

## Declaration of Conformity

We manufacturer

**Sonnen GmbH**

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declare that the product

**sonnenBatterie hybrid 9.53**

is in conformity with the applicable essential requirements of the following standard:

**Engineering Recommendation G98 Issue 1 – Amendment 4 June 2019**

Wildpoldsried, 20.09.2021



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Norbert Hinz (CTO)

Firmware v2.25 is currently implemented at field applications. The following results were measured at firmware v2.30 (or higher) at sonnen test lab and will be released soon to the field applications.

**Applicant:** **Sonnen GmbH**  
**Im Innovationspark Allgäu**  
 87499 Wildpoldsried  
 Germany

**Product:** Battery Storage System with Inverter. Inverter provide integrated automatic disconnection device between a generator and the public low-voltage grid

<b>Model:</b>	<b>sonnenBatterie hybrid 9.53</b>					
<b>Rating:</b>	9.53/2.5	9.53/5	9.53/7.5	9.53/10	9.53/12.5	9.53/15
Output Battery into AC grid <sup>1</sup> :	1,1 kVA	2,5 kVA	3,3 kVA			
Output PV + Battery into AC grid <sup>1</sup> :	3,68 kVA					
PV power ≠ AC grid power (DC internal PV power) <sup>2</sup>	4,6 kW					

<sup>1</sup>) at cosphi = 1,0

<sup>2</sup>) PV power can be split into grid and into battery path. At any operation mode (independent from battery state of charge), only 3,68 kW from PV power will be feed into AC grid.

**Intended use:**

An automatic disconnection device with single-phase mains surveillance in accordance Engineering Recommendation G98 Issue 1 – Amendment 4 for photovoltaic systems with a single parallel coupling via an inverter to the public mains supply. The automatic disconnection device is an integral part of the afore mentioned inverter.

**Applied standards and guidelines:**

**Engineering Recommendation G98 Issue 1 – Amendment 4 June 2019**

Requirements for the connection of Fully Type Tested Micro-generators (up to and including 16 A per phase in parallel with public Low Voltage Distribution Networks on or after 27 April 2019

The safety concept of an afore mentioned representative product corresponds at the time of issue of this certificate to the valid safety specifications for the specified use in accordance with regulations.

**Power Quality: Continuous voltage operation range**
**Continuous frequency operation range**

Generating Unit tested to EN 50438:2013

	U [V]	f [Hz]	Cos $\varphi$	P [kW]	Limit [%Sn]:
Test 1	85%Un	47,50 Hz	1,00	100%Sn	P $\geq$ 85%Sn
Measured 90min avg	195,6	47,50 Hz	-0,999	-3,66	99,5
Test 2	110%Un	51,50 Hz	1,00	100%Sn	-
Measured 90min avg	253,2	51,50 Hz	-0,999	-3,65	99,2
Test 3	110%Un	52,00 Hz	1,00	100%Sn	-
Measured 15min avg	253,1	52,10 Hz	-0,999	-3,65	99,2

Power Quality: Harmonics				
Micro-Generator tested to BS EN 61000-3-2				
Micro-Generator rating per phase (rpp)		3,3	kW	
Harmonic	At 45-55% of Registered capacity	100% of Registered capacity		
	Measured Value (MV) in Amps	Measured Value (MV) in Amps	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0,020	0,007	1,080	
3	0,053	0,043	2,300	
4	0,007	0,003	0,430	
5	0,014	0,003	1,140	
6	0,003	0,001	0,300	
7	0,016	0,004	0,770	
8	0,004	0,003	0,230	
9	0,007	0,003	0,400	
10	0,003	0,001	0,184	
11	0,009	0,004	0,330	
12	0,001	0,001	0,153	
13	0,009	0,003	0,210	
14	0,003	0,001	0,131	
15	0,004	0,003	0,150	
16	0,001	0,001	0,115	
17	0,004	0,003	0,132	
18	0,001	0,001	0,102	
19	0,006	0,003	0,118	
20	0,001	0,001	0,092	
21	0,004	0,003	0,107	0,160
22	0,001	0,001	0,084	
23	0,004	0,001	0,098	0,147
24	0,003	0,001	0,077	
25	0,004	0,001	0,090	0,135
26	0,003	0,003	0,071	
27	0,004	0,003	0,086	0,124
28	0,003	0,001	0,066	
29	0,004	0,001	0,078	0,117
30	0,003	0,001	0,061	
31	0,004	0,003	0,073	0,109
32	0,003	0,003	0,058	
33	0,006	0,001	0,068	0,102
34	0,003	0,001	0,054	
35	0,003	0,003	0,064	0,096
36	0,003	0,001	0,051	
37	0,004	0,001	0,061	0,091
38	0,003	0,001	0,048	
39	0,003	0,003	0,058	0,087
40	0,003	0,003	0,046	

