Certificate of compliance

Applicant:	**SMA Solar Technology AG** Sonnenallee 1 34266 Niestetal **Germany**
Product:	**Photovoltaic (PV) inverter**
Model:	**STP 50-40**

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 G99/1-4:2019
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:	**17TH0199-G99/1-4_3**
Certificate number:	**U19-0559**
Date of issue:	**2019-10-09**

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. 17TH0199-G99/1-4_3**

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G99.			
PGM Technology	Photovoltaic 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
Rated values	STP 50-40		
Maximum rated capacity	50 kW		
Rated voltage	400		
Firmware version	beginning with 3.00.05.R		
Measurement period:	2019-04-16 to 2019-04-18		
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.			
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. 17TH0199-G99/1-4_3**

Operating Range.	
Test 1	Voltage = 85% of nominal (195,5 V) Frequency = 47 Hz Power Factor = 1 Period of test 20 s
Connection:	Always connected
Limit:	Always connected
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 1	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 1	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	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. 17TH0199-G99/1-4_3**

Protection. Voltage tests.

Phase 1 to N

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184,0V	2,5s	183,7	2,527	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V	1,0s	264,3	1,027	258,2V / 5,0s	No trip
O/V stage 2	273,7V	0,5s	275,7	0,527	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

Phase 2 to N

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184,0V	2,5s	183,7	2,527	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V	1,0s	264,2	1,027	258,2V / 5,0s	No trip
O/V stage 2	273,7V	0,5s	275,7	0,527	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

Phase 3 to N

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184,0V	2,5s	183,8	2,527	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V	1,0s	264,3	1,027	258,2V / 5,0s	No trip
O/V stage 2	273,7V	0,5s	275,8	0,527	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

Note. For Voltage tests the Voltage required to trip is the setting ±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 ±4V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

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

Extract from test report according to the Engineering Recommendation G99 **Nr. 17TH0199-G99/1-4_3**

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	47,45	20,08	47,7Hz / 30s	No trip
U/F stage 2	47	0,5	46,95	0,586	47,2Hz / 19,95s	No trip
					46,8Hz / 0,45s	No trip
O/F stage 2	52	0,5	51,99	0,580	51,8Hz / 120s	No trip
					52,2Hz / 0,45s	No trip

Note. For Frequency Trip tests the Frequency required to trip is the setting ±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 ±0,2Hz 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]	0,110	0,106	0,156	0,129	0,116	0,141
Trip time. Ph2 fuse removed [s]	0,110	0,106	0,156	0,129	0,116	0,141
Trip time. Ph3 fuse removed [s]	0,110	0,106	0,156	0,129	0,116	0,141

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.

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

Extract from test report according to the Engineering Recommendation G99 **Nr. 17TH0199-G99/1-4_3**

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	28,73s
Under Voltage	
Time delay setting	**Measured delay**
20s	27,21s
Over Frequency	
Time delay setting	**Measured delay**
20s	27,58s
Under Frequency	
Time delay setting	**Measured delay**
20s	27,64s

	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2V	At 196,1V	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	49,50	+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

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules	
Extract from test report according to the Engineering Recommendation G99	**Nr. 17TH0199-G99/1-4_3**

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	51,15	50,70	50,45	50,00
$P_{expected}$ [kW]:	49,99	49,42	46,92	42,42	46,92	49,42	49,99
$P_{measured}$ [kW]:	49,99	48,98	46,48	41,94	46,49	49,42	49,99
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
$P_{expected}$ [kW]:	25,00	24,50	22,00	17,50	22,00	24,50	25,00
$P_{measured}$ [kW]:	25,00	24,44	21,93	17,40	21,98	24,47	25,00

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]:	50,19	50,22	50,21	50,22	50,19	0,00

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

Extract from test report according to the Engineering Recommendation G99 **Nr. 17TH0199-G99/1-4_3**

Power Quality. Harmonics.

