Certificate of compliance

Applicant: **KOSTAL Solar Electric GmbH**
Hanferstraße 6
79108 Freiburg im Breisgau
Germany

Product: **Grid-tied Photovoltaic Inverter**

Model: **PLENTICORE plus 3.0 G2**
PLENTICORE plus 4.2 G2
PLENTICORE plus 5.5 G2
PLENTICORE plus 7.0 G2
PLENTICORE plus 8.5 G2
PLENTICORE plus 10 G2

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 G99/1-8:2021
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-Hybrid-G2_G99-1_0**	**Certification program:**	**NSOP-0032-DEU-ZE-V01**
Certificate number:	**U22-0483**	**Date of issue:**	**2022-10-06**

Certification body

Alf Assenkamp

DAkkS Deutsche Akkreditierungsstelle D-ZE-12024-01-00

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

Testing laboratory accredited according to DIN EN ISO/IEC 17025

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-Hybrid-G2_G99-1_0**

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G99.			
PGM Technology:	Photovoltaic Inverter		
Manufacturer / applicant:	KOSTAL Industrie Elektrik GmbH		
Address:	Lange Eck 11, 58099 Hagen, Germany		
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 G2	PLENTICORE plus 4.2 G2	PLENTICORE plus 5.5 G2	PLENTICORE plus 7.0 G2
MPP DC voltage range [V]	180 - 720	180 - 720	225 - 720	290 - 720
Input DC voltage range [V]	120 - 1000	120 - 1000	120 - 1000	120 - 1000
Input DC current [A]	3x 13,0	3x 13,0	3x 13,0	3x 13,0
Output AC voltage [V]	3N~, 400V, 50Hz	3N~, 400V, 50Hz	3N~, 400V, 50Hz	3N~, 400V, 50Hz
Output AC current [A]	4,81	6,74	8,82	11,23
Output power [VA]	3000	4200	5500	7000

Rated values	PLENTICORE plus 8.5 G2	PLENTICORE plus 10 G2	--	--
MPP DC voltage range [V]	345 - 720	405 - 720	--	--
Input DC voltage range [V]	120 - 1000	120 - 1000	--	--
Input DC current [A]	3x 13,0	3x 13,0	--	--
Output AC voltage [V]	3N~, 400V, 50Hz	3N~, 400V, 50Hz	--	--
Output AC current [A]	13,63	16,04	--	--
Output power [VA]	8500	10000	--	--

Firmware version	02.04

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.

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

Extract from test report according to the Engineering Recommendation G99 **Nr. 19TH0374-Hybrid-G2_G99-1_0**

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 G2, PLENTICORE plus 4.2 G2 and PLENTICORE plus 5.5 G2 are based on the inverter PLENTICORE plus 5.5 G2. All the models use the same hardware and software. The different powers are realized by software derating. The models are equipped with three DC inputs.

The inverters of class B, PLENTICORE plus 7.0 G2, PLENTICORE plus 8.5 G2 and PLENTICORE plus 10 G2 are based on the inverter PLENTICORE plus 10 G2. All the models use the same hardware and software. The different powers are realized by software derating. The models are equipped with three DC inputs.

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.

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules	
Extract from test report according to the Engineering Recommendation G99	**Nr. 19TH0374-Hybrid-G2_G99-1_0**

