TEST REPORT
VDE-AR-N 4105:2011 in conjunction with E DIN V VDE V 0124-100:2011
Power generation systems connected to the low-voltage distribution network

Report Reference No. ..... :	TP12030011-ETS
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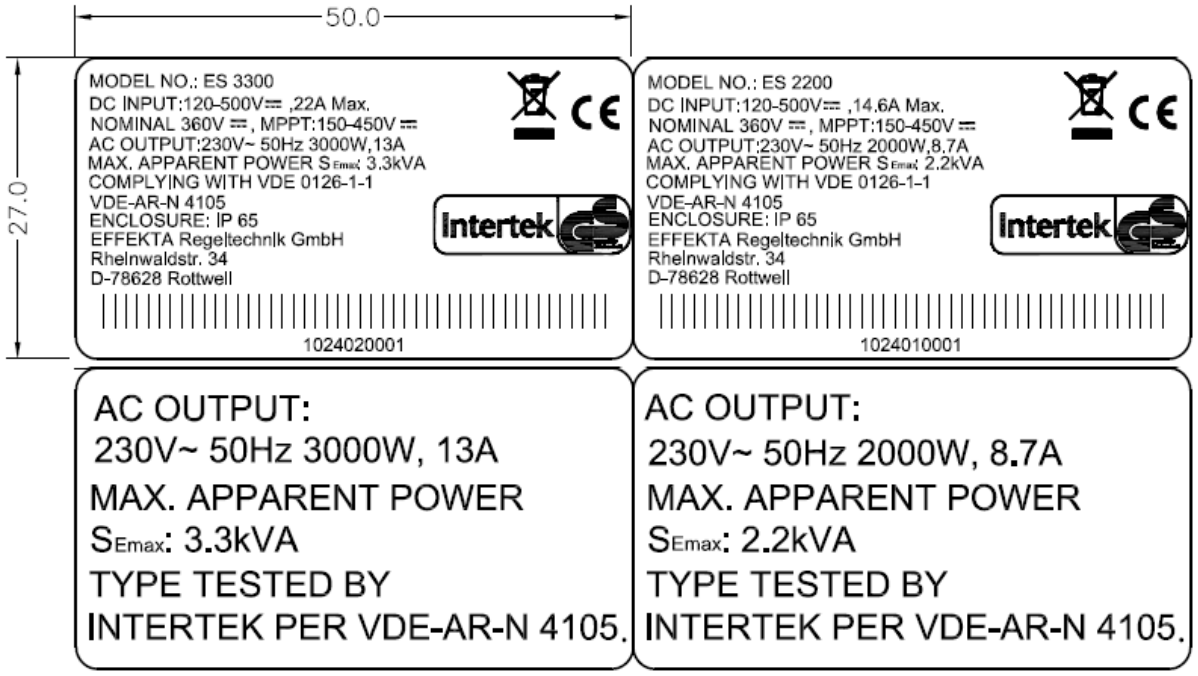
Test specification:	
Standard ..... :	VDE-AR-N 4105:2011 in conjunction with E DIN V VDE V 0124-100:2011
Test procedure ..... :	General testing
Non-standard test method..... :	N/A
Test Report Form No. ..... :	VDE-AR-N 4105A
Test Report Form(s) Originator..... :	Intertek Taiwan
Master TRF ..... :	Dated 2011-10

Test item description .....:	Power Inverter for PV
Trade Mark ..... :	EFFEKTA
Manufacturer ..... :	Same as applicant
Model/Type reference ..... :	1) ES 2200, 2) ES 3300
Ratings ..... :	1) ES 2200 : Input : 120~500Vdc, Nominal 360Vdc, MPPT 150~450Vdc, Max. 14.6A Output : 230Vac, 50Hz, 2000W, apparent power 2200VA, 8.7A 2) ES 3300 : Input : 120~500Vdc, Nominal 360Vdc, MPPT 150~450Vdc, Max. 22A Output : 230Vac, 50Hz, 3000W, apparent power 3300VA, 13A Class I equipment

Summary of testing:	
Tests performed (name of test and test clause):	**Testing location:**
5.4.3 System reactions – flicker 5.4.4 System reactions – harmonics and inter-harmonics 5.4.9 System reactions – precautionary measures against voltage drops an voltage interruptions 5.7.3.2 Active power output – generation management/network security management 5.7.3.3 Active power output – active power feed-in at over frequency 5.7.5 Reactive power 6 Construction of the power generation system/ network and system protection (NS protection) 6.5.2 Protective devices for the interface switch – protective functions 6.5.3 Protective devices for the interface switch – Islanding detection 8.3.1 Connection conditions and synchronization – general 8.3.4 Connection conditions and synchronization – connection of power generation units with inverters	Intertek Testing Services Taiwan Ltd.

Copy of marking plate



Test item particulars.....:					
Temperature range .....:	-25°C…+40 °C				
AC Overvoltage category.....:	☐ OVC I	☐ OVC II	☒ OVC III	☐ OVC IV	
DC Overvoltage category.....:	☐ OVC I	☒ OVC II	☐ OVC III	☐ OVC IV	
IP protection class .....:					
Possible test case verdicts:					
- test case does not apply to the test object .....:	N/A (Not applicable)				
- test object does meet the requirement.....:	P (Pass)				
- test object does not meet the requirement.....:	F (Fail)				
Testing.....:					
Date of receipt of test item .....:	January 6, 2012				
Date (s) of performance of tests.....:	January 6 to February 3, 2012				

General remarks:

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

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

General product information:
The testing item is a grid-connected type PV inverter for outdoor installation. The connection to the DC input is through quick connectors and the connection to the AC output is through screw terminals or quick connectors.

The two models, ES 2200 and ES 3300 are identical except for the firmware for controlling the output power which is 2000W for ES 22000, 3000W for ES 3300.

The model ES 3300 is main tested model.

The firmware version used for the testing is: Version PV000002.

VDE-AR-N 4105:2011 in conjunction with E DIN V VDE V 0124-100:2011			
Clause	Requirement - Test	Result - Remark	Verdict
4	**General framework conditions**		**P**
4.1	**Provisions and regulations**		P
4.2	**Application procedure and connection relevant document**		P
4.3	**Initial start-up of the power generation system**	Not applicable for system installation	N/A
5	**Network connection**		**N/A**
5.1	**Principles for determination of the network connection point** Power generation systems shall be connected at a suitable point in the network, the network operator determines the suitable network connection point that ensures safe network operation, also when taking account of the power generation system, and at which the power applied for can be drawn and transmitted. The decisive aspect for evaluation of the network connection is always the behaviour of the power generation system at the network connection point or at the PCC. This is to ensure that the power generation system is operated without interfering reactions and without affecting the supply of other customers. Annex E shows examples for connection evaluations of power generation systems. Power generation systems which are installed on different plots with their own respective network connections shall, as a rule, not be connected to the network operator's network together in the same network connection point. Power generation systems installed on a building with several network connections may be connected to the network operator's network together at the same network connection point. All separate supply points shall be permanently marked by te supply point owner with the following label "Sectioning point" power generation system/ supply network".	Not applicable for PGU testing	N/A
5.2	**Rating of the network equipment** Power generation systems may cause higher loading of lines, transformers and other network equipment. Therefore, the network operator examines the loading capacity of the network equipment with regard to the connected power generation systems in accordance with the relevant rating regulations. For calculation purposes the maximum apparent power of the sum of all power generation systems S_{Amax} and usually the load factor m=1 shall be used. The only exceptions are buried cables for the connection of photovoltaic systems for which a load factor m= 0.7 shall be used.	Not applicable for PGU testing	N/A

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Clause	Requirement - Test	Result - Remark	Verdict
5.3	Permissible voltage change For undisturbed operation of the network, the amount of the voltage change caused by all power generation systems with a network connection point in a low-voltage network shall at none of the PCCs in this network may a value of 3 % as compared with the voltage without power generation systems. If stipulated by the network operator and if necessary, taking into account the possibilities of the static voltage stability it may be permitted in individual justified cases to deviate from this value of 3%. When calculating the voltage change, the displacement factor shall be taken into account which is provided by the network operator for the maximum apparent connection power of the power generation system S_{Amax}. For determination of the voltage change for meshed low-voltage networks an high spatially distributed feed-in powers, it is recommended to use complex load-flow calculations.	Not applicable for PGU testing	N/A
5.4	**System reactions**		**P**
5.4.1	**General** The electrical installations of the customer system shall be planned, constructed and operated so that reactions to the network operator's network and to the systems of other customers are permanently reduced to a permissible minimum. Should interfering reactions on the network operator's network occur nonetheless, the customer shall apply measured to his system that is to be coordinated with the network operator. The network operator is entitled to disconnect the power generation system concerned from the network until the deficiencies are corrected. The connection owner provides the network operator with values from the device documents of the manufacturer which are necessary in order to evaluate system reactions (see Annex F.3).	(See appended table – Annex F.3 requirements for the test report for power generation units)	P
5.4.2	**Rapid voltage changes** Voltage chances at the PCC attributable to the simultaneous connection and disconnection of power generation units do not give rise to inadmissible network reactions if the maximum voltage change does not exceed a value of 3% (related to Un) at the PCC. For a value of 3% the frequency shall not exceed once every 10 min. Depending on the network short-circuit power S_{kV} at the PCC of maximum apparent connection power S_{Emax} of the activated power generation unit and on th ratio of starting current I_a to rated current I_{rE}, the voltage change can be estimated.	(See appended table – Annex F.3 requirements for the test report for power generation units)	P

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Clause	Requirement - Test	Result - Remark	Verdict
5.4.3	Flicker The measured variable and the evaluation criterion for flicker caused by power generation systems is the long-term flicker strength P_{lt}. For power generation systems with rated currents of up to 75 A, reactions are deemed to be limited sufficiently, if the power generation units comply with the limit values given in DIN EN 61000-3-3 (VDE 0838-3) or DIN EN 61000-3-11 (VDE 0838-11), respectively. Together, all power generation systems in the low-voltage network shall not exceed the following flicker strength at the most unfavourable PCC: Long-term flicker strength: $P_{lt} = 0.5$. This value also applies to power generation systems with rated currents above 75A.	Complied with DIN EN 61000-3-3. (See appended table – Annex F.3 requirements for the test report for power generation units)	P
5.4.4	**Harmonics and inter-harmonics** The currents of harmonics and inter-harmonics generated by power generation systems shall be included in the conformity check. For power generation systems reactions are deemed to be limited sufficiently, if the power generation units comply with the following limit values: - for rated currents of up to and including 16 A per conductor: the limit values of class A (Table 1) specified in DIN EN 61000-3-2 (VDE0838-2); - for rated currents above 16 A and up to and including 75 A per conductor: the limit values of Table 2 and Table 3 specified in DIN EN 61000-3-12 (VDE 0838-12). If in the standard mentioned, limit values are explicitly stated for power generation units then these limit values shall apply.	Complied with DIN EN 61000-3-2. (See appended table – Annex F.3 requirements for the test report for power generation units)	P
5.4.5	**Voltage unbalance** If several single-phase power generation systems are connected to the same network connection point, then uniform distribution of the power supplied to the three line conductors shall be aimed for, where a maximum power difference of 4.6kVA shall not exceed.	Maximum power is not more than 4.6kVA per phase.	P
5.4.6	**Commutation notches** The relative depth of commutation notches d_{kom} through line-commutated inverters shall not exceed the value of $d_{kom} = 5\ \%$	$d_{kom} \approx 0$	P

