TEST REPORT
NRS 097-2-1

Grid interconnection of embedded generation
Part 2: Small-scale embedded generation

Report reference number............. :	**ABYD-19JA1440FCSHP**
Date of issue........................ ……,,,:	2019-03-18
Total number of pages........... ……,,,:	106
Testing laboratory name............... :	**Bureau Veritas Consumer Products Services Germany GmbH**
Address..:	Businesspark A96 86842 Türkheim Germany
	Deutsche Akkreditierungsstelle D-PL-12024-03-03
Applicant's name .... :	**Alpha ESS Co., Ltd,**
Address..:	JiuHua Road 888, Nantong High-Tech Industrial Development Zone, Nantong city, 226300, Jiangsu Province, P,R,China
Test specification	
Standard ....:	NRS 097-2-1:2017
Zertifikate .... :	**Certificate of compliance**
Test report form number,..................:	NRS 097-2-1, version 2017
Master TRF.......................................:	Bureau Veritas Consumer Products Services Germany GmbH
Test item description ....:	**Hybrid photovoltaic inverter**
Trademark ....:	Alpha-ESS
Model / Type ....:	SMILE5-INV

Model / Type ....:	SMILE5-INV
Mppt voltage range [V] ....:	125-550
Max DC voltage [V] ....:	580
Max Input DC current [A].................:	2*12
Output AC voltage [V] ....:	230
Rated Grid Frequency [Hz] ....:	50/60
Max,Output AC current [A] ....:	22
Output power [VA]...........................:	4600
Battery Rated Voltage ....:	48
Max Charge and Discharge Current :	100

Testing Location............................:	**Bureau Veritas LCIE China Company Limited**
Address ....:	Building 4, No, 518, Xinzhuan Road, Caohejing, Songjiang High-Tech Park, Shanghai, P,R, China (201612)
Tested by (name and signature) ....:	Weizhao Zheng
Approved by (name and signature) ....:	Georg Loritz
Manufacturer's name ....:	**Alpha ESS Co., Ltd**
Factory address...............................:	JiuHua Road 888, Nantong High-Tech Industrial Development Zone, Nantong city, 226300, Jiangsu Province, P,R,China

Document History			
Date	**Internal reference**	**Modification / Change / Status**	**Revision**
2019-03-18	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].................... :	40 kg

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 .... :	2019-01-08
Date(s) of performance of test .... :	2019-01-08 to 2019-03-20

General remarks:

Test result of “Flicker” ,” was completely based on the original test report number:50108206001 which issued by TUV Rheinland (Shanghai)Co.,Ltd.
Test result of “4,2,2,4 Preventing of islanding” ,” was completely based on the original test report number:50156619001 which issued by TUV Rheinland (Shanghai)Co.,Ltd.

The test result presented in this report relate only to the object(s) tested,
This report shall not be reproduced, except in full, without the written approval of the applicant,

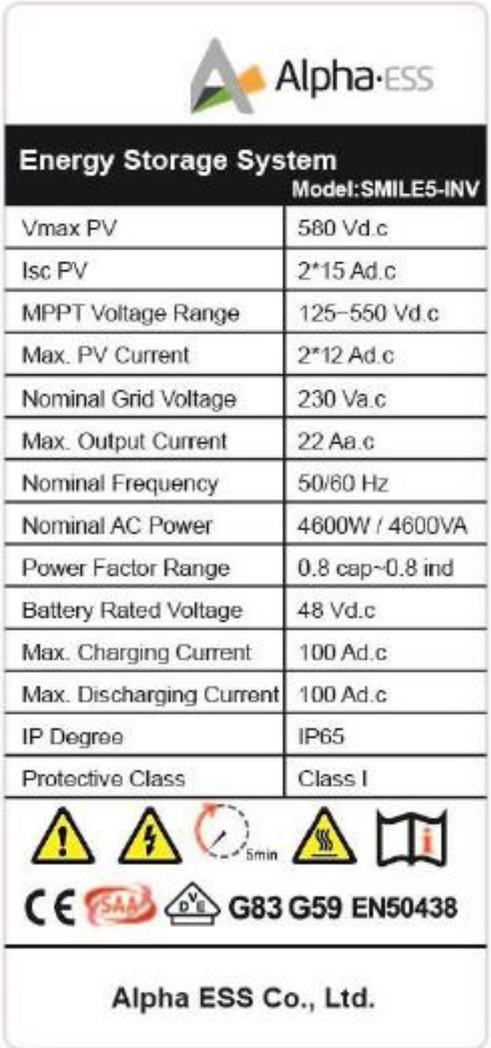
”(see Annex #)" refers to additional information appended to the report,
"(see appended table)" refers to a table appended to the report,

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

This Test Report consists of the following documents:

1. Test Report
2. Annex No, 1 – EMC Test Report
3. Annex No, 2 – Datasheet of the relay
4. Annex No, 3 – Pictures of the units
5. Annex No, 4 – Test equipment list

Copy of marking plate:



Alpha·ESS

Energy Storage System

Model:SMILE5-INV

Vmax PV	580 Vd.c
Isc PV	2*15 Ad.c
MPPT Voltage Range	125–550 Vd.c
Max. PV Current	2*12 Ad.c
Nominal Grid Voltage	230 Va.c
Max. Output Current	22 Aa.c
Nominal Frequency	50/60 Hz
Nominal AC Power	4600W / 4600VA
Power Factor Range	0.8 cap~0.8 ind
Battery Rated Voltage	48 Vd.c
Max. Charging Current	100 Ad.c
Max. Discharging Current	100 Ad.c
IP Degree	IP65
Protective Class	Class I

5min

CE SAA G83 G59 EN50438

Alpha ESS Co., Ltd.

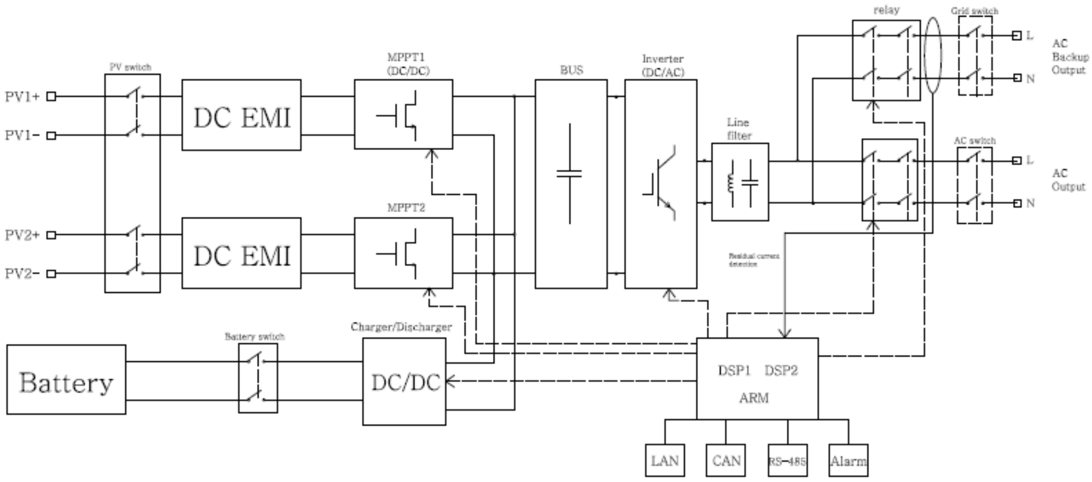
General product information:

The Solar Inverter converts DC voltage into AC voltage,

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

The PV inverters can also be used with an energy storage system, utilize the advanced power conversion technology IGBT to convert DC to AC,

Block diagram



Description of the power circuit :

The internal control is redundant built, It consists of master controller(U33) and slave controller(U37), the master controller(U33) can control relays, measures voltage, frequency, AC current with injected DC, insulation resistance and residual current, The slave controller (U37) 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 protection device makes up of two relay in series in each line and netural between inverter and grid ,Inverter and back-up load,Back-up load and grid,Communicative coupled AC relays so that the equipment could be effectively separated from utitlity even any one of relays short circuited or works unnormally,

The controlling section is also redundant built, one master DSP, and one slave DSP, The master DSP carries out the main calculation and driving instructions, Slave DSP is responsible for the redundant relay independently, In case any one of two chips breaks down or runs a wrong program, which result to the loss of protection funciton, the another chip could indicate the fault and disconnect the equipment immediately,

Hardware Version:

Model	SMILE5-INV
Hardware Version	V1.00

Software Version:

Model	SMILE5-INV
Software Version	V1.43

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
4,1,1	**General**		**P**
4,1,1,1	This clause describes the technical issues and the responsibilities related to interconnecting an embedded generator to a utility network,	Noticed,	**P**
4,1,1,2	The quality of power provided by the embedded generator in the case of the on-site a,c, loads and the power delivered to the utility is governed by practices and standards on voltage, flicker, frequency, harmonics and power factor, Deviation from these standards represents out-of-bounds conditions, The embedded generator is required to sense the deviation and might need to disconnect from the utility network,	Noticed,	**P**
4,1,1,3	All power quality parameters (voltage, flicker, frequency and harmonics) shall be measured at the POC, unless otherwise specified (see annex A),	See appended table and Annex No,1-EMC Test Report,	**P**
	The power quality to be supplied to customers and influenced by SSEG shall comply with NRS 048-2, This implies that the combined voltage disturbances caused by the specific EG and other customers, added to normal background voltage disturbances, may not exceed levels stipulated by NRS 048-2, The maximum emission levels that may be contributed by SSEG are provided in this document (see 4,1,5 to 4,1,10),	Noticed,	**P**
	The customer can expect power quality at the POC in line with NRS 048-2, As such, the generator may not contribute significant disturbances to the voltage supplied at the POC, Typical contributions for small customer installations (total installation) are provided in Annex D of NRS 048-4, NOTE 1 The frequency cannot be changed by a SSEG, NOTE 2 The utility is responsible for the power quality at the POC, however, the EG is responsible to mitigate power quality exceedances should it be shown to cause excessive power quality levels,	Must be taken under consideration for the installation,	**N/A**
4,1,1,4	The embedded generator's a,c, voltage, current and frequency shall be compatible with the utility at the POC,	Noticed,	**P**
4,1,1,5	The embedded generator shall be type approved, unless otherwise agreed upon with the utility (see annex A),	Noticed	**P**
4,1,1,6	The maximum size of the embedded generator is limited by the rating of the supply point on the premises, NOTE Also see NRS097-2-3,	Noticed,	**N/A**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
4,1,1,7	The utility will approve the size of the embedded generator and will decide on the connection point and conditions, In some cases it may be required to create a separate supply point,	Must be taken under consideration for the installation,	**N/A**
4,1,1,8	Embedded generators larger than 13,8 kVA shall be of the balanced three-phase type unless only a single-phase network supply is available, in which case NRS 097-2-3 recommendations can be applied based on the NMD, NOTE 1 This value refers to the maximum export potential of the generation device/system, NOTE 2 In the case of long feeder spurs the maximum desired capacity of the EG might require approval by the utility and might result in the requirement for a three-phase connection for smaller units,	Balanced three phase type of SSEG,	**N/A**
4,1,1,9	A customer with a multiphase connection shall split the embedded generator in a balanced manner over all phases if the EG is larger than 4,6 kVA, NOTE Balancing phases in a multiphase embedded generator is deemed desirable,		**P**
4,1,1,10	Embedded generators or generator systems larger than 100 kVA may have additional requirements, for example, they must be able to receive communication signals for ceasing generation/disconnection from the utility supply, if the utility requires such, Communication facilities shall be provided to utility at no charge for integration with SCADA or other system when required, See Annex G (G,1), NOTE The RPP Grid Code requires category A3 units to be able to interface with the utility in order to receive stop and start signals,	Must be taken under consideration for the installation,	**N/A**
4,1,1,11	In line with the current Renewable Power Plant Grid Code, embedded generators smaller than 1000 kVA connected to low-voltage form part of Category A generators, with the following subcategories:	,	**P**
	a) Category A1: 0 – 13,8 kVA; This sub-category includes RPPs of Category A with rated power in the range from 0 to 13,8 kVA, inclusive of 13,8 kVA,	See appended test table	**P**
	b) Category A2: 13,8 kVA – 100 kVA; and This sub-category includes RPPs of Category A with rated power in the range greater than 13,8 kVA but less than 100 kVA,	See appended test table	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
	c) Category A3: 100 kVA – 1 MVA, This sub-category includes RPPs of Category A with rated power in the range from 100 kVA but less than 1 MVA, NOTE 1 These sub-categories must be cross-checked with the Renewable Power Plant Grid Code (or other part of the Grid Code where applicable); where applicable, requirements will apply per sub-category and not per sizes defined here, NOTE 2 Until a separate Grid Code for non-renewable technologies have been compiled and published, relevant categories from this document will apply to non-renewable SSEG,		**N/A**
4,1,1,12	In accordance with SANS 10142-1, all generators shall be wired permanently, NOTE 1 Some international companies are distributing so-called "plug-in" generators, where a small PV panel and inverter is connected to the supply circuit via a standard (load) plug, At present such installations are not regarded as safe and in contravention of SANS 10142-1, NOTE 2 This option will be reviewed when internationally accepted norms are finalised to ensure plugs and plug points are safe when feeding power into the grid as well as additional requirements for such generators or plugs,		**P**
4,1,1,13	Any UPS/generating device that operates in parallel with the grid may only connect to the grid when it complies fully with the requirements of this part of NRS 097, This includes UPS configurations with or without EG, NOTE The requirement is applicable irrespective of the duration of parallel operation,	No UPS	**N/A**
4,1,1,14	Standby-generators are covered by SANS 10142-1,		**N/A**
4,1,1,15	All generators larger than 100 kVA will be controllable, i,e, be able to control the active output power dependent on network conditions/abnormal conditions, This includes several smaller units that totals more than 100 kVA at a single POC	Noticed,	**N/A**
4,1,1,16	Maximum DC Voltage may not exceed 1000V, This is the voltage on the DC side of the inverter, for example when no load is taken and maximum source energy is provided, e,g, peak solar radiation occurs on the solar panels,	Considered,	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
4,1,2	**Normal voltage operating range**		**P**
4,1,2,1	In accordance with IEC 61727, utility-interconnected embedded generators do not normally regulate voltage, they inject current into the utility, Therefore the voltage operating range for embedded generators is designed as protection which responds to abnormal utility network conditions and not as a voltage regulation function,	Derived from tests,	**P**
4,1,2,2	The embedded generator shall synchronise (see 4,1,12) with the utility network before a connection is established, The embedded generator shall not control the voltage, unless agreed to by the utility (see annex A),	See appended table,	**P**
4,1,2,3	An embedded generator that operates in parallel with the utility system shall operate within the voltage trip limits defined in 4,2,2,3,2,		**P**
4,1,3	Reference source impedance and short-circuit levels (fault levels)		**P**
4,1,3,1	The impact of the generator on the network voltage and quality of supply levels is directly linked to the (complex) source impedance and short-circuit level, The minimum short-circuit level to which a generator can be connected should be based on the size of the generator as well as the design criteria,		**P**
4,1,3,2	For general purposes of testing and design for potential worst case conditions, a minimum network strength of the following may be assumed: Z_{source} = 1,05 + j 0,32 ohm, i,e, I_{SC} = 210 A and S_{SC} = 146 kVA (three-phase), NOTE This does not imply a guarantee that the fault level will be more than this at all times, Fault levels less than this may be sufficient for small loads in certain applications,		**P**
4,1,3,3	The maximum network strength will be assumed to be no more than 33 times the rated active power of the generator, The R/X ratio will be assumed between 0,33 to 3, NOTE 1 In practice, the generators will connect to the network at a wide range of short-circuit ratios, The assumption of a maximum ratio of 33 will allow safe connection of the SSEG in most practical situations, NOTE 2 The minimum fault level at which the generator may be connected is at the discretion of the manufacturer, provided that the requirements of this specification is met at the specified fault level,		**P**
4,1,3,4	The relevant utility will advise whether equipment may be connected at other network characteristics, i,e, for weaker parts of the network,		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
4,1,3,5	The generator documentation and nameplate shall state the reference impedance (complex impedance) and fault level that was used for design and certification and that it is not intended to connect the generator to a network with a higher network impedance than specified for the certification, NOTE See Annex C (Network Impedance), for more information,		**P**
4,1,4	**General QOS requirements**		**P**
4,1,4,1	Embedded generators can expect QOS levels on networks to be in line with NRS 048-2, It is expected that the embedded generator will be able to operate continuously under worst-case conditions,		**P**
4,1,4,2	Notwithstanding this, the embedded generator must protect itself from potential excursions beyond NRS 048-2 and ensure fail-safe conditions, Should the embedded generator be unable to operate according to requirements of this document for such excursions, it shall disconnect and cease generation onto the network,		**P**
4,1,5	**Flicker and voltage changes**	See appended table and Annex No 1 – EMC Test Report	**P**
4,1,5,1	When connected to a network impedance equal to the reference impedance used during certification, no SSEG may generate flicker levels higher than the following: a) short-term flicker severity (Pst) = 0,35; and b) long-term flicker severity (Plt) = 0,30,		**P**
4,1,5,2	It is anticipated that the utility will plan the connections in line with acceptable flicker limits, i,e, the ratio of the size of the generator to the network strength at the point of connection,		**P**
4,1,5,3	According to VDE-AR-N 4105, no generator shall be connected to a system where generation rejection (i,e, tripping of SSEG while generating at full capacity, regardless of reason) will lead to a voltage change of 3 % or more at the PCC, thereby minimising the potential to exceed rapid voltage change limits, NOTE 1 A voltage change of 3 % aligns to a ratio of the network fault level to generator size of 33 (ignoring network impedance angle and load power factor), NOTE 2 Standard connection conditions for customers typically include a maximum flicker contribution in line with annex D of NRS 048-4, Should these flicker levels be exceeded, the customer will be required to put mitigating measures in place as and when required by the utility,		**P**
4,1,6	**Voltage unbalance**		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
4,1,6,1	Under normal circumstances, for single and dual-phase EG, the unbalanced generation may not exceed 4,6 kVA connected between any two or different phases at an installation, Units larger than 4,6 kVA will be split evenly over the available phase connections so that this can be maintained,		**N/A**
4,1,6,2	Three-phase generators may not contribute more than 0,2 % voltage unbalance when connected to a network with impedance equal to the reference impedance, NOTE Standard connection conditions for customers typically include a maximum voltage unbalance contribution in line with NRS 048-4, Annex D, Should a three-phase customer exceed these voltage unbalance levels, the customer will be required to put mitigating measures in place as and when required by the utility,	Balanced three phase type of unit,	**N/A**
4,1,7	**Commutation notches**		**P**
	The relative depth of commutation notches due to line-commutated inverters shall not exceed 5 % of nominal voltage at the POC for any operational state,		**P**
4,1,8	**DC injection**		**P**
4,1,8,1	The average d,c, current injected by the embedded generator shall not exceed 0,5 % of the rated a,c, output current over any 1-minute period, into the utility a,c, interface under any operating condition,	See appended table	**P**
4,1,8,2	According to section 4,2,2,5, the generator(s) must disconnect within 500 ms when the d,c, current exceeds this value,		**P**
4,1,9	**Normal frequency operating range**		**P**
	An embedded generator that operates in parallel with the utility system shall operate within the frequency trip limits defined in 4,2,2,3,3,	See appended table	**P**
4,1,10	**Harmonics and waveform distortion**	See appended table	**P**
4,1,10,1	Only devices that inject low levels of current and voltage harmonics will be accepted; the higher harmonic levels increase the potential for adverse effects on connected equipment,		**P**
4,1,10,2	Acceptable levels of harmonic voltage and current depend upon distribution system characteristics, type of service, connected loads or apparatus, and established utility practice,		**P**
4,1,10,3	The embedded generator output shall have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system,		**P**
4,1,10,4	The harmonic and inter-harmonic current distortion shall comply with the relevant emission limits in accordance with IEC 61727, reproduced in table 1,		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
4,1,10,5	The harmonic and inter-harmonic distortion applies up to 3 kHz (60th harmonic), NOTE The harmonic limits above 2,5 kHz and all inter-harmonic limits refer to limits measured in accordance with IEC 61000-4-7,	See appended table	**P**
4,1,11	**Power factor**	See test results	**P**
4,1,11,1	Irrespective of the number of phases to which an embedded generator is connected, it shall comply with the power factor requirements in accordance with 4,1,11,2 to 4,1,11,12 on each phase for system normal conditions when the output power exceeds 20 % of rated active power,		**P**
4,1,11,2	For static power converter embedded generators and synchronous embedded generators of sub-categories A1 and A2, the power factor shall remain above 0,98 as shown in Figure 1, The embedded generator shall operate anywhere in the shaded area of figure 1, NOTE At the time of publication, this is in contradiction with the RPP Grid Code,		**P**
4,1,11,3	For asynchronous embedded generators of sub-categories A1 and A2, which cannot control the power factor over any range, the power factor shall reach the shaded area of figure 1 within 60 s, The power factor shall remain above 0,98 as shown in figure 1, The embedded generator shall operate anywhere in the shaded area, NOTE At the time of publication, this is in contradiction with the RPP Grid Code,		**P**
4,1,11,4	For static power converter embedded generators and synchronous embedded generators of sub-category A3, the power factor shall remain above 0,95 as shown in Figure 2, The embedded generator shall operate anywhere in the shaded area of Figure 2,		**N/A**
4,1,11,5	For asynchronous embedded generators of sub-category A3, which cannot control the power factor over any range, the power factor shall reach the shaded area of Figure 2 within 60 s, The power factor shall remain above 0,95 as shown in Figure 2, The embedded generator shall operate anywhere in the shaded area,		**N/A**
4,1,11,6	Where the EG is capable of controlling the power factor at the POC, the EG should improve the power factor at the POC towards unity,		**P**
4,1,11,7	Unless otherwise agreed with the utility, the standard power factor setting shall be unity for the full power output range,		**P**
4,1,11,8	The maximum tolerance on the reactive power setting is 5 % of the rated active power,		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
4,1,11,9	For embedded generators of sub-category A3, the power factor shall be settable to operate according to a characteristic curve provided by the utility, if required by the utility, within the range 0,95 leading and 0,95 lagging; An example of a standard characteristic curve is shown in figure 3,		**N/A**
4,1,11,10	These limits apply, unless otherwise agreed upon with the utility (see annex A),		**P**
4,1,11,11	Equipment for reactive power compensation shall either:		**P**
	a) be connected or disconnected with the embedded generator, or		**P**
	b) operated via automatic control equipment for disconnection when not required,		**P**
4,1,11,12	The requirement for and type of detuning for reactive power compensation devices will be agreed upon by the owner of the generator and utility, NOTE Detuning is highly recommended for all reactive power compensation devices to prevent (a) potential current overloading of capacitors due to existing voltage harmonics, (b) potential voltage transient amplification at the POC due to upstream switching conditions, and (c) potential resonance with the network impedance that may lead to excessive harmonic amplification,		**P**
4,1,12	**Synchronization**		**P**
4,1,12,1	All embedded generators shall synchronize with the utility network before the parallel connection is made, This applies to all embedded generators where a voltage exists at the generator terminals before connection with the utility network,		**P**
4,1,12,2	Automatic synchronization equipment shall be the only method of synchronization,		**P**
4,1,12,3	For a synchronous generator, the limits for the synchronizing parameters for each phase are: a) frequency difference: 0,3 Hz, b) voltage difference: 5 % of nominal voltage per phase, and c) phase angle difference: 20 ° (degrees),	Photovoltaic inverter	**N/A**
4,1,12,4	Mains excited generators do not need to synchronise when the generator is started as a motor before generation starts,	Photovoltaic inverter	**N/A**
4,1,12,5	Mains excited generators may require soft-starting when the start-up voltage change is anticipated to be more than 3 %,	Photovoltaic inverter	**P**
4,1,12,6	The start-up current for static power converters shall not exceed the full-power rated current of the generator,	Noticed,	**P**
4,1,12,7	Also refer to 4,2,4 for re-synchronising conditions,	Noticed,	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
4,1,12,8	The embedded generator shall synchronize with the utility network only when the voltage and frequency has been stable within the ranges provided in 4,2,2,3 for at least 60 seconds, NOTE Some utilities may require this to be longer than 60 seconds,	See appended table	**P**
4,1,13	**Electromagnetic compatibility (EMC)**		**P**
4,1,13,1	Until acceptable EMC limits are available in the form of a published IEC standard (IEC 62578 or similar), the conditions of 4,1,13,2 to 4,1,13,3 shall apply, NOTE Acceptable EMC limits for conducted emissions of inverters in the range up to 150 kHz are currently being debated at IEC, A proposed edition of IEC 62578, which provided significantly relaxed limits for inverters specifically, has been rejected by the wider IEC community,	Inverter tested according to EN 61000-6-3:2007+A1and EN 61000-6-2:2005	**P**
4,1,13,2	Electromagnetic compatibility (EMC) refers to the ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment, EMC comprises two components, namely a radiated and conducted component, Significant attention is given to radiated EMC due to the potential impact over larger distances, However, with advances in smart grids and business management systems, the potential impacts from conducted EMI must be considered, The conditions in 4,1,13,3 and 4,1,13,4 apply to unintentional signals,	Inverter tested according to EN 61000-6-3:2007+A1and EN 61000-6-2:2005	**p**
4,1,13,3	All unintentional conducted emissions from generating equipment shall comply with limits for unintentional emissions in SANS 50065-1 in the frequency band 3 kHz to 148,5 kHz and with SANS 211 (CISPR11) above 148,5 kHz, using limits for Class B group 1 equipment, NOTE The start frequency given in SANS 211 is 150 kHz; however, to avoid the existing gap, limits applying at 150 kHz will be extrapolated down to 148,5 kHz,	Inverter tested according to EN 50065-1:2011	**p**
4,1,13,4	The conducted emission requirement applies to all ports or connections to the utility supply, whether the connection is intended for monitoring, communication, power transfer or any other reason for connecting to the utility supply,	Inverter tested according to EN 61000-6-3:2007+A1and EN 61000-6-2:2005	**P**
4,1,13,5	In the event of susceptibility to electromagnetic interference, the unit shall be fail-safe, i,e, any deviation from intended performance must comply with all relevant specifications, both in terms of safety (i,e, disconnection) and impact on the network,	Inverter tested according to EN 61000-6-3:2007+A1and EN 61000-6-2:2005	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,1: Utility compatibility			
4,1,13,6	Notwithstanding this, should any interference be experienced to existing or new ripple control, building management system equipment and/or other PLC-based communication, the owner of the embedded generator should take the necessary remedial action to prevent further interference as will be agreed with the utility or the other affected party,	Considered	**N/A**
4,1,13,7	All radiated emissions from generating equipment shall comply with SANS 211 (CISPR11), using limits for Class B group 1 equipment,	Inverter tested according to EN 61000-6-3:2007+A1and EN 61000-6-2:2005 Requirements for Emission are identical like in CISPR 11 for small power units	**P**
4,1,14	**Mains signalling (e,g, PLC and ripple control)**	No such device	**N/A**
4,1,14,1	Mains signalling refers to intentional signals induced into the utility supply network, where the intention is to facilitate data transfer from one component to another,		**N/A**
4,1,14,2	All intentional emissions (communication signals) from generating equipment shall comply with limits for intentional emissions in SANS 50065-1, limited to an acceptable band as prescribed by SANS 50065-1,		**N/A**
4,1,14,3	Notwithstanding this, should any interference be experienced to existing or new ripple control, building management system equipment and/or other PLC-based communication, the owner of the embedded generator shall take the necessary remedial action to prevent further interference as will be agreed with the utility or the other affected party,		**N/A**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
4,2,1	**General** The safe operation of the embedded generator in conjunction with the utility network shall be ensured at all times, Safe operation includes people and equipment safety	Noticed,	**P**
	a) People safety: i) owner (including personnel and /or inhabitants of the property) of the embedded generator, ii) general public safety : iii) utility personnel; iv) general emergency response personnel,e,g, fire brigade should a fire arise at the embedded generator,	Noticed,	**P**
	b) Equipment safety: i) Utility equipment; ii) Other customer's equipment connected to the same network(s);and **iii)** Generator own equipment,	Noticed,	**P**
4,2,2	**Safety disconnect from utility network**		**P**
4,2,2,1	**General**	Derived from tests,	**P**
4,2,2,1,1	All SSEG shall comply with the safety requirements in accordance with SANS/IEC 62109-1 and IEC 62109-2, NOTE In principle, IEC 62109 documents only apply to PV inverters, However, other SSEG shall prove compliance to these safety requirements to the satisfaction of the utility,	The inverters meet the requirements of IEC 62109-1 and IEC 62109-2,	**P**
4,2,2,1,2	The embedded generator shall automatically and safely disconnect from the grid in the event of an abnormal condition, Abnormal conditions include:	The inverters meet the requirements of IEC 62109-1 and IEC 62109-2	**P**
	a) network voltage or frequency out-of-bounds conditions,	See appended table	**P**
	b) loss-of-grid conditions,	See appended table	**P**
	c) d,c, current injection threshold exceeded (per phase),,	See appended table	**P**
	d) and residual d,c, current (phase and neutral currents summated),		**P**
4,2,2,2	**Disconnection device (previously disconnection switching unit)**		**P**
4,2,2,2,1	The embedded generator shall be equipped with a disconnection device, which separates the embedded generator from the grid due to abnormal conditions, The disconnection unit may be integrated into one of the components of the embedded generator (for example the PV utility interconnected inverter) or may be an independent device installed between the embedded generator and the utility interface,	The transformer less inverter provides two relays in series for each line,	**P**

