



**BUREAU
VERITAS**

Certificate of compliance

Applicant: Fronius International GmbH
Günter Fronius Straße 1
4600 Wels-Thalheim
Austria

Product: Photovoltaic (PV) inverter

Model: ECO27.0-3-S
ECO25.0-3-S

Use in accordance with regulations:

Automatic disconnection device with three-phase mains surveillance in accordance with Engineering Recommendation G99/1 for photovoltaic systems with a three-phase parallel coupling via an inverter in the public mains supply. The automatic disconnection device is an integral part of the aforementioned inverter. This serves as a replacement for the disconnection device with isolating function, which can be accessed the distribution network provider at any time.

Applied rules and standards:

Engineering Recommendation G99/1-6:2020

Requirements for the connection of generation equipment in parallel with public distribution networks

DIN V VDE V 0126-1-1:2006-02 (4.1 Functional safety)

Automatic disconnection device between a generator and the public low-voltage grid

At the time of issue of this certificate the safety concept of an aforementioned representative product corresponds to the valid safety specifications for the specified use in accordance with regulations.

Report number: 15TH0304-G99/1_0

Certification program: NSOP-0032-DEU-ZE-V01

Certificate number: U20-0529

Date of issue: 2020-07-01

Certification body



Thomas Lammel

Certification body Bureau Veritas Consumer Products Services Germany GmbH accredited according to DIN EN ISO/IEC 17065

A partial representation of the certificate requires the written approval of Bureau Veritas Consumer Products Services Germany GmbH

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G99.

PGM Technology:	Photovoltaic Inverter		
Manufacturer / applicant:	Fronius International GmbH		
Address:	Günter Fronius Straße 1 4600 Wels-Thalheim Austria		
Tel	+43 7242 241-2330	Fax:	+43 7242 241-952330
Email:	feichtinger.josef@fronius.com	Website:	www.fronius.com

Rated values	ECO27.0-3-S	ECO25.0-3-S
MPP DC voltage range [V]	580 - 850	
Input DC voltage range [V]	580 – 1000	
Input DC current [A]	47,7	44,2
Output AC voltage [V]	3~NPE 220 / 230	
Output AC current [A]	39,1	36,2
Output power [VA]	27000	25000

Firmware version	Beginning with V1.1.5.0
Measurement period:	2020-02-10 – 2020-05-15

Description of the structure of the power generation unit:

The power generation unit is equipped with a PV and line-side EMC filter. The power generation unit has no galvanic isolation between DC input and AC output (HF/LF transformer). Output switch-off is performed with single-fault tolerance based on two series-connected relays contacts in each line and neutral. This enables a safe disconnection of the power generation unit from the network in case of error.

The above stated Generating Units are tested according the requirements in the Engineering Recommendation G99/1. Any modification that affects the stated tests must be named by the manufacturer/supplier of the product to ensure that the product meets all requirements of the Engineering Recommendation G99/1.

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Operating Range.	
Test 1	Voltage = 85% of nominal (195,5V) Frequency = 47Hz Power Factor = 1 Period of test 20 s
Connection:	Always connected
Limit:	Always connected
Test 2	Voltage = 85% of nominal (195,5V) Frequency = 47,5Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 3	Voltage = 110% of nominal (253V) Frequency = 51,5Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 4	Voltage = 110% of nominal (253V) Frequency = 52,0Hz Power Factor = 1 Period of test 15 minutes
Connection:	Always connected
Limit:	Always connected
Test 5	Confirm that the Power Generating Module is capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500ms. Note that this is not expected to be demonstrated on site.
Connection:	Always connected
Limit:	Always connected

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Protection. Voltage tests.

Phase 1

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184	2,5	184,4	2,56	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	262,3	1,04	258,2V 5,0s	No trip
O/V stage 2	273,7	0,5	271,2	0,54	269,7V 0,95s	No trip
					277,7V 0,45s	No trip

Protection. Voltage tests.

Phase 2

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184	2,5	183,7	2,55	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	263,3	1,02	258,2V 5,0s	No trip
O/V stage 2	273,7	0,5	270,7	0,53	269,7V 0,95s	No trip
					277,7V 0,45s	No trip

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Protection. Voltage tests.

