Certificate of compliance

Applicant: **SMA Solar Technology AG**
Sonnenallee 1
34266 Niestetal
Germany

Product: **Grid-tied photovoltaic (PV) inverter**

Model: **SB1.5-1VL-40**
SB2.5-1VL-40

Use in accordance with regulations:

Automatic disconnection device with single-phase mains surveillance in accordance with EN 50438:2013 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.

Applied rules and standards:

EN 50438:2013
Requirements for micro-generating plants to be connected in parallel with public low-voltage distribution networks

DIN V VDE V 0126-1-1:2006-02 (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: **14TH0397-EN50438**
Certificate number: **U15-0104**
Date of issue: **2015-04-10**

Certification body

Dieter Zitzmann

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

Certification body of Bureau Veritas Consumer Products Services Germany GmbH
Accredited according to EN 45011 - ISO / IEC Guide 65

Appendix E Type Verification Test Report	
Extract from test report according to EN 50438	**Nr. 14TH0397**

Type Approval and declaration of compliance with the requirements of EN 50438.		
Manufacturer / applicant:	**SMA Solar Technology AG** **Sonnenallee 1** **34266 Niestetal** **Germany**	
Micro-generator Type	**Grid-tied photovoltaic inverter**	
Rated values	**SB1.5-1VL-40**	**SB2.5-1VL-40**
Maximum rated capacity	**1,50 kW**	**2,50 kW**
Rated voltage	**230V**	**230V**
Firmware version	**2.03**	
Measurement period:	**2015-03-19 to 2015-03-20**	

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 micro-generators are tested according to the requirements in the EN 50438. 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 EN 50438.

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Type testing of the interface protection

Over-/under-voltage tests

Parameter	Protection limit		Actual setting		Trip value (test result)	
	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [s]
Over-voltage stage 1	253	3*	253	600*	253,0	506*
Over-voltage stage 2	264,5	0,2	264,5	0,2	265,7	0,177
Under-voltage stage 1	195,5	1,5	195,5	1,5	195,5	1,477

*Tested with 600s setting.

Note.
Minimum operation time according to default interface protection:
Over-voltage stage 1 -
Over-voltage stage 2 0,1s
Under-voltage 1,2s

Over-/under-frequency tests

Parameter	Protection limit		Actual setting		Trip value (test result)	
	Frequency [Hz]	Disconnection time [s]	Frequency [Hz]	Disconnection time [s]	Frequency [Hz]	Disconnection time [s]
Over-frequency	52,0	0,5	52,0	0,5	52,02	487
Under-frequency	47,5	0,5	47,5	0,5	47,50	493

Note.
Minimum operation time according to default interface protection:
Over-frequency 0,5 s
Under-frequency 0,5 s

LoM test

Method used	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. Phase 1 fuse removed	516 ms	513 ms	991 ms	527 ms	516 ms	998 ms

Indicate additional shut down time included in above results. (Integrated interface switch)	Type of switching equipment 1: Relay with 10ms Type of switching equipment 2: Relay with 10ms

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Type testing of a micro-generator

Operating range

Test 1: U = 195,5 V; f = 47,5 Hz; P = 1,00 Sn; cosφ = 1
Test 2: U = 253,0 V; f = 51,5 Hz; P = 1,00 Sn; cosφ = 1

Test sequence	Voltage [V]	Frequency [Hz]	Output power [W]	Cos φ [1]
1	195,5	47,50	2220	1
2	253,0	51,50	2524	1

Active power at under-frequency			
5-min mean value (each)	**a) 50 ± 0,01 [Hz]**	**b) - 0,4 to – 0,5 [Hz]**	**c) - 2,4 to - 2,5 [Hz]**
Frequency [Hz]:	50,00	49,55	47,55
Active power [kW]:	2,22	2,22	2,22
ΔP/PM [%] per 1 Hz:			1,33

