Certificate of compliance

Applicant:	**SMA Solar Technology AG** Sonnenallee 1 34266 Niestetal **Germany**
Product:	**Photovoltaic (PV) inverter**
Model:	**SB4.0-1AV-41** **SB5.0-1AV-41** **SB6.0-1AV-41**

Use in accordance with regulations:

Automatic disconnection device with single-phase mains surveillance in accordance with Engineering Recommendation G99/NI for photovoltaic systems with a single-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/NI-1:2019
Requirements for the connection of generation equipment in parallel with public distribution networks in Northern Ireland

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:	**16TH0348_G99/NI-1_0**	**Certification program:**	**NSOP-0032-DEU-ZE-V01**
Certificate number:	**U22-0112**	**Date of issue:**	**2022-02-21**

Certification body

Thomas Lammel

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/NI **Nr. 16TH0348_G99/NI-1_0**

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G99/NI.			
PGM Technology:	Photovoltaic Inverter		
Manufacturer / applicant:	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

Rated values	**SB4.0-1AV-41**	**SB5.0-1AV-41**	**SB6.0-1AV-41**	**--**
MPP DC voltage range [V]	Max. 600	Max. 600	Max. 600	--
Input DC voltage range [V]	140 - 500	175 - 500	210 - 500	--
Input DC current [A]	2 x 15	2 x 15	2 x 15	--
Output AC voltage [V]	220 / 230 / 240 50/60 Hz	220 / 230 / 240 50/60 Hz	220 / 230 / 240 50/60 Hz	--
Output AC current [A]	18	22	26,1	--
Output power [VA]	4000	5000	6000	--

Firmware version	04.00.06.R or higher

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 SB4.0-1AV-41, SB5.0-1AV-41 and SB6.0-1AV-41 are completely identical and output power derated by software.

The above stated Generating Units are tested according the requirements in the Engineering Recommendation G99/NI. 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/NI.

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Operating Range.	
Test 1	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 2	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 3	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

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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 stage 1	195,5	3,0	195,0	3,026	199,5 V / 5,00 s	No trip
U/V stage 2	138,0	2,0	137,5	2,026	142,0 V / 2,50 s	No trip
					134,0 V / 1,98 s	No trip
O/V stage 1	253,0	0,5	253,6	0,526	249,0 V / 5,00 s	No trip
					257,0 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 V 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	48,0	0,5	48,00	0,583	48,2 Hz / 30,00 s	No trip
					47,8 Hz / 0,45 s	No trip
O/F stage 1	52,0	1,0	52,05	1,085	51,8 Hz / 120,00 s	No trip
					52,2 Hz / 0,98 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/NI **Nr. 16TH0348_G99/NI-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]:	0,371	0,369	0,388	0,388	0,388	0,386
Note: Trip time limit is 0,5 s.						

Protection. Re-connection timer.				
Test should prove that the reconnection sequence starts in no less than 60 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]**			
60	67,09			
Under Voltage				
Time delay setting [s]	**Measured delay [s]**			
60	65,81			
Over Frequency				
Time delay setting [s]	**Measured delay [s]**			
60	65,03			
Under Frequency				
Time delay setting [s]	**Measured delay [s]**			
60	67,01			
	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 257,0 V	At 191,5 V	At 47,9 Hz	At 52,1 Hz
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	+0,95 Hz/sec	2,1 s	No trip
Negative Frequency drift	51,0 to 49,0	-0,95 Hz/sec	2,1 s	No trip

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Extract from test report according to the Engineering Recommendation G99/NI **Nr. 16TH0348_G99/NI-1_0**

Limited Frequency Sensitive Mode – Over Frequency							
1-min mean value [Hz]:	**a) 50,00**	**b) 50,25**	**c) 50,70**	**d) 51,15**	**e) 50,70**	**f) 50,25**	**g) 50,00**
1. Measurement a) to g): Active power output > 80% Pn							
Frequency [Hz]:	50,00	50,25	50,70	51,15	50,70	50,25	50,00
$P_{expected}$ [W]:	N/A	5794	4441	3095	4441	5795	5942
$P_{measured}$ [W]:	5950	5829	4496	3163	4501	5835	5948
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% Pn							
Frequency [Hz]:	50,00	50,25	50,70	51,15	50,70	50,25	50,00
$P_{expected}$ [W]:	N/A	2936	2257	1581	2257	2935	6000
$P_{measured}$ [W]:	3001	2941	2264	1594	2268	2942	5941

Power output 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 [W]:	5963	5963	5963	5963	5963	5963
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/NI **Nr. 16TH0348_G99/NI-1_0**

Power Quality. Harmonics.

