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Certificate of compliance

Applicant: Zucchetti Centro Sistemi SpA
Via Lungarno 305/A
52028 Terranuova Bracciolini (AR)
Italy

Product: Photovoltaic (PV) inverter

Model: AZZURRO 3PH 15000TL-V3
AZZURRO 3PH 17000TL-V3
AZZURRO 3PH 20000TL-V3
AZZURRO 3PH 22000TL-V3
AZZURRO 3PH 24000TL-V3

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: 21TH0192-G99-1_ZCS_0

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

Certificate number: U22-0144

Date of issue: 2022-03-09

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



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Annex to the G99/1 certificate of compliance No. U22-0144

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

Extract from test report according to the Engineering Recommendation G99

Nr. 21TH0192-G99-1_ZCS_0

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

PGM Technology:	Photovoltaic Inverter		
Manufacturer / applicant:	Shenzhen SOFARSOLAR Co., Ltd.		
Address:	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China		
Telephone:	+86-510-66902301	Fax:	---
Email:	info@sofarsolar.com	Website:	www.sofarsolar.com

Rated values	AZZURRO 3PH 15000TL-V3	AZZURRO 3PH 17000TL-V3	AZZURRO 3PH 20000TL-V3	AZZURRO 3PH 22000TL-V3	AZZURRO 3PH 24000TL-V3
MPP DC voltage range [V]	140-1000Vd.c.				
Input DC voltage range [V]	Max. 1000Vd.c.				
Input DC current [A]	Max. 26,0A / 26,0A				
Output AC voltage [V]	3/N/PE, 380 / 400Va.c., 50/60Hz				
Output AC current [A]	3 * 23,9	3 * 27,1	3 * 31,9	3 * 35,1	3 * 38,3
Output power [kVA]	16,5	18,7	22,0	24,2	26,4

Firmware version	V010000
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Measurement period:	2020-05-11 - 2021-01-10
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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 Generating Units:
 The models AZZURRO 3PH 15000TL-V3, AZZURRO 3PH 17000TL-V3, AZZURRO 3PH 20000TL-V3, AZZURRO 3PH 22000TL-V3 and AZZURRO 3PH 24000TL-V3 differ in size of the performance-related components (Sine filter, EMC filter, power semiconductor, machine transformer).

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. 21TH0192-G99-1_ZCS_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:	
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



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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	183,4	2,602	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	263,3	1,102	258,2V / 5,0s	No trip
O/V stage 2	273,7	0,5	275,3	0,608	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	183,3	2,622	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	263,2	1,110	258,2V / 5,0s	No trip
O/V stage 2	273,7	0,5	275,2	0,614	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

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

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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	183,6	2,602	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	263,5	1,114	258,2V / 5,0s	No trip
O/V stage 2	273,7	0,5	275,6	0,616	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	47,48	20,10	47,7Hz / 30s	No trip
U/F stage 2	47	0,5	46,90	0,614	47,2Hz / 19,5s	No trip
					46,8Hz / 0,45s	No trip
O/F stage 2	52	0,5	52,00	0,628	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.



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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]	0,411	0,413	0,379	0,414	0,474	0,469
Trip time. Ph2 fuse removed [s]	0,411	0,413	0,379	0,414	0,474	0,469
Trip time. Ph3 fuse removed [s]	0,411	0,413	0,379	0,414	0,474	0,469

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

20s

Measured delay

88s

Under Voltage

Time delay setting

20s

Measured delay

88s

Over Frequency

Time delay setting

20s

Measured delay

88s

Under Frequency

Time delay setting

20s

Measured delay

88s

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	50,45	50,70	51,15	50,70	50,45	50,00
P _{expected} [kW]:	N/A	23,782	22,581	20,419	22,581	23,782	N/A
P _{measured} [kW]:	24,022	23,770	22,580	20,413	22,580	23,772	24,019
2. Measurement a) to g): Active power output 40% and 60% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
P _{expected} [kW]:	N/A	11,909	11,307	10,225	11,307	11,909	N/A
P _{measured} [kW]:	12,029	11,850	11,253	10,170	11,253	11,850	12,029

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]:	24,0	24,0	24,0	24,0	24,0	24,0
$\Delta P/P_{max}$ [%]:		0	0	0	0	0

Note.

