TEST REPORT

IEC 61727 / IEC 62116

Photovoltaic (PV) systems
Characteristics of the utility interface

Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters

Report reference number ..... :	**17TH0209-IEC61727_0**
Date of issue ..... ……..:	2018-05-04
Total number of pages ..... ……..:	57
Testing laboratory name ..... :	**Bureau Veritas Consumer Products Services Germany GmbH**
Address ..... :	Businesspark A96 86842 Türkheim Germany
Applicant's name ..... :	**SolarEdge Technologies Ltd.**
Address ..... :	1 HaMada Street, Herzliya 4673335, Israel
Test specification	
Standard ..... :	IEC 61727:2004, EN 61727:1995, DIN EN 61727:1996 IEC 62116:2008, EN 62116:2011, DIN EN 62116:2012 IEC 62116:2014
Certificate ..... :	**Certificate of compliance**
Test report form number ..... :	IEC 61727
Master TRF ..... :	Bureau Veritas Consumer Products Services Germany GmbH
Test item description ..... :	**Grid-tied photovoltaic inverter**
Trademark ..... :	solaredge architects of energy™
Model / Type ..... :	SE50K with 2 x SE25K
	SE55K with 2 x SE27.6K
	SE66.6K with 2 x SE33.3K
	SE75K with 3 x SE25K
	SE82.8K with 3 x SE27.6K
	SE100K with 3 x SE 33.3K

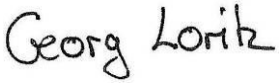
DAkkS Deutsche Akkreditierungsstelle D-PL-12024-03-03

Ratings..... :	**SE50K**	**SE55K**	**SE66.6K**
Input DC voltage range [V] .....:	680 – 1000	680 – 1000	680 – 1000
Input DC current [A].....:	72.5	80	80
Output AC voltage [V].....:	230	230	277
Output AC current [A] .....:	72,5	80	80
Output power [VA] .....:	50000	55000	66600

Ratings..... :	**SE75K**	**SE82.8K**	**SE100K**
Input DC voltage range [V] .....:	680 – 1000	680 – 1000	680 – 1000
Input DC current [A].....:	108,5	120	120
Output AC voltage [V].....:	230	230	277
Output AC current [A] .....:	109	120	120
Output power [VA] .....:	75000	82800	100000

Inverters above consists of:

Ratings..... :	**SE25K**	**SE27.6K**	**SE33.3K**
Input DC voltage range [V] .....:	680 – 1000	680 – 1000	680 – 1000
Input DC current [A].....:	37	40	40
Output AC voltage [V].....:	230	230	277
Output AC current [A] .....:	38	40	40
Output power [VA] .....:	25000	27600	33300

Testing Location ..... :	**Bureau Veritas Consumer Products Services Germany GmbH**
Address.....:	Businesspark A96, 86842 Türkheim, Germany
Tested by (name and signature).....:	Frederic Schmitt 
Approved by (name and signature).....:	Georg Loritz 
Manufacturer's name..... :	**Flextronics International Kft.**
Factory address ..... :	Posta ut 63 8900 Zalaegerszeg Hungary, part of EU
Manufacturer's name..... :	**Celestica SRL**
Factory address ..... :	88 Soseaua Borsului 417075 Bors, Bihor County Romania, part of EU
Manufacturer's name..... :	**Jabil Circuit (Guangzhou) Ltd.**
Factory address ..... :	No. 128, Jun Cheng Road,East section Guangzhou Economic and Technological, Development District 510530 Guangzhou, Guangdong Province, Luogang, China

Document History			
Date	**Internal reference**	**Modification / Change / Status**	**Revision**
2018-05-04	Frederic Schmitt	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].....:	48kg for primary ; 45kg for 2nd and 45kg for 3rd

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.....:	2011-02-28, 2015-02-24
Date(s) of performance test.....:	2017-06-12 to 2017-06-21, 2017-08-21, 2018-04-05

General remarks:

The test result presented in this report relate only to the object(s) tested.
This report must not be reproduced in part or in full without the written approval of the issuing testing laboratory.

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

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

The IEC61727 does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. If nothing different stated at the test table the values for tolerances given in EN 50438, Table 2 are used.

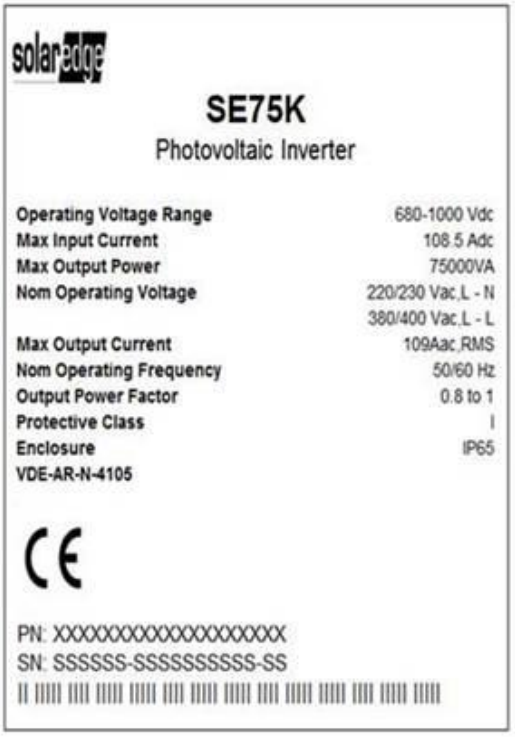
Tolerances on trip values tabel 2 EN50438:

- Voltage: +/- 1% of the nominal voltage
- Frequency: +/- 0,5% of the nominal frequency
- Clearance time: +/- 10%

This Test Report consists of the following documents:

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

Copy of marking plate



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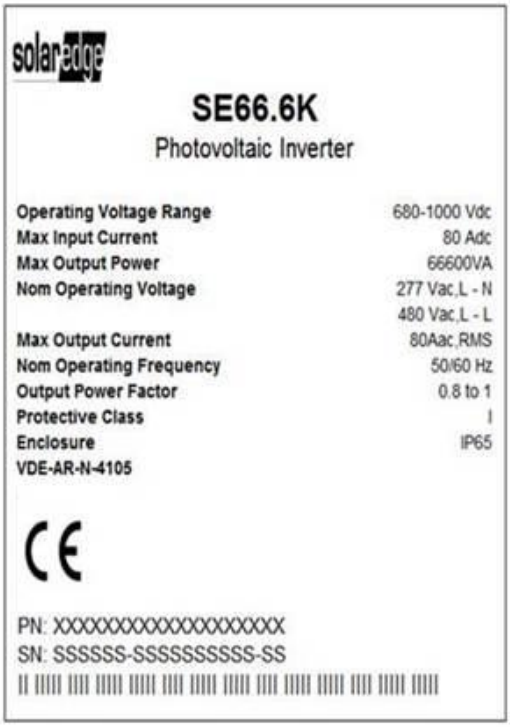
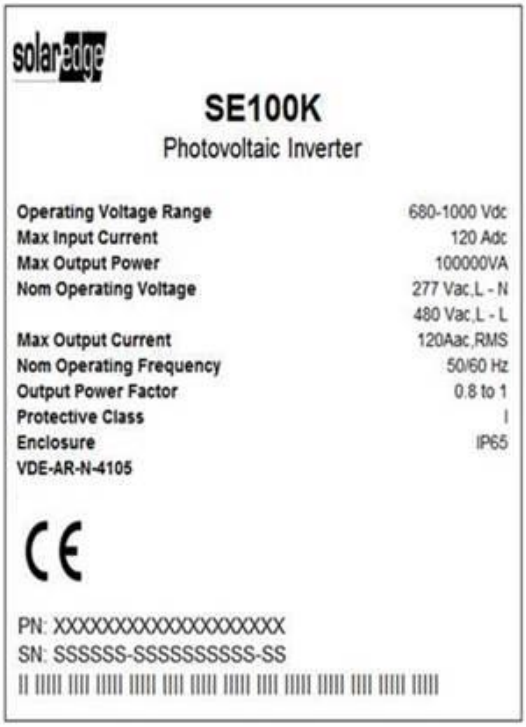




General product information:

The input of the inverter is fed by the SolarEdge Power Optimizers which is a MPP tracking junction box for solar panels. Thus the inverter itself does not have any MPP tracking implemented.

Differences of the models:

The inverters SE25K are based on the inverter SE27.6K and SE33.3K. They use the same controller unit, control system and software. Only difference is the AC voltage. The SE33.3K is for 480V grids the SE27.6K and SE25K for 400V grids.

The product was tested on

Hardware:

Power board is D1041
Relay board is D1043
Digital board is D1045
Display board is D1044
Software:

Main DSP software version is 1.13
Aux DSP software version is 2.19

Description of the electrical circuit:

Both PV input connectors are wired in parallel and EMC filtered by X/Y capacitors and inductors, in addition the input is protected against transient over-voltages by Varistor VR101 and VR102 in series to the surge arrestor SA101. The energy is stored in the two banks (according to bridge topology) of electrolytic capacitors: C779-C782, –upper bank, C783-C786, –lower bank PWM modulated by the three level bridge formed by IGBT modules: IGBT700, IGBT730 and IGBT760. This output signal is filtered by LCL filter formed by:

- L200, C211 and L211 for L1
- L201, C212 and L212 for L2
- L203, C213 and L213 for L3

The capacitor discharge is controlled by IGBT140 for the upper bank and IGBT 120 for the lower bank which shorts the resistors R130, R131 and R132, R133 respectively between V_DC+ and V_DC-.

Due to the transformer less technology of the inverter, there are two power relays in series to the power bridge in order to ensure the safe disconnection of the system also in the case of a single fault. In addition there is a RCD, Type B implemented. The inverters output is EMC filtered and also protected by Varistor VR200… VR252 in series to a surge arrestor SA250 to earth.

The Digital board realizes the redundancy of the safety functionality of the unit.

There are two DSP's monitoring independent from each other the grid voltage and frequency as well as residual current. Both can disable the power bridge and open the relays in case of fault.

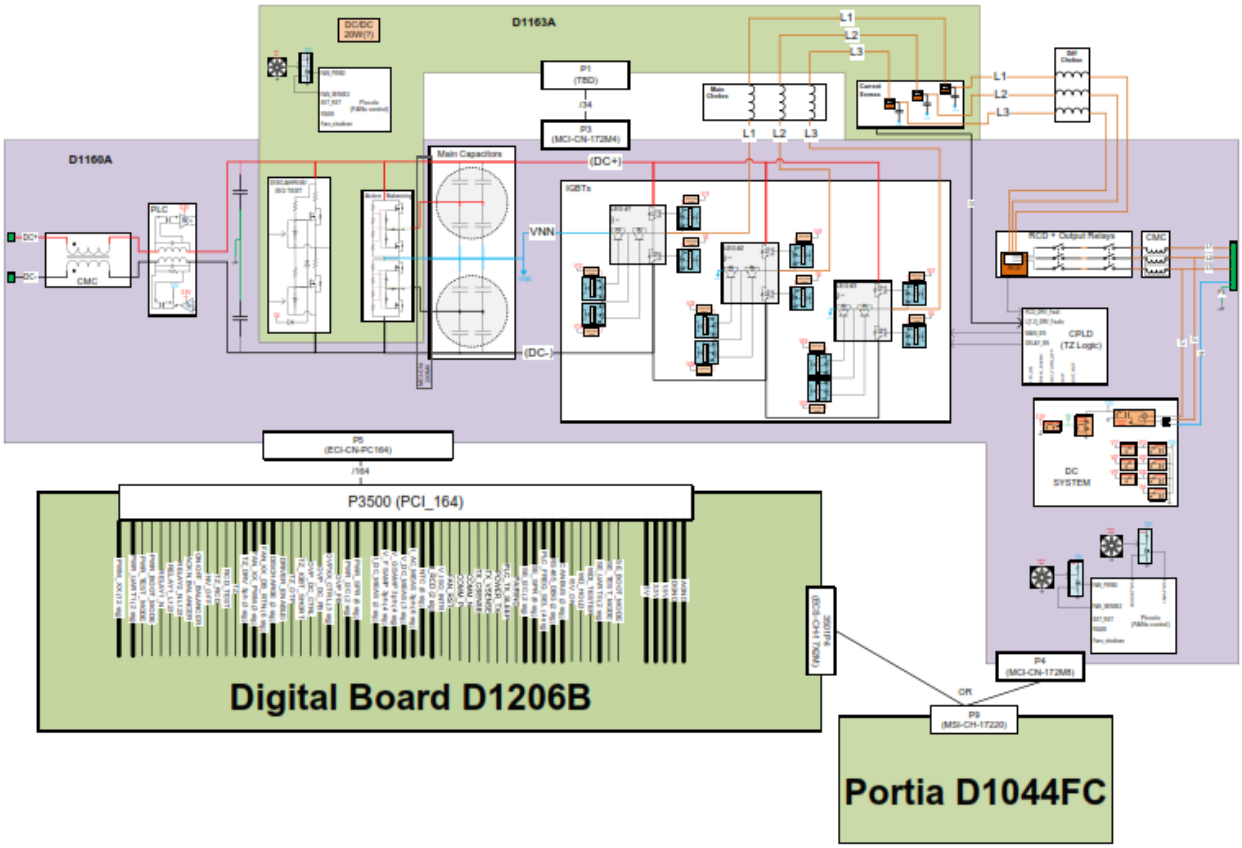
The voltage is one time measured directly on the PWM filter and one time on the AC output after the relays.