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Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
4,2,2,2,2	The disconnection switching unit shall be able to operate under all operating conditions of the utility network, NOTE It is the responsibility of the embedded generator owner to enquire about the operating conditions of the utility network, e,g, fault levels for the foreseeable future,	The disconnection switching unit was tested according the single fault safety of the IEC 62109-2, See appended table,	**P**
4,2,2,2,3	A failure within the disconnection device shall lead to disconnection of the generator from the utility supply and indication of the failure condition,	The disconnection switching unit was tested according the single fault safety of the IEC 62109-2, See appended table,	**P**
4,2,2,2,4	A single failure within the disconnection switching unit shall not lead to failure to disconnect, Failures with one common cause shall be taken into account and addressed through adequate redundancy,	The disconnection switching unit was tested according the single fault safety of the IEC 62109-2, See appended table,	**P**
4,2,2,2,5	The disconnection device shall disconnect the generator from the network by means of two series connected robust automated load disconnect switches,	The disconnection switching unit was tested according the single fault safety of the IEC 62109-2, See appended table,	**P**
4,2,2,2,6	Both switches shall be electromechanical switches,	Complied,	**P**
4,2,2,2,7	Each electromechanical switch shall disconnect the embedded generator on the neutral and the live wire(s), NOTE The switching unit need not disconnect its sensing circuits,		**P**
4,2,2,2,8	All rotating generating units, e,g, synchronous or asynchronous generating units shall have adequate redundancy in accordance with 4,2,2,2,5,	Not such type of SSEG,	**N/A**
4,2,2,2,9	A static power converter without simple separation shall make use of two series connected electromechanical disconnection switches,	The transformer less inverter provides two relays in series for each line,	**P**
4,2,2,2,10	The current breaking capacity of each disconnecting switch shall be appropriately sized for the application, In cases where the disconnecting device is an electromechanical switching device such as a contactor, this requires suitable coordination with the upstream short circuit protection device (circuit breaker),	See Annex No, 2 – Datasheet of the relay,	**P**
4,2,2,2,11	Any programmable parameters of the disconnection switching unit shall be protected from interference by third-parties, i,e, password protected or access physically sealed,	Protected by password,	**P**
4,2,2,2,12	In order to allow customers to supply their own load in isolated operation (islanded) where this is feasible and required, the disconnection device may be incorporated upstream of part of or all of a customers' loads, provided that none of the network disconnection requirements in this document are violated,	Rely in the responsibility of the installer,	**N/A**

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Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
4,2,2,2,13	All EG installations larger than 30 kVA shall have a central disconnection device, NOTE 1 This requirement may be amended by the utility, i,e, the utility may require a central disconnection switch unit for any size and type of generator, NOTE 2 This requirement may be amended by the utility, The central disconnection switch unit will typically be waived only when a lockable disconnection switch, accessible to the utility, is installed, NOTE 3 This is an interim requirement based on requirements of VDE AR 4105 and will be revisited as more information becomes available,	Rely in the responsibility of the installer,	**N/A**
4,2,2,2,14	The network and system grid protection voltage and frequency relay for the central disconnection device will be type-tested and certified on its own (stand-alone tested), All clauses of 4,2,2, except 4,2,2,4 (anti-islanding) apply,	Rely in the responsibility of the installer,	**N/A**
4,2,2,3,1	**General**		**P**
	The accuracy for voltage trip values shall be within 0 % to +1 % of the nominal voltage from the upper boundary trip setting, and within -1% to 0% of the nominal voltage from the lower boundary trip setting,	Noticed,	**P**
	The accuracy for frequency trip values shall be within 0 to +0,1 % of the fundamental frequency from the upper boundary trip setting, and within -0,1 % to 0 % of the fundamental frequency from the lower boundary the trip setting,	Noticed,	**P**
4,2,2,3,2	**Overvoltage and undervoltage**		**P**
	The embedded generator in sub-category A1 and A2 shall cease to energize the utility distribution system should the network voltage deviate outside the conditions specified in table 2, The following conditions shall be met, with voltages in r,m,s, and measured at the POC, NOTE 1 All discussions regarding system voltage refer to the nominal voltage, NOTE 2 At the time of publication, these settings are in contradiction to the RPP Grid Code, These may only be applied with exemption to the relevant clause or after the RPP Grid Code has been suitably amended, NOTE 3 Measurements at the generator terminals will generally be sufficient for the overvoltage settings, If the expected voltage drop across the cable connecting the EG to the POC is too high, undervoltage settings might have to be adjusted,	See appended table,	**P**
	The purpose of the allowed time delay is to ride through short-term disturbances to avoid excessive nuisance tripping, The generator does not have to cease to energize if the voltage returns to the normal utility continuous operating condition within the specified trip time, NOTE Induction/synchronous generators need to be mindful of synchronisation issues and may have to apply faster trip times,	Noticed,	**P**

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Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
	A customer with a multiphase connection shall monitor all phases for out-of-bounds voltage conditions, The EG shall be disconnected if an out-of-bounds voltage condition is detected on any of the phases,	Noticed,	**P**
	In line with NRS 048-2, it is recommended that A1 and A2 SSEG be able to ride through at least Y and X1 type dips, i,e, not disconnect for these events, The purpose is to avoid excessive nuisance tripping,	See appended table,	**N/A**
	Category A3 SSEG shall be able to ride through low and/or high voltage events in accordance with the RPP Grid Code,	See appended table,	**N/A**
	The generator shall maintain the pre-dip current during any dip event for which it remains connected,	Noticed,	**P**
	The ride-through and trip times are shown graphically in figure 4,	Noticed,	**P**
4,2,2,3,3	**Over-frequency and under-frequency**		**P**
	This requirement is in line with the RPP Grid Code (version 2,8) and applies to all EG in category A,		**P**
	The embedded generation system shall cease to energize the utility network when the utility frequency deviates outside the specified conditions, Both over- and under-frequency conditions indicate system abnormal conditions and all generators are expected to assist in stabilising the system during such periods,	Noticed,	**P**
	When the utility frequency is less than 47 Hz, the embedded generator shall disconnect from the utility network within 0,2 s,	See appended table,	**P**
	While the utility frequency is in the range of 47 Hz and 50,5 Hz, the system shall operate normally, In order to prevent hysteresis switching (on-off toggling) during over-frequency conditions, the output power shall be reduced as follows: When the utility frequency exceeds 50,5 Hz, the active power available at the time shall be stored as the maximum power value PM; this value PM shall not be exceeded until the frequency has stabilized below 50,5 Hz for at least 4 seconds, The EG system shall control the output power as a function of PM at a gradient of 50 % per Hertz as illustrated in figure 5, The power generation shall follow the curve shown in figure 5 up and down while the system frequency is in the range 50,5 Hz to 52 Hz, When the utility frequency is more than 52 Hz for longer than 4 seconds, the embedded generator shall cease to energise the utility line within 0,5 s,	See appended table,	**P**

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Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
4,2,2,3,3,1	**Relaxation for non-controllable generators**	See appended tabel	**P**
	Non-controllable generators may disconnect randomly within the frequency range 50,5 Hz to 52 Hz, The disconnect frequency for non-controllable generators will each be set at a random value by the manufacturer, with the option of changing this to a utility provided setting, The random disconnect frequency shall be selected so that all generators from any specific manufacturer will disconnect uniformly over the range with 0,1 Hz increments,		**P**
	When the utility frequency is more than the non-controllable generator over-frequency setpoint for longer than 4 seconds, the non-controllable generator shall cease to energise the utility line within 0,5 s, NOTE At the time of publication, this is in contradiction with the RPP Grid Code,		**P**
4,2,2,4	**Prevention of islanding**		**P**
4,2,2,4,1	A utility distribution network can become de-energized for several reasons: for example, a substation breaker that opens due to a fault condition or the distribution network might be switched off for maintenance purposes, Should the load and (embedded) generation within an isolated network be closely matched, then the voltage and frequency limits may not be triggered, If the embedded generator control system only made use of passive voltage and frequency out-of-bounds detection, this would result in an unintentional island that could continue beyond the allowed time limits,	See appended table,	**P**
4,2,2,4,2	In order to detect an islanding condition, the embedded generator shall make use of at least one active islanding detection method, An active islanding detection method intentionally varies an output parameter and monitors the response or it attempts to cause an abnormal condition at the utility interface to trigger an out-of-bounds condition, If the utility supply is available, the attempt to vary an output parameter or cause an abnormal condition will fail and no response will be detected, However, if the utility supply network is de-energized, there will be a response to the change which can be detected, This signals an island condition to the embedded generator upon detection of which the embedded generator shall cease to energize the utility network within a specific time period,	See appended table,	**P**
4,2,2,4,3	Active island detection shall be used in all cases where the EG interfaces with the utility network,	Noticed,	**P**

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Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
4,2,2,4,4	An islanding condition shall cause the embedded generator to cease to energize the utility network within 2 s, irrespective of connected loads or other embedded generators, The embedded generator employing active islanding detection shall comply with the requirements of IEC 62116 (ed,1), NOTE Prevention of islanding measures is only considered on the embedded generator side, i,e, no utility installed anti-islanding measures are considered,	See appended table,	**P**
4,2,2,4,5	All rotating generators shall use a minimum of two islanding detection methods (e,g, rate of-change-of-frequency and voltage vector shift detection due to the dead bands (slow detection) of islands in both methods), NOTE It is possible for a condition to exist, where a mains-excited generator becomes self-excited due to capacitance of the network (either cable capacitance or power factor correction), Under such conditions, the mains-excited generator will not disconnect from an island, hence effective islanding detection is required for all rotating generators,		**P**
4,2,2,4,6	Passive methods of islanding detection shall not be the sole method to detect an island condition, When used, passive methods of islanding detection shall be done by three-phase voltage detection and shall be verified by an AC voltage source,	Both methods of active and passive island detection are used,	**P**
4,2,2,4,7	The embedded generator shall physically disconnect from the utility network in accordance with the requirements in 4,2,2,2,	See 4,2,2,2,	**P**
4,2,2,5	**DC current injection**		**P**
	The embedded generator shall not inject d,c, current greater than 0,5 % of the rated a,c, output current into the utility interface under any operating condition, measured over a 1-minute interval, The EG shall cease to energize the utility network within 500 ms if this threshold is exceeded,	See appended table,	**P**
4,2,3	No requirements for emergency personnel safety (e,g, fire brigade) existed at the time of publication, It is expected that such issues will be dealt with in other documents, e,g, OHS Act, SANS 10142-1,	Rely in the responsibility of the installer,	**N/A**
4,2,4	**Response to utility recovery**		**P**
4,2,4,1	The embedded generator shall ensure synchronisation before re-energizing at all times in accordance with 4,1,12,	Complied,	**P**

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Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
4,2,4,2	After a voltage or frequency out-of-range condition that has caused the embedded generator to cease energizing the utility network, the generator shall not re-energize the utility network until the utility service voltage and frequency have remained within the specified ranges for a continuous and uninterrupted period of 60 s, The reconnection shall commence as follows:	See appended table,	**P**
4,2,4,2,1	Non-controllable generators may connect randomly within the 1 minute to 10 minute period after voltage and frequency recovery (period includes the 60 s to confirm recovery), The delay for non-controllable generators will each be set at a random value by the manufacturer, with the option of changing this to a utility provided setting, The random value shall be selected so that no more than 2 % of generators from any specific manufacturer will reconnect within 10s of each other,	Not such type of SSEG,	**N/A**
4,2,4,2,2	Controllable generators may reconnect immediately after the 60 s delay confirming recovery of the system voltage and frequency at a maximum rate of 10 % of rated power per minute, i,e, full power output will only be reached after 10 minutes, This ramp rate may be modified at the request of the utility or in consultation with the utility,	See appended table,	**P**
4,2,5	**Isolation**		**N/A**
4,2,5,1	In line with SANS 10142-1 (as amended), each energy source should have its own, appropriately rated, isolation device,		**N/A**
4,2,5,2	It is expected that isolation requirements will be dealt with in more detail in future in e,g, SANS 10142-1/3, Such requirements shall supersede 4,2,5,		**N/A**
4,2,5,3	The embedded generator shall provide a means of isolating from the utility interface in order to allow for safe maintenance of the EG, The disconnection device shall be a double pole for a single-phase EG, a three-pole for a three-phase delta-connected EG, and a four-pole for a three-phase star-connected EG, The grid supply side shall be wired as the source,	The installation instructions specify a disconnection device for the final installation, The correct assembling is part of the installer,	**N/A**
4,2,5,4	The breaking capacity of the isolation circuit-breaker closest to the point of utility connection shall be rated appropriately for the installation point in accordance with SANS 60947-2, This disconnection device does not need to be accessible to the utility,	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**

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Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
4,2,5,5	For dedicated supplies, a means shall be provided of isolating from the point of supply in order to allow for safe maintenance of the utility network, The disconnection device shall be a double pole for a single-phase EG, a three-pole for a three-phase delta-connected EG, and a four-pole for a three-phase star-connected EG, This disconnection device shall be lockable and accessible to the utility, NOTE 1 A device inside a lockable box is deemed a lockable device, NOTE 2 This disconnection device may become the new point of control as defined by SANS10142-1,		**N/A**
4,2,5,6	The requirement for the utility accessible disconnection device may only be waived by the utility where the risk to the network is deemed acceptable to the utility, Such permission shall be provided in writing, NOTE Full verification form to be signed off and accepted by the utility,		**N/A**
4,2,6	**Earthing**		**P**
4,2,6,1	The electrical installation shall be earthed in accordance with SANS 10142-1 (as applicable), The earthing requirements for different embedded generation configurations in conjunction with the customer network are described in annex B for the most common earthing systems, NOTE SANS 10142-1 applies to EG feeding a UPS and no connection to the utility supply (see table B5),	The transformer less inverter provides two relays in series for each line,	**N/A**
4,2,6,2	Installations with utility-interconnected inverters without simple separation shall make use of earth leakage protection which are able to respond to d,c, fault currents including smooth d,c, fault currents (i,e, without zero crossings) according to IEC 62109-2 unless the inverter can exclude the occurrence of d,c, earth fault currents on any phase, neutral or earth connection through its circuit design1), This function may be internal or external to the inverter, NOTE IEC 62109-2, Edition 2011, section 4,8,3,5 gives selection criteria for RCD sensitivities,		**P**

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Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
4,2,6,3	Where an electrical installation includes a PV power supply system without at least simple separation between the AC side and the DC side, an integrated RCD function shall be present to provide fault protection by automatic disconnection of supply shall be type B according to IEC/TR 60755, amendment 2, Where the PV inverter by construction is not able to feed DC fault currents into the electrical installation, an RCD of type B according to IEC/TR 60755 amendment 2 is not required, NOTE 1 Consideration must also be given to ensure that any d,c, currents do not impair the effectiveness of any other RCD'S installed throughout the a,c, system, NOTE 2 The earth leakage unit may also fulfil the requirement of the all-pole disconnection device as stated in 4,2,6, NOTE 3 The function of this RCD is not to provide protection against circulating d,c, currents in the inverter and a,c, supply, i,e, does not override 4,1,8,	The RCD protection is provided integral to the unit,	**N/A**
4,2,7	**Short-circuit protection**		**N/A**
4,2,7,1	The embedded generator shall have suitably rated short-circuit protection at the connection to the AC mains in accordance with SANS 10142-1 and 3,	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
4,2,7,2	The short-circuit characteristics for the SSEG shall be supplied to the utility,	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
4,2,8	**Maximum short-circuit contribution**		**P**
	Embedded generators have the potential to increase the fault level of the network to which it is connected, In order to limit the fault level changes in low voltage networks and allow coordination of fault levels with the utility, no generator will exceed the following fault level contribution: NOTE At the time of installation, the short-circuit capacity of all existing equipment should be confirmed and upgraded where necessary, Suitable fault current limiting devices may be required to ensure a safe installation, The potential impact on neighbouring installations should also be considered to ensure that those installations remain safe,	See below,	**P**
	a) for synchronous generators: 8 times the rated current;	Photovoltaic inverter	**P**
	b) for asynchronous generators: 6 times the rated current; and	Photovoltaic inverter	**P**
	c) for generators with inverters: 1 times the rated current,	Photovoltaic inverter	**P**
4,2,9	**Labelling**		**P**

