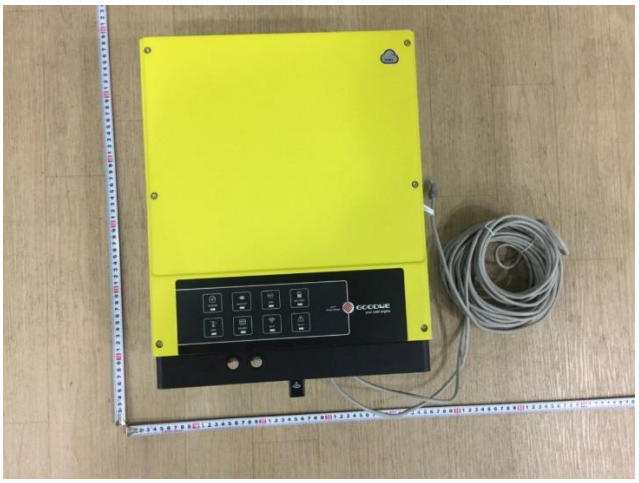
Prüfbericht-Nr.: *Test Report No.*:	**50085060 001**	**Auftrags-Nr.:** *Order No.*:	154247265	*Seite 1 von 32* *Page 1 of 32*
Kunden-Referenz-Nr.: *Client Reference No.*:	459803	**Auftragsdatum:** *Order date*:	11.05.2017	
Auftraggeber: *Client*:	JIANGSU GOODWE POWER SUPPLY TECHNOLOGY CO., LTD. NO.189 Kun Lun Shan Road Suzhou New District Jiangsu 215163 P.R. China			
Prüfgegenstand: *Test item*:	Hybrid inverter			
Bezeichnung / Typ-Nr.: *Identification / Type No.*:	GW3048-EM,GW3648-EM,GW5048-EM			
Auftrags-Inhalt: *Order content*:	Corrections			
Prüfgrundlage: *Test specification*:	NRS 097-2-1: 2017			

Wareneingangsdatum: *Date of receipt*:	05.06.2017
Prüfmuster-Nr.: *Test sample No.*:	1#
Prüfzeitraum: *Testing period*:	10.06.2017 – 30.06.2017
Ort der Prüfung: *Place of testing*:	See page 2
Prüflaboratorium: *Testing laboratory*:	TÜV Rheinland (Shanghai) Co., Ltd.
Prüfergebnis*: *Test result**:	Pass



geprüft von / *tested by*:

19.08.2017	Billy Chen/ Tester	
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

kontrolliert von / *reviewed by*:

19.08.2017	Tobias Yang / Reviewer	
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

Sonstiges / *Other*:

The report 50085060 001 issued on 10.07.2017 was cancelled and replaced by this report.

Zustand des Prüfgegenstandes bei Anlieferung: Prüfmuster vollständig und unbeschädigt
Condition of the test item at delivery: *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 specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

V04

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NRS 097-2-1
GRID INTERCONNECTION OF EMBEDDED GENERATION
PART 2: SMALL-SCALE EMBEDDED GENERATION
– Section 1: Utility interface

Report Reference No. .....:	50085060 001
Tested by (name + signature) .....:	Billy Chen .....
Approved by (name + signature)....:	Tobias Yang .....
Date of issue.....:	See cove page
Testing Laboratory.....:	**TÜV Rheinland (Shanghai) Co., Ltd.**
Address .....:	No. 177, Lane 777 West Guangzhong Road, Jingan District, Shanghai, P.R.China
Testing location/ procedure .....:	CBTL☐ TMP☐ WMT☐ SMT☐ RMT☐ CCATL ☒
Testing location/ address .....:	JIANGSU GOODWE POWER SUPPLY TECHNOLOGY CO., LTD. NO.189 Kun Lun Shan Road Suzhou New District Jiangsu 215163 P.R. China
Applicant's name .....:	JIANGSU GOODWE POWER SUPPLY TECHNOLOGY CO., LTD.
Address .....:	NO.189 Kun Lun Shan Road Suzhou New District Jiangsu 215163 P.R. China
Test specification:	
Standard .....:	NRS 097-2-1: 2017
Test procedure .....:	AK
Non-standard test method……..:	N/A
Test Report Form No.....:	MS-0025008-appendix 2
Test Report Form(s) Originator .....:	TÜV Rheinland Group
Master TRF.....:	2017-05

Test item description .....:	Hybrid Inverter
Trade Mark .....:	GOODWE your solar engine
Manufacturer .....:	JIANGSU GOODWE POWER SUPPLY TECHNOLOGY CO., LTD.
Model/Type reference .....:	GW5048-EM, GW3648-EM, GW3048-EM
Ratings .....:	See copy of marking plate for details

Equipment mobility:	☐ movable ☐ hand-held ☐ stationary ☒ fixed
Connection to the mains:	☐ pluggable equipment ☐ direct plug-in ☒ permanent connection ☐ for building-in
Operating condition:	☒ continuous ☐ short-time ☐ intermittent
Over voltage category Mains:	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV
Over voltage category PV:	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
Tested for IT power systems :	☐ Yes ☒ No
IT testing, phase-phase voltage (V) :	N/A
Class of equipment :	☒ Class I ☐ Class II ☐ Class III ☐ Not classified
Mass of equipment (kg):	18
Pollution degree	☐ PD 1 ☐ PD 2 ☒ PD 3
IP protection class :	IP65

Possible test case verdicts:

- test case does not apply to the test object..... : N/A
- test object does meet the requirement..... : Pass (P)
- test object does not meet the requirement..... : Fail (F)

Testing:

Date of receipt of test items: See cover page

Date(s) of performance of tests: See cover page

General remarks

” 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 Issuing testing laboratory.

"(see remark #)" refers to remark appended to the report.
"(see Annex #)" refers to an annex appended to the report.

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

History of report

Report no.	Issue date	Remarks
50085060 001	10.07.2017	Original report
50085060 001	19.08.2017	The following items was updated and corrected: 1. Corrected the spelling of word “larger” in clause 4.1.1.10 2. Updated the clauses 4.2.2.4.3, 4.2.2.4.4, 4.2.2.4.5, 4.2.2.4.6, 4.2.2.4.7, 4.2.4.2.1 and 4.2.4.2.2 3. Added the THD in Table 4.1.0 4. Add the general information of test sample and summary of testing. The original report issued on 10.07.2017 was cancelled and replaced by the report 50085060 001 issued on 19.08.2017.

Attachement:
This report also includes attached photo documentation 9 pages

Summary of testing:
All the test were performed on the GW5048-EM and valid for other models.
Tests performed (name of test and test clause)

Clause(s)		Test(s)
☒	4.1	Utility compatibility
☒	4.1.5.1	Flicker
☒	4.1.5.3	Voltage change
☐	4.1.6.1	Apparent power unblance
☒	4.1.6.2	Voltage unblance
☒	4.1.7	Commutation notches
☒	4.1.8	DC injection
☒	4.1.10	Harmonics and waveform distortion
☒	4.1.11.2	Power factor for sub-categories A1 and A2
☐	4.1.11.4	Power factor for sub-categories A3
☐	4.1.11.9	Power factor characteristics curve for sub-categories A3
☒	4.2	Safety protection and controls
☒	4.2.2.3.2	Over/under voltage
☒	4.2.2.3.3	Over/under frequency
☒	4.2.2.3.3	Active power under over frequency
☒	4.2.2.4	Prevention of islanding (IEC 62116)
☒	4.2.2.5	DC current injection
☒	4.2.4	Utility Response to recovery