The isolation measurement before start-up is monitored only by one DSP since its redundancy is guaranteed by the RCD. Residual currents are detected by the current sensor U601, driven by U600. The output signals I_rcd and I_rcd2 are wired to both DSP's. Additionally the drivers for the current sensor have an integrated hardware shutdown to guarantee its fail-safety.

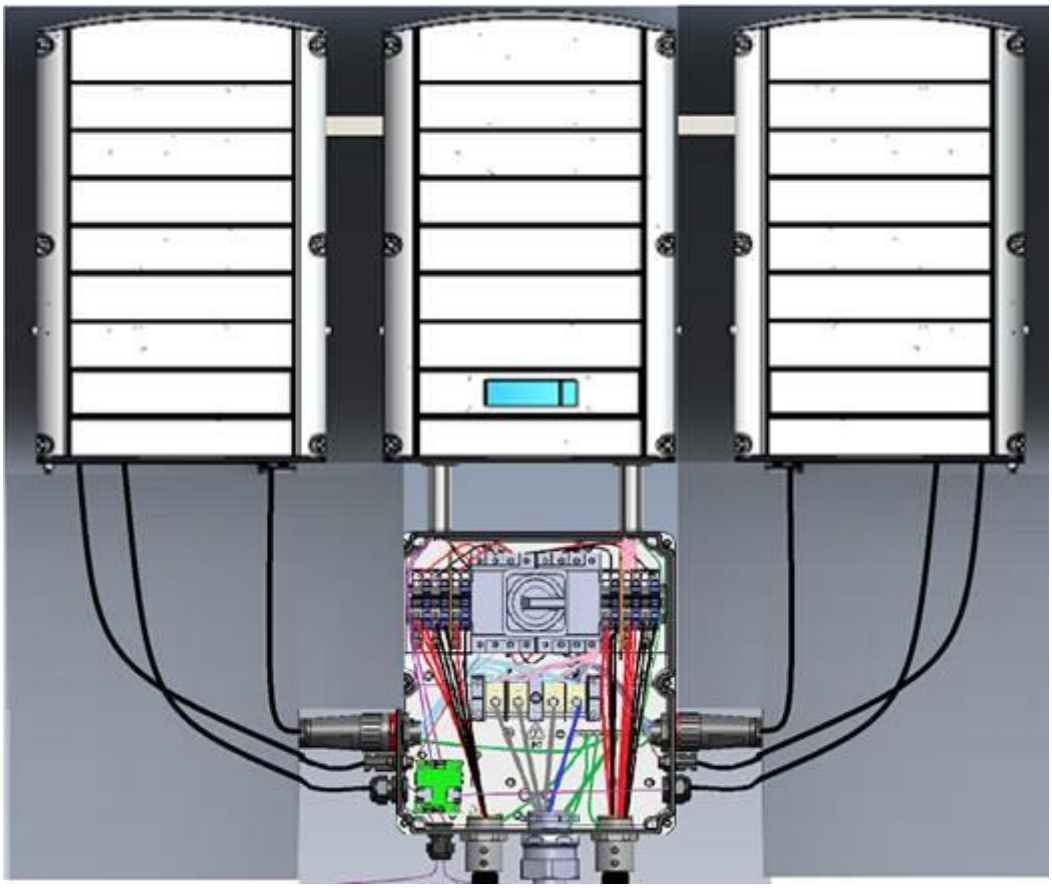
The dc-injection (signal DC_Current_measurement) is active compensated, in case of fault there is a disconnection if the dc-injection exceeds certain limits.

Before every start-up the safety functions are verified, including test of the relays. The unit monitors the grid voltage for at least 30s before it connects to the grid.

Block diagram of the utility interactive inverter:



Based on the single inverter models SE25K, SE27.6K and SE33.3K are the models build of:
SE50K with 2 x SE25K
SE55K with 2 x SE27.6K
SE66.6K with 2 x SE33.3K
SE75K with 3 x SE25K
SE82.8K with 3 x SE27.6K
SE100K with 3 x SE 33.3K



All 2 or 3 inverters are communicating by the internal RS485-2 bus of. Once there is an error at one of the inverters, it is displayed at the Master inverter (both LEDs and Portia).

On\Off switch is based at the master inverter and command the slaves as well (once the main inverter is shout down, it will also shout down the slaves), once the Master inverter is not connected, also the slaves arel not be able to turn on.

Default interface protection settings according IEC 61727:2004		
Parameter	**Max. clearance time***	**Trip setting**
Over voltage (level 2)	0,05s	230V +35% (310,5V)
Over voltage (level 1)	2,0s	230V +10% (253V)
Under voltage (level 1)	2,0s	230V -15% (195,5V)
Under voltage (level 2)	0,1s	230V -50% (115V)
Over frequency	0,2s	50Hz +2% (51,0Hz)
Under frequency	0,2s	50Hz -2% (49,0Hz)
Reconnection time	20s to 300s	
Permanent DC-injection	1% of rated inverter output current	
Loss of main IEC 62116	Inverter shall detect and disconnect within 2s	
* Trip time refers to the time between the abnormal condition occurring and the inverter ceasing to energize the utility line. The PV system control circuits shall actually remain connected to the utility to allow sensing of utility electrical conditions for use by the “reconnect” feature.		

Interface protection settings according CEA (India)		
Parameter	**Max. clearance time***	**Trip setting**
Over voltage (level 2)	0,05s	230V +35% (310,5V)
Over voltage (level 1)	2,0s	230V +10% (253V)
Under voltage (level 1)	2,0s	230V -15% (195,5V)
Under voltage (level 2)	0,1s	230V -50% (115V)
Over frequency	0,2s	50Hz +4% (52,0Hz)
Under frequency	0,2s	50Hz -5% (47,5Hz)
Reconnection time	20s to 300s	
Permanent DC-injection	0,5% of rated inverter output current	
Loss of main IEC 62116	Inverter shall detect and disconnect within 2s	
* Trip time refers to the time between the abnormal condition occurring and the inverter ceasing to energize the utility line. The PV system control circuits shall actually remain connected to the utility to allow sensing of utility electrical conditions for use by the “reconnect” feature.		

IEC61727:2004			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4: Utility compatibility			
4	**General** The quality of power provided by the PV system for the on-site AC loads and for 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 and may require the PV system to sense the deviation and properly disconnect from the utility system. All power quality parameters (voltage, flicker, frequency, harmonics, and power factor) must be measured at the utility interface/ point of common coupling unless otherwise specified.	Noticed	**P**
4.1	**Voltage, current and frequency** The PV system AC voltage, current and frequency shall be compatible with the utility system.	Derived from tests	**P**
4.2	**Normal voltage operating range** Utility-interconnected PV systems do not normally regulate voltage; they inject current into the utility. Therefore, the voltage operating range for PV inverters is selected as a protection function that responds to abnormal utility conditions, not as a voltage regulation function.	Derived from tests	**P**
4.3	**Flicker** The operation of the PV system should not cause voltage flicker in excess of limits stated in the relevant sections of IEC 61000-3-3 for systems less than 16 A or IEC 61000-3-5 for systems with current of 16 A and above.	See table 4.3	**P**
4.4	**DC injection** The PV system shall not inject DC current greater than 1 % of the rated inverter output current, into the utility AC interface under any operating condition.	See table 4.4	**P**
4.5	**Normal frequency operating range** The PV system shall operate in synchronism with the utility system, and within the frequency trip limits defined in 5.2.2.	See table 4.5 and 5.2.2	**P**

IEC61727:2004			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4: Utility compatibility			
4.6	**Harmonics and waveform distortion** Low levels of current and voltage harmonics are desirable; the higher harmonic levels increase the potential for adverse effects on connected equipment. Acceptable levels of harmonic voltage and current depend upon distribution system characteristics, type of service, connected loads/apparatus, and established utility practice. The PV system output should have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system. Total harmonic current distortion shall be less than 5 % at rated inverter output. Each individual harmonic shall be limited to the percentages listed in Table 1. Even harmonics in these ranges shall be less than 25 % of the lower odd harmonic limits listed. (see Clause 4.6 Table 1 – Current distortion limits)	See tables 4.6 (1) and 4.6 (2)	**P**
4.7	**Power factor** The PV system shall have a lagging power factor greater than 0,9 when the output is greater than 50 % of the rated inverter output power.	See table 4.7	**P**

IEC61727:2004			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 5: Personnel safety and equipment protection			
5	**General** This Clause provides information and considerations for the safe and proper operation of the utility-connected PV systems.	Noticed	**P**
5.1	**Loss of utility voltage** To prevent islanding, a utility connected PV system shall cease to energize the utility system from a de-energized distribution line irrespective of connected loads or other generators within specified time limits. A utility distribution line can become de-energized for several reasons. For example, a substation breaker opening due to fault conditions or the distribution line switched out during maintenance. If inverters (single or multiple) have DC SELV input and have accumulated power below 1 kW then no mechanical disconnect (relay) is required.		**P**
5.2	**Over/under voltage and frequency** Abnormal conditions can arise on the utility system that requires a response from the connected photovoltaic system. This response is to ensure the safety of utility maintenance personnel and the general public, as well as to avoid damage to connected equipment, including the photovoltaic system. The abnormal utility conditions of concern are voltage and frequency excursions above or below the values stated in this Clause, and the complete disconnection of the utility, presenting the potential for a distributed resource island.	See table 5.2.1 and 5.2.2	**P**
5.2.1	**Over/under voltage** When the interface voltage deviates outside the conditions specified in Table 2, the photovoltaic system shall cease to energize the utility distribution system. This applies to any phase of a multiphase system. All discussions regarding system voltage refer to the local nominal voltage. The system shall sense abnormal voltage and respond. The following conditions should be met, with voltages in RMS and measured at the point of utility connection. (see clause 5.2.1 Table 2 – Response to abnormal voltages) The purpose of the allowed time delay is to ride through short-term disturbances to avoid excessive nuisance tripping. The unit does not have to cease to energize if the voltage returns to the normal utility continuous operation condition within the specified trip time.	See table 5.2.1	**P**
5.2.2	**Over/under frequency** When the utility frequency deviates outside the specified conditions the photovoltaic system shall cease to energize the utility line. The unit does not have to cease to energize if the frequency returns to the normal utility continuous operation condition within the specified trip time. When the utility frequency is outside the range of ±1 Hz, the system shall cease to energize the utility line within 0,2 s. The purpose of the allowed range and time delay is to allow continued operation for short-term disturbances and to avoid excessive nuisance tripping in weak-utility system conditions.	See table 5.2.2	**P**
5.3	**Islanding protection** The PV system must cease to energize the utility line within 2 s of loss of utility.		**P**

IEC61727:2004			
Clause	Requirement – Test	Result – Remark	Verdict
5.4	**Response to utility recovery** Following an out-of-range utility condition that has caused the photovoltaic system to cease energizing, the photovoltaic system shall not energize the utility line for 20 s to 5 min after the utility service voltage and frequency have recovered to within the specified ranges**.**	See table 5.2 (1) and 5.2 (2)	**P**
5.5	**Earthing** The utility interface equipment shall be earthed/grounded in accordance with IEC 60364-7-712.	Stated in the manual.	**P**
5.6	**Short circuit protection** The photovoltaic system shall have short-circuit protection in accordance with IEC 60364-7-712.	Stated in the manual.	**P**
5.7	**Isolation and switching** A method of isolation and switching shall be provided in accordance with IEC 60364-7-712.	Stated in the manual.	**P**

Test overview:		
IEC 61727:2004		
Clause	**Test**	**Result**
1	Response to protection operation - fault condition tests (according VDE0126-1-1:2006)	**P**
4	Type test:	
4.3	Voltage Fluctuations and Flicker	**P**
4.4	Monitoring of DC-Injection	**P**
4.5	Normal frequency operating range (see 5.2.2 below)	**P**
4.6	Harmonics and waveform distortion	**P**
4.7	Power factor	**P**
5.2.1	Voltage monitoring	**P**
5.2.2	Frequency monitoring	**P**

IEC 62116:2008/2014		
Clause	**Test**	**Result**
	Type test:	
6.1	Islanding protection according table 6 - Load imbalance (real, reactive load) for test condition A (EUT ouput = 100%)	**P**
6.1	Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)	**P**
6.1	Load imbalance (reactive load) for test condition C (EUT output = 25 % – 33 %)	**P**

Test Results

1. Response to protection operation - fault condition tests								P
component No.	fault	test condition		test time	fuse	fault condition		result
		AC	DC			AC	DC	
Relay K220 defect	PIN1 to PIN2 short (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	After grid fault clearing no restart. Fault: Init Relay Test. No hazard, no defect
Relay K226 defect	PIN1 to PIN2 short (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	After grid fault clearing no restart. Fault: Init Relay Test. No hazard, no defect
Relay K222 defect	PIN1 to PIN2 short (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	After grid fault clearing no restart. Fault: Init Relay Test. No hazard, no defect
Relay K228 defect	PIN1 to PIN2 short (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	After grid fault clearing no restart. Fault: Init Relay Test. No hazard, no defect
Monitoring voltage L 1 defect	R400 open (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	Unit switched off immediately. Fault: Grid Min 1-L1. No restart. No hazard no defect.
Monitoring voltage L 1 defect	R425 open (Power board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	Unit switched off immediately. Fault: KL1-Min1. No restart. No hazard no defect.
Monitoring voltage L 2 defect	R410 open (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	Unit switched off immediately. Fault: Grid Min 1-L2. No restart. No hazard no defect
Monitoring voltage L 2 defect	R435 open (Power board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	Unit switched off immediately. Fault: V-L2-Min1. No restart. No hazard no defect
Monitoring voltage L 3 defect	R420 open (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	Unit switched off immediately. Fault: Grid Min 1-L3. No restart. No hazard no defect
Monitoring voltage L 3 defect	R450 open (Power board)	230V 2,7A	750V 2,5A	10min	ext. 63A	230V 0,1A	750V 0A	Unit switched off immediately. Fault:V-L3-Min 1. No restart. No hazard no defect
Monitoring voltage N defect	R430 open (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 32A	230V 0,1A	750V 0A	No effect on function in normal operation, since PE and N potential is connected. If the PE potential drifts away, normal disconnection. No hazard, no defect.
Monitoring voltage N defect	R475 open (Power board)	230V 2,7A	750V 2,5A	10min	ext. 32A	230V 0,1A	750V 0A	No effect on function in normal operation, since PE and N potential is connected. If the PE potential drifts away, normal disconnection. No hazard, no defect.