Electronic inverter no power reduction take place.



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Power Quality. Harmonics.

AZZURRO 3PH 15000TL-V3 - Phase 1

Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 2,523 kW		100% of rated output 5,011 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	0,015	0,137	0,026	0,237	8%	8%
3rd	0,044	0,402	0,105	0,958	21,6%	N/A
4th	0,011	0,100	0,013	0,119	4%	4%
5th	0,076	0,694	0,232	2,118	10,7%	10,7%
6th	0,005	0,046	0,008	0,073	2,67%	2,67%
7th	0,056	0,511	0,184	1,680	7,2%	7,2%
8th	0,004	0,037	0,006	0,055	2%	2%
9th	0,012	0,110	0,016	0,146	3,8%	N/A
10th	0,003	0,027	0,005	0,046	1,6%	1,6%
11th	0,034	0,310	0,089	0,812	3,1%	3,1%
12th	0,002	0,018	0,004	0,037	1,33%	1,33%
13th	0,025	0,228	0,019	0,173	2%	2%
14th	0,002	0,018	0,004	0,037	N/A	N/A
15th	0,005	0,046	0,024	0,219	N/A	N/A
16th	0,002	0,018	0,003	0,027	N/A	N/A
17th	0,016	0,146	0,047	0,429	N/A	N/A
18th	0,002	0,018	0,004	0,037	N/A	N/A
19th	0,010	0,091	0,065	0,593	N/A	N/A
20th	0,002	0,018	0,004	0,037	N/A	N/A
21th	0,007	0,064	0,009	0,082	N/A	N/A
22th	0,002	0,018	0,004	0,037	N/A	N/A
23th	0,014	0,128	0,019	0,173	N/A	N/A
24th	0,002	0,018	0,005	0,046	N/A	N/A
25th	0,009	0,082	0,041	0,374	N/A	N/A
26th	0,002	0,018	0,004	0,037	N/A	N/A
27th	0,005	0,046	0,009	0,082	N/A	N/A
28th	0,002	0,018	0,004	0,037	N/A	N/A
29th	0,012	0,110	0,036	0,329	N/A	N/A
30th	0,002	0,018	0,004	0,037	N/A	N/A
31th	0,009	0,082	0,046	0,420	N/A	N/A
32th	0,002	0,018	0,004	0,037	N/A	N/A
33th	0,002	0,018	0,007	0,064	N/A	N/A
34th	0,002	0,018	0,003	0,027	N/A	N/A
35th	0,011	0,100	0,043	0,393	N/A	N/A
36th	0,001	0,009	0,004	0,037	N/A	N/A
37th	0,016	0,146	0,030	0,274	N/A	N/A
38th	0,002	0,018	0,003	0,027	N/A	N/A
39th	0,003	0,027	0,005	0,046	N/A	N/A
40th	0,002	0,018	0,004	0,037	N/A	N/A
THD ₄₀ [%]	1,125		3,253		23%	13%
PWHD [%]	2,325		6,619		23%	22%



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Power Quality. Harmonics.