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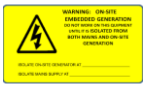
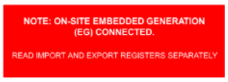
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4,2: Safety protection and control			
4,2,9,1	A label on the distribution board of the premises where the embedded generator is connected shown in figure 6, shall state: “WARNING: ON-SITE EMBEDDED GENERATION , DO NOT WORK ON THIS EQUIPMENT UNTIL IT IS ISOLATED FROM BOTH MAINS AND ON-SITE GENERATION SUPPLIES,” or similar warning, Disconnection points for all supplies shall be indicated,		**P**
4,2,9,2	The label shall be permanent with lettering of height at least 8 mm,		**P**
4,2,9,3	The label shall comply to requirements of SABS 1186-1, 		**P**
4,2,9,4	The absence of emergency shutdown capabilities will be indicated on signage in accordance with 4,2,2, 		**P**
4,2,10	**Robustness requirements**		**P**
	According to 4,2,2,1 all SSEG shall comply with safety requirements in accordance to SANS/IEC 62109-1 and IEC 62109-2, NOTE This section will be expanded in future revisions,	Inverter is tested according to IEC 62109-1 and IEC 62109-2,	**P**

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Clause	Requirement – Test	Result – Remark	Verdict
Metering			
4,3	**Metering**	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**

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Clause	Requirement – Test	Result – Remark	Verdict
Annex			
Annex A	**Notes to purchase**	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex B	**Earthing system**	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex C	**Network impedance**	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex D	**(Annex A of VDE-AR-N 4105) Explanations** (normative)	Noticed,	**P**
Annex E	**(Annex B of VDE-AR-N 4105) Connection examples** (normative)	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex F	**(Annex C of VDE-AR-N 4105) Example of meter panel configurations** (normative)	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex G	**Generation management network security management** (normative)	Noticed,	**P**

Test overview:

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Clause	**Test**	**Result**
4,	**Type test:**	
4,1,5	Voltage fluctuations and Flicker	**P**
4,1,6	Voltage unbalance	**N/A**
4,1,8	DC injection	**P**
4,1,10	Harmonics and waveform distortion	**P**
4,1,11,3	Power factor (no controllable reactive power)	**P**
4,1,11,4	Power factor (Fixed cos φ)	**N/A**
4,1,11,9	Test for a displacement factor/active power characteristic curve cos φ (P) (For embedded generators of sub-category A3)	**N/A**
4,1,12	Synchronization	**P**
4,2,2	Safety disconnect from utility network Response to protection operation - fault condition tests (according VDE AR-N 4105:2011 and VDE0124-100:2013)	**P**
4,2,2,3,2	Over voltage and under voltage	**P**
4,2,2,3,2	Low voltage fault Ride through capability	**N/A**
4,2,2,3,3	Over-frequency and under-frequency	**P**
4,2,2,3,3	Active power feed-in for over-frequency	**P**
4,2,2,4	Preventing of islanding	**P**

Test Results

4,1,5 Voltage fluctuation and flicker				**P**
Test conditions:	Maximum permissible voltage fluctuation (expressed as a percentage of nominal voltage at 100 % power) and flicker as per EN 61000-3-11			
	Starting	**Stopping**	**Running**	
Limit	3,3%	3,3%	Pst=1	Plt=0,65
Test value	*	*	*	*
inverter ≤ 16A				
Limit	dc% = 3,3		Pst=1	Plt=0,65
Test value	0,19		0,17	0,32

Note:

*The stationary deviance of dc% is more relevant than the dynamic deviance of d_{max} at starting and stopping,

Mains Impedance according EN61000-3-11: Rmax = 0,24Ω; jXmax= 0,15Ω @50Hz (|Zmax| = 0,283/0,4717Ω)

for single phase inverter use also Rn = 0,16Ω; jXn= 0,1Ω

Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:

$Z_{max} = Z_{ref} * 3,3\% / d_c(P_n)$

The tests should be based on the limits of the EN 61000-3-11 for more than 16A,

Rapid voltage changes			P
The purpose of the test is to determine k_i and k_{imax}, The following three cases must be tested to VDE-AR-N 4105, Annex F,3 (where applicable), - Switch-on for any capacity - Unfavourable case when switching the generator step - Switch-on for nominal capacity Note: For PV-plants the inverter is the generator Switch-off for nominal capacity (no emergency shutdown, but operative shutdown)			
Test conditions: Frequency: 50 Hz ± 0,5% THD of the voltage supply: ≤ 3 % Voltage rise of the PGU at 100 P_{Emax} %: ≤ 3 %			
Switch-on for any capacity (10% P_{Emax})			
Single period effective values of the current [A]	1,72	1,72	1,76
Single period effective values of the voltage [V]	232,0	232,2	232,4
k_i value	0,078	0,078	0,080
k_{imax} value	0,080		
Switch-on for nominal capacity			
Single period effective values of the current [A]	1,82	1,72	1,70
Single period effective values of the voltage [V]	232,0	232,4	232,0
k_i value	0,083	0,078	0,077
k_{imax} value	0,083		
Switch-off for nominal capacity			
Single period effective values of the current [A]	14,3	14,2	14,0
Single period effective values of the voltage [V]	233,0	233,1	233,4
k_i value	0,650	0,65	0,64
k_{imax} value	0,65		
Highest k_{imax} value for all switching operations			
0,65			

Flicker
These tests are designed to provide evidence that the requirements of VDE-AR-N 4105, 5,4,3 are met,

The purpose of the test is to determine 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,

Test conditions:
Voltage: 86% U_n to 109% U_n
Frequency: 50 Hz ± 0,5%
THD of the voltage supply: ≤ 3 %
Voltage rise of the PGU at 100 P_{Emax} %: ≤ 3 %

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

Flicker to:	Result:		
	P_{lt}	P_{st}	*dc%*
DIN EN 61000-3-11	0,19	0,17	0,32

Assessment criterion:

Long-term flicker strength P_{lt} to DIN EN 61000-3-3 (VDE 0838-3)

Determination of the flicker coefficient:

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

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

Flicker to DIN EN 61400-21 (VDE 0127-21) (or FGW TR3)

Grid impedance angle ψ_k	45°
Flicker coefficient $c(\psi_k)$	0,91
Short-term flicker P_{st}	0,21

Assessment criterion:

Long-term flicker strength**:** $P_{lt} \leq 0,3$

4,1,6 **Calculation of asymmetry**							**N/A**
Setting values	cos φ = 1:						
	cos φ over-excited:						
	cos φ under-excited:						
Test:							
1-min mean value	L1	L2	L3	L1 – L2	L2 – L3	L3 – L1	
a) cos φ = 1 at 100 % P_n ± 5 % P_n							
S_{E60} [VA]:							
cos $φ_{E60}$:							
max, asymmetry [VA]:							
U_{60} [V]:	--	--	--	--	--	--	
	--	--	--	--	--	--	
	--	--	--	--	--	--	
	--	--	--	--	--	--	
	--	--	--	--	--	--	
max, asymmetry [V]:	--						
max, asymmetry [%]:	--						
b) maximum under-excited (i) at 100 % P_n ± 5 % P_{Emax}							
S_{E60} [VA]:							
cos $φ_{E60}$:							
max, asymmetry [VA]:							
U_{60} [V]:	--	--	--	--	--	--	
	--	--	--	--	--	--	
	--	--	--	--	--	--	
	--	--	--	--	--	--	
	--	--	--	--	--	--	
max, asymmetry [V]:	--						
max, asymmetry [%]:	--						

c) maximum over-excited (c) at 100 % P_n ± 5 % P_{Emax}						
S_{E60} [VA]:						
cos φ_{E60}:						
max, asymmetry [VA]:						
U_{60} [V]:	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
max, asymmetry [V]:	--					
max, asymmetry [%]:	--					
d) cos φ = 1 at 50 % P_n ± 5 % P_{Emax}						
S_{E60} [kVA]:						
cos φ_{E60}:						
max, asymmetry [kVA]:						
U_{60} [V]:	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
max, asymmetry [V]:	--					
max, asymmetry [%]:	--					
e) maximum under-excited (i) at 50 % P_n ± 5 % P_{Emax}						
S_{E60} [VA]:						
cos φ_{E60}:						
max, asymmetry [VA]:						

U_{60} [V]:	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
max, asymmetry [V]:	--					
max, asymmetry [%]:	--					
f) maximum over-excited (c) at 50 % P_n ± 5 % P_{Emax}						
S_{E60} [VA]:						
cos φ_{E60}:						
max, asymmetry [kVA]:						
U_{60} [V]:	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
max, asymmetry [V]:	--					
max, asymmetry [%]:	--					
Power Limit [kVA]:	4,6 kVA					
Voltage Limit [%]:	0,2 %					

Test:
The maximum absolute difference between the apparent powers of the three phases is determined for each of the five measurements (1-min means) in the respective operating point, The maximum of these five values is again determined,

Assessment criterion:
The test is passed if the maximum value from the above measurements does not exceed 4,6 kVA for apparent power imbalance or 0,2% for voltage unbalance,

Note:
The maximum inductive and capacitive values are specified by the manufacturer,

4,1,6 Additional tests for communicatively coupled inverter modules **Failure of single inverter modules**						**N/A**
Test:						
1-min mean value	L1	L2	L3	L1 – L2	L2 – L3	L3 – L1
a) Failure of an inverter module						
SE60 [VA]:	Failure					
cos φ_{E60}:						
max, asymmetry [kVA]:						
U_{60} [V]*:						
max, asymmetry [V]:						
max, asymmetry [%]:						
b) Failure of two inverter modules						
S_{E60} [VA]:	Failure		Failure			
cos φ_{E60}:						
max, asymmetry [kVA]:						
U_{60} [V]*:						
max, asymmetry [V]:						
max, asymmetry [%]:						
Power Limit [kVA]:	4,6 kVA					
***Voltage Limit [%]:**	0,2 %					

Test: The maximum absolute difference between the apparent powers of the three phases is determined for each of the five measurements (1-min means) in the respective operating point, The maximum of these five values is again determined,
Assessment criterion: The test is passed if the maximum value from the above measurements does not exceed 4,6 kVA for apparent power imbalance or 0,2% for voltage unbalance,
Note:

4,1,6 Power drop of single inverter modules						**N/A**
Test:						
1-min mean value	L1	L2	L3	L1 – L2	L2 – L3	L3 – L1
a) Power reduction of one phase by at least 4,6 kVA + 10%						
S_{E60} [VA]:						
cos φ_{E60}:						
max, asymmetry [kVA]:						
U_{60} [V]*:						
max, asymmetry [V]:						
max, asymmetry [%]:						
Power Limit [kVA]:	4,6 kVA					
Voltage Limit [%]:	0,2 %					

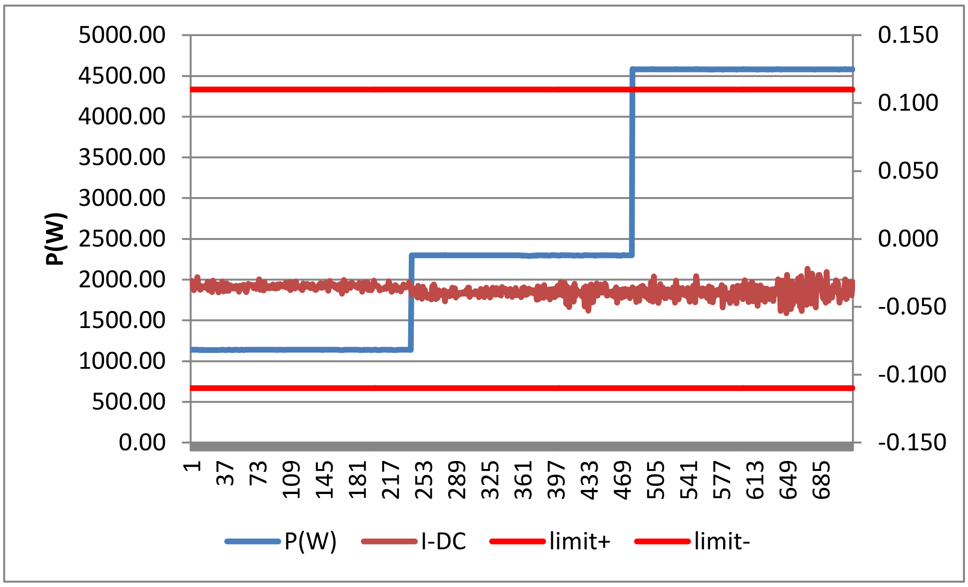
Test:
The maximum absolute difference between the apparent powers of the three phases is determined for each of the five measurements (1-min means) in the respective operating point, The maximum of these five values is again determined,

Assessment criterion:
The test is passed if the maximum value from the above measurements does not exceed 4,6 kVA for apparent power imbalance or 0,2% for voltage unbalance,

Note:

4,1,8 DC-Injection					**P**
Model: SMILE5-INV					
Test conditions:	U_N = 230 Vac; Uinput = 360 Vdc; Power = 4,6 kW				
DC Injection [A]	**Limits**	**Trip Time [ms]**			
+1A	I_{DC}:>0,5% than disconnection within 0,5 sec	119,0	119,0	111,0	
-1A		119,5	116,5	106,0	
Note: A dc-current of greater than 0,5% of Iac nom cause a disconnection time of max, 0,5s					

4,1,8 DC-Injection (Monitoring)				P
Model: SMILE5-INV				
Limit:		0,5% of I_{nom} (110mA)		
Output power:		25%	50%	100%
max test value:	Single Phase [mA]	4,0	5,3	5,5



4,1,10 Harmonics and waveform distortion	P
The currents of the interharmonics to 2 kHz must be measured in accordance with IEC 61000-4-7, Annex A, The measurements of higher-frequency harmonic currents between 2 kHz and 9 kHz must be conducted in line with IEC 61000-4-7, Annex B,	
Model: SMILE5-INV	

Harmonics											
P/P_n [%]	0/5	10	20	30	40	50	60	70	80	90	100
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2	0,10	0,10	0,12	0,16	0,19	0,24	0,28	0,33	0,38	0,43	0,45
3	0,62	0,70	0,56	0,50	0,50	0,55	0,62	0,72	0,81	0,92	0,96
4	0,03	0,02	0,02	0,03	0,03	0,04	0,04	0,05	0,05	0,06	0,06
5	0,36	0,20	0,28	0,20	0,14	0,11	0,10	0,11	0,12	0,13	0,14
6	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
7	0,28	0,24	0,21	0,20	0,16	0,13	0,12	0,11	0,11	0,12	0,12
8	0,01	0,02	0,02	0,02	0,02	0,01	0,01	0,02	0,02	0,02	0,02
9	0,19	0,27	0,14	0,16	0,13	0,11	0,10	0,09	0,09	0,09	0,10
10	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,01	0,01	0,02	0,02
11	0,12	0,18	0,12	0,14	0,12	0,09	0,08	0,07	0,08	0,08	0,08
12	0,02	0,01	0,02	0,02	0,02	0,02	0,01	0,01	0,02	0,02	0,02
13	0,08	0,12	0,13	0,11	0,10	0,08	0,06	0,06	0,06	0,06	0,07
14	0,01	0,01	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02
15	0,08	0,15	0,15	0,10	0,10	0,07	0,06	0,05	0,04	0,05	0,05
16	0,01	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
17	0,07	0,12	0,13	0,09	0,09	0,07	0,05	0,04	0,04	0,03	0,04
18	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
19	0,08	0,08	0,12	0,09	0,09	0,07	0,05	0,04	0,03	0,03	0,03
20	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
21	0,08	0,08	0,10	0,09	0,08	0,07	0,05	0,03	0,03	0,03	0,03
22	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,03	0,02	0,03
23	0,07	0,06	0,10	0,10	0,08	0,07	0,06	0,04	0,03	0,03	0,03
24	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03
25	0,07	0,04	0,09	0,09	0,07	0,07	0,05	0,04	0,03	0,03	0,03
26	0,02	0,02	0,03	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,04
27	0,06	0,05	0,09	0,10	0,07	0,07	0,06	0,04	0,04	0,02	0,03
28	0,02	0,02	0,03	0,03	0,03	0,02	0,02	0,03	0,03	0,03	0,03
29	0,05	0,04	0,07	0,09	0,07	0,07	0,05	0,04	0,03	0,04	0,04
30	0,04	0,03	0,03	0,03	0,04	0,04	0,04	0,04	0,04	0,04	0,04
31	0,05	0,05	0,07	0,09	0,07	0,07	0,06	0,05	0,04	0,03	0,04
32	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,03	0,04
33	0,05	0,05	0,07	0,08	0,07	0,06	0,06	0,04	0,04	0,03	0,04
34	0,04	0,04	0,03	0,04	0,04	0,04	0,03	0,05	0,04	0,05	0,05
35	0,05	0,05	0,06	0,07	0,07	0,07	0,07	0,04	0,03	0,03	0,03
36	0,04	0,04	0,04	0,04	0,04	0,05	0,05	0,05	0,05	0,06	0,05
37	0,05	0,05	0,05	0,07	0,08	0,07	0,06	0,04	0,04	0,03	0,04
38	0,02	0,03	0,04	0,04	0,04	0,03	0,05	0,06	0,06	0,06	0,09
39	0,05	0,06	0,05	0,08	0,08	0,06	0,05	0,05	0,04	0,05	0,05
40	0,03	0,04	0,04	0,04	0,05	0,07	0,06	0,04	0,07	0,09	0,08
41	0,04	0,04	0,04	0,04	0,04	0,05	0,05	0,05	0,05	0,06	0,05
42	0,05	0,05	0,05	0,07	0,08	0,07	0,06	0,04	0,04	0,03	0,04
43	0,01	0,03	0,04	0,04	0,04	0,03	0,05	0,06	0,06	0,06	0,09
44	0,05	0,06	0,05	0,08	0,08	0,06	0,05	0,05	0,04	0,05	0,05
45	0,03	0,04	0,04	0,04	0,05	0,07	0,06	0,04	0,07	0,09	0,08
46	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,01	0,02
47	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,01	0,02

Harmonics											
P/P_n [%]	0/5	10	20	30	40	50	60	70	80	90	100
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
48	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,01	0,01
49	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
50	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,01	0,02
51	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,01	0,02
52	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02
53	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,01	0,02
54	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02
55	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02
56	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,01	0,01
57	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,01	0,01	0,01	0,02
58	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,01	0,01
59	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,01	0,02
60	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,01	0,01	0,01	0,02

Interharmonics at continuous operation											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
75	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,09	0,09	0,09	0,09
125	0,05	0,03	0,05	0,04	0,04	0,05	0,05	0,06	0,06	0,06	0,08
175	0,03	0,03	0,03	0,03	0,03	0,04	0,03	0,04	0,04	0,04	0,08
225	0,03	0,02	0,03	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,04
275	0,03	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03
325	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,02	0,03
375	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03
425	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03
475	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03
525	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03
575	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03
625	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03
675	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03
725	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03
775	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,03
825	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,03
875	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,03
925	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,04
975	0,02	0,03	0,03	0,03	0,03	0,02	0,02	0,02	0,02	0,03	0,03
1025	0,02	0,02	0,02	0,02	0,02	0,03	0,04	0,03	0,03	0,03	0,04
1075	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,03	0,03	0,03	0,04
1125	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,04
1175	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,04	0,04
1225	0,03	0,03	0,04	0,04	0,04	0,03	0,03	0,03	0,03	0,04	0,04
1275	0,02	0,02	0,02	0,02	0,02	0,03	0,05	0,03	0,03	0,04	0,05
1325	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,05
1375	0,02	0,03	0,03	0,03	0,03	0,02	0,02	0,03	0,04	0,03	0,04
1425	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,05	0,05
1475	0,04	0,04	0,04	0,05	0,05	0,04	0,03	0,03	0,03	0,04	0,04
1525	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,05	0,06
1575	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04	0,03	0,05
1625	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
1675	0,04	0,04	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,06	0,06
1725	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06
1775	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1825	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1875	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,02	0,02	0,02	0,02
1925	0,02	0,02	0,02	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02
1975	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,02
2025	0,02	0,02	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02
2075	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
2125	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,02	0,02	0,02
2175	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,02	0,02	0,02	0,02
2225	0,02	0,02	0,02	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02
2275	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,02
2325	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
2375	0,02	0,02	0,02	0,02	0,01	0,01	0,02	0,02	0,02	0,01	0,02
2425	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,02	0,02	0,02
2475	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,02	0,02
2525	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,02	0,02	0,02
2575	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
2625	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,02
2675	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,02
2725	0,02	0,02	0,01	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02
2775	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,01
2825	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02

Interharmonics at continuous operation											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
2875	0,02	0,02	0,01	0,02	0,02	0,02	0,02	0,01	0,02	0,01	0,02
2925	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
2975	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,01	0,02	0,02	0,01

