TEST REPORT

Engineering recommendation G99/1

Requirements for the connection of generation equipment in parallel with public Low Voltage Distribution Networks.

Report reference number .... :	**SGR-ESH-P19121001-1**
Date of issue .... :	2019-12-17
Total number of pages .... :	58
Testing laboratory name .... :	**Bureau Veritas LCIE China Company Limited**
Address .... :	Building 4, No. 518, Xinzhuan Road, Caohejing Songjiang High-Tech Park, Shanghai, P.R. China (201612)
Applicant's name .... :	**SUNGROW POWER SUPPLY CO., LTD**
Address .... :	No,1699 Xiyou Rd, New & High Technology Industrial Development Zone, Hefei, 230088 P,R,China,
Test specification	
Standard .... :	G99 Issue 1 Amendment 5:2019
Certificate .... :	N/A
Test report form number. .... :	TEST REPORT G99/1 VER.0
Master TRF .... :	Bureau Veritas Consumer Products Services Germany GmbH
Test item description .... :	**Grid-tied photovoltaic inverter**
Trademark .... :	SUNGROW
Model / Type .... :	SG33CX, SG40CX, SG50CX

Ratings .... :	SG33CX	SG40CX	SG50CX
Input DC voltage range [V] .... :	MPPT: 200-1000, 1100(Max.)		
Input DC current [A] .... :	26(Max.)*3	26(Max.)*4	26(Max.)*5
Output AC voltage [V] .... :	3/N/PE,400/230, 50Hz/60Hz		
Max. Output AC current [A].............. :	55,2	66,9	83,6
Rated output power [kW] .... :	33	40	50

Testing Location ....:	**SUNGROW POWER SUPPLY CO., LTD**
Address ....:	No.1699 Xiyou Rd, New & High Technology Industrial Development Zone, Hefei, 230088 P.R.China.
Tested by (name and signature) ....:	Tony Huang Test engineer
Approved by (name and signature) ....:	Harvey Wang Project Manager
Manufacturer's name ....:	**SUNGROW POWER SUPPLY CO., LTD**
Factory address................................:	No.1699 Xiyou Rd, New & High Technology Industrial Development Zone, Hefei, 230088 P.R.China.
Factory's name 1 ....:	**SUNGROW POWER SUPPLY CO.,LTD**
Factory address................................:	No. 608 Changning Avenue, New & High Technology Industrial Development Zone, Hefei 230088 P.R. China
Factory's name 2 ....:	**Sungrow Developers (India) Private Limited**
Factory address................................:	No. 85, Kaniminike village, Kengeri hobli Bangalore South Taluk, 560074 Bangalore, India

Document History

Date	Internal reference	Modification / Change / Status	Revision
2019-12-17	Tony Huang	Initial report was written	0
Supplementary information:			

Test items particulars

Equipment mobility.......................... :	Permanent connection
Operating condition......................... :	Continuous
Class of equipment .... :	Class I
Protection against ingress of water.. :	IP65 according to EN 60529
Mass of equipment [kg].................... :	50kg for SG33CX 58kg for SG40CX 62kg for SG50CX

Test case verdicts

Test case does not apply to the test object.............................. :	N/A
Test item does meet the requirement............................... :	P(ass)
Test item does not meet the requirement............................... :	F(ail)

Testing

Date of receipt of test item .... :	2019-10-12
Date(s) of performance of test .... :	2019-10-12 to 2019-12-07

General remarks:

The test result presented in this report relate only to the object(s) tested. The report shall state compliance of the tested objects with the Type A requirements of G99-1. This report must not be reproduced in part or in full without the written approval of the issuing testing laboratory.

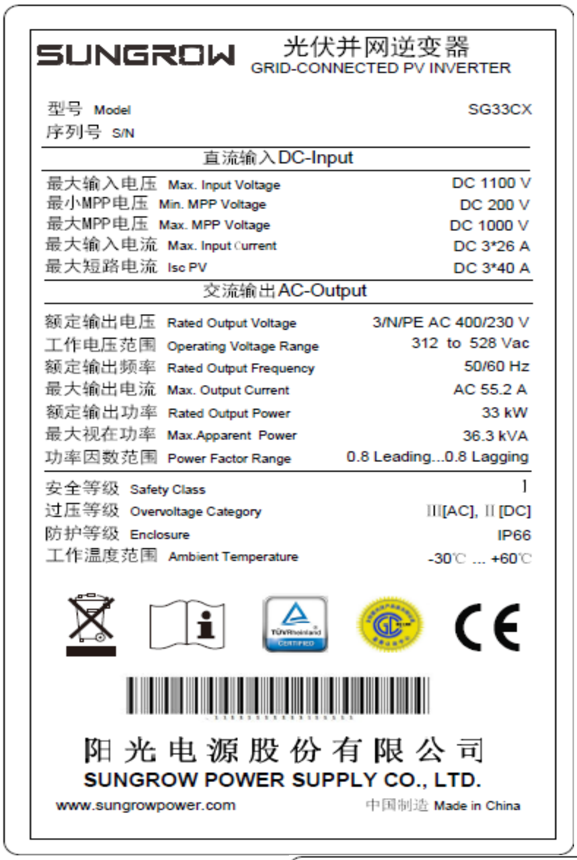
”(see Annex #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

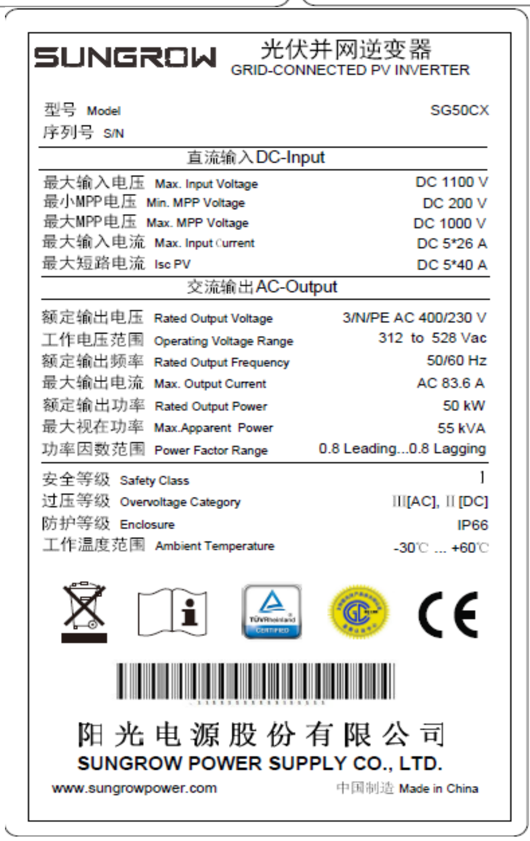
Throughout this report a comma is used as the decimal separator.

This Test Report consists of the following documents:

1. Test Results
2. Annex No. 1 – EMC Test Report
3. Annex No. 2 – Pictures of the unit
4. Annex No. 3 – Test equipment list

Copy of marking plate





General product information:

The Solar converter converts DC voltage into AC voltage.

The input and output are protected by varistors to earth. The unit is providing EMC filtering at the input and output towards mains. The output is switched off redundant by the high power switching bridge and two relay in series. This assures that the opening of the output circuit will also operate in case of one error.

Differences of the models:

Model	SG33CX	SG40CX	SG50CX
No. of independent MPPT inputs	3	4	5
Rate output power	33	40	50

Hardware:

Model	SG33CX	SG40CX	SG50CX
Hardware	SG33CX	SG40CX	SG50CX

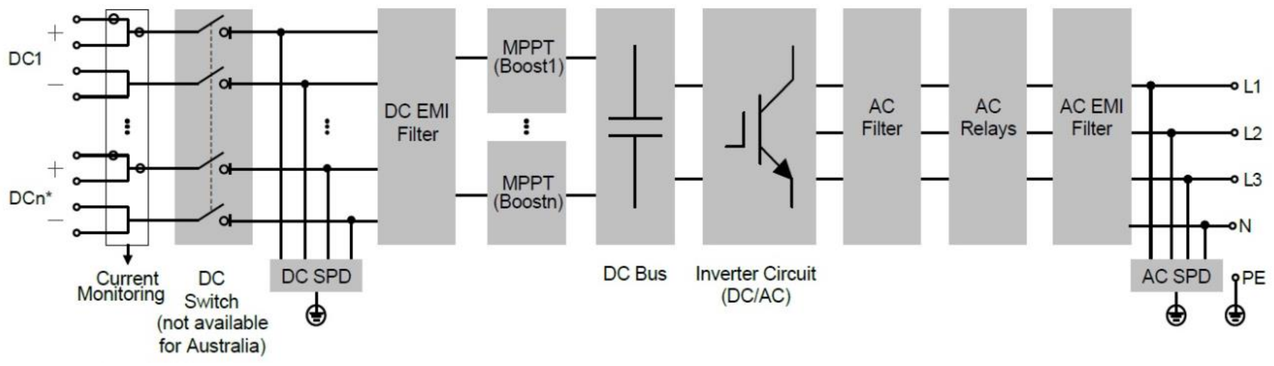
Software:

Model	SG33CX	SG40CX	SG50CX
LCD	LCD_AGATE-S_V11_V01_A		
MDSP	MDSP_AGATE-S_V11_V01_A		

Description of the electrical circuit:

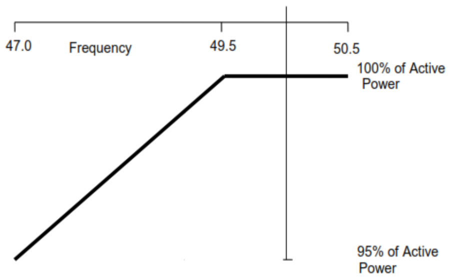
The internal control is redundant built, It consists of master controller(U2) and slave controller(U1), the master controller(U2) can control relays, measures voltage, frequency, AC current with injected DC, insulation resistance and residual current. The slave controller (U1)can control the relays, measures the voltage and frequency. Both controllers communicate with each other.
The voltage and frequency measurement is achieved with resistors in serial which are connected directly to line and neutral. Both controllers get these signals and calculate the data.
The unit provides two relays in series in each phase. The relays are tested before each start up. In addition the power bridge can be stopped by both controllers.