Power Quality: Voltage fluctuations and flicker								
	Starting			Stopping			Running	
	$d_{max}$ [%]	$d_c$ [%]	$d_{(t)}$ [ms]	$d_{max}$ [%]	$d_c$ [%]	$d_{(t)}$ [ms]	$P_{st}$	$P_{it}$ 2 hours
Measured Values at test impedance	-3,114	-3,112	0	3,093	3,093	0	0,057	0,056
Normalised to standard impedance	-3,114	-3,112	0	3,093	3,093	0	0,057	0,056
Normalised to required maximum impedance	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Limits set under BS EN 61000-3-11	4 %	3,3 %	3,3 %	4 %	3,3 %	3,3 %	1,0	0,65
Test impedance	R	0,40	$\Omega$	X		0,25	$\Omega$	
Standard impedance	R	0,40	$\Omega$	X		0,25	$\Omega$	
Maximum impedance	R	-	$\Omega$	X		-	$\Omega$	
Test start date	2020-11-15		Test end date			2020-11-30		
Test Location	sonnen GmbH, Am Riedbach 1, 87499 Wildpoldsried, Germany							

Power Quality: DC injection.				
Test power level	20%	50%	75%	100%
Recorded value in mA	1	-2	-3	-4
As % of rated AC current	0,01 %	-0,01 %	-0,01 %	-0,02 %
Limit	0,25 %	0,25 %	0,25 %	0,25 %

Power Quality: Power factor			
	216,2 V	230 V	253 V
20% of Registered Capacity	0,999	0,999	0,999
50% of Registered Capacity	1,000	1,000	1,000
75% of Registered Capacity	1,000	1,000	1,000
100% of Registered Capacity	1,000	1,000	1,000
Limit	>0,95	>0,95	>0,95

Protection: Frequency tests						
Function	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency/ time	Confirm no trip
U/F stage 1	47,5 Hz	20,0 s	47,50 Hz	20,21 s	47,7 Hz 25 s	No Trip
U/F stage 2	47,0 Hz	0,5 s	47,00 Hz	717 ms	47,2Hz 19,98 s	No Trip
					46,8 Hz 0,48 s	No Trip
O/F stage 1	52,0 Hz	0,5 s	52,10 Hz	736 ms	51,8 Hz 89,98 s	No Trip
					52,2 Hz 0,48 s	No Trip
Protection: Voltage tests						
Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage/ time	Confirm no trip
U/V stage	184,0 V	2,5 s	184,5	2,745 s	188,0 V 3,5 s	No trip
					180,0 V 2,48 s	No trip
O/V stage 1	262,2 V	1,0 s	260,12	1,246 s	258,2 V 2,0 s	No trip
O/V stage 2	273,7 V	0,5 s	271,3	743,4 ms	269,7 V 0,98 s	No trip
					277,7 V 0,48 s	No trip
Protection: Loss of Mains test and single phase test						
Note as an alternative, inverters can be tested to BS EN 62116. The following subset of tests should be recorded in the following table.						
Test power and imbalance	33% -5% Q (Test 22)	66% -5% Q (Test 12)	100% +5% Q (Test 5)	33% +5% Q (Test 31)	66% +5% Q (Test 21)	100% +5% P (Test 10)
Trip time	253 ms	381 ms	300 ms	482 ms	445 ms	395 ms
Single phase test for multi-phase <b>Generating Units</b> . Confirm that when generating in parallel with a network operating at around 50 Hz with no network disturbance, that the removal of a single phase connection to the <b>Generating Unit</b> , with the remaining phases connected causes a disconnection of the generating unit within a maximum of 1s.						
Ph 1 removed	Conform trip	Ph2 removed	N/A	Ph 3 removed	N/A	

