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Certificate of compliance

Applicant: SMA Solar Technology AG
Sonnenallee 1
34266 Niestetal
Germany

Product: Grid-tied photovoltaic (PV) inverter and battery inverter

Model: PV: SHP 75-10
STP 60-10
Battery: STPS60-10

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 that can access the distribution network provider at any time.

Applied rules and standards:

Engineering Recommendation G99/1-3:2018

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: 14TH0075-G99/1-3_2
Certificate number: U19-0368
Date of issue: 2019-06-17

Certification body



Holger Schaffer

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

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

Extract from test report according to the Engineering Recommendation G99

Nr. 14TH0075-G99/1-3_2

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

PGM Technology	Photovoltaic and battery inverter		
Manufacturer:	SMA Solar Technology AG		
Address:	Sonnenallee 1 34266 Niestetal Germany		
Tel	+49 5619522-0	Fax	+49 5619522-100
Email	info@SMA.de	Website	www.SMA.de

Generating Unit technology	Photovoltaic inverter		Battery inverter
Rated values	SHP 75-10	STP 60-10	STPS60-10
Maximum rated capacity	75 kW	60 kW	75 kW
Rated voltage	400V (3P + PE)	400V (3P + PE)	400V (3P + PE)
Firmware version	1.90	1.90	1.95
	Note. With a configuration file provided by the manufacturer with the appropriate settings.		
Measurement period:	2018-03-09 to 2018-05-14 2018-03-12 to 2018-08-05 2019-04-05 to 2019-04-10		

Description of the structure of the power generation unit:

The power generation unit is equipped with a DC 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. This enables a safe disconnection of the power generation unit from the network in case of an error.

Differences between Generating Units:

The models SHP 75-10, STP 60-10 and STPS60-10 are based on the same hardware platform and use the same control unit. The software is also based on the same platform for all units and differ only for the STPS60-10 related due to the battery use on DC side.

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. 14TH0075-G99/1-3_2

Operating Range.	
Test 1	Voltage = 85% of nominal (338,6 V) Frequency = 47 Hz Power Factor = 1 Period of test 20 s
Connection:	Always connected
Limit:	Always connected
Test 1	Voltage = 85% of nominal (338,6 V) Frequency = 47.5 Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 1	Voltage = 110% of nominal (438,2 V) Frequency = 51.5 Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 1	Voltage = 110% of nominal (438,2 V) Frequency = 52.0 Hz Power Factor = 1 Period of test 15 minutes
Connection:	Always connected
Limit:	Always connected

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Nr. 14TH0075-G99/1-3_2

Protection. Voltage tests.

Phase 1 to 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	318,7	2,5	318,7	2,534	325,6V / 3,5s	No trip
					311,8V / 2,48s	No trip
O/V stage 1	454,1	1,0	454,5	1,033	447,2V 2,0s	No trip
O/V stage 2	474,1	0,5	473,9	0,532	467,1V 0,98s	No trip
					481,0V / 0,48s	No trip

Phase 2 to 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	318,7	2,5	318,9	2,540	325,6V / 3,5s	No trip
					311,8V / 2,48s	No trip
O/V stage 1	454,1	1,0	454,2	1,054	447,2V 2,0s	No trip
O/V stage 2	474,1	0,5	473,8	0,554	467,1V 0,98s	No trip
					481,0V / 0,48s	No trip

Phase 3 to 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	318,7	2,5	318,7	2,524	325,6V / 3,5s	No trip
					311,8V / 2,48s	No trip
O/V stage 1	454,1	1,0	454,0	1,013	447,2V 2,0s	No trip
O/V stage 2	474,1	0,5	474,2	0,514	467,1V 0,98s	No trip
					481,0V / 0,48s	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. Inverter is a three phase inverter without neutral wire therefore the phase to phase voltages are applicable.

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

Extract from test report according to the Engineering Recommendation G99

Nr. 14TH0075-G99/1-3_2

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	20,04	47,7Hz / 25s	No trip
U/F stage 2	47	0,5	47,00	0,544	47,2Hz / 19,98s	No trip
					46,8Hz / 0,48s	No trip
O/F stage 2	52	0,5	52,00	0,542	51,8Hz / 89,98s	No trip
					52,2Hz / 0,48s	No trip

Note. For Frequency Trip tests the Frequency required to trip is the setting $\pm 0,1$ 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 $\pm 0,2$ Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

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]	0,416	0,396	0,496	0,426	0,416	0,466
Trip time. Ph2 fuse removed [s]	0,416	0,396	0,496	0,426	0,416	0,466
Trip time. Ph3 fuse removed [s]	0,416	0,396	0,496	0,426	0,416	0,466

Note. Trip time limit is 0,5s. For technologies which have a substantial shut down time this can be added to the 0,5s in establishing that the trip occurred in less than 0,5s maximum. Shut down time could therefore be up to 1,0s for these technologies.