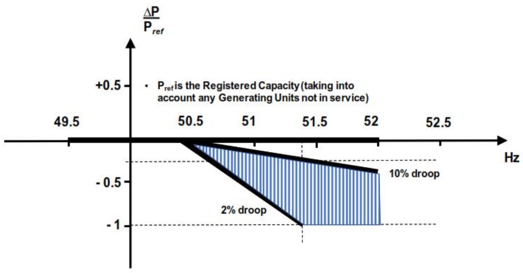
Block diagram of the utility interactive inverter:



Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
11	**Type A Power Generating Module Technical Requirements**		
11.1	**Power Generating Module Performance and Control Requirements – General**		**P**
11.1.1	The requirements of this Section 11 do not apply in full to: (a) Power Generation Facilities that are designed and installed for infrequent short-term parallel operation only; or (b) Electricity Storage Power Generation Modules within the Power Generating Facility. Refer to Annex A.4 for details.		**P**
11.1.2	The Active Power output of a Power Generating Module should not be affected by voltage changes within the statutory limits declared by the DNO in accordance with the ESQCR.		**P**
11.1.3	Power Generating Modules connected to the DNO’s Distribution Network shall be equipped with a logic interface (input port) in order to cease Active Power output within 5 s following an instruction being received at the input port.		**P**
11.1.3.1	By default the DNO logic interface will take the form of a simple binary output that can be operated by a simple switch or contactor. When the switch is closed the Power Generating Module can operate normally. When the switch is opened the Power Generating Module will reduce its Active Power to zero within 5 s. The signal from the Power Generating Module that is being switched can be either AC (maximum value 240 V) or DC (maximum value 110 V). If the DNO wishes to make use of the facility to cease Active Power output the DNO will agree with the Generator how the communication path is to be achieved.		**N/A**
11.1.4	Each item of a Power Generating Module and its associated control equipment shall be designed for stable operation in parallel with the Distribution Network.		**P**
11.1.5	When operating at rated power the Power Generating Module shall be capable of operating at a Power Factor within the range 0,95 lagging to 0,95 leading relative to the voltage waveform unless otherwise agreed with the DNO.		**P**
11.1.6	As part of the connection application process the Generator shall agree with the DNO the set points of the control scheme for voltage control, Power Factor control or Reactive Power control as appropriate. These settings, and any changes to these settings, shall be agreed with the DNO and recorded in the		**P**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	Connection Agreement. The information to be provided is detailed in Schedule 5a and Schedule 5b of the Data Registration Code.		
11.1.7	Load flow and System Stability studies may be necessary to determine any output constraints or post fault actions necessary for n-1 fault conditions and credible n-2 conditions (where n-1 and n-2 conditions are the first and second outage conditions as, for example, specified in EREC P2) involving a mixture of fault and planned outages. The Connection Agreement should include details of the relevant outage conditions. It may be necessary under these fault conditions, where the combination of Power Generating Module output, load and through flow levels leads to circuit overloading, to rapidly disconnect or constrain the Power Generating Module.		**P**
11.2	**Frequency response**		**P**
11.2.1	Under abnormal conditions automatic low-frequency load-shedding provides for load reduction down to 47 Hz. In exceptional circumstances, the frequency of the DNO's Distribution Network could rise above 50.5 Hz. Therefore all Power Generating Modules should be capable of continuing to operate in parallel with the Distribution Network in accordance with the following: (a) 47 Hz – 47.5 Hz Operation for a period of at least 20 s is required each time the frequency is within this range. (b) 47.5 Hz – 49.0 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range. (c) 49.0 Hz – 51.0 Hz Continuous operation of the Power Generating Module is required. (d) 51.0 Hz –51.5 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range. (e) 51.5 Hz – 52 Hz Operation for a period of at least 15 minutes is required each time the frequency is within this range.	See appendant table	**P**
11.2.2	With regard to the rate of change of frequency withstand capability, a Power Generating Module shall be capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500 ms unless disconnection was triggered by a rate of change of frequency type loss of mains protection or by the Power Generating Module's own protection system for a co-incident internal fault as detailed in paragraph 10.6.18.	See appendant table	**P**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
11.2.3	**Output power with falling frequency**		**P**
11.2.3.1	Each Power Generating Module, shall be capable of: (a) continuously maintaining constant Active Power output for system frequency changes within the range 50.5 to 49.5 Hz; and (b) (subject to the provisions of paragraph 11.2.1) maintaining its Active Power output at a level not lower than the figure determined by the linear relationship shown in Figure 11.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the Active Power output does not decrease by more than 5%. 	See appendant table	**P**
11.2.3.2	For the avoidance of doubt in the case of a Power Generating Module using an Intermittent Power Source where the power input will not be constant over time, the requirement is that the Active Power output shall be independent of system frequency under (a) above and should not drop with system frequency by greater than the amount specified in (b) above.	See appendant table	**P**
11.2.4	**Limited Frequency Sensitive Mode – Over frequency**		**P**
11.2.4.1	Each Power Generating Module shall be capable of reducing Active Power output in response to frequency on the Total System when this rises above 50.4 Hz. The Power Generating Module shall be capable of operating stably during LFSMO operation. If a Power Generating Module has been contracted to operate in Frequency Sensitive Mode the requirements of LFSM-O shall apply when frequency exceeds 50.5 Hz. (a) The rate of change of Active Power output shall be at a minimum a rate of 2% of output per 0.1 Hz deviation of system frequency above 50.4 Hz (ie a Droop of 10%) as shown in Figure 11.2. For the avoidance of doubt, this would not preclude a Generator from designing the Power Generating Module with a Droop of less than 10%, but in all cases the Droop should be 2% or greater.	See appendant table	**P**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	(b) The Power Generating Module shall be capable of initiating a power frequency response with an initial delay that is as short as possible. If the initial delay exceeds 2 s the Generator shall justify the delay, providing technical evidence to the DNO, who will pass this evidence to the NETSO. (c) For deviations in frequency up to 50.9 Hz at least half of the proportional reduction in Active Power output shall be achieved within 10 s of the time of the frequency increase above 50.4 Hz. (d) For deviations in frequency beyond 50.9 Hz the measured rate of change of Active Power reduction shall exceed 0.5% s^{-1} of the initial output. (e) The LFMS-O response shall be reduced when the frequency subsequently falls again and, when to a value less than 50.4 Hz, at least half the proportional increase in Active Power shall be achieved in 10 s. For a frequency excursion returning from beyond 50.9 Hz the measured rate of change Active Power increase shall t exceed 0.5% s^{-1}. (f) If the reduction in Active Power is such that the Power Generation Module reaches its Minimum Stable Operating Level, it shall continue to operate stably at this level.  Pref is the reference Active Power to which ΔP is related and. ΔP is the change in Active Power output from the Power Generating Module. Figure 11.2 Active Power Frequency Response capability when operating in LFSM-O		
11.2.4.2	When the Power Generating Module is providing Limited Frequency Sensitive Mode Over frequency (LFSM-O) response it shall continue to provide the frequency response until the frequency has returned to, or is below, 50.4 Hz.	See appendant table	**P**
11.2.4.3	Steady state operation below Minimum Stable Operating Level is not expected but if system operating conditions cause operation below Minimum Stable Operating Level which give	See appendant table	**P**

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Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	rise to operational difficulties then the Generator shall be able to return the output of the Power Generating Module to an output of not less than the Minimum Stable Operating Level.		
11.3	**Fault Ride Through and Phase Voltage Unbalance**		**N/A**
11.3.1	Where it has been specifically agreed between the DNO and the Generator that a Power Generating Facility will contribute to the DNO's Distribution Network security, (eg for compliance with EREC P2) the Power Generating Module(s) may be required to withstand, without tripping, the effects of a close up three phase fault and the Phase (Voltage) Unbalance imposed during the clearance of a close-up phase-to-phase fault, in both cases cleared by the DNO's main protection. The DNO will advise the Generator in each case of the likely tripping time of the DNO's protection, and for phase-phase faults, the likely value of Phase (Voltage) Unbalance during the fault clearance time.	Rely on the agreement with the DNO.	**N/A**
11.3.2	In the case of phase to phase faults on the DNO's Distribution Network that are cleared by system back-up protection which will be within the plant short time rating on the DNO's Distribution Network the DNO, on request during the connection process, will advise the Generator of the expected Phase (Voltage) Unbalance.	Rely on the agreement with the DNO.	**N/A**
11.4	**Voltage Limits and Control**		**N/A**
11.4.1	Where a Power Generating Module is remote from a Network voltage control point it may be required to withstand voltages outside the normal statutory limits. In these circumstances, the DNO should agree with the Generator the declared voltage and voltage range at the Connection Point. Immunity of the Power Generating Module to voltage changes of ± 10% of the declared voltage is recommended, subject to design appraisal of individual installations.	Rely on the agreement with the DNO.	**N/A**
11.4.2	The connection of a Power Generating Module to the Distribution Network shall be designed in such a way that operation of the Power Generating Module does not adversely affect the voltage profile of and voltage control employed on the Distribution Network. ETR 126 provides DNOs with guidance on active management solutions to overcome voltage control limitations. Information on the voltage regulation and control arrangements will be made available by the DNO if requested by the Generator.	Rely on the agreement with the DNO.	**N/A**

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Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
11.4.3	The final responsibility for control of Distribution Network voltage does however remain with the DNO.	Rely on the agreement with the DNO.	**N/A**
11.4.4	Automatic Voltage Control (AVC) schemes employed by the DNO often assume that power flows from parts of the Distribution Network operating at a higher voltage to parts of the Distribution Network operating at lower voltages. Export from Power Generating Modules in excess of the local loads may result in power flows in the reverse direction. In this case AVC referenced to the Low Voltage side may not operate correctly without an import of Reactive Power and relay settings appropriate to this operating condition. When load current compounding is used with the AVC and the penetration level of Power Generating Modules becomes significant compared to normal loads, it may be necessary to switch any compounding out of service.	Rely on the agreement with the DNO.	**N/A**
11.4.5	Power Generating Modules can cause problems if connected to networks employing AVC schemes which use negative reactance compounding and line drop compensation due to changes in Active Power and Reactive Power flows. ETR 126 provides guidance on connecting generation to such networks using techniques such as removing the generation circuit from the AVC scheme using cancellation CTs.	Rely on the agreement with the DNO.	**N/A**

G99-1
Test Results:

For Connection Design Type A

Engineering recommendation G99/1 Test Type A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A.7.1.2	Functional safety - fault condition tests	see Table A.7.1.2	**P**
A.7.1.2.2	Over / Under Voltage Tests	see Table A.7.1.2.2	**P**
A.7.1.2.3	Over / Under Frequency Tests	see Table A.7.1.2.3	**P**
A.7.1.2.4	Loss of Mains Protection	see Table A.7.1.2.4	**P**
A.7.1.2.5	Reconnection	see Table A.7.1.2.5	**P**
A.7.1.2.6	Frequency Drift and Step Change Stability test	see Table A.7.1.2.6	**P**
A.7.1.3	Limited Frequency Sensitive Mode – Over frequency	see Table A.7.1.3	**P**
A.7.2.3	Output Power with falling Frequency	see Table A.7.2.3	**P**
A.7.1.4.1	Harmonics	see Table A.7.1.4.1	**P**
A.7.1.4.2	Power Factor	see Table A.7.1.4.2	**P**
A.7.1.4.3	Voltage Flicker	see Table A.7.1.4.3	**P**
A.7.1.4.4	DC Injection for Inverters	see Table A.7.1.4.4	**P**
A.7.1.5	Short Circuit Current Contribution for Inverters	see Table A.7.1.5	**P**
A.7.1.6	Self-Monitoring - Solid State Disconnection		**N/A**