Phase 1

Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 8,3 kW		100% of rated output 16,5 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	0,128	0,181	0,108	0,152	8%	8%
3rd	0,015	0,021	0,013	0,018	21,6%	N/A
4th	0,062	0,088	0,058	0,082	4%	4%
5th	0,290	0,410	0,323	0,456	10,7%	10,7%
6th	0,035	0,049	0,036	0,050	2,67%	2,67%
7th	0,179	0,253	0,283	0,401	7,2%	7,2%
8th	0,062	0,088	0,054	0,077	2%	2%
9th	0,018	0,026	0,020	0,028	3,8%	N/A
10th	0,031	0,043	0,019	0,026	1,6%	1,6%
11th	0,080	0,113	0,113	0,159	3,1%	3,1%
12th	0,068	0,096	0,068	0,097	1,33%	1,33%
13th	0,069	0,097	0,098	0,139	2%	2%
14th	0,015	0,021	0,013	0,019	N/A	N/A
15th	0,012	0,017	0,014	0,020	N/A	N/A
16th	0,025	0,036	0,032	0,046	N/A	N/A
17th	0,036	0,050	0,065	0,092	N/A	N/A
18th	0,017	0,024	0,016	0,023	N/A	N/A
19th	0,027	0,038	0,048	0,068	N/A	N/A
20th	0,009	0,012	0,008	0,011	N/A	N/A
21th	0,007	0,010	0,008	0,012	N/A	N/A
22th	0,013	0,019	0,014	0,020	N/A	N/A
23th	0,020	0,029	0,044	0,062	N/A	N/A
24th	0,007	0,010	0,006	0,008	N/A	N/A
25th	0,015	0,021	0,031	0,044	N/A	N/A
26th	0,008	0,011	0,010	0,014	N/A	N/A
27th	0,005	0,007	0,006	0,009	N/A	N/A
28th	0,004	0,006	0,006	0,008	N/A	N/A
29th	0,012	0,017	0,026	0,036	N/A	N/A
30th	0,004	0,005	0,004	0,006	N/A	N/A
31th	0,013	0,019	0,022	0,031	N/A	N/A
32th	0,005	0,007	0,004	0,005	N/A	N/A
33th	0,004	0,006	0,005	0,007	N/A	N/A
34th	0,003	0,005	0,003	0,004	N/A	N/A
35th	0,007	0,011	0,016	0,022	N/A	N/A
36th	0,004	0,005	0,004	0,005	N/A	N/A
37th	0,007	0,010	0,013	0,019	N/A	N/A
38th	0,003	0,005	0,003	0,004	N/A	N/A
39th	0,003	0,004	0,004	0,006	N/A	N/A
40th	0,003	0,005	0,002	0,004	N/A	N/A
THD_{40} [%]	1,13		0,70		23%	13%
PWHD [%]	0,0006		0,0005		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. 17TH0199-G99/1-4_3**

Power Quality. Harmonics.

Phase 2

Generating Unit rating per phase (rpp)						
	At 45-55% of rated ouput 8,3kW		100% of rated output 16,5kW			
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	0,131	0,184	0,177	0,250	8%	8%
3rd	0,016	0,023	0,022	0,031	21,6%	N/A
4th	0,029	0,041	0,025	0,035	4%	4%
5th	0,282	0,398	0,311	0,439	10,7%	10,7%
6th	0,036	0,050	0,040	0,056	2,67%	2,67%
7th	0,184	0,260	0,289	0,408	7,2%	7,2%
8th	0,057	0,081	0,045	0,063	2%	2%
9th	0,013	0,019	0,017	0,023	3,8%	N/A
10th	0,081	0,115	0,074	0,105	1,6%	1,6%
11th	0,084	0,119	0,117	0,165	3,1%	3,1%
12th	0,036	0,051	0,034	0,049	1,33%	1,33%
13th	0,071	0,100	0,102	0,143	2%	2%
14th	0,057	0,080	0,059	0,084	N/A	N/A
15th	0,012	0,017	0,014	0,020	N/A	N/A
16th	0,024	0,034	0,035	0,050	N/A	N/A
17th	0,035	0,050	0,066	0,093	N/A	N/A
18th	0,016	0,023	0,016	0,023	N/A	N/A
19th	0,026	0,037	0,047	0,067	N/A	N/A
20th	0,011	0,015	0,012	0,017	N/A	N/A
21th	0,008	0,011	0,009	0,012	N/A	N/A
22th	0,012	0,018	0,008	0,011	N/A	N/A
23th	0,022	0,031	0,044	0,061	N/A	N/A
24th	0,014	0,020	0,014	0,020	N/A	N/A
25th	0,016	0,022	0,034	0,048	N/A	N/A
26th	0,006	0,009	0,009	0,013	N/A	N/A
27th	0,005	0,006	0,006	0,009	N/A	N/A
28th	0,005	0,007	0,006	0,008	N/A	N/A
29th	0,014	0,020	0,027	0,038	N/A	N/A
30th	0,006	0,008	0,006	0,008	N/A	N/A
31th	0,013	0,018	0,022	0,031	N/A	N/A
32th	0,006	0,008	0,005	0,007	N/A	N/A
33th	0,004	0,006	0,005	0,007	N/A	N/A
34th	0,004	0,006	0,003	0,005	N/A	N/A
35th	0,008	0,011	0,016	0,023	N/A	N/A
36th	0,003	0,004	0,003	0,004	N/A	N/A
37th	0,009	0,013	0,015	0,021	N/A	N/A
38th	0,004	0,005	0,005	0,007	N/A	N/A
39th	0,003	0,004	0,004	0,006	N/A	N/A
40th	0,004	0,005	0,004	0,005	N/A	N/A
THD_{40} [%]	1,13		0,73		23%	13%
PWHD [%]	0,0011		0,0006		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. 17TH0199-G99/1-4_3**

Power Quality. Harmonics.

