



Certificate of compliance

Applicant: Kostal Solar Elektric GmbH
Hanferstraße 6
79108 Freiburg im Breisgau
Germany

Product: Grid-tied Photovoltaic Inverter

Model:

PLENTICORE plus 3.0	PIKO IQ 3.0
PLENTICORE plus 4.2	PIKO IQ 4.2
PLENTICORE plus 5.5	PIKO IQ 5.5
PLENTICORE plus 7.0	PIKO IQ 7.0
PLENTICORE plus 8.5	PIKO IQ 8.5
PLENTICORE plus 10	PIKO IQ 10

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: 19TH0374-G99/1_0

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

Certificate number: U20-0653

Date of issue: 2020-08-11

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. 19TH0374-G99/1_0

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

PGM Technology:	Photovoltaic Inverter		
Manufacturer / applicant:	Kostal Solar Elektrik GmbH		
Address:	Hanferstraße 6, 79108 Freiburg im Breisgau		
Tel	+49 761 47744 - 100	Fax:	+49 761 47744 - 111
Email:	info-solar@kostal.com	Website:	https://www.kostal-solar-electric.com/

	PLENTICORE plus 3.0	PLENTICORE plus 4.2	PLENTICORE plus 5.5	PLENTICORE plus 7.0
MPP DC voltage range [V]	180 - 720	180 - 720	225 - 720	290 - 720
Input DC voltage range [V]	180 - 1000	180 - 1000	225 - 1000	290 - 1000
Input DC current [A]	2x 13,0			
Output AC voltage [V]	3N~, 400V, 50Hz			
Output AC current [A]	4,33	6,74	8,82	11,23
Output power [VA]	3000	4200	5500	7000

Rated values	PLENTICORE plus 8.5	PLENTICORE plus 10		
MPP DC voltage range [V]	345 - 720	405 - 720		
Input DC voltage range [V]	345 - 1000	405 - 1000		
Input DC current [A]	3x 13,0			
Output AC voltage [V]	3N~, 400V, 50Hz			
Output AC current [A]	13,63	16,04		
Output power [VA]	8500	10000		

Rated values	PIKO IQ 3.0	PIKO IQ 4.2,	PIKO IQ 5.5	PIKO IQ 7.0
MPP DC voltage range [V]	180 - 720	180 - 720	225 - 720	290 - 720
Input DC voltage range [V]	180 - 1000	180 - 1000	225 - 1000	290 - 1000
Input DC current [A]	2x 13,0			
Output AC voltage [V]	3N~, 400V, 50Hz			
Output AC current [A]	4,33	6,74	8,82	11,23
Output power [VA]	3000	4200	5500	7000

Rated values	PIKO IQ 8.5	PIKO IQ 10		
MPP DC voltage range [V]	345 - 720	405 - 720		
Input DC voltage range [V]	345 - 1000	405 - 1000		
Input DC current [A]	3x 13,0			
Output AC voltage [V]	3N~, 400V, 50Hz			
Output AC current [A]	13,63	16,04		
Output power [VA]	8500	10000		

Firmware version	FW = 01.43 / PAR = 03.19
Measurement period:	2020-06-01 – 2020-07-31

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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. Output switch-off is performed with single-fault tolerance based on two series-connected relays in line and neutral. This enables a safe disconnection of the power generation unit from the network in case of error.

Differences between the models:

The inverters are divided into two performance classes, namely classes A and B.

The inverters of class A, PLENTICORE plus 3.0, PIKO IQ 3.0, PLENTICORE plus 4.2, PIKO IQ 4.2, PLENTICORE plus 5.5, and PIKO IQ 5.5 are based on the inverter PLENTICORE plus 5.5. All the models use the same hardware and software. The different powers are realized by software derating. The models are equipped with two DC input and with two MPP tracker.

The inverters of class B, PLENTICORE plus 7.0, PIKO IQ 7.0, PLENTICORE plus 8.5, PIKO IQ 8.5, PLENTICORE plus 10 and PIKO IQ 10 are based on the inverter PLENTICORE plus 10. All the models use the same hardware and software. The different powers are realized by software derating. The models are equipped with three DC input and with three MPP tracker.

