.u.	DC power [kW]	DC power p.u.	Power factor (cos φ)
0% ±5%	0,256	0,008	0,324	0,010	0,301	0,009	0,6188
10% ±5%	3,299	0,100	0,071	0,002	3,412	0,103	0,9976
20% ±5%	6,640	0,201	0,236	0,007	6,814	0,206	0,9994
30% ±5%	9,939	0,301	0,252	0,008	10,185	0,309	0,9997
40% ±5%	13,233	0,401	0,286	0,009	13,558	0,411	0,9998
50% ±5%	16,545	0,501	0,332	0,010	16,959	0,514	0,9998
60% ±5%	19,847	0,601	0,381	0,012	20,363	0,617	0,9998
70% ±5%	23,141	0,701	0,439	0,013	23,768	0,720	0,9998
80% ±5%	26,425	0,801	0,504	0,015	27,176	0,824	0,9998
90% ±5%	29,693	0,900	0,572	0,017	30,577	0,927	0,9998
100% ±5%	33,031	1,001	0,652	0,020	34,074	1,033	0,9998

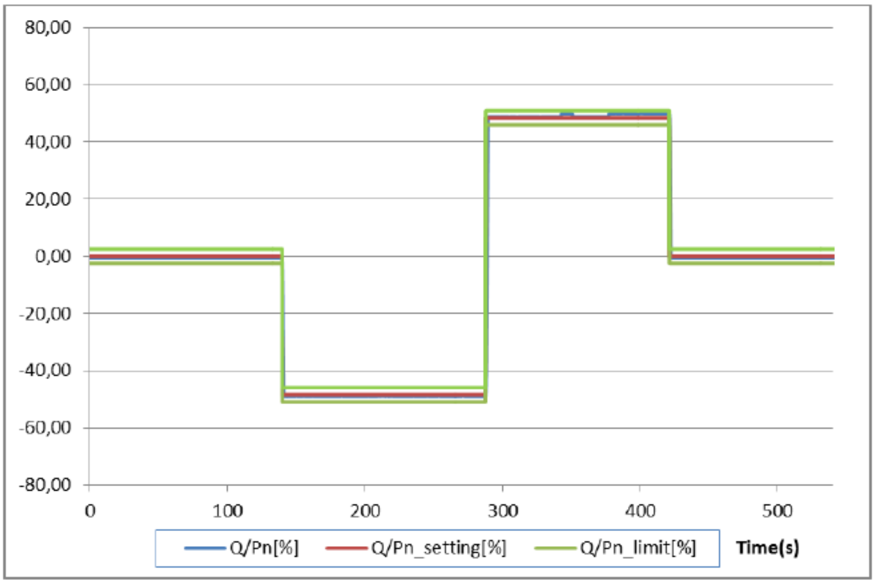
SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.4.6.2.1	**Mode of execution and registration of the test results (assuming Q regulation)**		**P**
	Set-point reactive power Q / Pn [%]	Measured reactive power Q / Pn [%]	Deviation from set point ΔQ / Pn [%]
Qmax[ind]	-43.60	-43.99	-0.39
0	0	-0.36	-0.36
Qmax[cap]	+43.60	43.87	0.27
Limit			± 2.5

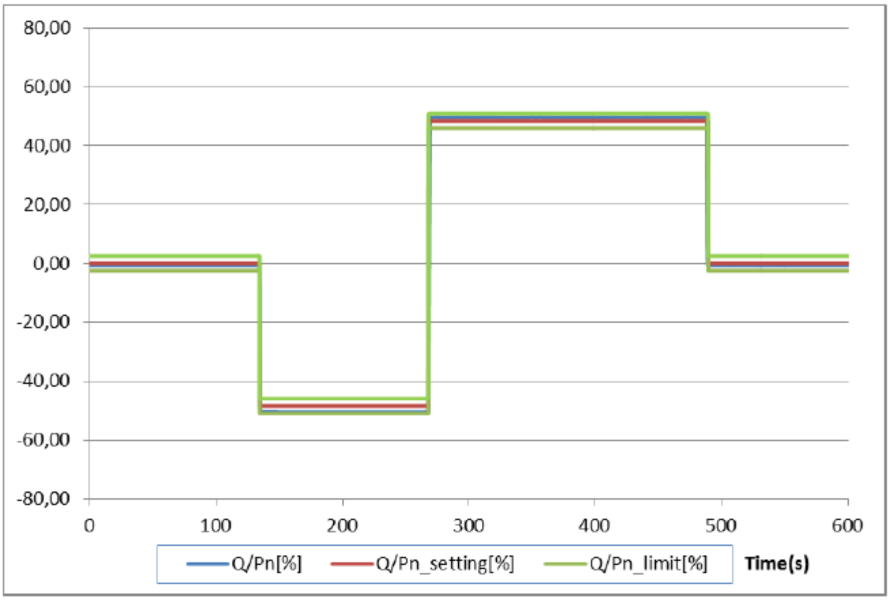
Graph : SOFAR 33000TL-G2



D.4.6.2.3	**Time response to a step change in the level assigned**		P
Reactive power set point	Maximum response time (s)		
	50% of rated active power	100% of rated active power	
Zero to -Qmin	1.2	0.6	
-Qmin to +Qmax	2.0	1.0	
+Qmax to zero	1.0	0.8	
Limit	10		



50% of rated active power

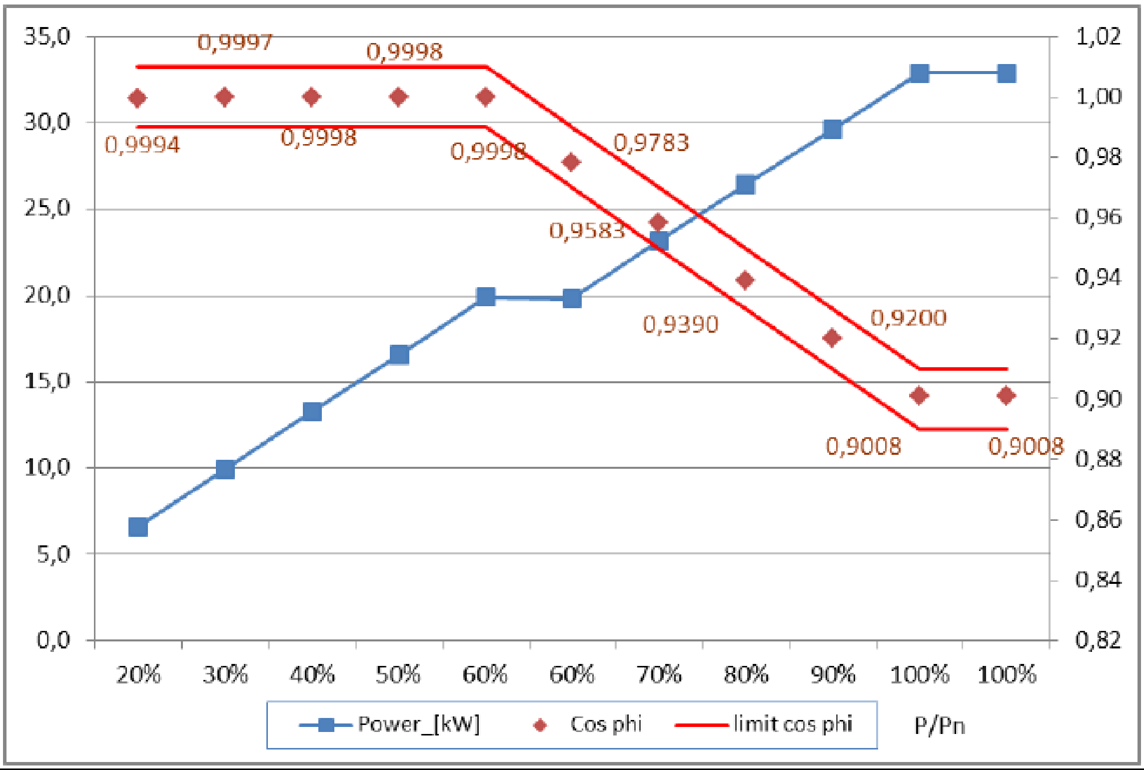


100% of rated active power

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.4.6.3	**Verification of compliance to rules for application of the characteristic curve cos φ = f (P)**				**P**
Lock-in parameter is set to 1.05Vn = 241.5Vac					
P / Pn [%]	P [KW]	Q [KVar]	Cos φ Measured	Cos φ Expected	∆ Cos φ
Voltage at the output terminals ≤ 1.05 Vn = 239.2Vac					
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	0.398	0.9998	1.00	-0.0002
Increase the network voltage to 1.06 Vn = 243.8Vac					
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	0.00
100%	32.877	-15.846	0.9008	0.90	0.0008