Phase 3

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184	2,5	184,4	2,55	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	264,4	1,03	258,2V / 5,0s	No trip
O/V stage 2	273,7	0,5	271,8	0,52	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

Note. For Voltage tests the Voltage required to trip is the setting $\pm 3,45V$. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting $\pm 4V$ and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

Protection. Frequency tests.

Function	Setting		Trip test		No trip test	
	Frequency [Hz]	Time delay [s]	Frequency [Hz]	Time delay [s]	Frequency / time	Confirm no trip
U/F stage 1	47,5	20	47,49	20,08	47,7Hz / 30s	No trip
U/F stage 2	47	0,5	47,00	0,59	47,2Hz / 19,5s	No trip
					46,8Hz / 0,45s	No trip
O/F stage 2	52	0,5	52,01	0,57	51,8Hz / 120s	No trip
					52,2Hz / 0,45s	No trip

Note. For Frequency Trip tests the Frequency required to trip is the setting $\pm 0,1Hz$. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The "No-trip tests" need to be carried out at the setting $\pm 0,2Hz$ and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Protection. Loss of Mains.

Inverters tested according to BS EN 62116.

Balancing load on islanded network	33% of -5% Q Test 22	66% of -5% Q Test 12	100% of -5% P Test 5	33% of +5% Q Test 31	66% of +5% Q Test 21	100% of +5% P Test 10
Trip time. Ph1 fuse removed [s]	0,158	0,150	0,392	0,120	0,183	0,343
Trip time. Ph2 fuse removed [s]	0,158	0,150	0,392	0,120	0,183	0,343
Trip time. Ph3 fuse removed [s]	0,158	0,150	0,392	0,120	0,183	0,343

Note. Trip time limit is 0,5s.

Protection. Re-connection timer.

Test should prove that the reconnection sequence starts in no less than 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 10.1.

Over Voltage				
Time delay setting	Measured delay			
20s	70s			
Under Voltage				
Time delay setting	Measured delay			
20s	86s			
Over Frequency				
Time delay setting	Measured delay			
20s	83s			
Under Frequency				
Time delay setting	Measured delay			
20s	85s			
	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2V	At 180,0V	At 47,4Hz	At 51,6Hz
Confirmation that the Generating Unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

Protection. Frequency change, Stability test.

	Start Frequency [Hz]	Change	Test Duration	Confirm no trip
Positive Vector Shift	49,5	+50 degrees		No trip
Negative Vector Shift	50,5	-50 degrees		No trip
Positive Frequency drift	49,0 to 51,0	+0,95Hz/sec	2,1s	No trip
Negative Frequency drift	51,0 to 49,0	-0,95Hz/sec	2,1s	No trip

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Limited Frequency Sensitive Mode – Over Frequency

1-min mean value [Hz]:	a) 50,00	b) 50,45	c) 50,70	d) 51,15	e) 50,70	f) 50,45	g) 50,00
1. Measurement a) to g): Active power output > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,71	51,14	50,70	50,45	50,00
P _{expected} [kW]:	N/A	27,10	26,40	25,22	26,42	27,11	N/A
P _{measured} [kW]:	27,23	26,99	25,56	23,16	25,65	27,02	27,25
2. Measurement a) to g): Active power output 40% and 60% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,14	50,70	50,45	50,00
P _{expected} [kW]:	N/A	13,17	12,83	12,25	12,84	13,17	N/A
P _{measured} [kW]:	13,24	13,12	12,46	11,30	12,46	13,13	14,56

Output Power with falling Frequency

Frequency setpoint [Hz]:	50,00	49,50	49,00	48,00	47,60	47,10
Frequency [Hz]:	50,00	49,50	49,00	48,00	47,60	47,10
Active power [kW]:	27,26	27,22	27,19	27,12	27,12	27,12
ΔP/P _{max} [%]:		0,81	0,70	0,44	0,44	0,44

Note.

Electronic inverter no power reduction take place.