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Clause	Requirement - Test	Result - Remark	Verdict
5.4.7	**Audio-frequency centralised ripple-control** Audio-frequency centralised ripple-control are usually operated at frequencies between approx. 100 Hz and 1500 Hz. Information about the locally applied ripple-control frequency can be obtained from the network operator. Broadcasting levels of audio-frequency impulses are normally about 1 % U_n to 4 % U_n. Apart from the limitation of the level reduction, it is not allowed to generate inadmissible interference voltages. The following rules shall apply in particular: - The interference voltage caused by a power generation system whose frequency corresponds to the locally applied ripple-control frequency or is very close to it (+/- 5 Hz), shall not exceed the value of 0.1 % U_n. - The interference voltage caused by a power generation system whose frequency lies at the ambient frequencies of +/- 100 Hz to the locally applied ripple-control frequency or in its immediate proximity, shall not exceed a value of 0.3 % U_n.	Advice only.	N/A
5.4.8	**Carrier frequency usage of the customer network** If the system operator runs a system with carrier frequency usage of this network, then shall be ensured by means of suitable devices that interfering influences on other customer systems as well as on the systems of the network operator are avoided. Shared usage of the network operator's network by the customer is permitted solely with the network operator's consent for the carrier frequent transmission of signals.	No carrier frequency used.	N/A
5.4.9	**Precautionary measures against voltage drops and voltage interruptions** If power generation systems are sensitive to short-time voltage drops or interruptions of supply, then the customer shall take suitable measured to safeguard the system and to ensure operation operational safety.	Complied with IEC 61000-4-11.	P

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Clause	Requirement - Test	Result - Remark	Verdict
5.5	**Connection criteria** For the technical execution of connections of the power generation system or the customer system with a power generation system, the technical connections of the network operator shall be considered. If the generated power is fully supplied to the network operator's network, then the connection line of the power generation system shall be firmly connected to the meter panel within the customer system and the meter panel shall then be executed in accordance with the applicable Technical connection condition. Power generation systems may also be single-phase connected to the network, if the sum of all single-phase connected power generation units per network connection does not exceed the flowing: $S_{Emax} = \leqq 4.6kVA$ per line conductor. It is possible to connect in single phase, distributed to the three line conductors, at maximum 3 x 4.6kVA= $S_{Emax} \leqq 13.8kVA$. The limits given above are exceeded at the network connection point, any extension shall be three-phase connected to the three-phase system. This requirement may also be satisfied by communicatively coupling single-phase connected power generation units of the same primary energy carrier. The communicative coupling between power generation units ensures the power generation system's balanced supply to the individual line conductors of the three-phase network in accordance with three-phase inverter systems. For all that, the maximum permissible imbalance of 4.6kVA at a single network connection point for the sum of all power generation systems applies here as well.	Requirement is for installation of power generation system only.	N/A
5.6	**Three-phase network**		**N/A**
5.6.1	**General** For the purposes of maintaining the symmetric characteristics of the three-phase network, three-phase power generation systems shall have the characteristics described in the following.	Single phase power generation systems.	-
5.6.2	**Three-phase synchronous generators** Synchronous generators generate an electromotive force (EMF) or synchronous generated voltage (open-circuit voltage), respectively, satisfying the conditions for ideal balance.	Not applicable	-

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Clause	Requirement - Test	Result - Remark	Verdict
5.6.3	**Three-phase inverter systems** For three-phase power generation systems with network feed-in over inverters, the power shall be fed three-phase balanced into the three line conductors. The inverter circuit shall preferably be set up as a three-phase current unit. A circuit of single –phase inverters is deemed to be technically equivalent, if these inverters feed three-phase balanced into the three line conductors by means of a suitable communicative coupling. In the medium term, three-phase inverter systems shall provide all the three-phase related functions of the three-phase synchronous generators.	Not applicable	-
5.7	**Behaviour of the power generation system at the network**		**P**
5.7.1	**General** Automatic disconnection from the network is not permitted for frequency deviations within the range of 47.5 Hz to 51.5 Hz. The mode of action is described in detail in 5.7.3.3 and 5.7.3.4. Implementation of the frequency dependent active load control is carried out in the open-loop control of the power generation units.	No automatic disconnection for frequency deviations within the range of 47.5 to 51.5 Hz.	P
5.7.2	**Maximum permissible short-circuit current** Due to operation of power generation system, the short-circuit current of the low-voltage network is increased by the short-circuit current of the power generation system. Therefore, information about the short-circuit current of the power generation system to be expected at the network connection point has shall be provided in accordance with 4.2. For determination of the short-circuit current contributed by the power generation system the following roughly estimated values can be assumed : - For synchronous generators: 8 times the rated current: - For asynchronous generators: 6 times the rated current; - For generators with inverters: 1 time the rated current.	Inverter type, 1 time the rated current (max. 13A)	P

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Clause	Requirement - Test	Result - Remark	Verdict
5.7.3	**Active power output**		**P**
5.7.3.1	**Basics**		P
5.7.3.2	**Generation management/network security management** Power generation systems with a system power of more than 100 kW shall be able to reduce their active power in steps of not more than 10 % of the maximum active power P_{Amax}. For every operational state and from each and every operation point, it shall be possible for this power to be reduced to a set point provided by the network operator. This set point is generally provided at the network connection point gradually or continually and it corresponds to a percentage related to the maximum active power P_{Amax}. Variable power generation systems shall carry out the power output reduction to the respective set point immediately, however, at maximum within a minute. It shall be technically possible for these power generation systems to reduce the power to the set point 10% without automatic disconnection from the network, and only at a value o less than 10% of the maximum active power P_{Amax} is they permitted to disconnect the network. All other power generation systems shall carry out the power output reduction to the respective set point within a maximum period of five minutes. If the set point is not reached within five minutes, then the power generation system shall be disconnected.	PGU is involved in the feed in management /network management and it is able to reduce their active power in steps of not more than 10% of the maximum active power $P_{Amax.}$ (See appended table)	P

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Clause	Requirement - Test	Result - Remark	Verdict
5.7.3.3	**Active power feed-in at overfrequency** At frequencies between 50.2 Hz and 51.5 Hz, all adjustable power generation systems shall reduce or increase the active power P_M generated instantaneously with a gradient of 40 % of P_M per Hz. It follows that the power generation unit will continuously move up and down the frequency characteristic curve in the frequency range of 50.2 Hz to 51.5 Hz with regard to its active power feed-in. the increment of the frequency measurement shall be ≤10 mHz. If the mains frequency drops again to a value below 50.2 Hz and if the possible generation power is greater at that instant than the active power P_M, then the increase of the active power supplied to the network operator's network shall not exceed a gradient of 10 % of the maximum active power P_{Amax} per minute. At mains frequencies > 51.5 Hz, the power generation system shall disconnect from the network immediately. There ar no restrictions for frequencies of 47.5 Hz ≤ f_{mains}≤ 50.2 Hz. Disconnection from the network is required for f_{mains} ≤ 47.5 Hz and f_{mains} ≥ 51.5 Hz.	(See appended table)	P
5.7.3.4	**Active power feed-in at underfrequency** For frequencies between 47.5 Hz and 50.0 Hz, automatic disconnection from the network as a result of a frequency deviation is not permitted.	Not disconnection from the network for frequency between 47.5 and 50.0 Hz.	P
5.7.4	**Principles for network support** Power generation systems shall be able to contribute to the static voltage stability in the network operator's network. Static voltage stability is understood to be the voltage stability in the low-voltage network at which the slow voltage changes are maintained within compatible limits in the distribution network.	Recommendation only for connection to LV-network	-

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5.7.5	**Reactive power** Irrespective of the number of feed-in phases, power generation systems shall allow for operation under normal stationary operating conditions in the voltage tolerance band U_n +/- 10% and in their permissible operation points starting with an active power of more than 20 % of the rated active power with the following displacement factors cosφ: - power generation system $S_{Emax} \leqq 3.68$ kVA: cosφ= 0.95 $_{under\text{-}excited}$ to 0.95 $_{over\text{-}excited}$. - power generation system 3.68 kVA < $S_{Emax} \leqq 13.8$ kVA: characteristic curve provided by the network operator within cosφ= 0.95 $_{under\text{-}excited}$ to 0.95 $_{over\text{-}excited}$ - power generation system S_{Emax} > 13.8 kVA: characteristic curve provided by the network operator within cosφ= 0.90 $_{under\text{-}excited}$ to 0.90 $_{over\text{-}excited}$.	Power generation system S_{Emax} > 13.8 kVA considered. Characteristic curve cosφ = 0.90 $_{under\text{-}excited}$ to 0.90 $_{over\text{-}excited}$ tested. (See appended table – Annex F.3 requirements for the test report for power generation units)	P
6	**Construction of the power generation system/network and system protection (NS protection)**		**P**
6.1	**General requirements** The network and system protection (NS protection) is a type-tested protective device with a conformity certificate in which all protective functions specified in 6.5 are installed. The NS protection acts on the interfaces switch in accordance with 6.4. The NS protection shall be realized as central NS protection at the central meter panel. For power generation systems of ≤ 30kVA it is also permitted to have an NS protection installed in the power generation unit(s). depending on the sum of the maximum apparent powers of all power generation systems connected to the same network connection point, S_{Amax}. The following conditions apply for the NS protection: - S_{Amax} > 30kVA: Central NS protection at the central meter panel. - SAmax ≤ 30kVA: Central NS protection at the central meter panel or decentralized in a sub-distribution or integrated NS protection The loss of the auxiliary voltage of the central NS protection or the control of the integrated NS protection shall lead to an instantaneous tripping of the interface switch. Tripping of a relay of the integrated protection disconnection periods is kept. The protective functions shall be maintained even in the event of a malfunction in the system control. Single-fault tolerance shall be ensured for both central and integrated NS protection.	$S_{Amax} \leq$ 30kVA: integrated NS protection considered. The interfaces switch is an integral part of the PV inverter. The interface switch of the PV inverter complies with the operating demands and outside influences. Description of design of functional safety and single fault simulation conducted. (See appended table).	P