Higher Frequencies components											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
2,1	0,01	0,03	0,04	0,04	0,05	0,04	0,05	0,05	0,05	0,05	0,06
2,3	0,01	0,05	0,05	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,07
2,5	0,01	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,05
2,7	0,01	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,04	0,04
2,9	0,01	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,04
3,1	0,01	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,04
3,3	0,01	0,06	0,06	0,06	0,07	0,07	0,07	0,08	0,08	0,09	0,09
3,5	0,01	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,04
3,7	0,01	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,02	0,02	0,03
3,9	0,01	0,02	0,02	0,02	0,03	0,03	0,02	0,02	0,02	0,02	0,02
4,1	0,01	0,02	0,02	0,02	0,03	0,03	0,03	0,02	0,02	0,02	0,02
4,3	0,01	0,02	0,03	0,03	0,03	0,02	0,03	0,02	0,02	0,02	0,02
4,5	0,01	0,02	0,03	0,03	0,03	0,03	0,03	0,02	0,02	0,02	0,02
4,7	0,01	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,02
4,9	0,01	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,02	0,02	0,02
5,1	0,01	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,02	0,02	0,02
5,3	0,01	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,02	0,02	0,02
5,5	0,01	0,02	0,02	0,02	0,03	0,02	0,03	0,02	0,02	0,02	0,02
5,7	0,01	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02
5,9	0,01	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02
6,1	0,01	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,02
6,3	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
6,5	0,01	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,02
6,7	0,01	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02
6,9	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
7,1	0,01	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,02
7,3	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
7,5	0,01	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02
7,7	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
7,9	0,01	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02
8,1	0,01	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02
8,3	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
8,5	0,01	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02
8,7	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
8,9	0,01	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02

Assessment criterion:

The harmonic and inter-harmonic current distortion shall comply with the relevant emission limits in accordance with IEC 61727, reproduced in table 1,

Note:

The normalization current is: 19,6A

4,1,10 Harmonics and waveform distortion In accordance with IEC 61727							**P**
Model: SMILE5-INV							
Output Power [W]				4576			
Grid-Voltage [V]				230			
Output current [A]				19,9			
Grid-Frequency [Hz]				50			
THD [%]				1,58			
Harmonics	**Current Magnitude [A]**			**Fundamental [%]**			**Harmonic Current Limits [%]**
	Phase L1	**Phase L2**	**Phase L3**	**Phase L1**	**Phase L2**	**Phase L3**	
1st	--	--	--	--	--	--	
2nd	0,16	--	--	0,82	--	--	1,00
3rd	0,25	--	--	1,27	--	--	4,00
4th	0,03	--	--	0,17	--	--	1,00
5th	0,03	--	--	0,17	--	--	4,00
6th	0,01	--	--	0,04	--	--	1,00
7th	0,04	--	--	0,21	--	--	4,00
8th	0,00	--	--	0,02	--	--	1,00
9th	0,03	--	--	0,14	--	--	4,00
10th	0,00	--	--	0,02	--	--	1,00
11th	0,02	--	--	0,11	--	--	2,00
12th	0,00	--	--	0,01	--	--	0,50
13th	0,02	--	--	0,11	--	--	2,00
14th	0,00	--	--	0,02	--	--	0,50
15th	0,02	--	--	0,09	--	--	2,00
16th	0,00	--	--	0,01	--	--	0,50
17th	0,02	--	--	0,08	--	--	1,50
18th	0,00	--	--	0,01	--	--	0,38
19th	0,01	--	--	0,06	--	--	1,50
20th	0,00	--	--	0,01	--	--	0,38
21th	0,01	--	--	0,06	--	--	1,50
22th	0,00	--	--	0,01	--	--	0,38
23th	0,01	--	--	0,05	--	--	0,60
24th	0,00	--	--	0,02	--	--	0,15
25th	0,01	--	--	0,05	--	--	0,60
26th	0,00	--	--	0,01	--	--	0,15
27th	0,01	--	--	0,04	--	--	0,60
28th	0,00	--	--	0,02	--	--	0,15
29th	0,01	--	--	0,05	--	--	0,60
30th	0,00	--	--	0,02	--	--	0,15
31th	0,01	--	--	0,04	--	--	0,60
32th	0,00	--	--	0,02	--	--	0,15
33th	0,01	--	--	0,04	--	--	0,60
34th	0,00	--	--	0,01	--	--	0,15
35th	0,01	--	--	0,04	--	--	0,30
36th	0,00	--	--	0,02	--	--	0,08
37th	0,01	--	--	0,04	--	--	0,30
38th	0,00	--	--	0,02	--	--	0,08
39th	0,01	--	--	0,04	--	--	0,30
40th	0,00	--	--	0,02	--	--	0,08
41th	0,01	--	--	0,03	--	--	0,30
42th	0,01	--	--	0,03	--	--	0,08
43th	0,01	--	--	0,03	--	--	0,30

4,1,10 Harmonics and waveform distortion In accordance with IEC 61727	**P**

Model: SMILE5-INV

Output Power [W]	4576
Grid-Voltage [V]	230
Output current [A]	19,9
Grid-Frequency [Hz]	50
THD [%]	1,58

Harmonics	**Current Magnitude [A]**			**Fundamental [%]**			**Harmonic Current Limits [%]**
	Phase L1	**Phase L2**	**Phase L3**	**Phase L1**	**Phase L2**	**Phase L3**	
44th	0,01	--	--	0,03	--	--	0,08
45th	0,00	--	--	0,02	--	--	0,30
46th	0,01	--	--	0,06	--	--	0,08
47th	0,00	--	--	0,02	--	--	0,30
48th	0,01	--	--	0,06	--	--	0,08
49th	0,01	--	--	0,03	--	--	0,30
50th	0,01	--	--	0,03	--	--	0,08
51th	0,00	--	--	0,02	--	--	0,30
52th	0,01	--	--	0,04	--	--	0,08
53th	0,01	--	--	0,04	--	--	0,30
54th	0,01	--	--	0,04	--	--	0,08
55th	0,01	--	--	0,04	--	--	0,30
56th	0,00	--	--	0,02	--	--	0,08
57th	0,01	--	--	0,03	--	--	0,30
58th	0,00	--	--	0,02	--	--	0,08
59th	0,01	--	--	0,03	--	--	0,30
60th	0,00	--	--	0,02	--	--	0,08

4,1,11,3 Power factor (no controllable reactive power)					P
Test conditions:	SMILE5-INV				
Output power [kW] / **Test voltage [Vac]**	**~10%** **0,46**	**~20%** **0,92**	**~50%** **2,30**	**~75%** **3,45**	**~100%** **4,60**
230	**0,9914i**	**0,9984i**	**0,9995i**	**0,9996i**	**0,9997i**

Note:

*The PV system shall have a lagging power factor greater than 0,98 when the output is greater than 20% of the rated inverter output power,

The letter "i" is short for "inductive" and indicates inductive power factor, In case of capacitive power factor the letter "c" is used instead,

4,1,11,3 Power factor (Fixed cos φ)				P
Test: SMILE5-INV				
Test condition: over-excited (c) (cos φ = 0,98)				
Rating power [%]	Active power [W]	Reactive power [Var]	Power factor [cos φ]	Voltage [V]
0%	240,48	-63,47	0,9669	228,60
10%	456,42	95,62	0,9787	228,65
20%	925,37	192,42	0,9791	228,79
30%	1381,41	291,72	0,9784	230,13
40%	1845,65	393,07	0,9781	229,15
50%	2298,30	492,83	0,9778	229,31
60%	2758,25	594,40	0,9776	229,47
70%	3215,60	695,88	0,9774	229,63
80%	3681,30	799,45	0,9772	229,79
90%	4143,72	901,77	0,9771	229,95
100%	4599,88	1003,33	0,9770	230,13
Test condition: under-excited (i) (cos φ = 0,98)				
Rating power [%]	Active power [W]	Reactive power [Var]	Power factor [cos φ]	Voltage [V]
0%	241,53	89,62	0,9375	228,54
10%	455,58	122,98	0,9654	228,62
20%	924,01	204,10	0,9765	228,82
30%	1379,66	266,71	0,9792	229,01
40%	1843,80	-370,58	0,9804	229,18
50%	2295,16	-453,56	0,9810	229,35
60%	2754,85	-538,69	0,9814	230,14
70%	3211,55	-623,22	0,9817	229,68
80%	3676,95	-709,95	0,9819	229,86
90%	4139,17	-796,39	0,9820	230,03
100%	4442,29	-854,04	0,9820	230,14
Test condition: power factor (cos φ = 1)				
Rating power [%]	Active power [W]	Reactive power [Var]	Power factor [cos φ]	Voltage [V]
0%	240,01	60,39	0,9698	228,49
10%	456,58	61,33	0,9911	228,56
20%	925,32	62,48	0,9977	228,75
30%	1381,89	66,00	0,9989	228,90
40%	1846,46	71,29	0,9993	229,05
50%	2299,37	76,04	0,9995	229,22
60%	2758,56	83,04	0,9995	229,38
70%	3215,85	89,44	0,9996	229,60
80%	3682,98	98,11	0,9996	229,81
90%	4144,95	109,10	0,9997	229,99
100%	4607,70	120,79	0,9997	230,17

Assessment criterion: The power factor resulting in each of the measurement points greater than between 20 % of the nominal power is equal to or lower than 0,98 for SSEG categories A1/A2 and 0,95 for SSEG categories A3 both in over excited and under excited operation, The maximum tolerance on the reactive power setting is 5 % of the rated active power or ±0,01 of power factor,
Note: a) 1 min-average-values were calculated using measurements at the basic frequency in a period of 200 ms, b) For each of the 10 active power levels, at least 3 under excited and 3 over excited reactive power levels were recorded, c) 1 min-average-values were calculated using voltage measurements at the basic frequency in a period of 200 ms,

4,1,11,9	Test for a displacement factor/active power characteristic curve cos φ (P) (For embedded generators of sub-category A3)	N/A

Test:

Rating power [%]	Active power P [kW]	Reactive power Q [kVar]	cos φ measured	cos φ expected	Δ cos φ
20%					
30%					
40%					
50%					
60%					
70%					
80%					
90%					
100%					

Test:

Rating power [%]	Active power P [kW]	Reactive power Q [kVar]	cos φ measured	cos φ expected	Δ cos φ
20%					
30%					
40%					
50%					
60%					
70%					
80%					
90%					
100%					

Assessment criterion:

Test: cos φ accuracy cos φ (±0,01)

For the test to be passed, the cos φ setpoint from the active power must be measured at the terminals of the PGU within a settling time of 10 s,

Note:

Using the standard characteristic curve increases the active power from 20% P_n in increments of 10% P_n to P_n, The test is carried out in reverse,

The network system composed of this unit is less than 100kVA,

4,1,12 **4,2,4**	**Synchronization** **Response to utility recovery**	**P**
Model: SMILE5-INV		
Test:		
Voltage conditons		
a) Out of voltage range	<85% U_n for twice of observation time	>110% U_n for twice of observation time
Connection:	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	≥85% U_n within twice setting observation time	≤110% U_n within twice setting observation time
Reconnection time [s]	77,5	77,0
Limit:	Connected after setting observation time (≥60s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_n/min, The connection after trip of the interface protection is delayed by a randomized value between 1 min and 10 min, For recorded gradient see diagram underneath,	
c) In voltage range after voltage failture	≥85% U_n for twice of setting observation time	≤110% U_n for twice of setting observation time
Reconnection time [s]	78,0	77,0
Limit:	Reconnection after setting observation time (≥60s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_n/min, The connection after trip of the interface protection is delayed by a randomized value between 1 min and 10 min, For recorded gradient see diagram underneath,	
Frequency conditions		
d) Out of frequency range	<47Hz for twice of setting observation time	>50,5Hz for twice of setting observation time
Connection:	No connection	No connection
Limit	No connection allowed	
e) In frequency range at start-up	≥47Hz within twice of setting observation time	≤50,5Hz within twice of setting observation time
Reconnection time [s]	77,5	76,5
Limit:	Connected after setting observation time (≥60s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_n/min, The connection after trip of the interface protection is delayed by a randomized value between 1 min and 10 min, For recorded gradient see diagram underneath,	

f) In frequency range after frequency failture	≥47Hz for twice of setting observation time	≤50,5Hz for twice of setting observation time
Reconnection time [s]	77,5	76,0
Limit:	Reconnection after setting observation time (≥60s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_n/min, The connection after trip of the interface protection is delayed by a randomized value between 1 min and 10 min, For recorded gradient see diagram underneath,	

Test:

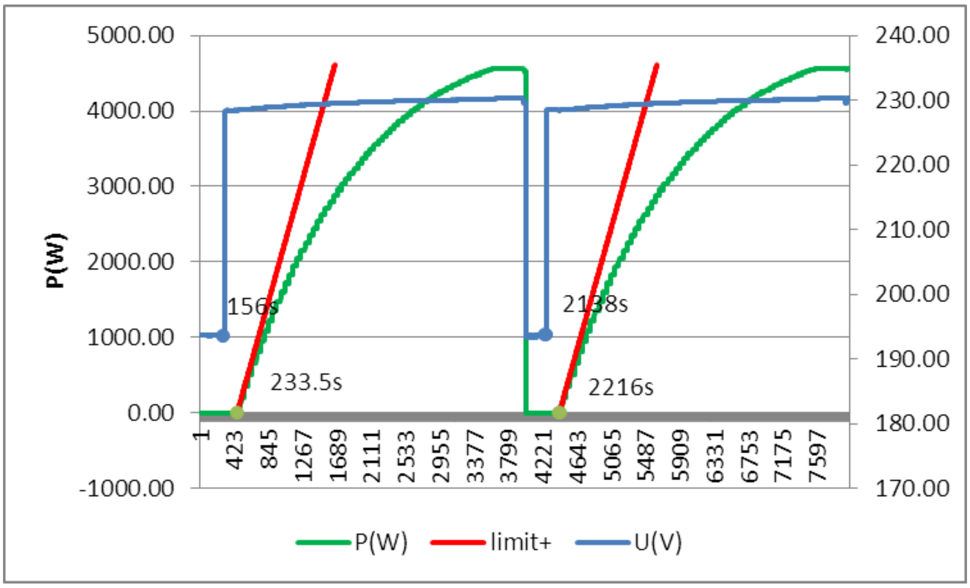
Test condition b) and c) : voltage within the limits of 85% to 110%U_n

Test condition e) and f) : frequency within the limits of 47,0Hz to 50,5Hz

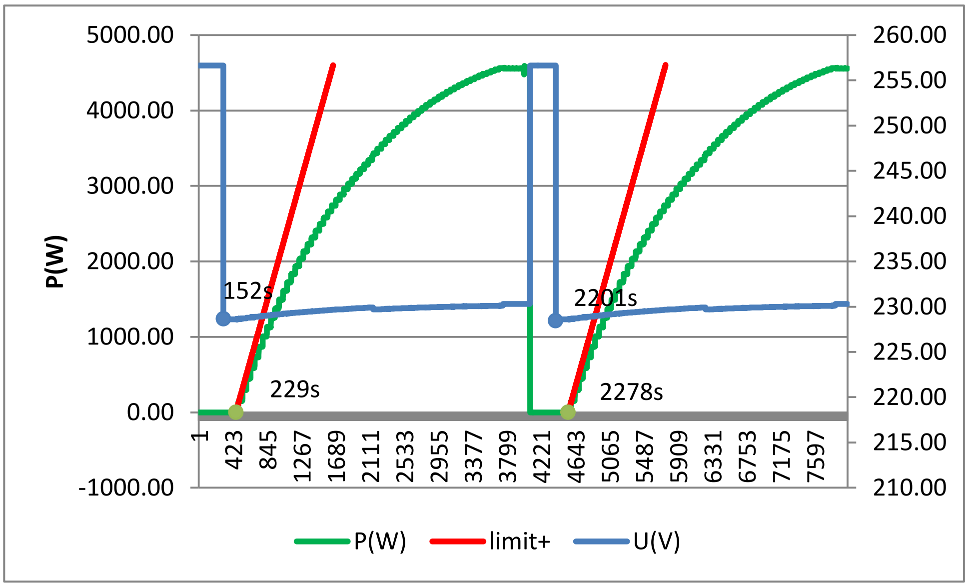
In order to avoid continuous starting and disengaging operations of the interface protection relay, the disengaging value of frequency and voltage functions shall be above 0,2%F_n and 2%U_n deviating from the operate value,

Controllable generators may reconnect immediately after the 60 s delay confirming recovery of the system voltage and frequency at a maximum rate of 10 % of rated power per minute, i,e, full power output will only be reached after 10 minutes,

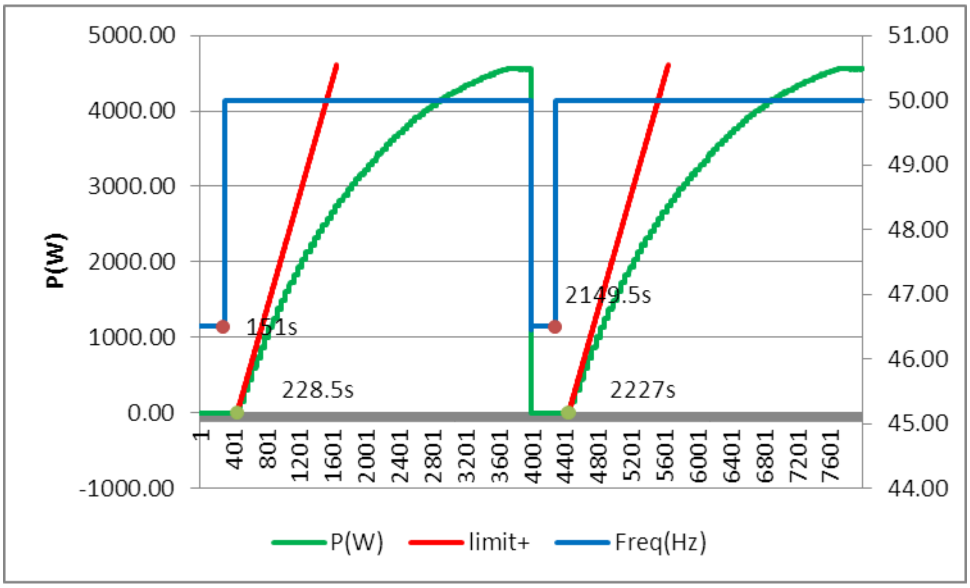
Graph of the gradual power supply: Test for ≥84%U



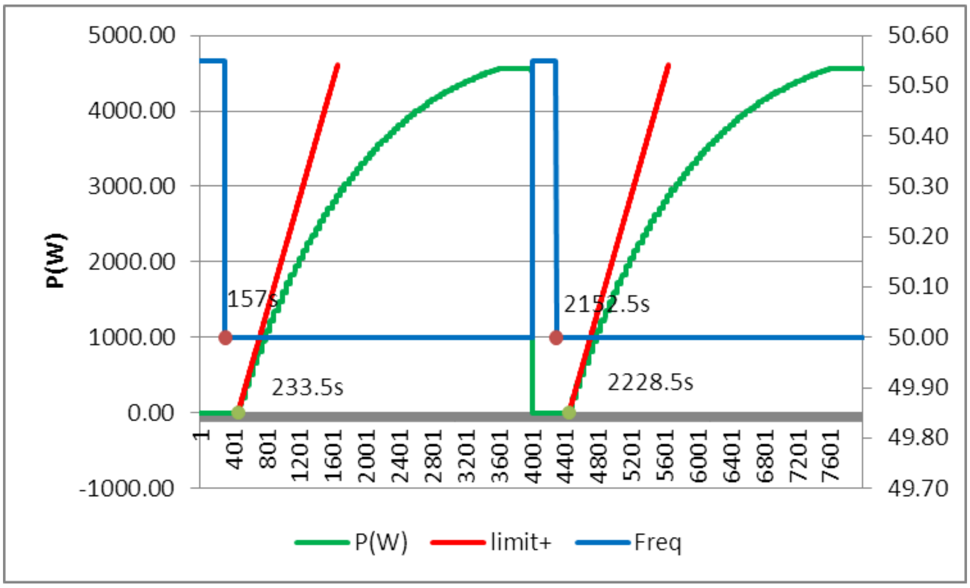
Graph of the gradual power supply : Test for ≤111%U



Graph of the gradual power supply: Test for ≥47,00



Graph of the gradual power supply : Test for ≤50,15



4,2,2, Response to protection operation - fault condition tests								P
component No,	fault	test condition		test time	fuse No,	fault condition		result
		AC	DC			AC	DC	
Output	Overlo ad	230V 20A	360V 12,78	2h	--	230V <0,1A	360V <0,1A	Unit Overload alarm and then shut down, no damage, no hazard, no fire.
Output battery	L phase Open circuit	230V 20A	360V 12,78	30mi n	--	230V <0,1A	360V <0,1A	Unit shut down immediately, no damage, no hazard, no fire.
Output battery	Ground open circuit	230V 20A	360V 12,78	2h	--	230V 20A	360V 12,78	Unit works properly, no damage, no hazard, no fire.
Output battery	L-N short circuit	230V 20A	360V 12,78	30mi n	--	230V <0,1A	360V <0,1A	Unit shut down immediately, no damage, no hazard, no fire.
Output PV	L phase open circuit	230V 20A	360V 12,78	30mi n	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message ”No grid” no damage, no hazard, no fire.
Output PV	Ground open circuit	230V 20A	360V 12,78	30mi n	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message ”Isolation fault” no damage, no hazard, no fire.
Output PV	L-N short circuit	230V 20A	360V 12,78	30mi n	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message ”No grid” no damage, no hazard, no fire.
Q4 Pin1-Pin3	Short circuit	230V 20A	360V 12,78	30mi n	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message ”Isolation fault” no damage, no hazard, no fire.
R28	Open circuit t	230V 20A	360V 12,78	2h	--	230V <10A	360V <6,39A	PV2 normal work and PV1 can’t work no damage, no hazard, no fire.
HCT2 Pin7-Pin8	Short circuit	230V 20A	360V 12,78	2h	--	230V 20A	360V 12,78	Unit normal work and PV2 current no display. No damage, no hazard, no fire.
TX1 pin1-pin2	Short circuit	230V 20A	360V 12,78	30mi n	--	230V <0,1A	360V <0,1A	Unit shut down immediately, no display, no damage, no hazard, no fire.
TX1 Pin9-Pin12	Short circuit	230V 20A	360V 12,78	30mi n	--	230V <0,1A	360V <0,1A	Unit shut down immediately, no display, no damage, no hazard, no fire.
U9 pin1-pin3	Open circuit	230V 20A	360V 12,78	30mi n	--	230V <0,1A	360V <0,1A	Unit shut down immediately, no display, no damage, no hazard, no fire.