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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 10.5.7.1.

Over Voltage	
Time delay setting	Measured delay
20s	21,16s
Under Voltage	
Time delay setting	Measured delay
20s	21,14s
Over Frequency	
Time delay setting	Measured delay
20s	21,37s
Under Frequency	
Time delay setting	Measured delay
20s	21,33s

	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 461,1V Ph-Ph (266,2V Ph-N)	At 339,7V Ph-Ph (180,0V Ph-N)	At 47,4Hz	At 52,1Hz
Confirmation that the Generating Unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

Note. Inverter is a three phase inverter without neutral wire therefore the phase to phase voltages are applicable.

Protection. Frequency change, Stability test.				
	Start Frequency [Hz]	Change	Test Duration	Confirm no trip
Positive Vector Shift	49,50	+50 degrees		No trip
Negative Vector Shift	50,50	-50 degrees		No trip
Positive Frequency drift	49,00 to 51,00	+0,95Hz/sec	2,1s	No trip
Negative Frequency drift	51,00 to 49,00	-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% Pn							
Frequency [Hz]:	50,00	50,45	50,70	51,14	50,70	50,45	50,00
PM [kW]:	N/A	74,75	67,08	53,52	67,08	74,75	N/A
PE60 [kW]:	76,20	74,15	66,39	53,13	66,15	74,04	76,18
Δ PE60/PM [%]:	N/A	-0,80	-0,92	-0,51	-1,24	-0,95	N/A
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% Pn							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
PM [kW]:	N/A	37,80	33,92	27,05	33,92	37,80	N/A
PE60 [kW]:	38,53	37,75	33,95	27,05	33,75	37,80	38,54
Δ PE60/PM [%]:	N/A	-0,06	0,04	0,01	-0,22	0,01	N/A

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]:	76,20	76,20	76,20	76,20	76,20	0,00

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Extract from test report according to the Engineering Recommendation G99

Nr. 14TH0075-G99/1-3_2

Power Quality. Harmonics.						
SHP 75-10						
Phase 1						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 12,44 kW		100% of rated output 24,82 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	0,490	0,454	0,515	0,477	8%	8%
3rd	0,285	0,265	0,359	0,333	21,6%	N/A
4th	0,146	0,135	0,236	0,219	4%	4%
5th	0,120	0,111	0,218	0,202	10,7%	10,7%
6th	0,095	0,088	0,169	0,157	2,67%	2,67%
7th	0,106	0,099	0,208	0,193	7,2%	7,2%
8th	0,084	0,078	0,132	0,123	2%	2%
9th	0,132	0,123	0,227	0,210	3,8%	N/A
10th	0,034	0,032	0,067	0,062	1,6%	1,6%
11th	0,154	0,142	0,093	0,086	3,1%	3,1%
12th	0,032	0,029	0,069	0,064	1,33%	1,33%
13th	0,167	0,155	0,127	0,118	2%	2%
14th	0,023	0,021	0,035	0,032	N/A	N/A
15th	0,018	0,017	0,037	0,034	N/A	N/A
16th	0,030	0,027	0,051	0,047	N/A	N/A
17th	0,167	0,154	0,166	0,154	N/A	N/A
18th	0,015	0,014	0,026	0,024	N/A	N/A
19th	0,106	0,098	0,111	0,103	N/A	N/A
20th	0,014	0,013	0,023	0,022	N/A	N/A
21th	0,012	0,011	0,021	0,020	N/A	N/A
22th	0,010	0,010	0,019	0,017	N/A	N/A
23th	0,055	0,051	0,090	0,083	N/A	N/A
24th	0,012	0,011	0,022	0,021	N/A	N/A
25th	0,050	0,046	0,076	0,071	N/A	N/A
26th	0,008	0,008	0,015	0,014	N/A	N/A
27th	0,009	0,008	0,017	0,016	N/A	N/A
28th	0,011	0,011	0,019	0,017	N/A	N/A
29th	0,039	0,036	0,060	0,056	N/A	N/A
30th	0,011	0,010	0,018	0,017	N/A	N/A
31th	0,036	0,033	0,047	0,044	N/A	N/A
32th	0,016	0,015	0,023	0,022	N/A	N/A
33th	0,019	0,018	0,035	0,032	N/A	N/A
34th	0,019	0,018	0,034	0,032	N/A	N/A
35th	0,029	0,027	0,040	0,037	N/A	N/A
36th	0,009	0,009	0,020	0,018	N/A	N/A
37th	0,038	0,035	0,059	0,055	N/A	N/A
38th	0,041	0,038	0,061	0,056	N/A	N/A
39th	0,033	0,030	0,054	0,050	N/A	N/A
40th	0,038	0,035	0,062	0,058	N/A	N/A
THD ₄₀ [%]	1,33		0,81		23%	13%
PWHD [%]	0,004		0,001		23%	22%