<b>Protection: Frequency change, Vector Shift Stability test.</b>			
	Start frequency	Change	Confirm no trip
Positive vector shift	49,5 Hz	+50 degrees	No Trip
Negative vector shift	50,5 Hz	-50 degrees	No Trip
<b>Protection: Frequency Change, RoCoF Stability Test</b>			
Ramp range	Test frequency ramp	Test duration	Confirm no Trip
49,0 Hz to 51,0 Hz	+0,95 Hz/s	2,1 s	No Trip
51,0 Hz to 49,0 Hz	-0,95 Hz/s	2,1 s	No Trip

Protection: Limited Frequency Sensitive Mode – Over frequency test (AC power into grid = max. 3.68 kVA, PV power (internal) = 4,6 kW) <sup>1)</sup>				
Test sequence at Registered Capacity >80% <sup>2)</sup>	Measured Active Power Output (kVA)	Frequency (Hz)	Primary Power Source	Active Power Gradient
Step a) 50,00 Hz ± 0,01 Hz	-3,605	50,00	N/A	-
Step b) 50,45 Hz ± 0,05 Hz	-3,386	50,45		-
Step c) 50,70 Hz ± 0,10 Hz	-3,2098	50,70		-
Step d) 51,15 Hz ± 0,05 Hz	-2,906	51,15		-
Step e) 50,70 Hz ± 0,10 Hz	-3,21	50,70		-
Step f) 50,45 Hz ± 0,05 Hz	-3,389	50,45		-
Step g) 50,00 Hz ± 0,01 Hz	-3,605	50,00		10% P <sub>n</sub> /min
Test sequence at Registered Capacity 40% - 60%	Measured Active Power Output (kVA)	Frequency (Hz)	Primary Power Source	Active Power Gradient
Step a) 50,00 Hz ± 0,01 Hz	-1,84	50,00	N/A	-
Step b) 50,45 Hz ± 0,05 Hz	-1,73	50,45		-
Step c) 50,70 Hz ± 0,10 Hz	-1,64	50,70		-
Step d) 51,15 Hz ± 0,05 Hz	-1,47	51,15		-
Step e) 50,70 Hz ± 0,10 Hz	-1,64	50,70		-
Step f) 50,45 Hz ± 0,05 Hz	-1,73	50,45		-
Step g) 50,00 Hz ± 0,01 Hz	-3,63	50,00		10% P <sub>n</sub> /min

<sup>1)</sup> PV power will be reduced internally, if battery is fully charged to also limit AC power into the grid to max. 3,68 kVA. If battery is not fully charged, PV power will be split into AC power and battery charge power, at which AC power is always limited to 3,68 kVA, see next page.