AZZURRO 3PH 15000TL-V3 - Phase 2

Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 2,525 kW		100% of rated output 5,020 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	0,010	0,091	0,016	0,146	8%	8%
3rd	0,009	0,082	0,032	0,292	21,6%	N/A
4th	0,007	0,064	0,009	0,082	4%	4%
5th	0,064	0,584	0,215	1,963	10,7%	10,7%
6th	0,005	0,046	0,006	0,055	2,67%	2,67%
7th	0,052	0,475	0,167	1,524	7,2%	7,2%
8th	0,003	0,027	0,004	0,037	2%	2%
9th	0,003	0,027	0,010	0,091	3,8%	N/A
10th	0,003	0,027	0,004	0,037	1,6%	1,6%
11th	0,030	0,274	0,080	0,730	3,1%	3,1%
12th	0,002	0,018	0,003	0,027	1,33%	1,33%
13th	0,024	0,219	0,026	0,237	2%	2%
14th	0,002	0,018	0,004	0,037	N/A	N/A
15th	0,003	0,027	0,015	0,137	N/A	N/A
16th	0,002	0,018	0,003	0,027	N/A	N/A
17th	0,016	0,146	0,060	0,548	N/A	N/A
18th	0,002	0,018	0,003	0,027	N/A	N/A
19th	0,009	0,082	0,072	0,657	N/A	N/A
20th	0,002	0,018	0,003	0,027	N/A	N/A
21th	0,003	0,027	0,011	0,100	N/A	N/A
22th	0,002	0,018	0,003	0,027	N/A	N/A
23th	0,014	0,128	0,024	0,219	N/A	N/A
24th	0,002	0,018	0,004	0,037	N/A	N/A
25th	0,009	0,082	0,051	0,466	N/A	N/A
26th	0,002	0,018	0,004	0,037	N/A	N/A
27th	0,004	0,037	0,011	0,100	N/A	N/A
28th	0,002	0,018	0,003	0,027	N/A	N/A
29th	0,013	0,119	0,038	0,347	N/A	N/A
30th	0,002	0,018	0,003	0,027	N/A	N/A
31th	0,012	0,110	0,059	0,539	N/A	N/A
32th	0,001	0,009	0,003	0,027	N/A	N/A
33th	0,003	0,027	0,005	0,046	N/A	N/A
34th	0,001	0,009	0,003	0,027	N/A	N/A
35th	0,011	0,100	0,039	0,356	N/A	N/A
36th	0,002	0,018	0,003	0,027	N/A	N/A
37th	0,017	0,155	0,032	0,292	N/A	N/A
38th	0,001	0,009	0,003	0,027	N/A	N/A
39th	0,003	0,027	0,006	0,055	N/A	N/A
40th	0,001	0,009	0,003	0,027	N/A	N/A
THD ₄₀ [%]	0,943		2,967		23%	13%
PWHD [%]	2,415		7,180		23%	22%



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Power Quality. Harmonics.

AZZURRO 3PH 15000TL-V3 - Phase 3

Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 2,527 kW		100% of rated output 5,023 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	0,009	0,082	0,017	0,155	8%	8%
3rd	0,052	0,475	0,085	0,776	21,6%	N/A
4th	0,005	0,046	0,006	0,055	4%	4%
5th	0,054	0,493	0,225	2,054	10,7%	10,7%
6th	0,003	0,027	0,005	0,046	2,67%	2,67%
7th	0,039	0,356	0,171	1,561	7,2%	7,2%
8th	0,003	0,027	0,004	0,037	2%	2%
9th	0,017	0,155	0,023	0,210	3,8%	N/A
10th	0,002	0,018	0,004	0,037	1,6%	1,6%
11th	0,028	0,256	0,049	0,447	3,1%	3,1%
12th	0,002	0,018	0,003	0,027	1,33%	1,33%
13th	0,021	0,192	0,031	0,283	2%	2%
14th	0,002	0,018	0,004	0,037	N/A	N/A
15th	0,006	0,055	0,010	0,091	N/A	N/A
16th	0,002	0,018	0,003	0,027	N/A	N/A
17th	0,015	0,137	0,068	0,621	N/A	N/A
18th	0,002	0,018	0,003	0,027	N/A	N/A
19th	0,010	0,091	0,078	0,712	N/A	N/A
20th	0,002	0,018	0,003	0,027	N/A	N/A
21th	0,003	0,027	0,006	0,055	N/A	N/A
22th	0,002	0,018	0,003	0,027	N/A	N/A
23th	0,013	0,119	0,021	0,192	N/A	N/A
24th	0,002	0,018	0,004	0,037	N/A	N/A
25th	0,008	0,073	0,048	0,438	N/A	N/A
26th	0,002	0,018	0,005	0,046	N/A	N/A
27th	0,004	0,037	0,006	0,055	N/A	N/A
28th	0,002	0,018	0,003	0,027	N/A	N/A
29th	0,011	0,100	0,031	0,283	N/A	N/A
30th	0,002	0,018	0,004	0,037	N/A	N/A
31th	0,012	0,110	0,054	0,493	N/A	N/A
32th	0,002	0,018	0,003	0,027	N/A	N/A
33th	0,003	0,027	0,005	0,046	N/A	N/A
34th	0,002	0,018	0,003	0,027	N/A	N/A
35th	0,010	0,091	0,038	0,347	N/A	N/A
36th	0,002	0,018	0,003	0,027	N/A	N/A
37th	0,017	0,155	0,031	0,283	N/A	N/A
38th	0,002	0,018	0,003	0,027	N/A	N/A
39th	0,003	0,027	0,007	0,064	N/A	N/A
40th	0,002	0,018	0,003	0,027	N/A	N/A
THD ₄₀ [%]	0,951		3,086		23%	13%
PWHD [%]	2,395		7,064		23%	22%



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Power Quality. Harmonics.