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Clause	Requirement - Test	Result - Remark	Verdict
6.2	**Central NS protection** The central NS protection shall be accommodated as independent apparatus in a suitable circuit distributor in accordance with TAB 2007, Clause 8, Paragraph 1, and not in the upper connection compartment specified in TAB 2007, 7.2, Paragraph 9 and connected to the central meter panel.	Integrated NS protection used.	N/A
6.3	**Integrated NS protection** The NS protection can be integrated in the programmable system control of the power generation units. If so, then both the test button and the sealing may be omitted, however, password protection is required, if the protective function U > is adjustable.	The NS protection is integrated in the programmable system control of the power generation unit. The protection function U> is not adjustable.	P
6.4	**Interface switch**		P
6.4.1	**General** For the connection of the power generation system to the network operator's low-voltage network or to the remaining customer system, it is necessary to use an interface switch. It consists of two electric switching devices connected in series and shall thus be constructed redundantly. The interface switch is controlled by the NS protection and activates automatically if at least one protective function responds. The breaking devices of the interface switch shall be designed to be short-circuit proof and shall be releasable without delay and with due regard to the protective devices required by clause 6.5. The breaking capacity of the two breaking devices of the interface switch shall be dimensioned at least in accordance with the responding range of the upstream safety fuse or the maximum short-circuit current contribution of the power generation system. Switches with at least breaking capacity shall be use for both breaking devices of the interface switch. In addition to that, all-pole disconnection shall be ensured.	Two switches (mechanical relays, RY1, RY2) connected in series in both poles of ac circuits. The rating of the interface switch as below Song Chuan, 841-P-2A-C-H (250Vac, 20A) Interface switch's time delay is 30 ms max.	P
6.4.2	**Central interface switch** The two break devices of the central interface switch shall be executed as galvanic break devices. The two break devices of the interface switch shall be installed directly at the central meter panel in the circuit distributor of the power generation system.	Integrated interface-switch used.	N/A

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6.4.3	**Integrated interface switch** Construction of the interface switch shall be carried out taking into consideration the single-fault tolerance. An interface switch ensures a single-fault tolerant all-phase galvanic breaking. For power generation systems with inverters, the interface switch shall be provided on the inverter's network side. A short circuit in the inverter shall not impair the switching function of the interface switch.	Both the relays have mechanical contacts rated 25A, 250V, with the separation of the contacts of > 1.5 mm each. The switches are located both line and neutral poles.	P
6.5	**Protective devices for the interface switch**		**P**
	Comments: • The mains voltage is measured before and after the relays by both MCPU and SCPU. The voltage is scanned with 50 µs and each 20 ms formed the arithmetic average value of one cycle. • Each measured 20 ms value is compared with the limit value by both channels. If the value exceeding the limit for more than 100 ms, the inverter-bridges and one relay are switched off by MCPU and another relay switched off by the SCPU.		

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6.5.1	**General** The purpose of the NS protection is to disconnect the power generation system from the net in the event of inadmissible voltage and frequency values. This is intended to prevent an unintentional feed-in of the power generation system into a power-supply unit separated from the remaining distribution network as well as the feed-in of faults within this network. The system operator shall himself take precautions to prevent damages to his systems and installations as might be caused by switching actions, voltage fluctuations and automatic reclosings in the network connected upstream or other process in the network of the network operator. The following functions of the decoupling protection shall be implemented: - Voltage drop protection *U* <; - Rise-in-voltage protection *U* >; - Rise-in-voltage protection *U* >>; - Frequency decrease protection *f* <; - Frequency increase protection *f* >; - Islanding detection. The setting values of the protective functions and the last five dated failure reports shall be readable at the NS protection. Interruptions of supply with durations of 3 s or longer shall not lead to loss of any of the failure reports. Read-out shall be possible at the central NS protection irrespective of the operational state of the power generation system and without any additional aids. For integrated NS protection read-out may be carried out using a data interface.	**Voltage drop & rise-in voltage protection:** The disconnection device switched off for undervoltage and overvoltage testing are less than 200 ms. The voltage is not changeable in the equipment. **Rise-in-voltage protection:** The disconnection device of the PV inverter has the function to monitor the overvoltage and cut off for a moving average time over 10 min. The factory setting of the overvoltage is at 230V + 10% = 253 Vac. Installer is possible to change the setting to the range of 110% to 115% Un. **Frequency decrease & increase protection:** The mains frequency is continued measured by the MCPU and SCPU through the time difference between the zero crossing of the mains voltage. If the mains frequency exceeds the limit value for 100 ms, the inverter-bridges and relays are switched off. The switched off time tested for under/over frequency is less than 200 ms. **Islanding detection:** MCPU of the inverter system is trying to change (increase) the mains frequency by adding a current disturbance to the output current. The mains frequency will be shifted outside the limit once the mains is not appeared and such deviation will be detected by both MCPU and SCPU. The islanding will be recognized by the CPUs as one of over/undervoltage or over/underfrequency and the disconnection devices be switched off.	P

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6.5.2	**Protective functions** The protective functions of the NS protection shall be designed so that the disconnection time (the sum of the proper times of NS protection and interface switch plus a delay for the protection relay, which may or may not be adjustable) does not exceed 200 ms.	(See appended table – Annex F.4 requirements for the test report for the NS protection)	P
6.5.3	**Islanding detection** The islanding detection is implemented in the central NS protection or in the integrated NS protection of the power generation unit. If an islanding detection system acting on the integrated interface switch is integrated in all power generation units of a power generation system, then it is permitted to omit the islanding detection in the central NS protection regardless of the system power. Detection of an isolated network and disconnection of the power generation system by means of the interface switch shall be completed within 5 seconds.	(See appended table)	P
7	**Metering for billing purposes**		**N/A**
	Installation and operation of the measuring devices shall be agreed in due time between the system operator and the network or metering point operator, respectively. According to the German Calibration Act, only certified and calibrated meters and transformers shall be used in the course of business.	Related to the installation system not to inverter.	N/A
8	**Operation of the system**		**P**

VDE-AR-N 4105:2011 in conjunction with E DIN V VDE V 0124-100:2011			
Clause	Requirement - Test	Result - Remark	Verdict
8.1	**General** The operation of electrical installations included all technical and organisational activities required to ensure the functional efficiency and safety of the systems. These activities include all operating measures as well as electrical and non-electrical operations as described in the applicable rules and regulations. For connection of the power generator systems, the conditions given in 8.3 shall be satisfied. During operation, the conditions of clause 5, which the decisions regarding the connection of the power generation system were based on, shall only be changed with the consent of the network operator. The system operator shall ensure that the equipment - required for parallel operation with the low-voltage network is always in proper technical condition. It is required to have an electrically skilled person check the switches and protective devices for proper functioning at regular intervals. This requirement is deemed to be satisfied for normal operating and environmental conditions if the test intervals mentioned in BGV A3 or TRBS 1201 are adhered to. Te repeat tests shall include at least the following: - Check of the environmental conditions and elimination of deficiencies, if required; - Tripping control of the interface switch. Power reduction or disconnection required due to network conditions: upon request of the network operator, the system operator is obliged to switch off the power generation system or to disconnect it from the network if this is required for conduction work that are necessary for operational purposes in the network operator's network. Access: upon co-ordination with the system operator, the network operator shall be granted access to all components of the power generation system, interfaces switch, facilities of the power generation/ network security management, and the power generation units. Exchange of information: the network operator will inform the system operator about substantial modifications in his network which will have an impact on the current parallel operation. Coupling of network connection points: different network connection points on the network of the network operator shall not be operated in galvanic connection through systems of one or more system operators. Behaviour in the event of disturbances: the reconnection conditions given in 8.3 shall be satisfied.	Not related to the power generation unit.	N/A

VDE-AR-N 4105:2011 in conjunction with E DIN V VDE V 0124-100:2011			
Clause	Requirement - Test	Result - Remark	Verdict
8.2	**Particular characteristics of the management of the network operator's network** - Earthing and short-circuiting for works on the network: After isolation, a prerequisite for the safety of works on the network is to prevent any voltage sources from reconnecting unintentionally. - Operation of the network stand-by systems: For certain works on the network, the network operator has to disconnect sub-networks from the remaining network. In order to ensure continuous supply to the customers during this time, the network operator may use network stand-by systems. Normally, the network operator will inform the customers concerned about the use and operation of network stand-by systems.	Not related to the power generation unit.	N/A
8.3	**Connection conditions and synchronisation**		P
8.3.1	**General** A power generation system shall be connected to the network operator's network only if a suitable device determines that both the mains voltage and the mains frequency are within the tolerance range of 85 % Un to 110 % Un or 47.5 Hz to 50.05 Hz, respectively, for a period of at least 60 seconds. If decoupling protection devices are tripped because of a short interruption, then the power generation system is permitted to already reconnect as soon as the mains voltage and mains frequency have uninterruptedly remained within the tolerance ranges given above for a period of 5 seconds. Short time interruptions are characterised by the NS protection settings of the mains frequency and/ or network voltage being exceeded or undershot for a maximum period of 3 seconds. The power generation system being reconnected to the network operator's network at the tripping of the decoupling protection device, the active power of controllable power generation systems supplied to the network operator's network shall not exceed the gradient of 10 % of the active power per minute.	Both the mains voltage and frequency are within the tolerance range of 85% Un to 110% or 47.5 Hz to 50.05 Hz, respectively, for a period of at least 60 s. For short time interruptions of 2 s, the time of reconnection is > 5 s. For interruptions of 4 s, the time of reconnection is > 60 s.	P

VDE-AR-N 4105:2011 in conjunction with E DIN V VDE V 0124-100:2011			
Clause	Requirement - Test	Result - Remark	Verdict
8.3.2	**Connection of synchronous generators** A synchronisation device shall be provided in a suitable place for synchronous generators coupled directly to the network.	Not synchronous generators coupled directly to the network.	N/A
8.3.3	**Connection of asynchronous generator** For asynchronous generators started by a prime mover and connected at a rotational speed between 95 % and 105 % of the synchronous rotational speed, k_{imax} is expected to be = 4.	Not asynchronous generators.	N/A
8.3.4	**Connection of power generation units with inverters** Power generation units with inverters shall only be connected with $k_{imax} \leq 1.2$.	k_{imax} is 0.753	P
8.4	**Reactive power compensation** Equipment for reactive power compensation shall either: be connected or disconnected together with the consumption devices or power generation systems; or operated via control equipment.	Via control equipment.	P

VDE-AR-N 4105:2011 in conjunction with E DIN V VDE V 0124-100:2011			
Clause	Requirement - Test	Result - Remark	Verdict
9	**Verification of the electrical properties**		**P**
9.1	**General** The certificates of conformity issued for the power generation units and the NS protection shall confirm their conformity with requirements of this VDE application guide at least with regard to the properties described in 9.2 to 9.4.	Forms of G.2 & F.3 for PGU, and forms of G.3 & F.4 for integrated NS protection provided.	P
9.2	**Verification of the feed-in power**		**P**
9.2.1	**Verification of the feed-in power** For power generation units, it is sufficient to indicate the maximum active power feed-in.	Maximum active power feed-in is stated.	P
9.2.2	**Verification of the reactive power values** Indication of the maximum reactive powers for inductive and maximum capacitive reactive power extraction as a function of the feed-in active power is required. For this at least the conditions give in 5.7.5 shall be satisfied. For power generations units with a generator directly coupled to the network which, due its very operational principle, cannot control the reactive power and, therefore, uses non-controllable, fixed capacities cosφ shall be reached within 60 seconds. The maximum deviation at cosφ nominal voltage shall be 0.02.	See sub-clause 5.7.5.	P
9.2.3	**Verification of the reactive power transition function** In order to check the standard characteristic curve cos φ (P) given in 5.7.5, the change of the active power mode of operation is to be checked in correspondence to the magnitude of the active power feed-in.	See sub-clause 5.7.5.	P
9.3	**Verification of the network reactions** In order to verity the permissible network reactions specified in 5.4, it is required to submit evidence provided by the manufacturer for the radiated interference produced by the power generation unit.	Complied with sub-clause 5.4.	P
9.4	**Verification of the features of the network and system protection** Compliance with the conditions required by Clause 6 for NS protection for the protection against inadmissible voltage and frequency increase/decrease shall be verified based on measurements.	PGU is evaluated to clause 6 for NS protection by providing forms of F.4 PGU with integrated NS protection, sub-clause 6.4.3 integrated interface switch is checked; sub-clause 6.5.3 islanding detection is verified.	P