The Class A and Class B power models have a different inverter-bridge, EMC filter, higher current rating. In addition Class B models have a DC input and MPP tracker. Compared to Type A.

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.

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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:	
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. 19TH0374-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	184,0	2,5	185,1	2,597	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	261,6	1,084	258,2V 5,0s	No trip
O/V stage 2	273,7	0,5	273,3	0,583	269,7V 0,95s	No trip
					277,7V 0,45s	No trip

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	184,7	2,567	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	261,4	1,061	258,2V 5,0s	No trip
O/V stage 2	273,7	0,5	273,0	0,560	269,7V 0,95s	No trip
					277,7V 0,45s	No trip

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	184,7	2,570	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	184,7	2,570	258,2V 5,0s	No trip
O/V stage 2	273,7	0,5	273,0	0,587	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.

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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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	47,50	20,176	47,7Hz / 30s	No trip
U/F stage 2	47	0,5	47,00	0,573	47,2Hz / 19,5s	No trip
					46,8Hz / 0,45s	No trip
O/F stage 2	52	0,5	52,00	0,584	51,8Hz / 120s	No trip
					52,2Hz / 0,45s	No trip

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

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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]	0,348	0,421	0,232	0,342	0,347	0,286
Trip time. Ph2 fuse removed [s]	0,348	0,421	0,232	0,342	0,347	0,286
Trip time. Ph3 fuse removed [s]	0,348	0,421	0,232	0,342	0,347	0,286

Note. For technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies

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		64s		
Under Voltage				
Time delay setting		Measured delay		
20s		62s		
Over Frequency				
Time delay setting		Measured delay		
20s		70s		
Under Frequency				
Time delay setting		Measured delay		
20s		70s		
	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 52,1Hz
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	50,55	50,70	51,15	50,70	50,55	50,00
P _{expected} [kW]:	10,00	9,69	9,39	8,49	9,39	9,69	10,00
P _{measured} [kW]:	10,00	9,69	9,39	8,49	9,39	9,69	10,00
2. Measurement a) to g): Active power output 40% and 60% P_n							
Frequency [Hz]:	50,00	50,55	50,70	51,15	50,70	50,55	50,00
P _{expected} [kW]:	5,01	4,86	4,71	4,26	4,71	4,86	5,01
P _{measured} [kW]:	5,01	4,86	4,71	4,26	4,71	4,86	5,01

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]:	10,00	10,00	10,00	10,00	9,99	9,99
ΔP/P _{max} [%]:		0,00	0,00	0,00	0,06	0,06

Note.

Electronic inverter no power reduction take place.

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Power Quality. Harmonics.

Plenticore plus 10, Phase 1

Generating Unit rating per phase (rpp)						
Harmonic	At 45-55% of rated output 920W		100% of rated output 1827W		Limit in BS EN61000-3-12 in %	
	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	1 phase	3 phase
2nd	0,023	0,158	0,034	0,239	8%	8%
3rd	0,015	0,105	0,028	0,198	21,6%	N/A
4th	0,007	0,048	0,022	0,154	4%	4%
5th	0,021	0,146	0,038	0,263	10,7%	10,7%
6th	0,010	0,073	0,005	0,034	2,67%	2,67%
7th	0,050	0,350	0,046	0,319	7,2%	7,2%
8th	0,011	0,077	0,013	0,089	2%	2%
9th	0,017	0,120	0,018	0,128	3,8%	N/A
10th	0,006	0,039	0,003	0,023	1,6%	1,6%
11th	0,022	0,152	0,024	0,166	3,1%	3,1%
12th	0,009	0,065	0,003	0,023	1,33%	1,33%
13th	0,016	0,111	0,045	0,313	2%	2%
14th	0,014	0,100	0,010	0,067	N/A	N/A
15th	0,004	0,029	0,006	0,042	N/A	N/A
16th	0,012	0,080	0,004	0,025	N/A	N/A
17th	0,021	0,147	0,037	0,259	N/A	N/A
18th	0,006	0,038	0,005	0,035	N/A	N/A
19th	0,029	0,199	0,022	0,154	N/A	N/A
20th	0,005	0,033	0,005	0,038	N/A	N/A
21th	0,009	0,060	0,006	0,041	N/A	N/A
22th	0,006	0,041	0,006	0,039	N/A	N/A
23th	0,035	0,244	0,017	0,117	N/A	N/A
24th	0,007	0,046	0,006	0,040	N/A	N/A
25th	0,039	0,268	0,017	0,116	N/A	N/A
26th	0,009	0,060	0,013	0,091	N/A	N/A
27th	0,008	0,053	0,006	0,043	N/A	N/A
28th	0,004	0,025	0,005	0,037	N/A	N/A
29th	0,018	0,123	0,023	0,158	N/A	N/A
30th	0,004	0,029	0,004	0,029	N/A	N/A
31th	0,015	0,106	0,018	0,127	N/A	N/A
32th	0,007	0,048	0,005	0,033	N/A	N/A
33th	0,004	0,025	0,006	0,040	N/A	N/A
34th	0,005	0,036	0,003	0,021	N/A	N/A
35th	0,011	0,078	0,011	0,074	N/A	N/A
36th	0,002	0,014	0,003	0,018	N/A	N/A
37th	0,005	0,036	0,018	0,122	N/A	N/A
38th	0,005	0,032	0,005	0,035	N/A	N/A
39th	0,004	0,026	0,002	0,016	N/A	N/A
40th	0,004	0,028	0,002	0,014	N/A	N/A
THD ₄₀ [%]	1,440		0,809		23%	13%
PWHD [%]	0,021		0,004		23%	22%