Power response to 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**
1. Measurement a) to f): Active power output > 80% Pn						
P_{AC}, 30s [W]:	2224	2208	2037	1867	2037	2208
P_{des} [W]:	N/A	2211	2040	1870	2040	2211
ΔP [W]:	N/A	-2,571	-3,05	-2,58	-3,02	-2,50
ΔP [%P_{nom}]:	N/A	-0,10	-0,12	-0,10	-0,12	-0,10
P_{MPP} [W]	2332	2332	2332	2332	2332	2332
2. Measurement a) to f): Active power output 40% and 60% after freezing > 80% Pn						
P_{AC}, 30s [W]:	1258	1247	1150	1054	1150	1246
P_{des} [W]:	N/A	1246	1150	1054	1150	1246
ΔP [W]:	N/A	0,15	-0,21	-0,023	-0,18	-0,28
ΔP [%P_{nom}]:	N/A	0,006	-0,008	-0,001	-0,007	-0,011
P_{MPP} [W]	1295	1295	2331	2331	2331	2331

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Controllable reactive power			
Inductive (supply reactive power)			
Power-BIN	**Active power [%]**	**Reactive power [%]**	**Power factor (cos φ)**
0% - 10%	5,2	-3,5	0,823
10% - 20%	15,5	-9,8	0,845
20% - 30%	25,4	-15,9	0,849
30% - 40%	35,3	-21,9	0,850
40% - 50%	45,1	-27,9	0,851
50% - 60%	55,0	-33,9	0,851
60% - 70%	64,8	-39,9	0,851
70% - 80%	74,0	-45,6	0,851
80% - 90%	83,5	-51,3	0,852
90% - 100%	85,4	-52,8	0,851
Capacitive (supply reactive power)			
Power-BIN	**Active power [%]**	**Reactive power [%]**	**Power factor (cos φ)**
0% - 10%	5,3	3,0	0,867
10% - 20%	15,6	9,6	0,853
20% - 30%	25,6	15,8	0,850
30% - 40%	35,4	22,0	0,849
40% - 50%	45,3	28,2	0,849
50% - 60%	55,1	34,5	0,848
60% - 70%	64,9	40,7	0,848
70% - 80%	74,2	46,4	0,848
80% - 90%	83,6	52,4	0,847
90% - 100%	84,7	52,9	0,848
Reactive power supply with set point Q=0			
Power-BIN	**Active power [W]**	**Reactive power [Var]**	**Power factor (cos φ)**
0% - 10%	5,2	0,27	0,999
10% - 20%	15,7	0,21	1,000
20% - 30%	25,6	0,15	1,000
30% - 40%	35,5	0,07	1,000
40% - 50%	45,5	0,01	1,000
50% - 60%	55,5	0,07	1,000
60% - 70%	65,3	0,13	1,000
70% - 80%	74,6	0,19	1,000
80% - 90%	84,1	0,25	1,000
90% - 100%	93,8	0,30	1,000

Q adjustment				
	Reactive power set point Q [Var]	**Measured reactive power Q [Var]**	**Measured cos φ**	**Deviation compared to setpoint ΔQ / PN [%]**
- Qmin	-1250	-1252	-0,865	-0,07
0	0	2,08	0,999	0,08
+ Qmax	1250	1255	0,865	0,22

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Connection and starting to generate electrical power		
	Voltage conditions	
a) Start up for voltage range	**<84% Un for twice of observation time**	**>111% Un for twice of observation time**
Connection:	No connection	No connection
Limit:	No connection allowed	
b) In voltage range at start-up	**≥84% Un within twice setting observation time**	**≤111% Un within twice setting observation time**
Reconnection time [s]	75,91	75,93
Limit:	Connected after setting observation time (≥60s)	
Gradient:	For adjustable micro generators the maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%Pn/min. For recorded gradient see diagram below.	
c) In voltage range after voltage failure	**≥84% Un for twice of setting observation time**	**≤111% Un for twice of setting observation time**
Reconnection time [s]	66,3	63,4
Limit:	Reconnection after setting observation time (≥60s)	
Gradient:	For adjustable micro generators the maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%Pn/min. For recorded gradient see diagram below.	
	Frequency conditions	
d) Start up for frequency range	**<47,45 Hz for twice of setting observation time**	**>50,10 Hz for twice of setting observation time**
Connection:	No connection	No connection
Limit	No connection allowed	
e) In frequency range at start-up	**≥47,45 Hz within twice of setting observation time**	**≤51,15 Hz within twice of setting observation time**
Reconnection time [s]	75,98	75,78
Limit:	Connected after setting delay time(≥60s)	
Gradient:	For adjustable micro generators the maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%Pn/min. For recorded gradient see diagram below.	
f) In frequency range after frequency failure	**≥47,45 Hz for twice of setting observation time**	**≤51,15 Hz for twice of setting observation time**
Reconnection time [s]	67,0	63,6
Limit:	Reconnection after setting observation time (≥60s)	
Gradient:	For adjustable micro generators the maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%Pn/min. For recorded gradient see diagram below.	

