



**BUREAU
VERITAS**

Certificate of compliance

Applicant: SMA Solar Technology AG
Sonnenallee 1
34266 Niestetal
Germany

Product: Grid-tied photovoltaic (PV) inverter

Model: SB3.0-1AV-41
SB3.6-1AV-41
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 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

The generators SB4.0-1AV-41, SB5.0-1AV-41 and SB6.0-1AV-41 are rated >16A per phase. However all requirements of the EN 50438:2013 are fulfilled.

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: PV180906N088-2
Certificate number: U18-0688
Date of issue: 2018-12-21

Certification body



Holger Schaffer

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



Deutsche
Akkreditierungsstelle
D-ZE-12024-01-00

Appendix E Type Verification Test Report

Extract from test report according to EN 50438

Nr. PV180906N088-2

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	SB3.0-1AV-41	SB3.6-1AV-41	SB4.0-1AV-41	SB5.0-1AV-41	SB6.0-1AV-41
Maximum rated capacity	3,0 kW	3,68 kW	4,0 kW	5,0 kW	6,0 kW
Rated voltage	230/400V				
Firmware version	V1.00				
Measurement period:	2018-09-06 to 2018-11-20				

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

Phase1						
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	253,0	3* / 600*	253,0	3* / 600*	252,5	1,970 / 478
Over-voltage stage 2	264,5	0,2	264,5	0,2	265,5	0,172
Under-voltage stage 1	195,5	1,5	195,5	1,5	194,7	1,465

Note.

Minimum operation time according to default interface protection:

Over-voltage stage 1 -
 Over-voltage stage 2 0,1s
 Under-voltage 1,2s

* The over-voltage-stage 1 is a 10-min-mean-value according to EN 50160. The disconnection after detection of an overvoltage at the 10-min-mean-value takes place within 200ms.

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	52,01	0,481
Under-frequency	47,5	0,5	47,5	0,5	47,50	0,478

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 [ms]	479	148	159	150	476	188

Indicate additional shut down time included in above results.
 (Integrated interface switch)

Type of switching equipment 1:
 Relay with 30ms
 Type of switching equipment 2:
 Relay with 30ms

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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	195,59	47,50	5,194	0,9988
2	253,23	51,50	5,999	0,9993

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]:	5,972	5,972	5,973
ΔP/PM [%] per 1 Hz:			0,001

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	g) 50,00
1. Measurement a) to g): Active power output > 80% P_n							
Frequency [Hz]:	50,00	50,25	50,70	51,15	50,70	50,25	50,00
PM [kW]:	6,000	5,868	4,790	3,713	4,790	5,868	6,000
PE60 [kW]:	5,988	5,894	4,814	3,737	4,814	5,894	5,988
ΔPE60/PM [%]:	-0,40	0,85	0,79	0,82	0,79	0,87	-0,42
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% P_n							
Frequency [Hz]:	50,00	50,25	50,70	51,15	50,70	50,25	50,00
PM [kW]:	3,000	2,972	2,426	1,880	2,426	2,973	6,000
PE60 [kW]:	3,033	2,982	2,433	1,884	2,427	2,969	5,987
ΔPE60/PM [%]:	1,11	0,33	0,22	0,11	0,01	-0,11	-0,42
Limit ΔP/P _{1min} :	+ 10 % of P _M						

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Reactive power			
Uncontrollable reactive power			
Test Voltage	211,6V	230V	248,4V
Output power			
25% PN	0,999	0,999	0,999
50% PN	0,999	0,999	0,999
75% PN	0,999	0,999	0,999
100% PN	0,999	0,999	0,999
Limit	>0,95	>0,95	>0,95