A.7.1.2 Type Verification Functional Testing of the Interface Protection Functional safety - fault condition tests according DIN V VDE V 0126-1-1									P
	ambient temperature [°C] :				24				P
component No.	fault	test condition		test time	fuse No.	fault condition		result	
		AC	DC			AC	DC		
Model: SG50CX									
PCE input	Short	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, no hazard, no fire	
PCE input	Over-voltage	230V 72,5A*3	1100V 24A*5	10min	--	230V <0,01 A	1100 V <0,01 A	Unit shut down immediately, error message"Excessively high bus voltage", no damage, no hazard, no fire	
PCE output	Short	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, error message"AC power failure,AC switch or circuit is disconnected", no damage, no hazard, no fire	
PCE output	Over-Load	230V 86,9A*3	850V 24A*5	4,8h	--	230V 79,5*3A	850V 13,2*5A	Unit work normally, no damage, no hazard, no fire	
DSP failure	+1,2V power supply disable (L4 open)	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, no damage, no hazard, no fire	
DSP failure	+3,3V power supply disable (L3 open)	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, no damage, no hazard, no fire	
DSP failure	reset	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, no damage, no hazard, no fire	
IGBT PMW (Pin 6 to Pin 7)	short	230V 17,39A *3	850V 24A*5	10min	--	230V 1,55*3A	850V 0,26*5A	Unit work with output derated, no damage, no hazard, no fire	
IGBT PMW	Loss/failure (one bridge on always)	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, error message"device anomaly", no damage, no hazard, no fire	
PV/DC Voltage Detector R158	open	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit didn't work, no damage, no hazard, no fire	
PV/DC Current Detector R125	open	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, error message"device anomaly", no damage, no hazard, no fire	
Bus Voltage Detector R179	open	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, error message"device anomaly", no damage, no hazard, no fire	

Inverter Current Detector R192	open	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, error message“device anomaly”, no damage, no hazard, no fire
Inverter Voltage Detector R269	open	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, no damage, no hazard, no fire
Grid/AC Voltage Detector R268	open	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, no damage, no hazard, no fire
DC isolation device function check	Loss/failure before start	230V <0,01A	850V <0,01A	10min	--	230V <0,01 A	850V <0,01 A	Unit didn’t start, no damage, no hazard, no fire
Relay K1	Loss/failure before start	230V <0,01A	850V <0,01A	10min	--	230V <0,01 A	850V <0,01 A	Unit didn’t start, error message“device anomaly”, no damage, no hazard, no fire
Relay K3	Loss/failure before start	230V <0,01A	850V <0,01A	10min	--	230V <0,01 A	850V <0,01 A	Unit didn’t start, error message“device anomaly”, no damage, no hazard, no fire
Relay K5	Loss/failure before start	230V <0,01A	850V <0,01A	10min	--	230V <0,01 A	850V <0,01 A	Unit didn’t start, error message“device anomaly”, no damage, no hazard, no fire
RCD/RCM Function check R289	open	230V <0,01A	850V <0,01A	10min	--	230V <0,01 A	850V <0,01 A	Unit didn’t start, error message“device anomaly”, no damage, no hazard, no fire
IGBT(D-S)	short	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, error message“device anomaly”, no damage, no hazard, no fire
DC Input Bus capacitor	short	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, IGBT damaged, no hazard, no fire
LC filter capacitor	short	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately, error message“AC Power failture”, no damaged, no hazard, no fire
Transformer T1(pin 11 to pin 12, pin 7 to pin 8)	short	230V 72,5A*3	850V 24A*5	10min	--	230V <0,01 A	850V <0,01 A	Unit shut down immediately,no damaged, no hazard, no fire
Transformer T2(pin9 to pin 10)	short	230V 17,39A*3	800V 15A	10min	--	230V 17,39 A*3	800V 15A	Unit work normally,no damaged, no hazard, no fire

A.7.1.2.2 Over / Under Voltage						P
Model: SG50CX L1 Phase						
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage	184V	2,5s	184V	2,50s	188V / 5,00s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V	1,0s	262,2V	1,00s	258,2V / 5,0s	No trip
O/V stage 2	273,7V	0,5s	273,7V	0,50s	269,7V / 0,95s	No trip
					277,7V 0,45s	No trip

Note:
The total disconnection time for voltage and frequency protection including the operating time of the disconnection device shall be the trip delay setting with a tolerance of, -0s + 0,5s.

For the avoidance of doubt voltage and frequency excursions lasting less than the trip delay setting shall not result in disconnection.

For grid surge voltages greater than 230V +19% which are present for periods of <0,5s the Generating unit is permitted to reduce/cease exporting in order to protect the generating unit.

The Manufacturer must ensure that the Interface Protection in a Type Tested Generating Unit is capable of measuring voltage to an accuracy of ± 1,5% of the nominal value (± 3,45V) and of measuring frequency to ± 0,2% of the nominal value (± 0,1Hz) across its operating range of voltage, frequency and temperature.

To establish a trip voltage, the test voltage should be applied in steps of ± 0,5% or less, of the nominal voltage for a duration that is longer than the trip time delay, for example 1 second in the case of a delay setting of 0,5 second starting at least 4V below or above the setting. The test voltage at which this trip occurred is to be recorded. Additional tests just above and below the trip voltage should be undertaken to show that the test is repeatable and the figure at which a repeatable trip occurs should be recorded on the type test declaration Appendix 13.1.

To establish the trip time, the test voltage should be applied starting from 4V below or above the recorded trip voltage and should be changed to 4V above or below the recorded trip voltage in a single step. The time taken from the step change to the generating unit tripping is to be recorded on the type test declaration Appendix 13.1.

A.7.1.2.2 Over / Under Voltage						P
Model: SG50CX L2 Phase						
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage	184V	2,5s	184V	2,50s	188V / 2,48s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V	1,0s	262V	1,01s	258,2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	273V	0,53s	269,7V 0,98s	No trip
					277,7V 0,45s	No trip

Note:
The total disconnection time for voltage and frequency protection including the operating time of the disconnection device shall be the trip delay setting with a tolerance of, -0s + 0,5s.

For the avoidance of doubt voltage and frequency excursions lasting less than the trip delay setting shall not result in disconnection.

For grid surge voltages greater than 230V +19% which are present for periods of <0,5s the Generating unit is permitted to reduce/cease exporting in order to protect the generating unit.

The Manufacturer must ensure that the Interface Protection in a Type Tested Generating Unit is capable of measuring voltage to an accuracy of ± 1,5% of the nominal value (± 3,45V) and of measuring frequency to ± 0,2% of the nominal value (± 0,1Hz) across its operating range of voltage, frequency and temperature.

To establish a trip voltage, the test voltage should be applied in steps of ± 0,5% or less, of the nominal voltage for a duration that is longer than the trip time delay, for example 1 second in the case of a delay setting of 0,5 second starting at least 4V below or above the setting. The test voltage at which this trip occurred is to be recorded. Additional tests just above and below the trip voltage should be undertaken to show that the test is repeatable and the figure at which a repeatable trip occurs should be recorded on the type test declaration Appendix 13.1.

To establish the trip time, the test voltage should be applied starting from 4V below or above the recorded trip voltage and should be changed to 4V above or below the recorded trip voltage in a single step. The time taken from the step change to the generating unit tripping is to be recorded on the type test declaration Appendix 13.1.

A.7.1.2.2 Over / Under Voltage						P
Model: SG50CX L3 Phase						
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage	184V	2,5s	184V	2,50s	188V / 2,48s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V	1,0s	262,2V	1,00s	258,2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	273,7V	0,50s	269,7V 0,98s	No trip
					277,7V 0,45s	No trip

Note:
The total disconnection time for voltage and frequency protection including the operating time of the disconnection device shall be the trip delay setting with a tolerance of, -0s + 0,5s.

For the avoidance of doubt voltage and frequency excursions lasting less than the trip delay setting shall not result in disconnection.

For grid surge voltages greater than 230V +19% which are present for periods of <0,5s the Generating unit is permitted to reduce/cease exporting in order to protect the generating unit.

The Manufacturer must ensure that the Interface Protection in a Type Tested Generating Unit is capable of measuring voltage to an accuracy of ± 1,5% of the nominal value (± 3,45V) and of measuring frequency to ± 0,2% of the nominal value (± 0,1Hz) across its operating range of voltage, frequency and temperature.

To establish a trip voltage, the test voltage should be applied in steps of ± 0,5% or less, of the nominal voltage for a duration that is longer than the trip time delay, for example 1 second in the case of a delay setting of 0,5 second starting at least 4V below or above the setting. The test voltage at which this trip occurred is to be recorded. Additional tests just above and below the trip voltage should be undertaken to show that the test is repeatable and the figure at which a repeatable trip occurs should be recorded on the type test declaration Appendix 13.1.

To establish the trip time, the test voltage should be applied starting from 4V below or above the recorded trip voltage and should be changed to 4V above or below the recorded trip voltage in a single step. The time taken from the step change to the generating unit tripping is to be recorded on the type test declaration Appendix 13.1.

L1 Phase U/V stage :

L1 Phase O/V stage 1

L1 Phase O/V stage 2:

L2 Phase U/V stage

L2 Phase O/V stage 1

L2 Phase O/V stage 2:

L3 Phase U/V stage

L3 Phase O/V stage 1

L3 Phase O/V stage 2:

A.7.1.2.3 Over / Under Frequency — P

Model: SG50CX

Function	Setting		Trip test		No trip test	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47,5Hz	20s	47,49Hz	20,04s	47,7Hz / 30s	No trip
U/F stage 2	47Hz	0,5s	46,90Hz	0,50s	47,2Hz / 19,5s	No trip
					46,8Hz / 0.48s	No trip
O/F stage	52Hz	0,5s	52,00Hz	0,50s	51,8Hz / 120s	No trip
					52,2Hz / 0,48s	No trip

Note:
The total disconnection time for voltage and frequency protection including the operating time of the disconnection device shall be the trip delay setting with a tolerance of, -0s + 0,5s.

For the avoidance of doubt voltage and frequency excursions lasting less than the trip delay setting shall not result in disconnection.