Operating Range.	
Test 1	Voltage = 85 % of nominal (195,5 V) Frequency = 47,0 Hz Power Factor = 1 Period of test 20 seconds
Connection:	Always connected
Limit:	Always connected
Test 2	Voltage = 85 % of nominal (195,5 V) Frequency = 47,5 Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 3	Voltage = 110 % of nominal (253,0 V) Frequency = 51,5 Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 4	Voltage = 110 % of nominal (253,0 V) Frequency = 52,0 Hz Power Factor = 1 Period of test 15 minutes
Connection:	Always connected
Limit:	Always connected
Test 5	Voltage = 100 % of nominal (230,0 V) Frequency = 50,0 Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 6 RoCof withstand	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 500 ms. 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-Hybrid-G2_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 stage 1	184,0	2,5	185,1	2,597	188,0 V / 5,00 s	No trip
					180,0 V / 2,45 s	No trip
O/V stage 1	262,2	1,0	261,6	1,084	258,2 V 5,00 s	No trip
O/V stage 2	273,7	0,5	273,3	0,583	269,7 V 0,95 s	No trip
					277,7 V 0,45 s	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 stage 1	184,0	2,5	184,7	2,567	188,0 V / 5,00 s	No trip
					180,0 V / 2,45 s	No trip
O/V stage 1	262,2	1,0	261,4	1,061	258,2 V 5,00 s	No trip
O/V stage 2	273,7	0,5	273,0	0,560	269,7 V 0,95 s	No trip
					277,7 V 0,45 s	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 stage 1	184,0	2,5	184,7	2,570	188,0 V / 5,00 s	No trip
					180,0 V / 2,45 s	No trip
O/V stage 1	262,2	1,0	184,7	1,076	258,2 V 5,00 s	No trip
O/V stage 2	273,7	0,5	273,0	0,587	269,7 V 0,95 s	No trip
					277,7 V 0,45 s	No trip

Note:

For Voltage tests the Voltage required to trip is the setting ± 3,45 V. 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 ± 4,00 V 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. 19TH0374-Hybrid-G2_G99-1_0**

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	20,0	47,50	20,176	47,7 Hz / 30,00 s	No trip
U/F stage 2	47,0	0,5	47,00	0,573	47,2 Hz / 19,50 s	No trip
					46,8 Hz / 0,45 s	No trip
O/F stage 1	52,0	0,5	52,00	0,584	51,8 Hz / 120,00 s	No trip
					52,2 Hz / 0,45 s	No trip

Note:

For Frequency Trip tests the Frequency required to trip is the setting ± 0,1 Hz. 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 ± 0,2 Hz 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. 19TH0374-Hybrid-G2_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]	0,348	0,421	0,142	0,342	0,347	0,230
Trip time. Ph2 fuse removed [s]	0,348	0,421	0,142	0,342	0,347	0,230
Trip time. Ph3 fuse removed [s]	0,348	0,421	0,142	0,342	0,347	0,230
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 [s]	**Measured delay [s]**
20	65
Under Voltage	
Time delay setting [s]	**Measured delay [s]**
20	63
Over Frequency	
Time delay setting [s]	**Measured delay [s]**
20	64
Under Frequency	
Time delay setting [s]	**Measured delay [s]**
20	63

	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2 V	At 180,0 V	At 47,4 Hz	At 52,1 Hz
Confirmation that the Generating Unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules	
Extract from test report according to the Engineering Recommendation G99	**Nr. 19TH0374-Hybrid-G2_G99-1_0**

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	+ 0,95 Hz/sec	2,1 s	No trip
Negative Frequency drift	51,0 to 49,0	- 0,95 Hz/sec	2,1 s	No trip

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
$\Delta P/P_{max}$ [%]:		0,00	0,00	0,00	0,06	0,06
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. 19TH0374-Hybrid-G2_G99-1_0**

Power Quality. Harmonics.