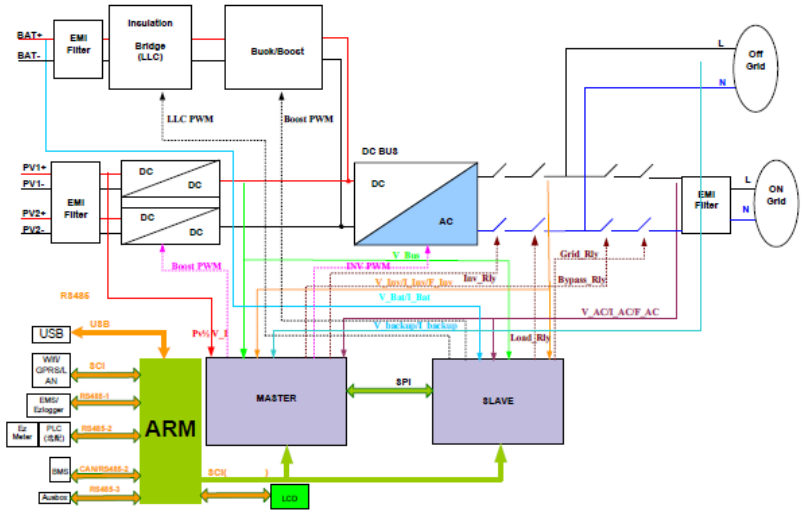
Testing location:
All tests as described in Test Case and Measurement Sections were performed at the laboratory described on page 2.

Description of the test item:

The **Jiangsu Goodwe Power Supply,** type **GW5048-EM, 230 V a.c., single-phase, 5000 W. class I, IP65**, is a Hybrid inverter designed to work with PV panels up to 550V d.c and batteries up to 60Vd.c.. It is responsible for converting the direct current generated by photovoltaic panels and batteries into single-phase 230 V, 50 Hz alternative current for feeding into the electrical power distribution grid or the backup load. The Hybrid inverter can operates when it is connected to the electrical power distribution line and as a stand-alone unit or in case of AC grid disruption.

Block diagram:

GW5048-EM, GW3648-EM and GW3048-EM



The protection device makes up of two in series in each line and netural between inverter and gird. inverter and back-up load.. communicative coupled AC relays so that the equipment could be effectively separated from utitlity even any one of relays short circuited or works abnormally.

The controlling section is also redundant built. one master DSP. and one slave MCU. The master DSP carries out the main calculation and driving instructions. Slave MCU 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.

Model list:

Model:		GW3048-EM	GW3648-EM	GW5048-EM
Solar	Max. allowed PV Power(W)	3900	4600	6500
	Nominal DC Power(W)	3300	4000	5500
	Max. DC voltage (V)	550		
	MPPT voltage range (V)	100~500		
	Start feeding voltage (V)	125		
	Max. DC current (A)	11	11/11	
	No. of DC connectors	1	2(can parallel)	
	No. of MPPTs	1	2	
	DC connector	MC4/ Phoenix/ Amphenol(Optional)		
Battery	Battery Type	Lead-acid or Li-Ion		
	Norminal Voltage(V)	48		
	Max Charge Current (A)*	50		
	Max Discharge Current (A)	50 (configurable)		
	Battery capacity (Ah)	>=100 (depending requirement)		
	Charging curve	3-stage adaptive with maintenance		

		Max Charge voltage (V)	60 (configurable)		
		Battery temperature compensation	included(Li-Ion)		
		Battery voltage sense	integrated		
		Current shunt	integrated		
	AC Output Data (On-grid)	Norminal AC power(VA)	3000	3680	5000
		Max. AC power(VA)	3000	3680	5000
		Max. AC current(A)	13.6	16	22.8
		Norminal AC output	50/60Hz; 230Vac		
		AC output range	45~55Hz/55~65Hz; 180~270Vac		
		THDi	<3%		
		Power factor	0.8 leading~0.8 lagging		
		Grid connection	Single phase		
	AC Output Data (Back-up)	AC output (Back-up)	230Vac ±2%, 50Hz (60Hz Optional)±0.2%, THDv<3%(linear load),Single phase		
		Max. AC current(A)	10		
		Norminal AC power(VA)	2300		
		Peak AC power(VA)**	3500, 10sec		
	Efficiency	Max. efficiency	97.6%		
		Euro efficiency	>97.%		
		MPPT adaptation efficiency	99.9%		
		Max Battery efficiency	94.5%		
	Protection	Residual current monitoring unit	Integrated		
		Anti-islanding protection	Integrated		
		DC switch(PV)	Integrated(Optional)		
		AC over current protection	Integrated		
		Insulation monitoring	Integrated		
	Certifications &Standards	Grid regulation	VDE-AR-N 4105, AS4777.2, VDE0126-1-1, G83/G59		
		Safety	IEC62109-1&-2		
		EMC	EN61000-6-1, EN61000-6-2, EN61000-6-3, EN61000-6-4, EN61000-3-2, EN61000-3-3		
	General Data	Dimensions (W*H*D)	347*432*145mm		
		Weight (kg)	16	18	
		Mounting	Wall bracket		
		Ambient temperature range	-25~60°C		
		Relative humidity	0~95%		
		Max. operating altitude	2000m		
		Protection degree	IP65		
		Cooling	Nature convection		
		Noise emision(dB)	<25		
		Display	LED, APP		
		Communication	USB; RS485;CAN;WiFi		

Copy of marking plate:

GOODWE
your solar engine

Name:Hybrid Inverter
Type :GW5048-EM

Max. PV-generator power	6500W
Vmax PV	550Vd.c.
Isc PV	13.8/13.8Ad.c.
MPPT voltage range	100...500Vd.c.
Battery rated voltage	48Vd.c.
Battery voltage range	40~60Vd.c.
Battery max. charge/discharge current	50/50Ad.c.
Battery type	Lead-acid or Li-Ion
Grid/Backup rated voltage	230Va.c.
Grid/Backup frequency	50/60Hz
Grid rated current	22.8/21.7A**a.c.
Grid rated apparent power	5.0/4.6*KVA
Backup rated current	10Aa.c.
Backup rated apparent power	2300VA
Inverter topology	Non-isolated
Power factor range	Default >0.99 0.8cap...0.8ind
Operating temperature range	-25~60°C
Overvoltage-category	DC II ; AC III
IP degree	IP65
Protective class	Class I

Grid-connected standard: VDE-AR-N 4105; VDE0126-1-1; AS/NZS 4777.2:2015; G59/3; G100; CEI 0-21;
**:21.7A for Australia *:4.6kVA for VDE-AR-N4105 and NRS 097

5min

G83 G59

S/N:

TEL: +86 512 6239 7998 EMAIL:service@goodwe.com.cn
ADD:NO.189 KunLunShan Road,Suzhou New District,Jiangsu,China

GOODWE
your solar engine

Name:Hybrid Inverter
Type :GW3648-EM

Max. PV-generator power	4600W
Vmax PV	550Vd.c.
Isc PV	13.8/13.8Ad.c.
MPPT voltage range	100...500Vd.c.
Battery rated voltage	48Vd.c.
Battery voltage range	40~60Vd.c.
Battery max. charge/discharge current	50/50Ad.c.
Battery type	Lead-acid or Li-Ion
Grid/Backup rated voltage	230Va.c.
Grid/Backup frequency	50/60Hz
Grid rated current	16Aa.c.
Grid rated apparent power	3680VA
Backup rated current	10Aa.c.
Backup rated apparent power	2300VA
Inverter topology	Non-isolated
Power factor range	Default >0.99 0.8cap...0.8ind
Operating temperature range	-25~60°C
Overvoltage-category	DC II ; AC III
IP degree	IP65
Protective class	Class I

Grid-connected standard: VDE-AR-N 4105; VDE0126-1-1; AS/NZS 4777.2:2015; G59/3;

5min

G83 G59

S/N:

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ADD:NO.189 KunLunShan Road,Suzhou New District,Jiangsu,China

GOODWE
your solar engine

Name:Hybrid Inverter
Type :GW3048-EM

Max. PV-generator power	3900W
Vmax PV	550Vd.c.
Isc PV	13.8Ad.c.
MPPT voltage range	100...500Vd.c.
Battery rated voltage	48Vd.c.
Battery voltage range	40~60Vd.c.
Battery max. charge/discharge current	50/50Ad.c.
Battery type	Lead-acid or Li-Ion
Grid/Backup rated voltage	230Va.c.
Grid/Backup frequency	50/60Hz
Grid rated current	13.6Aa.c.
Grid rated apparent power	3000VA
Backup rated current	10Aa.c.
Backup rated apparent power	2300VA
Inverter topology	Non-isolated
Power factor range	Default >0.99 0.8cap...0.8ind
Operating temperature range	-25~60°C
Overvoltage-category	DC II ; AC III
IP degree	IP65
Protective class	Class I

Grid-connected standard: VDE-AR-N 4105; VDE0126-1-1; AS/NZS 4777.2:2015; G59/3;

S/N:

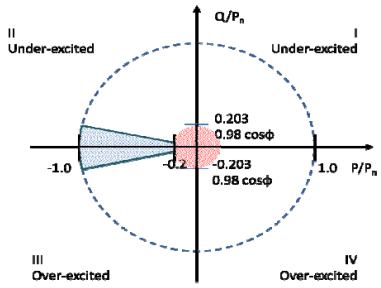
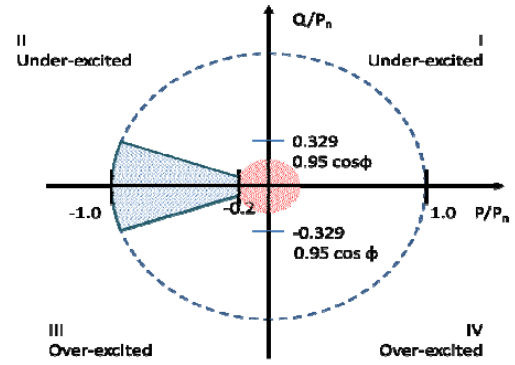
TEL: +86 512 6239 7998 EMAIL:service@goodwe.com.cn
ADD:NO.189 KunLunShan Road,Suzhou New District,Jiangsu,China

NRS 097-2-1			
Clause	Requirement – Test	Result – Remark	Verdict

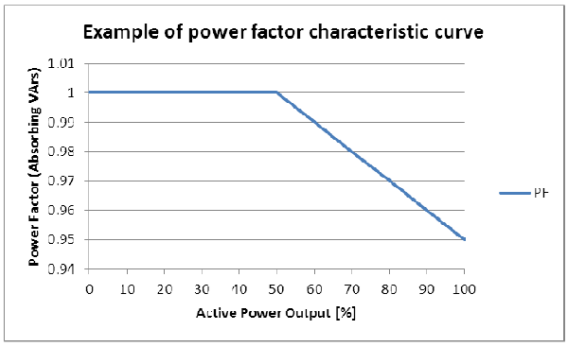
4.1	**Utility compatibility**		**P**
4.1.1	**General**		**P**
4.1.1.1	This clause describes the technical issues and the responsibilities related to interconnecting an embedded generator to a utility network.		**P**
4.1.1.2	The quality of power provided by the embedded generator in the case of the on-site 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-ofbounds conditions. The embedded generator is required to sense the deviation and might need to disconnect from the utility network.		**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 at the end of report for detailed test	**P**
4.1.1.4	The embedded generator's a.c. voltage, current and frequency shall be compatible with the utility at the POC.		**P**
4.1.1.5	The embedded generator shall be type approved, unless otherwise agreed upon with the utility (see annex A).		**P**
4.1.1.6	The maximum size of the embedded generator is limited to the rating of the supply point on the premises.	Shall be evaluated in final installation	**N/A**
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.		**P**
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.	Not larger than 13.8kVA	**P**
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.	Not larger than 4.6kVA for single phase	**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	Not larger than 100kVA.	**N/A**

NRS 097-2-1			
Clause	Requirement – Test	Result – Remark	Verdict

	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.		
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: a) Category A1: 0 – 13,8 kVA; b) Category A2: 13,8 kVA – 100 kVA; c) Category A3: 100 kVA – 1 MVA.	Category A1	**P**
4.1.1.12	In accordance with SANS 10142-1, all generators shall be wired permanently.	Considered	**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.	Considered	**P**
4.1.1.14	Standby-generators are covered by SANS 10142-1.	Considered	**P**
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.		**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.	Maximum DC voltage 550Vdc	**P**
4.1.2	**Normal voltage operating range**	See appended table	**P**
4.1.3	**Reference source impedance and short-circuit levels (fault levels)**		**P**
4.1.4	**General QOS requirements**		**P**
4.1.5	**Flicker and voltage changes**	See appended table	**P**
4.1.6	**Voltage unbalance**	See appended table	**P**
4.1.7	**Commutation notches**	See appended table	**P**
4.1.8	**DC injection**	See appended table	**P**
4.1.9	**Normal frequency operating range**	See appended table	**P**
4.1.10	**Harmonics and waveform distortion**	See appended table	**P**
4.1.11	**Power factor**		**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**

NRS 097-2-1			
Clause	Requirement – Test	Result – Remark	Verdict
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.	See appended table	**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.		**N/A**
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.		**N/A**

NRS 097-2-1			
Clause	Requirement – Test	Result – Remark	Verdict

4.1.11.7	Unless otherwise agreed with the utility, the standard power factor setting shall be unity for the full power output range.		**N/A**
4.1.11.8	The maximum tolerance on the reactive power setting is 5 % of the rated active power.		**N/A**
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: a) be connected or disconnected with the embedded generator, or 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.	Confirmed	**P**
4.1.12	**Synchronization**		**P**
4.1.13	**Electromagnetic compatibility (EMC)**	Refer to EMC report	**P**
4.1.14	**Mains signalling (e.g. PLC and ripple control)**	External use PLC will be used, shall be re-evaluated in final installation	**N/A**

4.2	**Safety and protection**		**P**
4.2.1	**General**		**P**
4.2.2	**Safety disconnect from utility network**		**P**
4.2.2.1	General		**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.	Refer to IEC 62109-1 and IEC 62109-2 reports	**P**
4.2.2.1.2	The embedded generator shall automatically and safely disconnect from the grid in the event of an abnormal condition.		**P**

NRS 097-2-1			
Clause	Requirement – Test	Result – Remark	Verdict

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.	PV inverter provided two relays in series used in each line and neutral as disconnection devices	**P**
4.2.2.2.2	The disconnection switching unit shall be able to operate under all operating conditions of the utility network.	Simulated fault test has been performed, see appended table	**P**
4.2.2.2.3	A failure within the disconnection switching unit shall lead to disconnection and indication of the failure condition.	Refer to IEC 62109-1 and IEC 62109-2 reports	**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.	Refer to IEC 62109-1 and IEC 62109-2 reports	**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.	PV inverter provided two relays in series used in each line and neutral as disconnection devices	**P**
4.2.2.2.6	Both switches shall be electromechanical switches.	Relays with suitable rating provided	**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.	Considered.	**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.	PV inverter	**N/A**
4.2.2.2.9	A static power converter without simple separation shall make use of two series connected electromechanical disconnection switches.	PV inverter provided two relays in series used in each line and neutral as disconnection devices	**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 contractor, this requires suitable coordination with the upstream short circuit protection device (circuit breaker).	Considered.	**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.	Considered.	**P**
4.2.2.2.12	In order to allow customers to supply their own load in isolated operation (islanded)	Considered.	**P**