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Annex to the G99/1 certificate of compliance No. U19-0368

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

Extract from test report according to the Engineering Recommendation G99 Nr. 14TH0075-G99/1-3_2

Power Quality. Harmonics.						
SHP 75-10						
Phase 2						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 12,45kW		100% of rated output 24,84kW			
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	0,532	0,493	0,671	0,622	8%	8%
3rd	0,228	0,211	0,225	0,208	21,6%	N/A
4th	0,157	0,146	0,169	0,157	4%	4%
5th	0,061	0,057	0,092	0,085	10,7%	10,7%
6th	0,060	0,055	0,129	0,120	2,67%	2,67%
7th	0,061	0,056	0,111	0,103	7,2%	7,2%
8th	0,049	0,046	0,071	0,066	2%	2%
9th	0,107	0,099	0,165	0,153	3,8%	N/A
10th	0,055	0,051	0,105	0,097	1,6%	1,6%
11th	0,159	0,147	0,151	0,140	3,1%	3,1%
12th	0,041	0,038	0,094	0,087	1,33%	1,33%
13th	0,177	0,164	0,155	0,143	2%	2%
14th	0,032	0,030	0,048	0,044	N/A	N/A
15th	0,024	0,022	0,038	0,035	N/A	N/A
16th	0,024	0,022	0,031	0,029	N/A	N/A
17th	0,177	0,164	0,174	0,161	N/A	N/A
18th	0,017	0,015	0,028	0,026	N/A	N/A
19th	0,119	0,110	0,120	0,111	N/A	N/A
20th	0,015	0,014	0,019	0,018	N/A	N/A
21th	0,011	0,010	0,017	0,016	N/A	N/A
22th	0,014	0,013	0,024	0,022	N/A	N/A
23th	0,054	0,050	0,090	0,084	N/A	N/A
24th	0,015	0,014	0,027	0,025	N/A	N/A
25th	0,050	0,047	0,077	0,071	N/A	N/A
26th	0,014	0,013	0,022	0,020	N/A	N/A
27th	0,012	0,011	0,020	0,018	N/A	N/A
28th	0,010	0,009	0,014	0,013	N/A	N/A
29th	0,040	0,037	0,060	0,055	N/A	N/A
30th	0,009	0,008	0,015	0,014	N/A	N/A
31th	0,037	0,034	0,051	0,047	N/A	N/A
32th	0,016	0,015	0,028	0,026	N/A	N/A
33th	0,028	0,026	0,048	0,045	N/A	N/A
34th	0,031	0,028	0,061	0,057	N/A	N/A
35th	0,040	0,037	0,060	0,056	N/A	N/A
36th	0,040	0,037	0,060	0,055	N/A	N/A
37th	0,030	0,027	0,044	0,041	N/A	N/A
38th	0,019	0,017	0,022	0,021	N/A	N/A
39th	0,018	0,017	0,030	0,027	N/A	N/A
40th	0,020	0,018	0,033	0,030	N/A	N/A
THD ₄₀ [%]	1,32		0,81		23%	13%
PWHD [%]	0,005		0,001		23%	22%



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Extract from test report according to the Engineering Recommendation G99

Nr. 14TH0075-G99/1-3_2

Power Quality. Harmonics.