Remark: ∆cos φ_max ≤ ± 0.01

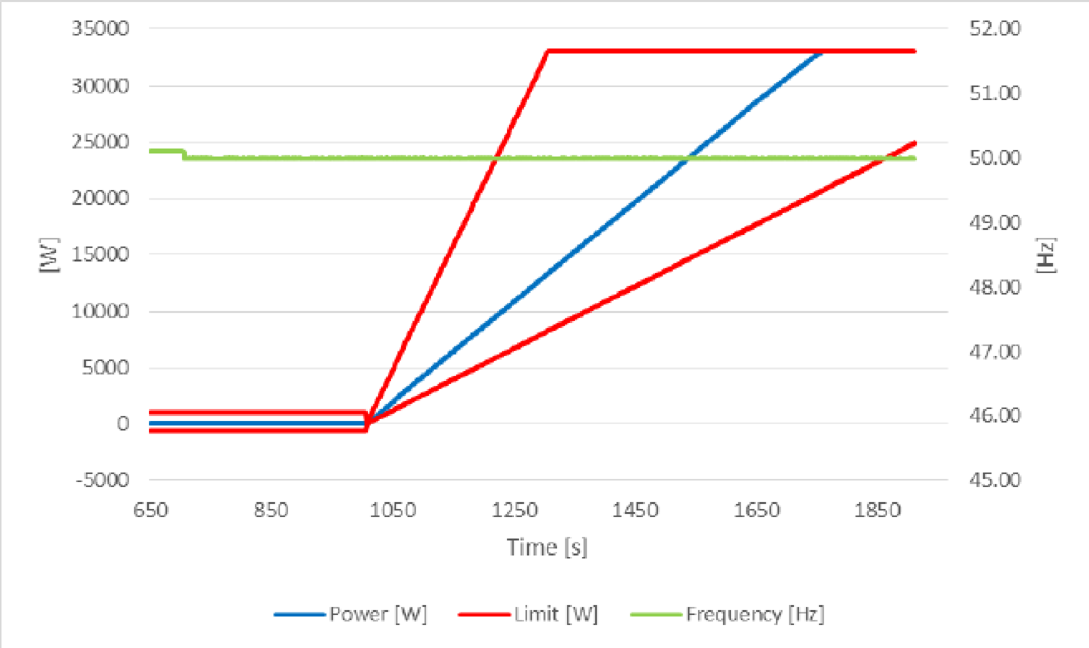


D.4.7.2	**Check automatic reduction of active power in the presence of over frequency transients on the network**					**P**
a) Tests at full power on the simulated network						
Frequency	Sequences A (50% Pn) (W)			Sequences B (100% Pn) (W)		
	Output power (measured)	Output power (expected)	Deviation	Output power (measured)	Output power (expected)	Deviation
47.51 Hz	16665	16500	165	33099	33000	99
50.2 Hz	16682	16500	182	33099	33000	99
50.4 Hz	15914	15749	165	31384	31499	-115
50.6 Hz	13895	14248	-353	27770	28496	-726
52.49 Hz	23	59	-36	28	117	-89
50.11 Hz	13	59	-46	20	117	-97
50 Hz	18	59	-41	25	117	-92
Limit	--	--	±825	--	--	±825

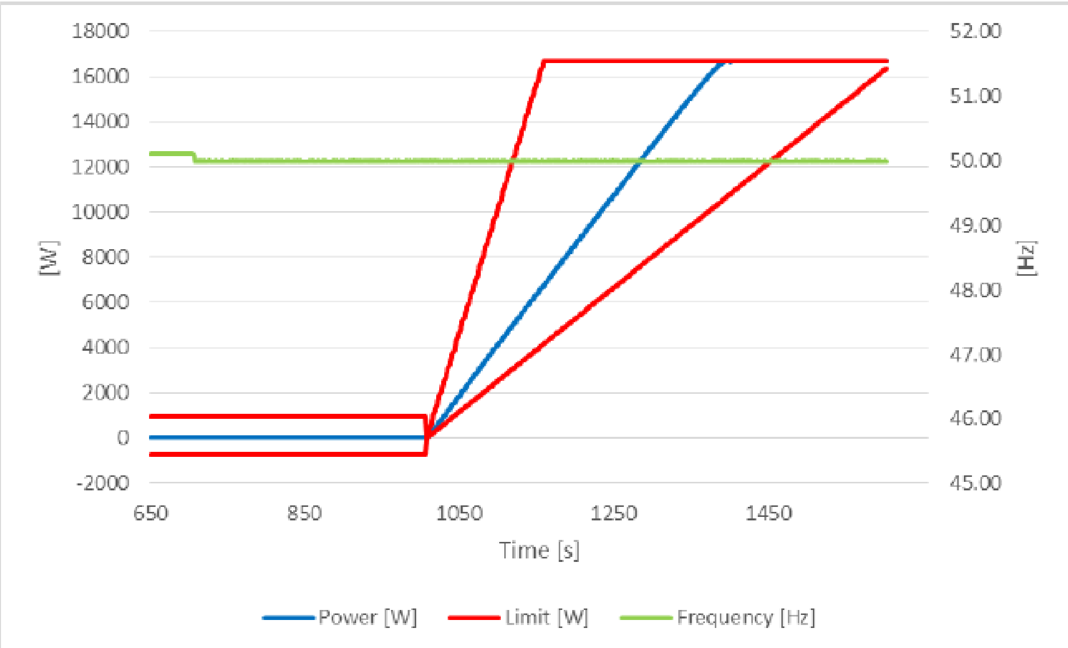
50 Hz	Waiting time (s)	Positive gradient of output power (W/ min.)	Waiting time (s)	Positive gradient of output power (W/ min.)
	347	2828.58	350	2828.57
Limit	300	3300	300	6600