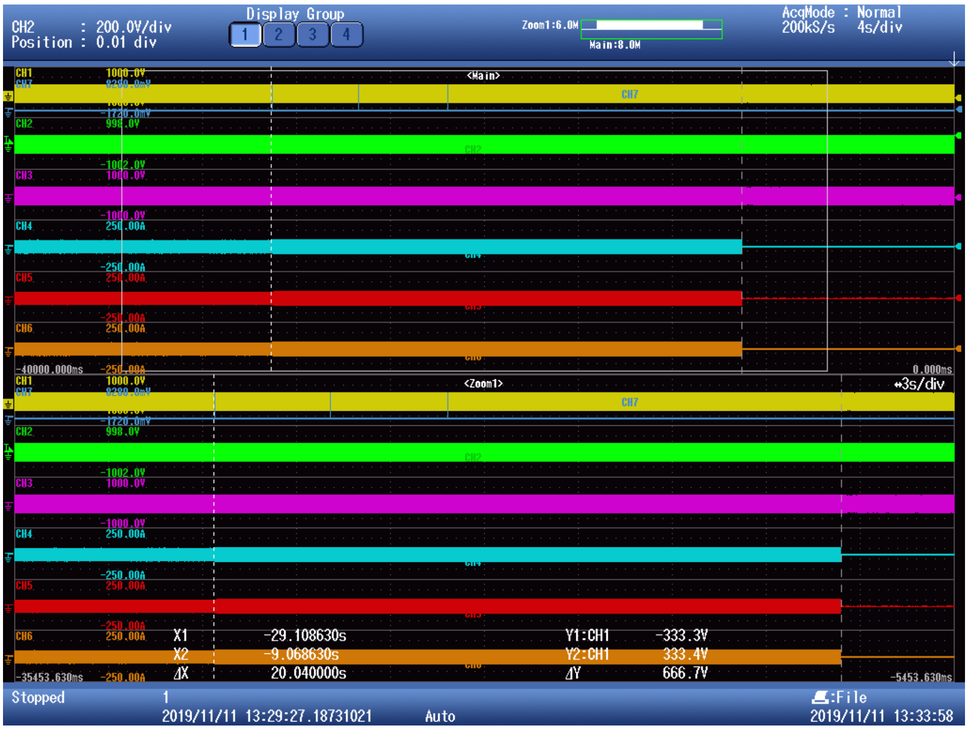
The Manufacturer must ensure that the Interface Protection in a Type Tested Generating Unit is capable of measuring voltage to an accuracy of ± 1,5% of the nominal value (± 3,45V) and of measuring frequency to ± 0,2% of the nominal value (± 0,1Hz) across its operating range of voltage, frequency and temperature.

To establish a trip frequency, the test frequency should be applied in a slow ramp rate of less than 0,1Hz/second, or if this is not possible in steps of 0,05Hz for a duration that is longer than the trip time delay, for example 1 second in the case of a delay setting of 0,5 second. The test frequency at which this trip occurred is to be recorded. Additional tests just above and below the trip frequency should be undertaken to show that the test is repeatable and the figure at which a repeatable trip occurs should be recorded on the type test declaration Appendix 13.1.

To establish the trip time, the test frequency should be applied starting from 0,3Hz below or above the recorded trip frequency and should be changed to 0,3Hz above or below the recorded trip frequency in a single step. The time taken from the step change to the Generating Unit is to be recorded on the type test declaration section 13.1. It should be noted that with some loss of mains detection techniques this test may result in a faster trip due to operation of the loss of mains protection. There are two ways around this. Firstly the loss of mains protection may be able to be turned off in order to carry out this test. Secondly by establishing an accurate frequency for the trip a much smaller step change could be used to initiate the trip and establish a trip time. This may require the test to be repeated several times to establish that the dime delay is correct.

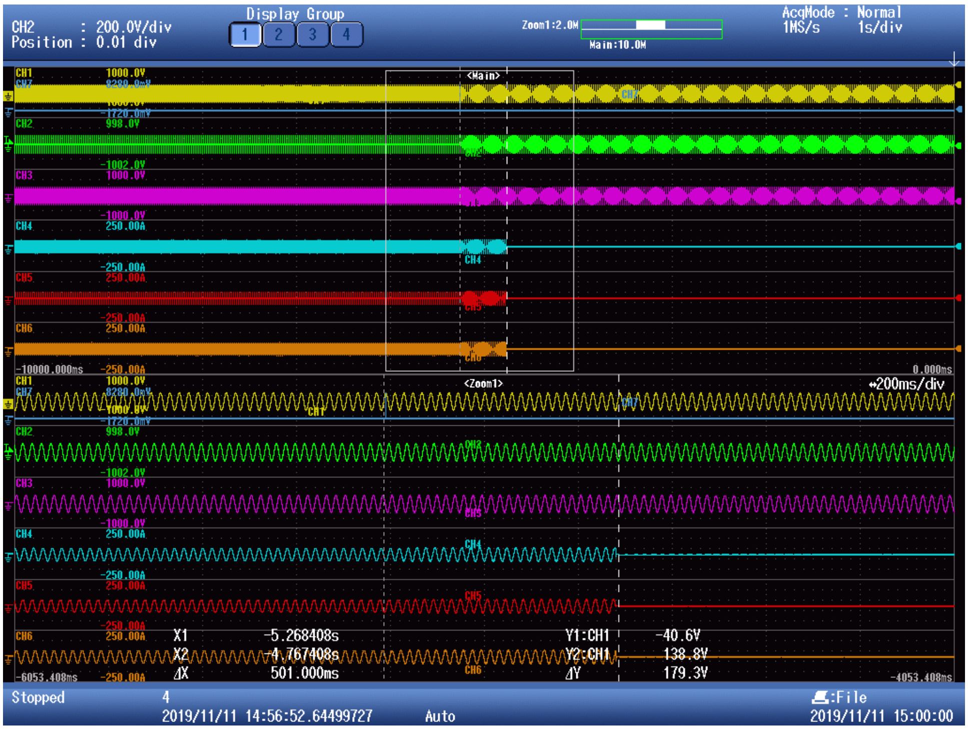
To establish the correct ride-through operation, the test frequency should be applied at each setting plus or minus 0.2 Hz and for the relevant times shown in Appendix 13.1.

U/F stage 1



U/F stage 2

O/F stage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Position : 0.01 div
Display Group
AcqMode : Normal
1MS/s 1s/div
<Main>
<Zoom1>
200ms/div
X1 -5.268408s
X2 -4.767408s
ΔX 501.000ms
Y1:CH1 -40.6V
Y2:CH1 138.8V
ΔY 179.3V
Stopped
2019/11/11 14:56:52.64499727
Auto
2019/11/11 15:00:00

A.7.1.2.4 Loss of mains protection, Inverter connected machines BS EN 62116 Load imbalance (real, reactive load) for test condition A (EUT output = 100%)	**P**
Model: SG50CX	

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	0,5s

No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks5)
1	100	100	0	0	--	50,00	200	1,00	149,25	BL
2	100	100	-10	-10	--	50,00	200	0,91	346,80	IB
3	100	100	-10	-5	--	50,00	200	0,95	78,00	IB
4	100	100	-10	0	--	50,00	200	1,00	206,00	IB
5	100	100	-10	+5	--	50,00	200	1,05	83,60	IB
6	100	100	-10	+10	--	50,00	200	1,10	74,40	IB
7	100	100	-5	-10	--	50,00	200	0,90	60,00	IB
8	100	100	-5	-5	--	50,00	200	0,95	70,20	IB
9	100	100	-5	0	--	50,00	200	1,00	284,2	IB
10	100	100	-5	+5	--	50,00	200	1,05	91,20	IB
11	100	100	-5	+10	--	50,00	200	1,10	72,00	IB
12	100	100	0	-10	--	50,00	200	0,90	75,40	IB
13	100	100	0	-5	--	50,00	200	0,95	74,60	IB
14	100	100	0	+5	--	50,00	200	1,05	104,2	IB
15	100	100	0	+10	--	50,00	200	1,10	74,00	IB
16	100	100	+5	-10	--	50,00	200	0,90	79,40	IB
17	100	100	+5	-5	--	50,00	200	0,95	73,00	IB
18	100	100	+5	0	--	50,00	200	1,00	179,80	IB
19	100	100	+5	+5	--	50,00	200	1,05	97,00	IB
20	100	100	+5	+10	--	50,00	200	1,10	75,40	IB

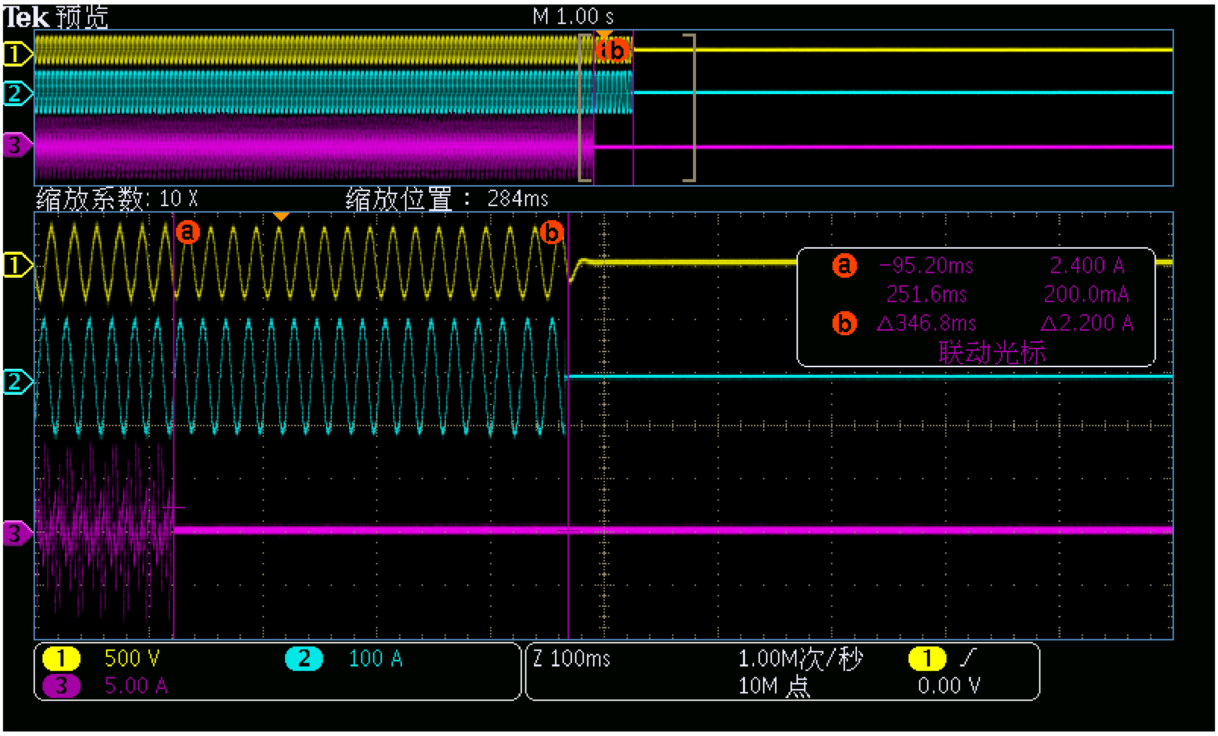
21	100	100	+10	-10	--	50,00	200	0,90	75,40	IB
22	100	100	+10	-5	--	50,00	200	0,95	85,60	IB
23	100	100	+10	0	--	50,00	200	1,00	75,40	IB
24	100	100	+10	+5	--	50,00	200	1,05	64,60	IB
25	100	100	+10	+10	--	50,00	200	1,10	53,80	IB
Parameter at 0% per phase		L= 3,37 mH			R=1,06 Ω			C=3010,13 µF		

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) Fundamental of I_{AC} when RLC is adjusted
5) BL: Balance condition, IB: Imbalance condition.