VDE-AR-N 4105:2011 in conjunction with E DIN V VDE V 0124-100:2011			
Clause	Requirement - Test	Result - Remark	Verdict
	Annex A: Explanations (informative)		
	Annex B: Connection examples (informative)		
	Annex C: Examples of meter panel configurations (informative)		
	Annex D: Islanding detection (normative)		**P**
D.1	Islanding detection by means of the oscillation circuit test		P
D.2	Islanding detection by three-phase voltage monitoring		N/A
	Annex E: Examples for the connection evaluation of power generation systems (informative)		
	Annex F: Forms (mandatory)		**P**
F.1	Initial start-up protocol – Power generation systems, low voltage		N/A
F.2	Data sheet for power generation systems		N/A
F.3	Requirements for the test report for power generation units		P
F.4	Requirements for the test report for the NS protection		P
	Annex G: Forms (optional) (informative)		
G.1	**Application**		
G.2	**Certificate of conformity for power generation units**		
G.3	**Certificate of conformity of the network and system protection**		

Appended Table - Testing Result

5.7.3.2	Table: Generation management/network security management (the signal of the reference value must be reduced from 100%, 90% …10% P_n)					P
String	1	U_{DC} = Un	360 Vdc	Uac = Un	230 Vac	P = (W)	3000 W

P (W)	P (W)
100%	3003
90%	2699
80%	2399
70%	2099
60%	1798
50%	1497
40%	1195
30%	890
20%	589
10%	269

Supplementary information:

5.7.3.2	Table: Table: Generation management/network security management (the response time over a change in required value of 100% to 30% P_n)						P
String	1	U_{DC} = Un	360 Vdc	Uac = Un	230 Vac	P = (W)	3000 W

P (W)	Setting value	Tripping value	Response time (sec)
Power change from 100% to 30%	30% P_n	900	40

Supplementary information:

5.7.3.3	Table: Active poewr output feed-in at overfrequency (for model ES 3300)									P
String	1	U_{DC} = Un	360	Vdc	Uac = Un	230	Vac	**P =0.8 P_n= (W)**	2400	W
Udc (Vdc)		F (Hz)			F (Hz)			P (W)	time	
360		a) 50Hz (± 0.01Hz)			50.004			2397.3		
360		b) 50.25Hz (± 0.05Hz)			50.252			2298.2		
360		c) 50.7Hz (± 0.1Hz)			50.704			1875.6		
360		d) 51.15Hz (± 0.05Hz)			51.153			1443.1		
360		e) 50.75Hz (± 0.10Hz)			50.753			1841.6		
360		f) 50.25Hz (± 0.05Hz)			50.254			2065.7		
360		g) 50Hz (± 0.01Hz)			50.002			2321.3		
360		h) 51.65Hz (± 0.05Hz)			51.659				111 ms	
360		i) 50Hz (+0.06 ~ +0.1Hz)			50.083				180s	
360		j) 50Hz (± 0.01Hz)			50.003			2400.9		
Supplementary information: **the test is carried out for 80% P_n**										
String	1	U_{DC} = Un	360	Vdc	Uac = Un	230	Vac	**P =0.5 P_n= (W)**	1500	W
Udc (Vdc)		F (Hz)			F (Hz)			P (W)	Time	
360		a) 50Hz (± 0.01Hz)			50.004			1499.7		
360		b) 50.25Hz (± 0.05Hz)			50.252			1398.8		
360		c) 50.7Hz (± 0.1Hz)			50.704			1192.5		
360		d) 51.15Hz (± 0.05Hz)			51.153			860.09		
360		e) 50.75Hz (± 0.10Hz)			50.753			1150.5		
360		f) 50.25Hz (± 0.05Hz)			50.254			1419.1		
360		g) 50Hz (± 0.01Hz)			50.002			1445.3		
360		h) 51.65Hz (± 0.05Hz)			51.659				112 ms	
360		i) 50Hz (+0.06 ~ +0.1Hz)			50.083				180s	
360		j) 50Hz (± 0.01Hz)			50.003			2398		
Supplementary information: **the test is carried out for 50% P_n**										

6.1	TABLE: General requirements	P

Design of functional sefaty:

The following comments were based on the documents provided by the manufacturer:

- The inverter has no galvanic isolation between DC and AC circuits.
- The automatic switch is integrated in the control of the inverter and considered as homogeneous redundant processor system. The master CPU (MCPU), TI brand, model TMS320LF2407A, the slave CPU (SCPU), Microchip brand, model PIC18F252. Each processor controls a relay individually.
- The relay is controlled by a transistor circuit driven by the MCPU or SCPU respectively. The control power 12Vdc is derived from DC input of PV through a switched mode power supply before the ac grid is connected.
- The function of each relay is checked by a switching-on process. The checking is accomplished by a switching on and off of each relay to measure the existing voltage.
- Each CPU measures voltage, frequency, DC injection, impedance and fault current (RCMU) independently. In case any CPU detects the parameters exceeding the limit, the CPU switches off the relay and communicate with the other CPU to switch off the other relay.
- The CPUs exchange their measured data through internal circuits (voltage, frequency, fault current, dc component and impedance) and compare their measured data with other CPU. A watching dog program is monitoring both MCPU and SCPU whether they are working properly or not.
- If measured data exceeding the limit, both CPUs switch off the relays and the fault displayed on the LCD display.
- The parameters for the monitoring and protection function are stored in an EEPROM (U3). During start of the device, the parameters in the EEPROM are read by the MCPU and then transferred to the SCPU. Once a fault occurs, the device will not be switched on.
- The user can not change the parameters.

6.1	TABLE: General requirements						P
String	1	U_{DC} = Un	360 Vdc	Uac = Un	230 Vac	P = (W)	—

Component No.	Fault	Observation
U14C (pin 9 &10), control voltage	Shorted	Observation: unit shut down, LCD monitor show the error code fro AL14.
UL14D (pin 12&13), control voltage sensor	Shorted	Observation: Unit shut down, LCD monitor show the error code for AL 14(Utility over-voltage)
U14D (pin 12& 13), control frequency sensor	shorted	ObservationL Unit shut down, LCD monitor show the error code for AL14.
U10A (pin 2& 3), control d.c current sensor	shorted	Obseravtion: unit shut sown, LCD monitor show the error code for ER09
U10D (pin 12&13), control d.c. current sensor	shorted	ObservationL Unit shut down, LCD monitor show the error code for ER09.
U9D (pin 12, 13), control RCMU sensor	shortd	ObsevationL: Unit shut down, LCD monitor show the error code for AL10.

Supplementary information:

6.5.3	TABLE: Islanding detection				P
Q =	2		Klurfactor =	0.82%	
L =	112 mH		C =	90 uF	
P = 1.0 P_N = (W)	3000W	P = 0.5 P_N = (W)	1500W	P = 0.25 P_N = (W)	750W
L =6000Var	Cut-off time (ms)	L =3000Var	Cut-off time	L =1500Var	Cut-off time
95%	80.2 ms	95%	51.2 ms	95%	57.6 ms
96%	87.6 ms	96%	53.6 ms	96%	46.8 ms
97%	108 ms	97%	57.6 ms	97%	60.0 ms
98%	112 ms	98%	60.8 ms	98%	46.0 ms
99%	174 ms	99%	52.6 ms	99%	51.0 ms
100%	111 ms	100%	61.0 ms	100%	16.4 ms
101%	132 ms	101%	70.2 ms	101%	49.2 ms
102%	83.6 ms	102%	65.8 ms	102%	53.0 ms
103%	127 ms	103%	54.2 ms	103%	61.8 ms
104%	75.4 ms	104%	56.0 ms	104%	27.4 ms
105%	70.0 ms	105%	62.2 ms	105%	27.6 ms
Supplementary information:					

F.3 Requirements for the test report for power generation units

Extract from test report for unit certificate: TP12030011-ETS										
Determination of electrical properties										
Model/ type reference: ES 2200								**Manufacturer's data**		
System manufacturer:								**Model/ type reference:** ES 2200		
								Active power: 2 kW		
								Rated voltage: 230 V		
Measuring period: from January 9 to February 3, 2012										
Active power: P_{Emax} 2 kW										
Reactive power reference (for model ES 2200)										
Active power P/P_n(%)	10	20	30	40	50	60	70	80	90	100
Max. possible cos φ underexcited	0.890	0.893	0.893	0.892	0.893	0.892	0.893	0.891	0.894	0.895
Max. possible cos φ overexcited	0.861	0.896	0.905	0.902	0.906	0.905	0.907	0.908	0.905	0.902
Compliance of required displacement factor cos φ (for model ES 2200)										
Default in system control	0.90 over	0.92 over	0.94 over	0.96 over	0.98 over	1.00	0.98 under	0.96 under	0.94 under	0.92 under	0.90 under
Measured value at PGU terminals	0.901	0.919	0.941	0.956	0.981	0.999	0.980	0.961	0.940	0.920	0.902
Reactive power transfer function – Standard-cos φ-(P)-characteristic (for model ES 2200)										
Active power P/P_n (%)	10	20	30	40	50	60	70	80	90	100
cos φ	0.866	0.903	0.904	0.904	0.905	0.949	0.994	0.940	0.896	0.895
Conform to Standard-cos φ-(P)-characteristic										

Switching actions (for model ES 2200)		
Making operation without default (of primary energy carrier)	k_i	0.362
Worst case at switch over of generator sections	k_i	—
Making operation at reference conditions (of primary energy carrier)	k_i	0.087
Breaking operation at nominal power	k_i	0.753
Worst-case value of all switching operations	k_{imax}	0.753

Flicker (for model ES 2200)	
Angle of network impedance ψ_k:	32°
Coefficient of system flicker c_{ψ}:	P_{st}= 0.223 ; P_{lt}= 0.223