PLENTICORE plus 10 G2, Phase 1

Generating Unit rating per phase (rpp)						
	At 45 - 55 % of rated output 1652 W		100 % of rated output 3221 W			
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	0,047	0,333	0,044	0,315	8%	8%
3rd	0,024	0,173	0,051	0,367	21,6%	--
4th	0,027	0,191	0,024	0,175	4%	4%
5th	0,014	0,101	0,033	0,236	10,7%	10,7%
6th	0,008	0,057	0,008	0,060	2,67%	2,67%
7th	0,049	0,353	0,059	0,425	7,2%	7,2%
8th	0,014	0,100	0,011	0,082	2%	2%
9th	0,005	0,039	0,009	0,064	3,8%	--
10th	0,006	0,040	0,009	0,063	1,6%	1,6%
11th	0,008	0,054	0,037	0,268	3,1%	3,1%
12th	0,004	0,026	0,005	0,039	1,33%	1,33%
13th	0,010	0,068	0,034	0,242	2%	2%
14th	0,022	0,155	0,018	0,131	--	--
15th	0,005	0,033	0,008	0,060	--	--
16th	0,010	0,072	0,013	0,095	--	--
17th	0,032	0,228	0,014	0,101	--	--
18th	0,007	0,051	0,009	0,062	--	--
19th	0,030	0,216	0,022	0,157	--	--
20th	0,009	0,063	0,016	0,115	--	--
21th	0,008	0,060	0,009	0,063	--	--
22th	0,014	0,100	0,011	0,080	--	--
23th	0,029	0,209	0,016	0,113	--	--
24th	0,004	0,026	0,008	0,058	--	--
25th	0,036	0,260	0,020	0,145	--	--
26th	0,010	0,072	0,019	0,133	--	--
27th	0,003	0,024	0,008	0,058	--	--
28th	0,006	0,043	0,010	0,073	--	--
29th	0,010	0,074	0,027	0,191	--	--
30th	0,002	0,018	0,006	0,042	--	--
31th	0,009	0,068	0,017	0,123	--	--
32th	0,011	0,082	0,007	0,053	--	--
33th	0,003	0,019	0,005	0,035	--	--
34th	0,004	0,025	0,008	0,055	--	--
35th	0,008	0,059	0,009	0,061	--	--
36th	0,003	0,022	0,004	0,029	--	--
37th	0,004	0,028	0,021	0,154	--	--
38th	0,006	0,042	0,008	0,056	--	--
39th	0,004	0,031	0,004	0,030	--	--
40th	0,007	0,048	0,005	0,032	--	--
THD_{40} [%]	0,080		0,095		23%	13%
PWHD [%]	0,025		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-Hybrid-G2_G99-1_0**

Power Quality. Harmonics.

PLENTICORE plus 10 G2, Phase 2

Generating Unit rating per phase (rpp)						
	At 45 - 55 % of rated output 1678 W		100 % of rated output 3270 W			
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	0,034	0,237	0,026	0,186	8%	8%
3rd	0,032	0,227	0,053	0,372	21,6%	--
4th	0,026	0,182	0,025	0,176	4%	4%
5th	0,030	0,211	0,045	0,315	10,7%	10,7%
6th	0,004	0,031	0,004	0,028	2,67%	2,67%
7th	0,041	0,287	0,055	0,388	7,2%	7,2%
8th	0,005	0,036	0,005	0,035	2%	2%
9th	0,012	0,087	0,018	0,128	3,8%	--
10th	0,004	0,028	0,008	0,054	1,6%	1,6%
11th	0,009	0,064	0,049	0,346	3,1%	3,1%
12th	0,006	0,041	0,008	0,058	1,33%	1,33%
13th	0,008	0,058	0,040	0,285	2%	2%
14th	0,011	0,077	0,008	0,055	--	--
15th	0,009	0,064	0,011	0,079	--	--
16th	0,010	0,070	0,007	0,051	--	--
17th	0,035	0,249	0,021	0,149	--	--
18th	0,004	0,027	0,006	0,045	--	--
19th	0,037	0,260	0,016	0,115	--	--
20th	0,006	0,044	0,008	0,058	--	--
21th	0,013	0,090	0,007	0,046	--	--
22th	0,007	0,050	0,007	0,052	--	--
23th	0,038	0,267	0,008	0,054	--	--
24th	0,004	0,028	0,006	0,044	--	--
25th	0,028	0,194	0,015	0,107	--	--
26th	0,008	0,055	0,011	0,078	--	--
27th	0,009	0,063	0,007	0,047	--	--
28th	0,005	0,038	0,005	0,036	--	--
29th	0,015	0,108	0,025	0,176	--	--
30th	0,003	0,019	0,005	0,036	--	--
31th	0,007	0,052	0,017	0,122	--	--
32th	0,007	0,047	0,005	0,035	--	--
33th	0,005	0,032	0,004	0,027	--	--
34th	0,005	0,034	0,004	0,026	--	--
35th	0,006	0,044	0,014	0,100	--	--
36th	0,004	0,026	0,003	0,023	--	--
37th	0,005	0,033	0,014	0,101	--	--
38th	0,005	0,033	0,006	0,044	--	--
39th	0,002	0,015	0,006	0,041	--	--
40th	0,004	0,031	0,002	0,015	--	--
THD_{40} [%]	0,770		0,910		23%	13%
PWHD [%]	0,025		0,020		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-Hybrid-G2_G99-1_0**