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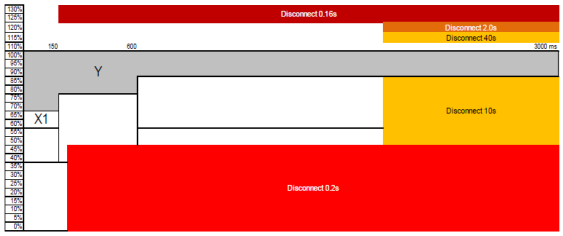
	where this is feasible and required, the disconnection device may be incorporated upstream of part of or all of a customers' loads, provided that none of the network disconnection requirements in this document are violated.		
4.2.2.2.13	All EG installations larger than 30 kVA shall have a central disconnection device.	Less than 30kVA	**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.	No central disconnection device used.	**N/A**
4.2.2.3	**Overvoltage, undervoltage and frequency**		**P**
4.2.2.3.1	**General**		**P**
	The values in 4.2.2.3 relate to SSEG in sub-categories A1 and A2. These are kept from a historical perspective. The Grid Code requirements will override values and requirements in this category. Sub-category A3 generators shall disconnect from the network according to the RPP Grid Code for all abnormal conditions as well as stay connected in accordance with the voltage ride-through requirements of the RPP Grid Code.		**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.	See appended table	**P**

1	2
Voltage range (at point of connection)	**Maximum trip time** S
V < 50 %	0,2 s
50 % ≤ V < 85 %	10 s
85 % ≤ V ≤ 110 %	Continuous operation
110 % < V < 115 %	40 s
115% ≤ V < 120%	2 s
120 % ≤ V	0,16 s
NOTE 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.	



4.2.2.3.3	**Overfrequency and underfrequency**		**P**
	This requirement is in line with the RPP Grid Code (version 2.8) and applies to all EG in category A.	See appended table.	**P**
4.2.2.3.3.1	Relaxation for non-controllable generators		**P**

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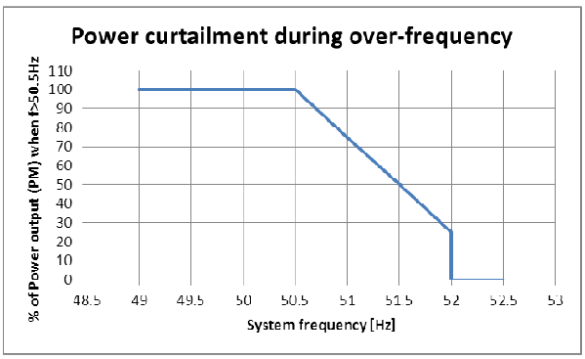
	Non-controllable generators may disconnect randomly within the frequency range 50.5 Hz to 52 Hz. The disconnect frequency for non-controllable generators will each be set at a random value by the manufacturer, with the option of changing this to a utility provided setting. The random disconnect frequency shall be selected so that all generators from any specific manufacturer will disconnect uniformly over the range with 0,1 Hz increments. 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. 	See appended table.	**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	See appended table.	**P**

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Clause	Requirement – Test	Result – Remark	Verdict
	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.		
4.2.2.4.3	Active islanding shall be detected in all cases where the EG interfaces with the utility network.		**P**
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.	Not rotating generator	**N/A**
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.	Considered	**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.	Two series connected relays used as the disconnection device in both line and neutral	**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	**Emergency personnel safety**		**N/A**
	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.		**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		**P**

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Clause	Requirement – Test	Result – Remark	Verdict
	in accordance with 4.1.12.		
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.	Considered	**P**
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.	Not controllable generator.	**N/A**
4.2.5	**Isolation**		**P**
4.2.5.1	In line with SANS 10142-1 (as amended), each energy source should have its own, appropriately rated, isolation device.	Isolation device is not integral part of the unit. The installation instructions specify a isolation device for the final installation. This shall be re-evaluated in final installation	**P**
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.	Requirement specified in the installation instruction, shall be re-evaluated in final installation	**P**
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 isolation device for the final installation. This shall be re-evaluated in final installation	**P**
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.	The installation instructions specify a isolation device for the final installation. This shall be re-evaluated in final installation	**P**
4.2.5.5	For dedicated supplies, a means shall be	The installation instructions	**P**

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Clause	Requirement – Test	Result – Remark	Verdict

	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.	specify a isolation device for the final installation. This shall be re-evaluated in final installation	
4.2.6	**Earthing**		**P**
4.2.6.1	The electrical installation shall be earthed in accordance with SANS 10142-1. 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	Requirement specified in the installation instruction, shall be re-evaluated in final installation	**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.	Refer to IEC 62109-2 report.	**P**
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.	Requirement specified in the installation instruction, shall be re-evaluated in final installation	**P**
4.2.7	**Short-circuit protection**		**P**
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.	Requirement for using circuit breaker specified in the installation instruction, shall be re-evaluated in final installation	**P**
4.2.7.2	The short-circuit characteristics for the SSEG shall be supplied to the utility.	See instruction manual	**P**
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: a) for synchronous generators: 8 times the rated current; b) for asynchronous generators: 6 times the rated	1 times of the rated current for PV inverter.	**P**

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Clause	Requirement – Test	Result – Remark	Verdict

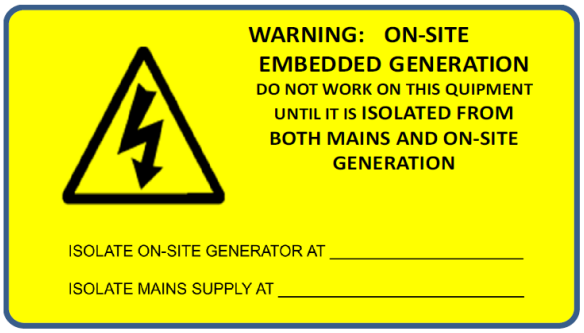
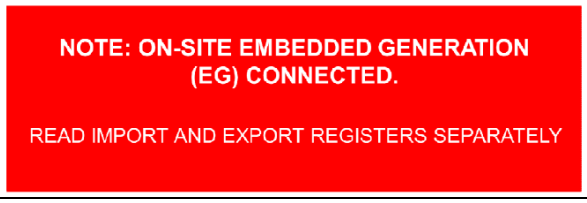
	current; and c) for generators with inverters: 1 times the rated current.		
4.2.9	**Labelling**		**P**
4.2.9.1	A label on the distribution board of the premises where the embedded generator is connected, shall state: “ON-SITE EMBEDDED GENERATION (EG) CONNECTED. THE EG IS FITTED WITH AN AUTOMATIC DISCONNECTION SWITCH WHICH DISCONNECTS THE EG IN THE CASE OF UTILITY NETWORK DE-ENERGIZATION.”  	Requirement specified in the installation instruction, shall be re-evaluated in final installation	**P**
4.2.9.2	The label shall be permanent, coloured red, and with white 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.  	Requirement specified in the installation instruction, shall be re-evaluated in final installation	**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.	Refer to IEC 62109-1 and IEC 62109-2 reports.	**P**
4.3	**Metering**	Shall be re-evaluated in final installation	**N/A**
Annex A	**Notes to purchase**		**--**
Annex B	**Earthing system**	Shall be re-evaluated in final installation	**N/A**

Table 4.1.5	**Voltage fluctuations and flicker**		**P**
Reference Impedance used:	L=0.15+0.15j, N=0.1+0.1j		
Pst (Limits: 0.35)			
Interval	Phase A	Phase B	Phase C
1	0.19	N/A	N/A
2	0.19	N/A	N/A
3	0.17	N/A	N/A
4	0.17	N/A	N/A
5	0.21	N/A	N/A
6	0.19	N/A	N/A
7	0.18	N/A	N/A
8	0.20	N/A	N/A
9	0.18	N/A	N/A
10	0.19	N/A	N/A
11	0.19	N/A	N/A
12	0.18	N/A	N/A
P_{lt} =	0.3	N/A	N/A

