SMA Solar Technology AG | Sonnenallee 1 | 34266 Niestetal | Germany
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Amtsgericht Kassel (District Court) HRB (registration number) 3972
Vorsitzender des Aufsichtsrats (Chairman of the Supervisory Board): Dr. Erik Ehrentrautr
Managing Board: Roland Grebe, Martin Kinne, Dr.-Ing. Jürgen Reinert, Pierre-Pascal Urbon

Certificate EN 50438/2013

European Standard

Manufacturer	**SMA Solar Technology AG**
Address	Sonnenallee 1, 34266 Niestetal (Germany)

Type Tested reference number	ZE_EN50438_2013_STP60-10_en_10
Generating Unit technology	Three phase inverter
Test house details	**SMA Solar Technology AG**
Test period	From 2015-06-11 until 2015-07-15

Type reference	Max. apparent AC power (VA)	Rated AC power (W)	From FW Pack
STP 60-10	60000	60000	1,45

The results of the EN 50438:2013 are summarized in this certificate. SMA declares that all units shipped to Poland, with at least the aforementioned FW version, are within the specifications and parameters set by the EN 50438:2013 European Standard.

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Test Results - Protection

Interface protection							
Trip Tests	EN 50438:2007		Setting		Measures Values		Verification
Function	Magnitude	Time	Magnitude	Time	Magnitude	Time	
Undervoltage	340 V	1500 ms	340 V	1500 ms	339,6 V	1487 ms	✓
Overvoltage	460 V	200 ms	460 V	200 ms	458,8 V	187 ms	✓
Underfrequency	47,5 Hz	500 ms	47,5 Hz	500 ms	47,53 Hz	485 ms	✓
Overfrequency	52 Hz	500 ms	52 Hz	500 ms	51,98 Hz	482 ms	✓
Tolerances on trip values:							
- Voltage:±1% Vnom	- Frequency: ± 0,5% fnom		- Clearance time: in accordance with table 4 of EN 50438:2013				

Loss of mains test according to the EN 62116						
Test power and imbalance	29 % -5%Q (Test 22)	58 % -5%Q (Test 12)	100 % -5%P (Test 5)	29 % +5%Q (Test 31)	58 % +5%Q (Test 21)	100 % +5%P (Test 10)
Trip time limit (s)	2 s	2 s	2 s	2 s	2 s	2 s
Measured Value (s)	0,09 s	0,06 s	0,14 s	0,09 s	0,06 s	0,11 s
Verification	✓	✓	✓	✓	✓	✓

Connection and starting to generate electrical power			
Test sequence	Limit	Test value	Verification
f < 47,45 Hz	no connect	no connect	✓
f ≥ 47,45 Hz	60 s	298,3 s	✓
f > 50,10 Hz	no connect	no connect	✓
f ≤ 50,10 Hz	60 s	131,2 s	✓
U < 0,84 Un	no connect	no connect	✓
U ≥ 0,84 Un	60 s	232,1 s	✓
U > 1,11 Un	no connect	no connect	✓
U ≤ 1,11 Un	60 s	252,5 s	✓
Power gradient after connection			
	Limit	Test value	Verification
max. allowed gradient	10 %P/min	9,85 %P/min	✓

Short-circuit current contribution		
Time after fault	Voltage (V)	Current (A)
< 50 ms	37,65	43,6
100 ms	24,66	19,5
250 ms	22,07	12,33
500 ms	21,13	6,72
Time to Trip	0,49	in seconds

DC injection			
P/Pn [%]	Limit	MV (A)	Verification
20	0,5% In	0,0345	✓
50	0,5% In	0,0289	✓
75	0,5% In	0,0289	✓
100	0,5% In	0,0321	✓

Test Results - Power quality

Voltage fluctuations and flicker as per EN 61000-3-11					
	dmax	dc	d(t) in ms	Pst	Plt (2hours)
Limit	4,0%	3,3%	500	1	0,65
Test value	0,33%	3,26%	0,00	0,42	0,42
Verification	✓	✓	✓	✓	✓

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Test Results - Power quality