Q8 D-S	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message "Relay fault", no damage, no hazard, no fire.
R14	Open circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message "GFCI fault", no damage, no hazard, no fire.
R140	Open circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message "Relay fault", no damage, no hazard, no fire.
TX1 Pin6-pin7	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message "DCI fault", no damage, no hazard, no fire.
TX2 Pin2-pin4	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, nodisplay, no damage, no hazard, no fire.
Q14 Pin2-pin3	Short circuit	230V 20A	360V 12,78	2h	--	230V 20A	360V 12,78	Unit works properly, no damage, no hazard, no fire.
CX1	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, nodisplay, no damage, no hazard, no fire.
CX1	Open circuit	230V 20A	360V 12,78	2h	--	230V 20A	360V 12,78	Unit works properly, no damage, no hazard, no fire.
OP2 Pin1-pin2	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message " Communication fault", no damage, no hazard, no fire.
R204	Open circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message "Frequency fault", no damage, no hazard, no fire.
Q5 D-S	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message "Charger ocp fault", no damage, no hazard, no fire.
Q10 D-S	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message "Charger ocp fault", no damage, no hazard, no fire.
RY8 Pin3-pin4	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message "Relay fault", no damage, no hazard, no fire.

RY9 Pin3-pin4	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message ”Relay fault”, no damage, no hazard, no fire.
RY12 Pin3-pin4	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message ”Relay fault”, no damage, no hazard, no fire.
RY13 Pin3-pin4	Short circuit	230V 20A	360V 12,78	30min	--	230V <0,1A	360V <0,1A	Unit shut down immediately, Error message ”Relay fault”, no damage, no hazard, no fire.

Addendum – Shutdown device	
Each active phase can be switched, (L and N)	Confirmed
If no galvanic separation between AC and DC (PV): Two relays in series on each active phase are necessary to fulfil the basic insulation or simple separation based on the PV working voltage,	Confirmed
Note: The errors in the control circuit simulate that the safety is even under one error ensured,	

4,2,2,3,2	**Overvoltage and undervoltage**				**P**
Test: SMILE5-INV					
First Level					
	Under Voltage		**Over Voltage**		
Parameter		Voltage [V]		Voltage [V]	
Set value		**195,5**		**253**	
Measured trip value [V]	Phase	Line to Neutral	Phase	Line to Neutral	
		196,0		254,5	
		195,6		254,6	
		195,8		254,5	
Parameter		Time [s]		Time [s]	
Limit		**≤ 10,0**		**≤ 40,0**	
Disconnetion time [s]	200V to 190V	9,09	248V to 258V	38,00	
		9,05		38,10	
		9,07		38,00	
Second Level					
	Under Voltage		**Over Voltage**		
Parameter		Voltage [V]		Voltage [V]	
Set value		**115**		**264,5**	
Measured trip value [V]	Phase	Line to Neutral	Phase	Line to Neutral	
		115,1		265,4	
		115,3		265,6	
		115,2		265,5	
Parameter		Time [s]		Time [s]	
Limit		**≤ 0,2**		**≤ 2,0**	
Disconnetion time [s]	200V to 113V	0,1772	248V to 270V	0,1318	
		0,1864		0,1388	
		0,1712		0,1456	

Third Level				
	--		**Over Voltage**	
Parameter				Voltage [V]
Set value				**276**
Measured trip value [V]	--		Phase	Line to Neutral
				277,0
				276,8
				276,7
Parameter				Time [ms]
Limit				**<= 0,16**
Disconnetion time [ms]	--		248V to 280V	0,1412
				0,1472
				0,1360

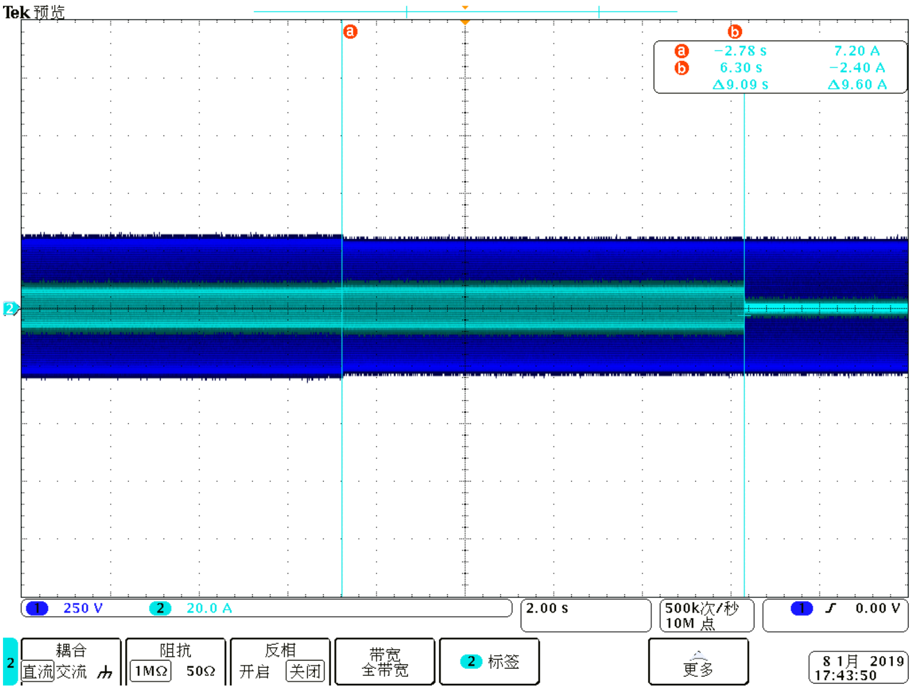
Note:

The NRS 097-2-1 provide limits of accuracy for the utility voltage and frequency measurement of the power system, The values for tolerances given in Table 2 are used,

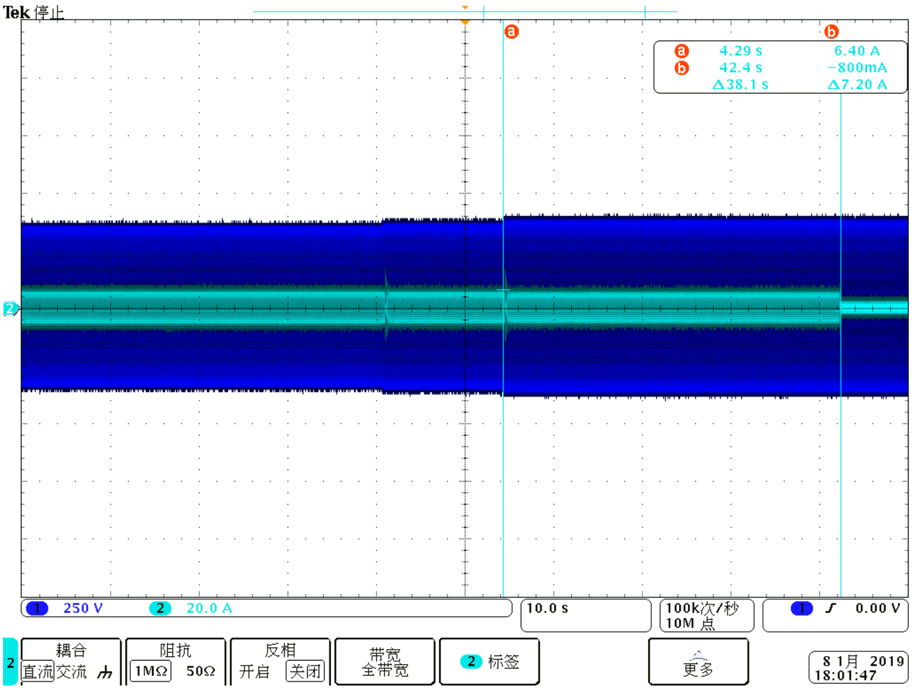
The accuracy for voltage trip values shall be within 0 % to +1 % of the nominal voltage from the upper boundary trip setting, and within -1% to 0% of the nominal voltage from the lower boundary trip setting,

If multi-voltage control settings are not possible, the more stringent trip time should be implemented, e,g, 2 s between 110% and 120% of voltage,

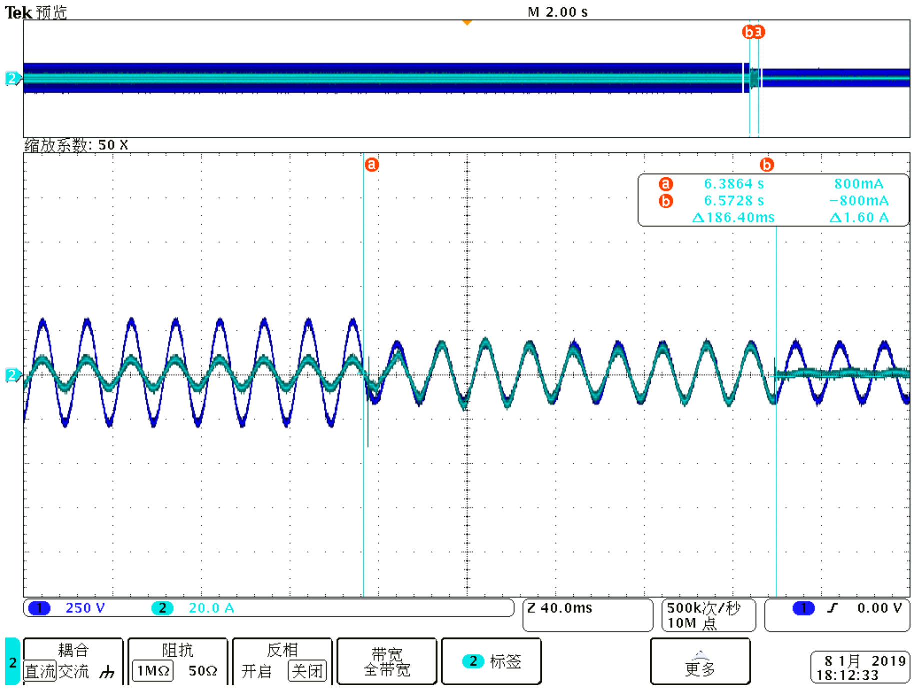
Under Voltage: First Level



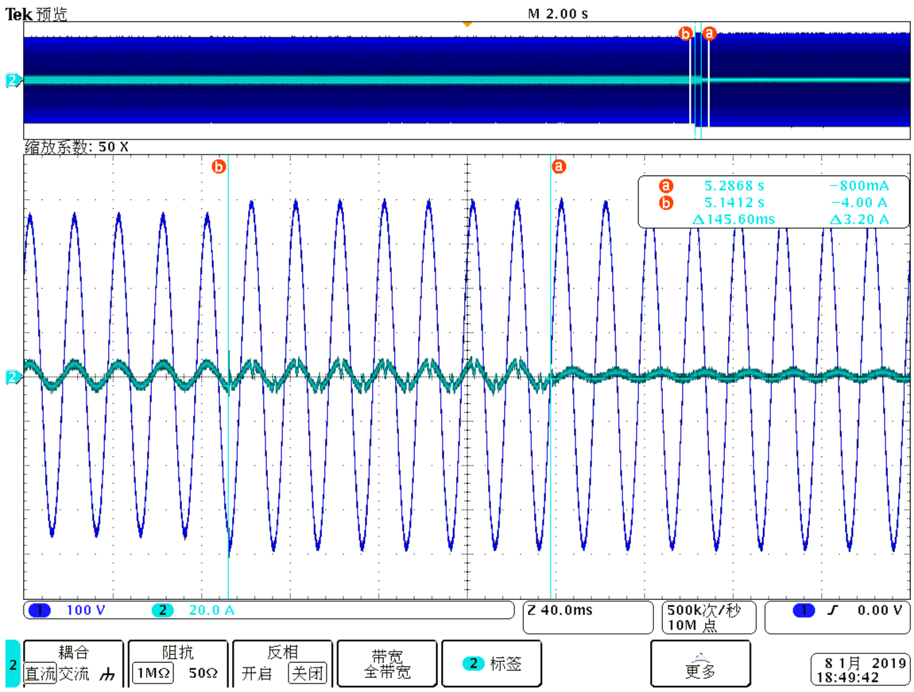
Over Voltage: First Level



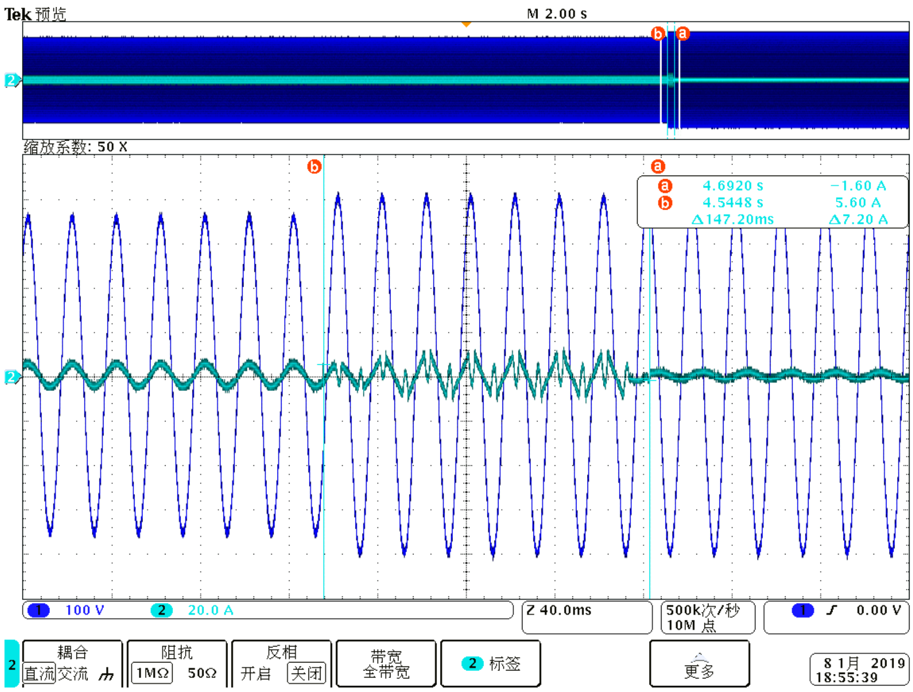
Under Voltage: Second Level



Over Voltage: Second Level



Over Voltage: Third Level



4,2,2,3,2 Low voltage fault Ride through capability (Category A1 and A2)	N/A

General:

The purpose of these tests is to ensure that the converter, which in category A1 and A2, is insensitive to voltage dips according to the time-amplitude profile shown in the diagram,

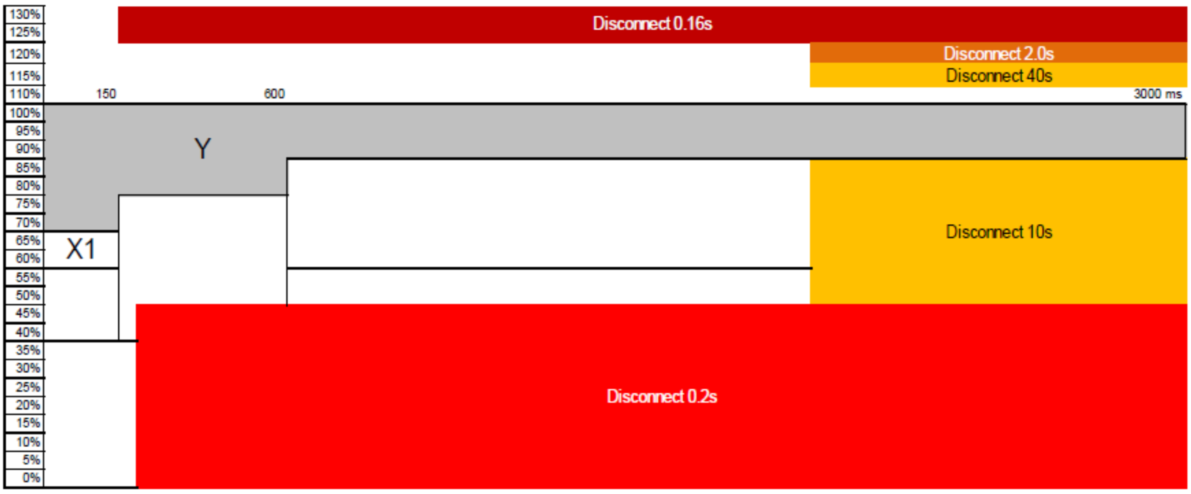


Figure 4 — Graphical representation of voltage-ride-through and voltage disconnect requirements for A1 and A2 EG

List of tests	Residual amplitude of phase-to-phase voltage V/V_{nom}	Tolerance	Duration [ms]	Form (*)
1 - three-phase symmetrical fault	0,60	± 0,05 ($V1/V_{nom}$)	150 ± 20	
2 - three-phase symmetrical fault	0,70	± 0,05 ($V2/V_{nom}$)	150 ± 20	
3 - three-phase symmetrical fault	0,80	± 0,05 ($V3/V_{nom}$)	600 ± 20	
4 - two-phase asymmetrical fault	0,60	± 0,05 ($V4/V_{nom}$)	150 ± 20	
5 - two -phase asymmetrical fault	0,70	± 0,05 ($V5/V_{nom}$)	150 ± 20	
6 - two -phase asymmetrical fault	0,80	± 0,05 ($V6/V_{nom}$)	600 ± 20	
7 - single-phase symmetrical fault	0,60	± 0,05 ($V7/V_{nom}$)	150 ± 20	
8 - single-phase symmetrical fault	0,70	± 0,05 ($V8/V_{nom}$)	150 ± 20	
9 - single-phase symmetrical fault	0,80	± 0,05 ($V9/V_{nom}$)	600 ± 20	

Assessment criterion:

The SSEG shall be able to withstand voltage drops without disconnecting, as shown in Figures 4 for Area X1 and Y, SSEGs of category A1 and A2 should not inject any reactive current into the network,

The test conditions are performed as worst case conditions, The inverter feeds maximal active and reactive power during the complete test,

Graph of LVRT test one				
Test: SMILE5-INV				
List of tests	**Residual amplitude of phase-to-phase voltage V/V_{nom}**	**Duration limit of Voltage dips [ms]**	**Duration measured [ms]**	**Result**
1 – three-phase symmetrical fault (P = 0,1 - 0,3)	0,60	150 + 20		
1 – three-phase symmetrical fault (P > 0,9)	0,60	150 + 20		
2 – three-phase symmetrical fault (P = 0,1 - 0,3)	0,70	150 + 20		
2 – three-phase symmetrical fault (P > 0,9)	0,70	150 + 20		
3 – three-phase symmetrical fault (P = 0,1 - 0,3)	0,80	600 + 20		
3 – three-phase symmetrical fault (P > 0,9)	0,80	600 + 20		
4 – two-phase asymmetrical fault (P = 0,1 - 0,3)	0,60	150 + 20		
4 – two-phase asymmetrical fault (P > 0,9)	0,60	150 + 20		
5 – two-phase asymmetrical fault (P = 0,1 - 0,3)	0,70	150 + 20		
5 – two-phase asymmetrical fault (P > 0,9)	0,70	150 + 20		
6 – two-phase asymmetrical fault (P = 0,1 - 0,3)	0,80	600 + 20		
6 – two-phase asymmetrical fault (P > 0,9)	0,80	600 + 20		
7 –single-phase symmetrical fault (P = 0,1 - 0,3)	0,60	150 + 20		
7 –single-phase symmetrical fault (P > 0,9)	0,60	150 + 20		
8 –single-phase symmetrical fault (P = 0,1 - 0,3)	0,70	150 + 20		
8 –single-phase symmetrical fault (P > 0,9)	0,70	150 + 20		
9 –single-phase symmetrical fault (P = 0,1 - 0,3)	0,80	600 + 20		
9 –single-phase symmetrical fault (P > 0,9)	0,80	600 + 20		
Test conditions: Voltage simulator fall and rise time: < 10ms				
Note:				

4,2,2,3,2	Low voltage fault Ride through capability (Category A3 (For RPP Grid Code))	N/A

General:

The purpose of these tests is to ensure that the converter, which in category A3, is insensitive to voltage dips according to the time-amplitude profile shown in the diagram, (Area B)

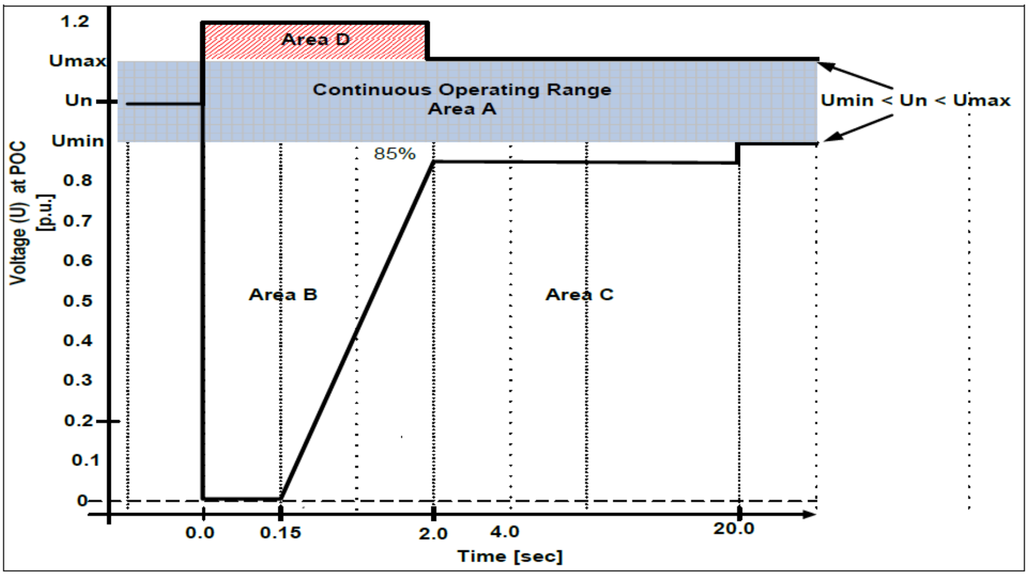


Figure 4: Voltage Ride through Capability for the RPPs of Category A3, B and C utilising non-synchronous machines