AZZURRO 3PH 24000TL-V3 - Phase 1

Generating Unit rating per phase (rpp)						
At 45-55% of rated output 4,037 kW		100% of rated output 8,015 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	0,024	0,137	0,042	0,240	8%	8%
3rd	0,071	0,405	0,168	0,958	21,6%	N/A
4th	0,017	0,097	0,021	0,120	4%	4%
5th	0,122	0,696	0,368	2,099	10,7%	10,7%
6th	0,009	0,051	0,013	0,074	2,67%	2,67%
7th	0,090	0,513	0,294	1,677	7,2%	7,2%
8th	0,006	0,034	0,009	0,051	2%	2%
9th	0,019	0,108	0,025	0,143	3,8%	N/A
10th	0,005	0,029	0,007	0,040	1,6%	1,6%
11th	0,055	0,314	0,142	0,810	3,1%	3,1%
12th	0,005	0,029	0,006	0,034	1,33%	1,33%
13th	0,041	0,234	0,031	0,177	2%	2%
14th	0,004	0,023	0,007	0,040	N/A	N/A
15th	0,006	0,034	0,040	0,228	N/A	N/A
16th	0,003	0,017	0,005	0,029	N/A	N/A
17th	0,026	0,148	0,075	0,428	N/A	N/A
18th	0,003	0,017	0,005	0,029	N/A	N/A
19th	0,016	0,091	0,102	0,582	N/A	N/A
20th	0,004	0,023	0,006	0,034	N/A	N/A
21th	0,011	0,063	0,014	0,080	N/A	N/A
22th	0,003	0,017	0,005	0,029	N/A	N/A
23th	0,022	0,126	0,030	0,171	N/A	N/A
24th	0,004	0,023	0,007	0,040	N/A	N/A
25th	0,014	0,080	0,065	0,371	N/A	N/A
26th	0,004	0,023	0,008	0,046	N/A	N/A
27th	0,009	0,051	0,015	0,086	N/A	N/A
28th	0,003	0,017	0,006	0,034	N/A	N/A
29th	0,020	0,114	0,057	0,325	N/A	N/A
30th	0,003	0,017	0,007	0,040	N/A	N/A
31th	0,015	0,086	0,074	0,422	N/A	N/A
32th	0,003	0,017	0,006	0,034	N/A	N/A
33th	0,004	0,023	0,011	0,063	N/A	N/A
34th	0,003	0,017	0,005	0,029	N/A	N/A
35th	0,018	0,103	0,069	0,394	N/A	N/A
36th	0,003	0,017	0,005	0,029	N/A	N/A
37th	0,026	0,148	0,048	0,274	N/A	N/A
38th	0,003	0,017	0,005	0,029	N/A	N/A
39th	0,006	0,034	0,008	0,046	N/A	N/A
40th	0,003	0,017	0,006	0,034	N/A	N/A
THD ₄₀ [%]	1,134		3,236		23%	13%
PWHD [%]	2,388		6,595		23%	22%



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

Extract from test report according to the Engineering Recommendation G99

Nr. 21TH0192-G99-1_ZCS_0

Power Quality. Harmonics.