Power Quality. Harmonics.

PLENTICORE plus 10 G2, Phase 3

Generating Unit rating per phase (rpp)						
	At 45 - 55 % of rated output 1705 W		100 % of rated output 3325 W			
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	0,047	0,329	0,041	0,282	8%	8%
3rd	0,031	0,216	0,051	0,353	21,6%	--
4th	0,036	0,250	0,036	0,248	4%	4%
5th	0,030	0,206	0,037	0,254	10,7%	10,7%
6th	0,008	0,059	0,009	0,061	2,67%	2,67%
7th	0,035	0,244	0,046	0,319	7,2%	7,2%
8th	0,012	0,084	0,014	0,095	2%	2%
9th	0,013	0,088	0,012	0,083	3,8%	--
10th	0,008	0,056	0,011	0,079	1,6%	1,6%
11th	0,005	0,038	0,037	0,254	3,1%	3,1%
12th	0,007	0,046	0,009	0,064	1,33%	1,33%
13th	0,011	0,075	0,029	0,204	2%	2%
14th	0,020	0,138	0,017	0,118	--	--
15th	0,007	0,049	0,015	0,101	--	--
16th	0,014	0,100	0,014	0,098	--	--
17th	0,021	0,149	0,026	0,178	--	--
18th	0,007	0,047	0,008	0,053	--	--
19th	0,021	0,146	0,014	0,096	--	--
20th	0,013	0,090	0,013	0,090	--	--
21th	0,016	0,110	0,007	0,049	--	--
22th	0,012	0,084	0,009	0,062	--	--
23th	0,040	0,277	0,011	0,079	--	--
24th	0,003	0,024	0,008	0,053	--	--
25th	0,024	0,164	0,012	0,082	--	--
26th	0,006	0,044	0,015	0,104	--	--
27th	0,007	0,050	0,008	0,055	--	--
28th	0,003	0,020	0,011	0,075	--	--
29th	0,010	0,071	0,020	0,141	--	--
30th	0,003	0,020	0,005	0,036	--	--
31th	0,004	0,026	0,017	0,120	--	--
32th	0,008	0,055	0,005	0,035	--	--
33th	0,005	0,033	0,005	0,033	--	--
34th	0,006	0,045	0,006	0,039	--	--
35th	0,007	0,046	0,010	0,066	--	--
36th	0,003	0,022	0,005	0,036	--	--
37th	0,005	0,036	0,013	0,087	--	--
38th	0,005	0,032	0,006	0,043	--	--
39th	0,004	0,028	0,008	0,052	--	--
40th	0,007	0,048	0,004	0,027	--	--
THD_{40} [%]	0,760		0,870		23%	13%
PWHD [%]	0,023		0,021		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-Hybrid-G2_G99-1_0**

Power Quality. Harmonics.