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Extract from test report according to the Engineering Recommendation G99

Nr. 19TH0374-G99/1_0

Power Quality. Harmonics.

Plenticore plus 10, Phase 2

Generating Unit rating per phase (rpp)						
At 45-55% of rated output 1665W			100% of rated output 3337W			
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	0,023	0,159	0,034	0,231	8%	8%
3rd	0,013	0,092	0,009	0,062	21,6%	N/A
4th	0,018	0,125	0,025	0,174	4%	4%
5th	0,030	0,204	0,049	0,337	10,7%	10,7%
6th	0,022	0,148	0,004	0,024	2,67%	2,67%
7th	0,030	0,204	0,036	0,246	7,2%	7,2%
8th	0,014	0,096	0,015	0,101	2%	2%
9th	0,005	0,037	0,008	0,056	3,8%	N/A
10th	0,006	0,038	0,003	0,019	1,6%	1,6%
11th	0,021	0,145	0,040	0,278	3,1%	3,1%
12th	0,007	0,047	0,005	0,037	1,33%	1,33%
13th	0,025	0,174	0,037	0,254	2%	2%
14th	0,015	0,106	0,009	0,061	N/A	N/A
15th	0,008	0,052	0,006	0,041	N/A	N/A
16th	0,010	0,067	0,004	0,026	N/A	N/A
17th	0,026	0,180	0,038	0,258	N/A	N/A
18th	0,005	0,035	0,003	0,023	N/A	N/A
19th	0,025	0,174	0,023	0,157	N/A	N/A
20th	0,006	0,041	0,007	0,051	N/A	N/A
21th	0,005	0,034	0,006	0,038	N/A	N/A
22th	0,006	0,045	0,009	0,064	N/A	N/A
23th	0,043	0,294	0,014	0,098	N/A	N/A
24th	0,005	0,031	0,005	0,036	N/A	N/A
25th	0,029	0,199	0,021	0,147	N/A	N/A
26th	0,009	0,064	0,013	0,090	N/A	N/A
27th	0,003	0,023	0,004	0,030	N/A	N/A
28th	0,004	0,030	0,004	0,028	N/A	N/A
29th	0,019	0,134	0,027	0,183	N/A	N/A
30th	0,006	0,040	0,004	0,025	N/A	N/A
31th	0,014	0,098	0,018	0,123	N/A	N/A
32th	0,007	0,047	0,004	0,028	N/A	N/A
33th	0,003	0,019	0,005	0,036	N/A	N/A
34th	0,003	0,020	0,004	0,028	N/A	N/A
35th	0,011	0,074	0,014	0,098	N/A	N/A
36th	0,003	0,017	0,002	0,013	N/A	N/A
37th	0,003	0,024	0,016	0,113	N/A	N/A
38th	0,004	0,028	0,005	0,037	N/A	N/A
39th	0,002	0,017	0,003	0,020	N/A	N/A
40th	0,003	0,019	0,003	0,017	N/A	N/A
THD ₄₀ [%]	1,394		0,803		23%	13%
PWHD [%]	0,021		0,004		23%	22%