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99 Nr. 15TH0304-G99/1_0

Power Quality. Harmonics.						
ECO27.0-3-S / Phase 1						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 4,52 kW		100% of rated output 8,97 kW			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-12 in %	
					1 phase	3 phase
2nd	0,018	0,047	0,015	0,039	8%	8%
3rd	0,084	0,216	0,110	0,283	21,6%	N/A
4th	0,025	0,065	0,021	0,053	4%	4%
5th	0,058	0,149	0,102	0,263	10,7%	10,7%
6th	0,024	0,061	0,019	0,049	2,67%	2,67%
7th	0,068	0,174	0,094	0,242	7,2%	7,2%
8th	0,022	0,056	0,021	0,055	2%	2%
9th	0,063	0,161	0,089	0,230	3,8%	N/A
10th	0,013	0,034	0,015	0,038	1,6%	1,6%
11th	0,018	0,047	0,039	0,101	3,1%	3,1%
12th	0,008	0,021	0,009	0,023	1,33%	1,33%
13th	0,055	0,141	0,075	0,193	2%	2%
14th	0,008	0,022	0,009	0,024	N/A	N/A
15th	0,023	0,058	0,033	0,084	N/A	N/A
16th	0,008	0,021	0,009	0,022	N/A	N/A
17th	0,029	0,074	0,037	0,095	N/A	N/A
18th	0,005	0,013	0,005	0,014	N/A	N/A
19th	0,008	0,021	0,017	0,043	N/A	N/A
20th	0,007	0,019	0,007	0,019	N/A	N/A
21th	0,007	0,019	0,009	0,023	N/A	N/A
22th	0,008	0,020	0,008	0,021	N/A	N/A
23th	0,009	0,024	0,020	0,051	N/A	N/A
24th	0,003	0,008	0,003	0,008	N/A	N/A
25th	0,009	0,023	0,005	0,012	N/A	N/A
26th	0,006	0,016	0,007	0,018	N/A	N/A
27th	0,007	0,018	0,010	0,026	N/A	N/A
28th	0,004	0,010	0,004	0,011	N/A	N/A
29th	0,005	0,014	0,008	0,022	N/A	N/A
30th	0,003	0,009	0,004	0,009	N/A	N/A
31th	0,009	0,023	0,013	0,033	N/A	N/A
32th	0,004	0,010	0,004	0,011	N/A	N/A
33th	0,005	0,012	0,004	0,010	N/A	N/A
34th	0,005	0,013	0,005	0,013	N/A	N/A
35th	0,007	0,018	0,008	0,021	N/A	N/A
36th	0,003	0,007	0,003	0,008	N/A	N/A
37th	0,004	0,010	0,009	0,023	N/A	N/A
38th	0,006	0,015	0,006	0,015	N/A	N/A
39th	0,005	0,013	0,005	0,012	N/A	N/A
40th	0,005	0,013	0,005	0,013	N/A	N/A
THD ₄₀ [%]	0,84		0,59		23%	13%
PWHD [%]	0,001		0,000		23%	22%

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Power Quality. Harmonics.

Phase 2

Generating Unit rating per phase (rpp)