SHP 75-10

Phase 3

Generating Unit rating per phase (rpp)		100% of rated output 24,84kW		Limit in BS EN61000-3-12 in %		
Harmonic	At 45-55% of rated output 12,45kW		100% of rated output 24,84kW		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	0,259	0,240	0,357	0,330	8%	8%
3rd	0,211	0,195	0,244	0,226	21,6%	N/A
4th	0,160	0,148	0,237	0,220	4%	4%
5th	0,089	0,083	0,163	0,151	10,7%	10,7%
6th	0,067	0,062	0,111	0,103	2,67%	2,67%
7th	0,069	0,064	0,109	0,101	7,2%	7,2%
8th	0,064	0,059	0,131	0,122	2%	2%
9th	0,065	0,060	0,161	0,150	3,8%	N/A
10th	0,046	0,042	0,102	0,094	1,6%	1,6%
11th	0,155	0,144	0,125	0,116	3,1%	3,1%
12th	0,040	0,037	0,063	0,058	1,33%	1,33%
13th	0,171	0,159	0,137	0,127	2%	2%
14th	0,024	0,022	0,037	0,035	N/A	N/A
15th	0,019	0,018	0,038	0,035	N/A	N/A
16th	0,023	0,021	0,037	0,034	N/A	N/A
17th	0,176	0,163	0,178	0,165	N/A	N/A
18th	0,019	0,018	0,034	0,032	N/A	N/A
19th	0,106	0,098	0,115	0,106	N/A	N/A
20th	0,012	0,011	0,019	0,017	N/A	N/A
21th	0,011	0,010	0,018	0,016	N/A	N/A
22th	0,013	0,012	0,021	0,020	N/A	N/A
23th	0,057	0,053	0,091	0,085	N/A	N/A
24th	0,013	0,012	0,021	0,019	N/A	N/A
25th	0,049	0,046	0,073	0,068	N/A	N/A
26th	0,013	0,012	0,021	0,020	N/A	N/A
27th	0,011	0,010	0,019	0,018	N/A	N/A
28th	0,010	0,009	0,015	0,014	N/A	N/A
29th	0,039	0,036	0,057	0,053	N/A	N/A
30th	0,010	0,009	0,015	0,014	N/A	N/A
31th	0,034	0,032	0,050	0,047	N/A	N/A
32th	0,012	0,011	0,022	0,020	N/A	N/A
33th	0,026	0,024	0,037	0,034	N/A	N/A
34th	0,027	0,025	0,045	0,042	N/A	N/A
35th	0,039	0,036	0,064	0,060	N/A	N/A
36th	0,037	0,034	0,063	0,058	N/A	N/A
37th	0,032	0,030	0,060	0,056	N/A	N/A
38th	0,024	0,022	0,043	0,040	N/A	N/A
39th	0,018	0,017	0,028	0,026	N/A	N/A
40th	0,021	0,020	0,033	0,031	N/A	N/A
THD ₄₀ [%]	0,98		0,64		23%	13%
PWHD [%]	0,005		0,001		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. 14TH0075-G99/1-3_2

Power Quality. Harmonics.

STPS60-10

Phase 1

Generating Unit rating per phase (rpp)		100% of rated output 24,82kW		Limit in BS EN61000-3-12 in %		
Harmonic	At 45-55% of rated output 12,44kW		100% of rated output 24,82kW		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	0,337	0,315	0,112	0,105	8%	8%
3rd	0,212	0,198	0,043	0,040	21,6%	N/A
4th	0,128	0,120	0,072	0,067	4%	4%
5th	0,156	0,146	0,062	0,058	10,7%	10,7%
6th	0,092	0,086	0,045	0,042	2,67%	2,67%
7th	0,098	0,091	0,044	0,041	7,2%	7,2%
8th	0,032	0,030	0,039	0,037	2%	2%
9th	0,041	0,039	0,159	0,149	3,8%	N/A
10th	0,061	0,057	0,050	0,047	1,6%	1,6%
11th	0,162	0,152	0,100	0,094	3,1%	3,1%
12th	0,026	0,024	0,034	0,032	1,33%	1,33%
13th	0,157	0,147	0,123	0,115	2%	2%
14th	0,027	0,025	0,028	0,026	N/A	N/A
15th	0,029	0,027	0,033	0,031	N/A	N/A
16th	0,029	0,028	0,043	0,040	N/A	N/A
17th	0,182	0,170	0,194	0,181	N/A	N/A
18th	0,014	0,013	0,024	0,022	N/A	N/A
19th	0,122	0,114	0,131	0,122	N/A	N/A
20th	0,014	0,013	0,021	0,019	N/A	N/A
21th	0,014	0,013	0,022	0,020	N/A	N/A
22th	0,013	0,012	0,013	0,012	N/A	N/A
23th	0,067	0,062	0,107	0,100	N/A	N/A
24th	0,010	0,009	0,014	0,013	N/A	N/A
25th	0,058	0,054	0,088	0,083	N/A	N/A
26th	0,015	0,014	0,013	0,012	N/A	N/A
27th	0,019	0,017	0,024	0,023	N/A	N/A
28th	0,009	0,009	0,013	0,012	N/A	N/A
29th	0,042	0,039	0,066	0,062	N/A	N/A
30th	0,013	0,012	0,013	0,012	N/A	N/A
31th	0,042	0,039	0,054	0,050	N/A	N/A
32th	0,021	0,019	0,022	0,021	N/A	N/A
33th	0,018	0,017	0,037	0,035	N/A	N/A
34th	0,012	0,011	0,036	0,033	N/A	N/A
35th	0,039	0,036	0,043	0,040	N/A	N/A
36th	0,036	0,034	0,017	0,016	N/A	N/A
37th	0,024	0,023	0,060	0,057	N/A	N/A
38th	0,008	0,008	0,067	0,063	N/A	N/A
39th	0,021	0,020	0,055	0,051	N/A	N/A
40th	0,027	0,025	0,065	0,061	N/A	N/A
THD ₄₀ [%]	1,079		0,500		23%	13%
PWHD [%]	0,005		0,002		23%	22%



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Annex to the G99/1 certificate of compliance No. U19-0368

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

Extract from test report according to the Engineering Recommendation G99

Nr. 14TH0075-G99/1-3_2

Power Quality. Harmonics.