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Extract from test report according to the Engineering Recommendation G99

Nr. 19TH0374-G99/1_0

Power Quality. Harmonics.
Plenticore plus 10, Phase 3

Generating Unit rating per phase (rpp)						
At 45-55% of rated output 1690W			100% of rated output 3369W			
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	0,014	0,095	0,032	0,220	8%	8%
3rd	0,014	0,097	0,020	0,137	21,6%	N/A
4th	0,011	0,078	0,025	0,169	4%	4%
5th	0,014	0,093	0,043	0,294	10,7%	10,7%
6th	0,032	0,221	0,005	0,034	2,67%	2,67%
7th	0,047	0,322	0,031	0,210	7,2%	7,2%
8th	0,004	0,029	0,011	0,076	2%	2%
9th	0,004	0,026	0,004	0,026	3,8%	N/A
10th	0,008	0,056	0,003	0,020	1,6%	1,6%
11th	0,014	0,098	0,034	0,234	3,1%	3,1%
12th	0,016	0,109	0,004	0,025	1,33%	1,33%
13th	0,031	0,213	0,035	0,236	2%	2%
14th	0,018	0,121	0,009	0,059	N/A	N/A
15th	0,004	0,028	0,007	0,048	N/A	N/A
16th	0,011	0,075	0,004	0,028	N/A	N/A
17th	0,023	0,157	0,035	0,238	N/A	N/A
18th	0,004	0,029	0,005	0,037	N/A	N/A
19th	0,027	0,184	0,023	0,159	N/A	N/A
20th	0,006	0,043	0,008	0,053	N/A	N/A
21th	0,011	0,073	0,005	0,033	N/A	N/A
22th	0,004	0,027	0,008	0,055	N/A	N/A
23th	0,036	0,249	0,012	0,081	N/A	N/A
24th	0,007	0,050	0,004	0,025	N/A	N/A
25th	0,037	0,252	0,020	0,133	N/A	N/A
26th	0,007	0,049	0,011	0,073	N/A	N/A
27th	0,008	0,053	0,003	0,019	N/A	N/A
28th	0,006	0,043	0,004	0,027	N/A	N/A
29th	0,018	0,120	0,022	0,151	N/A	N/A
30th	0,003	0,018	0,002	0,016	N/A	N/A
31th	0,018	0,122	0,016	0,110	N/A	N/A
32th	0,007	0,046	0,004	0,027	N/A	N/A
33th	0,003	0,022	0,004	0,025	N/A	N/A
34th	0,005	0,037	0,005	0,032	N/A	N/A
35th	0,012	0,080	0,013	0,087	N/A	N/A
36th	0,003	0,023	0,002	0,016	N/A	N/A
37th	0,006	0,040	0,014	0,094	N/A	N/A
38th	0,004	0,027	0,005	0,033	N/A	N/A
39th	0,003	0,019	0,004	0,026	N/A	N/A
40th	0,003	0,022	0,002	0,014	N/A	N/A
THD ₄₀ [%]	1,449		0,728		23%	13%
PWHD [%]	0,020		0,003		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. 19TH0374-G99/1_0

Power Quality. Harmonics.