Harmonics as per BS EN 61000-3-12								
Order	Frequency [Hz]	Thresholds I/In [%]	P/Pn [%]					
			50		100		Max. MV / Limit [%]	
			MV		MV			
2	100	8,00%	0,171 A	0,20%	0,242 A	0,28%	3,48%	✓
3	150	-	0,193 A	0,22%	0,084 A	0,10%	-	-
4	200	4,00%	0,07 A	0,08%	0,053 A	0,06%	2,01%	✓
5	250	10,70%	0,155 A	0,18%	0,049 A	0,06%	1,67%	✓
6	300	2,67%	0,04 A	0,05%	0,033 A	0,04%	1,72%	✓
7	350	7,20%	0,049 A	0,06%	0,052 A	0,06%	0,83%	✓
8	400	2,00%	0,03 A	0,03%	0,025 A	0,03%	1,72%	✓
9	450	-	0,053 A	0,06%	0,031 A	0,04%	-	-
10	500	1,60%	0,028 A	0,03%	0,025 A	0,03%	2,01%	✓
11	550	3,10%	0,098 A	0,11%	0,159 A	0,18%	5,90%	✓
12	600	1,33%	0,024 A	0,03%	0,019 A	0,02%	2,07%	✓
13	650	2,00%	0,101 A	0,12%	0,166 A	0,19%	9,54%	✓
14	700	-	0,014 A	0,02%	0,014 A	0,02%	-	-
15	750	-	0,013 A	0,01%	0,012 A	0,01%	-	-
16	800	-	0,013 A	0,01%	0,013 A	0,01%	-	-
17	850	-	0,127 A	0,15%	0,155 A	0,18%	-	-
18	900	-	0,008 A	0,01%	0,009 A	0,01%	-	-
19	950	-	0,097 A	0,11%	0,113 A	0,13%	-	-
20	1000	-	0,007 A	0,01%	0,009 A	0,01%	-	-
21	1050	-	0,009 A	0,01%	0,01 A	0,01%	-	-
22	1100	-	0,006 A	0,01%	0,008 A	0,01%	-	-
23	1150	-	0,074 A	0,09%	0,082 A	0,09%	-	-
24	1200	-	0,008 A	0,01%	0,01 A	0,01%	-	-
25	1250	-	0,073 A	0,08%	0,064 A	0,07%	-	-
26	1300	-	0,008 A	0,01%	0,009 A	0,01%	-	-
27	1350	-	0,033 A	0,04%	0,033 A	0,04%	-	-
28	1400	-	0,006 A	0,01%	0,007 A	0,01%	-	-
29	1450	-	0,041 A	0,05%	0,037 A	0,04%	-	-
30	1500	-	0,006 A	0,01%	0,006 A	0,01%	-	-
31	1550	-	0,034 A	0,04%	0,032 A	0,04%	-	-
32	1600	-	0,007 A	0,01%	0,006 A	0,01%	-	-
33	1650	-	0,008 A	0,01%	0,006 A	0,01%	-	-
34	1700	-	0,006 A	0,01%	0,005 A	0,01%	-	-
35	1750	-	0,019 A	0,02%	0,014 A	0,02%	-	-
36	1800	-	0,016 A	0,02%	0,012 A	0,01%	-	-
37	1850	-	0,015 A	0,02%	0,011 A	0,01%	-	-
38	1900	-	0,013 A	0,01%	0,01 A	0,01%	-	-
39	1950	-	0,007 A	0,01%	0,005 A	0,01%	-	-
40	2000	-	0,008 A	0,01%	0,005 A	0,01%	-	-

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MV=Measured Value

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Test Results - Grid management

Operating range				
Test sequence	Voltage (V)	Frequency (Hz	Power (W)	Verification
ULL=340 V; f=47,5 Hz P=1,00 Sn; cosϕ=1	340	47,5	52007	✓
ULL=460 V; f=51,5 Hz P=1,00 Sn; cosϕ=1	460	51,5	60339	✓

Active power feed-in at under-frequency				
Test sequence (Hz)	Frequency (Hz)	Power (W)	available power (W)	Verification
fnom ± 0,01	50	58650	60000	✓
fnom - 0,5	49,55	58643	60000	✓
fnom - 2,5	47,55	58611	60000	✓

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Power response to over-frequency								
	P >80%, f1= 50,2 Hz and droop 12%				P >40%, f1= 50,5 Hz and droop 2%			
Test sequence (Hz)	Frequency (Hz)	Power (W)	available power (W)	Verification	Frequency (Hz)	Power (W)	available power (W)	Verification
fnom ± 0,01	50	58077	58077	✓	50	29982	30000	✓
f1 + 0,05	50,25	57559	58077	✓	50,549	28431	30000	✓
50,70 ± 0,10	50,7	53264	58077	✓	50,7	23918	30000	✓
51,15 ± 0,05	51,149	48955	58077	✓	51,149	10484	30000	✓
50,70 ± 0,10	50,7	53261	58077	✓	50,7	23913	30000	✓
f1 + 0,05	50,25	57557	58077	✓	50,549	28429	30000	✓
Power gradient:		9,67 %Pm/min		✓	Power gradient:		9,67 %Pm/min	✓

Reactive power output								
Controllable reactive power					Reactive power output according to an assigned level			
P (%)	cosϕ under-excited	cosϕ unity	cosϕ over-excited	Verification	Q setpoint (%Pmax)	Q setpoint (VA)	Q actual (VA)	Verification
5%	0,866	0,999	0,831	✓	0%	0	-115,8	✓
15%	0,852	1	0,847	✓	50%	30000	29971,2	✓
25%	0,85	1	0,851	✓	0%	0	-117	✓
35%	0,849	1	0,852	✓	-50%	-30000	-30192,6	✓
45%	0,848	1	0,853	✓	0%	0	-115,2	✓
55%	0,848	1	0,854	✓				
65%	0,848	1	0,854	✓				
75%	0,847	1	0,855	✓				
85%	0,847	1	0,855	✓				
95%	0,847	1	0,855	✓				