STPS60-10

Phase 2

Generating Unit rating per phase (rpp)		100% of rated output 24,84kW		Limit in BS EN61000-3-12 in %		
Harmonic	At 45-55% of rated output 12,45kW		100% of rated output 24,84kW		1 phase	3 phase
	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]		
2nd	0,303	0,283	0,293	0,274	8%	8%
3rd	0,221	0,207	0,036	0,034	21,6%	N/A
4th	0,176	0,165	0,094	0,088	4%	4%
5th	0,113	0,106	0,046	0,043	10,7%	10,7%
6th	0,080	0,074	0,063	0,059	2,67%	2,67%
7th	0,064	0,059	0,029	0,027	7,2%	7,2%
8th	0,058	0,054	0,041	0,038	2%	2%
9th	0,066	0,062	0,176	0,165	3,8%	N/A
10th	0,041	0,038	0,061	0,057	1,6%	1,6%
11th	0,129	0,121	0,110	0,103	3,1%	3,1%
12th	0,066	0,062	0,038	0,036	1,33%	1,33%
13th	0,160	0,150	0,132	0,124	2%	2%
14th	0,042	0,039	0,036	0,033	N/A	N/A
15th	0,043	0,040	0,032	0,030	N/A	N/A
16th	0,023	0,021	0,028	0,027	N/A	N/A
17th	0,196	0,183	0,217	0,203	N/A	N/A
18th	0,019	0,017	0,022	0,021	N/A	N/A
19th	0,126	0,118	0,135	0,127	N/A	N/A
20th	0,017	0,016	0,017	0,016	N/A	N/A
21th	0,014	0,013	0,019	0,018	N/A	N/A
22th	0,020	0,019	0,019	0,018	N/A	N/A
23th	0,066	0,062	0,107	0,100	N/A	N/A
24th	0,022	0,021	0,017	0,016	N/A	N/A
25th	0,060	0,056	0,083	0,078	N/A	N/A
26th	0,013	0,012	0,011	0,011	N/A	N/A
27th	0,017	0,016	0,024	0,022	N/A	N/A
28th	0,010	0,009	0,013	0,012	N/A	N/A
29th	0,043	0,040	0,064	0,060	N/A	N/A
30th	0,012	0,012	0,013	0,012	N/A	N/A
31th	0,043	0,041	0,053	0,049	N/A	N/A
32th	0,029	0,027	0,031	0,029	N/A	N/A
33th	0,037	0,035	0,050	0,046	N/A	N/A
34th	0,043	0,040	0,064	0,060	N/A	N/A
35th	0,031	0,029	0,065	0,061	N/A	N/A
36th	0,024	0,022	0,066	0,061	N/A	N/A
37th	0,029	0,028	0,046	0,043	N/A	N/A
38th	0,021	0,019	0,027	0,025	N/A	N/A
39th	0,017	0,016	0,033	0,031	N/A	N/A
40th	0,015	0,014	0,034	0,032	N/A	N/A
THD ₄₀ [%]	1,056		0,502		23%	13%
PWHD [%]	0,006		0,002		23%	22%



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Annex to the G99/1 certificate of compliance No. U19-0368