TABLE 4.1.5.3	**Rapid voltage change**	P
Mains voltage: 230V		
Switching actions		Ki
Marking operation without default (to primary energy carrier)		0.5
Marking operation at reference conditions(of primary energy carrier)		1.0
Breaking operation at nominal power		1.0
Worst case value of all switching operations Ki max		1.0

Table 4.1.7	**Commutation notches**		P
Test condition	Commutation notches current [A]		
Between 25% P_{Emax} and 35% P_{Emax}	1.1	1.5	1.3
Between 65% P_{Emax} and 75% P_{Emax}	0.0	0.0	0.0
> 90 P_{Emax}	0.0	0.0	0.0

Table 4.1.8	DC injection			P
Rated output current [A]	Measured value [mA]			Limit [mA]
	Phase A	Phase B	Phase C	
100% output				
20	80	--	--	100
75% output				
20	90	--	--	100
50% output				
20	40	--	--	100
25% output				
20	60	--	--	100
10% output				
20	30	--	--	100
Injected DC current exceeded 1% rated current [A]	Turn off time measured [ms]			Limit [ms]
	Phase A	Phase B	Phase C	
0.15	210	--	--	500
Remark:				

TABLE 4.1.10	Harmonics and waveform distortion					P
Harmonics	100%Pn	Limits		Harmonics	100%Pn	Limits
Order	I[%]	I[%]		Frequency [Hz]	I[%]	I[%]
2	0.478	1		75	0.098	0.1
3	1.271	4		125	0.045	0.1
4	0.159	1		175	0.036	0.1
5	0.436	4		225	0.037	0.1
6	0.165	1		275	0.041	0.1
7	0.669	4		325	0.047	0.1
8	0.130	1		375	0.052	0.1
9	0.193	4		425	0.059	0.1
10	0.204	1		475	0.060	0.1
11	0.301	2		525	0.059	0.1
12	0.145	0.5		575	0.060	0.25
13	0.205	2		625	0.060	0.25
14	0.153	0.5		675	0.059	0.25
15	0.221	2		725	0.063	0.25
16	0.114	0.5		775	0.075	0.25
17	0.141	1.5		825	0.075	0.25
18	0.095	0.38		875	0.067	0.19
19	0.134	1.5		925	0.049	0.19
20	0.087	0.38		975	0.044	0.19

21	0.118	1.5		1025	0.043	0.19
22	0.096	0.38		1075	0.041	0.19
23	0.092	0.6		1125	0.040	0.19
24	0.100	0.38		1175	0.039	0.08
25	0.085	0.6		1225	0.038	0.08
26	0.079	0.15		1275	0.036	0.08
27	0.074	0.6		1325	0.034	0.08
28	0.080	0.15		1375	0.031	0.08
29	0.072	0.6		1425	0.030	0.08
30	0.070	0.15		1475	0.029	0.08
31	0.086	0.6		1525	0.030	0.08
32	0.076	0.15		1575	0.031	0.08
33	0.083	0.6		1625	0.028	0.08
34	0.069	0.15		1675	0.029	0.08
35	0.070	0.3		1725	0.025	0.08
36	0.062	0.08		1775	0.024	0.03
37	0.055	0.3		1825	0.024	0.03
38	0.058	0.08		1875	0.024	0.03
39	0.055	0.3		1925	0.027	0.03
40	0.060	0.08		1975	0.026	0.03
42	0.115	0.08		--	--	--
43	0.099	0.3		--	--	--
50	0.091	0.08		--	--	--
THD	1.754	5		--	--	--

TABLE4.1.11.2	Power factor for generators of sub-categories A1 and A2					P
P/Pn (%)	DC input Voltage(V)	DC input current (A)	Output voltage (V)	Output current (A)	Power factor	Limit
10%	374.86	1.16	A:230.05	A:1.92	A:0.939	--
			B:	B:	B:	
			C:	C:	C:	
25%	367.17	3.09	A:230.09	A:4.69	A:0.991	0.98
			B:	B:	B:	
			C:	C:	C:	
50%	353.25	6.46	A:230.23	A:9.19	A:0.998	0.98
			B:	B:	B:	
			C:	C:	C:	
75%	338.05	10.68	A:230.44	A:14.67	A:0.999	0.98
			B:	B:	B:	
			C:	C:	C:	
100%	321.67	15.01	A:230.55	A:19.7	A:0.999	0.98
			B:	B:	B:	
			C:	C:	C:	
Remark:						

4.2.2.3.2	Table: Overvoltage and under-voltage/ Voltage-ride-through				P
Target value U	Trip value (V)	Trip value limit	Trip time(s)	Limit(s)	Remark
For phase A					
U<50%Ur	114V	49%Ur≤U<50%Ur	0.180	≤0.2	Trip vlaue : 112.7V to 115V
50 %Ur ≤ U < 85 %Ur	194V	84%Ur≤U<85%Ur	9.936	0.6 to 10	Trip vlaue : 193.2V to 195.5V
85 %Ur ≤ U ≤ 110 % Ur	--	--	--	--	Continuous operation
110 % Ur < U < 115 % Ur	254V	110%Ur<U≤111%Ur	39.934	≤40	Trip vlaue : 253V to 255.3V
115 %Ur ≤ U < 120%Ur	266V	115%Ur≤U≤116%Ur	0.086	≤2	Trip vlaue : 264.5V to 266.8V
120%Ur ≤ U	277V	120%Ur≤U≤121%Ur	0.051	≤0.16	Trip vlaue : 276V to 278.3V
For phase B					

U<50%Ur	N/A	49%Ur≤U<50%	N/A	≤0.2	Trip vlaue : 112.7V to 115V
50 %Ur ≤ U < 85 %Ur	N/A	84%Ur≤U<85%	N/A	0.6 to 10	Trip vlaue : 193.2V to 195.5V
85 %Ur ≤ U ≤ 110 % Ur	--	--	--	--	Continuous operation
110 % Ur < U < 115 % Ur	N/A	110%Ur<U≤111%	N/A	≤40	Trip vlaue : 253V to 255.3V
115 %Ur ≤ U < 120%Ur	N/A	115%Ur≤U≤116%	N/A	≤2	Trip vlaue : 264.5V to 266.8V
120%Ur ≤ U	N/A	120%Ur≤U≤121%	N/A	≤0.16	Trip vlaue : 276V to 278.3V
For phase C					
U<50%Ur	N/A	49%Ur≤U<50%	N/A	≤0.2	Trip vlaue : 112.7V to 115V
50 %Ur ≤ U < 85 %Ur	N/A	84%Ur≤U<85%	N/A	0.6 to 10	Trip vlaue : 193.2V to 195.5V
85 %Ur ≤ U ≤ 110 % Ur	--	--	--	--	Continuous operation
110 % Ur < U < 115 % Ur	N/A	110%Ur<U≤111%	N/A	≤40	Trip vlaue : 253V to 255.3V
115 %Ur ≤ U < 120%Ur	N/A	115%Ur≤U≤116%	N/A	≤2	Trip vlaue : 264.5V to 266.8V
120%Ur ≤ U	N/A	120%Ur≤U≤121%	N/A	≤0.16	Trip vlaue : 276V to 278.3V
Remark:					

4.2.2.3.3	Over-frequency and under-frequency				P
Target value F	Trip value (Hz)	Trip value limits (Hz)	Trip time(s)	Limit (s)	Remark
F< 47 Hz	46.98	46.95 ≤ F< 47	0.182	≤0.2	Trip vlaue : 276V to 278.3V
47≤ F≤ 50.5Hz	--	--	--	--	Normal operation
F> 52Hz	52.03	52 <F≤ 52.05	4.432	4 to 4.5	Trip vlaue : 276V to 278.3V

Step #	Set output power [%]	frequency [Hz] [± 10 mHz]	Expected power value [W]	Actual power values [W]	Limit	Graph point
1	100	47.50	4600	4576	± 2.5% Pn	t1
2	100	50.40	4600	4572		t2
3	100	50.55	4447	4480		t3
4	100	51.00	3067	3086		t4
5	100	51.50	1533	1604		t5
6	100	50.11	4600	4579		t6
7	100	50.00	4600	4574	Pn	t7

Note:
50.5Hz: 100%P_M
52.0 Hz: 25%P_M
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 stabilized below 50.5 Hz for at least 4 seconds.