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

Graph of Measurement 2.: Power gradient 100% P_{nom}

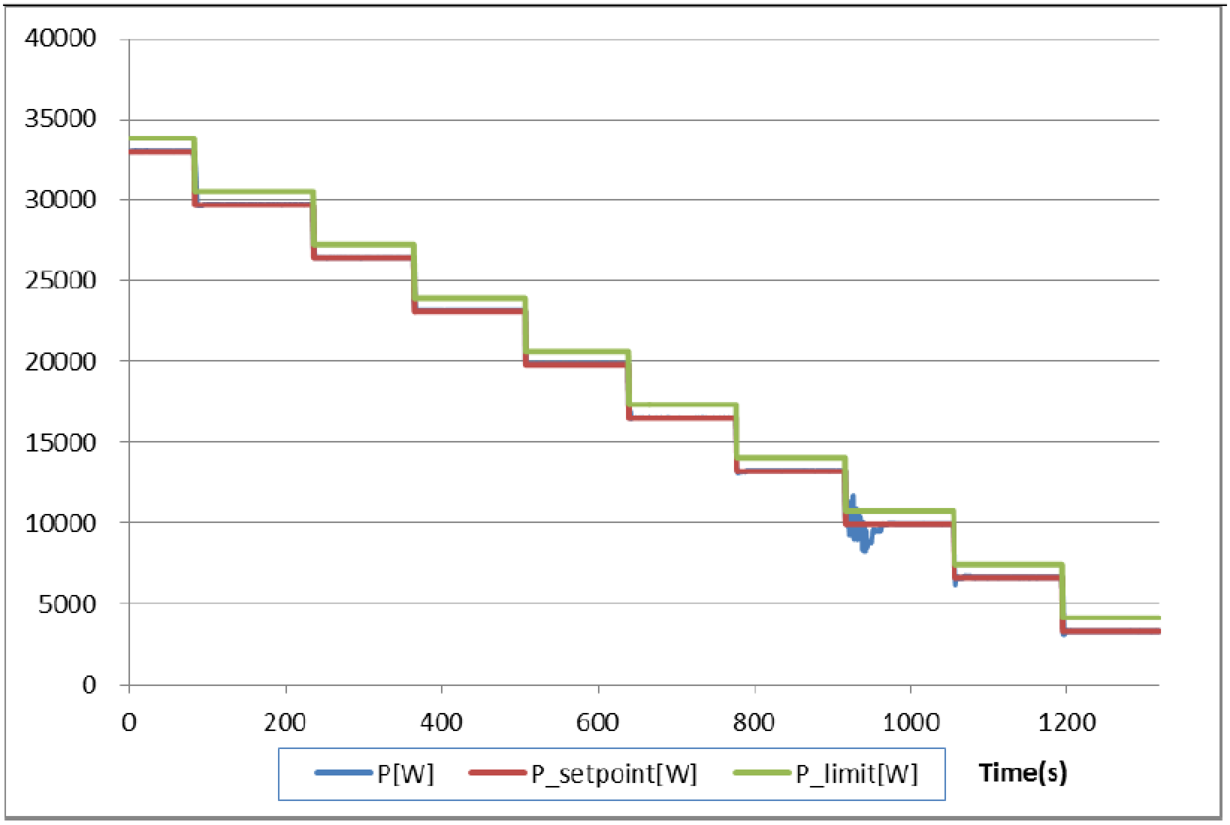


Graph of Measurement 2.: Power gradient 50% P_{nom}



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

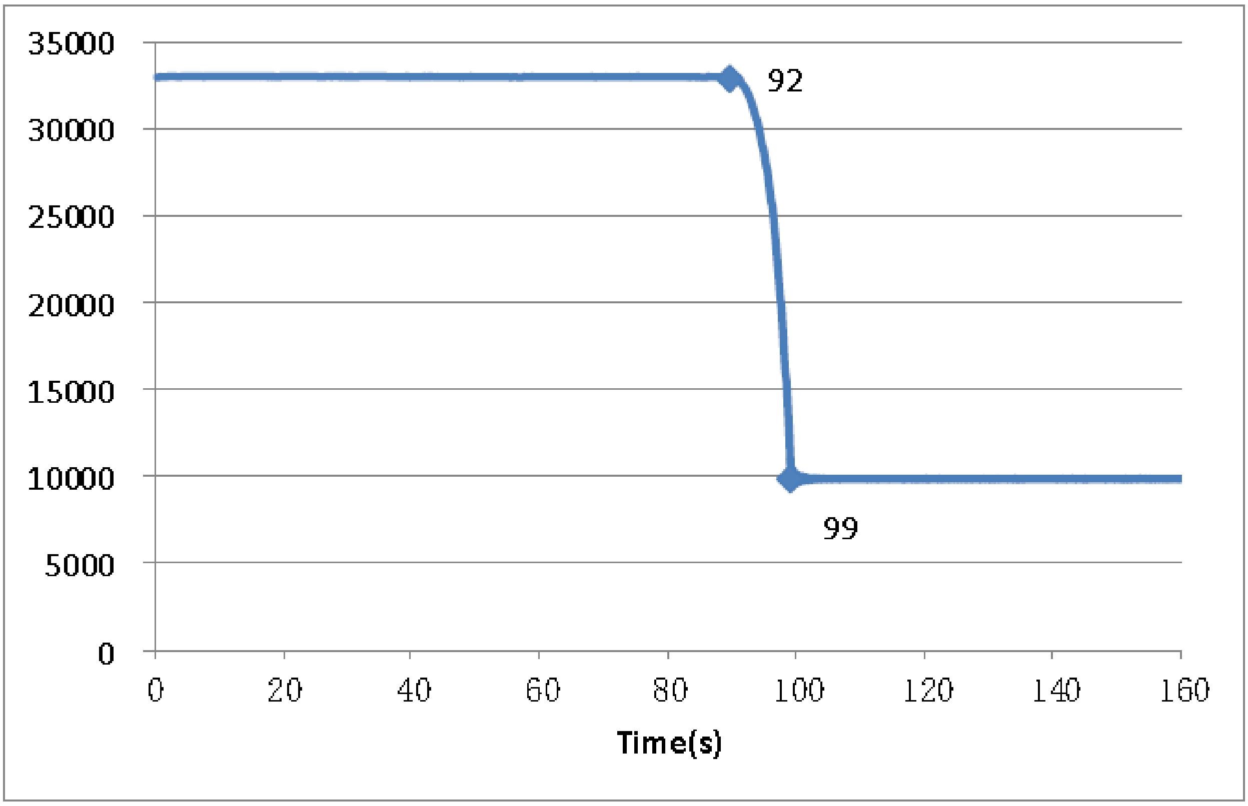
D.4.7.3	**Verification of active power limitation upon external control**			**P**
Set point P [P / Pn]	Set point P [KW]	Measured P [KW]	Accuracy [%]	Limit [%
100%	33.000	33.036	0.109	±2.5
90%	29.700	29.740	0.121	±2.5
80%	26.400	26.409	0.027	±2.5
70%	23.100	23.149	0.148	±2.5
60%	19.800	19.848	0.145	±2.5
50%	16.500	16.511	0.033	±2.5
40%	13.200	13.252	0.158	±2.5
30%	9.900	9.923	0.070	±2.5
20%	6.600	6.629	0.088	±2.5
10%	3.300	3.302	0.006	+2.5%~ 0
0%	0	0.198	0.600	+2.5%~ 0



SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

D.4.7.3.1	**Checking the settling time following a command of power reduction**	P
Set up time; P = 100% Pn -> 30 %Pn		
Measured active power [W]:	9900 (30% ±5%Pn)	
Settling time [s]:	7.0	
Limit setting time:	≤ 50 s	
Set up time; P = 100% Pn -> 15 %Pn		
Measured active power [W]:	5000 (15% ±5%Pn)	
Settling time [s]:	7.2	
Limit setting time:	≤ 60 s	

Graph – setting time 100%Pn _ 30% Pn

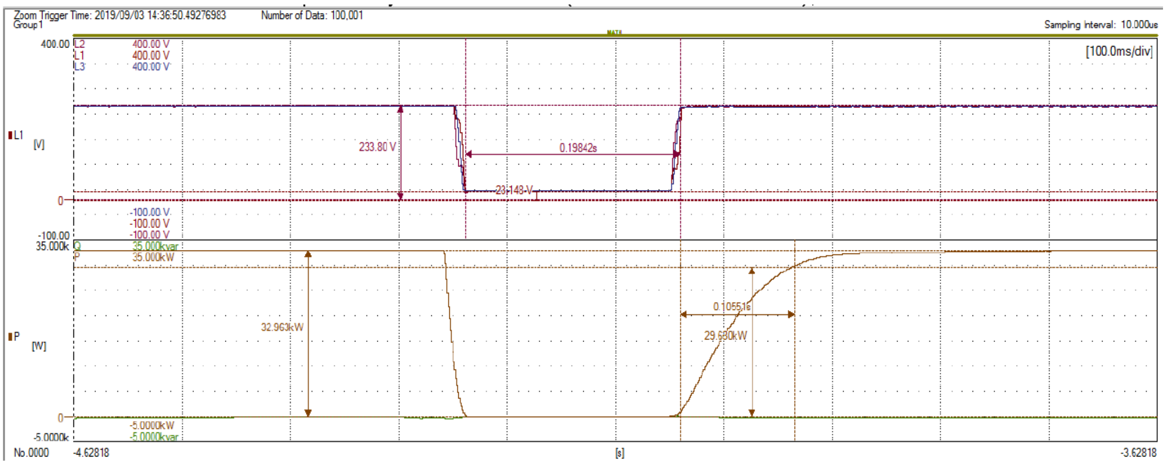


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

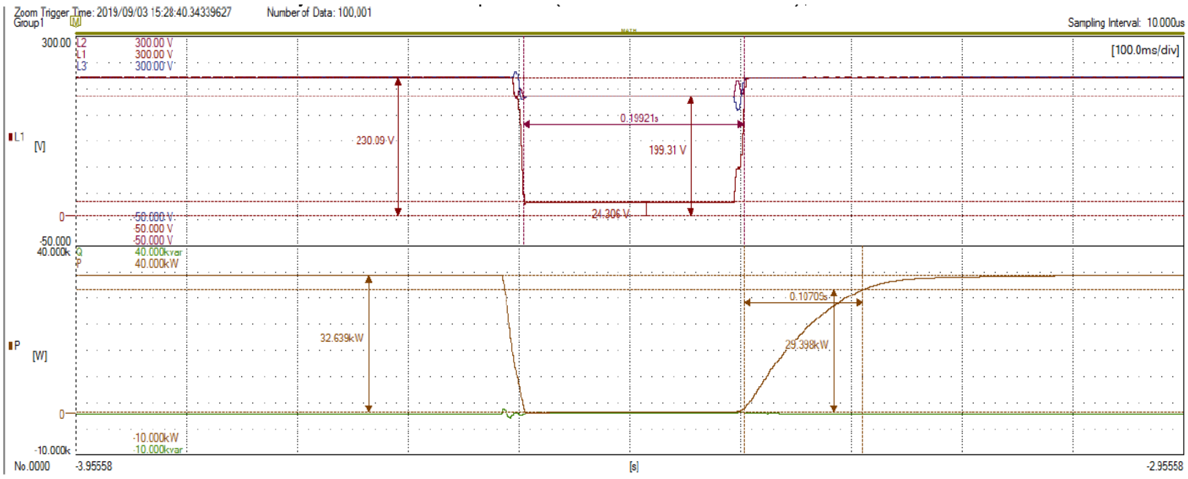
D.4.8	**Table: Verification of insensitivity to voltage dips (LVFRT capability)**								**P**
Output power: 33KW	Limits: >90% Pnom,								
	R	S	T	R	S	T	**Duration**	**Recovery time**	**Limits of recovery time**
	U/Unom	U/Unom	U/Unom	φ1	φ2	φ3	[ms]	[ms]	[ms]
1s – symmetric 3 phase fault	0.05	0.05	0.05	0°	-120°	120°	200± 20	105.51	<1000
1a – asymmetric 2 phase fault	0.86	0.86	0.05	28°	-148°	120°	200± 20	107.09	<1000
2s - symmetric 3 phase fault	0.25	0.25	0.25	0°	-120°	120°	500± 20	104.72	<1000
2a - asymmetric 2 phase fault	0.88	0.88	0.25	22°	-142°	120°	500± 20	110.24	<1000
3s –symmetric 3 phase fault	0.55	0.55	0.55	0°	-120°	120°	950 ± 20	99.27	<1000
3a –asymmetric 2 phase fault	0.90	0.90	0.50	14°	-134°	120°	950 ± 20	107.08	<1000
4s - symmetric 3 phase fault	0.75	0.75	0.75	0°	-120°	120°	1400 ± 20	100.07	<1000
4a –asymmetric 2 phase fault	0.94	0.94	0.75	7°	-127°	120°	1400 ± 20	99.43	<1000