List of tests	Residual amplitude of phase-to-phase voltage V/V_{nom}	Tolerance	Duration [ms]	Form (*)
1 - three-phase symmetrical fault	0,00-0,05	$(V1/V_{nom})$	150 + 20	
2 - three-phase symmetrical fault	0,40	$\pm$ 0,05(V2//V_{nom})	1075 + 20	
3 - three-phase symmetrical fault	0,75	$\pm$ 0,05 ($V3/V_{nom}$)	1780 + 20	
4 - three-phase symmetrical fault	0,85	$\pm$ 0,05(V4/Vnom)	20000 + 20	
5 - two-phase asymmetrical fault	0,00-0,05	$(V5/V_{nom})$	150 + 20	
6 - two -phase asymmetrical fault	0,40	$\pm$ 0,05 ($V6/V_{nom}$)	1075 + 20	
7 - two -phase asymmetrical fault	0,75	$\pm$ 0,05 ($V7/V_{nom}$)	1780 + 20	
8 - two -phase asymmetrical fault	0,85	$\pm$ 0,05 ($V8/V_{nom}$)	20000 + 20	
9 - single-phase symmetrical fault	0,00-0,05	$(V9/V_{nom})$	150 + 20	
10 - single-phase symmetrical fault	0,40	$\pm$ 0,05($V10/V_{nom}$)	1075 + 20	
11 - single-phase symmetrical fault	0,75	$\pm$ 0,05($V11/V_{nom}$)	1780 + 20	
12 - single-phase symmetrical fault	0,85	$\pm$ 0,05($V12/V_{nom}$)	20000 + 20	

Assessment criterion:
The SSEG shall be able to withstand voltage drops without disconnecting, as shown in Figures 4 for Area B, SSEGs of category A3 should not inject any reactive current into the network,
The test conditions are performed as worst case conditions, The inverter feeds maximal active and reactive power during the complete test,

Graph of LVRT test one

Test: SMILE5-INV

List of tests	Residual amplitude of phase-to-phase voltage V/V_{nom}	Duration limit of Voltage dips [ms]	Duration measured [ms]	Result
1 – three-phase symmetrical fault (P = 0,1 - 0,3)	0,00-0,05	150 + 20		
1 – three-phase symmetrical fault (P > 0,9)	0,00-0,05	150 + 20		
2 – three-phase symmetrical fault (P = 0,1 - 0,3)	0,40	1075 + 20		
2 – three-phase symmetrical fault (P > 0,9)	0,40	1075 + 20		
3 – three-phase symmetrical fault (P = 0,1 - 0,3)	0,75	1780 + 20		
3 – three-phase symmetrical fault (P > 0,9)	0,75	1780 + 20		
4 – three-phase symmetrical fault (P = 0,1 - 0,3)	0,85	20000 + 20		
4 – three-phase symmetrical fault (P > 0,9)	0,85	20000 + 20		
5 – two-phase asymmetrical fault (P = 0,1 - 0,3)	0,00-0,05	150 + 20		
5 – two-phase asymmetrical fault (P > 0,9)	0,00-0,05	150 + 20		
6 – two-phase asymmetrical fault (P = 0,1 - 0,3)	0,40	1075 + 20		
6 – two-phase asymmetrical fault (P > 0,9)	0,40	1075 + 20		
7 – two-phase asymmetrical fault (P = 0,1 - 0,3)	0,75	1780 + 20		
7 – two-phase asymmetrical fault (P > 0,9)	0,75	1780 + 20		
8 – two-phase asymmetrical fault (P = 0,1 - 0,3)	0,85	20000 + 20		
8 – two-phase asymmetrical fault (P > 0,9)	0,85	20000 + 20		
9 –single-phase symmetrical fault (P = 0,1 - 0,3)	0,00-0,05	150 + 20		
9 –single-phase symmetrical fault (P > 0,9)	0,00-0,05	150 + 20		

10 –single-phase symmetrical fault (P = 0,1 - 0,3)	0,40	1075 + 20		
10 –single-phase symmetrical fault (P > 0,9)	0,40	1075 + 20		
11 –single-phase symmetrical fault (P = 0,1 - 0,3)	0,75	1780 + 20		
11 –single-phase symmetrical fault (P > 0,9)	0,75	1780 + 20		
12 –single-phase symmetrical fault (P = 0,1 - 0,3)	0,85	20000 + 20		
12 –single-phase symmetrical fault (P > 0,9)	0,85	20000 + 20		
Test conditions: Voltage simulator fall and rise time: < 10ms				
Note:				

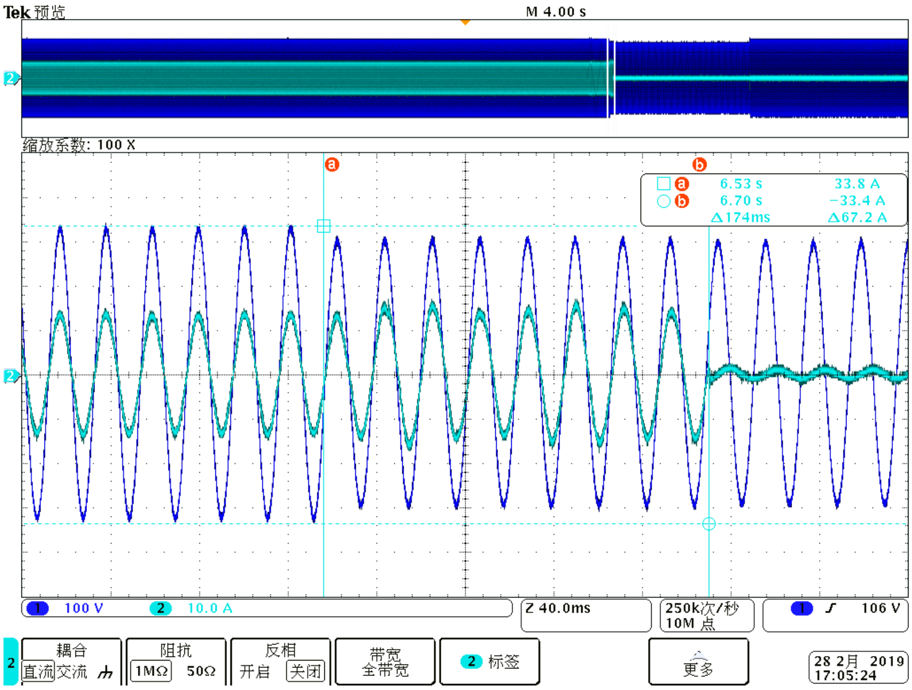
4,2,2,3,3	**Overfrequency and underfrequency**								**P**
	Under frequency				**Over frequency**				
Parameter		Frequency [Hz]				Frequency [Hz]			
Output Voltage		~85%U_N	~U_N	~110%U_N		~85%U_N	~U_N	~110%U_N	
Limit [s]	47,00Hz	0,2s			52,00 Hz	4 ≤ t ≤ 4,5s			
Measured trip value [Hz]		47,0	47,0	47,0		52,0	52,0	52,0	
Disconnetion time [s]	48,0 Hz to 46,5 Hz	0,160	0,174	0,166	51,0 Hz to 52,5 Hz	4,260	4,250	4,180	

Note:
Method for ramp:
It was measured at a continuous change of frequency of 1Hz/s at lower, nominal and upper U_N and arbitary output power, The trip value was determined manually by reducing the frequency in 10mHz steps, When the trip value is known (e,g, 47Hz), the ac-source is programmed to run from e,g, 47,50Hz to 46,50Hz with 1Hz/s, The disconnection time is calculated by the measured time minus the 500ms from 47,5Hz to 47Hz,

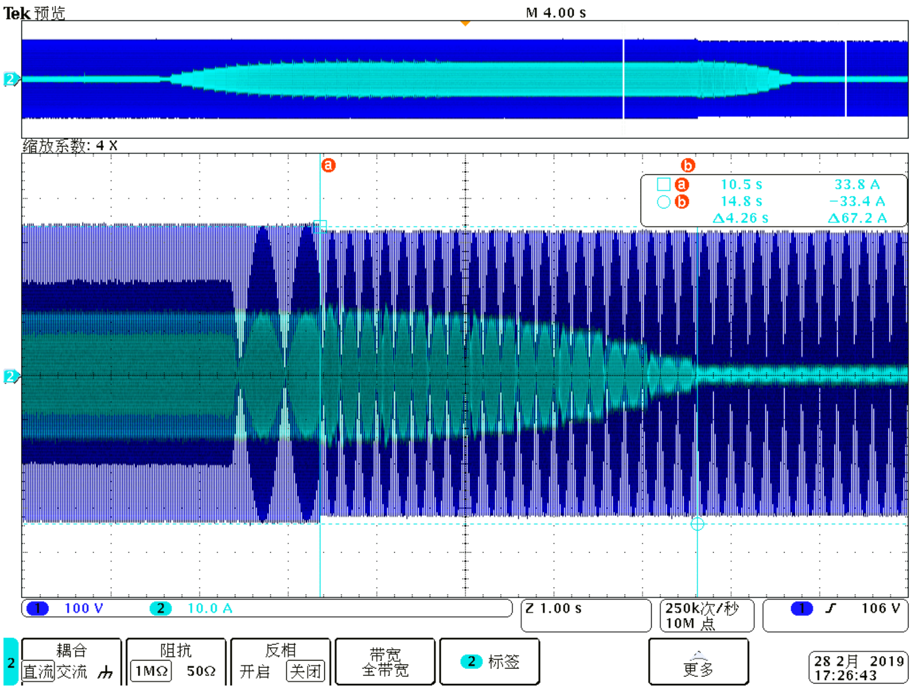
Method for trip:
The frequency which inverter stops feeding power to electrical system in each test must be in the range of the frequency trip setting +/- 0,1Hz and the time it takes to cut off the power must be within limit value,

The accuracy for frequency trip values shall be within 0 % to +1 % of the nominal frequency from the upper boundary trip setting, and within -1% to 0% of the nominal frequency from the lower boundary trip setting,

Under frequency:

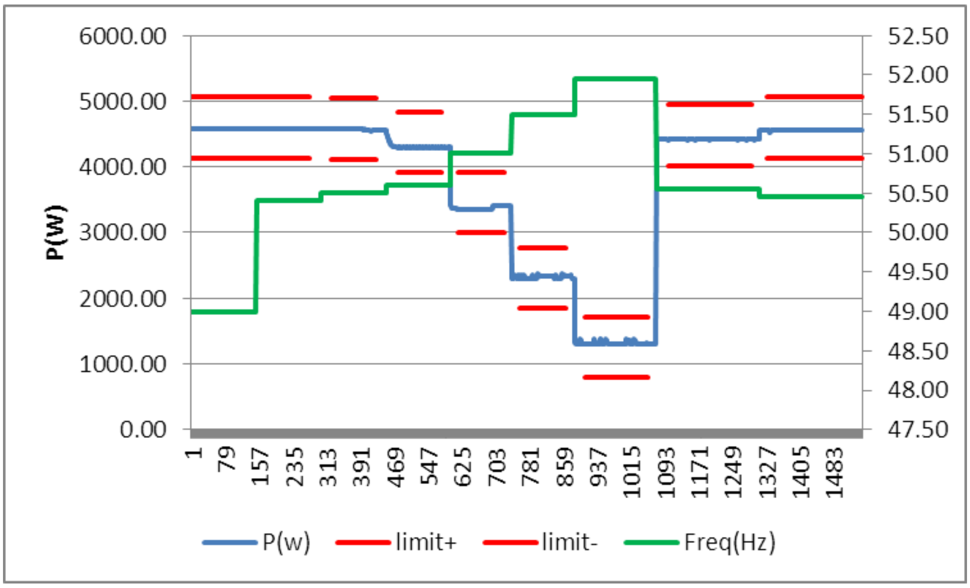


Over frequency:

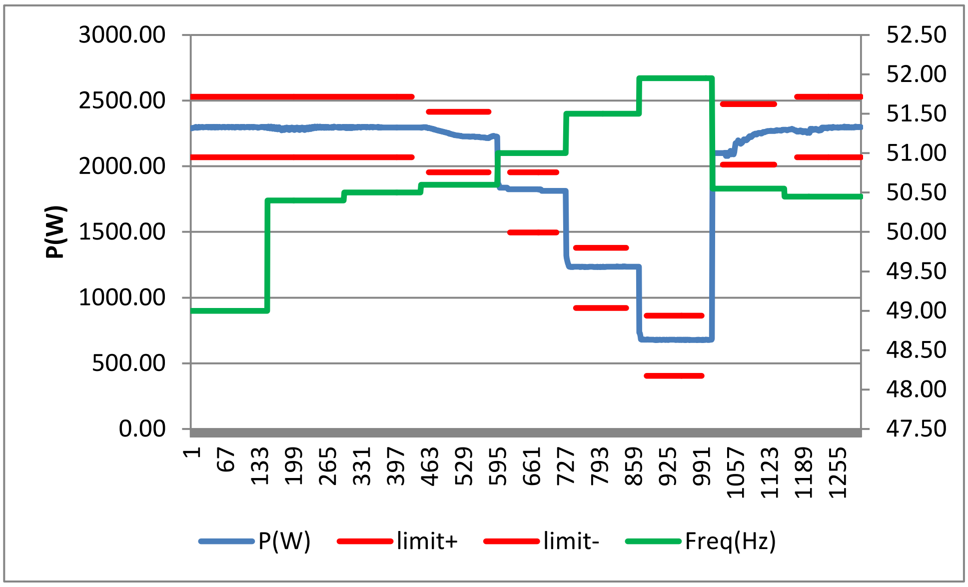


4,2,2,3,3	**Active power feed-in for over-frequency**								**P**
Model : SMILE5-INV									
Test:									
1-min mean value [Hz]	a) 49,00	b) 50,40	c) 50,50	c) 50,60	d) 51,00	e) 51,50	g) 51,95	h) 50,55	i) 50,45
1, Measurement a) to g): Active power output > 80% P_n									
Frequency [Hz]:	49,0	50,4	50,5	50,6	51,0	51,5	51,95	50,55	50,45
$P_{setpoint}$ [kW]:	4,60	4,60	4,58	4,38	3,46	2,30	1,26	4,48	4,60
P_{E60} [kW]:	4,58	4,58	4,57	4,31	3,37	2,33	1,32	4,42	4,56
$\Delta P_{E60}/P_{Setpoint}$ [%]:	0,43	0,43	0,22	1,52	1,96	0,65	1,31	1,31	0,87
2, Measurement a) to i): Active power output 40% and 60% after freezing > 80% P_n									
Frequency [Hz]:	49,0	50,4	50,5	50,6	51,0	51,5	51,95	50,55	50,45
$P_{setpoint}$ [kW]:	2,30	2,30	2,29	2,19	1,73	1,15	0,63	2,24	2,30
P_{E60} [kW]:	2,29	2,29	2,28	2,25	1,82	1,24	0,68	2,18	2,28
$\Delta P_{E60}/P_{Setpoint}$ [%]:	0,40	0,40	0,40	2,61	3,91	3,91	2,17	2,61	0,87
Limit $\Delta P_{E60}/P_{Setpoint}$:	+ 10 % of P_{Emax}								

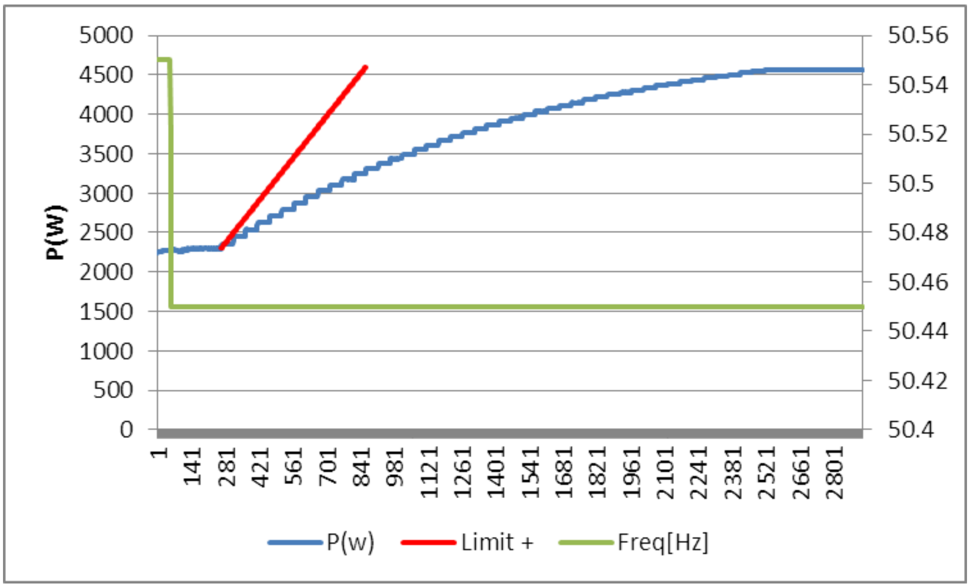
Graph of Measurement 1,: Active power output > 80% P_n



Graph of Measurement 2,:Active power output 40% and 60% after freezing > 80% P_n



Graph of power gradient:



Test:

The test is conducted for two powers, First, the test must start at a power > 80% P_n ("Measurement 1"), and in a second test, for a power between 40% to 60% P_n ("Measurement 2"), In the second test, after freezing of the PM, the available active power output must be increased to a value > 80% P_n, and after the network frequency of 50,5 Hz is fallen below, the rise of the active power gradient must be recorded,

Assessment criterion:

For f=50,5 Hz, the value of the PM active power currently being generated is "frozen",

For adjustable PGUs when:

1) the active power reduces between measuring points c) and g) given above with a gradient of 50% P_M per Hz for a decreasing frequency (or rises for a frequency decreasing again),
2) the reaction value of the setpoint determined by the gradient characteristic curve does not differ from P_n by more than ± 10%,

When the utility frequency exceeds 50,5 Hz, the active power available at the time shall be stored as the maximum power value P_M; this value P_M shall not be exceeded until the frequency has stabilised below 50,5 Hz for at least 4 seconds,

Note:

4,2,2,4 Preventing of islanding

Test circuit and parameters

Parameter	Symbol	Units
EUT DC Input		
DC voltage	V_{DC}	V
DC Current	I_{DC}	A
DC Power	P_{DC}	W
EUT AC ouput		
AC voltage	V_{EUT}	V
AC current	I_{EUT}	A
Real power	P_{EUT}	W
Reactive power	Q_{EUT}	VAr
Test Load		
Resistive load current	I_R	A
Inductive load current	I_L	A
Capacitive load current	I_C	A
AC (utility) power source		
Utility real power	P_{AC}	W
Utility reactive power	Q_{AC}	VAr
Utility current	I_{AC}	A

Block diagram test circuit IEC 62116:2014

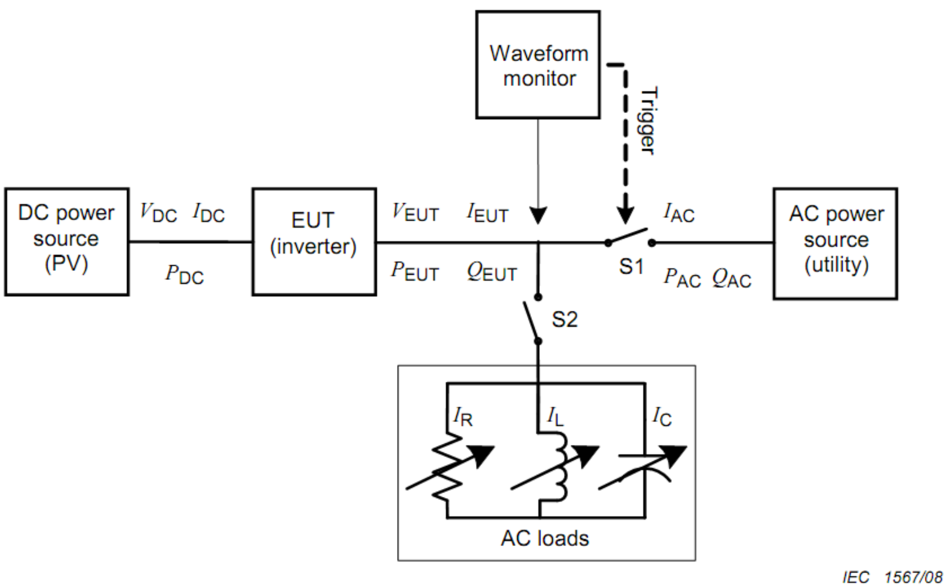


Figure 1 – Test circuit for islanding detection function in a power conditioner (inverter)

4,2,2,4	Islanding protection according IEC 62116 table 6 Load imbalance (real, reactive load) for test condition A (EUT ouput = 100%)								P
Test: SMILE5-INV									
Test conditions			Frequency: 50+/-0,1Hz U_N=230 +/-3Vac Distortion factor of chokes < 2% Quality = 1						
Disconnection limit			2s						
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]	Run on Time [ms]	P_{EUT} [kW]	Actual Q_f	V_{DC} [V]	Remarks4)
1	100	100	0	0	345	4,6	1,00	443,75	Test A at BL
2	100	100	-10	-10	45	4,6	0,91	443,75	Test A at IB
3	100	100	-10	-5	190	4,6	0,95	443,75	Test A at IB
4	100	100	-10	0	240	4,6	1,00	443,75	Test A at IB
5	100	100	-10	+5	115	4,6	1,05	443,75	Test A at IB
6	100	100	-10	+10	65	4,6	1,10	443,75	Test A at IB
7	100	100	-5	-10	75	4,6	0,90	443,75	Test A at IB
8	100	100	-5	-5	135	4,6	0,95	443,75	Test A at IB
9	100	100	-5	0	240	4,6	1,00	443,75	Test A at IB
10	100	100	-5	+5	145	4,6	1,05	443,75	Test A at IB
11	100	100	-5	+10	55	4,6	1,10	443,75	Test A at IB
12	100	100	0	-10	60	4,6	0,90	443,75	Test A at IB
13	100	100	0	-5	130	4,6	0,95	443,75	Test A at IB
14	100	100	0	+5	125	4,6	1,05	443,75	Test A at IB
15	100	100	0	+10	90	4,6	1,10	443,75	Test A at IB
16	100	100	+5	-10	115	4,6	0,90	443,75	Test A at IB
17	100	100	+5	-5	95	4,6	0,95	443,75	Test A at IB
18	100	100	+5	0	335	4,6	1,00	443,75	Test A at IB
19	100	100	+5	+5	140	4,6	1,05	443,75	Test A at IB
20	100	100	+5	+10	45	4,6	1,10	443,75	Test A at IB
21	100	100	+10	-10	125	4,6	0,90	443,75	Test A at IB
22	100	100	+10	-5	90	4,6	0,95	443,75	Test A at IB
23	100	100	+10	0	175	4,6	1,00	443,75	Test A at IB
24	100	100	+10	+5	75	4,6	1,05	443,75	Test A at IB
25	100	100	+10	+10	80	4,6	1,10	443,75	Test A at IB

Parameter at 0% per phase	L=	36,62	mH	R=	11,50	Ω	C=	276,93	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) BL: Balance condition, IB: Imbalance condition,