Frequency Measurement disabled	-	-	-	-	-	-	-	Frequency measurement is done via voltage measurement input.
Leakage Sensor N600 defect	C602 short (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 32A	230V 0,1A	750V 0A	Unit switched off immediately. Fault: Grid-I RCD 2. No restart. No hazard no defect
Leakage Sensor N600 defect	U600 PIN6 to 8 short (Relay board)	230V 2,7A	750V 2,5A	10min	ext. 32A	230V 0,1A	750V 0A	No effect on function. After restart grid fault no reconnection. Fault: Init-RCD test. No hazard, no defect.
Leakage Sensor N600 self test defect	R611 open (Relay board) Before startup	230V 2,7A	750V 2,5A	10min	ext. 32A	230V 0,1A	750V 0A	The Unit does not star up. Fault: Init-RCD test. No hazard, no defect.
Communication Microcontroller defect	SCL data open	230V 2,7A	750V 2,5A	10min	ext. 32A	230V 0,1A	750V 0A	Unit switched off immediately. Fault: communication. No restart. No hazard, no defect.
Loss of control	U100 Reset	230V 2,7A	750V 2,5A	10min	ext. 32A	230V 0,1A	750V 0A	Unit switched off immediately. No fault. No hazard, no defect.
Loss of control 2	U200 Reset	230V 2,7A	750V 2,5A	10min	ext. 32A	230V 0,1A	750V 0A	Unit switched off immediately. Fault: communication stop. No hazard, no defect
Note: The errors in the control circuit simulate that the safety is even under one error ensured.								
Addendum – Shutdown device								
Each active phase can be switched. (L and N)								Relay with min. 2,1mm gap used. See attached datasheets Annex-1
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.								Single relay used in each active phase (L and N)

4.3 Voltage fluctuation and flicker				**P**
SE27.6K				
Test conditions:	Maximum permissible voltage fluctuation (expressed as a percentage of nominal voltage at 100 % power) and flicker as per EN 61000-3-3			
	Starting	**Stopping**	**Running**	
Limit	dc% = 3,3		P_{st}=1,0	P_{lt}=0,65*
Test value	3,3%		0,38	0,38

Note:
Mains Impedance according EN61000-3-3: **R_{max} = 0,24Ω; jX_{max}= 0,15Ω @50Hz (|Z_{max}| = 0,283Ω)**

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 EN61000-3-11 for more than 16A.

4.4 Monitoring of Permanent DC-Injection IEC 61727:2004			P
SE27.6			
IEC61727 Limit:	**1% of Inom (400mA)**		
Output power:	33%	66%	100%
mean test value phase L1 [mA]:	6,18	4,78	8,10
mean test value phase L2 [mA]:	7,43	8,14	9,94
mean test value phase L3 [mA]:	2,78	6,36	12,09

Diagram 33%

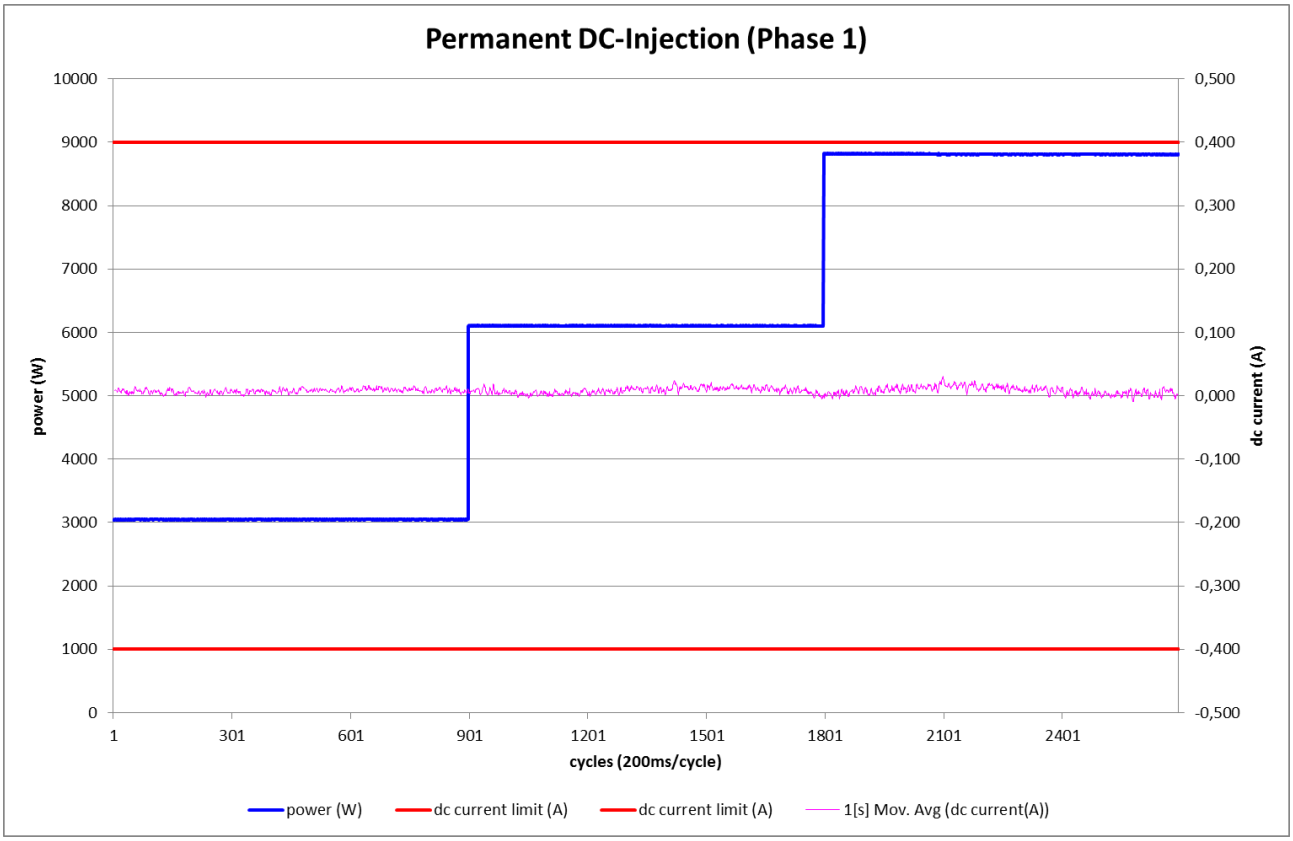


Diagram 66%

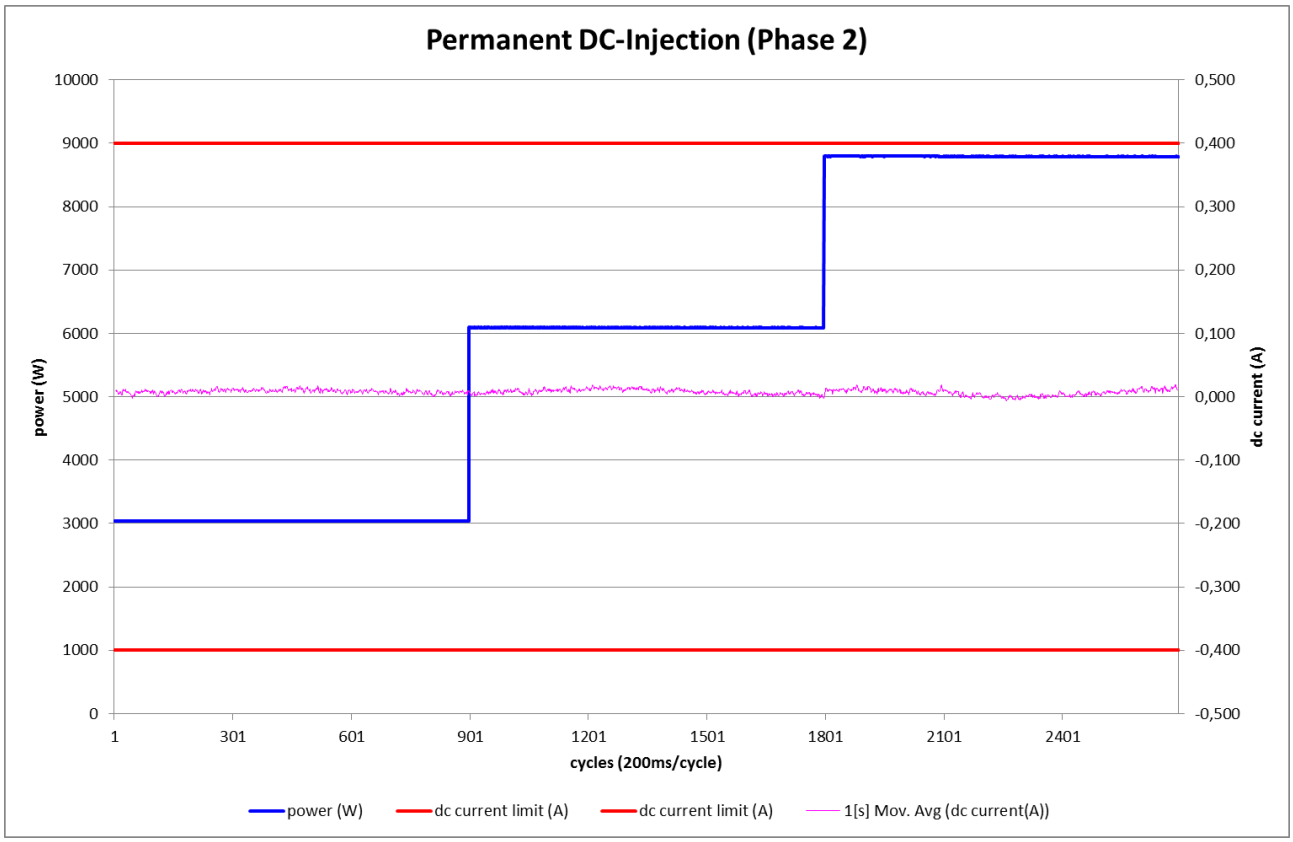
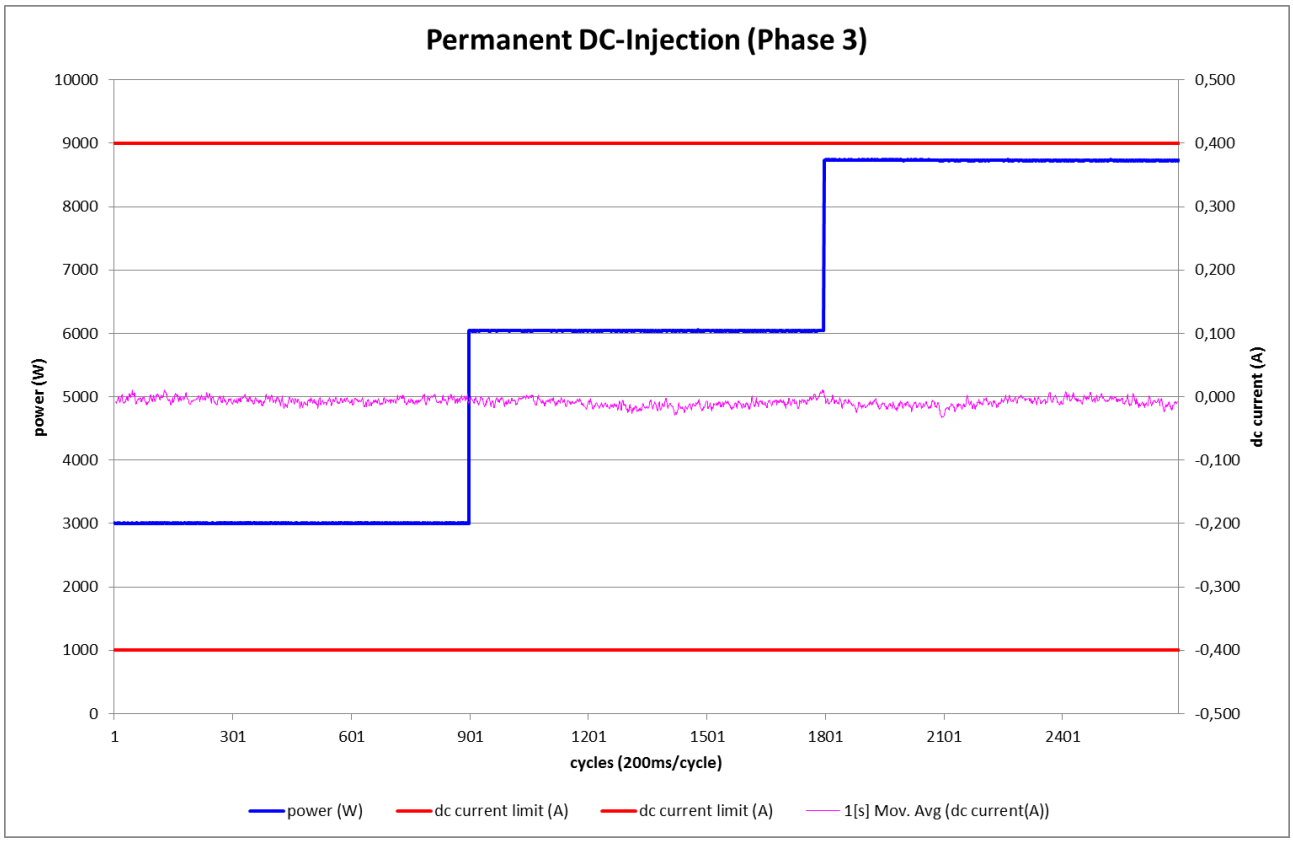