Harmonics (for model ES 2200)											
Active power P/P_n (%)	0	10	20	30	40	50	60	70	80	90	100
Harmonic number	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2	0.000	0.0909	0.1050	0.1062	0.1105	0.1172	0.1349	0.1349	0.1312	0.1297	0.013
3	0.000	0.5028	0.3934	0.2814	0.2228	0.1776	0.1379	0.1379	0.1175	0.1099	0.053
4	0.000	0.0220	0.0183	0.0116	0.0092	0.014	0.0201	0.0201	0.0214	0.0214	0.07
5	0.000	0.0394	0.1486	0.0986	0.05	0.0104	0.0507	0.0507	0.0717	0.0885	0.078
6	0.000	0.0057	0.0153	0.0162	0.0128	0.0159	0.0238	0.0238	0.0244	0.0244	0.005
7	0.000	0.0712	0.0537	0.108	0.1056	0.0818	0.0409	0.0409	0.0229	0.0153	0.017
8	0.000	0.0110	0.0113	0.0131	0.0153	0.014	0.022	0.022	0.0214	0.0244	0.007
9	0.000	0.0398	0.0513	0.0378	0.0629	0.0702	0.0531	0.0531	0.0427	0.0336	0.016
10	0.000	0.0070	0.0092	0.0125	0.0214	0.025	0.0238	0.0238	0.0229	0.0198	0.005
11	0.000	0.0195	0.0412	0.032	0.0165	0.0427	0.0684	0.0684	0.0641	0.0702	0.053
12	0.000	0.0065	0.0070	0.0089	0.0146	0.022	0.0256	0.0256	0.0244	0.0229	0.009
13	0.000	0.0132	0.0128	0.0354	0.0311	0.0293	0.0378	0.0378	0.0458	0.0412	0.059
14	0.000	0.0066	0.0125	0.0186	0.0177	0.0165	0.0275	0.0275	0.032	0.0259	0.007
15	0.000	0.0115	0.0214	0.0201	0.0287	0.014	0.0232	0.0232	0.0351	0.0473	0.017
16	0.000	0.0062	0.0098	0.0107	0.0159	0.0177	0.0159	0.0159	0.0137	0.0153	0.003
17	0.000	0.0074	0.0153	0.0143	0.0171	0.0244	0.0146	0.0146	0.0168	0.0214	0.019
18	0.000	0.0050	0.0092	0.0125	0.0122	0.0134	0.0146	0.0146	0.0153	0.0198	0.004
19	0.000	0.0071	0.0134	0.0146	0.0116	0.0171	0.0171	0.0171	0.0214	0.0244	0.008
20	0.000	0.0052	0.0098	0.0119	0.0104	0.0122	0.0171	0.0171	0.0137	0.0137	0.003
21	0.000	0.0089	0.0082	0.0153	0.0159	0.0153	0.0214	0.0214	0.0198	0.0137	0.008
22	0.000	0.0045	0.0101	0.0092	0.0098	0.0128	0.014	0.014	0.0137	0.0137	0.007
23	0.000	0.0046	0.0143	0.0128	0.0116	0.0104	0.0287	0.0287	0.0259	0.0214	0.018
24	0.000	0.0068	0.0098	0.0122	0.0146	0.014	0.0214	0.0214	0.0214	0.0198	0.004
25	0.000	0.0081	0.0143	0.0134	0.0165	0.0201	0.0238	0.0238	0.0336	0.0336	0.030
26	0.000	0.0115	0.0186	0.0165	0.0208	0.0232	0.0269	0.0269	0.029	0.029	0.013
27	0.000	0.0111	0.0098	0.0143	0.0165	0.0226	0.0195	0.0195	0.0244	0.029	0.038
28	0.000	0.0175	0.0287	0.0336	0.0354	0.0378	0.0488	0.0488	0.0488	0.0534	0.011
29	0.000	0.0322	0.0620	0.0726	0.0757	0.0812	0.0885	0.0885	0.0854	0.0946	0.020
30	0.000	0.0258	0.0467	0.0507	0.0531	0.0537	0.0629	0.0629	0.061	0.061	0.013
31	0.000	0.0088	0.0174	0.0244	0.0262	0.0281	0.0348	0.0348	0.0336	0.0397	0.026
32	0.000	0.0118	0.0089	0.0128	0.014	0.0146	0.0214	0.0214	0.0214	0.0244	0.004
33	0.000	0.0082	0.0122	0.0146	0.0159	0.0208	0.0323	0.0323	0.029	0.032	0.016
34	0.000	0.0094	0.0095	0.0119	0.0128	0.0159	0.0214	0.0214	0.0214	0.0214	0.008
35	0.000	0.0088	0.0134	0.0134	0.0116	0.0128	0.0183	0.0183	0.0198	0.0153	0.006
36	0.000	0.0073	0.0101	0.0107	0.014	0.0177	0.0159	0.0159	0.0168	0.0168	0.005
37	0.000	0.0072	0.0137	0.0146	0.0134	0.0214	0.0128	0.0128	0.0229	0.0366	0.012
38	0.000	0.0079	0.0082	0.0165	0.0171	0.0153	0.0208	0.0208	0.0229	0.0198	0.011
39	0.000	0.0082	0.0131	0.0162	0.0159	0.0165	0.0262	0.0262	0.0275	0.0275	0.011
40	0.000	0.0077	0.0095	0.0134	0.0214	0.0238	0.0275	0.0275	0.0229	0.0229	0.013

Sub-harmonics (for model ES 2200)											
Active power P/P_n (%)	0	10	20	30	40	50	60	70	80	90	100
Frequency (Hz)	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0.000	0.017	0.017	0.021	0.024	0.028	0.037	0.034	0.050	0.066	0.055
125	0.000	0.008	0.007	0.006	0.009	0.010	0.013	0.013	0.018	0.016	0.018
175	0.000	0.008	0.006	0.008	0.007	0.008	0.012	0.010	0.011	0.010	0.010
225	0.000	0.004	0.008	0.007	0.007	0.008	0.009	0.009	0.011	0.014	0.013
275	0.000	0.004	0.005	0.005	0.007	0.006	0.007	0.008	0.011	0.006	0.012
325	0.000	0.004	0.005	0.007	0.005	0.005	0.006	0.010	0.009	0.007	0.009
375	0.000	0.004	0.006	0.008	0.005	0.006	0.008	0.009	0.011	0.011	0.014
425	0.000	0.005	0.006	0.006	0.009	0.007	0.012	0.011	0.009	0.011	0.012
475	0.000	0.005	0.007	0.006	0.009	0.011	0.007	0.010	0.011	0.015	0.014
525	0.000	0.006	0.006	0.008	0.007	0.012	0.009	0.011	0.012	0.013	0.016
575	0.000	0.003	0.008	0.010	0.008	0.008	0.012	0.010	0.014	0.010	0.013
625	0.000	0.004	0.005	0.005	0.008	0.006	0.010	0.010	0.014	0.014	0.014
675	0.000	0.004	0.005	0.007	0.008	0.008	0.007	0.011	0.013	0.012	0.014
725	0.000	0.003	0.006	0.007	0.006	0.009	0.006	0.010	0.012	0.016	0.013
775	0.000	0.004	0.005	0.004	0.008	0.008	0.008	0.009	0.011	0.008	0.013
825	0.000	0.003	0.004	0.008	0.006	0.010	0.007	0.009	0.009	0.011	0.017
875	0.000	0.005	0.007	0.009	0.011	0.013	0.013	0.011	0.011	0.012	0.016
925	0.000	0.007	0.006	0.006	0.008	0.011	0.010	0.011	0.008	0.011	0.013
975	0.000	0.007	0.009	0.009	0.010	0.011	0.013	0.015	0.009	0.011	0.015
1025	0.000	0.004	0.005	0.008	0.006	0.011	0.010	0.011	0.007	0.015	0.017
1075	0.000	0.005	0.006	0.008	0.012	0.013	0.012	0.012	0.014	0.013	0.010
1125	0.000	0.005	0.010	0.009	0.008	0.006	0.010	0.011	0.010	0.016	0.014
1175	0.000	0.005	0.009	0.010	0.005	0.009	0.009	0.011	0.011	0.016	0.013
1225	0.000	0.006	0.011	0.013	0.010	0.011	0.013	0.015	0.013	0.018	0.019
1275	0.000	0.007	0.009	0.016	0.015	0.014	0.017	0.017	0.019	0.017	0.021
1325	0.000	0.006	0.014	0.016	0.012	0.012	0.015	0.015	0.019	0.020	0.027
1375	0.000	0.013	0.010	0.013	0.014	0.016	0.014	0.020	0.017	0.017	0.024
1425	0.000	0.019	0.022	0.022	0.034	0.032	0.038	0.041	0.038	0.038	0.033
1475	0.000	0.045	0.042	0.051	0.068	0.064	0.077	0.074	0.062	0.064	0.074
1525	0.000	0.027	0.033	0.039	0.042	0.041	0.046	0.040	0.046	0.043	0.053
1575	0.000	0.010	0.008	0.019	0.014	0.021	0.023	0.020	0.016	0.019	0.027
1625	0.000	0.006	0.008	0.012	0.015	0.015	0.018	0.017	0.020	0.025	0.030
1675	0.000	0.009	0.009	0.010	0.019	0.018	0.023	0.021	0.022	0.021	0.031
1725	0.000	0.009	0.011	0.018	0.021	0.012	0.018	0.024	0.025	0.022	0.026
1775	0.000	0.005	0.012	0.017	0.017	0.010	0.015	0.013	0.018	0.021	0.024
1825	0.000	0.012	0.012	0.012	0.013	0.016	0.016	0.029	0.020	0.024	0.028
1875	0.000	0.010	0.013	0.016	0.012	0.014	0.022	0.023	0.025	0.025	0.026
1925	0.000	0.008	0.013	0.010	0.022	0.015	0.017	0.018	0.021	0.026	0.022
1975	0.000	0.009	0.012	0.016	0.019	0.019	0.024	0.022	0.021	0.025	0.030