Condition A:
EUT output power PEUT = Maximum [6)]
EUT input voltage [6)] = >75% of rated input voltage range

6) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
7) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0,75 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

Disconnection at No.24: PAC -10% and QAC -10% reactive load and 100% nominal power



Note:
Yellow Channel: Waveform of PV inverter output voltage
Blue Channel: Waveform of PV inverter output current
Purple Channel: EUT Current signal for switch S1

A.7.1.2.4 Loss of mains protection, Inverter connected machines BS EN 62116 Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)	**P**

Model: SG50CX

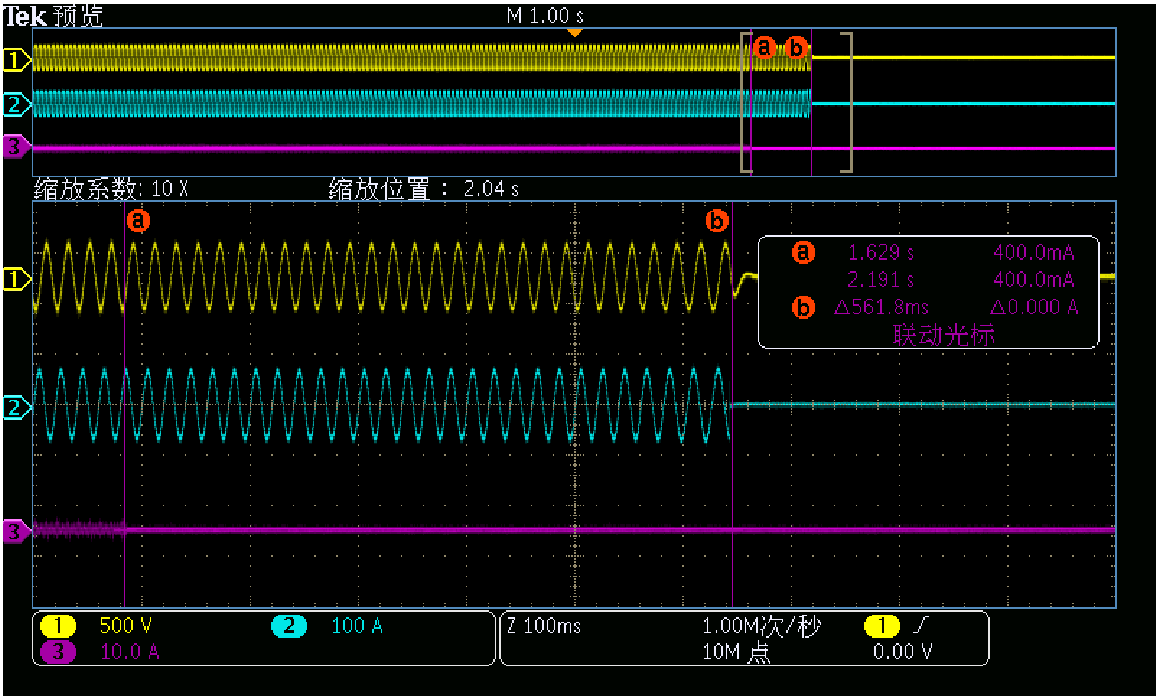
Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	0,5s

No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks5)
1	66	66	0	-5	--	33	600	0,95	69,8	IB
2	66	66	0	-4	--	33	600	0,94	75,8	IB
3	66	66	0	-3	--	33	600	0,93	83,8	IB
4	66	66	0	-2	--	33	600	0,92	92,8	IB
5	66	66	0	-1	--	33	600	0,91	106,8	IB
6	66	66	0	0	--	33	600	1,00	127,8	BL
7	66	66	0	1	--	33	600	1,01	561,8	IB
8	66	66	0	2	--	33	600	1,02	101,8	IB
9	66	66	0	3	--	33	600	1,03	76,8	IB
10	66	66	0	4	--	33	600	1,04	67,8	IB
11	66	66	0	5	--	33	600	1,05	68,8	IB

Parameter at 0% per phase	L= 5,11 mH	R=1,60 Ω	C= 1986,68 µF

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) Fundamental of I_{AC} when RLC is adjusted
5) BL: Balance condition, IB: Imbalance condition.
Condition B:
EUT output power P_{EUT} = 50 % – 66 % of maximum
EUT input voltage 6) = 50 % of rated input voltage range, ±10 %
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 50 % of range =X + 0,5 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.
.

Disconnection at No. 9: PAC 0% and QAC +1% reactive load and 66% nominal power



Note:
Yellow Channel: Waveform of PV inverter output voltage
Blue Channel: Waveform of PV inverter output current
Purple Channel: EUT Current signal for switch S1

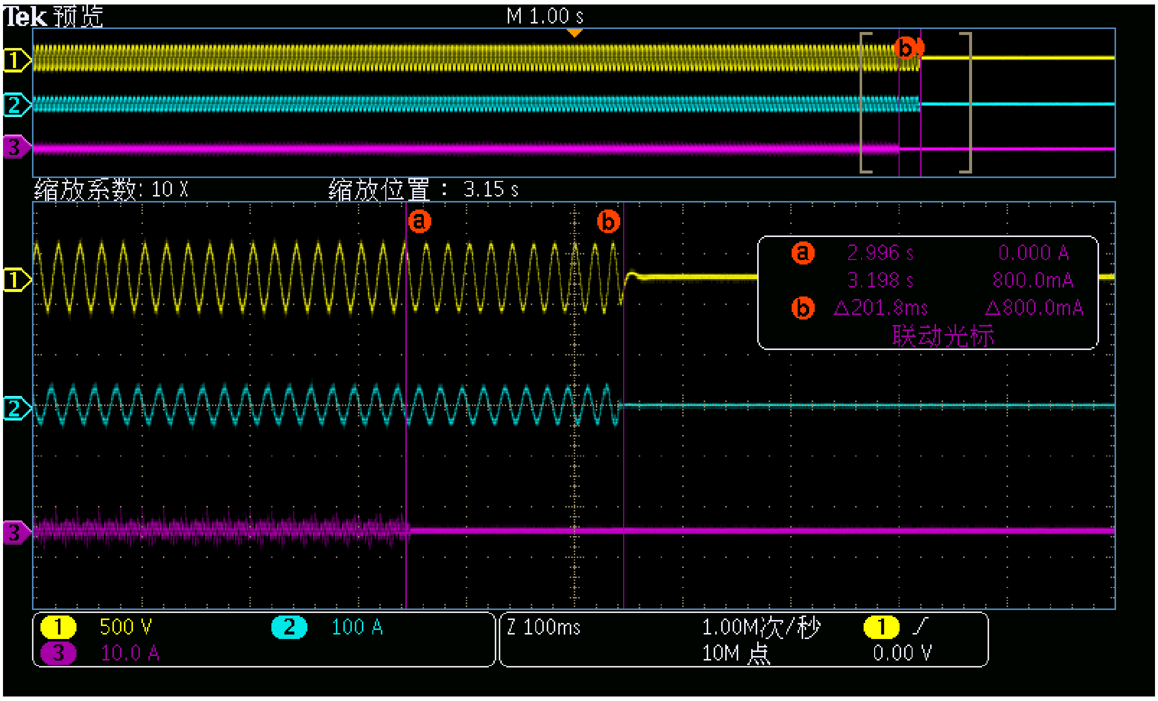
A.7.1.2.4 Loss of mains protection, Inverter connected machines BS EN 62116 Load imbalance (reactive load) for test condition C (EUT output = 25 % – 33 %)	**P**
Model: SG50CX	
Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	0,5s

No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [kW per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks 5)
1	33	33	0	-5	--	16,5	360	0,95	68,8	IB
2	33	33	0	-4	--	16,5	360	0,96	74,8	IB
3	33	33	0	-3	--	16,5	360	0,97	81,8	IB
4	33	33	0	-2	--	16,5	360	0,08	95,8	IB
5	33	33	0	-1	--	16,5	360	0,99	121,8	IB
6	33	33	0	0	--	16,5	360	1,00	85,2	BL
7	33	33	0	1	--	16,5	360	1,01	201,8	IB
8	33	33	0	2	--	16,5	360	1,02	80,8	IB
9	33	33	0	3	--	16,5	360	1,03	70,8	IB
10	33	33	0	4	--	16,5	360	1,04	59,6	IB
11	33	33	0	5	--	16,5	360	1,05	57,6	IB

Parameter at 0% per phase	L=10,21 mH	R= 3,21 Ω	C=993,34 µF

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) Fundamental of I_{AC} when RLC is adjusted
5) BL: Balance condition, IB: Imbalance condition.
Condition B:
EUT output power PEUT = 25 % – 33 % 6) of maximum
EUT input voltage 7) = <20 % of rated input voltage range
6) Or minimum allowable EUT output level if greater than 33 %.
7) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 10 % of range =X + 0,2 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

Disconnection at No. 8: PAC 0% and QAC +1% reactive load and 33% nominal power



Note:
Yellow Channel: Waveform of PV inverter output voltage
Blue Channel: Waveform of PV inverter output current
Purple Channel: EUT Current signal for switch S1

<table>
<tr><td colspan="4">A.7.1.2.5 Reconnection
These tests should be carried out in accordance with Annex A.7.1.2.5.</td><td>P</td></tr>
<tr><td colspan="5">Test should prove that the reconnection sequence starts after a minimum delay of 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 1.</td></tr>
<tr><td colspan="5">Under Voltage (182V)</td></tr>
<tr><td colspan="2">Time delay setting [s]</td><td colspan="3">Measured delay [s]</td></tr>
<tr><td colspan="2">20</td><td colspan="3">24,3</td></tr>
<tr><td colspan="5">Over Voltage(275V)</td></tr>
<tr><td colspan="2">Time delay setting [s]</td><td colspan="3">Measured delay [s]</td></tr>
<tr><td colspan="2">20</td><td colspan="3">20,4</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Under Frequency(47,4Hz)</td></tr>
<tr><td colspan="2">Time delay setting [s]</td><td colspan="3">Measured delay [s]</td></tr>
<tr><td colspan="2">20</td><td colspan="3">43,5</td></tr>
<tr><td colspan="5">Over Frequency(52,1Hz)</td></tr>
<tr><td colspan="2">Time delay setting [s]</td><td colspan="3">Measured delay [s]</td></tr>
<tr><td colspan="2">20</td><td colspan="3">28,2</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="2"></td><td colspan="4">Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.</td></tr>
<tr><td>At 275,0V</td><td>At 180,0V</td><td>At 47,4Hz</td><td>At 51,6Hz</td></tr>
<tr><td>Confirmation that the SSEG does not re-connect.</td><td>No reconnection</td><td>No reconnection</td><td>No reconnection</td><td>No reconnection</td></tr>
</table>