Diagram 100%



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

SE27.6K			P
CEA Limit:	**0,5% of Inom (200mA)**		
Output power:	33%	66%	100%
mean test value phase L1 [mA]:	6,18	4,78	8,10
mean test value phase L2 [mA]:	7,43	8,14	9,94
mean test value phase L3 [mA]:	2,78	6,36	12,09

Diagram 33%

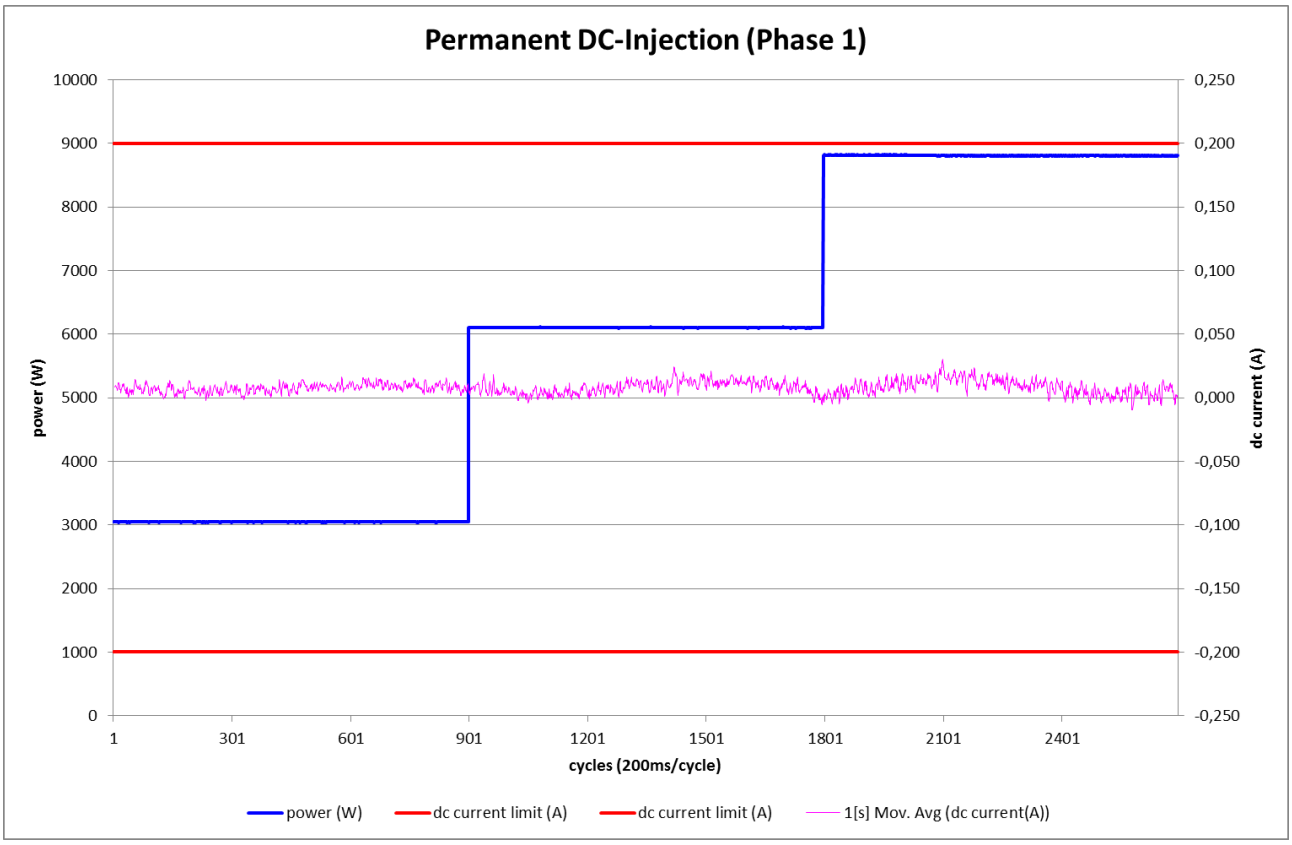


Diagram 66%

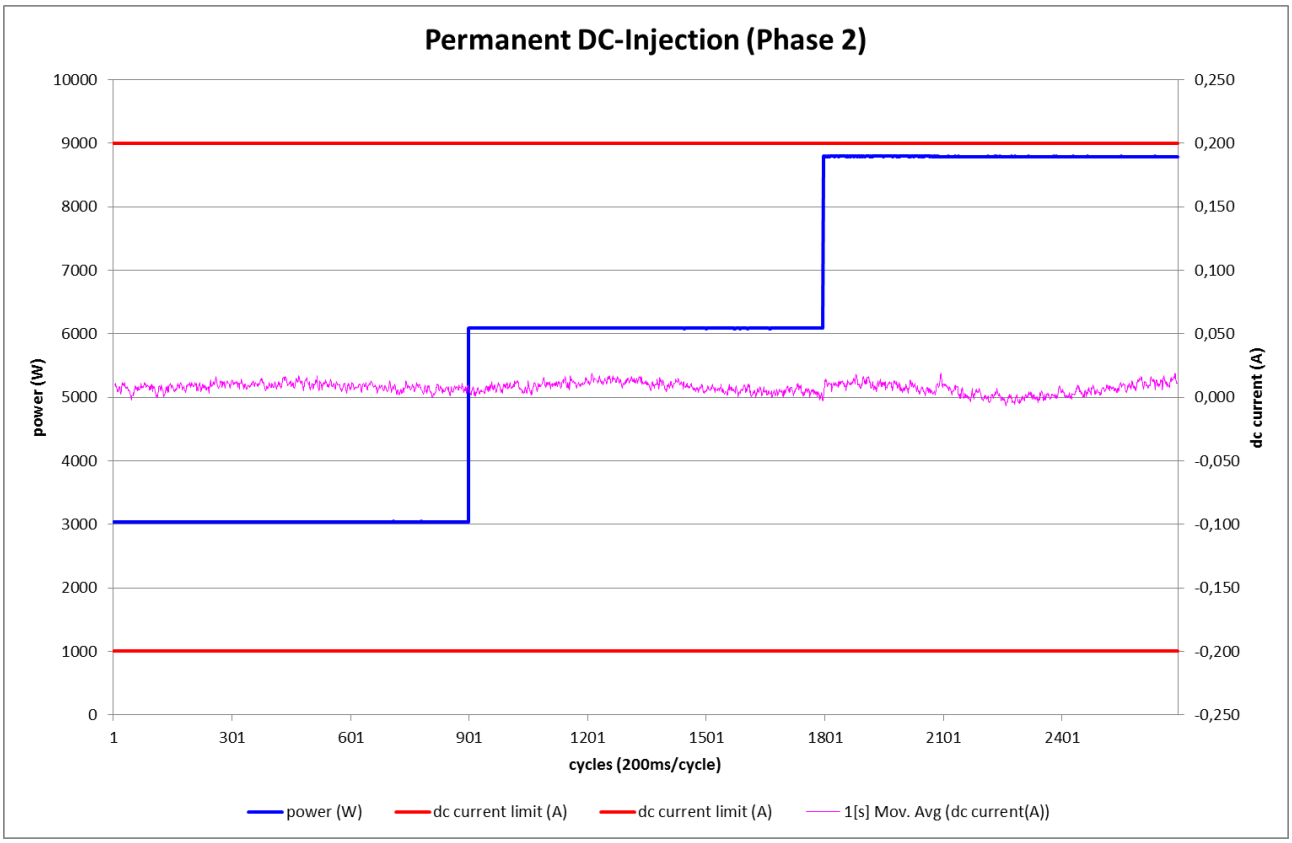
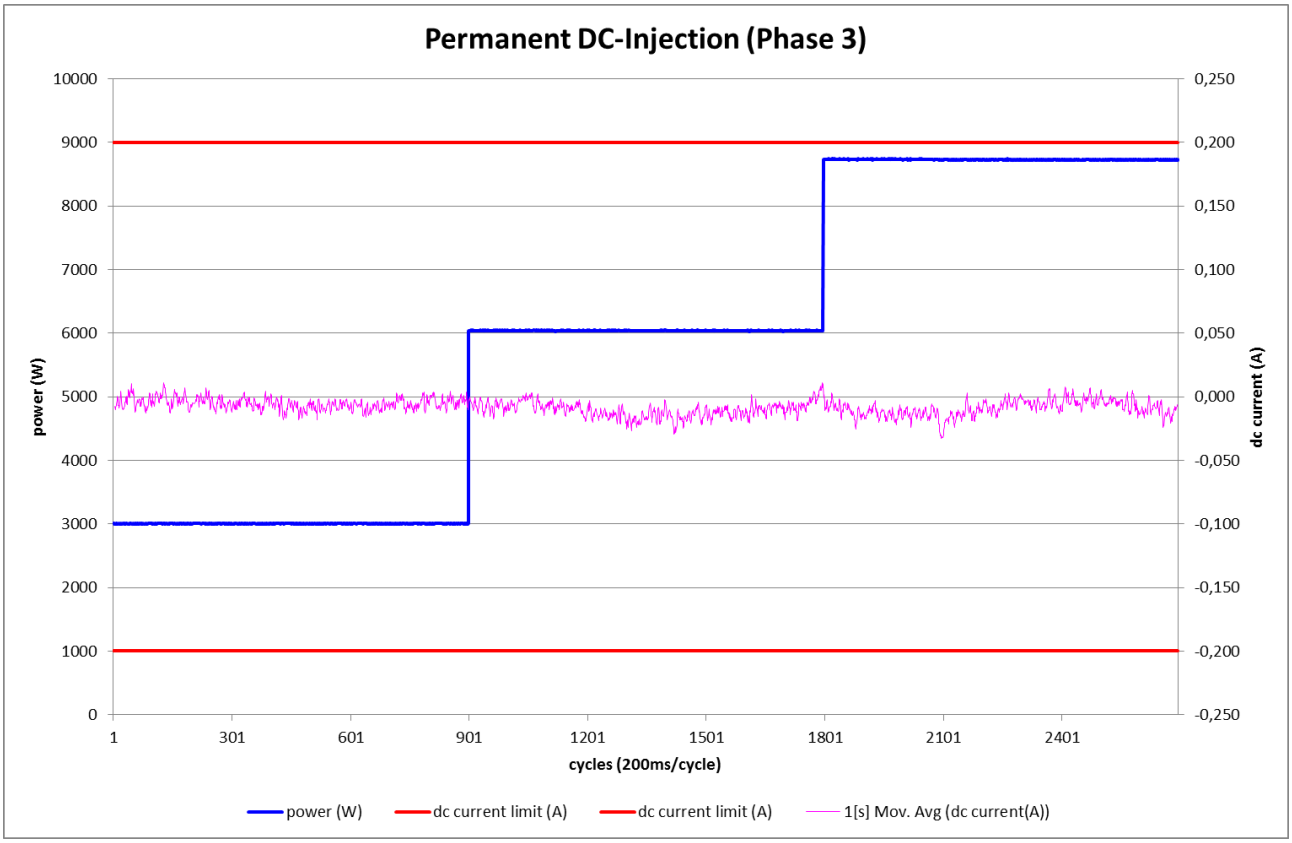