Higher frequencies (for model ES 2200)											
Active power P/P_n (%)	0	10	20	30	40	50	60	70	80	90	100
Frequency (kHz)	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2,1	0.000	0.178	0.412	0.140	0.080	0.098	0.095	0.273	0.042	0.114	0.050
2,3	0.000	1.218	0.577	0.380	0.165	0.192	0.032	0.228	0.068	0.008	0.129
2,5	0.000	0.262	0.288	0.065	0.124	0.105	0.111	0.063	0.121	0.073	0.020
2,7	0.000	0.384	0.207	0.216	0.110	0.068	0.086	0.107	0.010	0.136	0.101
2,9	0.000	1.388	0.358	0.275	0.092	0.145	0.042	0.111	0.176	0.017	0.070
3,1	0.000	0.573	0.051	0.249	0.038	0.066	0.094	0.070	0.118	0.033	0.031
3,3	0.000	0.241	0.263	0.192	0.087	0.135	0.104	0.033	0.061	0.046	0.100
3,5	0.000	0.397	0.251	0.185	0.069	0.085	0.075	0.063	0.055	0.072	0.016
3,7	0.000	0.463	0.137	0.065	0.074	0.089	0.115	0.083	0.023	0.028	0.052
3,9	0.000	0.290	0.522	0.170	0.194	0.096	0.102	0.152	0.069	0.072	0.089
4,1	0.000	0.316	0.114	0.056	0.104	0.122	0.070	0.078	0.101	0.142	0.028
4,3	0.000	0.290	0.126	0.139	0.169	0.042	0.116	0.115	0.032	0.125	0.124
4,5	0.000	0.308	0.145	0.020	0.099	0.085	0.101	0.021	0.067	0.021	0.082
4,7	0.000	0.151	0.372	0.078	0.026	0.095	0.078	0.026	0.062	0.050	0.068
4,9	0.000	0.048	0.087	0.012	0.130	0.026	0.049	0.050	0.060	0.025	0.077
5,1	0.000	0.442	0.217	0.177	0.150	0.160	0.092	0.118	0.074	0.036	0.049
5,3	0.000	0.460	0.268	0.162	0.266	0.205	0.147	0.180	0.184	0.093	0.101
5,5	0.000	0.024	0.098	0.050	0.012	0.035	0.033	0.013	0.050	0.026	0.024
5,7	0.000	0.136	0.042	0.025	0.019	0.022	0.016	0.012	0.004	0.021	0.022
5,9	0.000	0.020	0.057	0.015	0.021	0.016	0.023	0.011	0.012	0.032	0.025
6,1	0.000	0.058	0.030	0.032	0.031	0.007	0.016	0.004	0.010	0.021	0.019
6,3	0.000	0.050	0.035	0.012	0.021	0.012	0.017	0.011	0.014	0.001	0.004
6,5	0.000	0.056	0.010	0.019	0.014	0.013	0.020	0.006	0.001	0.004	0.006
6,7	0.000	0.027	0.033	0.018	0.005	0.010	0.005	0.004	0.006	0.008	0.002
6,9	0.000	0.064	0.032	0.015	0.010	0.007	0.005	0.011	0.002	0.005	0.007
7,1	0.000	0.034	0.034	0.018	0.021	0.011	0.006	0.008	0.013	0.008	0.010
7,3	0.000	0.063	0.025	0.015	0.004	0.002	0.009	0.011	0.006	0.004	0.002
7,5	0.000	0.083	0.026	0.013	0.011	0.006	0.006	0.008	0.003	0.013	0.008
7,7	0.000	0.058	0.010	0.009	0.022	0.002	0.008	0.003	0.002	0.007	0.006
7,9	0.000	0.048	0.016	0.010	0.015	0.004	0.004	0.006	0.009	0.007	0.002
8,1	0.000	0.035	0.017	0.005	0.010	0.008	0.009	0.005	0.007	0.002	0.005
8,3	0.000	0.011	0.011	0.006	0.006	0.007	0.006	0.003	0.004	0.004	0.002
8,5	0.000	0.034	0.008	0.005	0.007	0.010	0.005	0.002	0.004	0.002	0.005
8,7	0.000	0.025	0.012	0.012	0.002	0.005	0.008	0.004	0.004	0.003	0.002
8,9	0.000	0.038	0.011	0.005	0.008	0.009	0.005	0.008	0.003	0.004	0.002

F.3 Requirements for the test report for power generation units

Extract from test report for unit certificate: TP12030011-ETS										
Determination of electrical properties										
Model/ type reference:: ES 3300						**Manufacturer's data**				
System manufacturer:						**Model/ type reference:**: ES 3300				
						Active power: 3 kW				
						Rated voltage: 230V				
Measuring period: from January 9 to February 3, 2012										
Active power: P_{Emax} 3 kW										
Reactive power reference (for model ES 3300)										
Active power P/P_n(%)	10	20	30	40	50	60	70	80	90	100
Max. possible cos φ underexcited	0.890	0.893	0.893	0.892	0.893	0.892	0.893	0.891	0.894	0.895
Max. possible cos φ overexcited	0.861	0.896	0.905	0.902	0.906	0.905	0.907	0.908	0.905	0.902
Compliance of required displacement factor cos φ (for model ES 3300)										
Default in system control	0.90 over	0.92 over	0.94 over	0.96 over	0.98 over	1.00	0.98 under	0.96 under	0.94 under	0.92 under	0.90 under
Measured value at PGU terminals	0.901	0.919	0.941	0.956	0.981	0.999	0.980	0.961	0.940	0.920	0.902
Reactive power transfer function – Standard-cos φ-(P)-characteristic (for model ES 3300)										
Active power P/P_n (%)	10	20	30	40	50	60	70	80	90	100
cos φ	0.866	0.903	0.904	0.904	0.905	0.949	0.994	0.940	0.896	0.895
Conform to Standard-cos φ-(P)-characteristic										
Switching actions (for model ES 3300)										
Making operation without default (of primary energy carrier)					k_i			0.362		
Worst case at switch over of generator sections					k_i			—		
Making operation at reference conditions (of primary energy carrier)					k_i			0.087		
Breaking operation at nominal power					k_i			0.753		
Worst-case value of all switching operations					k_{imax}			0.753		
Flicker (for model ES 3300)										
Angle of network impedance $\psi_{k:}$					32°					
Coefficient of system flicker $c_{\psi:}$					P_{st}= 0.223 ; P_{lt}= 0.223					

Harmonics (for model ES 3300)											
Active power P/P_n (%)	0	10	20	30	40	50	60	70	80	90	100
Harmonic number	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2	0.000	0.1093	0.1096	0.116	0.1221	0.1251	0.1343	0.1373	0.2243	0.1373	0.013
3	0.000	0.4694	0.2841	0.1923	0.1147	0.1208	0.1022	0.1038	0.1938	0.1038	0.053
4	0.000	0.0155	0.0113	0.0116	0.0146	0.0189	0.0229	0.0275	0.0365	0.0275	0.07
5	0.000	0.1294	0.1004	0.0232	0.0244	0.0616	0.090	0.1083	0.1993	0.1083	0.078
6	0.000	0.0145	0.0168	0.0165	0.0171	0.0232	0.0275	0.029	0.059	0.029	0.005
7	0.000	0.0466	0.1053	0.0897	0.0714	0.0323	0.0153	0.0214	0.0454	0.0214	0.017
8	0.000	0.0128	0.0128	0.0128	0.0134	0.0201	0.0244	0.0275	0.0275	0.0275	0.007
9	0.000	0.0516	0.0369	0.0714	0.0659	0.0464	0.032	0.029	0.029	0.029	0.016
10	0.000	0.0077	0.0131	0.0232	0.0226	0.0238	0.0214	0.0198	0.0198	0.0198	0.005
11	0.000	0.0326	0.0323	0.0311	0.0537	0.0659	0.0641	0.0656	0.0656	0.0656	0.053
12	0.000	0.009	0.0085	0.0195	0.022	0.0256	0.0259	0.0244	0.0244	0.0244	0.009
13	0.000	0.0137	0.0339	0.0269	0.0354	0.0439	0.0412	0.0397	0.0397	0.0397	0.059
14	0.000	0.0093	0.0192	0.0177	0.0165	0.025	0.0305	0.0366	0.0366	0.0366	0.007
15	0.000	0.0128	0.0201	0.0226	0.0128	0.033	0.0473	0.0488	0.0488	0.0488	0.017
16	0.000	0.0107	0.0098	0.0159	0.0189	0.0171	0.0137	0.0168	0.0168	0.0168	0.003
17	0.000	0.0159	0.015	0.0232	0.0201	0.0159	0.0229	0.032	0.032	0.032	0.019
18	0.000	0.0073	0.0125	0.0153	0.0128	0.0159	0.0198	0.0198	0.0198	0.0198	0.004
19	0.000	0.0104	0.0153	0.0159	0.0281	0.0165	0.0259	0.0275	0.0275	0.0275	0.008
20	0.000	0.0078	0.0122	0.0104	0.0146	0.0128	0.0122	0.0153	0.0153	0.0153	0.003
21	0.000	0.0082	0.015	0.0159	0.0226	0.0208	0.0122	0.0122	0.0122	0.0122	0.008
22	0.000	0.0088	0.0101	0.0104	0.0171	0.0159	0.0137	0.0137	0.0137	0.0137	0.007
23	0.000	0.010	0.014	0.0116	0.0159	0.0305	0.0183	0.0137	0.0137	0.0137	0.018
24	0.000	0.0059	0.0122	0.0153	0.014	0.0238	0.0229	0.0183	0.0183	0.0183	0.004
25	0.000	0.0142	0.0134	0.0226	0.0226	0.0269	0.0351	0.0305	0.0305	0.0305	0.030
26	0.000	0.0178	0.018	0.0244	0.0201	0.025	0.0305	0.0305	0.0305	0.0305	0.013
27	0.000	0.0078	0.0143	0.0208	0.0317	0.0232	0.0305	0.0336	0.0336	0.0336	0.038
28	0.000	0.0256	0.0348	0.0378	0.0574	0.0482	0.0549	0.0626	0.0626	0.0626	0.011
29	0.000	0.0525	0.0726	0.0787	0.1099	0.0891	0.0946	0.0977	0.0977	0.0977	0.020
30	0.000	0.040	0.0531	0.0525	0.0623	0.061	0.0626	0.0656	0.0656	0.0656	0.013
31	0.000	0.0118	0.025	0.0275	0.0421	0.0342	0.0412	0.0397	0.0397	0.0397	0.026
32	0.000	0.0078	0.0128	0.0153	0.0232	0.0201	0.0229	0.032	0.032	0.032	0.004
33	0.000	0.0107	0.014	0.0214	0.0275	0.0323	0.0336	0.0427	0.0427	0.0427	0.016
34	0.000	0.011	0.0113	0.0153	0.0183	0.0208	0.0214	0.0244	0.0244	0.0244	0.008
35	0.000	0.0111	0.0128	0.0122	0.0159	0.022	0.0168	0.0244	0.0244	0.0244	0.006
36	0.000	0.0094	0.0101	0.0122	0.0177	0.0183	0.0183	0.0183	0.0183	0.0183	0.005
37	0.000	0.0121	0.014	0.0153	0.0262	0.0171	0.0351	0.032	0.032	0.032	0.012
38	0.000	0.009	0.0156	0.0165	0.0189	0.0244	0.0198	0.0229	0.0229	0.0229	0.011
39	0.000	0.0076	0.0143	0.025	0.0177	0.0281	0.0259	0.0275	0.0275	0.0275	0.011
40	0.000	0.0073	0.0131	0.0201	0.0226	0.025	0.0229	0.0214	0.0214	0.0214	0.013