SB6.0-1AV-41

Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 2970 W		100% of rated output 5950 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	0,021	0,08	0,045	0,17	8%	8%
3rd	0,265	1,02	0,585	2,24	21,6%	--
4th	0,007	0,03	0,006	0,02	4%	4%
5th	0,234	0,90	0,370	1,42	10,7%	10,7%
6th	0,005	0,02	0,005	0,02	2,67%	2,67%
7th	0,114	0,44	0,168	0,64	7,2%	7,2%
8th	0,004	0,02	0,006	0,02	2%	2%
9th	0,070	0,27	0,099	0,38	3,8%	--
10th	0,004	0,02	0,005	0,02	1,6%	1,6%
11th	0,044	0,17	0,066	0,25	3,1%	3,1%
12th	0,003	0,01	0,004	0,02	1,33%	1,33%
13th	0,036	0,14	0,056	0,21	2%	2%
14th	0,003	0,01	0,003	0,01	--	--
15th	0,025	0,10	0,044	0,17	--	--
16th	0,002	0,01	0,004	0,01	--	--
17th	0,022	0,08	0,039	0,15	--	--
18th	0,003	0,01	0,003	0,01	--	--
19th	0,015	0,06	0,028	0,11	--	--
20th	0,002	0,01	0,003	0,01	--	--
21th	0,014	0,06	0,026	0,10	--	--
22th	0,002	0,01	0,002	0,01	--	--
23th	0,009	0,04	0,022	0,08	--	--
24th	0,002	0,01	0,003	0,01	--	--
25th	0,008	0,03	0,021	0,08	--	--
26th	0,002	0,01	0,002	0,01	--	--
27th	0,005	0,02	0,017	0,06	--	--
28th	0,002	0,01	0,002	0,01	--	--
29th	0,006	0,02	0,016	0,06	--	--
30th	0,002	0,01	0,002	0,01	--	--
31th	0,005	0,02	0,015	0,06	--	--
32th	0,001	0,01	0,002	0,01	--	--
33th	0,005	0,02	0,014	0,05	--	--
34th	0,001	0,01	0,002	0,01	--	--
35th	0,005	0,02	0,014	0,05	--	--
36th	0,001	0,01	0,002	0,01	--	--
37th	0,005	0,02	0,013	0,05	--	--
38th	0,001	0,01	0,002	0,01	--	--
39th	0,006	0,02	0,012	0,05	--	--
40th	0,002	0,01	0,002	0,01	--	--
THD_{40} [%]	2,825		2,990		23%	13%
PWHD [%]	1,519		1,519		23%	22%

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

Extract from test report according to the Engineering Recommendation G99/NI **Nr. 16TH0348_G99/NI-1_0**

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

Power Quality. Voltage fluctuation and Flicker.								
	Starting			**Stopping**			**Running**	
	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	3,70	3,70	1337	4,10	3,90	1010	0,37	0,35
Measured values at standard impedance	5,90	5,80	1337	6,60	6,30	1010	0,59	0,56
Values for maximum impedance	3,10	3,04	0,00	3,46	3,30	0,00	0,31	0,29
Limits set under BS EN 61000-3-11	4%	3,3%	3,3% 500 ms	4%	3,3%	3,3% 500 ms	1,0	0,65

Test impedance	R	0,250	Ω	X_l	0,250	Ω
	Z	0,354	Ω			
Standard impedance	R	0,400	Ω	X_l	0,250	Ω
	Z	0,472	Ω			
Maximum impedance	R	0,254	Ω	X_l	0,159	Ω
	Z_{max}	0,299	Ω			

Power quality. DC injection.			
Test level power [%]	10	55	100
Recorded value [mA]	2,9	2,7	2,6
Recorded value [%]	0,01	0,01	0,01
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/NI **Nr. 16TH0348_G99/NI-1_0**

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	20 ms	230,0	30,9
Initial Value of aperiodic current	A	N/A	100 ms	27,2	26,8
Initial symmetrical short-circuit current*	I_k	N/A	250 ms	25,1	26,0
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500 ms	26,2	27,2
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to Trip [s]**	2,026	
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.					

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