Diagram 100%



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

4.6 Harmonic Current Limit Test **IEC 61727:2004** **SE27.6K**	**P**

Power [W]	**8812,49**
Voltage [V rms]	**233,97**
Current [A rms]	**37,67**
PF [1]	**0,999**
Frequency [Hz]	**49,99**
THD50 [%]	**1,11**

Harmonics	Current Magnitude [A]	% of Fundamental	Phase	Harmonic Current Limits [%]
1st	37,664	100,000	L1	
2nd	0,042	0,111	L1	1%
3rd	0,108	0,287	L1	4%
4th	0,068	0,181	L1	1%
5th	0,284	0,754	L1	4%
6th	0,011	0,030	L1	1%
7th	0,154	0,408	L1	4%
8th	0,013	0,036	L1	1%
9th	0,008	0,022	L1	4%
10th	0,014	0,038	L1	0.5%
11th	0,121	0,322	L1	2%
12th	0,008	0,020	L1	0.5%
13th	0,116	0,308	L1	2%
14th	0,010	0,025	L1	0.5%
15th	0,005	0,014	L1	2%
16th	0,008	0,021	L1	0.5%
17th	0,075	0,198	L1	1.5%
18th	0,006	0,015	L1	0.5%
19th	0,080	0,212	L1	1.5%
20th	0,007	0,020	L1	0.5%
21th	0,004	0,011	L1	1.5%
22th	0,005	0,014	L1	0.5%
23th	0,052	0,139	L1	0.6%
24th	0,004	0,011	L1	0.5%
25th	0,055	0,146	L1	0.6%
26th	0,006	0,015	L1	0.5%
27th	0,005	0,012	L1	0.6%
28th	0,004	0,012	L1	0.5%
29th	0,037	0,098	L1	0.6%
30th	0,004	0,009	L1	0.5%
31th	0,038	0,101	L1	0.6%
32th	0,005	0,012	L1	0.5%
33th	0,004	0,010	L1	0.6%
34th	0,004	0,012	L1	N/A
35th	0,027	0,073	L1	N/A
36th	0,003	0,009	L1	N/A
37th	0,028	0,075	L1	N/A
38th	0,005	0,013	L1	N/A
39th	0,004	0,011	L1	N/A
40th	0,005	0,013	L1	N/A

Note:
The harmonics are tested and evaluated according the IEC 61727:2004.

4.6 Harmonic Current Limit Test **IEC 61727:2004** **SE27.6K**	**P**

Power [W]	**8792,98**
Voltage [V rms]	**233,86**
Current [A rms]	**37,60**
PF [1]	**0,999**
Frequency [Hz]	**49,99**
THD50 [%]	**1,16**

Harmonics	**Current Magnitude [A]**	**% of Fundamental**	**Phase**	**Harmonic Current Limits [%]**
1st	37,600	100,000	L2	
2nd	0,049	0,130	L2	1%
3rd	0,211	0,561	L2	4%
4th	0,050	0,134	L2	1%
5th	0,256	0,680	L2	4%
6th	0,038	0,101	L2	1%
7th	0,159	0,424	L2	4%
8th	0,013	0,035	L2	1%
9th	0,015	0,039	L2	4%
10th	0,012	0,032	L2	0.5%
11th	0,130	0,346	L2	2%
12th	0,011	0,028	L2	0.5%
13th	0,105	0,280	L2	2%
14th	0,007	0,019	L2	0.5%
15th	0,012	0,031	L2	2%
16th	0,007	0,018	L2	0.5%
17th	0,080	0,212	L2	1.5%
18th	0,008	0,021	L2	0.5%
19th	0,067	0,178	L2	1.5%
20th	0,006	0,016	L2	0.5%
21th	0,012	0,032	L2	1.5%
22th	0,006	0,017	L2	0.5%
23th	0,055	0,146	L2	0.6%
24th	0,005	0,014	L2	0.5%
25th	0,046	0,123	L2	0.6%
26th	0,006	0,015	L2	0.5%
27th	0,009	0,025	L2	0.6%
28th	0,006	0,016	L2	0.5%
29th	0,038	0,102	L2	0.6%
30th	0,004	0,010	L2	0.5%
31th	0,033	0,089	L2	0.6%
32th	0,006	0,015	L2	0.5%
33th	0,007	0,017	L2	0.6%
34th	0,005	0,013	L2	N/A
35th	0,027	0,073	L2	N/A
36th	0,004	0,010	L2	N/A
37th	0,027	0,073	L2	N/A
38th	0,005	0,014	L2	N/A
39th	0,005	0,013	L2	N/A
40th	0,005	0,013	L2	N/A

Note:
The harmonics are tested and evaluated according the IEC 61727:2004.

4.6 Harmonic Current Limit Test **IEC 61727:2004** **SE27.6K**	**P**

Power [W]	**8731,68**
Voltage [V rms]	**233,73**
Current [A rms]	**37,36**
PF [1]	**0,999**
Frequency [Hz]	**49,99**
THD50 [%]	**1,18**

Harmonics	**Current Magnitude [A]**	**% of Fundamental**	**Phase**	**Harmonic Current Limits [%]**
1st	37,359	100,000	L3	
2nd	0,042	0,112	L3	1%
3rd	0,135	0,361	L3	4%
4th	0,068	0,183	L3	1%
5th	0,303	0,811	L3	4%
6th	0,038	0,102	L3	1%
7th	0,129	0,345	L3	4%
8th	0,019	0,050	L3	1%
9th	0,054	0,144	L3	4%
10th	0,016	0,042	L3	0.5%
11th	0,117	0,312	L3	2%
12th	0,012	0,032	L3	0.5%
13th	0,129	0,345	L3	2%
14th	0,011	0,029	L3	0.5%
15th	0,033	0,089	L3	2%
16th	0,010	0,025	L3	0.5%
17th	0,100	0,268	L3	1.5%
18th	0,009	0,025	L3	0.5%
19th	0,067	0,179	L3	1.5%
20th	0,007	0,019	L3	0.5%
21th	0,011	0,031	L3	1.5%
22th	0,007	0,019	L3	0.5%
23th	0,064	0,171	L3	0.6%
24th	0,006	0,017	L3	0.5%
25th	0,047	0,125	L3	0.6%
26th	0,005	0,014	L3	0.5%
27th	0,009	0,025	L3	0.6%
28th	0,006	0,017	L3	0.5%
29th	0,041	0,110	L3	0.6%
30th	0,004	0,010	L3	0.5%
31th	0,037	0,099	L3	0.6%
32th	0,005	0,013	L3	0.5%
33th	0,007	0,019	L3	0.6%
34th	0,005	0,013	L3	N/A
35th	0,033	0,087	L3	N/A
36th	0,003	0,009	L3	N/A
37th	0,025	0,068	L3	N/A
38th	0,005	0,013	L3	N/A
39th	0,003	0,008	L3	N/A
40th	0,005	0,013	L3	N/A

Note:
The harmonics are tested and evaluated according the IEC 61727:2004.

4.7 Power factor					**P**
	SE27.6K				
Output power [kW] / **Test AC voltage [V]**	**~10% 2,8kW**	**~25% 6,9kW**	**~50% 13,8kW**	**~75% 20,7kW**	**~100% 27,6kW**
230V	0,976	0,998	0,999	0,999	0,999
	SE33.3K				
Output power [kW] / **Test AC voltage [V]**	**~10% 3,3kW**	**~25% 8,4kW**	**~50% 16,7kW**	**~75% 25kW**	**~100% 33,3kW**
277V	0,979	0,999	0,999	0,999	0,999

Note:
The PV system shall have a lagging power factor greater than 0,95 when the output is greater than 50% 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.

5.2.1 Voltage monitoring 230V grid									**P**
Phase L1									
IEC 61727: First Level									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**195,5V**	**<= 2,0s**			**253V**	**<= 2,0s**			
Trip value	195,0V				252,9V				
Trip time	200V to 190V	2,00s	2,00s	2,00s	248V to 258V	2,00s	2,00s	2,00s	
Reconnection time	20s	327s			20s	327s			
IEC 61727: Second Level									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**115V**	**<= 100ms**			**310V**	**<= 50ms**			
Trip value	116,0V				309,7V				
Trip time	230V to 115V	102ms	101ms	101ms	230V to 300V	0,42ms	0,50ms	14ms	
Reconnection time	20s	327s			20s	327s			
Phase L2									
IEC 61727: First Level									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**195,5V**	**<= 2,0s**			**253V**	**<= 2,0s**			
Trip value	195,0V				253,0V				
Trip time	200,0V to 190,0V	2,00s	2,02s	2,01s	248V to 258V	2,01s	2,01s	2,01s	
Reconnection time	20s	327s			20s	327s			
IEC 61727: Second Level									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**115V**	**<= 100ms**			**310V**	**<= 50ms**			
Trip value	116,1V				309,6				
Trip time	230V to 115V	109ms	109ms	109ms	230V to 300V	12ms	12ms	12ms	
Reconnection time	20s	327s			20s	327s			

Phase L3								
IEC 61727: First Level								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**195,5V**	**<= 2,0s**			**253V**	**<= 2,0s**		
Trip value	195,3V				252,6V			
Trip time	200,0V to 190,0V	2,00s	1,99s	1,99s	248V to 258V	2,00s	2,00s	2,00s
Reconnection time	20s	327s			20s	327s		
IEC 61727: Second Level								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**115V**	**<= 100ms**			**310V**	**<= 50ms**		
Trip value	116,2				309,5			
Trip time	230V to 115V	102ms	102ms	102ms	230V to 300V	12ms	12ms	12ms
Reconnection time	20s	327s			20s	327s		

Note:

The IEC61727 does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. Therefore the values for tolerances given in EN 50438, Table 2 are used.

Tolerances on trip values tabel 2 EN50438:

- Voltage: +/- 1% of the nominal voltage
- Frequency: +/- 0,5% of the nominal frequency
- Clearance time: +/- 10%

5.2.1 Voltage monitoring 277V grid									**P**
Phase L1									
IEC 61727: First Level									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**235,5V**	**<= 2,0s**			**304V**	**<= 2,0s**			
Trip value	235,0V				304,7V				
Trip time	277V to 230V	1,99s	1,99s	1,99s	277V to 310V	1,99s	1,99s	1,99s	
Reconnection time	20s	327s			20s	327s			
IEC 61727: Second Level									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**138,5V**	**<= 100ms**			**373,3V**	**<= 50ms**			
Trip value	138,1V				332,5V*				
Trip time	277V to 130V	88ms	89ms	89ms	277V to 337V	6ms	6ms	6ms	
Reconnection time	20s	327s			20s	327s			
Phase L2									
IEC 61727: First Level									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**235,5V**	**<= 2,0s**			**304V**	**<= 2,0s**			
Trip value	235,4V				305,1V				
Trip time	277V to 230V	1,99s	1,99s	1,99s	277V to 310V	1,98s	1,99s	1,99s	
Reconnection time	20s	327s			20s	327s			
IEC 61727: Second Level									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**138,5V**	**<= 100ms**			**373,3V**	**<= 50ms**			
Trip value	135,2V				332,7V*				
Trip time	277V to 130V	94ms	94ms	94ms	277V to 337V	6ms	6ms	6ms	
Reconnection time	20s	327s			20s	327s			

Phase L3								
IEC 61727: First Level								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**235,5V**	**<= 2,0s**			**304V**	**<= 2,0s**		
Trip value	235,4V				304,7V			
Trip time	277V to 230V	1,99s	1,99s	1,99s	277V to 310V	1,99s	1,99s	1,99s
Reconnection time	20s	327s			20s	327s		
IEC 61727: Second Level								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**138,5V**	**<= 100ms**			**373,3V**	**<= 50ms**		
Trip value	138,4V				332,9V			
Trip time	277V to 130V	93ms	93ms	93ms	277V to 337V	12ms	12ms	12ms
Reconnection time	20s	327s			20s	327s		

Note:

The IEC61727 does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. Therefore the values for tolerances given in EN 50438, Table 2 are used.

Tolerances on trip values tabel 2 EN50438:

- Voltage: +/- 1% of the nominal voltage
- Frequency: +/- 0,5% of the nominal frequency
- Clearance time: +/- 10%

* The inverter has an overvoltage protection to secure from an hardware defect. Max. Overvoltage value is about 332V that can be reached.

5.2.2 Frequency monitoring									**P**
IEC 61727									
	Under Frequency				**Over Frequency**				
Parameter	Frequency	Time [ms]			Frequency	Time [ms]			
Output Voltage		85%U_N	U_N	110%U_N		85%U_N	U_N	110%U_N	
Limit	**49,00Hz**	**<= 200ms**			**51,00Hz**	**<= 200ms**			
Trip value		49,01Hz	49,01Hz	49,01Hz		51,01Hz	51,01Hz	51,01Hz	
Trip time	49,51Hz to 48,51Hz	172ms	174ms	172ms	50,51Hz to 51,51Hz	192ms	192ms	192ms	
Reconnection time	20s<t<300s	331s			20s<t<300s	327s			

Note:
It was measured at a continuous change of frequency of 1Hz/s at lower, nominal and upper UN 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. 49Hz), the ac-source is programmed to run from e.g. 49,51Hz to 48,51Hz with 1Hz/s. The disconnection time is calculated by the measured time minus the 500ms from 49,51Hz to 49,01Hz.