Plenticore plus 5.5, Phase 1

Generating Unit rating per phase (rpp)						
Harmonic	At 45-55% of rated output 920W		100% of rated output 1827W		Limit in BS EN61000-3-12 in %	
	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]		
					1 phase	3 phase
2nd	0,030	0,390	0,020	0,257	8%	8%
3rd	0,045	0,578	0,042	0,541	21,6%	N/A
4th	0,031	0,401	0,035	0,450	4%	4%
5th	0,021	0,267	0,064	0,821	10,7%	10,7%
6th	0,025	0,324	0,012	0,149	2,67%	2,67%
7th	0,045	0,579	0,062	0,794	7,2%	7,2%
8th	0,015	0,197	0,032	0,408	2%	2%
9th	0,007	0,091	0,014	0,175	3,8%	N/A
10th	0,014	0,185	0,022	0,278	1,6%	1,6%
11th	0,042	0,534	0,013	0,167	3,1%	3,1%
12th	0,018	0,226	0,012	0,149	1,33%	1,33%
13th	0,046	0,588	0,016	0,210	2%	2%
14th	0,014	0,179	0,044	0,561	N/A	N/A
15th	0,053	0,675	0,017	0,224	N/A	N/A
16th	0,041	0,527	0,038	0,490	N/A	N/A
17th	0,068	0,864	0,066	0,850	N/A	N/A
18th	0,066	0,849	0,027	0,348	N/A	N/A
19th	0,075	0,961	0,054	0,696	N/A	N/A
20th	0,071	0,906	0,044	0,567	N/A	N/A
21th	0,040	0,514	0,021	0,264	N/A	N/A
22th	0,052	0,670	0,042	0,543	N/A	N/A
23th	0,025	0,321	0,021	0,269	N/A	N/A
24th	0,019	0,246	0,016	0,204	N/A	N/A
25th	0,009	0,112	0,046	0,585	N/A	N/A
26th	0,016	0,207	0,016	0,205	N/A	N/A
27th	0,010	0,123	0,006	0,070	N/A	N/A
28th	0,019	0,248	0,005	0,068	N/A	N/A
29th	0,014	0,181	0,021	0,269	N/A	N/A
30th	0,004	0,054	0,003	0,038	N/A	N/A
31th	0,007	0,095	0,018	0,234	N/A	N/A
32th	0,007	0,088	0,006	0,075	N/A	N/A
33th	0,003	0,035	0,004	0,055	N/A	N/A
34th	0,013	0,168	0,007	0,088	N/A	N/A
35th	0,005	0,063	0,009	0,116	N/A	N/A
36th	0,003	0,043	0,003	0,037	N/A	N/A
37th	0,006	0,080	0,007	0,092	N/A	N/A
38th	0,004	0,055	0,005	0,064	N/A	N/A
39th	0,005	0,067	0,003	0,034	N/A	N/A
40th	0,005	0,066	0,007	0,083	N/A	N/A
THD ₄₀ [%]	5,230		2,359		23%	13%
PWHD [%]	0,300		0,048		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. 19TH0374-G99/1_0

Power Quality. Harmonics.

Plenticore plus 5.5, Phase 2

Generating Unit rating per phase (rpp)

Harmonic	At 45-55% of rated output 919W		100% of rated output 1826W		Limit in BS EN61000-3-12 in %	
	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]		
					1 phase	3 phase
2nd	0,016	0,207	0,016	0,199	8%	8%
3rd	0,017	0,216	0,015	0,191	21,6%	N/A
4th	0,018	0,226	0,017	0,216	4%	4%
5th	0,020	0,251	0,058	0,739	10,7%	10,7%
6th	0,016	0,204	0,009	0,115	2,67%	2,67%
7th	0,017	0,213	0,047	0,605	7,2%	7,2%
8th	0,013	0,164	0,025	0,326	2%	2%
9th	0,014	0,184	0,007	0,092	3,8%	N/A
10th	0,011	0,142	0,013	0,166	1,6%	1,6%
11th	0,053	0,675	0,015	0,188	3,1%	3,1%
12th	0,019	0,245	0,008	0,108	1,33%	1,33%
13th	0,027	0,341	0,010	0,125	2%	2%
14th	0,032	0,405	0,030	0,389	N/A	N/A
15th	0,018	0,230	0,014	0,182	N/A	N/A
16th	0,017	0,220	0,024	0,309	N/A	N/A
17th	0,032	0,406	0,049	0,625	N/A	N/A
18th	0,026	0,327	0,020	0,261	N/A	N/A
19th	0,039	0,504	0,029	0,371	N/A	N/A
20th	0,058	0,746	0,032	0,411	N/A	N/A
21th	0,024	0,313	0,014	0,181	N/A	N/A
22th	0,019	0,245	0,027	0,339	N/A	N/A
23th	0,015	0,186	0,025	0,323	N/A	N/A
24th	0,011	0,146	0,011	0,137	N/A	N/A
25th	0,019	0,248	0,037	0,470	N/A	N/A
26th	0,014	0,184	0,013	0,161	N/A	N/A
27th	0,006	0,082	0,008	0,104	N/A	N/A
28th	0,019	0,247	0,006	0,074	N/A	N/A
29th	0,015	0,189	0,020	0,252	N/A	N/A
30th	0,004	0,048	0,003	0,036	N/A	N/A
31th	0,003	0,041	0,020	0,252	N/A	N/A
32th	0,004	0,053	0,007	0,094	N/A	N/A
33th	0,003	0,042	0,004	0,049	N/A	N/A
34th	0,012	0,152	0,007	0,085	N/A	N/A
35th	0,005	0,068	0,013	0,160	N/A	N/A
36th	0,003	0,043	0,002	0,027	N/A	N/A
37th	0,004	0,047	0,008	0,102	N/A	N/A
38th	0,003	0,039	0,005	0,067	N/A	N/A
39th	0,004	0,051	0,002	0,032	N/A	N/A
40th	0,004	0,050	0,005	0,063	N/A	N/A
THD ₄₀ [%]	3,314		1,740		23%	13%
PWHD [%]	0,118		0,025		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. 19TH0374-G99/1_0