AZZURRO 3PH 24000TL-V3 - Phase 2

Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 4,040 kW		100% of rated output 8,029 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	0,016	0,091	0,025	0,143	8%	8%
3rd	0,015	0,086	0,052	0,297	21,6%	N/A
4th	0,011	0,063	0,014	0,080	4%	4%
5th	0,103	0,588	0,342	1,951	10,7%	10,7%
6th	0,008	0,046	0,009	0,051	2,67%	2,67%
7th	0,083	0,474	0,266	1,517	7,2%	7,2%
8th	0,005	0,029	0,006	0,034	2%	2%
9th	0,005	0,029	0,017	0,097	3,8%	N/A
10th	0,005	0,029	0,005	0,029	1,6%	1,6%
11th	0,048	0,274	0,127	0,725	3,1%	3,1%
12th	0,004	0,023	0,005	0,029	1,33%	1,33%
13th	0,038	0,217	0,043	0,245	2%	2%
14th	0,004	0,023	0,006	0,034	N/A	N/A
15th	0,005	0,029	0,025	0,143	N/A	N/A
16th	0,003	0,017	0,005	0,029	N/A	N/A
17th	0,026	0,148	0,095	0,542	N/A	N/A
18th	0,003	0,017	0,004	0,023	N/A	N/A
19th	0,014	0,080	0,114	0,650	N/A	N/A
20th	0,003	0,017	0,005	0,029	N/A	N/A
21th	0,005	0,029	0,017	0,097	N/A	N/A
22th	0,003	0,017	0,004	0,023	N/A	N/A
23th	0,022	0,126	0,038	0,217	N/A	N/A
24th	0,004	0,023	0,007	0,040	N/A	N/A
25th	0,014	0,080	0,081	0,462	N/A	N/A
26th	0,004	0,023	0,007	0,040	N/A	N/A
27th	0,006	0,034	0,018	0,103	N/A	N/A
28th	0,003	0,017	0,005	0,029	N/A	N/A
29th	0,021	0,120	0,061	0,348	N/A	N/A
30th	0,003	0,017	0,006	0,034	N/A	N/A
31th	0,020	0,114	0,094	0,536	N/A	N/A
32th	0,002	0,011	0,004	0,023	N/A	N/A
33th	0,005	0,029	0,008	0,046	N/A	N/A
34th	0,002	0,011	0,005	0,029	N/A	N/A
35th	0,017	0,097	0,063	0,359	N/A	N/A
36th	0,003	0,017	0,005	0,029	N/A	N/A
37th	0,027	0,154	0,052	0,297	N/A	N/A
38th	0,002	0,011	0,004	0,023	N/A	N/A
39th	0,004	0,023	0,009	0,051	N/A	N/A
40th	0,003	0,017	0,005	0,029	N/A	N/A
THD ₄₀ [%]	0,946		2,953		23%	13%
PWHD [%]	2,432		7,168		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. 21TH0192-G99-1_ZCS_0

Power Quality. Harmonics.

AZZURRO 3PH 24000TL-V3 - Phase 3

Generating Unit rating per phase (rpp)						
At 45-55% of rated output 4,041 kW		100% of rated output 8,036 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	0,016	0,091	0,030	0,171	8%	8%
3rd	0,084	0,479	0,136	0,776	21,6%	N/A
4th	0,008	0,046	0,010	0,057	4%	4%
5th	0,086	0,491	0,357	2,037	10,7%	10,7%
6th	0,005	0,029	0,008	0,046	2,67%	2,67%
7th	0,063	0,359	0,273	1,557	7,2%	7,2%
8th	0,005	0,029	0,006	0,034	2%	2%
9th	0,027	0,154	0,037	0,211	3,8%	N/A
10th	0,004	0,023	0,006	0,034	1,6%	1,6%
11th	0,045	0,257	0,078	0,445	3,1%	3,1%
12th	0,004	0,023	0,005	0,029	1,33%	1,33%
13th	0,033	0,188	0,049	0,280	2%	2%
14th	0,004	0,023	0,006	0,034	N/A	N/A
15th	0,009	0,051	0,016	0,091	N/A	N/A
16th	0,004	0,023	0,005	0,029	N/A	N/A
17th	0,024	0,137	0,108	0,616	N/A	N/A
18th	0,003	0,017	0,005	0,029	N/A	N/A
19th	0,016	0,091	0,124	0,707	N/A	N/A
20th	0,003	0,017	0,005	0,029	N/A	N/A
21th	0,005	0,029	0,009	0,051	N/A	N/A
22th	0,004	0,023	0,005	0,029	N/A	N/A
23th	0,021	0,120	0,033	0,188	N/A	N/A
24th	0,004	0,023	0,007	0,040	N/A	N/A
25th	0,013	0,074	0,076	0,434	N/A	N/A
26th	0,004	0,023	0,008	0,046	N/A	N/A
27th	0,006	0,034	0,009	0,051	N/A	N/A
28th	0,003	0,017	0,006	0,034	N/A	N/A
29th	0,017	0,097	0,050	0,285	N/A	N/A
30th	0,003	0,017	0,006	0,034	N/A	N/A
31th	0,020	0,114	0,086	0,491	N/A	N/A
32th	0,003	0,017	0,005	0,029	N/A	N/A
33th	0,005	0,029	0,008	0,046	N/A	N/A
34th	0,003	0,017	0,005	0,029	N/A	N/A
35th	0,015	0,086	0,060	0,342	N/A	N/A
36th	0,003	0,017	0,005	0,029	N/A	N/A
37th	0,028	0,160	0,050	0,285	N/A	N/A
38th	0,003	0,017	0,005	0,029	N/A	N/A
39th	0,005	0,029	0,010	0,057	N/A	N/A
40th	0,003	0,017	0,005	0,029	N/A	N/A
THD ₄₀ [%]	0,957		3,070		23%	13%
PWHD [%]	2,461		7,044		23%	22%