The IEC61727 does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. Therefore the values for tolerances given in EN 50438, Table 2 are used.

Tolerances on trip values tabel 2 EN50438:

- Voltage: +/- 1% of the nominal voltage
- Frequency: +/- 0,5% of the nominal frequency
- Clearance time: +/- 10%

5.2.2 Frequency monitoring									**P**
CEA									
	Under Frequency				**Over Frequency**				
Parameter	Frequency	Time [ms]			Frequency	Time [ms]			
Output Voltage		85%U_N	U_N	110%U_N		85%U_N	U_N	110%U_N	
Limit	**47,50Hz**	**<= 200ms**			**52,00Hz**	**<= 200ms**			
Trip value		47,50Hz	47,50Hz	47,50Hz		52,00Hz	52,00Hz	52,00Hz	
Trip time	48,00Hz to 47,00Hz	180ms	179ms	181ms	51,50Hz to 52,50Hz	184ms	184ms	184ms	
Reconnection time	20s<t<300s	331			20s<t<300s	327			

Note:
It was measured at a continuous change of frequency of 1Hz/s at lower, nominal and upper UN 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. 49Hz), the ac-source is programmed to run from e.g. 48,00Hz to 47,00Hz with 1Hz/s. The disconnection time is calculated by the measured time minus the 500ms from 48,00Hz to 47,50Hz.

The IEC61727 does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. Therefore the values for tolerances given in EN 50438, Table 2 are used.

Tolerances on trip values tabel 2 EN50438:

- Voltage: +/- 1% of the nominal voltage
- Frequency: +/- 0,5% of the nominal frequency
- Clearance time: +/- 10%

6.1 Islanding protection

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 62116:2008

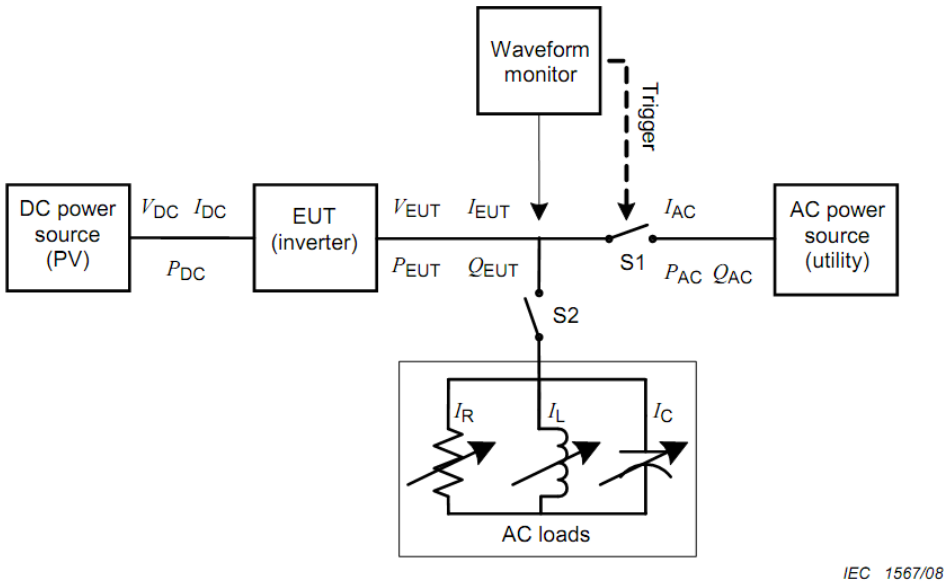


Figure 1 – Test circuit for islanding detection function in a power conditioner (inverter)

Islanding protection according table 6 - Load imbalance (real, reactive load) for test condition A (EUT ouput = 100%) **SE27.6K**	**P**

Test conditions	Frequency: 50+/-0,1Hz U_N=220+/-3Vac Distortion factor of chokes < 2% Quality = 1
Disconnection limit	IEC 62116 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]	I_{AC} 4) [A]			P_{EUT} [W per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks5)
					L1	L2	L3					
1	100	100	0	0	0,11	0,11	0,11	8799	909	1,00	114	BL
32	100	100	-10	-10	8,68	0,68	8,68	8799	909	0,98	87	IB
33	100	100	-10	-5	4,38	4,38	4,37	8799	909	0,92	422	IB
34	100	100	-10	0	3,05	3,05	3,05	8799	909	0,98	224	IB
35	100	100	-10	+5	5,28	5,28	5,28	8799	909	0,93	124	IB
36	100	100	-10	+10	4,06	4,06	4,06	8799	909	0,91	442	IB
37	100	100	-5	-10	3,57	3,57	3,57	8799	909	0,94	109	IB
4	100	100	-5	-5	2,17	2,17	2,17	8799	909	0,95	426	IB
5	100	100	-5	0	9,86	9,86	9,86	8799	909	1,05	90	IB
6	100	100	-5	+5	9,86	9,86	9,85	8799	909	0,99	90	IB
38	100	100	-5	+10	7,05	7,05	7,05	8799	909	0,90	101	IB
39	100	100	0	-10	2,58	2,58	2,57	8799	909	1,14	79	IB
7	100	100	0	-5	1,05	1,06	1,05	8799	909	1,08	462	IB
8	100	100	0	+5	18,3	18,3	18,3	8799	909	0,99	397	IB
40	100	100	0	+10	3,67	3,66	3,66	8799	909	0,98	88	IB
41	100	100	+5	-10	7,70	7,69	7,69	8799	909	1,13	117	IB
9	100	100	+5	-5	3,13	3,13	3,13	8799	909	1,11	416	IB
10	100	100	+5	0	3,54	3,54	3,54	8799	909	1,07	270	IB
11	100	100	+5	+5	2,52	2,52	2,51	8799	909	1,01	115	IB
42	100	100	+5	+10	5,03	5,02	5,03	8799	909	1,02	128	IB
43	100	100	+10	-10	3,85	3,85	3,85	8799	909	1,14	146	IB
44	100	100	+10	-5	7,51	7,51	7,51	8799	909	1,16	84	IB
45	100	100	+10	0	3,82	3,82	3,82	8799	909	1,12	323	IB
46	100	100	+10	+5	6,83	6,83	6,83	8799	909	0,93	359	IB
47	100	100	+10	+10	5,29	5,29	5,29	8799	909	1,01	110	IB

Parameter at 0% per phase	L= 17,5 mH	R= 5,5 Ω	C= 578,7 µF

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

Condition A:
EUT output power PEUT = Maximum [6]
EUT input voltage [6] = >90% of rated input voltage range

[6] Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
[7] Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0,9 × (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.

Islanding protection according Table 7 – Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)												**P**
Test conditions			Frequency: 50+/-0,1Hz U_N=220+/-3Vac Distortion factor of chokes < 2% Quality =1									
Disconnection limit			IEC 62116 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]	I_{AC} [4] [A]			P_{EUT} [W per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks[5]
					L1	L2	L3					
12	66	66	0	-5	0,11	0,11	0,09	5563	839	0,96	426	IB
13	66	66	0	-4	1,46	1,45	1,45	5563	839	0,96	102	IB
14	66	66	0	-3	2,21	2,21	2,21	5563	839	0,97	105	IB
15	66	66	0	-2	4,53	4,53	4,53	5563	839	0,98	72	IB
16	66	66	0	-1	0,57	0,57	0,57	5563	839	0,99	191	IB
2	66	66	0	0	0,24	0,29	0,24	5563	839	1,00	123	BL
17	66	66	0	1	0,50	0,50	0,49	5563	839	1,01	122	IB
18	66	66	0	2	1,11	1,11	1,11	5563	839	1,01	77	IB
19	66	66	0	3	6,97	6,97	6,97	5563	839	1,02	89	IB
20	66	66	0	4	1,24	1,24	1,24	5563	839	1,04	97	IB
21	66	66	0	5	1,17	1,17	1,16	5563	839	1,05	126	IB
Parameter at 0% per phase			L= 27,7mH			R= 8,7 Ω			C= 365,9µF			

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

Islanding protection according Table 7 – Load imbalance (reactive load) for test condition C (EUT output = 25 % – 33 %)	**P**

Test conditions	Frequency: 50+/-0,1Hz U_N=220+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	IEC 62116 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]	I_{AC} [4)] [A]			P_{EUT} [W per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks[5)]
					L1	L2	L3					
22	33	33	0	-5	2,11	2,11	2,11	3071	741	0,96	450	IB
23	33	33	0	-4	0,93	0,93	0,93	3071	741	0,96	434	IB
24	33	33	0	-3	1,89	1,89	1,89	3071	741	0,97	207	IB
25	33	33	0	-2	0,76	0,76	0,76	3071	741	0,98	116	IB
26	33	33	0	-1	1,89	1,88	1,88	3071	741	0,99	188	IB
3	33	33	0	0	0,11	0,11	0,11	3071	741	1,00	118	BL
27	33	33	0	1	1,68	1,65	1,68	3071	741	1,01	460	IB
28	33	33	0	2	2,69	2,68	2,68	3071	741	1,01	98	IB
29	33	33	0	3	0,56	0,56	0,56	3071	741	1,03	125	IB
30	33	33	0	4	2,12	2,12	2,11	3071	741	1,04	187	IB
31	33	33	0	5	0,71	0,71	0,71	3071	741	1,05	170	IB

Parameter at 0% per phase	L= 50,2 mH	R= 15,8 Ω	C= 201,9 µF

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) Fundamental of I_{AC} when RLC is adjusted
5) BL: Balance condition, IB: Imbalance condition.
Condition B:
EUT output power PEUT = 25 % – 33 % 6) of maximum
EUT input voltage 7) = <10 % of rated input voltage range
6) Or minimum allowable EUT output level if greater than 33 %.
7) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 10 % of range =X + 0,1 × (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.

Islanding protection according table 6 - Load imbalance (real, reactive load) for test condition A (EUT ouput = 100%) **SE25K**	**P**

Test conditions	Frequency: 50+/-0,1Hz U_N=220+/-3Vac Distortion factor of chokes < 2% Quality = 1
Disconnection limit	IEC 62116 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]	I_{AC} 4) [A]			P_{EUT} [W per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks5)
					L1	L2	L3					
1	100	100	0	0	0,10	0,10	0,09	8531	909	1,00	85	BL
32	100	100	-10	-10	4,71	4,70	4,71	8531	909	0,98	458	IB
33	100	100	-10	-5	4,69	4,67	4,68	8531	909	0,92	124	IB
34	100	100	-10	0	4,90	4,89	4,88	8531	909	0,98	112	IB
35	100	100	-10	+5	4,96	4,97	4,96	8531	909	0,93	97	IB
36	100	100	-10	+10	7,35	7,34	7,35	8531	909	0,91	90	IB
37	100	100	-5	-10	10,2	10,1	10,1	8531	909	0,94	69	IB
4	100	100	-5	-5	10,9	10,9	10,9	8531	909	0,95	317	IB
5	100	100	-5	0	2,01	2,00	2,00	8531	909	1,05	118	IB
6	100	100	-5	+5	4,92	4,92	4,92	8531	909	0,99	133	IB
38	100	100	-5	+10	2,52	2,53	2,58	8531	909	0,90	427	IB
39	100	100	0	-10	5,95	5,97	5,97	8531	909	1,14	191	IB
7	100	100	0	-5	5,42	5,44	5,42	8531	909	1,08	92	IB
8	100	100	0	+5	0,90	0,90	0,89	8531	909	0,99	371	IB
40	100	100	0	+10	4,80	4,80	4,73	8531	909	0,98	92	IB
41	100	100	+5	-10	2,00	2,00	2,00	8531	909	1,13	76	IB
9	100	100	+5	-5	5,16	5,16	5,17	8531	909	1,11	84	IB
10	100	100	+5	0	6,34	6,34	6,35	8531	909	1,07	184	IB
11	100	100	+5	+5	4,80	4,80	4,79	8531	909	1,01	184	IB
42	100	100	+5	+10	5,36	5,37	5,36	8531	909	1,02	375	IB
43	100	100	+10	-10	5,34	5,34	5,33	8531	909	1,14	100	IB
44	100	100	+10	-5	6,81	6,82	6,80	8531	909	1,16	92	IB
45	100	100	+10	0	3,92	3,91	3,97	8531	909	1,12	129	IB
46	100	100	+10	+5	7,81	7,89	7,89	8531	909	0,93	90	IB
47	100	100	+10	+10	4,01	4,01	4,00	8531	909	1,01	102	IB

Parameter at 0% per phase	L= 18,4 mH	R= 5,7 Ω	C= 561,1 µF

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

Condition A:
EUT output power PEUT = Maximum [6)]
EUT input voltage [6)] = >90% of rated input voltage range

[6)] Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
[7)] Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0,9 × (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.