<sup>2)</sup> diagrams are shown at page 10 and 11 in this document





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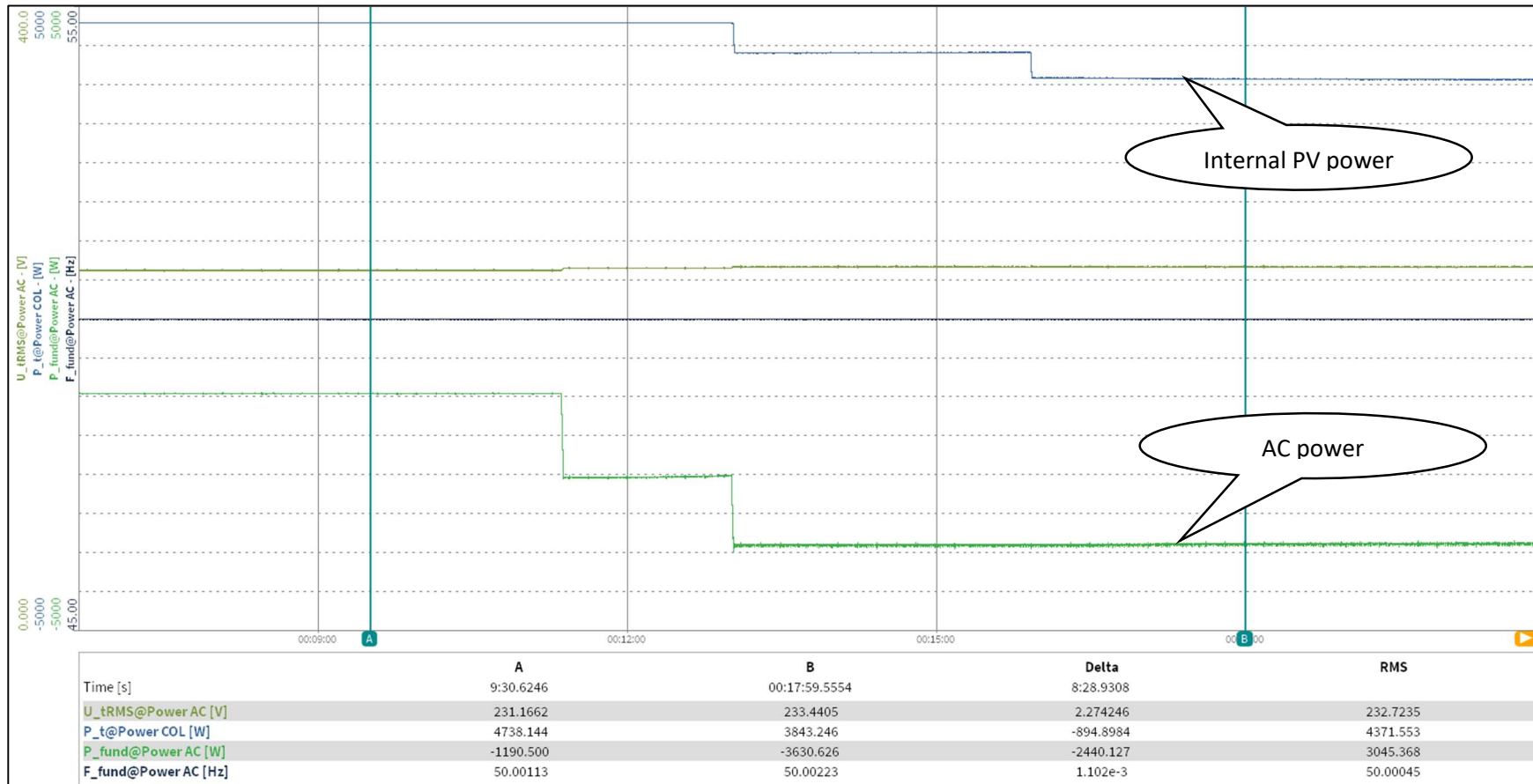