PLENTICORE plus 5.5, Phase 1

Generating Unit rating per phase (rpp)						
	At 45 - 55 % of rated output 920 W		100 % of rated output 1827 W			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-2 in Amps	
					1 phase	3 phase
2nd	0,031	0,552	0,020	0,364	1,080	--
3rd	0,045	0,818	0,042	0,764	2,300	--
4th	0,031	0,568	0,035	0,636	0,430	--
5th	0,021	0,378	0,064	1,162	1,140	--
6th	0,026	0,466	0,012	0,210	0,300	--
7th	0,045	0,820	0,062	1,122	0,770	--
8th	0,016	0,281	0,032	0,576	0,230	--
9th	0,007	0,128	0,014	0,246	0,400	--
10th	0,015	0,263	0,022	0,394	0,184	--
11th	0,042	0,754	0,013	0,237	0,330	--
12th	0,018	0,322	0,012	0,211	0,153	--
13th	0,046	0,835	0,016	0,297	0,210	--
14th	0,014	0,251	0,044	0,795	0,131	--
15th	0,053	0,959	0,018	0,318	0,150	--
16th	0,041	0,750	0,038	0,693	0,115	--
17th	0,067	1,212	0,067	1,203	0,132	--
18th	0,066	1,193	0,027	0,492	0,102	--
19th	0,075	1,358	0,054	0,981	0,118	--
20th	0,071	1,280	0,044	0,801	0,092	--
21th	0,040	0,724	0,021	0,372	0,107	0,160
22th	0,052	0,946	0,042	0,765	0,084	--
23th	0,025	0,454	0,021	0,379	0,098	0,147
24th	0,019	0,348	0,016	0,289	0,077	--
25th	0,009	0,157	0,046	0,826	0,090	0,135
26th	0,016	0,294	0,016	0,290	0,071	--
27th	0,010	0,175	0,005	0,099	0,083	0,124
28th	0,019	0,350	0,005	0,094	0,066	--
29th	0,014	0,257	0,021	0,381	0,078	0,117
30th	0,004	0,077	0,003	0,053	0,061	--
31th	0,007	0,133	0,018	0,330	0,073	0,109
32th	0,007	0,124	0,006	0,107	0,058	--
33th	0,003	0,050	0,004	0,077	0,068	0,102
34th	0,013	0,238	0,007	0,123	0,054	--
35th	0,005	0,090	0,009	0,164	0,064	0,096
36th	0,003	0,061	0,003	0,052	0,051	--
37th	0,006	0,113	0,007	0,131	0,061	0,091
38th	0,004	0,078	0,005	0,091	0,048	--
39th	0,005	0,094	0,003	0,048	0,058	0,087
40th	0,005	0,094	0,007	0,118	0,046	0,046

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

Extract from test report according to the Engineering Recommendation G99 **Nr. 19TH0374-Hybrid-G2_G99-1_0**

Power Quality. Harmonics.

PLENTICORE plus 5.5, Phase 2

Generating Unit rating per phase (rpp)						
	At 45 - 55 % of rated output 918 W		100 % of rated output 1826 W			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-2 in Amps	
					1 phase	3 phase
2nd	0,017	0,298	0,015	0,279	1,080	--
3rd	0,017	0,305	0,015	0,270	2,300	--
4th	0,018	0,320	0,017	0,306	0,430	--
5th	0,020	0,353	0,058	1,045	1,140	--
6th	0,016	0,295	0,009	0,163	0,300	--
7th	0,017	0,303	0,047	0,855	0,770	--
8th	0,013	0,234	0,025	0,459	0,230	--
9th	0,015	0,263	0,007	0,129	0,400	--
10th	0,011	0,203	0,013	0,235	0,184	--
11th	0,053	0,953	0,015	0,266	0,330	--
12th	0,019	0,348	0,008	0,152	0,153	--
13th	0,027	0,480	0,010	0,176	0,210	--
14th	0,032	0,572	0,030	0,549	0,131	--
15th	0,018	0,321	0,014	0,259	0,150	--
16th	0,017	0,309	0,024	0,435	0,115	--
17th	0,032	0,573	0,049	0,882	0,132	--
18th	0,026	0,462	0,021	0,373	0,102	--
19th	0,040	0,714	0,029	0,523	0,118	--
20th	0,058	1,056	0,032	0,581	0,092	--
21th	0,024	0,442	0,014	0,259	0,107	0,160
22th	0,019	0,341	0,027	0,479	0,084	--
23th	0,014	0,261	0,025	0,458	0,098	0,147
24th	0,011	0,207	0,011	0,195	0,077	--
25th	0,019	0,348	0,037	0,666	0,090	0,135
26th	0,015	0,263	0,013	0,227	0,071	--
27th	0,006	0,115	0,008	0,147	0,083	0,124
28th	0,019	0,348	0,006	0,105	0,066	--
29th	0,015	0,269	0,020	0,356	0,078	0,117
30th	0,004	0,067	0,003	0,050	0,061	--
31th	0,003	0,059	0,020	0,356	0,073	0,109
32th	0,004	0,075	0,007	0,133	0,058	--
33th	0,003	0,059	0,004	0,069	0,068	0,102
34th	0,012	0,215	0,007	0,119	0,054	--
35th	0,005	0,097	0,013	0,226	0,064	0,096
36th	0,003	0,063	0,002	0,038	0,051	--
37th	0,004	0,066	0,008	0,144	0,061	0,091
38th	0,003	0,055	0,005	0,094	0,048	--
39th	0,004	0,072	0,002	0,044	0,058	0,087
40th	0,004	0,072	0,005	0,089	0,046	0,046