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

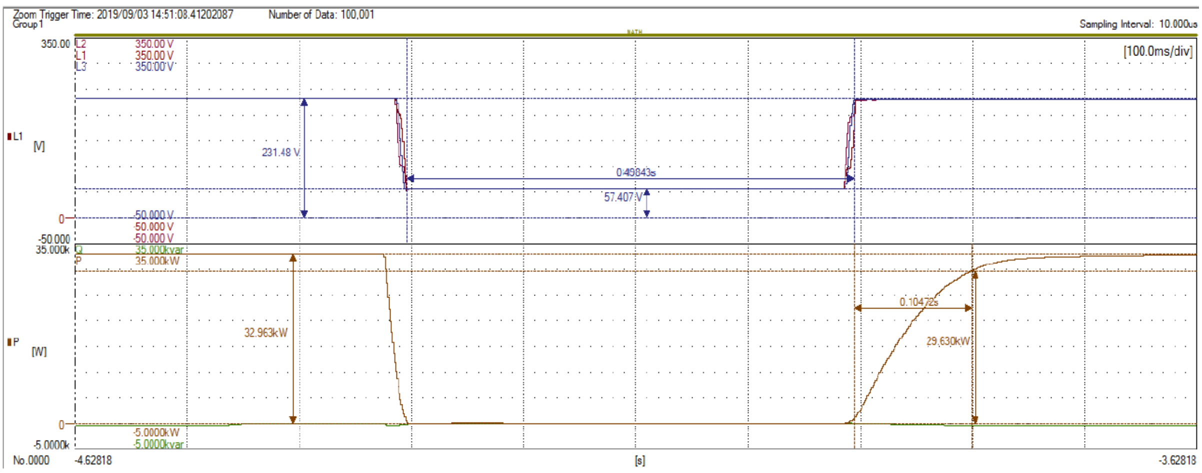
1s – symmetric 3 phase fault



1a – asymmetric 2 phase fault

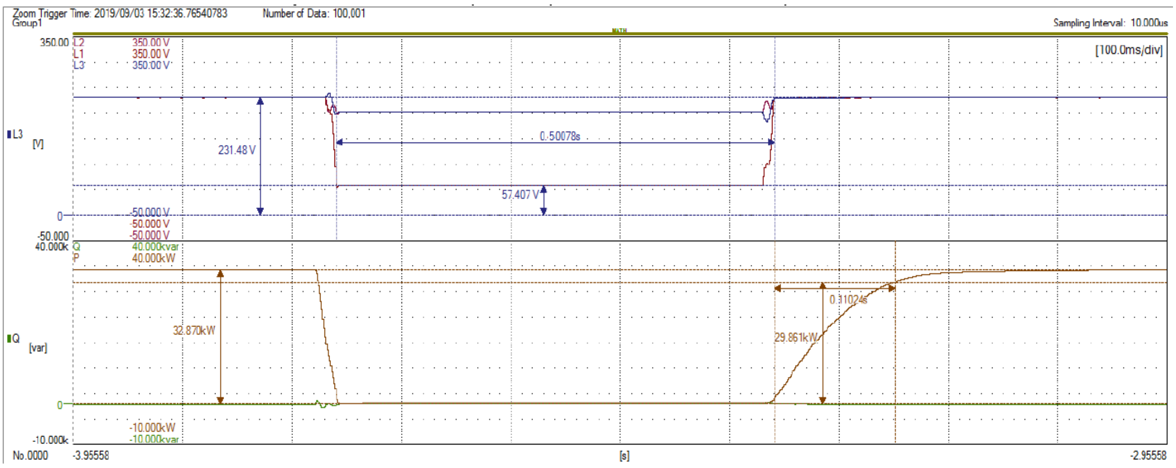


2s - symmetric 3 phase fault

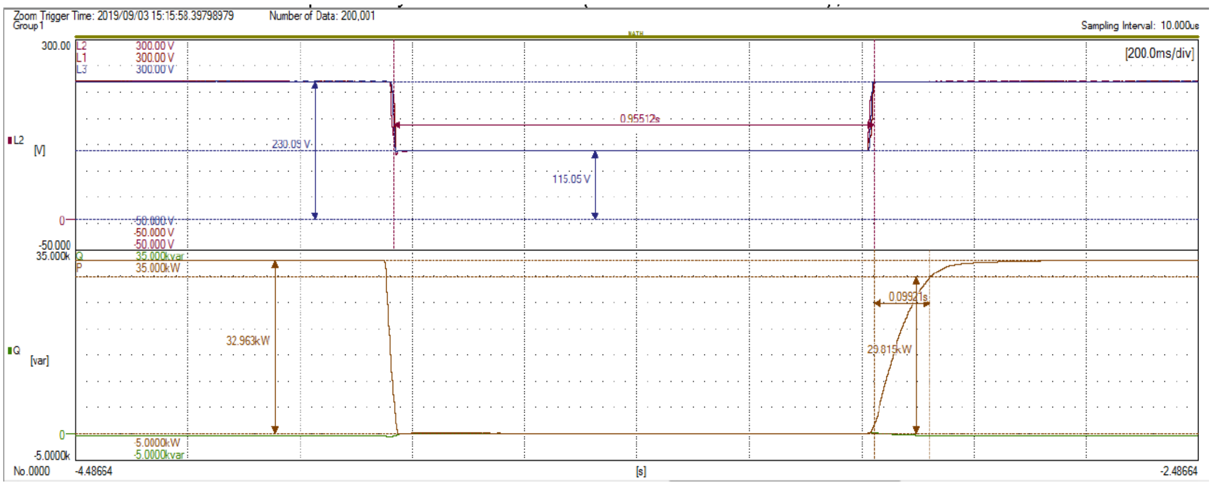


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

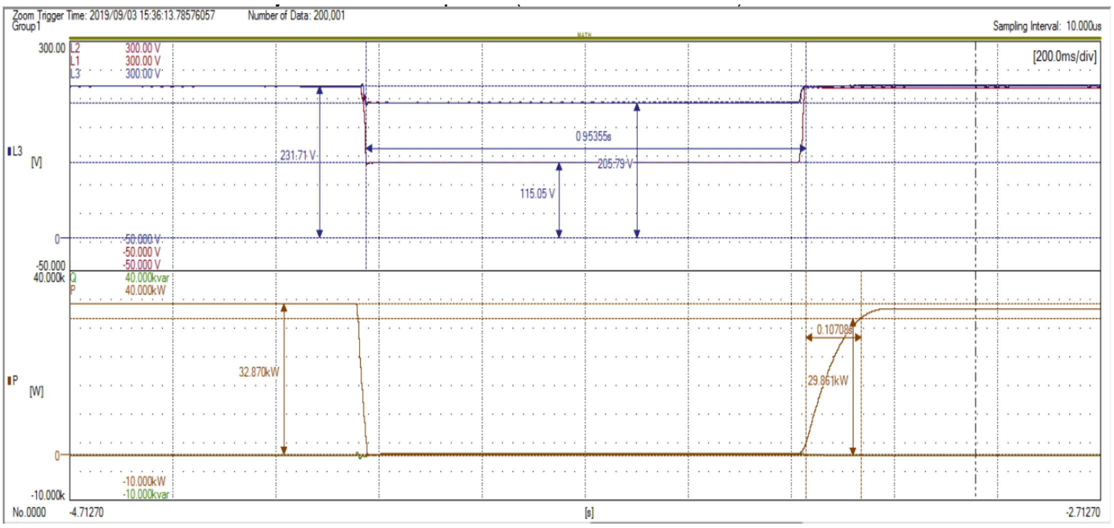
2a - asymmetric 2 phase fault



3s –symmetric 3 phase fault

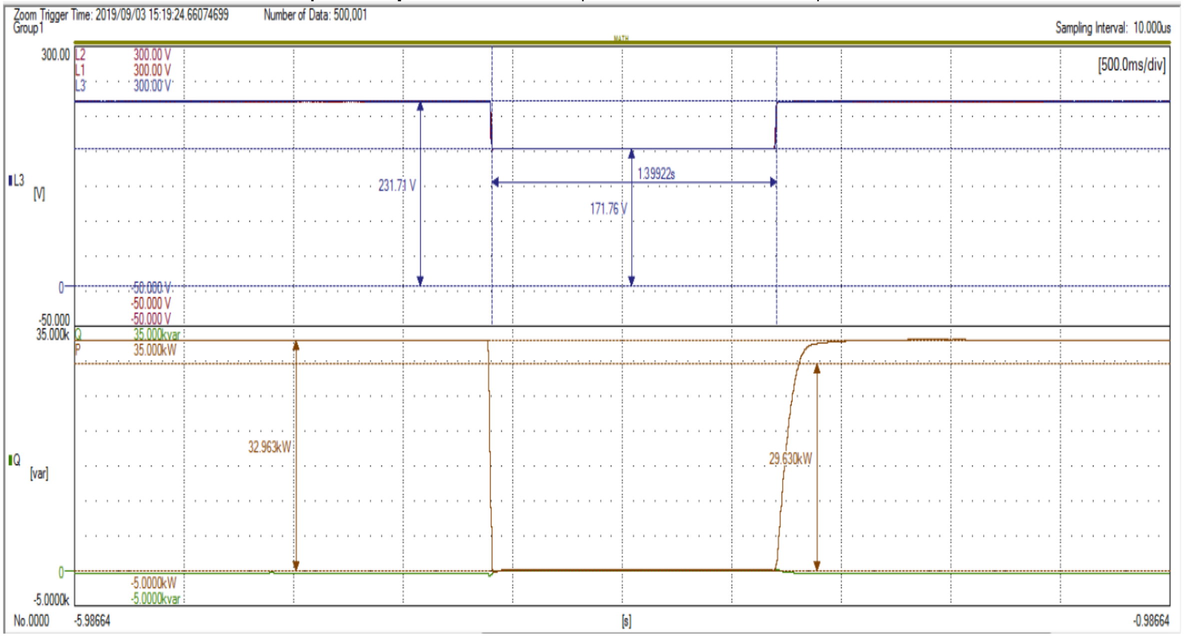


3a –asymmetric 2 phase fault

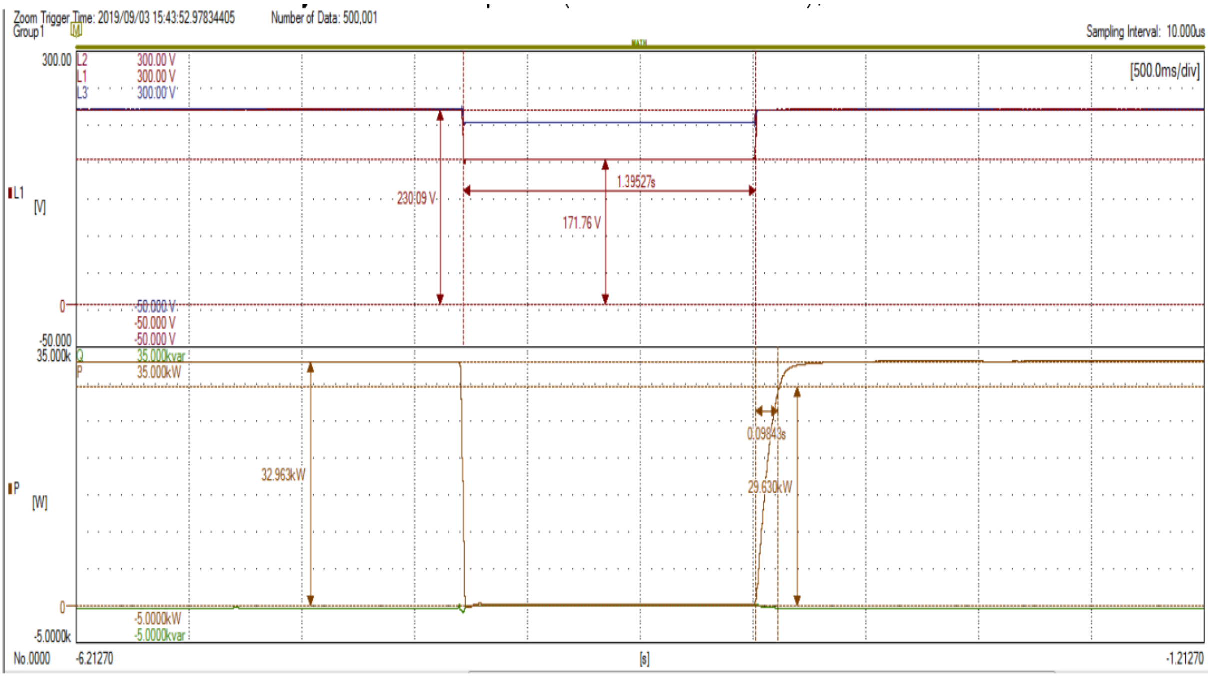


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

4s - symmetric 3 phase fault



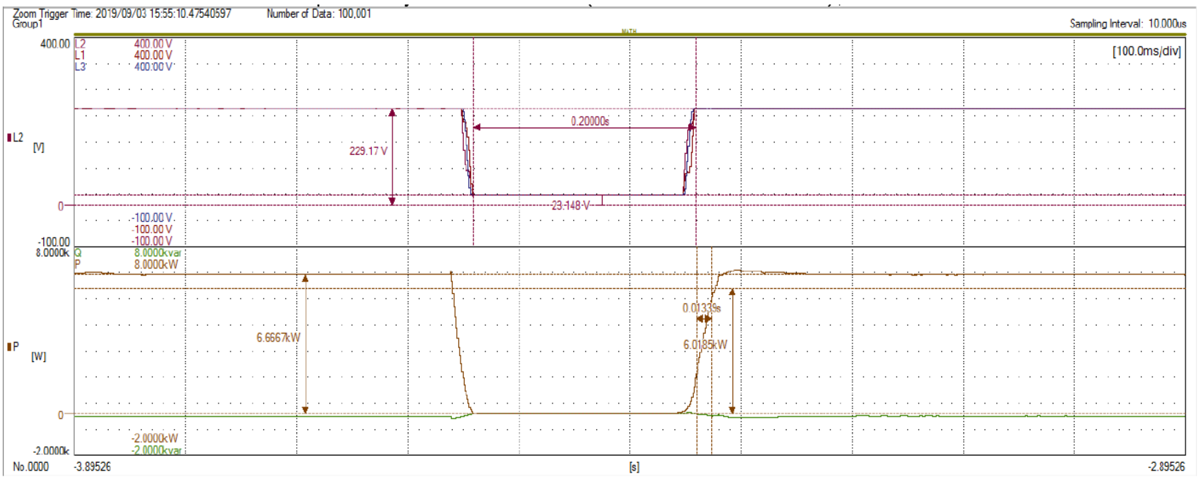
4a –asymmetric 2 phase fault



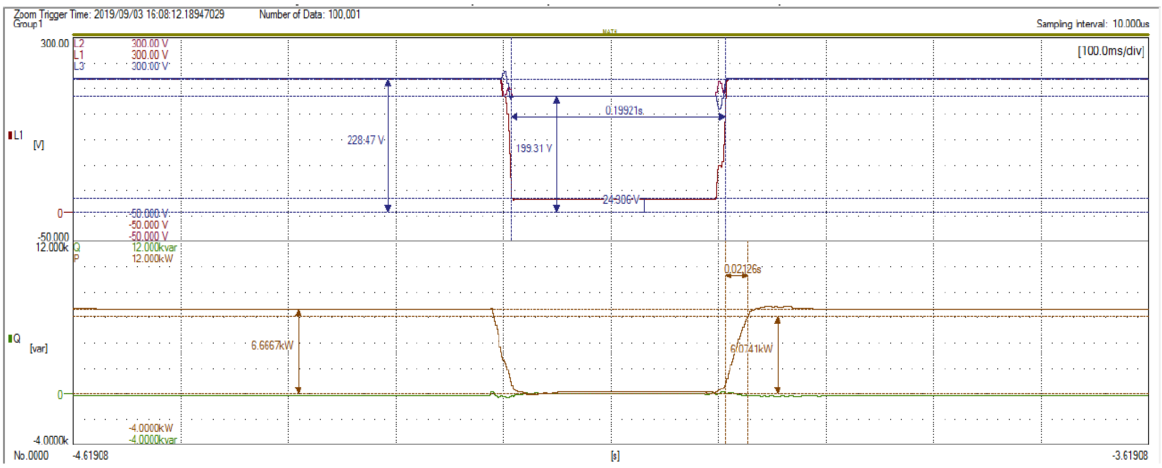
D.4.8	Table: Verification of insensitivity to voltage dips (LVFRT capability)								P