Figure 1: Internal PV power reduction to maximum feed-in power



Figure 2: LFSM-O function, step B in relation to step D

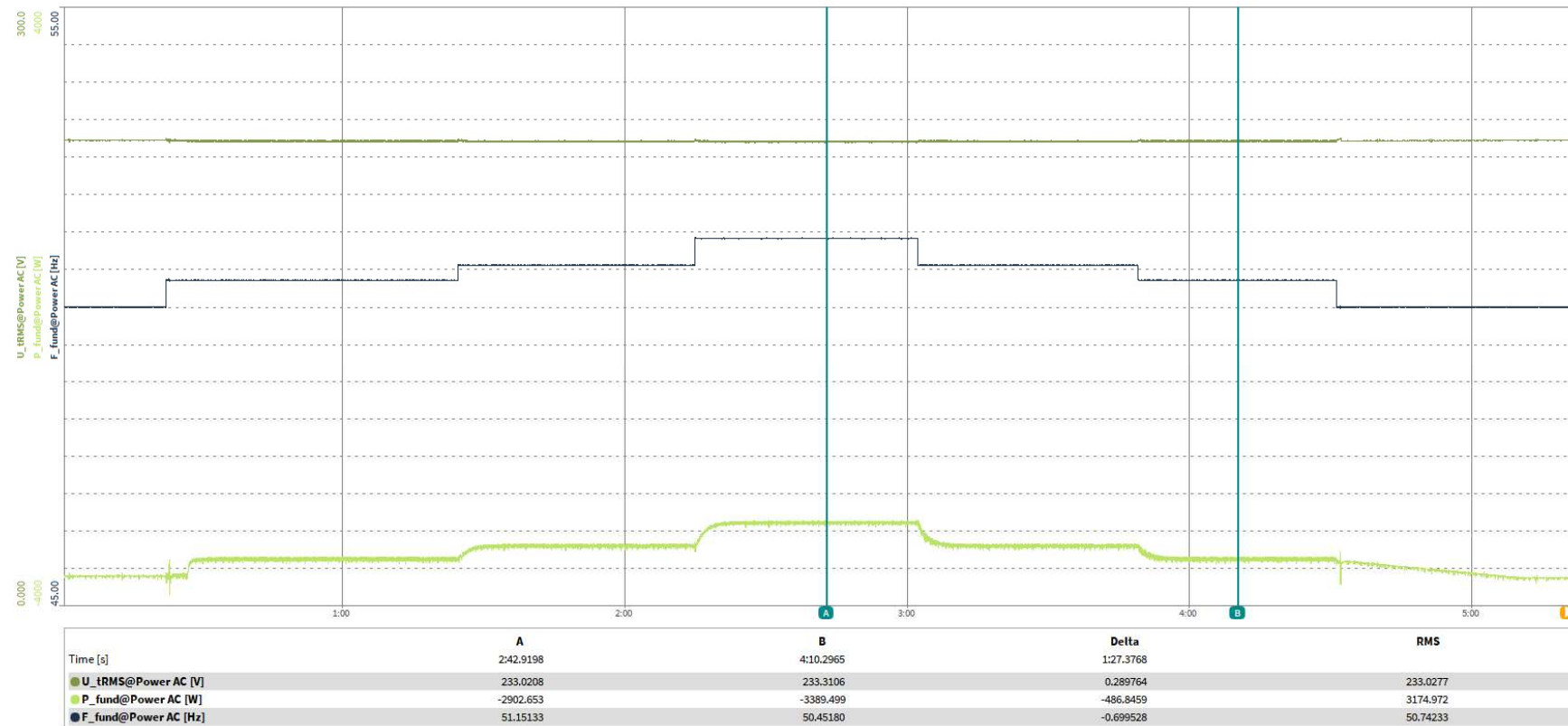


Figure 3: LFSM-O function, step D in relation to step F

Protection: Power output with falling frequency test					
Test sequence	Measured Active Power output	Frequency (Hz)	Primary power source		
Test a) 50 Hz ± 0,01 Hz	-3,66	50,00	N/A		
Test b) Point between 49,5 Hz and 49,6 Hz	-3,66	49,55			
Test c) Point between 47,5 Hz and 47,6 Hz	-3,66	47,55			
Protection: Re-connection timer.					
Time delay settings (s)	Measured delay (s)	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 10.5.7.1			
20	288	At 266,2V	At 180,0V	At 47,7Hz	At 52,1Hz
Confirmation that the <b>Micro-generator</b> does not re- connect		No reconnection	No reconnection	No reconnection	No reconnection
Fault Level contribution.					
For machines with electro-magnetic output			For inverter output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	$i_p$	N/A	20 ms	61,9	18,7
Initial Value of aperiodic current	A	N/A	100 ms	24,3	0,01
Initial symmetrical short-circuit current	$I_k$	N/A	250 ms	24,1	0,01
Decaying (aperiodic) component of short-circuit current	$i_{DC}$	N/A	500 ms	24,1	0,01
Reactance/Resistance Ratio of source	X/R	N/A	Time to trip	0,040	in seconds
Logic Interface					Yes
Self Monitoring solid state switching					
It has been verified that in the event of the solid state switching device failing to disconnect the Micro-Generator, the voltage on the output side of the switching device is reduced to a value below 50 volt within 0,5s.					N/A*
*The inverter provides mechanical relay.					