Islanding protection according Table 7 – Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)												**P**
Test conditions			Frequency: 50+/-0,1Hz U_N=220+/-3Vac Distortion factor of chokes < 2% Quality =1									
Disconnection limit			IEC 62116 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]	I_{AC} [4] [A]			P_{EUT} [W per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks[5]
					L1	L2	L3					
12	66	66	0	-5	2,60	2,58	2,58	5022	839	0,96	104	IB
13	66	66	0	-4	0,67	0,67	0,67	5022	839	0,96	191	IB
14	66	66	0	-3	1,33	1,32	1,33	5022	839	0,97	105	IB
15	66	66	0	-2	1,23	1,22	1,23	5022	839	0,98	188	IB
16	66	66	0	-1	0,42	0,42	0,41	5022	839	0,99	85	IB
2	66	66	0	0	0,11	0,12	0,11	5022	839	1,00	94	BL
17	66	66	0	1	0,41	0,41	0,41	5022	839	1,01	95	IB
18	66	66	0	2	2,09	2,08	2,08	5022	839	1,01	93	IB
19	66	66	0	3	2,09	2,00	2,07	5022	839	1,02	78	IB
20	66	66	0	4	3,90	3,90	3,88	5022	839	1,04	77	IB
21	66	66	0	5	3,60	3,60	3,61	5022	839	1,05	86	IB

Parameter at 0% per phase	L= 30,7 mH	R= 9,6 Ω	C= 330,3 µF

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

Islanding protection according Table 7 – Load imbalance (reactive load) for test condition C (EUT output = 25 % – 33 %)												**P**
Test conditions			Frequency: 50+/-0,1Hz U_N=220+/-3Vac Distortion factor of chokes < 2% Quality =1									
Disconnection limit			1s (deviations for PEA)									
No	P_{EUT} [1] [% of EUT rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} [2] [% of nominal]	Q_{AC} [3] [% of nominal]	I_{AC} [4] [A]			P_{EUT} [W per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks[5]
					L1	L2	L3					
22	33	33	0	-5	0,89	0,80	0,89	2520	741	0,96	83	IB
23	33	33	0	-4	0,92	0,90	0,91	2520	741	0,96	117	IB
24	33	33	0	-3	0,56	0,51	0,51	2520	741	0,97	88	IB
25	33	33	0	-2	0,55	0,50	0,52	2520	741	0,98	109	IB
26	33	33	0	-1	0,25	0,26	0,25	2520	741	0,99	191	IB
3	33	33	0	0	0,11	0,10	0,09	2520	741	1,00	432	BL
27	33	33	0	1	0,86	0,90	0,90	2520	741	1,01	291	IB
28	33	33	0	2	1,46	1,46	1,47	2520	741	1,01	375	IB
29	33	33	0	3	2,19	2,16	2,12	2520	741	1,03	375	IB
30	33	33	0	4	3,21	3,19	3,18	2520	741	1,04	85	IB
31	33	33	0	5	0,56	0,56	0,57	2520	741	1,05	132	IB

Parameter at 0% per phase	L= 61,1 mH	R= 19,2 Ω	C= 165,7 µF

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
[1] P_{EUT}: EUT output power
[2] P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
[3] Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
[4] Fundamental of I_{AC} when RLC is adjusted
[5] BL: Balance condition, IB: Imbalance condition.
Condition B:
EUT output power PEUT = 25 % – 33 % [6] of maximum
EUT input voltage [7] = <10 % of rated input voltage range
[6] Or minimum allowable EUT output level if greater than 33 %.
[7] Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 10 % of range =X + 0,1 × (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

Electromagnetic Compatibility Test Report

Test Report No: SGD 180615
Issued on: June 30, 2015

Product Name
Jupiter Plus (Three Phase Inverter)
Models: SE20K, SE25K, SE27.6K, SE33.3K

Tested According to
EN 61000-6-3:2007 + A1:2011
EN 61000-6-2:2005

Tests Performed for
SolarEdge Technologies Ltd.
1 HaMada Street, Herzeliya 4673335, Israel
Tel: +972-9-9576620

QualiTech EMC Laboratory
30 Hasivim Street,P.O.Box 7500
Petah-Tikva, 4951169, Israel
Tel: +972-3-926 8443
Fax: +972-3-928 7490

Certificate 1633.01
Electrical Testing

Test Personnel

Tests Performed By: ----------

Michael Shtier **Nissim Bitan**

Report Prepared By: ----------

Bina Talkar

Report Approved By: ----------

Rami Nataf
EMC Lab. Manager
QualiTech EMC Laboratory

Test Report Details:

Test commencement date:	06.05.2015
Test completion date:	18.06.2015
Customer's representative:	Lior Maor
Issued on:	30.06.2015

Assessment Information:

This report contains an assessment of the EUT against Electromagnetic Compatibility based upon tests carried out on the samples submitted. The results contained in this report relate only to the items tested. Manufactured products will not necessarily give identical results due to production and measurement tolerances. QualiTech, EMC Lab does not assume responsibility for any conclusion and generalization drawn from the test results with regards to other specimens or samples of type of the equipment represented by test item.

The EUT was setup and exercised using the configuration, modes of operation and arrangements defined in this report only.

Customer's declaration:

Per customer's declaration the EUT i.e. Jupiter Plus (Three Phase Inverter) has four models, SE20K, SE25K, SE27.6K, SE33.3K. All models are identical and belong to one product family and differ only in power components. Tests were performed on model SE27.6K.

Modifications:

Modifications made to the EUT

None

Modifications made to the Test Standard

None

Summary of Compliance Status

The EUT was tested according to the following test method.
Test results are given in full in sections 3-13.

Emission Tests

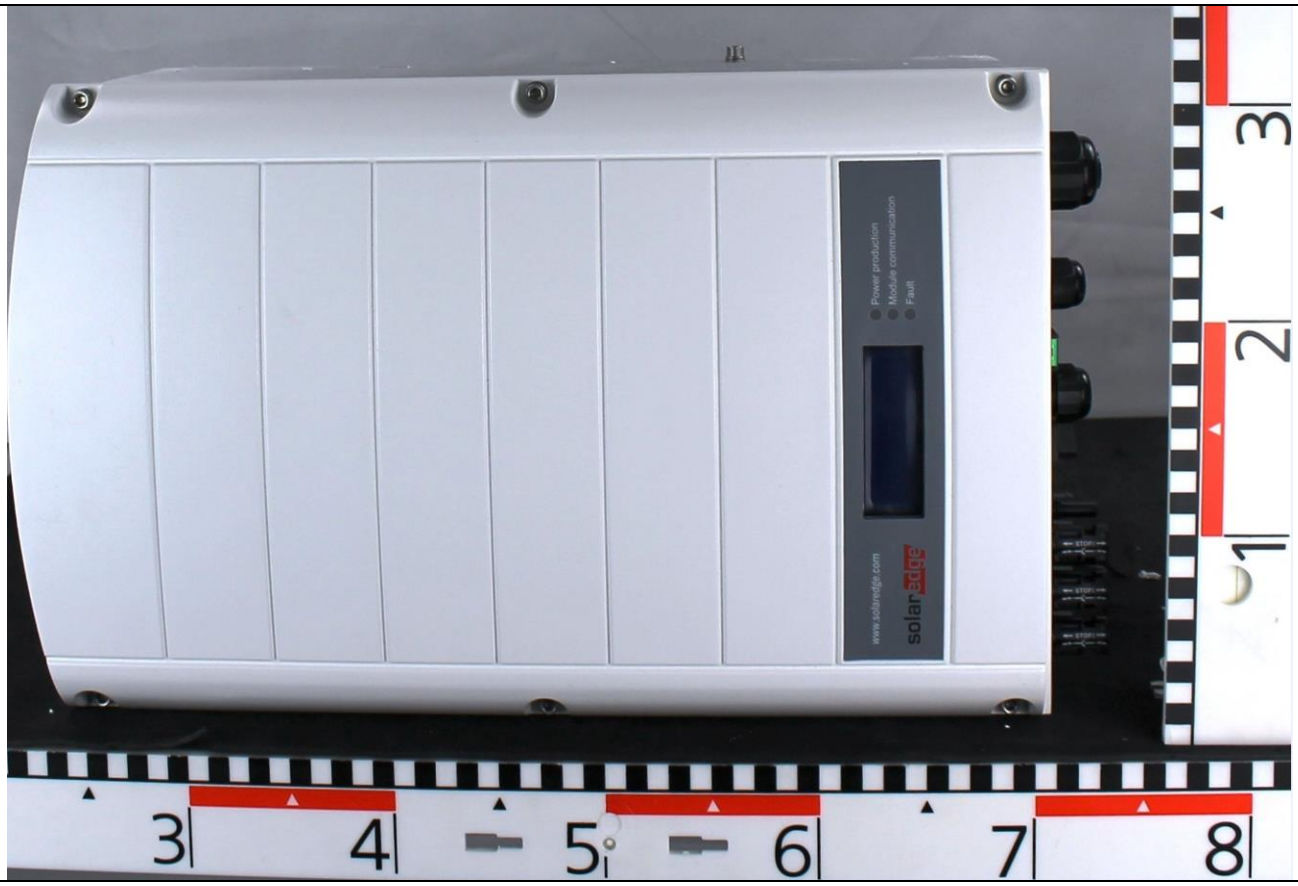
Test type	Test Method	Class applied	Frequency Range	Test results
Radiated Emission	EN55022	B	30MHz÷1GHz	Comply
Conducted Emission on 380 VAC	EN55022	B	150kHz÷30MHz	Comply
Harmonic current emission	EN 61000-3-2	-	50Hz to harmonic order 40	Comply
Voltage Fluctuations & flicker	EN 61000-3-3	-	50Hz	Comply

Immunity Tests

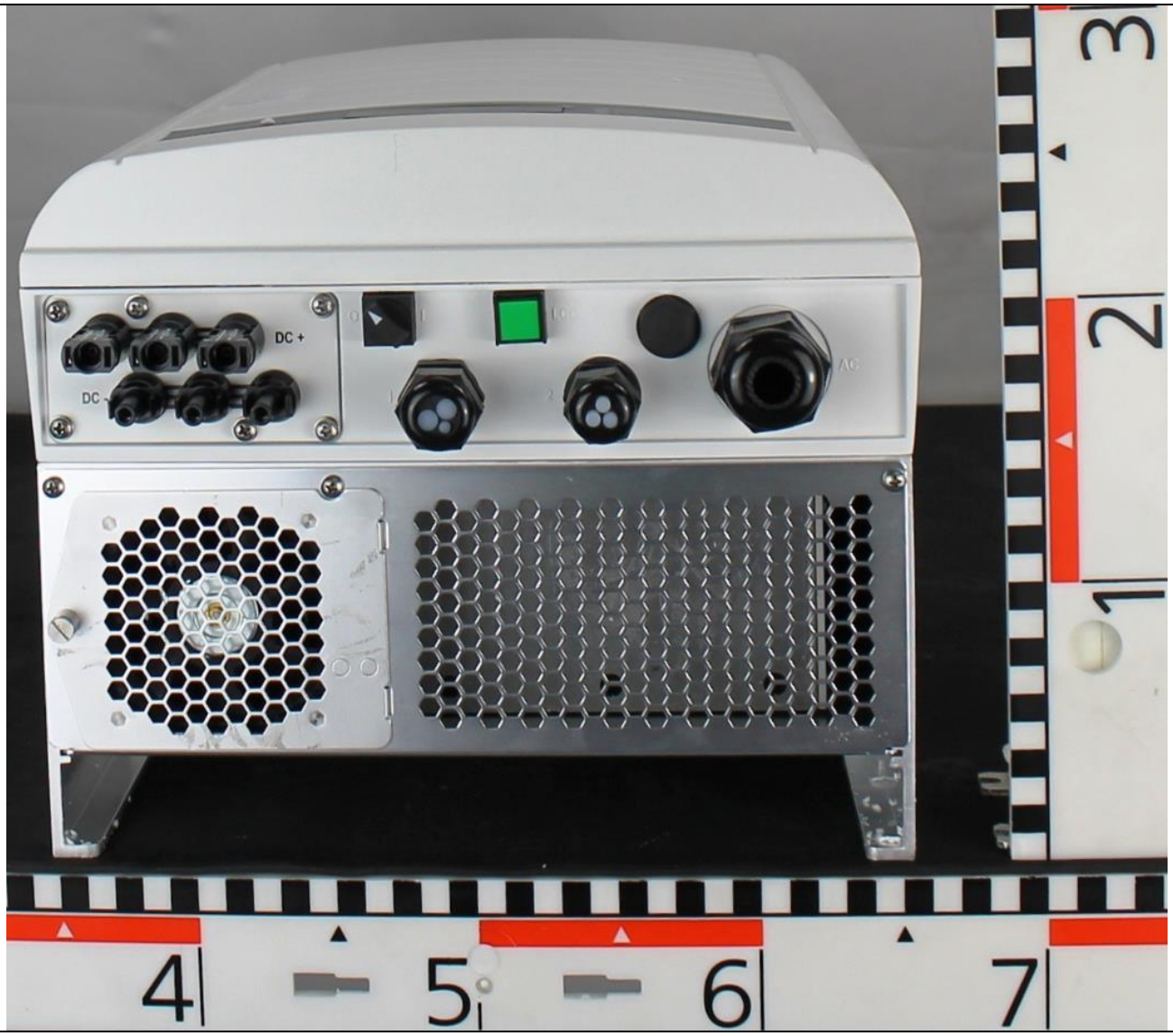
Test type	Applied on	Test Method	Frequency Range/ application type	Test level	Performance Criteria applied	Test results
ESD	Enclosure	IEC 61000-4-2	Contact	±4kV	A	Comply
			Air	±8kV	A	Comply
Radiated Immunity	System	IEC 61000-4-3	80 MHz - 800MHz	10V/m	A	Comply
			800MHz - 960MHz	10V/m	A	Comply
			960MHz -1GHz	10V/m	A	Comply
			1.4GHz - 2GHz	10V/m	A	Comply
			2GHz - 2.7GHz	10V/m	A	Comply
EFT	380 VAC	IEC 61000-4-4	-	±1kV	B	Comply
	1000 VDC		-	±1kV	B	Comply
	RS 232		-	±1kV	B	Comply
	Ethernet		-	±1kV	B	Comply
	RS 485		-	±1kV	B	Comply
Surge	380 VAC	IEC 61000-4-5	Line to Line	±1kV	B	Comply
			Line to Earth	±2kV	B	Comply
	1000 VDC		Line to Line	±1kV	B	Comply
			Line to Earth	±1kV	B	Comply
	RS 232		Braid to Earth	±1kV	B	Comply
	Ethernet		Braid to Earth	±1kV	B	Comply
	RS 485		Braid to Earth	±1kV	B	Comply
Conducted Immunity	380 VAC	IEC 61000-4-6	150kHz-80MHz	10Vrms	A	Comply
	1000 VDC		150kHz-80MHz	10Vrms	A	Comply
	RS 232		150kHz-80MHz	10Vrms	A	Comply
	Ethernet		150kHz-80MHz	10Vrms	A	Comply
	RS 485		150kHz-80MHz	10Vrms	A	Comply
Magnetic Field	System	IEC 61000-4-8	50Hz	30A/m	A	Comply
Voltage dips and short interruptions	380 VAC	IEC 61000-4-11	50 Hz	100%,60%,30%	B & C	Comply