Output power: 6.6KW	Limits: 10%-30% Pnom,								
	R	S	T	R	S	T	**Duration**	**Recovery time**	**Limits of recovery time**
	U/Unom	U/Unom	U/Unom	φ1	φ2	φ3	[ms]	[ms]	[ms]
1s – symmetric 3 phase fault	0.05	0.05	0.05	0°	-120°	120°	200± 20	13.90	<1000
1a – asymmetric 2 phase fault	0.86	0.86	0.05	28°	-148°	120°	200± 20	21.26	<1000
2s - symmetric 3 phase fault	0.25	0.25	0.25	0°	-120°	120°	500± 20	19.69	<1000
2a - asymmetric 2 phase fault	0.88	0.88	0.25	22°	-142°	120°	500± 20	21.26	<1000
3s –symmetric 3 phase fault	0.55	0.55	0.55	0°	-120°	120°	950 ± 20	19.27	<1000
3a –asymmetric 2 phase fault	0.90	0.90	0.50	14°	-134°	120°	950 ± 20	17.28	<1000
4s - symmetric 3 phase fault	0.75	0.75	0.75	0°	-120°	120°	1400 ± 20	20.07	<1000
4a –asymmetric 2 phase fault	0.94	0.94	0.75	7°	-127°	120°	1400 ± 20	19.73	<1000

SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

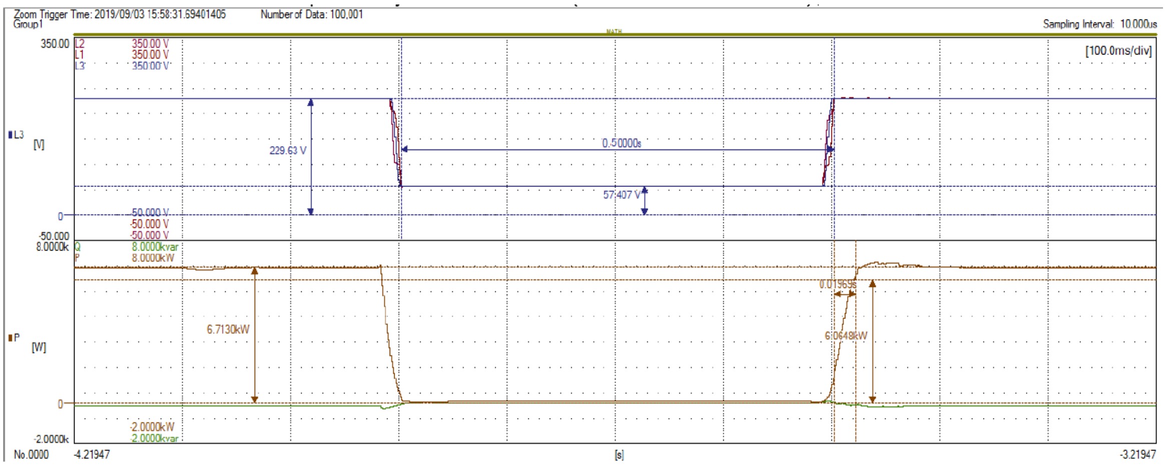
1s – symmetric 3 phase fault



1a – asymmetric 2 phase fault

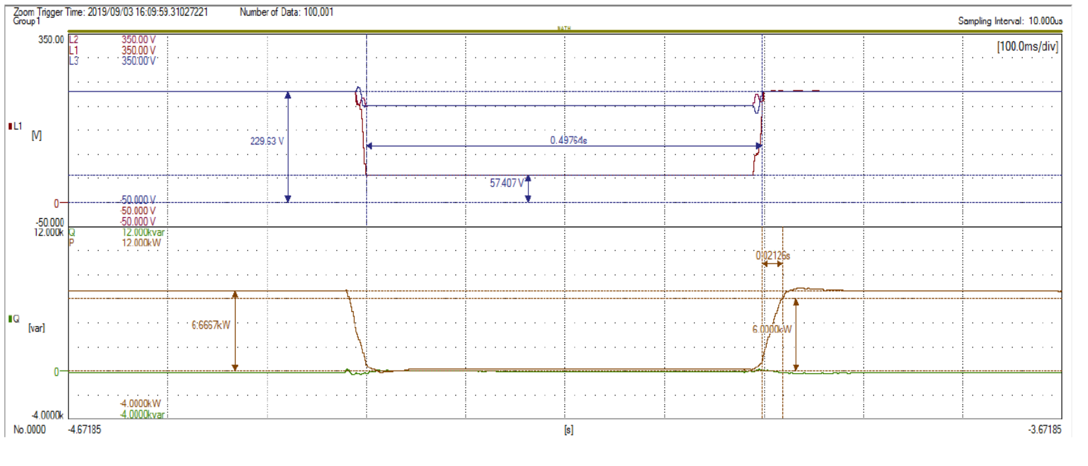


2s - symmetric 3 phase fault

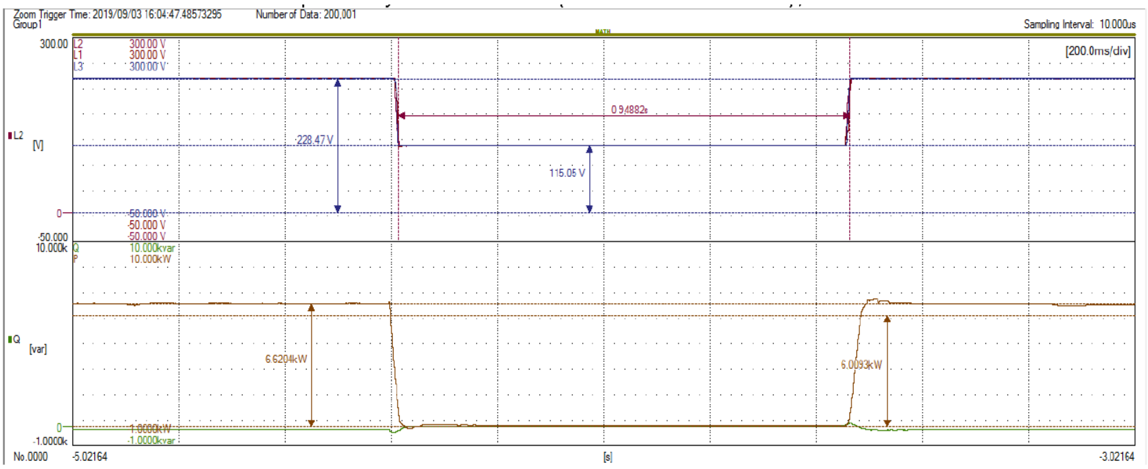


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

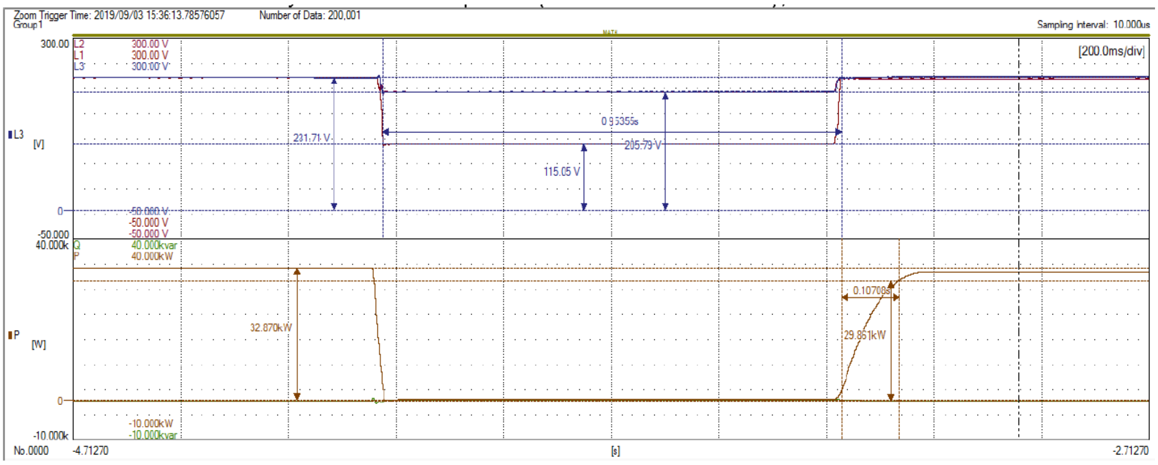