A.7.1.2.6 Frequency Drift and Step Change Stability test				**P**
Model: SG50CX				
	Start Frequency	Change	End Frequency	Confirm no trip
Positive Vector Shift	49,5Hz	+9 degrees		No trip
Negative Vector Shift	50,5Hz	- 9 degrees		No trip
Positive Frequency drift	49,5Hz	+0,19Hz/sec	51,5Hz	No trip
Negative Frequency drift	50,5Hz	-0,19Hz/sec	47,5Hz	No trip

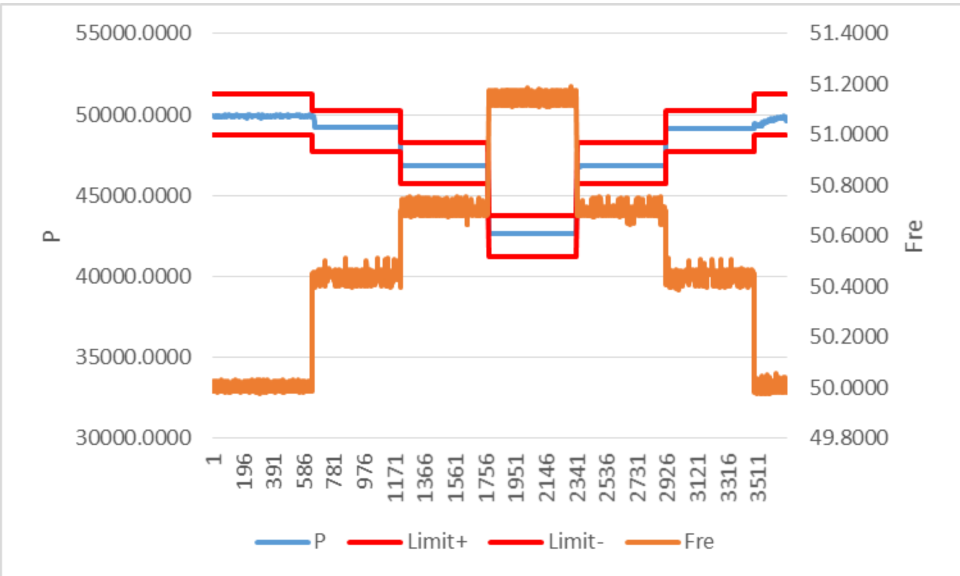
Note:

For the step change test the Generating Unit should be operated with a measureable output at the start frequency and then a vector shift should be applied by extending or reducing the time of a single cycle with subsequent cycles returning to the start frequency. The start frequency should then be maintained for a period of at least 10 seconds to complete the test. The Generating Unit should not trip during this test.

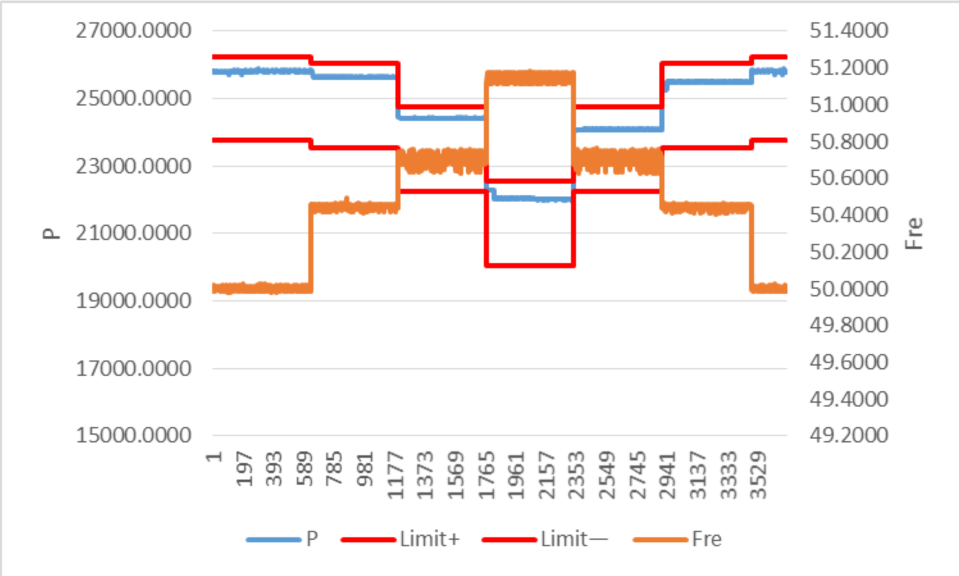
For frequency drift tests the Generating Unit should be operated with a measureable output at the start frequency and then the frequency changed in a ramp function at 0,19Hz per second to the end frequency. On reaching the end frequency it should be maintained for a period of at least 10 seconds. The Generating Unit should not trip during this test.

A.7.1.3 Limited Frequency Sensitive Mode – Over frequency							P
1-min mean value [Hz]:	a) 50,00	b) 50,45	c) 50,70	d) 51,15	e) 50,70	f) 50,45	g) 50,00
1. Measurement a) to g): Active power output > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
$P_{expected}$ [kW]:	50,0	49,0	47,0	42,5	47,0	49,0	50,0
$P_{measured}$ [kW]:	49,9	49,2	46,9	42,6	46,8	49,1	49,6
$\Delta P_{E60}/P_{Setpoint}$ [%]:	0,2	0,4	0,2	0,2	0,4	0,2	0,8
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
$P_{expected}$ [kW]:	25,0	24,8	23,5	21,3	23,5	24,8	25,0
$P_{measured}$ [kW]:	25,8	25,6	24,4	22,1	24,1	25,5	25,8
$\Delta P_{E60}/P_{Setpoint}$ [%]:	1,6	1,6	1,8	1,6	1,2	1,4	1,6
Limit $\Delta P_{E60}/P_{Setpoint}$:	± 2,5% % of P_{Emax}						
Graph of power gradient:							

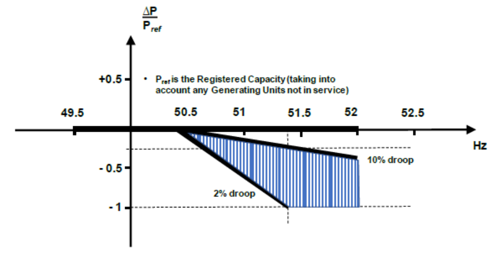
Graph of Measurement 1,: Active power output reduction 100% P_{nom}



Graph of Measurement 2,: Active power output reduction 50% Pnom



Test.



Pref is the reference Active Power to which ΔP is related and. ΔP is the change in Active Power output from the Power Generating Module.

Figure 12.2 Active Power Frequency Response capability when operating in LFSM-O

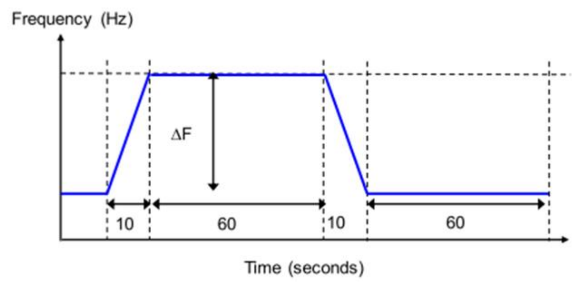


Figure B.4.1 – LFSM-O frequency step response simulation

The test is conducted for two powers. First, the test must start at a power > 80% Pn ("Measurement 1"), and in a second test, for a power between 40% to 60% Pn ("Measurement 2"). In the second test, after freezing of the P_M, the available active power output must be increased to a value > 80% Pn, and after the network frequency of 50,4 Hz is fallen below, the rise of the active power gradient must be recorded.

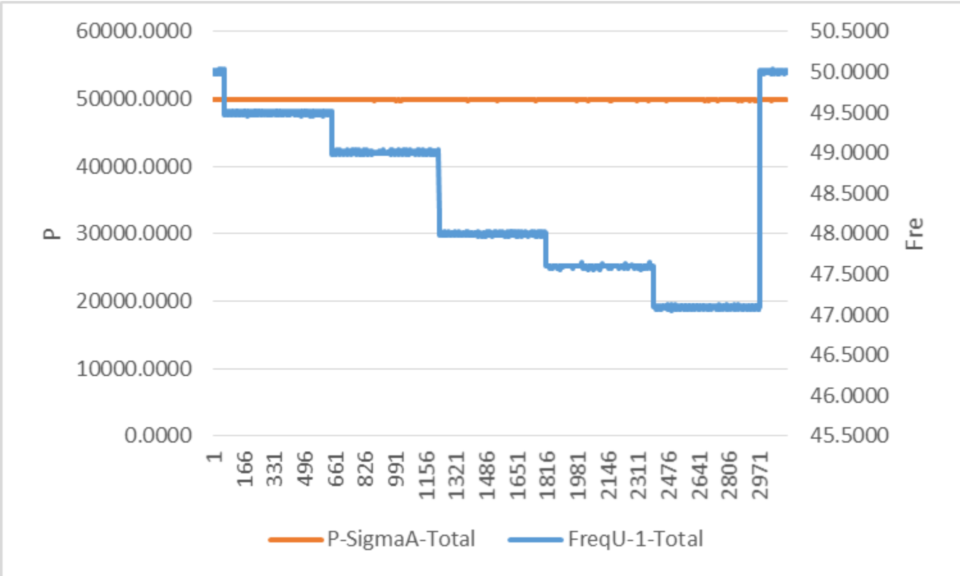
Point g) must be held until the micro-generator is again feeding in with the active power output available.

Note.

The test was performed with a droop of 2% (20%Pn/Hz).

A.7.2.3 Output Power with falling Frequency	P

Graph of frequency :



	Switch to:					
5-min mean value (each)	50Hz	49,5Hz	49Hz	48Hz	47,6Hz	47,1Hz
Frequency [Hz]:	50,0	49,50	49,0	48,0	47,6	47,1
Active power [kW]:	49,9	49,9	49,9	49,9	49,0	49,0
$\Delta P/P_M$ [%] per 1 Hz:	--	0	0	0	0	0

Note:

The frequency should then be set to 49,5 Hz for 5 minutes. The output should remain at 100% of registered Capacity. The frequency should then be set to 49,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 99% of registered Capacity. The frequency should then be set to 48,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 97% of registered Capacity. The frequency should then be set to 47,6 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 96.2% of registered Capacity. The frequency should then be set to 47,1 Hz and held at this frequency for 20s. The Active Power output must not be below 95,0% of registered Capacity and the Synchronous Power Generating Module must not trip in less than the 20s of the test.