**At 45-55% of rated output
4,55 kW**

**100% of rated output
9,02 kW**

Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-12 in %	
					1 phase	3 phase
2nd	0,032	0,081	0,035	0,090	8%	8%
3rd	0,043	0,109	0,012	0,031	21,6%	N/A
4th	0,020	0,050	0,013	0,032	4%	4%
5th	0,059	0,152	0,034	0,086	10,7%	10,7%
6th	0,024	0,060	0,023	0,058	2,67%	2,67%
7th	0,009	0,024	0,010	0,025	7,2%	7,2%
8th	0,013	0,034	0,013	0,034	2%	2%
9th	0,006	0,015	0,006	0,014	3,8%	N/A
10th	0,013	0,033	0,013	0,034	1,6%	1,6%
11th	0,027	0,070	0,036	0,093	3,1%	3,1%
12th	0,014	0,036	0,014	0,036	1,33%	1,33%
13th	0,024	0,060	0,029	0,073	2%	2%
14th	0,009	0,022	0,009	0,022	N/A	N/A
15th	0,012	0,030	0,007	0,017	N/A	N/A
16th	0,007	0,018	0,008	0,019	N/A	N/A
17th	0,016	0,042	0,020	0,052	N/A	N/A
18th	0,008	0,021	0,009	0,022	N/A	N/A
19th	0,015	0,037	0,016	0,042	N/A	N/A
20th	0,005	0,014	0,005	0,013	N/A	N/A
21th	0,009	0,023	0,005	0,012	N/A	N/A
22th	0,004	0,011	0,004	0,011	N/A	N/A
23th	0,010	0,026	0,013	0,032	N/A	N/A
24th	0,005	0,012	0,005	0,012	N/A	N/A
25th	0,011	0,027	0,011	0,028	N/A	N/A
26th	0,005	0,012	0,005	0,012	N/A	N/A
27th	0,003	0,008	0,003	0,009	N/A	N/A
28th	0,005	0,012	0,005	0,013	N/A	N/A
29th	0,006	0,015	0,011	0,029	N/A	N/A
30th	0,006	0,014	0,006	0,015	N/A	N/A
31th	0,005	0,014	0,010	0,025	N/A	N/A
32th	0,004	0,011	0,005	0,012	N/A	N/A
33th	0,003	0,007	0,003	0,008	N/A	N/A
34th	0,004	0,010	0,004	0,010	N/A	N/A
35th	0,008	0,020	0,008	0,020	N/A	N/A
36th	0,004	0,009	0,004	0,010	N/A	N/A
37th	0,005	0,013	0,008	0,021	N/A	N/A
38th	0,004	0,009	0,004	0,009	N/A	N/A
39th	0,007	0,018	0,004	0,011	N/A	N/A
40th	0,004	0,011	0,004	0,010	N/A	N/A
THD ₄₀ [%]	0,53		0,23		23%	13%
PWHD [%]	0,000		0,000		23%	22%

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules
 Extract from test report according to the Engineering Recommendation G99 Nr. 15TH0304-G99/1_0

Power Quality. Harmonics.						
Phase 3						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 4,53 kW		100% of rated output 9,00 kW			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-12 in %	
					1 phase	3 phase
2nd	0,040	0,102	0,037	0,095	8%	8%
3rd	0,030	0,076	0,019	0,048	21,6%	N/A
4th	0,027	0,069	0,019	0,048	4%	4%
5th	0,057	0,146	0,032	0,083	10,7%	10,7%
6th	0,019	0,049	0,020	0,050	2,67%	2,67%
7th	0,014	0,037	0,009	0,024	7,2%	7,2%
8th	0,014	0,036	0,015	0,038	2%	2%
9th	0,010	0,026	0,006	0,016	3,8%	N/A
10th	0,013	0,033	0,013	0,034	1,6%	1,6%
11th	0,024	0,062	0,033	0,085	3,1%	3,1%
12th	0,013	0,034	0,014	0,035	1,33%	1,33%
13th	0,021	0,054	0,027	0,069	2%	2%
14th	0,007	0,018	0,008	0,019	N/A	N/A
15th	0,012	0,031	0,007	0,017	N/A	N/A
16th	0,007	0,017	0,007	0,018	N/A	N/A
17th	0,015	0,037	0,018	0,047	N/A	N/A
18th	0,009	0,022	0,009	0,024	N/A	N/A
19th	0,015	0,038	0,019	0,048	N/A	N/A
20th	0,007	0,018	0,007	0,018	N/A	N/A
21th	0,008	0,021	0,005	0,014	N/A	N/A
22th	0,006	0,015	0,006	0,014	N/A	N/A
23th	0,010	0,025	0,012	0,030	N/A	N/A
24th	0,005	0,013	0,005	0,012	N/A	N/A
25th	0,011	0,028	0,011	0,028	N/A	N/A
26th	0,004	0,010	0,004	0,011	N/A	N/A
27th	0,004	0,011	0,004	0,009	N/A	N/A
28th	0,005	0,012	0,005	0,013	N/A	N/A
29th	0,006	0,015	0,010	0,026	N/A	N/A
30th	0,006	0,015	0,006	0,016	N/A	N/A
31th	0,005	0,013	0,010	0,025	N/A	N/A
32th	0,004	0,011	0,004	0,012	N/A	N/A
33th	0,004	0,011	0,005	0,012	N/A	N/A
34th	0,004	0,010	0,004	0,011	N/A	N/A
35th	0,008	0,020	0,009	0,024	N/A	N/A
36th	0,004	0,010	0,004	0,011	N/A	N/A
37th	0,004	0,011	0,008	0,020	N/A	N/A
38th	0,005	0,012	0,005	0,012	N/A	N/A
39th	0,007	0,017	0,005	0,012	N/A	N/A
40th	0,005	0,012	0,005	0,013	N/A	N/A
THD ₄₀ [%]	0,51		0,23		23%	13%
PWHD [%]	0,000		0,000		23%	22%

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Power Quality. Harmonics.