Power Quality. Harmonics.

Plenticore plus 5.5, Phase 3

Generating Unit rating per phase (rpp)						
At 45-55% of rated output 919W			100% of rated output 1819W			
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	0,038	0,488	0,027	0,345	8%	8%
3rd	0,028	0,365	0,025	0,318	21,6%	N/A
4th	0,026	0,333	0,024	0,310	4%	4%
5th	0,013	0,167	0,070	0,896	10,7%	10,7%
6th	0,031	0,394	0,005	0,066	2,67%	2,67%
7th	0,033	0,426	0,045	0,579	7,2%	7,2%
8th	0,013	0,169	0,022	0,286	2%	2%
9th	0,008	0,104	0,005	0,070	3,8%	N/A
10th	0,007	0,090	0,016	0,203	1,6%	1,6%
11th	0,045	0,571	0,013	0,169	3,1%	3,1%
12th	0,009	0,115	0,007	0,090	1,33%	1,33%
13th	0,044	0,570	0,018	0,233	2%	2%
14th	0,040	0,517	0,034	0,442	N/A	N/A
15th	0,033	0,423	0,009	0,111	N/A	N/A
16th	0,029	0,369	0,018	0,235	N/A	N/A
17th	0,035	0,449	0,049	0,634	N/A	N/A
18th	0,041	0,529	0,011	0,147	N/A	N/A
19th	0,041	0,524	0,041	0,524	N/A	N/A
20th	0,033	0,430	0,024	0,308	N/A	N/A
21th	0,025	0,322	0,015	0,196	N/A	N/A
22th	0,039	0,506	0,041	0,524	N/A	N/A
23th	0,015	0,198	0,012	0,157	N/A	N/A
24th	0,013	0,163	0,008	0,103	N/A	N/A
25th	0,027	0,349	0,052	0,664	N/A	N/A
26th	0,018	0,226	0,009	0,118	N/A	N/A
27th	0,006	0,073	0,003	0,043	N/A	N/A
28th	0,016	0,205	0,006	0,079	N/A	N/A
29th	0,008	0,105	0,014	0,186	N/A	N/A
30th	0,005	0,062	0,003	0,039	N/A	N/A
31th	0,006	0,073	0,022	0,285	N/A	N/A
32th	0,007	0,092	0,009	0,116	N/A	N/A
33th	0,005	0,059	0,004	0,048	N/A	N/A
34th	0,009	0,110	0,006	0,075	N/A	N/A
35th	0,002	0,031	0,009	0,118	N/A	N/A
36th	0,003	0,040	0,003	0,033	N/A	N/A
37th	0,009	0,111	0,008	0,107	N/A	N/A
38th	0,004	0,054	0,004	0,052	N/A	N/A
39th	0,004	0,048	0,002	0,028	N/A	N/A
40th	0,003	0,037	0,006	0,077	N/A	N/A
THD ₄₀ [%]	3,834		1,929		23%	13%
PWHD [%]	0,111		0,034		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. 19TH0374-G99/1_0

Power Quality. Power factor.