Condition A:

EUT output power P_{EUT} = Maximum [5)]

EUT input voltage [6)] = >90% of rated input voltage range

5) Maximum EUT output power condition should be achieved using the maximum allowable input power, Actual output power may exceed nominal rated output,

6) 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,

4,2,2,4	Islanding protection according IEC 62116 table 6 Load imbalance (real, reactive load) for test condition B (EUT output = 50% – 66%)								P
Test: SMILE5-INV									
Test conditions			Frequency: 50+/-0,1Hz U_N=230 +/-3Vac Distortion factor of chokes < 2% Quality = 1						
Disconnection limit			2s						
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]	Run on Time [ms]	P_{EUT} [kW]	Actual Q_f	V_{DC} [V]	Remarks4)
1	66	66	0	-5	124	3,036	0,95	337,5	Test B at IB
2	66	66	0	-4	180	3,036	0,96	337,5	Test B at IB
3	66	66	0	-3	200	3,036	0,97	337,5	Test B at IB
4	66	66	0	-2	250	3,036	0,98	337,5	Test B at IB
5	66	66	0	-1	270	3,036	0,99	337,5	Test B at IB
6	66	66	0	0	330	3,036	1,00	337,5	Test B at BL
7	66	66	0	+1	210	3,036	1,01	337,5	Test B at IB
8	66	66	0	+2	165	3,036	1,02	337,5	Test B at IB
9	66	66	0	+3	180	3,036	1,03	337,5	Test B at IB
10	66	66	0	+4	215	3,036	1,04	337,5	Test B at IB
11	66	66	0	+5	130	3,036	1,05	337,5	Test B at IB

Parameter at 0% per phase	L=	55,49	mH	R=	17,42	Ω	C=	182,77	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) BL: Balance condition, IB: Imbalance condition,

Condition B:

EUT output power P_{EUT} = 50 % – 66 % of maximum

EUT input voltage 5) = 50 % of rated input voltage range, ±10 %

5) 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,

4,2,2,4	Islanding protection according IEC 62116 table 6 Load imbalance (real, reactive load) for test condition C (EUT output = 25% – 33%)	P

Test: SMILE5-INV

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

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]	Run on Time [ms]	P_{EUT} [kW]	Actual Q_f	V_{DC} [V]	Remarks4)
1	33	33	0	-5	80	1,518	0,95	167,5	Test B at IB
2	33	33	0	-4	160	1,518	0,96	167,5	Test B at IB
3	33	33	0	-3	186	1,518	0,97	167,5	Test B at IB
4	33	33	0	-2	190	1,518	0,98	167,5	Test B at IB
5	33	33	0	-1	180	1,518	0,99	167,5	Test B at IB
6	33	33	0	0	172	1,518	1,00	167,5	Test B at BL
7	33	33	0	+1	202	1,518	1,01	167,5	Test B at IB
8	33	33	0	+2	302	1,518	1,02	167,5	Test B at IB
9	33	33	0	+3	195	1,518	1,03	167,5	Test B at IB
10	33	33	0	+4	200	1,518	1,04	167,5	Test B at IB
11	33	33	0	+5	70	1,518	1,05	167,5	Test B at IB

Parameter at 0% per phase	L=	110,98	mH	R=	34,85	Ω	C=	91,39	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) BL: Balance condition, IB: Imbalance condition,

Condition C:

EUT output power P_{EUT} = 25 % – 33 % 5) of maximum

EUT input voltage 6) = <10 % of rated input voltage range

5) Or minimum allowable EUT output level if greater than 33 %,

6) Based on EUT rated input operating range, For example, If range is between X volts and Y volts, 10 % of range =X + 0,1 × (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,

Annex 1

EMC Test Report

(The whole EMC test report was stored in internal of BV LCIE CHINA)

Produkte
Products

TÜVRheinland®

Prüfbericht-Nr.: *Test Report No.:*	50108188 001	**Auftrags-Nr.:** *Order No.:*	154277994	**Seite 1 von 38** *Page 1 of 38*
Kunden-Referenz-Nr.: *Client Reference No.:*	610091	**Auftragsdatum:** *Order date.:*	15.09.2017	
Auftraggeber: *Client:*	**Alpha ESS Co., Ltd.** *Build No. 1, Dong Da Science Park, Nantong High-Tech Industrial Development Zone, Nantong City, Jiangsu 226300, P.R. China*			
Prüfgegenstand: *Test item:*	**Grid-connected Hybrid Inverter**			
Bezeichnung / Typ-Nr.: *Identification / Type No.:*	**SMILE5-INV**			
Auftrags-Inhalt: *Order content:*	**EMC test**			
Prüfgrundlage: *Test specification:*	**EN 61000-6-4:2007+A1** **EN 61000-6-3:2007+A1** **EN 61000-6-2:2005** **EN 61000-6-1:2007**			
Wareneingangsdatum: *Date of receipt:*	**13.10.2017**			
Prüfmuster-Nr.: *Test sample No.:*	**A000642474-001/002**			
Prüfzeitraum: *Testing period:*	**Refer to test report**			
Ort der Prüfung: *Place of testing:*	**EMC laboratory**			
Prüflaboratorium: *Testing laboratory:*	**TÜV Rheinland (Shanghai) Co., Ltd.**			
Prüfergebnis*: *Test result*:*	**Pass**			

geprüft von / *tested by:*

05.12.2017	Jimmy Qian/Assistant project manager	
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

kontrolliert von / *reviewed by:*

05.12.2017	Jiayi Zhou/Department manager	
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

Sonstiges / *Other:*

The emission requirements of EN 61000-6-3:2007+A1 and immunity requirements of EN 61000-6-2:2005 are stricter than that of EN 61000-6-4:2007+A1 and of EN 61000-6-1:2007 respectively, so the EMI tests were performed according to EN 61000-6-3:2007+A1 and EMS tests were performed according to EN 61000-6-2:2005.

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery:* **Prüfmuster vollständig und unbeschädigt** Test item complete and undamaged

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	1 = very good	2 = good	3 = satisfactory	4 = sufficient	5 = poor
	P(ass) = passed a.m. test specifications(s)		F(ail) = failed a.m. test specifications(s)	N/A = not applicable	N/T = not tested

Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.

This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.

TÜV Rheinland (Shanghai) Co., Ltd. No.177, 178, Lane 777 West Guangzhong Road, Jing'an District,Shanghai, China

Produkte
Products

TEST SUMMARY

4.1.1 HARMONICS ON AC MAINS
Result:
Passed
4.1.2 VOLTAGE CHANGES, VOLTAGE FLUCTUATIONS AND FLICKER ON AC MAINS
Result:
Passed
4.1.3 MAINS TERMINAL CONTINUOUS DISTURBANCE VOLTAGE
Result:
Passed
4.2.1 RADIATED EMISSION
Result:
Passed
5.1.1 ELECTROSTATIC DISCHARGE
Result:
Passed
5.1.2 RADIO FREQUENCY ELECTROMAGNETIC FIELD
Result:
Passed
5.1.3 POWER FREQUENCY MAGNETIC FIELDS
Result:
Passed
5.2.1 ELECTRICAL FAST TRANSIENTS AND BURSTS
Result:
Passed
5.2.2 CONDUCTED DISTURBANCES, INDUCED BY RF FIELDS
Result:
Passed
5.2.3 SURGES
Result:
Passed
5.2.4 VOLTAGE DIPS AND INTERRUPTIONS ON AC POWER PORT
Result:
N/A

Produkte
Products

Prüfbericht - Nr.: *Test Report No.:*	**50108188 001**	**Seite 3 von 38** *Page 3 of 38*

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1 Test Sites

1.1 Test Facilities

Laboratory: TÜV Rheinland (Shanghai) Co., Ltd.
Address: No.177, 178, Lane 777 West Guangzhong Road, Jing'an District,Shanghai, China.

The used test equipment is in accordance with CISPR 16-1 series standards for measurement of radio interference.

1.2 List of Test and Measurement Instruments

Produkte
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Prüfbericht - Nr.: 50108188 001
Test Report No.:

Table 1: List of Test and Measurement Equipment

No.	Equipment	Model	Inventory no.	Cal. due date
1.	3-phase Harmonics/Fluctuation Tester	ProfLine 2145-400	1549A00526, 1548A00453	03.03.2018
2.	Artificial mains network	ENV216	101199	21.09.2018
3.	EMI test receiver	ESCI	101083	21.09.2018
4.	3m modified semi-anechoic chamber	SAC3	FJ129002	04.02.2019
5.	EMI test receiver	ESCI	100280	03.11.2017
6.	Bilog antenna	CBL 6112D	40530	13.02.2020
7.	ESD generator	NSG 437	392	27.07.2018
8.	Barometer	DYM3	08102717	06.04.2018
9.	Capacitive coupling clamp	CDN 8014	31008	03.11.2018
10.	EMC test system	NSG 3040	1705	22.11.2017
11.	RF generator	NSG 2070	1083	12.05.2018
12.	Coupling/decoupling network	CDN M016	20810	02.11.2017
13.	Current injection probe	KEMZ 801	19231	N/A
14.	Conducted Immunity Test System	NSG 4070B-75	34305	05.09.2018
15.	Mains frequency magnetic fields generator	MFO 6501&INA702	34296&142	21.02.2018
16.	Fully anechoic chamber	FAC3plus	FJ139001	24.07.2019
17.	Broadband field meter	NBM-520	C-0120	05.07.2019
18.	E-field probe	EF1891	A-0387	05.07.2019
19.	Signal generator	SML 02	101162	12.05.2018
20.	Power amplifier	80RF1000-30	1077138	21.11.2018
21.	EMS antenna	HL 046	100039	N/A
22.	Power meter	PMS_1081	1081A3123	21.02.2018
23.	Power meter	PMS_1081	1081A3122	21.02.2018
24.	Power amplifier	AS0102-55	1007954	02.11.2018
25.	Broadband horn antenna	BBHA 9120 E	BBHA 9120 E 224	N/A
26.	Signal generator	SMR20	101393	02.11.2020
27.	Power amplifier	AS0206-50	1035578	02.11.2018
28.	Power meter	NRVS	836333/067	12.05.2018
29.	Power sensor	NRV-Z1	100091	12.05.2018
30.	Single channel power meter	E4418B	MY50000152	21.02.2018
31.	Power sensor	E9300H	MY41495960	21.02.2018

2 General Product Information

2.1 Product Function and Intended Use

The EUT (equipment under test) are ordinary Grid-connected Hybrid Inverter. For the further information, refer to the user's manual.

2.2 Ratings and System Details

DC-input (Solar array specifications)		
V_{max} PV.	:	580V ⎓
$V_{MPPTmin.}$ voltage	:	125V ⎓
$V_{MPPTmax.}$ voltage	:	580V ⎓
Max. input current	:	2*12A d.c.
AC-output(Solar array specifications)		
Rated output power	:	4.6kW (on grid) 4.0kW (Stand-Alone)
Rated output voltage	:	230V AC
Rated output frequency	:	50Hz
Max. output current	:	22A
Protection class	:	I

DC-input (Battery interface specifications)

Battery voltage	:	DC 40-60V
Maximum charging current	:	100A
Maximum discharge current	:	100A

2.3 Independent Operation Modes

The basic operation modes are: "On" or "Off".

2.4 Noise Generating and Noise Suppressing Parts

Refer to the circuit diagram for further information.

2.5 Submitted Documents

Circuit diagram and rating label.

3 Test Set-up and Operation Modes

3.1 Principle of Configuration Selection

Emission: The equipment under test (EUT) was configured to measure its highest possible emission level. The test conditions were adapted accordingly in reference to the instructions for use.

Refer to the related paragraph of this report.

Immunity: The equipment under test (EUT) was configured to have its highest possible susceptibility against the tested phenomena. The test conditions were adapted accordingly in reference to the instructions for use.

Refer to the related paragraph of this report.

3.2 Physical Configuration for Testing

Refer to the related paragraph of this report.

3.3 Test Operation and Test Software

During the test, EUT was monitored by wireless connection, no signal line incorporated.

3.4 Special Accessories and Auxiliary Equipment

None.

3.5 Countermeasures to achieve EMC Compliance

Ferrite ring core was incorporated in the power line: HITACHI METALS LTD OR EQ T40*25*15.
EUT also contains noise suppression components as described in electric circuit diagram.

4 Test Results EMISSION

4.1 Emission in the Frequency Range up to 30 MHz

4.1.1 Harmonics on AC Mains

Result:	Passed

Date of testing	:	01.11.2017
Test procedure	:	EN 61000-3-12:2011
Test duration	:	2.5min
Harmonic order	:	2 – 40th
Frequency range	:	0 – 2kHz
Ambient condition	:	Temperature: 23.2°C; Relative humidity: 43.7%

Following are the measurement results, which were obtained via an automatic measurement system.

Note 1: For "Battery operation" and "normal PV operation"mode, due to the characteristics of the system which mentioned in clause 2.2, the harmonic current emission requirements as specified by IEC 61000-3-2 are not applicable.

STIEE

CMA 180008221885

中国认可
国际互认
检测
TESTING
CNAS L1145

报告编号：
Reference №： ETI2019-2-631

检验报告
Test Report

产品名称： Name of products：	Energy Storage inverter
型　　号： Type：	SMILE5-INV
委托方： Client：	Alpha ESS Co., Ltd.
检验类别： Kind of test：	Commission test

上 海 电 器 设 备 检 测 所 有 限 公 司

SHANGHAI TESTING & INSPECTION INSTITUTE
FOR ELECTRICAL EQUIPMENT CO., LTD.

No. ETI2019-2-631 Page 1 of 9

Shanghai Testing & Inspection Institute For Electrical Equipment Co., Ltd.
Test Report

Name of product	Energy Storage inverter		Trade mark	Alpha-ESS	
Type	SMILE5-INV				
Technical parameters	Input:DC220V Output:AC230V/50Hz				
Kind of test	Commission test				
Applicant	Alpha ESS Co., Ltd.	Address	JiuHua Road 888,Nantong High-Tech Industrial Development Zone, Nantong city, 226300, Jiangsu Province, P.R.China		
Manufacturer	Alpha ESS Co., Ltd.	Address	JiuHua Road 888,Nantong High-Tech Industrial Development Zone, Nantong city, 226300, Jiangsu Province, P.R.China		
Sampling address	/	Sampler	/	Sampling base	/
Number of samples	1	Deliverer	/	Product number	/
Sampling date	/	Date of receiving samples	/		
Samples number	#01				
Test specification	EN 50065-1:2011 Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz - Part 1: General requirements, frequency bands and electromagnetic disturbances				
Test criteria	EN 50065-1:2011 Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz - Part 1: General requirements, frequency bands and electromagnetic disturbances				
Test date	2019-03-07				
Test results	Compliance 上海电器设备检测所有限公司 检验检测专用章 Date of Issue：2019.3.19				
Remark	/				

Approved by: 叶承瑜 Verified by: 谢延萍 Edited by: [signature]

ET/RP0001-2016(1/2)E 171215

CONTENT

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3.1 CONDUCTED EMISSION TEST 5

1.Test Summary

The Electromagnetic Compatibility requirements on model SMILE5-INV tested for this test are stated below. All results listed in this report relate exclusively as the Equipment Under Test.

Electromagnetic Compatibility Test				
Test Item	**Test standard**	**Test Port**	**Acceptance test performance**	**Test Results**
Conducted Emission	EN 50065-1:2011	AC power port	/	P

Note: P-Pass; F-Fail

Annex 2

Datasheet of the relay

FUJITSU

POWER RELAY
1 POLE - High Capacity 32A Type

FTR-K3-PV Series

FEATURES

- 1 pole, 32A
- 1 form A contact
- Wide contact gap: 1.5mm
  Surge strength (B/T open contacts) 2.5kV
  Compliant with European photovoltaic standard (VDE0126)
- High insulation in small package (between coil and contacts)
  - Dielectric strength: AC 4,000V
  - Surge strength: 6,000V
- Low coil power consumption: 1,200mW
- Coil holding voltage can be reduced up to 35% of nominal coil voltage (ambient temperature; +20 °C, contact current; 32A)
  Power consumption at the lowest coil holding voltage; 147mW
  * Coil holding voltage is the coil voltage after 100ms of applied nominal coil voltage
- Plastic materials: Flammability; UL94 V-0
- Cadmium-free contacts
- Flux free, cat. RTII protection
- RoHS compliant.
  Please see page 5 for more information

PARTNUMBER INFORMATION

[Example] FTR-K3 (a) A (b) B (c) 012 (d) W (e) - PV (f)

(a)	Relay type	FTR-K3 : FTR-K3-Series
(b)	Contact configuration	A : 1 form A / PCB type
(c)	Coil power	B : Standard (1,200mW)
(d)	Coil rated voltage	012 : 5.....48 VDC Coil rating table at page 3
(e)	Contact material	W : Silver alloy
(f)	Option code	PV : High current (32A) / contact gap 1.5mm

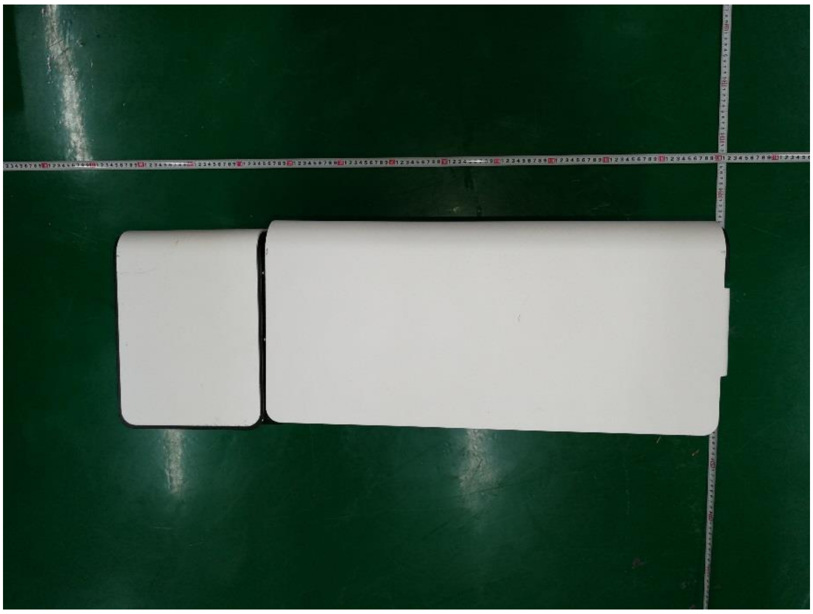
E.g.: Ordering code: FTR-K3AB012W-PV   Actual marking: K3AB012W-PV