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

Extract from test report according to the Engineering Recommendation G99 **Nr. 19TH0374-Hybrid-G2_G99-1_0**

Power Quality. Harmonics.

PLENTICORE plus 5.5, Phase 3

Generating Unit rating per phase (rpp)						
	At 45 - 55 % of rated output 919 W		100 % of rated output 1819 W			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-2 in Amps	
					1 phase	3 phase
2nd	0,038	0,691	0,027	0,487	1,080	--
3rd	0,029	0,517	0,025	0,450	2,300	--
4th	0,026	0,477	0,024	0,438	0,430	--
5th	0,013	0,240	0,070	1,266	1,140	--
6th	0,032	0,574	0,005	0,094	0,300	--
7th	0,034	0,609	0,045	0,818	0,770	--
8th	0,013	0,242	0,022	0,405	0,230	--
9th	0,008	0,147	0,006	0,100	0,400	--
10th	0,007	0,131	0,016	0,285	0,184	--
11th	0,044	0,803	0,013	0,238	0,330	--
12th	0,009	0,168	0,007	0,127	0,153	--
13th	0,045	0,811	0,018	0,328	0,210	--
14th	0,040	0,727	0,035	0,625	0,131	--
15th	0,033	0,606	0,009	0,156	0,150	--
16th	0,029	0,526	0,018	0,335	0,115	--
17th	0,035	0,625	0,049	0,895	0,132	--
18th	0,041	0,741	0,012	0,208	0,102	--
19th	0,040	0,733	0,041	0,742	0,118	--
20th	0,034	0,614	0,024	0,431	0,092	--
21th	0,025	0,460	0,015	0,278	0,107	0,160
22th	0,040	0,718	0,041	0,739	0,084	--
23th	0,015	0,280	0,012	0,222	0,098	0,147
24th	0,013	0,227	0,008	0,146	0,077	--
25th	0,027	0,491	0,052	0,938	0,090	0,135
26th	0,018	0,321	0,009	0,166	0,071	--
27th	0,006	0,107	0,003	0,061	0,083	0,124
28th	0,016	0,286	0,006	0,111	0,066	--
29th	0,008	0,150	0,014	0,261	0,078	0,117
30th	0,005	0,085	0,003	0,056	0,061	--
31th	0,006	0,100	0,022	0,403	0,073	0,109
32th	0,007	0,126	0,009	0,165	0,058	--
33th	0,005	0,082	0,004	0,067	0,068	0,102
34th	0,009	0,157	0,006	0,105	0,054	--
35th	0,002	0,045	0,009	0,166	0,064	0,096
36th	0,003	0,056	0,003	0,047	0,051	--
37th	0,009	0,157	0,008	0,151	0,061	0,091
38th	0,004	0,077	0,004	0,074	0,048	--
39th	0,004	0,068	0,002	0,040	0,058	0,087
40th	0,003	0,052	0,006	0,109	0,046	0,046