Phase 3

Generating Unit rating per phase (rpp)						
	At 45-55% of rated ouput 8,3kW		100% of rated output 16,5kW			
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	0,090	0,127	0,118	0,167	8%	8%
3rd	0,012	0,016	0,020	0,028	21,6%	N/A
4th	0,035	0,050	0,037	0,052	4%	4%
5th	0,278	0,393	0,310	0,439	10,7%	10,7%
6th	0,030	0,043	0,030	0,042	2,67%	2,67%
7th	0,169	0,239	0,273	0,386	7,2%	7,2%
8th	0,064	0,091	0,055	0,078	2%	2%
9th	0,018	0,025	0,018	0,025	3,8%	N/A
10th	0,077	0,109	0,072	0,102	1,6%	1,6%
11th	0,081	0,115	0,112	0,158	3,1%	3,1%
12th	0,038	0,054	0,037	0,052	1,33%	1,33%
13th	0,060	0,084	0,089	0,125	2%	2%
14th	0,052	0,074	0,053	0,075	N/A	N/A
15th	0,013	0,018	0,015	0,021	N/A	N/A
16th	0,024	0,034	0,030	0,042	N/A	N/A
17th	0,038	0,054	0,070	0,098	N/A	N/A
18th	0,016	0,023	0,017	0,024	N/A	N/A
19th	0,026	0,037	0,042	0,060	N/A	N/A
20th	0,010	0,014	0,012	0,017	N/A	N/A
21th	0,007	0,011	0,009	0,013	N/A	N/A
22th	0,014	0,020	0,014	0,020	N/A	N/A
23th	0,024	0,034	0,045	0,064	N/A	N/A
24th	0,014	0,020	0,014	0,020	N/A	N/A
25th	0,015	0,021	0,031	0,044	N/A	N/A
26th	0,006	0,009	0,005	0,008	N/A	N/A
27th	0,005	0,008	0,006	0,009	N/A	N/A
28th	0,005	0,007	0,004	0,006	N/A	N/A
29th	0,013	0,019	0,024	0,033	N/A	N/A
30th	0,005	0,007	0,004	0,006	N/A	N/A
31th	0,012	0,017	0,020	0,029	N/A	N/A
32th	0,005	0,008	0,004	0,006	N/A	N/A
33th	0,004	0,006	0,005	0,007	N/A	N/A
34th	0,004	0,006	0,004	0,005	N/A	N/A
35th	0,008	0,011	0,017	0,024	N/A	N/A
36th	0,003	0,005	0,003	0,005	N/A	N/A
37th	0,009	0,012	0,014	0,020	N/A	N/A
38th	0,004	0,005	0,005	0,007	N/A	N/A
39th	0,002	0,003	0,005	0,006	N/A	N/A
40th	0,003	0,005	0,003	0,004	N/A	N/A
THD_{40} [%]	1,07		0,68		23%	13%
PWHD [%]	0,0010		0,0005		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. 17TH0199-G99/1-4_3**

Power Quality. Power factor.				
Output power	216,2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within ±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	0,04%	0,01%	0,00%	0,04%	0,01%	0,00%	0,042	0,035
Values for maximum impedance								
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	0,15	Ω	Xl	0,15	Ω
	Z	0,21	Ω			
Maximum Impedance	Rmax	0,10	Ω	Xlmax	0,06	Ω
	Zmax	0,12	Ω			

Power Quality. DC injection.			
Phase1			
Test level power [%]	10	55	100
Recorded value [mA]	21,95	42,79	45,45
Recorded value [%]	0,03	0,06	0,06
Limit [%]	0,25	0,25	0,25
Phase2			
Test level power [%]	10	55	100
Recorded value [mA]	66,61	38,09	43,84
Recorded value [%]	0,09	0,05	0,06
Limit [%]	0,25	0,25	0,25
Phase3			
Test level power [%]	10	55	100
Recorded value [mA]	66,89	38,15	35,51
Recorded value [%]	0,09	0,05	0,05
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. 17TH0199-G99/1-4_3**

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	229,97	80,25
Initial Value of aperiodic current	A	N/A	100ms	13,98	72,58
Initial symmetrical short-circuit current*	I_k	N/A	250ms	13,91	72,92
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	13,87	73,44
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to Trip [s]**	2,52	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 0126-1-1).

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