ECO25.0-3-S / Phase 1

Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 4,08 kW		100% of rated output 8,36 kW			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-12 in %	
					1 phase	3 phase
2nd	0,018	0,050	0,015	0,043	8%	8%
3rd	0,084	0,232	0,105	0,290	21,6%	N/A
4th	0,026	0,071	0,021	0,058	4%	4%
5th	0,055	0,152	0,093	0,256	10,7%	10,7%
6th	0,024	0,066	0,020	0,054	2,67%	2,67%
7th	0,069	0,191	0,090	0,248	7,2%	7,2%
8th	0,022	0,061	0,022	0,059	2%	2%
9th	0,062	0,170	0,085	0,234	3,8%	N/A
10th	0,013	0,037	0,015	0,040	1,6%	1,6%
11th	0,019	0,052	0,033	0,091	3,1%	3,1%
12th	0,008	0,023	0,009	0,024	1,33%	1,33%
13th	0,053	0,146	0,072	0,197	2%	2%
14th	0,009	0,024	0,009	0,025	N/A	N/A
15th	0,022	0,060	0,029	0,081	N/A	N/A
16th	0,008	0,023	0,008	0,023	N/A	N/A
17th	0,027	0,075	0,036	0,098	N/A	N/A
18th	0,005	0,014	0,005	0,014	N/A	N/A
19th	0,008	0,022	0,015	0,041	N/A	N/A
20th	0,008	0,021	0,007	0,020	N/A	N/A
21th	0,007	0,019	0,008	0,021	N/A	N/A
22th	0,008	0,022	0,008	0,022	N/A	N/A
23th	0,008	0,021	0,020	0,054	N/A	N/A
24th	0,003	0,009	0,003	0,008	N/A	N/A
25th	0,009	0,024	0,006	0,016	N/A	N/A
26th	0,006	0,017	0,007	0,019	N/A	N/A
27th	0,007	0,019	0,010	0,027	N/A	N/A
28th	0,004	0,011	0,004	0,012	N/A	N/A
29th	0,005	0,014	0,007	0,020	N/A	N/A
30th	0,003	0,009	0,004	0,010	N/A	N/A
31th	0,008	0,022	0,012	0,034	N/A	N/A
32th	0,004	0,011	0,004	0,012	N/A	N/A
33th	0,005	0,013	0,004	0,010	N/A	N/A
34th	0,005	0,015	0,005	0,013	N/A	N/A
35th	0,007	0,018	0,008	0,022	N/A	N/A
36th	0,003	0,008	0,003	0,008	N/A	N/A
37th	0,004	0,011	0,008	0,023	N/A	N/A
38th	0,006	0,016	0,006	0,016	N/A	N/A
39th	0,005	0,013	0,005	0,014	N/A	N/A
40th	0,005	0,014	0,005	0,014	N/A	N/A
THD ₄₀ [%]	0,92		0,60		23%	13%
PWHD [%]	0,001		0,001		23%	22%

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Power Quality. Harmonics.