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Short-circuit current contribution					
Short-circuit current parameters					
For a directly coupled micro-generator			**For a Inverter micro-generator**		
Parameter	**Symbol**	**Value**	**Time after fault**	**Volts**	**Amps**
Peak Short Circuit current	I_p	N/A	20ms	76,89	12,37
Initial Value of aperiodic current	A	N/A	100ms	73,80	11,52
Initial symmetrical short-circuit current*	I_k	N/A	250ms	73,27	11,44
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	73,11	11,50
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to trip**	1,465	In seconds

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Power Quality. Harmonic current emission				
micro-generator		SB2.5-1VL-40		
Harmonic order n	Current Magnitude [A] at 100% rated output power	% of Fundamental	Phase	Harmonic current limit EN 61000-3-2, Class A [A]
1st	10,736	100,000	Phase 1	-
2nd	0,016	0,149	Phase 1	1,080
3rd	0,094	0,876	Phase 1	2,300
4th	0,003	0,028	Phase 1	0,430
5th	0,035	0,326	Phase 1	1,140
6th	0,003	0,028	Phase 1	0,300
7th	0,024	0,224	Phase 1	0,770
8th	0,002	0,019	Phase 1	0,230
9th	0,015	0,140	Phase 1	0,400
10th	0,002	0,019	Phase 1	0,184
11th	0,009	0,084	Phase 1	0,330
12th	0,002	0,019	Phase 1	0,153
13th	0,01	0,093	Phase 1	0,210
14th	0,002	0,019	Phase 1	0,131
15th	0,009	0,084	Phase 1	0,150
16th	0,001	0,009	Phase 1	0,115
17th	0,008	0,075	Phase 1	0,132
18th	0,001	0,009	Phase 1	0,102
19th	0,006	0,056	Phase 1	0,118
20th	0,001	0,009	Phase 1	0,092
21th	0,007	0,065	Phase 1	0,107
22th	0,001	0,009	Phase 1	0,084
23th	0,009	0,084	Phase 1	0,098
24th	0,001	0,009	Phase 1	0,077
25th	0,008	0,075	Phase 1	0,090
26th	0,001	0,009	Phase 1	0,071
27th	0,006	0,056	Phase 1	0,083
28th	0,001	0,009	Phase 1	0,066
29th	0,007	0,065	Phase 1	0,078
30th	0,001	0,009	Phase 1	0,061
31th	0,006	0,056	Phase 1	0,073
32th	0,001	0,009	Phase 1	0,058
33th	0,007	0,065	Phase 1	0,068
34th	0,001	0,009	Phase 1	0,054
35th	0,007	0,065	Phase 1	0,064
36th	0,001	0,009	Phase 1	0,051
37th	0,007	0,065	Phase 1	0,061
38th	0,001	0,009	Phase 1	0,048
39th	0,006	0,056	Phase 1	0,058
40th	0,001	0,009	Phase 1	0,046

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Voltage fluctuation and Flicker.					
	Maximum permissible flicker and voltage fluctuation as per EN 61000-3-3				
Value	**Pst**	**Plt 2 hours**	**d(t) $_{500ms}$**	**dc**	**dmax**
Limit	1,0	0,65	3,3%	3,3%	4%
Test value	0,07	0,07	0,00%	0,00%	0,00%

DC-Injection.				
Protection limit	Tested at four power levels limit 0,5% of IAC_{nom}			
Output power	**~20%**	**~50%**	**75%**	**~100%**
Max. test value (phase L1) [mA]	3,70	2,94	0,85	4,78