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

Extract from test report according to the Engineering Recommendation G99

Nr. 14TH0075-G99/1-3_2

Power Quality. Harmonics.						
STPS60-10						
Phase 3						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 12,45kW		100% of rated output 24,84kW			
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	0,160	0,149	0,195	0,183	8%	8%
3rd	0,204	0,191	0,034	0,032	21,6%	N/A
4th	0,155	0,145	0,072	0,067	4%	4%
5th	0,121	0,113	0,032	0,030	10,7%	10,7%
6th	0,086	0,080	0,057	0,053	2,67%	2,67%
7th	0,072	0,067	0,034	0,032	7,2%	7,2%
8th	0,050	0,046	0,038	0,036	2%	2%
9th	0,058	0,054	0,046	0,043	3,8%	N/A
10th	0,050	0,047	0,058	0,054	1,6%	1,6%
11th	0,138	0,129	0,093	0,087	3,1%	3,1%
12th	0,056	0,052	0,039	0,036	1,33%	1,33%
13th	0,168	0,157	0,132	0,124	2%	2%
14th	0,034	0,031	0,026	0,024	N/A	N/A
15th	0,037	0,035	0,027	0,025	N/A	N/A
16th	0,023	0,021	0,033	0,031	N/A	N/A
17th	0,194	0,182	0,216	0,202	N/A	N/A
18th	0,021	0,019	0,032	0,030	N/A	N/A
19th	0,123	0,115	0,139	0,130	N/A	N/A
20th	0,016	0,015	0,015	0,014	N/A	N/A
21th	0,015	0,014	0,017	0,016	N/A	N/A
22th	0,018	0,017	0,019	0,018	N/A	N/A
23th	0,072	0,068	0,113	0,105	N/A	N/A
24th	0,020	0,018	0,016	0,015	N/A	N/A
25th	0,057	0,053	0,082	0,077	N/A	N/A
26th	0,014	0,013	0,012	0,011	N/A	N/A
27th	0,017	0,016	0,022	0,021	N/A	N/A
28th	0,010	0,010	0,013	0,012	N/A	N/A
29th	0,044	0,041	0,066	0,062	N/A	N/A
30th	0,015	0,014	0,013	0,012	N/A	N/A
31th	0,043	0,040	0,055	0,051	N/A	N/A
32th	0,026	0,024	0,024	0,022	N/A	N/A
33th	0,033	0,031	0,039	0,037	N/A	N/A
34th	0,040	0,037	0,048	0,045	N/A	N/A
35th	0,036	0,034	0,065	0,061	N/A	N/A
36th	0,029	0,027	0,065	0,061	N/A	N/A
37th	0,030	0,028	0,060	0,056	N/A	N/A
38th	0,022	0,020	0,044	0,042	N/A	N/A
39th	0,017	0,016	0,027	0,025	N/A	N/A
40th	0,017	0,016	0,036	0,033	N/A	N/A
THD ₄₀ [%]	0,928		0,422		23%	13%
PWHD [%]	0,006		0,002		23%	22%



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Annex to the G99/1 certificate of compliance No. U19-0368

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

Extract from test report according to the Engineering Recommendation G99

Nr. 14TH0075-G99/1-3_2

Power Quality. Harmonics.						
STP 60-10						
Phase 1						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 10,04kW		100% of rated output 19,90kW			
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
2 nd	0,171	0,199	0,242	0,281	8%	8%
3 rd	0,193	0,223	0,084	0,097	21,6%	N/A
4 th	0,070	0,081	0,053	0,062	4%	4%
5 th	0,155	0,180	0,049	0,057	10,7%	10,7%
6 th	0,040	0,047	0,033	0,039	2,67%	2,67%
7 th	0,049	0,057	0,052	0,060	7,2%	7,2%
8 th	0,030	0,035	0,025	0,028	2%	2%
9 th	0,053	0,061	0,031	0,036	3,8%	N/A
10 th	0,028	0,033	0,025	0,029	1,6%	1,6%
11 th	0,098	0,113	0,159	0,185	3,1%	3,1%
12 th	0,024	0,027	0,019	0,022	1,33%	1,33%
13 th	0,101	0,118	0,166	0,192	2%	2%
14 th	0,014	0,016	0,014	0,017	N/A	N/A
15 th	0,013	0,016	0,012	0,014	N/A	N/A
16 th	0,013	0,015	0,013	0,015	N/A	N/A
17 th	0,127	0,147	0,155	0,179	N/A	N/A
18 th	0,008	0,009	0,009	0,011	N/A	N/A
19 th	0,097	0,112	0,113	0,131	N/A	N/A
20 th	0,007	0,008	0,009	0,011	N/A	N/A
21 th	0,009	0,011	0,010	0,012	N/A	N/A
22 th	0,006	0,007	0,008	0,009	N/A	N/A
23 th	0,074	0,086	0,062	0,072	N/A	N/A
24 th	0,008	0,010	0,010	0,011	N/A	N/A
25 th	0,073	0,084	0,064	0,074	N/A	N/A
26 th	0,008	0,009	0,009	0,010	N/A	N/A
27 th	0,033	0,039	0,033	0,039	N/A	N/A
28 th	0,006	0,007	0,007	0,008	N/A	N/A
29 th	0,041	0,048	0,037	0,043	N/A	N/A
30 th	0,006	0,007	0,006	0,007	N/A	N/A
31 th	0,034	0,040	0,032	0,037	N/A	N/A
32 th	0,007	0,008	0,006	0,007	N/A	N/A
33 th	0,008	0,009	0,006	0,007	N/A	N/A
34 th	0,006	0,007	0,005	0,006	N/A	N/A
35 th	0,019	0,022	0,014	0,017	N/A	N/A
36 th	0,016	0,019	0,012	0,014	N/A	N/A
37 th	0,015	0,018	0,011	0,013	N/A	N/A
38 th	0,013	0,015	0,010	0,011	N/A	N/A
39 th	0,007	0,008	0,005	0,006	N/A	N/A
40 th	0,008	0,009	0,005	0,006	N/A	N/A
THD ₄₀ [%]	0,47		0,98		23%	13%
PWHD [%]	0,0012		0,0062		23%	22%