2a - asymmetric 2 phase fault



3s –symmetric 3 phase fault

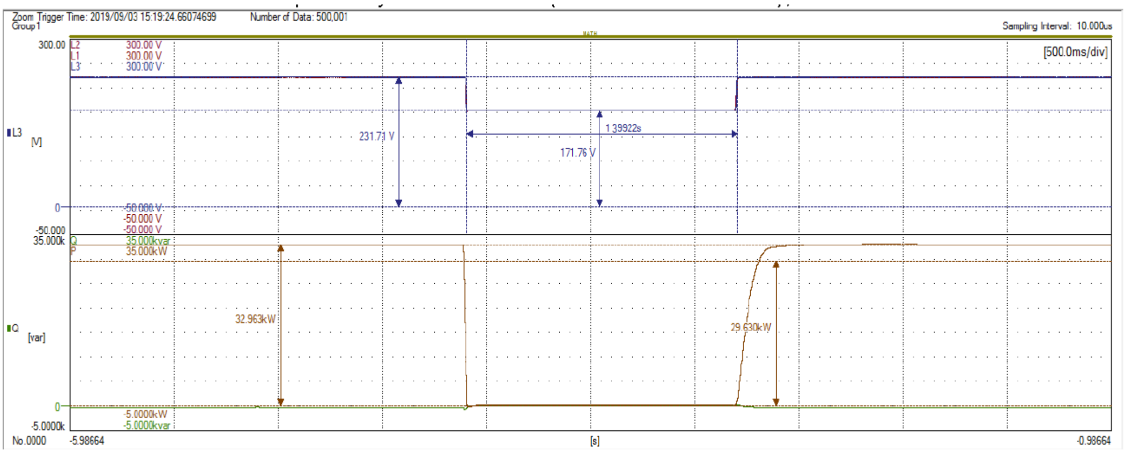


3a –asymmetric 2 phase fault

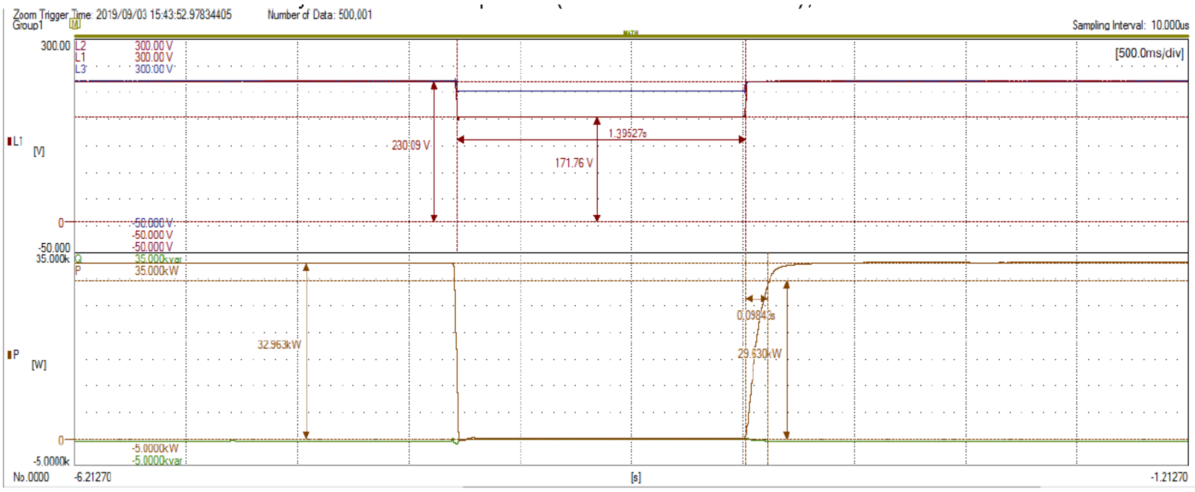


SHAMS DUBAI - DRRG Standards Version 2.0			
Clause	Requirement + Test	Result - Remark	Verdict

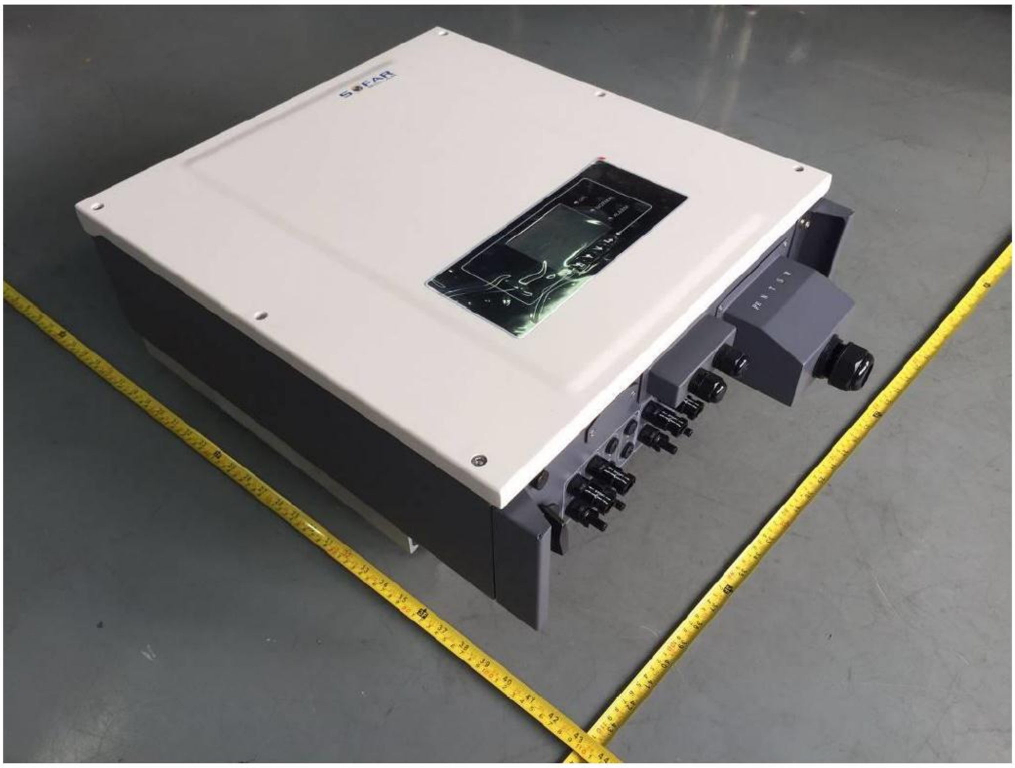
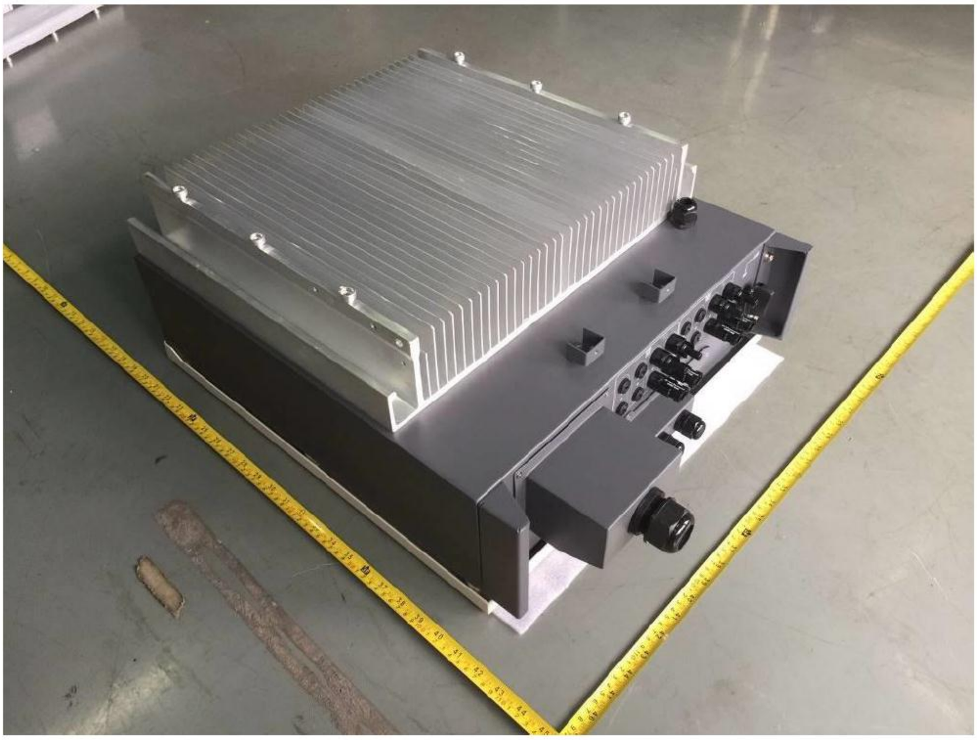
4s - symmetric 3 phase fault