Plenticore plus 10

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	

Plenticore plus 5.5

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	

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

Extract from test report according to the Engineering Recommendation G99

Nr. 19TH0374-G99/1_0

Power Quality. Voltage fluctuation and Flicker.

Plenticore plus 10

	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured values at test impedance	0,870	0,850	0,000	0,870	0,850	0,000	0,192	0,151
Measured values at standard impedance	0,870	0,850	0,000	0,870	0,850	0,000	0,192	0,151
Values for maximum impedance	3,378	3,300	0,000	3,378	3,300	0,000	0,745	0,585
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	0,28	Ω			
Standard impedance	R	0,24	Ω	XI	0,15	Ω
	Z	0,28	Ω			
Maximum impedance	R	0,93	Ω	XI	0,58	Ω
	Zmax	1,10	Ω			

Plenticore plus 5.5

	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured values at test impedance	0,870	0,850	0,000	0,870	0,850	0,000	0,192	0,129
Measured values at standard impedance	0,870	0,850	0,000	0,870	0,850	0,000	0,192	0,129
Values for maximum impedance	3,378	3,300	0,000	3,378	3,300	0,000	0,745	0,501
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	0,28	Ω			
Standard impedance	R	0,24	Ω	XI	0,15	Ω
	Z	0,28	Ω			
Maximum impedance	R	0,93	Ω	XI	0,58	Ω
	Zmax	1,10	Ω			

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

Extract from test report according to the Engineering Recommendation G99

Nr. 19TH0374-G99/1_0

Power Quality. DC injection.

Plenticore plus 10

Phase 1

Test level power [%]	10	55	100
Recorded value [mA]	19	15	11
Recorded value [%]	0,12	0,09	0,07
Limit [%]	0,25	0,25	0,25

Phase 2

Test level power [%]	10	55	100
Recorded value [mA]	9	8	3
Recorded value [%]	0,06	0,05	0,02
Limit [%]	0,25	0,25	0,25

Phase 3

Test level power [%]	10	55	100
Recorded value [mA]	11	15	19
Recorded value [%]	0,07	0,09	0,12
Limit [%]	0,25	0,25	0,25

Plenticore plus 5.5

Phase 1

Test level power [%]	10	55	100
Recorded value [mA]	10	13	9
Recorded value [%]	0,11	0,15	0,10
Limit [%]	0,25	0,25	0,25

Phase 2

Test level power [%]	10	55	100
Recorded value [mA]	8	7	4
Recorded value [%]	0,09	0,08	0,05
Limit [%]	0,25	0,25	0,25

Phase 3

Test level power [%]	10	55	100
Recorded value [mA]	15	8	17
Recorded value [%]	0,17	0,09	0,19
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

Nr. 19TH0374-G99/1_0

Fault level Contribution.
Phase 1

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	8,6	4,17
Initial Value of aperiodic current	A	N/A	100ms	7,3	1,96
Initial symmetrical short-circuit current*	I_k	N/A	250ms	7,1	1,25
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	7,0	0,89
Reactance/Resistance Ratio of source*	X/R	N/A	Time to Trip [s]	2,568	In seconds

Phase 2

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	8,3	2,93
Initial Value of aperiodic current	A	N/A	100ms	7,8	1,40
Initial symmetrical short-circuit current*	I_k	N/A	250ms	7,5	0,90
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	7,2	0,64
Reactance/Resistance Ratio of source*	X/R	N/A	Time to Trip [s]	2,568	In seconds

Phase 3

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	8,5	5,40
Initial Value of aperiodic current	A	N/A	100ms	7,8	2,43
Initial symmetrical short-circuit current*	I_k	N/A	250ms	7,4	1,56
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	7,2	1,11
Reactance/Resistance Ratio of source*	X/R	N/A	Time to Trip [s]	2,568	In seconds

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

Extract from test report according to the Engineering Recommendation G99

Nr. 19TH0374-G99/1_0

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

Additional comments