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Annex to the G99/1 certificate of compliance No. U19-0368

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

Extract from test report according to the Engineering Recommendation G99

Nr. 14TH0075-G99/1-3_2

Power Quality. Harmonics.

STP 60-10

Phase 2

Generating Unit rating per phase (rpp)		100% of rated output 19,90kW		Limit in BS EN61000-3-12 in %		
Harmonic	At 45-55% of rated output 10,04kW		Measured Value (MV) in [A]	Measured Value (MV) in [%]	1 phase	3 phase
	Measured Value (MV) in [A]	Measured Value (MV) in [%]				
2nd	0,234	0,271	0,238	0,276	8%	8%
3rd	0,073	0,084	0,129	0,149	21,6%	N/A
4th	0,058	0,068	0,071	0,082	4%	4%
5th	0,034	0,040	0,074	0,086	10,7%	10,7%
6th	0,031	0,036	0,035	0,041	2,67%	2,67%
7th	0,045	0,052	0,029	0,033	7,2%	7,2%
8th	0,022	0,025	0,025	0,029	2%	2%
9th	0,022	0,026	0,059	0,068	3,8%	N/A
10th	0,025	0,029	0,030	0,034	1,6%	1,6%
11th	0,153	0,177	0,100	0,115	3,1%	3,1%
12th	0,022	0,025	0,024	0,028	1,33%	1,33%
13th	0,164	0,189	0,096	0,111	2%	2%
14th	0,017	0,019	0,016	0,019	N/A	N/A
15th	0,012	0,013	0,016	0,018	N/A	N/A
16th	0,012	0,014	0,012	0,014	N/A	N/A
17th	0,154	0,178	0,128	0,148	N/A	N/A
18th	0,011	0,013	0,009	0,011	N/A	N/A
19th	0,117	0,135	0,095	0,110	N/A	N/A
20th	0,009	0,010	0,007	0,008	N/A	N/A
21th	0,009	0,011	0,009	0,010	N/A	N/A
22th	0,009	0,010	0,007	0,008	N/A	N/A
23th	0,058	0,067	0,073	0,085	N/A	N/A
24th	0,010	0,012	0,010	0,011	N/A	N/A
25th	0,064	0,074	0,071	0,082	N/A	N/A
26th	0,009	0,011	0,008	0,009	N/A	N/A
27th	0,033	0,039	0,032	0,037	N/A	N/A
28th	0,006	0,007	0,006	0,007	N/A	N/A
29th	0,035	0,040	0,040	0,046	N/A	N/A
30th	0,006	0,006	0,006	0,007	N/A	N/A
31th	0,032	0,037	0,033	0,039	N/A	N/A
32th	0,007	0,008	0,007	0,009	N/A	N/A
33th	0,007	0,008	0,008	0,009	N/A	N/A
34th	0,007	0,008	0,009	0,010	N/A	N/A
35th	0,013	0,016	0,019	0,022	N/A	N/A
36th	0,013	0,015	0,017	0,020	N/A	N/A
37th	0,012	0,014	0,014	0,017	N/A	N/A
38th	0,009	0,011	0,012	0,014	N/A	N/A
39th	0,004	0,004	0,006	0,007	N/A	N/A
40th	0,003	0,004	0,004	0,004	N/A	N/A
THD ₄₀ [%]	0,45		0,95		23%	13%
PWHD [%]	0,0012		0,006		23%	22%



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Annex to the G99/1 certificate of compliance No. U19-0368

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

Extract from test report according to the Engineering Recommendation G99

Nr. 14TH0075-G99/1-3_2

Power Quality. Harmonics.