4.2.2.4	`TABLE: Prevention of islanding (IEC 62116)	P

Power 100%

Conditions	P_W [w]	Q_L [VA]	Q_C [VA]	Q_f	Trip time [ms]	Limitation [ms]
R: 90% L / C: 110%	L1: 4.149	L1: 5.038	L1: 4.590	1.16	121	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	0.00		
R: 90% L / C: 105%	L1: 4.149	L1: 4.809	L1: 4.590	1.13	177	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 90% L / C: 100%	L1: 4.149	L1: 4.580	L1: 4.590	1.11	354	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 90% L / C: 95%	L1: 4.149	L1: 4.351	L1: 4.590	1.08	153	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 90% L / C: 90%	L1: 4.149	L1: 4.122	L1: 4.590	1.05	33	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 95% L / C: 110%	L1: 4.380	L1: 5.038	L1: 4.590	1.10	110	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 95% L / C: 90%	L1: 4.380	L1: 4.122	L1: 4.590	0.99	134	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 100% L / C: 110%	L1: 4.610	L1: 5.038	L1: 4.590	1.04	110	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 95% L / C: 105%	L1: 4.380	L1: 4.809	L1: 4.590	1.07	94	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 95% L / C: 100%	L1: 4.380	L1: 4.580	L1: 4.590	1.05	114	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 95% L / C: 95%	L1: 4.380	L1: 4.351	L1: 4.590	1.02	156	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 100%	L1: 4.610	L1: 4.809	L1: 4.590	1.02	166	

L / C: 105%	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 100% L / C: 100%	L1:	4.610	L1:	4.580	L1:	4.590	0.99	128	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 100% L / C: 95%	L1:	4.610	L1:	4.351	L1:	4.590	0.97	130	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 105% L / C: 105%	L1:	4.841	L1:	4.809	L1:	4.590	0.97	102	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 105% L / C: 100%	L1:	4.841	L1:	4.580	L1:	4.590	0.95	98	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 105% L / C: 95%	L1:	4.841	L1:	4.351	L1:	4.590	0.92	61	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 100% L / C: 90%	L1:	4.610	L1:	4.122	L1:	4.590	0.94	108	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 105% L / C: 110%	L1:	4.841	L1:	5.038	L1:	4.590	0.99	116	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 105% L / C: 90%	L1:	4.841	L1:	4.122	L1:	4.590	0.90	107	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 110% L / C: 110%	L1:	5.071	L1:	5.038	L1:	4.590	0.95	49.2	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		
R: 110% L / C: 105%	L1:	5.071	L1:	4.809	L1:	4.590	0.93	36.8	
	L2:	--	L2:	--	L2:	--	--		2000
	L3:	--	L3:	--	L3:	--	--		

R: 110% L / C: 100%	L1: 5.071 L2: -- L3: --	L1: 4.580 L2: -- L3: --	L1: 4.590 L2: -- L3: --	0.90 -- --	58	2000
R: 110% L / C: 95%	L1: 5.071 L2: -- L3: --	L1: 4.351 L2: -- L3: --	L1: 4.590 L2: -- L3: --	0.88 -- --	60	2000
R: 110% L / C: 90%	L1: 5.071 L2: -- L3: --	L1: 4.122 L2: -- L3: --	L1: 4.590 L2: -- L3: --	0.86 -- --	55	2000
Power 66%						
Conditions	P_W [w]	Q_L [VA]	Q_C [VA]	Q_f	Trip time [ms]	Limitation [ms]
R: 100% L / C: 95%	L1: 3.040 L2: -- L3: --	L1: 2.710 L2: -- L3: --	L1: 3.010 L2: -- L3: --	0.94 -- --	53	2000
R: 100% L / C: 96%	L1: 3.040 L2: -- L3: --	L1: 2.756 L2: -- L3: --	L1: 3.010 L2: -- L3: --	0.95 -- --	165	2000
R: 100% L / C: 97%	L1: 3.040 L2: -- L3: --	L1: 2.802 L2: -- L3: --	L1: 3.010 L2: -- L3: --	0.96 -- --	155	2000
R: 100% L / C: 98%	L1: 3.040 L2: -- L3: --	L1: 2.848 L2: -- L3: --	L1: 3.010 L2: -- L3: --	0.96 -- --	59	2000
R: 100% L / C: 99%	L1: 3.040 L2: -- L3: --	L1: 2.894 L2: -- L3: --	L1: 3.010 L2: -- L3: --	0.97 -- --	186	2000
R: 100% L / C: 100%	L1: 3.040 L2: -- L3: --	L1: 2.940 L2: -- L3: --	L1: 3.010 L2: -- L3: --	0.98 -- --	98	2000
R: 100% L / C: 101%	L1: 3.040 L2: -- L3: --	L1: 2.986 L2: -- L3: --	L1: 3.010 L2: -- L3: --	0.99 -- --	118	2000
R: 100% L / C: 102%	L1: 3.040 L2: -- L3: --	L1: 3.032 L2: -- L3: --	L1: 3.010 L2: -- L3: --	0.99 -- --	122	2000
R: 100% L / C: 103%	L1: 3.040 L2: --	L1: 3.078 L2: --	L1: 3.010 L2: --	1.00 --	150	2000

	L3: --	L3: --	L3: --	--		
R: 100% L / C: 104%	L1: 3.040	L1: 3.124	L1: 3.010	1.01	143	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
R: 100% L / C: 105%	L1: 3.040	L1: 3.171	L1: 3.010	1.02	120	2000
	L2: --	L2: --	L2: --	--		
	L3: --	L3: --	L3: --	--		
Power 33%						
Conditions	P_W [w]	Q_L [VA]	Q_C [VA]	Q_f	Trip time [ms]	Limitation [ms]
R: 100% L / C: 95%	L1: 1.510	L1: 1.260	L1: 1.520	0.92	123	2000
	L2: --	L2: 2.020	L2: --	--		
	L3: --	L3: 2.028	L3: --	--		
R: 100% L / C: 96%	L1: 1.510	L1: 1.306	L1: 1.520	0.93	126	2000
	L2: --	L2: 2.020	L2: --	--		
	L3: --	L3: 2.028	L3: --	--		
R: 100% L / C: 97%	L1: 1.510	L1: 1.352	L1: 1.520	0.95	36	2000
	L2: --	L2: 2.020	L2: --	--		
	L3: --	L3: 2.028	L3: --	--		
R: 100% L / C: 98%	L1: 1.510	L1: 1.398	L1: 1.520	0.97	107	2000
	L2: --	L2: 2.020	L2: --	--		
	L3: --	L3: 2.028	L3: --	--		
R: 100% L / C: 99%	L1: 1.510	L1: 1.444	L1: 1.520	0.98	214	2000
	L2: --	L2: 2.020	L2: --	--		
	L3: --	L3: 2.028	L3: --	--		
R: 100% L / C: 100%	L1: 1.510	L1: 1.490	L1: 1.520	1.00	116	2000
	L2: --	L2: 2.020	L2: --	--		
	L3: --	L3: 2.028	L3: --	--		
R: 100% L / C: 101%	L1: 1.510	L1: 1.536	L1: 1.520	1.01	122	2000
	L2: --	L2: 2.020	L2: --	--		
	L3: --	L3: 2.028	L3: --	--		
R: 100% L / C: 102%	L1: 1.510	L1: 1.582	L1: 1.520	1.03	35	2000
	L2: --	L2: 2.020	L2: --	--		
	L3: --	L3: 2.028	L3: --	--		
R: 100% L / C: 103%	L1: 1.510	L1: 1.628	L1: 1.520	1.04	142	2000
	L2: --	L2: 2.020	L2: --	--		
	L3: --	L3: 2.028	L3: --	--		
R: 100%	L1: 1.510	L1: 1.674	L1: 1.520	1.06	214	