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

Extract from test report according to the Engineering Recommendation G99 **Nr. 19TH0374-Hybrid-G2_G99-1_0**

Power Quality. Power factor.				
PLENTICORE plus 10 G2				
Output power	216,2 V	230,0 V	253,0 V	
20%	0,999	0,999	0,999	Measured at three voltage levels and at full output. Voltage to be maintained within ± 1,5 % of the stated level during the test.
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	216,2 V	230,0 V	253,0 V	
20%	0,999	0,999	0,999	Measured at three voltage levels and at full output. Voltage to be maintained within ± 1,5 % of the stated level during the test.
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-Hybrid-G2_G99-1_0**

Power Quality. Voltage fluctuation and Flicker.

PLENTICORE plus 10 G2

	Starting			Stopping			Running	
	d_{max} [%]	d_c [%]	$d_{(t)}$ [ms]	d_{max} [%]	d_c [%]	$d_{(t)}$ [ms]	P_{st}	P_{lt} 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	X_l	0,15	Ω
	Z	0,28	Ω			
Standard impedance	R	0,24	Ω	X_l	0,15	Ω
	Z	0,28	Ω			
Maximum impedance	R	0,93	Ω	X_l	0,58	Ω
	Z_{max}	1,10	Ω			

PLENTICORE plus 5.5

	Starting			Stopping			Running	
	d_{max} [%]	d_c [%]	$d_{(t)}$ [ms]	d_{max} [%]	d_c [%]	$d_{(t)}$ [ms]	P_{st}	P_{lt} 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	0,499
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	X_l	0,15	Ω
	Z	0,28	Ω			
Standard impedance	R	0,24	Ω	X_l	0,15	Ω
	Z	0,28	Ω			
Maximum impedance	R	0,93	Ω	X_l	0,58	Ω
	Z_{max}	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-Hybrid-G2_G99-1_0**

Power Quality. DC injection.			
PLENTICORE plus 10 G2			
Phase 1			
Test level power [%]	10	55	100
Recorded value [mA]	- 18,19	- 7,29	- 28,08
Recorded value [%]	0,11	0,05	0,18
Limit [%]	0,25	0,25	0,25
Phase 2			
Test level power [%]	10	55	100
Recorded value [mA]	9,42	9,67	21,64
Recorded value [%]	0,06	0,00	0,13
Limit [%]	0,25	0,25	0,25
Phase 3			
Test level power [%]	10	55	100
Recorded value [mA]	- 31,44	- 26,99	- 26,79
Recorded value [%]	0,20	0,17	0,17
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-Hybrid-G2_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	20 ms	8,6	4,17
Initial Value of aperiodic current	A	N/A	100 ms	7,3	1,96
Initial symmetrical short-circuit current*	I_k	N/A	250 ms	7,1	1,25
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500 ms	7,0	0,89
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to Trip [s]**	1,472	

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	20 ms	8,3	2,93
Initial Value of aperiodic current	A	N/A	100 ms	7,8	1,40
Initial symmetrical short-circuit current*	I_k	N/A	250 ms	7,5	0,90
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500 ms	7,2	0,64
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to Trip [s]**	1,472	

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	20 ms	8,5	5,40
Initial Value of aperiodic current	A	N/A	100 ms	7,8	2,43
Initial symmetrical short-circuit current*	I_k	N/A	250 ms	7,4	1,56
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500 ms	7,2	1,11
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to Trip [s]**	1,472	

For rotating machines and linear piston machines the test should produce a 0 s – 2 s 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.

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules	
Extract from test report according to the Engineering Recommendation G99	**Nr. 19TH0374-Hybrid-G2_G99-1_0**

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).	

Wiring functional tests if required by para. 15.2.1	**N/A**
Type test of components wired correct together on site is part of the commissioning test.	N/A

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