Controllable reactive power
SB6.0-1AV-41

Inductive (supply reactive power)				
Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	AC voltage [V]
0% - 10%	0,535	-3,009	0,1747	229,83
10% - 20%	1,152	-3,008	0,3560	230,10
20% - 30%	1,766	-3,008	0,5062	230,53
30% - 40%	2,377	-3,008	0,6197	230,79
40% - 50%	2,983	-3,008	0,7040	231,06
50% - 60%	3,585	-3,008	0,7660	230,44
60% - 70%	4,185	-3,008	0,8119	230,36
70% - 80%	4,782	-3,008	0,8464	230,81
80% - 90%	5,232	-3,010	0,8667	230,36
90% - 100%	5,225	-3,011	0,8663	230,36

Capacitive (supply reactive power)				
Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	AC voltage [V]
0% - 10%	0,543	3,027	0,1760	229,19
10% - 20%	1,159	3,027	0,3576	229,57
20% - 30%	1,773	3,028	0,5052	230,12
30% - 40%	2,343	3,028	0,6159	229,77
40% - 50%	2,988	3,028	0,7023	230,09
50% - 60%	3,591	3,028	0,7643	230,37
60% - 70%	4,190	3,028	0,8104	229,29
70% - 80%	4,787	3,028	0,8450	229,98
80% - 90%	5,241	3,024	0,8661	230,19
90% - 100%	5,236	3,020	0,8662	230,21

Reactive power supply with set point Q=0				
Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	AC voltage [V]
0% - 10%	0,594	0,009	0,9999	229,31
10% - 20%	1,206	0,010	0,9999	229,61
20% - 30%	1,815	0,010	0,9999	229,89
30% - 40%	2,422	0,010	0,9999	230,15
40% - 50%	3,026	0,010	0,9999	230,40
50% - 60%	3,627	0,009	0,9999	230,32
60% - 70%	4,224	0,009	0,9999	229,87
70% - 80%	4,818	0,009	0,9999	230,15
80% - 90%	5,412	0,009	0,9999	230,42
90% - 100%	6,001	0,009	0,9999	230,67

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Controllable reactive power

SB3.0-1AV-41

Inductive (supply reactive power)

Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	AC voltage [V]
0% - 10%	0,263	-1,516	0,1709	230,05
10% - 20%	0,573	-1,517	0,3537	230,17
20% - 30%	0,884	-1,518	0,5031	230,30
30% - 40%	1,192	-1,519	0,6174	230,44
40% - 50%	1,499	-1,519	0,7023	230,56
50% - 60%	1,806	-1,520	0,7650	230,70
60% - 70%	2,111	-1,520	0,8080	230,85
70% - 80%	2,417	-1,522	0,8462	231,00
80% - 90%	2,635	-1,524	0,8656	231,18
90% - 100%	2,635	-1,524	0,8655	231,18

Capacitive (supply reactive power)

Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	AC voltage [V]
0% - 10%	0,269	1,534	0,1727	229,93
10% - 20%	0,580	1,533	0,3534	230,08
20% - 30%	0,890	1,533	0,4992	230,22
30% - 40%	1,198	1,532	0,6156	230,35
40% - 50%	1,505	1,532	0,6975	229,83
50% - 60%	1,811	1,532	0,7635	229,98
60% - 70%	2,116	1,531	0,8100	230,13
70% - 80%	2,421	1,530	0,8453	230,28
80% - 90%	2,642	1,526	0,8660	230,21
90% - 100%	2,643	1,525	0,8661	230,23

Reactive power supply with set point Q=0

Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	AC voltage [V]
0% - 10%	0,285	0,004	0,5609	229,99
10% - 20%	0,596	0,008	0,9999	230,14
20% - 30%	0,903	0,007	0,9999	230,30
30% - 40%	1,210	0,007	0,9999	230,47
40% - 50%	1,516	0,006	0,9999	230,61
50% - 60%	1,821	0,005	0,9999	230,74
60% - 70%	2,126	0,005	0,9999	230,92
70% - 80%	2,401	0,005	0,9999	231,06
80% - 90%	2,734	0,004	0,9999	231,22
90% - 100%	3,036	0,003	0,9999	231,36