STP 60-10

Phase 3

Generating Unit rating per phase (rpp)		100% of rated output 19,90kW		Limit in BS EN61000-3-12 in %		
Harmonic	At 45-55% of rated output 10,04kW		100% of rated output 19,90kW			
	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	1 phase	3 phase
2nd	0,171	0,197	0,108	0,125	8%	8%
3rd	0,068	0,079	0,096	0,111	21,6%	N/A
4th	0,055	0,064	0,071	0,082	4%	4%
5th	0,038	0,044	0,129	0,149	10,7%	10,7%
6th	0,031	0,035	0,033	0,039	2,67%	2,67%
7th	0,042	0,049	0,036	0,041	7,2%	7,2%
8th	0,022	0,025	0,027	0,031	2%	2%
9th	0,026	0,030	0,042	0,049	3,8%	N/A
10th	0,024	0,028	0,029	0,034	1,6%	1,6%
11th	0,153	0,177	0,094	0,108	3,1%	3,1%
12th	0,021	0,024	0,024	0,027	1,33%	1,33%
13th	0,164	0,190	0,099	0,115	2%	2%
14th	0,015	0,017	0,015	0,018	N/A	N/A
15th	0,011	0,013	0,014	0,016	N/A	N/A
16th	0,012	0,014	0,013	0,015	N/A	N/A
17th	0,159	0,184	0,133	0,153	N/A	N/A
18th	0,011	0,012	0,009	0,011	N/A	N/A
19th	0,115	0,132	0,095	0,109	N/A	N/A
20th	0,008	0,009	0,008	0,009	N/A	N/A
21th	0,010	0,011	0,010	0,012	N/A	N/A
22th	0,009	0,010	0,007	0,008	N/A	N/A
23th	0,062	0,072	0,078	0,090	N/A	N/A
24th	0,010	0,011	0,009	0,010	N/A	N/A
25th	0,061	0,071	0,071	0,082	N/A	N/A
26th	0,008	0,010	0,009	0,011	N/A	N/A
27th	0,033	0,038	0,034	0,039	N/A	N/A
28th	0,006	0,007	0,006	0,007	N/A	N/A
29th	0,038	0,044	0,043	0,050	N/A	N/A
30th	0,006	0,007	0,006	0,007	N/A	N/A
31th	0,031	0,035	0,033	0,038	N/A	N/A
32th	0,006	0,007	0,007	0,008	N/A	N/A
33th	0,006	0,007	0,007	0,008	N/A	N/A
34th	0,007	0,008	0,007	0,008	N/A	N/A
35th	0,016	0,018	0,020	0,023	N/A	N/A
36th	0,013	0,015	0,017	0,019	N/A	N/A
37th	0,011	0,013	0,016	0,018	N/A	N/A
38th	0,010	0,011	0,012	0,014	N/A	N/A
39th	0,003	0,004	0,004	0,004	N/A	N/A
40th	0,003	0,004	0,005	0,006	N/A	N/A
THD ₄₀ [%]	0,39		0,87		23%	13%
PWHD [%]	0,0012		0,006		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. 14TH0075-G99/1-3_2

Power Quality. Power factor.

Output power	374,5V	400V	438,2V	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%	1,000	1,000	1,000	
50%	1,000	1,000	1,000	
75%	1,000	1,000	1,000	
100%	1,000	1,000	1,000	
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	0,33%	3,3%	0%	0,33%	3,3%	0%	0,42	0,42
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	0,074	Ω	XI	0,046	Ω		

Note. Inverter has a current above 75A per phase and is above 50kW therefore following evaluation method according to EN 61000-3-11 was used.

The device reacts with a current slope of 774 A/sec upwards and 1115 A/sec downwards. Taking into account the form factors given in figure 5 of EN 61000-3-11 the resulting values are as given above.

The mains network impedance must be $R = 0,074 \Omega$ and $X = 0,046 \Omega$ or smaller ($|Z| = 0,088 \Omega$).

Power Quality. DC injection.

Phase1			
Test level power [%]	10	55	100
Recorded value [mA]	7,46	12,10	14,40
Recorded value [%]	0,01	0,01	0,01
Limit [%]	0,25	0,25	0,25
Phase2			
Test level power [%]	10	55	100
Recorded value [mA]	31,27	33,96	37,68
Recorded value [%]	0,03	0,03	0,03
Limit [%]	0,25	0,25	0,25
Phase3			
Test level power [%]	10	55	100
Recorded value [mA]	32,10	14,96	16,97
Recorded value [%]	0,03	0,01	0,02
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. 14TH0075-G99/1-3_2

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	50,8	38,7
Initial Value of aperiodic current	A	N/A	100ms	50,6	36,3
Initial symmetrical short-circuit current*	I_k	N/A	250ms	50,3	57,3
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	50,3	64,6
Reactance/Resistance Ratio of source*	X/R	N/A	Time to Trip [s]	0,526	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 Generating Unit, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0,5 seconds.	
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 0126-100).	

Logic Interface (Input port).	
Confirm that an input port is provided and can be used to shut down the module.	Yes
Note. A Modbus signal can be used to cease Active Power output within 5 s.	