Sub-harmonics (for model ES 3300)											
Active power P/P_n (%)	0	10	20	30	40	50	60	70	80	90	100
Frequency (Hz)	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0.000	0.014	0.020	0.034	0.036	0.037	0.048	0.051	0.064	0.064	0.087
125	0.000	0.004	0.008	0.009	0.014	0.016	0.017	0.019	0.024	0.025	0.035
175	0.000	0.007	0.008	0.009	0.016	0.014	0.013	0.013	0.015	0.019	0.020
225	0.000	0.006	0.008	0.010	0.006	0.010	0.017	0.013	0.017	0.019	0.016
275	0.000	0.004	0.006	0.006	0.008	0.009	0.008	0.008	0.010	0.012	0.009
325	0.000	0.004	0.006	0.006	0.011	0.015	0.010	0.012	0.007	0.016	0.012
375	0.000	0.005	0.006	0.008	0.010	0.010	0.011	0.010	0.013	0.015	0.019
425	0.000	0.005	0.008	0.008	0.011	0.009	0.009	0.009	0.009	0.011	0.016
475	0.000	0.005	0.006	0.005	0.012	0.012	0.014	0.012	0.015	0.010	0.017
525	0.000	0.005	0.014	0.006	0.015	0.014	0.012	0.009	0.019	0.016	0.019
575	0.000	0.005	0.008	0.008	0.010	0.014	0.011	0.014	0.015	0.014	0.020
625	0.000	0.005	0.006	0.006	0.010	0.011	0.012	0.016	0.020	0.015	0.015
675	0.000	0.007	0.006	0.011	0.011	0.010	0.014	0.013	0.011	0.021	0.017
725	0.000	0.004	0.007	0.006	0.009	0.014	0.012	0.012	0.011	0.022	0.020
775	0.000	0.005	0.007	0.007	0.010	0.012	0.009	0.010	0.013	0.012	0.014
825	0.000	0.004	0.009	0.005	0.011	0.014	0.012	0.009	0.011	0.015	0.013
875	0.000	0.005	0.008	0.010	0.016	0.018	0.012	0.010	0.019	0.017	0.014
925	0.000	0.006	0.010	0.008	0.013	0.012	0.013	0.010	0.009	0.020	0.019
975	0.000	0.007	0.007	0.011	0.009	0.012	0.009	0.009	0.014	0.016	0.018
1025	0.000	0.007	0.008	0.006	0.011	0.017	0.013	0.013	0.014	0.017	0.020
1075	0.000	0.007	0.011	0.011	0.010	0.007	0.013	0.015	0.012	0.015	0.016
1125	0.000	0.006	0.008	0.010	0.008	0.009	0.015	0.012	0.016	0.015	0.027
1175	0.000	0.007	0.011	0.004	0.017	0.014	0.012	0.015	0.010	0.020	0.019
1225	0.000	0.007	0.014	0.012	0.011	0.014	0.021	0.022	0.019	0.016	0.016
1275	0.000	0.010	0.012	0.012	0.018	0.017	0.021	0.022	0.021	0.017	0.019
1325	0.000	0.008	0.013	0.009	0.013	0.013	0.020	0.025	0.024	0.012	0.024
1375	0.000	0.010	0.012	0.009	0.021	0.020	0.015	0.017	0.022	0.023	0.026
1425	0.000	0.023	0.023	0.032	0.026	0.033	0.042	0.039	0.039	0.054	0.054
1475	0.000	0.045	0.051	0.067	0.060	0.079	0.082	0.076	0.065	0.090	0.083
1525	0.000	0.027	0.035	0.039	0.038	0.039	0.040	0.045	0.049	0.047	0.057
1575	0.000	0.010	0.016	0.015	0.020	0.023	0.020	0.027	0.027	0.032	0.031
1625	0.000	0.008	0.012	0.014	0.015	0.014	0.022	0.021	0.021	0.033	0.034
1675	0.000	0.012	0.013	0.017	0.016	0.019	0.025	0.026	0.029	0.042	0.036
1725	0.000	0.006	0.012	0.016	0.020	0.015	0.026	0.018	0.031	0.031	0.048
1775	0.000	0.010	0.013	0.014	0.013	0.016	0.016	0.017	0.021	0.024	0.023
1825	0.000	0.009	0.0014	0.016	0.014	0.010	0.023	0.019	0.028	0.021	0.033
1875	0.000	0.006	0.0017	0.014	0.015	0.018	0.016	0.020	0.024	0.023	0.028
1925	0.000	0.010	0.0017	0.015	0.018	0.016	0.017	0.027	0.032	0.037	0.040
1975	0.000	0.014	0.0018	0.018	0.014	0.023	0.021	0.021	0.022	0.028	0.035

Higher frequencies (for model ES 3300)											
Active power P/P_n (%)	0	10	20	30	40	50	60	70	80	90	100
Frequency (kHz)	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2,1	0.000	0.288	0.280	0.123	0.088	0.141	0.177	0.161	0.193	0.225	0.126
2,3	0.000	0.940	0.511	0.339	0.263	0.185	0.099	0.365	0.439	0.227	0.118
2,5	0.000	0.163	0.247	0.176	0.014	0.082	0.088	0.110	0.073	0.140	0.155
2,7	0.000	0.413	0.059	0.095	0.094	0.206	0.039	0.089	0.047	0.067	0.033
2,9	0.000	1.103	0.293	0.219	0.163	0.126	0.113	0.064	0.159	0.062	0.108
3,1	0.000	0.031	0.104	0.106	0.118	0.032	0.065	0.055	0.057	0.057	0.078
3,3	0.000	0.097	0.122	0.087	0.043	0.039	0.039	0.160	0.056	0.045	0.071
3,5	0.000	0.169	0.177	0.060	0.065	0.065	0.057	0.042	0.035	0.081	0.044
3,7	0.000	0.182	0.075	0.114	0.010	0.047	0.081	0.016	0.087	0.015	0.012
3,9	0.000	0.246	0.114	0.147	0.067	0.048	0.026	0.058	0.037	0.053	0.066
4,1	0.000	0.324	0.089	0.125	0.045	0.058	0.083	0.124	0.017	0.058	0.037
4,3	0.000	0.189	0.089	0.114	0.032	0.022	0.080	0.058	0.025	0.040	0.089
4,5	0.000	0.136	0.131	0.145	0.054	0.071	0.037	0.031	0.039	0.040	0.106
4,7	0.000	0.314	0.053	0.101	0.077	0.128	0.042	0.099	0.018	0.056	0.013
4,9	0.000	0.262	0.101	0.043	0.088	0.026	0.002	0.035	0.030	0.008	0.068
5,1	0.000	0.370	0.162	0.164	0.126	0.359	0.021	0.045	0.047	0.033	0.016
5,3	0.000	0.385	0.116	0.259	0.212	0.131	0.128	0.132	0.192	0.158	0.143
5,5	0.000	0.107	0.058	0.043	0.031	0.020	0.033	0.026	0.023	0.022	0.011
5,7	0.000	0.075	0.027	0.020	0.014	0.014	0.028	0.024	0.009	0.013	0.007
5,9	0.000	0.109	0.043	0.014	0.009	0.018	0.023	0.018	0.009	0.011	0.013
6,1	0.000	0.067	0.032	0.020	0.004	0.008	0.010	0.019	0.007	0.006	0.017
6,3	0.000	0.040	0.014	0.016	0.011	0.005	0.006	0.006	0.011	0.004	0.008
6,5	0.000	0.027	0.023	0.011	0.009	0.014	0.004	0.002	0.001	0.009	0.009
6,7	0.000	0.045	0.013	0.006	0.007	0.005	0.009	0.009	0.015	0.005	0.002
6,9	0.000	0.032	0.021	0.009	0.003	0.004	0.013	0.003	0.004	0.005	0.003
7,1	0.000	0.032	0.044	0.032	0.008	0.012	0.016	0.010	0.007	0.006	0.006
7,3	0.000	0.021	0.007	0.010	0.007	0.006	0.004	0.003	0.010	0.004	0.003
7,5	0.000	0.041	0.018	0.007	0.003	0.010	0.012	0.011	0.009	0.007	0.006
7,7	0.000	0.016	0.013	0.005	0.004	0.004	0.006	0.001	0.002	0.007	0.002
7,9	0.000	0.016	0.015	0.005	0.006	0.004	0.006	0.005	0.003	0.005	0.003
8,1	0.000	0.028	0.014	0.017	0.009	0.004	0.008	0.004	0.005	0.006	0.005
8,3	0.000	0.022	0.008	0.007	0.002	0.002	0.001	0.002	0.003	0.002	0.002
8,5	0.000	0.018	0.002	0.007	0.003	0.001	0.002	0.003	0.001	0.002	0.001
8,7	0.000	0.012	0.015	0.005	0.005	0.004	0.005	0.002	0.005	0.002	0.002
8,9	0.000	0.026	0.006	0.008	0.004	0.002	0.007	0.006	0.003	0.006	0.004

F.4 Requirements for the test report for the NS protection

Extract from test report for unit certificate: TP12030011-ETS	
Determination of electrical properties	
☒ NS protection as integrated NS protection	
Type of NS protection: Integrated part of ES 2200 and ES 3300	**Other manufacturer's data**
Software/ firmware version: PV000002	**Assigned to PGU type:** ES 2200, ES 3300
Manufacturer:	**Integrated interface switch** **Type of switching equipment 1:** SONG CHUAN, type 841-P-2A-C-H (250Vac, 25A)
Measuring period: from January 9 to February 3, 2012	

Protection function	Setting value	Tripping value (Vac)			Break time (ms)		
		1st	2nd	3rd	1st	2nd	3rd
Voltage drop protection *U* <	0.77 U_n	161.3Vac	161.3Vac	161.3Vac	89 ms	97 ms	85 ms
Voltage drop protection *U* <	0.8 U_n	183.4Vac	183.4Vac	183.4Vac	127 ms	126 ms	121 ms
Rise-in-voltage protection *U* >	1.1 U_n	253.8Vac	253.8Vac	253.8Vac	9m57s	10m2s	10m5s
Rise-in-voltage protection *U* >>	1.15 U_n	264.9Vac	264.9Vac	264.9Vac	118 ms	114ms	122ms
Rise-in-voltage protection *U* >>	1.18 U_n	271.4Vac	271.4Vac	271.4Vac	110 ms	103ms	107ms
Frequency decrease protection *f* <	47.5 Hz	47.42Hz	47.42 Hz	47.44Hz	117 ms	112ms	108ms
Frequency increase protection *f* >	51.5 Hz	51.51Hz	51.51Hz	51.51Hz	174 ms	167 ms	185ms
Proper time of interface switch		30 ms max.					

The break time (sum of tripping time NS protection plus proper time of interface switch) shall not exceed 200ms.
The verification of the full functional chain "NS protection – Interface switch" has yield to intended disconnection.

G.2 *(Konformitätsnachweis für Erzeugungseinheiten)*
Certificate of conformity for power generation units

(Konformitätsnachweis NA-Schutz) **Certificate of conformity power generation unit**	*(Nr)* No. TP12030011-ETS *(Unterzeichnete Kopie No.1)* Signed copy No. 1	
(Hersteller) **Manufacturer:**		
(Typ Erzeugungseinheit) **Type power generation unit:**	Power Inverter for PV	
(Bemessungswerte) **Assessment values:**	*(Max. Wirkleistung P_{Emax})* Max. active power P_{Emax}	2kW
	(Max. Scheinleistung S_{Emax}) Max. apparent power S_{Emax}	2.2kVA
	(Bemessungsspannung) Rated voltage	230V
(Netzanschlussregel) **Network connection rule:**	**VDE-AR-N 4105** ***(" Erzeugungsanlagen am Niederspannungsnetz")*** **"Power generation systems connected to the low-voltage network"** *(Technische Mindestanforderungen für Anschluss und Parallelbetrieb von Erzeugungsanlagen am Niederspaannungsnetz)* Technical minimum requirements for connection and parallel operation of power generation systems connected to the low-voltage network	
(Die oben bezeichnete Erzeugungseinheit erfüllt die Anforderungen der VDE-AR-N 4105) The above mentioned power generation unit meets the requirements of VDE-AR-N 4105.		
(Der Konformitätsnachweis beinhaltet folgende Angaben): The certificate of conformity includes the following details: - *(Technische Daten der Erzeugungseinheit, der eingesetzten Hilfseinrichtungen und der verwendeten softwareversion)* technical data of the power generation unit, auxiliary equipment used and software/ firmware version used; - *(Den schematischen Aufbau der Erzeugungseinheit)* schematic set-up of the power generation unit; - *(Zusammengefasste Angaben zu den Eigenschaften der Erzeugungseinheit (Wirkungsweise))* summarized details on the properties of the power generation unit of (mode of action)		
(Ort) **Place:** ***(Datum)*** **Date:** ***(Hersteller)*** **Manufacturer:**		
(Dieser Konformitätsnahweis darf nicht in Ausschnitten verwendet warden) This certificate of conformity shall not be used in parts.		
(Anlagen-Hersteller) **System manufacturer:** ***(Firmen-LOGO)*** **Company logo:** ***(Adresse)*** **Address:** ***(E-Mail)*** **E-mail:**		