Q adjustment

	Reactive power set point Q [Var]	Measured reactive power Q [Var]	Measured cos φ	Deviation compared to setpoint ΔQ / PN [%]
- Qmin	-2,906	-3,011	0,8664	-1,75
0	0	0,077	0,9999	0,16
+ Qmax	-2,906	3,021	0,8661	1,91

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Connection and starting to generate electrical power		
Test according EN 50438 with standard setting	Min. voltage for connection to grid:	195,5
	Max. voltage for connection to grid:	253,0
	Min. frequency for connection to grid:	47,50
	Max. frequency for connection to grid:	50,05
	Observation time ($\geq 60s$)	60s
Test		
	Voltage conditions	
a) Start up for voltage range	<85% U_n for twice of observation time	>110% U_n for twice of observation time
Connection:	No connection	No connection
Limit:	No connection allowed	
b) In voltage range at start-up	$\geq 85\% U_n$ within twice setting observation time	$\leq 110\% U_n$ within twice setting observation time
Reconnection time [s]	66	64
Limit:	Connected after setting observation time ($\geq 60s$)	
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% P_n /min.	
c) In voltage range after voltage failure	$\geq 85\% U_n$ for twice of setting observation time	$\leq 110\% U_n$ for twice of setting observation time
Reconnection time [s]	65	66
Limit:	Reconnection after setting observation time ($\geq 60s$)	
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% P_n /min.	
	Frequency conditions	
d) Start up for frequency range	<47,50 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	$\geq 47,50$ Hz within twice of setting observation time	$\leq 50,10$ Hz within twice of setting observation time
Reconnection time [s]	63	64
Limit:	Connected after setting delay time ($\geq 60s$)	
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% P_n /min.	
f) In frequency range after frequency failure	$\geq 47,50$ Hz for twice of setting observation time	$\leq 50,05$ Hz for twice of setting observation time
Reconnection time [s]	64	64
Limit:	Reconnection after setting observation time ($\geq 60s$)	
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% P_n /min.	

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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	36,8	14,9
Initial Value of aperiodic current	A	N/A	100ms	N/A	N/A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	N/A	N/A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	N/A	N/A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,0009	In seconds

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Power Quality. Harmonic current emission					
micro-generator		SB6.0-1AV-41			
Harmonic order n	Current Magnitude [A] at 100% rated output power	% of Fundamental	Phase	Harmonic current limit EN61000-3-12 [%]	
				1 phase	3 phase
1st	25,976	99,962	Phase 1	-	-
2nd	0,008	0,032	Phase 1	8	8
3rd	0,637	2,452	Phase 1	21,6	N/A
4th	0,006	0,025	Phase 1	4	4
5th	0,292	1,125	Phase 1	10,7	10,7
6th	0,004	0,016	Phase 1	2,67	2,67
7th	0,099	0,383	Phase 1	7,2	7,2
8th	0,004	0,016	Phase 1	2	2
9th	0,052	0,199	Phase 1	3,8	N/A
10th	0,003	0,011	Phase 1	1,6	1,6
11th	0,036	0,138	Phase 1	3,1	3,1
12th	0,003	0,010	Phase 1	1,33	1,33
13th	0,030	0,116	Phase 1	2	2
14th	0,004	0,014	Phase 1	N/A	N/A
15th	0,024	0,091	Phase 1	N/A	N/A
16th	0,005	0,019	Phase 1	N/A	N/A
17th	0,021	0,080	Phase 1	N/A	N/A
18th	0,004	0,014	Phase 1	N/A	N/A
19th	0,015	0,056	Phase 1	N/A	N/A
20th	0,002	0,007	Phase 1	N/A	N/A
21th	0,015	0,059	Phase 1	N/A	N/A
22th	0,002	0,007	Phase 1	N/A	N/A
23th	0,013	0,050	Phase 1	N/A	N/A
24th	0,001	0,005	Phase 1	N/A	N/A
25th	0,011	0,043	Phase 1	N/A	N/A
26th	0,001	0,005	Phase 1	N/A	N/A
27th	0,010	0,037	Phase 1	N/A	N/A
28th	0,002	0,006	Phase 1	N/A	N/A
29th	0,010	0,037	Phase 1	N/A	N/A
30th	0,001	0,005	Phase 1	N/A	N/A
31th	0,008	0,033	Phase 1	N/A	N/A
32th	0,001	0,006	Phase 1	N/A	N/A
33th	0,009	0,035	Phase 1	N/A	N/A
34th	0,001	0,004	Phase 1	N/A	N/A
35th	0,007	0,026	Phase 1	N/A	N/A
36th	0,002	0,006	Phase 1	N/A	N/A
37th	0,008	0,029	Phase 1	N/A	N/A
38th	0,001	0,005	Phase 1	N/A	N/A
39th	0,008	0,031	Phase 1	N/A	N/A
40th	0,001	0,005	Phase 1	N/A	N/A
THD ₄₀	-	2,744	Phase 1	13	13
PWHD	-	0,856	Phase 1	22	22