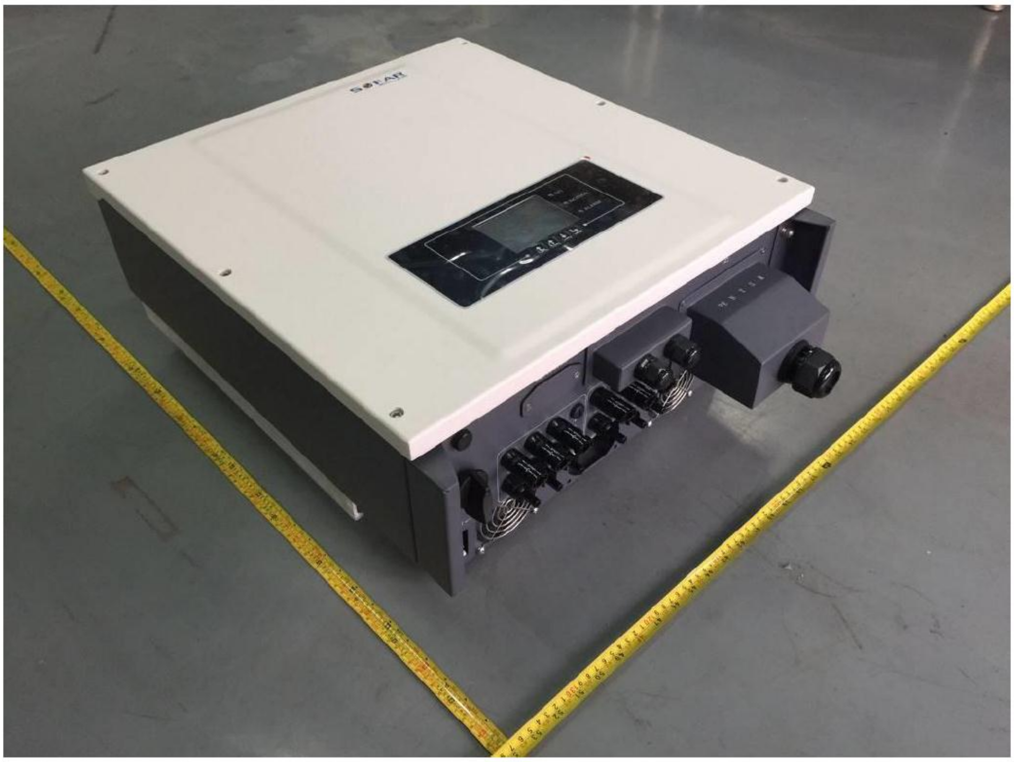
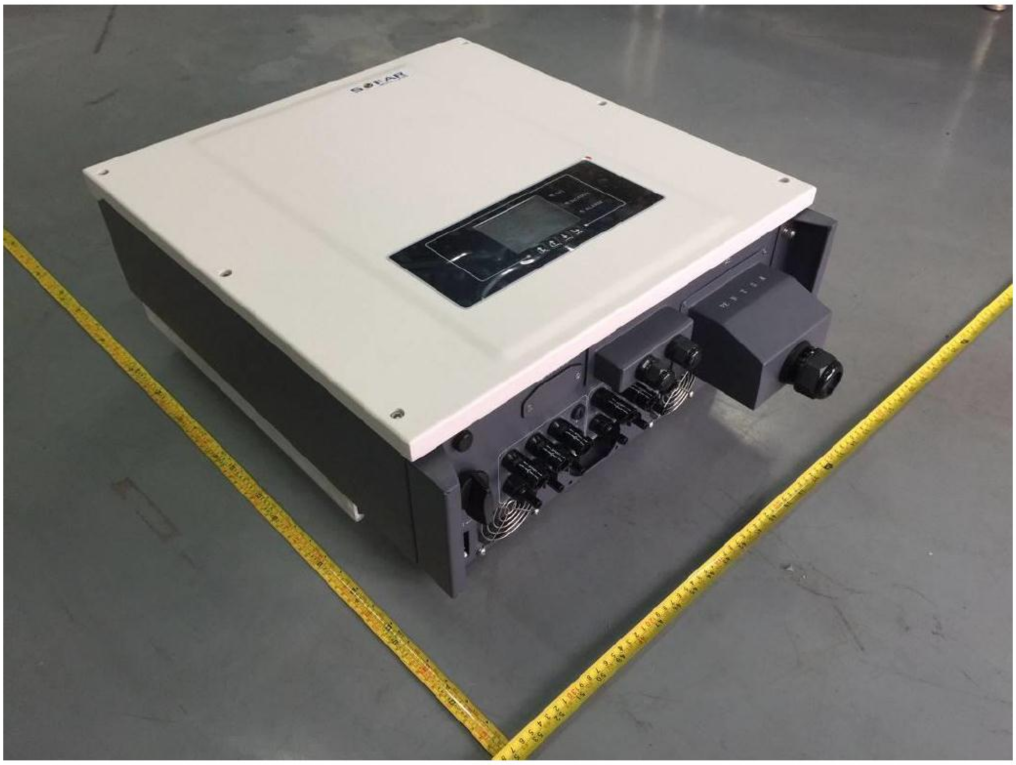
4a –asymmetric 2 phase fault



Appendix photos

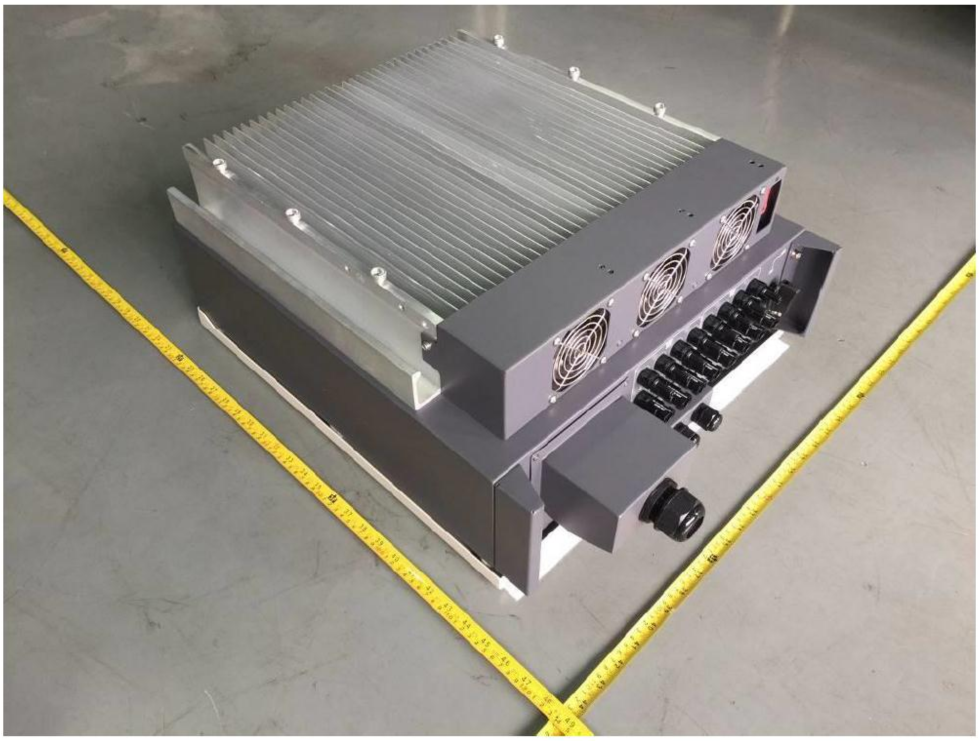
Enclosure front view: SOFAR 20000TL-G2

Enclosure rear view: SOFAR 20000TL-G2


Appendix photos

Enclosure front view: SOFAR 25000TL-G2

Enclosure rear view: SOFAR 25000TL-G2


Appendix photos

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

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


Appendix photos

Enclosure terminal view: SOFAR 20000TL-G2

Enclosure terminal view: SOFAR 25000TL-G2

Appendix photos

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


Internal view: SOFAR 20000TL-G2


Appendix photos

Internal view: SOFAR 25000TL-G2


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


(End of report)