L / C: 104%	L2:	--	L2:	2.020	L2:	--	--		2000
	L3:	--	L3:	2.028	L3:	--	--		
R: 100% L / C: 105%	L1:	1.510	L1:	1.721	L1:	1.520	1.07	121	
	L2:	--	L2:	2.020	L2:	--	--		2000
	L3:	--	L3:	2.028	L3:	--	--		

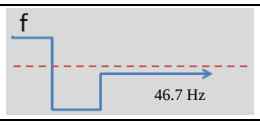
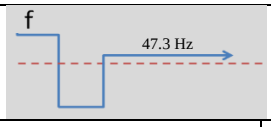
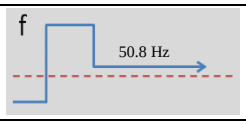
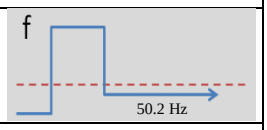
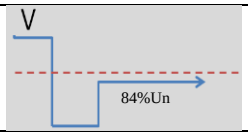
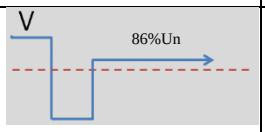
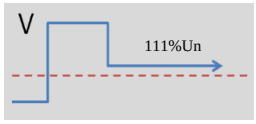
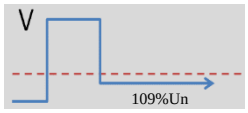
Remark:

Single phase test for multi phase **Generating Units**. Confirm that when generating in parallel with a network operating at around 50Hz with no network disturbance. that the removal of a single phase connection to the **Generating Unit**. with the remaining phases connected causes a disconnection of the generating unit within a maximum of 1s.

Note:
Note for technologies which have a substantial shut down time this can be added to the 0.5 seconds in establishing that the trip occurred in less than 0.5s. Maximum shut down time could therefore be up to 1.0 seconds for these technologies.
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 PEUT = 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 + 0.9 × (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.

Condition B:
EUT output power PEUT = 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. 90 % of range =X + 0.9 × (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.

Condition C:
EUT output power PEUT = 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. 90 % of range =X + 0.9 × (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.

4.2.4.2.2	TABLE: Response to utility recovery			P
Conditions-Frequency				
Connection	☐ Yes/ ☒ No	☒ Yes/ ☐ No	☐ Yes/ ☒ No	☒ Yes/ ☐ No
Time [s]	N/A	76s	N/A	78s
Limits	Not connected	>60 s	Not connected	>60 s
Power rate	N/A	9.86%	N/A	9.90%
Limits	N/A	≤10%Pn/min	N/A	≤10%Pn/min
Conditions-Voltage				
Connection	☐ Yes/ ☒ No	☒ Yes/ ☐ No	☐ Yes/ ☒ No	☒ Yes/ ☐ No
Time [s]	N/A	78s	N/A	78s
Limits	Not connected	>60 s	Not connected	>60 s
Power rate	N/A	9.88%	N/A	9.85%
Limits	N/A	≤10%Pn/min	N/A	≤10%Pn/min
Note:				