Phase 2

Generating Unit rating per phase (rpp)

**At 45-55% of rated output
4,10 kW**

**100% of rated output
8,41 kW**

Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-12 in %	
					1 phase	3 phase
2nd	0,031	0,086	0,035	0,095	8%	8%
3rd	0,046	0,126	0,015	0,042	21,6%	N/A
4th	0,021	0,056	0,013	0,036	4%	4%
5th	0,054	0,148	0,038	0,104	10,7%	10,7%
6th	0,024	0,065	0,023	0,062	2,67%	2,67%
7th	0,009	0,024	0,008	0,021	7,2%	7,2%
8th	0,014	0,037	0,014	0,037	2%	2%
9th	0,006	0,016	0,005	0,014	3,8%	N/A
10th	0,013	0,035	0,013	0,036	1,6%	1,6%
11th	0,028	0,076	0,038	0,104	3,1%	3,1%
12th	0,014	0,038	0,014	0,038	1,33%	1,33%
13th	0,022	0,061	0,028	0,076	2%	2%
14th	0,009	0,023	0,009	0,023	N/A	N/A
15th	0,012	0,032	0,008	0,021	N/A	N/A
16th	0,007	0,019	0,008	0,021	N/A	N/A
17th	0,016	0,044	0,020	0,055	N/A	N/A
18th	0,008	0,022	0,009	0,024	N/A	N/A
19th	0,013	0,036	0,016	0,043	N/A	N/A
20th	0,006	0,016	0,005	0,014	N/A	N/A
21th	0,009	0,023	0,006	0,016	N/A	N/A
22th	0,004	0,012	0,004	0,012	N/A	N/A
23th	0,009	0,024	0,013	0,036	N/A	N/A
24th	0,005	0,014	0,005	0,013	N/A	N/A
25th	0,010	0,027	0,012	0,032	N/A	N/A
26th	0,005	0,013	0,005	0,013	N/A	N/A
27th	0,003	0,008	0,003	0,009	N/A	N/A
28th	0,005	0,013	0,005	0,013	N/A	N/A
29th	0,005	0,014	0,011	0,030	N/A	N/A
30th	0,006	0,016	0,006	0,016	N/A	N/A
31th	0,005	0,014	0,009	0,025	N/A	N/A
32th	0,004	0,012	0,005	0,013	N/A	N/A
33th	0,003	0,007	0,003	0,008	N/A	N/A
34th	0,004	0,010	0,004	0,010	N/A	N/A
35th	0,007	0,019	0,008	0,022	N/A	N/A
36th	0,004	0,010	0,004	0,011	N/A	N/A
37th	0,005	0,014	0,008	0,021	N/A	N/A
38th	0,004	0,010	0,004	0,010	N/A	N/A
39th	0,007	0,018	0,005	0,014	N/A	N/A
40th	0,004	0,012	0,004	0,011	N/A	N/A
THD ₄₀ [%]	0,57		0,25		23%	13%
PWHD [%]	0,001		0,0002		23%	22%

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Power Quality. Harmonics.

Phase 3

Generating Unit rating per phase (rpp)

**At 45-55% of rated output
4,08 kW**

**100% of rated output
8,39 kW**

Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-12 in %	
					1 phase	3 phase
2nd	0,039	0,108	0,037	0,103	8%	8%
3rd	0,031	0,085	0,019	0,053	21,6%	N/A
4th	0,028	0,077	0,020	0,056	4%	4%
5th	0,050	0,139	0,035	0,097	10,7%	10,7%
6th	0,019	0,053	0,019	0,053	2,67%	2,67%
7th	0,012	0,033	0,007	0,020	7,2%	7,2%
8th	0,014	0,039	0,015	0,040	2%	2%
9th	0,010	0,028	0,007	0,020	3,8%	N/A
10th	0,013	0,036	0,013	0,036	1,6%	1,6%
11th	0,024	0,065	0,034	0,093	3,1%	3,1%
12th	0,013	0,037	0,014	0,037	1,33%	1,33%
13th	0,020	0,055	0,028	0,078	2%	2%
14th	0,007	0,020	0,007	0,020	N/A	N/A
15th	0,012	0,033	0,008	0,021	N/A	N/A
16th	0,007	0,018	0,007	0,019	N/A	N/A
17th	0,014	0,039	0,017	0,048	N/A	N/A
18th	0,009	0,024	0,009	0,025	N/A	N/A
19th	0,014	0,037	0,017	0,047	N/A	N/A
20th	0,007	0,019	0,007	0,020	N/A	N/A
21th	0,008	0,022	0,006	0,016	N/A	N/A
22th	0,006	0,016	0,006	0,016	N/A	N/A
23th	0,009	0,024	0,013	0,035	N/A	N/A
24th	0,005	0,014	0,005	0,013	N/A	N/A
25th	0,010	0,027	0,012	0,034	N/A	N/A
26th	0,004	0,011	0,004	0,012	N/A	N/A
27th	0,004	0,012	0,003	0,009	N/A	N/A
28th	0,005	0,013	0,005	0,014	N/A	N/A
29th	0,005	0,014	0,009	0,026	N/A	N/A
30th	0,006	0,017	0,006	0,017	N/A	N/A
31th	0,004	0,012	0,008	0,023	N/A	N/A
32th	0,004	0,012	0,004	0,012	N/A	N/A
33th	0,005	0,013	0,004	0,011	N/A	N/A
34th	0,004	0,011	0,004	0,011	N/A	N/A
35th	0,007	0,020	0,009	0,024	N/A	N/A
36th	0,004	0,011	0,004	0,012	N/A	N/A
37th	0,004	0,011	0,008	0,021	N/A	N/A
38th	0,005	0,013	0,005	0,013	N/A	N/A
39th	0,007	0,019	0,006	0,015	N/A	N/A
40th	0,005	0,013	0,005	0,013	N/A	N/A
THD ₄₀ [%]	0,55		0,25		23%	13%
PWHD [%]	0,0005		0,0002		23%	22%