G.2 *(Konformitätsnachweis für Erzeugungseinheiten)*
Certificate of conformity for power generation units

(Konformitätsnachweis NA-Schutz) **Certificate of conformity power generation unit**	*(Nr)* No. TP12030011-ETS *(Unterzeichnete Kopie No.1)* Signed copy No. 1	
(Hersteller) **Manufacturer:**		
(Typ Erzeugungseinheit) **Type power generation unit:**	Power Inverter for PV	
(Bemessungswerte) **Assessment values:**	*(Max. Wirkleistung P_{Emax})* Max. active power P_{Emax}	3kW
	(Max. Scheinleistung S_{Emax}) Max. apparent power S_{Emax}	3.3kVA
	(Bemessungsspannung) Rated voltage	230V
(Netzanschlussregel) **Network connection rule:**	**VDE-AR-N 4105** ***(" Erzeugungsanlagen am Niederspannungsnetz")*** **"Power generation systems connected to the low-voltage network"** *(Technische Mindestanforderungen für Anschluss und Parallelbetrieb von Erzeugungsanlagen am Niederspaannungsnetz)* Technical minimum requirements for connection and parallel operation of power generation systems connected to the low-voltage network	
(Die oben bezeichnete Erzeugungseinheit erfüllt die Anforderungen der VDE-AR-N 4105) The above mentioned power generation unit meets the requirements of VDE-AR-N 4105.		
(Der Konformitätsnachweis beinhaltet folgende Angaben): The certificate of conformity includes the following details: - *(Technische Daten der Erzeugungseinheit, der eingesetzten Hilfseinrichtungen und der verwendeten softwareversion)* technical data of the power generation unit, auxiliary equipment used and software/ firmware version used; - *(Den schematischen Aufbau der Erzeugungseinheit)* schematic set-up of the power generation unit; - *(Zusammengefasste Angaben zu den Eigenschaften der Erzeugungseinheit (Wirkungsweise))* summarized details on the properties of the power generation unit of (mode of action)		
(Ort) **Place:** ***(Datum)*** **Date:** ***(Hersteller)*** **Manufacturer:**		
(Dieser Konformitätsnahweis darf nicht in Ausschnitten verwendet warden) This certificate of conformity shall not be used in parts.		
(Anlagen-Hersteller) **System manufacturer:** ***(Firmen-LOGO)*** **Company logo:** ***(Adresse)*** **Address:** ***(E-Mail)*** **E-mail:**		

G.3 (Konformitätsnachweis für Netz-und Anlagenschutz)
Certificate of conformity of the network and system protection

(Konformitätsnachweis NA-Schutz) **Certificate of conformity NS protection**		*(Nr)* No. TP12030011-ETS *(Unterzeichnete Kopie No.1)* Signed copy No. 1
(Hersteller) **Manufacturer:**		
(Typ NA-Schutz) **Type of NS protection:**		Integrated part of ES 2200
(Zentraler NA-Schutz) **Central NS protection:**	☐	Not applicable
(Netzanschlussregel**) Integrated NS protection:**	☒	***(Zugeordnet zu Erzeugungseinheit Typ)*** **Assigned to power generation unit of type:** SONG CHUAN, 841-P-2A-C-H (250Vac, 25A)
(Netzanschlussregel) **Network connection rule:**		**VDE-AR-N 4105** ***("Erzeugungsanlagen am Niederspannungsnetz")*** **"Power generation systems connected to the low-voltage network"** *(Techniche Mindestanforderungen für Anschluss und Parallelbetrieb von Erzeugungsanlagen am Niederspannungsnetz)* Technical minimum requirements for connection and parallel operation of power generation systems connected to the low-voltage network
(Der oben bezeichnete Netz-und Anlagenschutz erfüllt die Anforderungen der VDE-AR-N 4105) The network and system protection mentioned above meet the requirement of VDE-AR-N 4105.		
(Der Konformitätsnachweis beinhaltet folgende Angaben): The certificate of conformity includes the following details: - *(Die Einstellwerte und die Abschaltzeiten der in 5.5 beschriebenen Schutzfunktionen)* the setting values and disconnection times of the protective functions described in 5.5; - *(Bei integriertem NA-Schutz die funktionstüchtige Wirkungskette" NA-Schutz-Kuppelschalter" sowie die technischen Daten der Schalteinrichtungen des Kuppelschalters)* for integrated NS protection the operational functional chain " NS protection – interface switch " as well as the technical data of the breaking devices of the interface switch; - *(Die verwendete software-Version des NA-Schutzes)* the software/firmware version used for the NS protection; - *(Die Überprüfung der Selbstüberwachung nach Anhang A "Zu 5.1 Generelle Anforderungen, Einfehlersicherheit")* the check of the self-monitoring in accordance with Annex A" to 5.1, General requirements, single-fault tolerance."		
(Ort) Place: **(Datum) Date:** **(Hersteller) Manufacturer:**		
(Dieser Konformitätsnachwe5s darf nicht in Ausschnitten verwendet werden) This certificate of conformity shall not be used in parts.		
(Schutzgeräte-Hersteller) Protective devices manufacturer: ***(Firmen-LOGO)*** **Company logo**: ***(Adresse)*** **Address:** ***(E-Mail)*** **E-mail:**		

G.3 (Konformitätsnachweis für Netz-und Anlagenschutz)
Certificate of conformity of the network and system protection

(Konformitätsnachweis NA-Schutz) **Certificate of conformity NS protection**		*(Nr)* No. TP12030011-ETS *(Unterzeichnete Kopie No.1)* Signed copy No. 1
(Hersteller) **Manufacturer:**		
(Typ NA-Schutz) **Type of NS protection:**		Integrated part of ES 3300
(Zentraler NA-Schutz) **Central NS protection:**	☐	Not applicable
(Netzanschlussregel**) Integrated NS protection:**	☒	***(Zugeordnet zu Erzeugungseinheit Typ)*** **Assigned to power generation unit of type:** SONG CHUAN, 841-P-2A-C-H (250Vac, 25A)
(Netzanschlussregel) **Network connection rule:**		**VDE-AR-N 4105** ***("Erzeugungsanlagen am Niederspannungsnetz")*** **"Power generation systems connected to the low-voltage network"** *(Techniche Mindestanforderungen für Anschluss und Parallelbetrieb von Erzeugungsanlagen am Niederspannungsnetz)* Technical minimum requirements for connection and parallel operation of power generation systems connected to the low-voltage network

(Der oben bezeichnete Netz-und Anlagenschutz erfüllt die Anforderungen der VDE-AR-N 4105)
The network and system protection mentioned above meet the requirement of VDE-AR-N 4105.

(Der Konformitätsnachweis beinhaltet folgende Angaben):
The certificate of conformity includes the following details:

- *(Die Einstellwerte und die Abschaltzeiten der in 5.5 beschriebenen Schutzfunktionen)* the setting values and disconnection times of the protective functions described in 5.5;
- *(Bei integriertem NA-Schutz die funktionstüchtige Wirkungskette" NA-Schutz-Kuppelschalter" sowie die technischen Daten der Schalteinrichtungen des Kuppelschalters)* for integrated NS protection the operational functional chain " NS protection – interface switch " as well as the technical data of the breaking devices of the interface switch;
- *(Die verwendete software-Version des NA-Schutzes)* the software/firmware version used for the NS protection;
- *(Die Überprüfung der Selbstüberwachung nach Anhang A "Zu 5.1 Generelle Anforderungen, Einfehlersicherheit")* the check of the self-monitoring in accordance with Annex A" to 5.1, General requirements, single-fault tolerance."

(Ort) Place:
(Datum) Date:
(Hersteller) Manufacturer:

(Dieser Konformitätsnachwe5s darf nicht in Ausschnitten verwendet werden)
This certificate of conformity shall not be used in parts.

(Schutzgeräte-Hersteller) Protective devices manufacturer:
(Firmen-LOGO) **Company logo**:
(Adresse) **Address:**
(E-Mail) **E-mail:**

Testing Equipment list

Equipment Description:				
Number:	**Equipment No.**	**Name**	**Brand**	**Model**
01	EC0001	AC/DC current probe	TEKTRONIX	A622
02	EC0154	Thermo-hygrometer	WISEWIND	HTC-1
03	EC0163	LCR meter	Zentech	9570
04	EC0170	Oscilloscope	TEKTRONIX	DPO3014
05	EC0170-1	Oscilloscope probe	TEKTRONIX	HP9258R
06	EC0186	AC/DC Current probe	TEKTRONIX	A622
07	EC0214	Multimeter	BRYMEN	BM817
08	EC0215	Multimeter	BRYMEN	BM817
09	EC0223	Power analyzer (B)	KINETIQ	PPA2530
10	EC0222	AC source (30 kVA)	EXTECH	6330
11	EC0230	Oscilloscope	TEKTRONIX	DPO4304
12	EC0230-1	Oscilloscope probe	TEKTRONIX	HP9258R
13	EC0231	Power analyzer (A)	KINETIQ	PPA2530
14	EC0232	Power meter	YOKOGAWA	WT210
15	EC0234	Multimeter	BRYMEN	BM817
16	EC0261	25MHz Differential probe	Sapphire	LDP-6002
17	EC0262	25MHz Differential probe	Sapphire	LDP-6002
18	EC0267	Power analyzer (C)	KINETIQ	PPA2630
19	EC0268	Power analyzer (D)	KINETIQ	PPA2630
20	EC0269	AC/DC Digital clamp meter	KYORITSU	Kew snap 2033
21	EP0040	Adjustable inductor (A)	LTEC	-
22	EP0126	Adjustable inductor (B)	LTEC	-
23	EP0215	3 phase isolating transformer (A)	Smile	082334
24	EP0216	3 phase isolating transformer (B)	Smile	082334
25	EP0217	Auto-transformer (A)	Smile	SE-250X2
26	EP0218	Auto-transformer (B)	Smile	SE-250X2
27	EP0219	Resistive load (A)	YS	-
28	EP0220	Resistive load (B)	YS	-
29	EP0221	Resistive load (C)	YS	
30	EP0226	Inductor load (A)	CHENG TEN	-
31	EP0227	Inductor load (B)	CHENG TEN	-
32	EP0229	AC source (6 kVA)	CHROMA	6560
33	EP0230	AC source (9 kVA)	CHROMA	6590
34	EP0231	DC source (12 kW) (A)	CHROMA	62120-600
35	EP0232	DC source (12 kW) (B)	CHROMA	62120-600
36	EP0243	Capacitor load test module (A)	-	-
37	EP0244	Capacitor load test module (B)		
38	EP0261	DC source (9 kW)	EA	EA-PS 9750-25
39	-	Precision power analyzer	YOKOGAWA	WT-1800
40	-	Power quality analyzer	HIOKI	PW3198