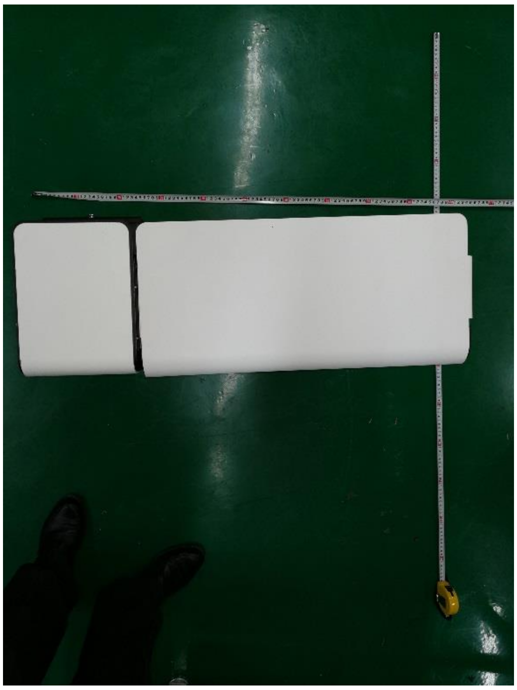
1

Annex 3
Pictures of the unit

Front enclosure view for all models

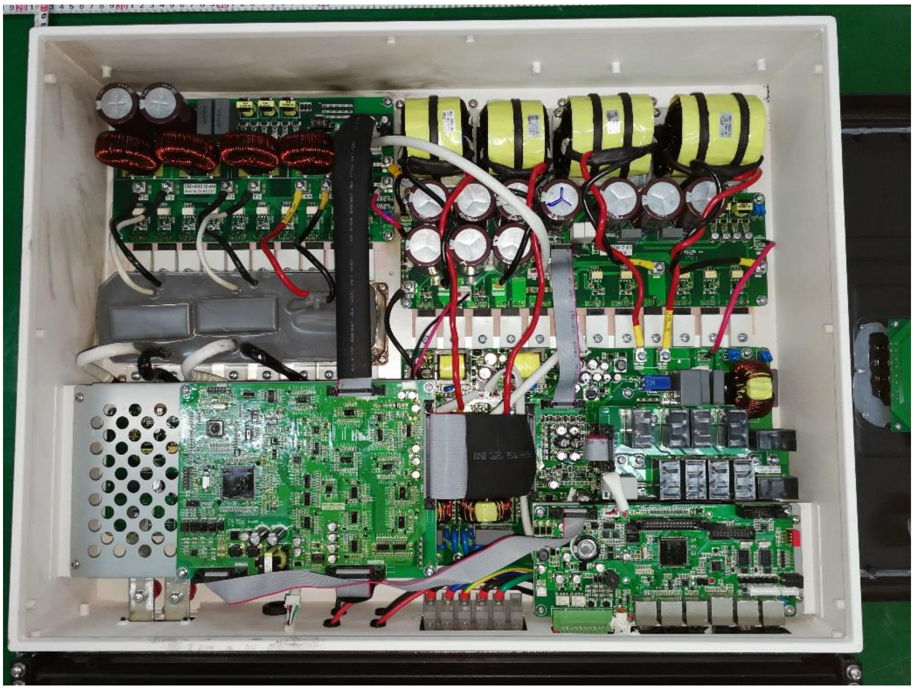

Back enclosure view for all models


Right enclosure view for all models

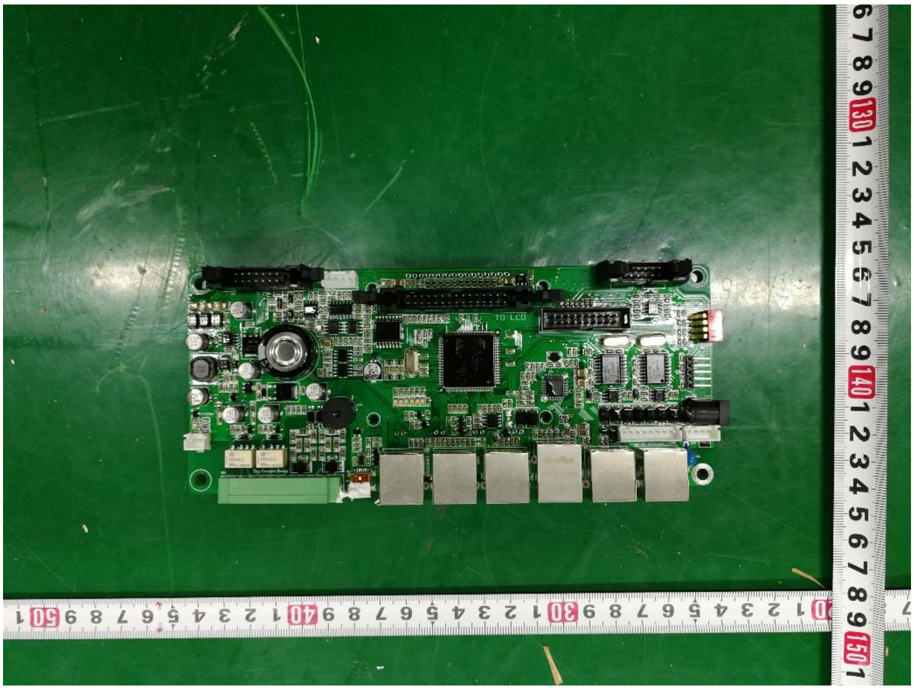

Left enclosure view for all models

Top enclosure view

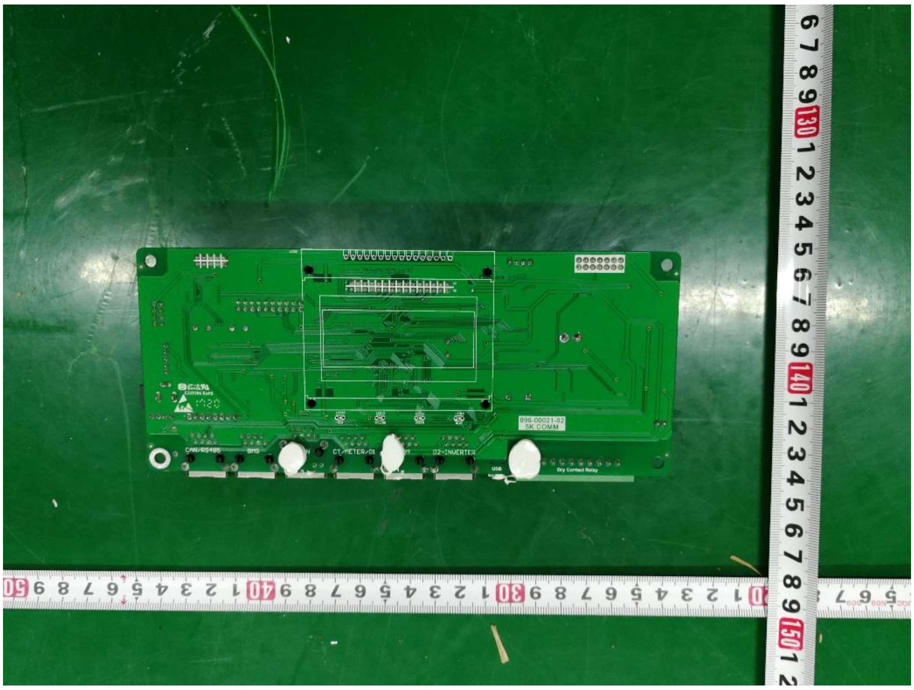
Bottom enclosure view



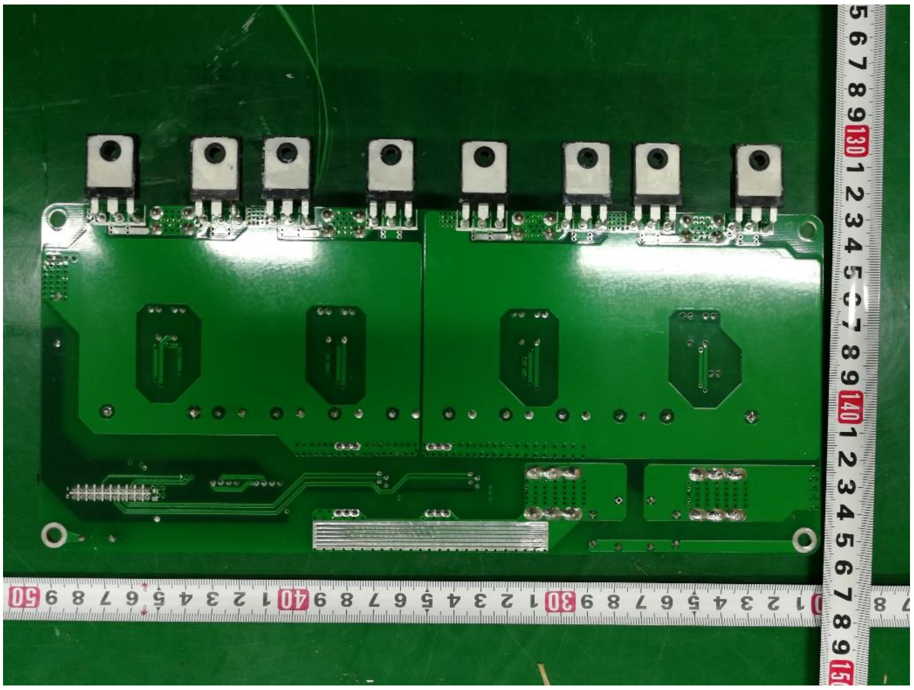
Internal view for all model



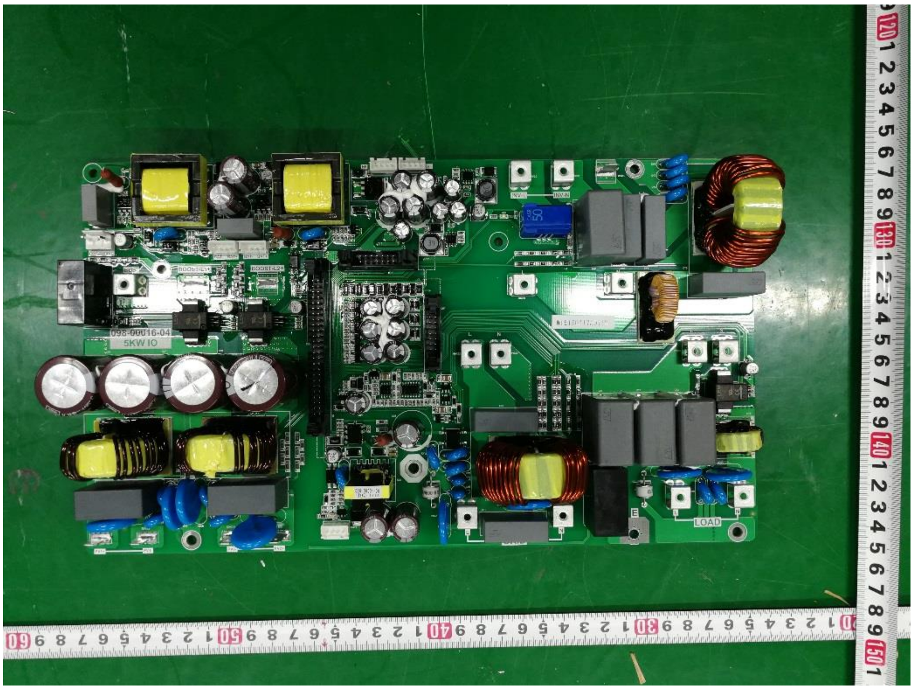
Component side of communication board


Solder side of communication board

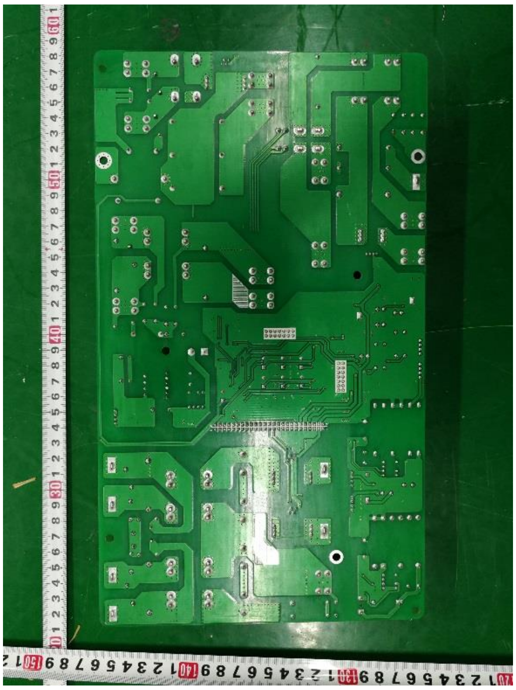

Component side of INV board

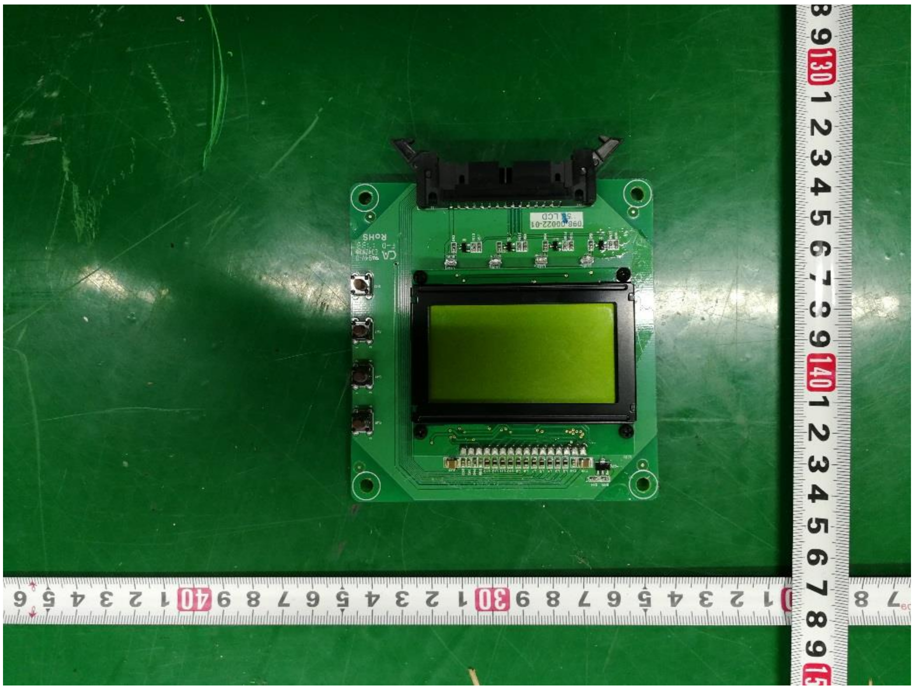


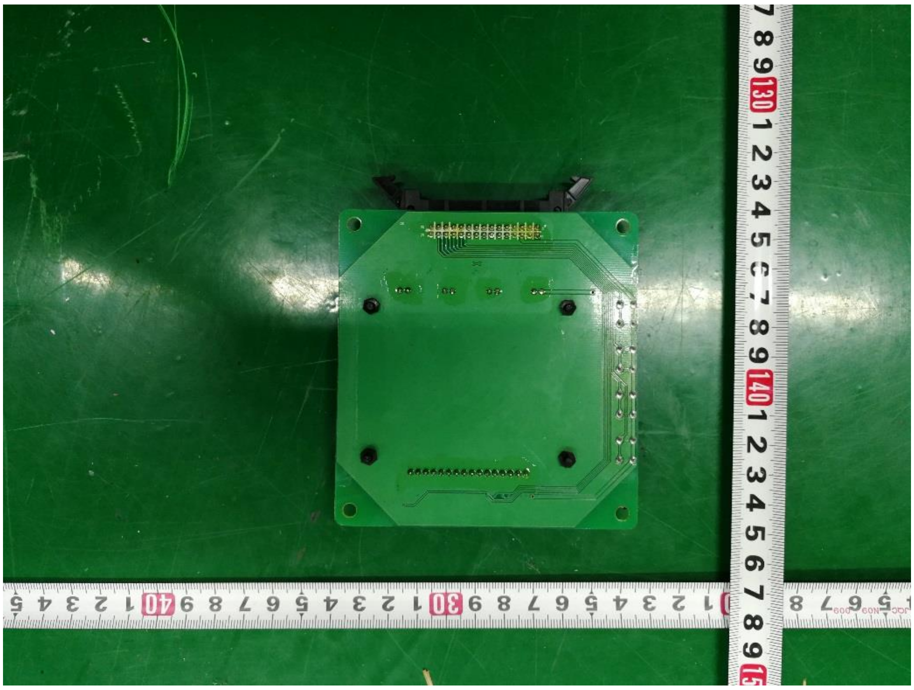
Solder side of INV board



Component side of IO board

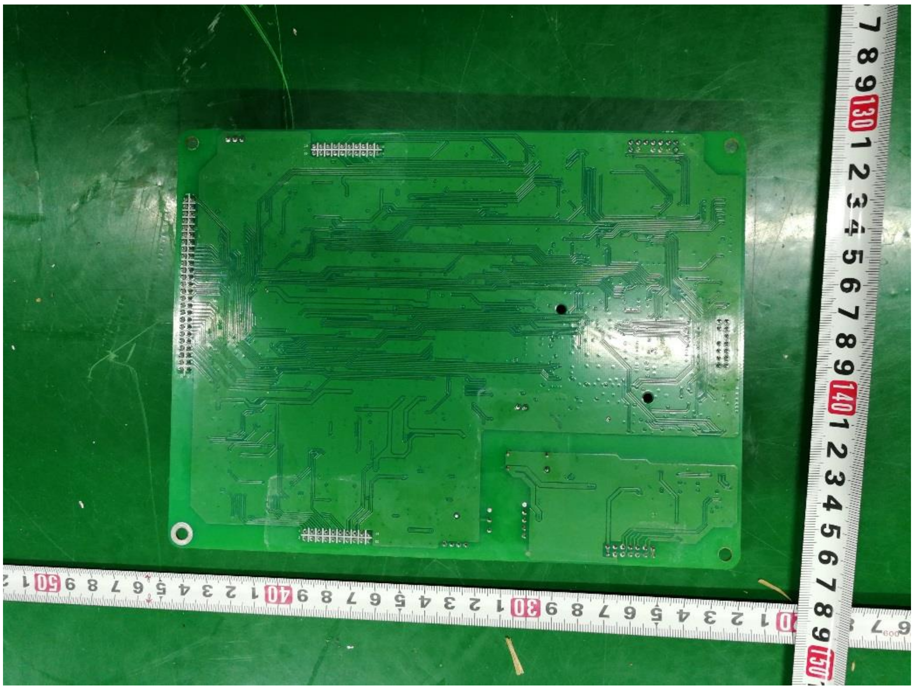

Solder side of IO board


Component side of Display board

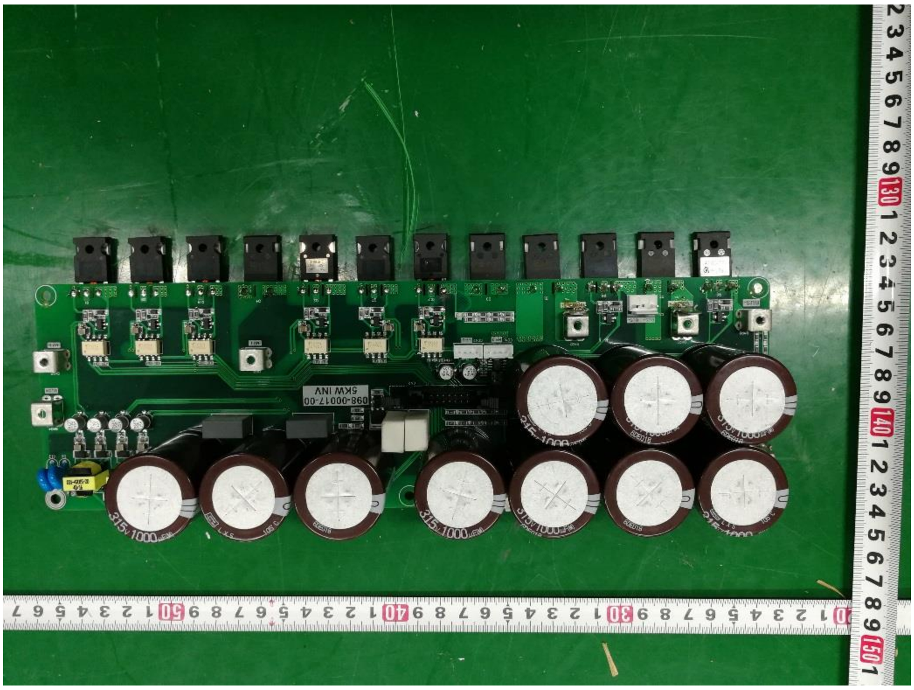


Solder side of Display board

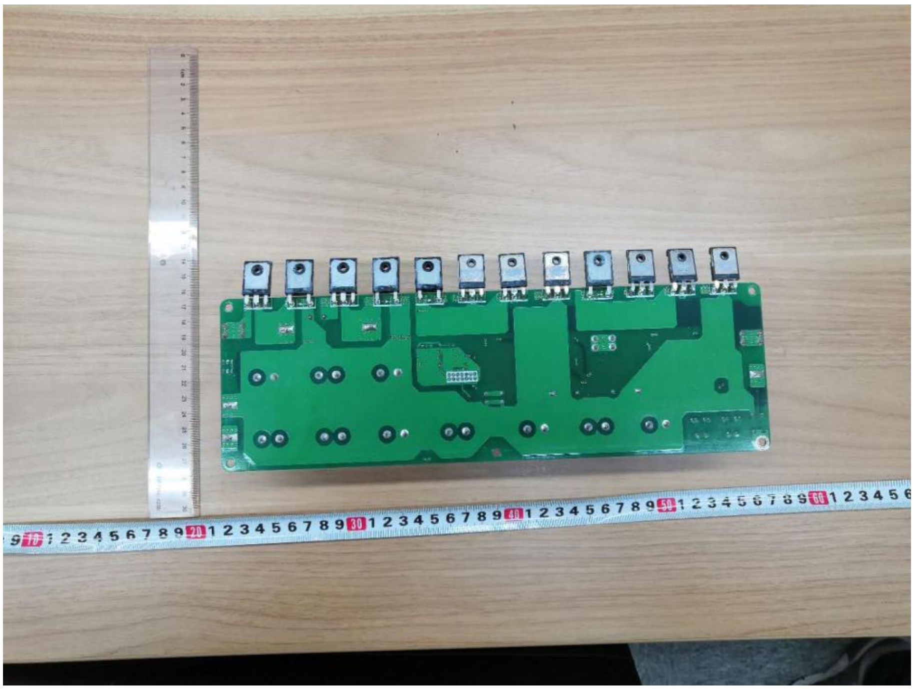
Component side of Cotrol board



Solder side of Control board



Component side of Battery board


Solder side of Battery board

Annex 4

Test equipment list

Testing Location: Bureau Veritas LCIE China Company Limited

No,	Equipment	Internal No,	Type/characteristics	Manufacturer	Last Calibration	Due Data
1	Oscilloscope	A4089024SH	P4034B	Tektronix	26/Jul/18	25/Jul/19
2	Oscilloscope	A4089008SH	DPO3014	Tektronix	23/Jan/19	22/Jan/20
3	Oscilloscope	A4089036SH	DL850	YOKOGAWA	29/Aug/18	28/Aug/19
4	High Voltage probe	A4089026SH	P5200A	Tektronix	23/Jan/19	22/Jan/20
5	Voltage probe	A4089004SH	P2220	Tektronix	10/Oct/18	09/Oct/19
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	10/Oct/18	09/Oct/19
9	Current probe	A4089038SH	960 30	YOKOGAWA	10/Oct/18	09/Oct/19
10	Current probe	A4089039SH	960 30	YOKOGAWA	10/Oct/18	09/Oct/19
11	Current probe	A4089017SH	TCP0150	Tektronix	26/Jul/18	25/Jul/19
12	AC power supply	A7040066SH	AFC-31010T	APC	08/Aug/18	31/Jul/20
13	AC power supply	A7040071SH	29/May/68	Chroma	22/Feb/18	21/Feb/20
14	AC power supply	A7040057SH	29/May/68	Chroma	19/Jul/17	18/Jul/19
15	AC power supply	A7040077SH	MX-30	AMETEK	-	-
16	Programmable DC source	A7040058SH	62150H-1000S	Chroma	-	-
17	Programmable DC source	A7040059SH	62150H-1000S	Chroma	-	-
18	Programmable DC source	A7040069SH	62150H-1000S	Chroma	-	-
19	Programmable DC source	A7040074SH	62150H-1000S	Chroma	-	-
20	Programmable DC source	A7040075SH	62150H-1000S	Chroma	-	-

21	Programmable DC source	A7040076SH	62150H-1000S	Chroma	-	-
22	Programmable DC source	A7040070SH	62150H-1000S	Chroma	-	-
23	Power Analyzer	A1240096SH	WT3000	YOKOGAWA	31/Oct/18	30/Oct/19
24	Power Analyzer	A1240097SH	WT3000	YOKOGAWA	09/May/18	08/May/19
25	Power Analyzer	A1240103SH	LMG500	ZES ZIMMER	26/Jul/18	25/Jul/19
26	Power Analyzer	A1240101SH	WT3000	YOKOGAWA	26/Jul/18	25/Jul/19
27	Anti-isolating test stystem	A7150074SH	ACTL-380SH	qunling	-	-
28	Load cabinet	A7150083SH	WSTF-LDJ60K/300	shanghai wen shun	-	-
29	Load cabinet	A7150084SH	WSTF-LDJ45K/0385	shanghai wen shun	-	-
30	Load cabinet	A7150085SH	WSTF-LDJ45K/0385	shanghai wen shun	-	-
31	Load cabinet	A7150075SH	WSTF-RC25k/0,3D 0,001kVA-25kVA	shanghai wen shun	-	-
32	Temperature recorder	A740037SH	G820	GRAPHIEC	10/Oct/18	09/Oct/19
33	Load cabinet(for flick)	A7150090SH	200Ω， 250V;1200W	shanghai wen shun	-	-
34	Variable resistor	A7150076SH	BX8-67	LingOu	-	-