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Power Quality. Harmonic current emission				
micro-generator		SB3.0-1AV-41		
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	13,170	99,952	Phase 1	-
2nd	0,003	0,026	Phase 1	1,080
3rd	0,353	2,680	Phase 1	2,300
4th	0,006	0,045	Phase 1	0,430
5th	0,175	1,330	Phase 1	1,140
6th	0,005	0,041	Phase 1	0,300
7th	0,066	0,501	Phase 1	0,770
8th	0,004	0,031	Phase 1	0,230
9th	0,045	0,341	Phase 1	0,400
10th	0,003	0,020	Phase 1	0,184
11th	0,031	0,236	Phase 1	0,330
12th	0,002	0,019	Phase 1	0,153
13th	0,026	0,198	Phase 1	0,210
14th	0,003	0,022	Phase 1	0,131
15th	0,019	0,141	Phase 1	0,150
16th	0,004	0,027	Phase 1	0,115
17th	0,020	0,151	Phase 1	0,132
18th	0,003	0,022	Phase 1	0,102
19th	0,012	0,095	Phase 1	0,118
20th	0,002	0,013	Phase 1	0,092
21th	0,013	0,096	Phase 1	0,107
22th	0,001	0,011	Phase 1	0,084
23th	0,009	0,068	Phase 1	0,098
24th	0,001	0,008	Phase 1	0,077
25th	0,009	0,066	Phase 1	0,090
26th	0,001	0,008	Phase 1	0,071
27th	0,005	0,042	Phase 1	0,083
28th	0,001	0,008	Phase 1	0,066
29th	0,004	0,033	Phase 1	0,078
30th	0,001	0,007	Phase 1	0,061
31th	0,003	0,023	Phase 1	0,073
32th	0,001	0,007	Phase 1	0,058
33th	0,002	0,018	Phase 1	0,068
34th	0,001	0,007	Phase 1	0,054
35th	0,002	0,014	Phase 1	0,064
36th	0,001	0,008	Phase 1	0,051
37th	0,002	0,013	Phase 1	0,061
38th	0,001	0,008	Phase 1	0,048
39th	0,003	0,019	Phase 1	0,058
40th	0,001	0,007	Phase 1	0,046

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Voltage fluctuation and Flicker.					
SB3.0-1AV-41	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	0,078	0,074	0,00	0,00	0,2
SB6.0-1AV-41	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	0,073	0,073	0,00	0,00	0,15

DC-Injection.				
SB6.0-1AV-41				
Protection limit	Tested at four power levels, limit 0,5% of IAC _{nom} (130mA)			
Output power	~20%	~50%	75%	~100%
Max. test value (phase L1) [mA]	-20	-56	-55	-52
SB3.0-1AV-41				
Protection limit	Tested at four power levels, limit 0,5% of IAC _{nom} (65mA)			
Output power	~20%	~50%	75%	~100%
Max. test value (phase L1) [mA]	-27	-18	-19	-16