A.7.1.4.1Harmonic Current Emissions — P

Model: SG50CX L1 phase

Generating Unit tested to BS EN 61000-3-12

Generating Unit rating per phase (rpp)						
	At 45-55% of rated ouput 25kW		100% of rated output 50kW			
Harmonic	Measured Value (MV) in Amps	%	Measured Value (MV) in Amps	%	Limit in BS EN 61000-3-12 Higher limit for odd harmonics 21 and above	
1st	36,200	100,000	72,074	100,000	1 phase	3 phase
2nd	0,162	0,447	0,246	0,342	8%	8%
3rd	0,152	0,421	0,218	0,302	21,6%	N/A
4th	0,173	0,479	0,206	0,286	4%	4%
5th	0,428	1,182	0,585	0,812	10,7%	10,7%
6th	0,165	0,455	0,208	0,288	2,67%	2,67%
7th	0,682	1,884	0,344	0,477	7,2%	7,2%
8th	0,202	0,558	0,249	0,345	2%	2%
9th	0,173	0,478	0,197	0,274	3,8%	N/A
10th	0,187	0,516	0,199	0,276	1,6%	1,6%
11th	0,562	1,552	0,357	0,496	3,1%	3,1%
12th	0,184	0,508	0,261	0,362	1,33%	1,33%
13th	0,353	0,975	0,252	0,349	2%	2%
14th	0,198	0,548	0,245	0,340	N/A	N/A
15th	0,194	0,537	0,204	0,283	N/A	N/A
16th	0,233	0,644	0,224	0,311	N/A	N/A
17th	0,273	0,755	0,263	0,365	N/A	N/A
18th	0,184	0,509	0,205	0,284	N/A	N/A
19th	0,191	0,527	0,206	0,286	N/A	N/A
20th	0,200	0,552	0,227	0,315	N/A	N/A
21th	0,193	0,533	0,213	0,296	N/A	N/A
22th	0,196	0,541	0,269	0,373	N/A	N/A
23th	0,199	0,550	0,280	0,389	N/A	N/A
24th	0,194	0,537	0,228	0,317	N/A	N/A
25th	0,205	0,565	0,272	0,377	N/A	N/A
26th	0,201	0,556	0,202	0,280	N/A	N/A
27th	0,190	0,526	0,203	0,282	N/A	N/A
28th	0,194	0,536	0,200	0,277	N/A	N/A
29th	0,186	0,515	0,213	0,296	N/A	N/A
30th	0,189	0,523	0,202	0,280	N/A	N/A
31th	0,197	0,545	0,211	0,293	N/A	N/A
32th	0,193	0,533	0,194	0,269	N/A	N/A
33th	0,180	0,496	0,197	0,274	N/A	N/A
34th	0,195	0,539	0,191	0,265	N/A	N/A
35th	0,181	0,500	0,205	0,284	N/A	N/A
36th	0,186	0,514	0,187	0,260	N/A	N/A
37th	0,168	0,463	0,207	0,287	N/A	N/A
38th	0,174	0,481	0,189	0,262	N/A	N/A
39th	0,191	0,529	0,187	0,260	N/A	N/A
40th	0,166	0,458	0,177	0,245	N/A	N/A
THD	--	7,14	--	3,62	23%	13%
PWHD	--	14,32	--	7,94	23%	22%

Note:

A.7.1.4.1Harmonic Current Emissions						P
Model: SG50CX L2 phase						
Generating Unit tested to BS EN 61000-3-12						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated ouput 25kW		100% of rated output 50kW			
Harmonic	Measured Value (MV) in Amps	%	Measured Value (MV) in Amps	%	Limit in BS EN 61000-3-12 Higher limit for odd harmonics 21 and above	
1st	36,300	100,000	72,276	100,000	1 phase	3 phase
2nd	0,160	0,440	0,217	0,300	8%	8%
3rd	0,185	0,510	0,210	0,290	21,6%	N/A
4th	0,160	0,440	0,202	0,280	4%	4%
5th	0,428	1,180	0,585	0,810	10,7%	10,7%
6th	0,167	0,460	0,195	0,270	2,67%	2,67%
7th	0,653	1,800	0,282	0,390	7,2%	7,2%
8th	0,163	0,450	0,195	0,270	2%	2%
9th	0,178	0,490	0,195	0,270	3,8%	N/A
10th	0,182	0,500	0,188	0,260	1,6%	1,6%
11th	0,515	1,420	0,354	0,490	3,1%	3,1%
12th	0,192	0,530	0,224	0,310	1,33%	1,33%
13th	0,287	0,790	0,282	0,390	2%	2%
14th	0,214	0,590	0,224	0,310	N/A	N/A
15th	0,185	0,510	0,210	0,290	N/A	N/A
16th	0,207	0,570	0,202	0,280	N/A	N/A
17th	0,247	0,680	0,253	0,350	N/A	N/A
18th	0,185	0,510	0,195	0,270	N/A	N/A
19th	0,207	0,570	0,217	0,300	N/A	N/A
20th	0,185	0,510	0,217	0,300	N/A	N/A
21th	0,196	0,540	0,195	0,270	N/A	N/A
22th	0,196	0,540	0,195	0,270	N/A	N/A
23th	0,207	0,570	0,210	0,290	N/A	N/A
24th	0,192	0,530	0,202	0,280	N/A	N/A
25th	0,185	0,510	0,253	0,350	N/A	N/A
26th	0,189	0,520	0,210	0,290	N/A	N/A
27th	0,178	0,490	0,202	0,280	N/A	N/A
28th	0,189	0,520	0,195	0,270	N/A	N/A
29th	0,196	0,540	0,210	0,290	N/A	N/A
30th	0,178	0,490	0,202	0,280	N/A	N/A
31th	0,192	0,530	0,195	0,270	N/A	N/A
32th	0,178	0,490	0,188	0,260	N/A	N/A
33th	0,182	0,500	0,195	0,270	N/A	N/A
34th	0,178	0,490	0,188	0,260	N/A	N/A
35th	0,167	0,460	0,195	0,270	N/A	N/A
36th	0,167	0,460	0,188	0,260	N/A	N/A
37th	0,171	0,470	0,188	0,260	N/A	N/A
38th	0,163	0,450	0,181	0,250	N/A	N/A
39th	0,167	0,460	0,173	0,240	N/A	N/A
40th	0,171	0,470	0,181	0,250	N/A	N/A
THD	--	7,05	--	3,56	23%	13%
PWHD	--	13,74	--	7,46	23%	22%
Note:						

A.7.1.4.1Harmonic Current Emissions — P

Model: SG50CX L3 phase

Generating Unit tested to BS EN 61000-3-12

Generating Unit rating per phase (rpp)						
	At 45-55% of rated ouput 25kW		100% of rated output 50kW			
Harmonic	Measured Value (MV) in Amps	%	Measured Value (MV) in Amps	%	Limit in BS EN 61000-3-12 Higher limit for odd harmonics 21 and above	
1st	36,200	100,000	72,081	100,000	1 phase	3 phase
2nd	0,163	0,450	0,238	0,330	8%	8%
3rd	0,167	0,460	0,202	0,280	21,6%	N/A
4th	0,156	0,430	0,180	0,250	4%	4%
5th	0,395	1,090	0,584	0,810	10,7%	10,7%
6th	0,159	0,440	0,202	0,280	2,67%	2,67%
7th	0,623	1,720	0,310	0,430	7,2%	7,2%
8th	0,177	0,490	0,252	0,350	2%	2%
9th	0,167	0,460	0,202	0,280	3,8%	N/A
10th	0,185	0,510	0,231	0,320	1,6%	1,6%
11th	0,550	1,520	0,353	0,490	3,1%	3,1%
12th	0,177	0,490	0,216	0,300	1,33%	1,33%
13th	0,326	0,900	0,267	0,370	2%	2%
14th	0,250	0,690	0,296	0,410	N/A	N/A
15th	0,203	0,560	0,223	0,310	N/A	N/A
16th	0,203	0,560	0,231	0,320	N/A	N/A
17th	0,221	0,610	0,223	0,310	N/A	N/A
18th	0,195	0,540	0,245	0,340	N/A	N/A
19th	0,192	0,530	0,245	0,340	N/A	N/A
20th	0,195	0,540	0,202	0,280	N/A	N/A
21th	0,199	0,550	0,223	0,310	N/A	N/A
22th	0,195	0,540	0,267	0,370	N/A	N/A
23th	0,181	0,500	0,296	0,410	N/A	N/A
24th	0,206	0,570	0,223	0,310	N/A	N/A
25th	0,192	0,530	0,259	0,360	N/A	N/A
26th	0,199	0,550	0,202	0,280	N/A	N/A
27th	0,174	0,480	0,209	0,290	N/A	N/A
28th	0,203	0,560	0,209	0,290	N/A	N/A
29th	0,195	0,540	0,231	0,320	N/A	N/A
30th	0,188	0,520	0,216	0,300	N/A	N/A
31th	0,188	0,520	0,209	0,290	N/A	N/A
32th	0,195	0,540	0,209	0,290	N/A	N/A
33th	0,185	0,510	0,216	0,300	N/A	N/A
34th	0,185	0,510	0,209	0,290	N/A	N/A
35th	0,185	0,510	0,202	0,280	N/A	N/A
36th	0,185	0,510	0,209	0,290	N/A	N/A
37th	0,181	0,500	0,202	0,280	N/A	N/A
38th	0,177	0,490	0,195	0,270	N/A	N/A
39th	0,185	0,510	0,202	0,280	N/A	N/A
40th	0,174	0,480	0,202	0,280	N/A	N/A
THD	--	7,10	--	3,67	23%	13%
PWHD	--	14,26	--	8,27	23%	22%

Note:

A.7.1.4.2 Power factor				P
Output power	216,2 V	230 V	253 20 V	
20%	0,9836	0,9817	0,9794	Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test.
50%	0,9983	0,9981	0,9976	
75%	0,9992	0,9993	0,9992	
100%	0,9995	0,9996	0,9996	
Limit	>0,95	>0,95	>0,95	

Note.

The power factor capability of the SSEG shall conform to EN 50438. When operating at Registered Capacity the SSEGshall operate at apower factor within the range 0,95 lagging to 0,95 leading relative to the voltage waveform unless otherwise agreed with the DNO eg for power factor improvement.

The test set up shall be such that the Inverter supplies full load to the DNO’s Distribution System via the power factor (pf) meter and the variac as shown below in figure A5. The Inverter pf should be within the limits given in 5.6, for three test voltages 230 V –6%, 230V and 230 V +10%.

A.7.1.4.3 Voltage Flicker								P
	Starting			Stopping			Running	
	d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{lt} 2 hours
Measured values at test impedance	0,96	0,21	0	0,98	0,19	0	0,27	0,28
Normalised to standard impedance	4%	3,3%	3,3%	4%	3,3%	3,3%	1,0	0,65
Limits set under BS EN 61000-3-11	4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65

Test impedance	R	0,24*	Ω	Xl	0,15*	Ω
Standard impedance	R	0,24* 0,4^	Ω	Xl	0,15* 0,25^	Ω

Note.