The end of report

TÜVRheinland®

PHOTO DOCUMENTATION

50085060 001

for

Hybrid inverter

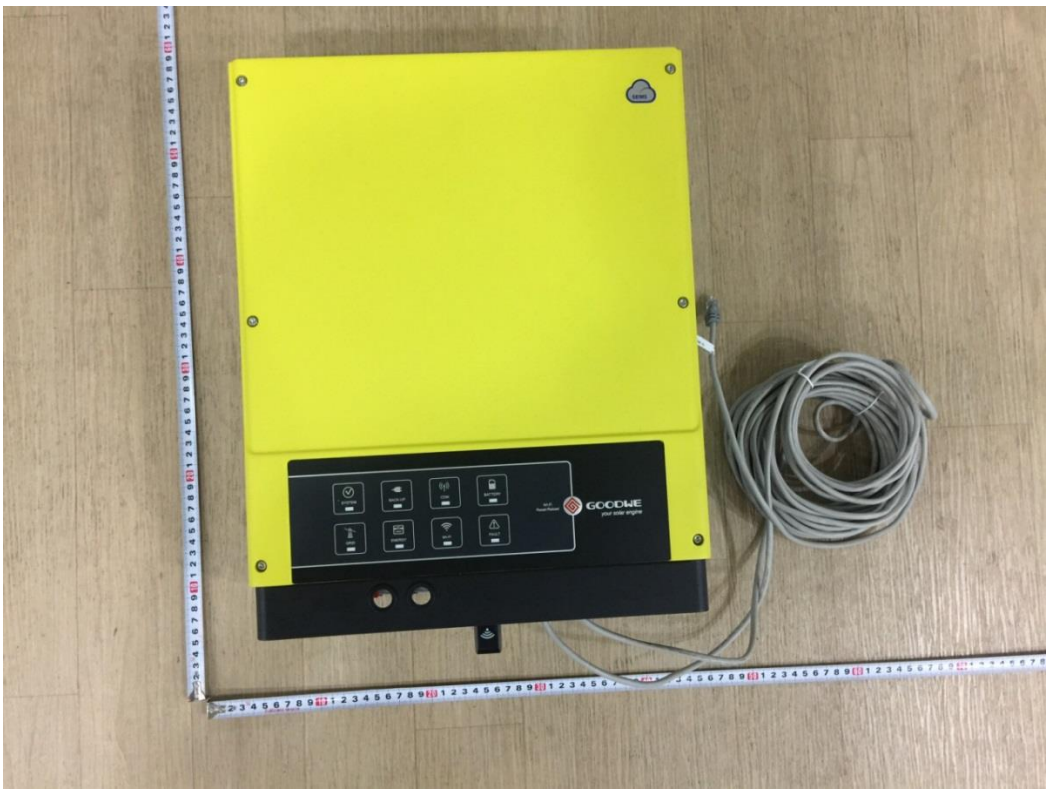
GW5048-EM, GW3648-EM, GW3048-EM

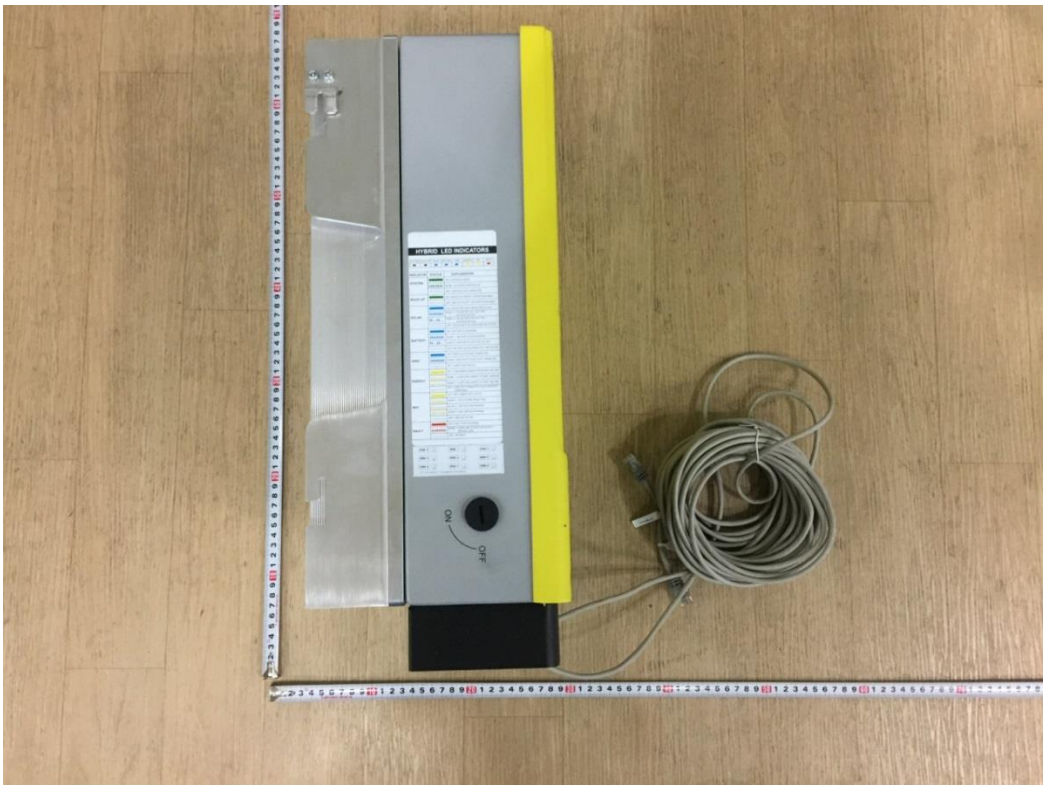
JIANGSU GOODWE POWER SUPPLY TECHNOLOGY CO., LTD.

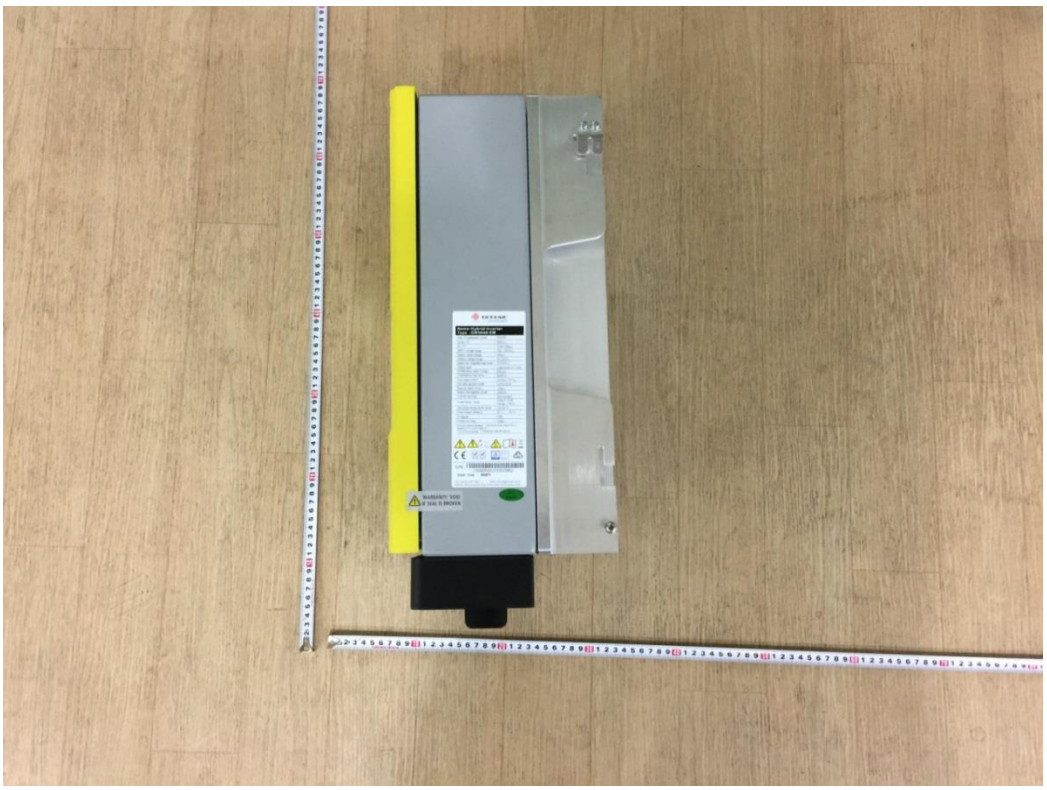
This documentation consists of 9 pages (excluding this cover page)

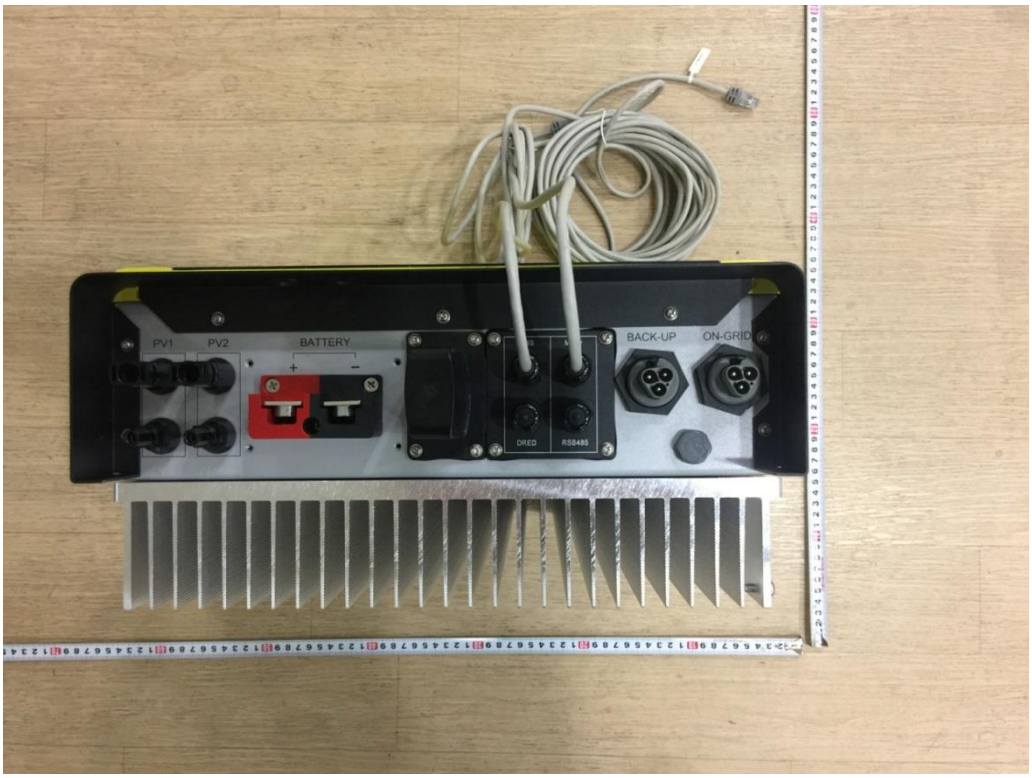
Report Number: 50085060 001

Model: GW5048-EM, GW3648-EM, GW3048-EM




HYBRID LED INDICATORS
ON
OFF




PV1
PV2
BATTERY
+
-
BACK-UP
ON-GRID
DRED
RS485