Annex 2
Pictures of the unit

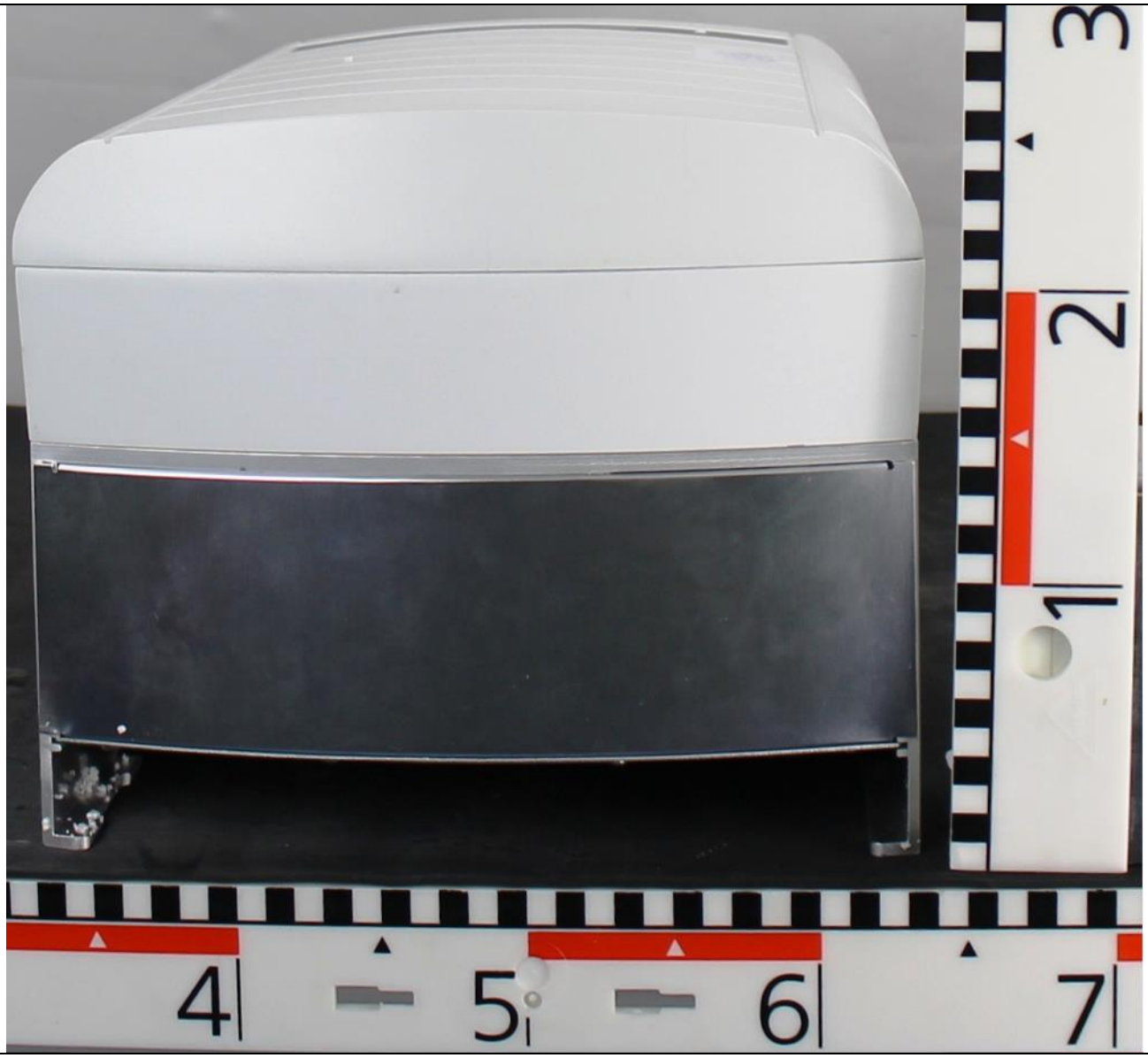
Inverter
Enclosure front



Enclosure bottom
(connectors)



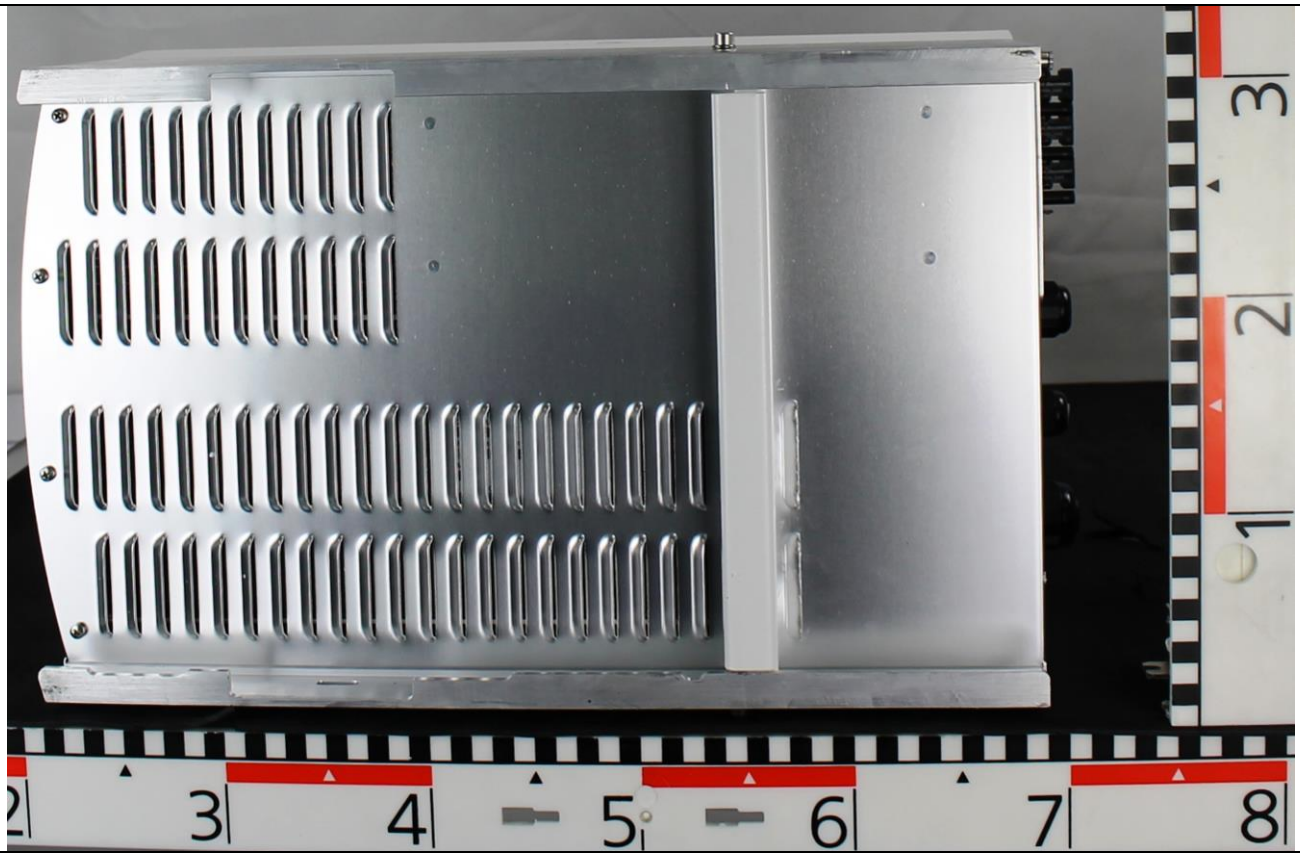
Enclosure top side



Enclosure left side

Enclosure right side

Enclosure back



Annex 3
Test equipment list

Date(s) of performance test: 2017-06-12 to 2017-06-21

Equipment	Internal No.	Manufacturer	Type	Serial No.	Last Calibration
3-Phase Voltage Source	660	Spitzenberger & Spies	EMC D20000/30000/PAS	A4108 0x/y 0608	Feb. 17
Current Transducer	1032	LEM Danfysik	IT 200-S Ultrastab	9112220137	Aug. 16
Current Transducer	1033	LEM Danfysik	IT 200-S Ultrastab	9112220138	Aug. 16
Current Transducer	1034	LEM Danfysik	IT 200-S Ultrastab	9112220139	Aug. 16
Current Transducer	1035	LEM Danfysik	IT 200-S Ultrastab	9112220140	Aug. 16
Electronics Rack/Current Transducer Powersupply	1040	Signaltec	MCTS	37-004-0201	
Dewetron Multi Channel Data Acquisition System	1043	Dewetron	DEWE-2600 with Voltage and Current Modules	28110299	Feb. 16
DC Source	1057	Regatron	Model T.C.P. 32.1000.400.PV. HMI	1239CC621	N/A
Hygro-/Thermo-/Barometer	1073	Greisinger	GFTB 100	90258040	Apr. 17

Date(s) of performance test: 2017-08-21

Equipment	Internal No.	Manufacturer	Type	Serial No.	Last Calibration
Spitzenberger & Spies Test system for PV-inverter	1091	Spitzenberger & Spies	PVS 127500 / EMV D 75000/PAS / PRU 12750 / Mobile box / RLC 3500/2.5	A5191 00 / A5192 00 / A5193 00 / A5194 00 / A5195 00	N/A
Dewetron Multi Channel Data Acquisition System	1092	Dewetron	DEWE-800 / DEWE-30-16 with voltage and current modules	12130573, 56121690	Mai. 16
Hygro-/Thermo-/Barometer	1073	Greisinger	GFTB 100	90258040	Apr. 17
Current Transducer	1096	LEM Danfysik	IT 400-S	1131010011	Aug. 16
Current Transducer	1097	LEM Danfysik	IT 400-S	1131010012	Aug. 16
Current Transducer	1098	LEM Danfysik	IT 400-S	1131010013	Aug. 16

Date(s) of performance test: 2018-04-05

Equipment	Internal No.	Manufacturer	Type	Serial No.	Last Calibration
Voltage Source 3-Phase	660	Spitzenberger & Spies	EMC D20000/30000/PAS	A4108 0x/y 0608	Feb. 17
Current Transducer	907	Danfysik	Ultrstab 867	10076239	Aug. 16
Current Transducer	908	Danfysik	Ultrstab 867	10076242	Aug. 16
Current Transducer	909	Danfysik	Ultrstab 867	10089923	Aug. 16
Current Transducer	910	Danfysik	Ultrstab 867	10089927	Aug. 16
Transducer Power Supply	906	Signaltec	TPS	37-010-008	N/A
Universal Measuring Instrument	747	Ahlborn GmbH	Almemo 2590-3S	H08090697	Feb. 17