* Applies to three phase and split single phase Generating Units

^ Applies to single phase Generating Units and Generating Units using two phases on a three phase system

For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the power factor of the generation ouput is 0,98 or above.

Normalised value = Measured value*reference source resistance/measured source resistance at test point.

Single phase unit reference source resistance is 0,4Ω

Two phase units in a three phase system reference source resistance 0,4Ω

Two phase units in a split phase system reference source resistance is 0,24Ω

Three phase units reference source resistance is 0,24Ω

Where the power factor of the output is under 0,98 then the Xl to R ratio of the test impedance should be close to that of the Standard impedance.

The stopping test should be a trip from full load operation.

dc : (3.30%)
dmax : (4.00%)
d(t) : (500ms)
Pst : (1.00%)
Plt : (0.65)

No.	dc[%]	dmax[%]	d(t)[ms]		pst
1	0.14	0.29	-----		0.21
2	0.13	0.27	-----		0.24
3	0.14	0.28	-----		0.21
4	0.13	0.29	-----		0.22
5	0.14	0.28	-----		0.23
6	0.13	0.26	-----		0.21
7	0.13	0.29	-----		0.21
8	0.14	0.25	-----		0.22
9	0.14	0.27	-----		0.24
10	0.13	0.29	-----		0.21
11	0.13	0.26	-----		0.22
12	0.14	0.29	-----		0.21
				Plt	0.22

A.7.1.4.4 DC injection			**P**
Model: SG50CX			
Test level power	10%	55%	100%
L1 Phase Recorded value(A)	0,047	0,043	0,052
L2 Phase Recorded value(A)	0,075	0,096	0,064
L3 Phase Recorded value(A)	0,075	0,058	0,052
L1 Phase As % of rated AC current	0,06	0,05	0,06
L2 Phase As % of rated AC current	0,09	0,11	0,08
L3 Phase As % of rated AC current	0,09	0,07	0,06
Limit	0,25%	0,25%	0,25%

Note:
The level of DC injection from the Generating Unit in to the DNO’s Distribution System shall not exceed the levels specified in 9.6.4 when measured during operation at three levels, 10%, 55% and 100% of rating with a tolerance of plus or minus 5%.

Testing must be performed according to WI 10.4.-03.doc rev D. The internal temperature of the EUT must be stabilized. No temperature drift of more than 2K within 1 hour is allowed.

A.7.1.5 Short circuit Current Contribution					P
Model: SG50CX L1 Phase					
For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	I_p	N/A	20ms	26,65 V	45,71A
Initial Value of aperiodic current	A	N/A	100ms	26,45 V	40,40A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	26,41V	27,29A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	26,41V	27,20A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	2,47s	In seconds

Diagram

Note:
The values of voltage and current should be recorded for a period of up to 1 second when the changeover switch should be returned to the normal position. The voltage and current at relevant times shall be recorded in the type test report (Appendix 4) including the time taken for the Inverter to trip.

A.7.1.5 Short circuit Current Contribution					P
Model: SG50CX L2 Phase					
For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	I_p	N/A	20ms	27,03V	45,85 A
Initial Value of aperiodic current	A	N/A	100ms	26,46V	52,51 A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	26,44V	52,82 A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	26,49V	52,86 A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	2,48s	In seconds

Diagram

Note:
The values of voltage and current should be recorded for a period of up to 1 second when the changeover switch should be returned to the normal position. The voltage and current at relevant times shall be recorded in the type test report (Appendix 4) including the time taken for the Inverter to trip.

A.7.1.5 Short circuit Current Contribution					P
Model: SG50CX L3 Phase					
For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	I_p	N/A	20ms	26,41V	45,33A
Initial Value of aperiodic current	A	N/A	100ms	26,47V	52,28A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	26,50V	52,83A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	26,49V	52,69A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	2,475s	In seconds

Diagram

Note:
The values of voltage and current should be recorded for a period of up to 1 second when the changeover switch should be returned to the normal position. The voltage and current at relevant times shall be recorded in the type test report (Appendix 4) including the time taken for the Inverter to trip.

A.7.1.6 Self-Monitoring - Solid State Disconnection	N/A
It has been verified that in the event of the solid state switching device failing to disconnect the SSEG, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0,5 seconds.	
Note:	

Annex No. 1
EMC Test Report

The complete EMC test report is stored at Bureau Veritas LCIE China.

CERTIFICATE

of Conformity

EC Council Directive 2014/30/EU

Electromagnetic Compatibility

Registration No.: AE 50435999 0001

Report No.: 50239652 001

Holder: Sungrow Power Supply Co., Ltd.
No.1699 Xiyou Rd.,New & High
Technology Industrial
Development Zone,
Hefei 230088
P. R. China

Product: PV-Inverter
(Grid-connected PV Inverter)

Identification: SG30CX SG33CX SG40CX SG50CX
Serial No.: n.a.
Remark: Refer to test report 50239652 001 for details.

Tested acc. to:
EN 61000-6-1:2007
EN 61000-6-2:2005
EN 61000-6-3:2007+A1
EN 61000-6-4:2007+A1
IEC 61000-6-1:2005
IEC 61000-6-2:2005
IEC 61000-6-3:2006+A1
IEC 61000-6-4:2006+A1

This certificate of conformity is based on an evaluation of a sample of the above mentioned product. Technical Report and documentation are at the Licence Holder's disposal. This is to certify that the tested sample is in conformity with all provisions of Annex I of Council Directive 2014/30/EU. This certificate does not imply assessment of the production of the product and does not permit the use of a TÜV Rheinland mark of conformity. The holder of the certificate is authorized to use this certificate in connection with the EC declaration of conformity according to the a.m. Directive.

Certification Body

Date 10.05.2019

Xinhua Lu

TÜV Rheinland LGA Products GmbH - Tillystraße 2 - 90431 Nürnberg

The CE marking may only be used if all relevant and effective EC Directives are complied with.

TÜV Rheinland (China) Ltd.
Member of TÜV Rheinland Group

TÜVRheinland®
Precisely Right.

Sungrow Power Supply Co., Ltd.
Shandong Cao
-
No.1699 Xiyou Rd.,New & High
Technology Industrial
Development Zone,
Hefei 230088
P. R. China

Date : 10.05.2019
Our ref. : LHX 01
Your ref.: C.S.D.

Ref : AE Certificate of Conformity EMC

Type of Equipment : Grid-connected PV Inverter
Model Designation : See Certificate
Certificate No. : AE 50435999 0001
Report No. : 50239652 001

Dear Shandong Cao,

We herewith confirm that a sample of the above mentioned technical equipment has been tested and was found to be in accordance with the relevant requirements.

Enclosed please find your Certificate of Conformity.

We appreciate your kind support and would like to offer our assistance and continuous services in the future.

With kind regards,

Certification Body

Xinhua Lu

CC: Sungrow Power Supply Co., Ltd.

Enclosure

TÜV Rheinland (China) Ltd.
莱茵检测认证服务（中国）有限公司
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北京市朝阳区东三环中路乙10号艾维克大厦第7层第01、03B-08号，第11层第01、04B-08号
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Internet: http://www.chn.tuv.com

Annex No. 2

Pictures of the unit

The complete Pictures of the unit is stored at Bureau Veritas LCIE China.

Figure 1. Overview

Figure 2.Right side view

Figure 3.Left side view

Figure 4.Top side view

Figure 5. Bottom side view

Figure 6.Rear view

Annex No. 3
Test Equipment list

No,	Equipment	Internal No,	Type/characteristics	Manufacturer	Last Calibration	Due Data
1	Oscilloscope	A4089024SH	P4034B	Tektronix	03/Jul/19	02/Jul/20
2	Oscilloscope	A4089008SH	DPO3014	Tektronix	23/Jan/19	22/Jan/20
3	Oscilloscope	A4089036SH	DL850	YOKOGAWA	20/Aug/19	19/Aug/20
4	High Voltage probe	A4089026SH	P5200A	Tektronix	23/Jan/19	22/Jan/20
5	Voltage probe	A4089004SH	P2220	Tektronix	12/Oct/19	11/Oct/20
6	Current probe	A4089009SH	P6139B	Tektronix	23/Jan/19	22/Jan/20
7	Current probe	A4089013SH	A622	Tektronix	23/Jan/19	22/Jan/20
8	Current probe	A4089037SH	960 30	YOKOGAWA	12/Oct/19	11/Oct/20
9	Current probe	A4089038SH	960 30	YOKOGAWA	12/Oct/19	11/Oct/20
10	Current probe	A4089039SH	960 30	YOKOGAWA	12/Oct/19	11/Oct/20
11	AC power supply	A7040066SH	AFC-31010T	APC	08/Aug/18	31/Jul/20
12	AC power supply	A7040071SH	61512	Chroma	22/Feb/18	21/Feb/20
13	AC power supply	A7040057SH	61512	Chroma	07/Jul/19	06/Jul/20
14	AC power supply	A7040077SH	MX-30	AMETEK	-	-
15	Programmable DC source	A7040058SH	62150H-1000S	Chroma	-	-
16	Programmable DC source	A7040059SH	62150H-1000S	Chroma	-	-
17	Programmable DC source	A7040069SH	62150H-1000S	Chroma	-	-
18	Programmable DC source	A7040074SH	62150H-1000S	Chroma	-	-
19	Programmable DC source	A7040075SH	62150H-1000S	Chroma	-	-

20	Programmable DC source	A7040076SH	62150H-1000S	Chroma	-	-
21	Programmable DC source	A7040070SH	62150H-1000S	Chroma	-	-
22	Power Analyzer	A1240096SH	WT3000	YOKOGAWA	11/Oct/19	10/Oct/20
23	Power Analyzer	A1240103SH	LMG500	ZES ZIMMER	03/Jul/19	02/Jul/20
24	Power Analyzer	A1240101SH	WT3000	YOKOGAWA	03/Jul/19	02/Jul/20
25	Anti-isolating test stystem	A7150074SH	ACTL-380SH	qunling	-	-
26	Load cabinet	A7150083SH	WSTF-LDJ60K/300	shanghai wen shun	-	-
27	Load cabinet	A7150084SH	WSTF-LDJ45K/0385	shanghai wen shun	-	-
28	Load cabinet	A7150085SH	WSTF-LDJ45K/0385	shanghai wen shun	-	-
29	Load cabinet	A7150075SH	WSTF-RC25k/0,3D 0,001kVA-25kVA	shanghai wen shun	-	-
30	Temperature recorder	A740037SH	G820	GRAPHIEC	11/Oct/19	10/Oct/20
31	Load cabinet(for flick)	A7150090SH	200Ω ,250V;1200W	shanghai wen shun	-	-
32	Variable resistor	A7150076SH	BX8-67	LingOu	-	-