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Power Quality. Power factor.

Output power	216,2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1,5\%$ of the stated level during the test.
20%	0,999	0,999	0,999	
50%	0,999	0,999	0,999	
75%	0,999	0,999	0,999	
100%	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	

Power Quality. Voltage fluctuation and Flicker.

	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured values at test impedance	3,200	3,160	0,0	3,200	3,160	0,0	0,185	0,185
Measured values at standard impedance	3,200	3,160	0,0	3,200	3,160	0,0	0,185	0,185
Values for maximum impedance	3,342	3,300	0,0	3,342	3,300	0,0	0,193	0,193
Limits set under BS EN 61000-3-11	4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65
Test impedance	R	0,24	Ω	XI	0,15	Ω		
	Z	0,283	Ω					
Standard impedance	R	0,24	Ω	XI	0,15	Ω		
	Z	0,283	Ω					
Maximum impedance	R	0,251	Ω	XI	0,157	Ω		
	Zmax	0,296	Ω					

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 15TH0304-G99/1_0

Power Quality. DC injection.			
Phase1			
Test level power [%]	10	55	100
Recorded value [mA]	82,00	75,00	63,00
Recorded value [%]	0,21	0,19	0,16
Limit [%]	0,25	0,25	0,25
Phase2			
Test level power [%]	10	55	100
Recorded value [mA]	8,00	8,00	12,00
Recorded value [%]	0,02	0,02	0,03
Limit [%]	0,25	0,25	0,25
Phase3			
Test level power [%]	10	55	100
Recorded value [mA]	13,00	8,00	13,00
Recorded value [%]	0,03	0,02	0,03
Limit [%]	0,25	0,25	0,25
Note. DC-injection is tested at each phase of the inverter and a limit of 0,25% per phase was used as pass criteria.			

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

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Fault level Contribution.

For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts [V]	Amps [A]
Peak Short Circuit current	I_p	N/A	20ms	232,8	38,98
Initial Value of aperiodic current	A	N/A	100ms	232,8	38,91
Initial symmetrical short-circuit current*	I_k	N/A	250ms	147,5	29,79
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	20,91	0,45
Reactance/Resistance Ratio of source*	X/R	N/A	Time to Trip [s]	2,550	In seconds

For rotating machines and linear piston machines the test should produce a 0s – 2s plot of the short circuit current as seen at the Generating Unit terminals.

* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot.

Self Monitoring – Solid state switching.	N/A
It has been verified that in the event of the solid state switching device failing to disconnect the Power Park Module, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0,5 seconds.	N/A
Note. Unit do not provide solid state switching relays. In case the semiconductor bridge is switched off, then the voltage on the output drops to 0. In this case the relays on the output will also open (Functional safety of the internal automatic disconnection device according to VDE 0126-1-1).	

Logic Interface (input port)	P
Confirm that an input port is provided and can be used to shut down the module.	Yes