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

Extract from test report according to the Engineering Recommendation G99

Nr. 21TH0192-G99-1_ZCS_0

Power Quality. Power factor.				
AZZURRO 3PH 15000TL-V3				
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%	0,996	0,996	0,995	
50%	0,999	0,999	0,998	
75%	0,999	0,999	0,999	
100%	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	
AZZURRO 3PH 24000TL-V3				
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%	0,996	0,996	0,995	
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.								
AZZURRO 3PH 15000TL-V3								
	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured values at test impedance	0,188	0,087	--	0,154	0,099	--	0,058	0,053
Measured values at standard impedance	0,188	0,087	--	0,154	0,099	--	0,058	0,053
Values for maximum impedance	2,304	1,067	--	1,888	1,214	--	0,711	0,650
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	2,94	Ω	XI	1,84	Ω		
	Zmax	3,47	Ω					



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Power Quality. Voltage fluctuation and Flicker.

AZZURRO 3PH 24000TL-V3

	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured values at test impedance	0,159	0,114	--	0,090	0,144	--	0,044	0,032
Measured values at standard impedance	0,159	0,114	--	0,090	0,144	--	0,044	0,032
Values for maximum impedance	3,229	2,315	--	1,828	2,925	--	0,894	0,650
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	4,87	Ω	XI	3,05	Ω		
	Zmax	5,750	Ω					

Power Quality. DC injection.

AZZURRO 3PH 15000TL-V3

Test level power [%]	10			55			100		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
Recorded value [mA]	27,8	9,2	0,13	19,4	5,8	25,0	-10,9	0,5	24,1
Recorded value [%]	0,13	0,04	0,07	0,09	0,03	0,12	-0,05	0,00	0,11
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.

AZZURRO 3PH 24000TL-V3

Test level power [%]	10			55			100		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
Recorded value [mA]	23,5	5,7	23,5	18,5	6,0	24,5	-10,3	2,1	23,6
Recorded value [%]	0,07	0,02	0,07	0,02	0,07	0,05	0,03	0,01	0,07
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.



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Fault level Contribution.

AZZURRO 3PH 24000TL-V3 – 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	42,4	28,8
Initial Value of aperiodic current	A	N/A	100ms	37,1	13,7
Initial symmetrical short-circuit current*	I_k	N/A	250ms	38,2	9,80
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	34,9	7,75
Reactance/Resistance Ratio of source*	X/R	N/A	Time to Trip [s]	0,013	

AZZURRO 3PH 24000TL-V3 – 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	30,2	24,4
Initial Value of aperiodic current	A	N/A	100ms	28,9	11,8
Initial symmetrical short-circuit current*	I_k	N/A	250ms	29,2	8,35
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	29,1	6,91
Reactance/Resistance Ratio of source*	X/R	N/A	Time to Trip [s]	0,011	

AZZURRO 3PH 24000TL-V3 – 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	44,0	37,1
Initial Value of aperiodic current	A	N/A	100ms	62,7	36,0
Initial symmetrical short-circuit current*	I_k	N/A	250ms	38,8	37,4
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	33,1	26,3
Reactance/Resistance Ratio of source*	X/R	N/A	Time to Trip [s]	0,124	

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.



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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