Suzhou Bytewatt Technology Co., Ltd.

Type Test Verification Report

We

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declare that the test report is issued under our sole responsibility and belongs to the following product:

Product(s):	Hybrid Inverter
Model(s):	BW-INV-SPH3.6K
Parameter(s):	INV Parameter： MPPT Voltage Range：100 ~ 550 V Max. PV Input Power：7200 W Rated output Apparent Power：3600VA IP Protection: IP65 (Outdoor) Humidity:0~90% (No Condensing)
Test date	2022.12.1
Test location	Suzhou Bytewatt Technology Co., Ltd.
Report number	BWG9822120101.2

Singed for and on behalf of:

Baolin. Tan

_____	2023-3-16
Place of issue	Date of issue

Compliance Verification Report –Tests for Inverter Connected Power Generating Modules – test record		
1. Operating Range:		
1	Voltage = 85% of nominal (195.5 V), Frequency = 47 Hz, Power Factor = 1, Period of test 20 s	Pass
2	Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, Power Factor = 1, Period of test 90 minutes	Pass
3	Voltage = 110% of nominal (253 V), Frequency = 51.5 Hz, Power Factor = 1, Period of test 90 minutes	Pass
4	Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, Power Factor = 1, Period of test 15 minutes	Pass
5	Voltage = 100% of nominal (230 V), Frequency = 50,0 Hz to 50,5 Hz, Power Factor = 1, RoCoF 1Hz/s, Period of test 0,5 seconds	Pass
6	Voltage = 100% of nominal (230 V), Frequency = 50,0 Hz, Power Factor = 1, Period of test 90 minutes	Pass

2. Power Quality – Harmonics:					
Power Generating Module tested to BS EN 61000-3-2					
Prated			3.6 kVA		
Harmonics	50%Prated		100% Prated		Limits
	Amps	%	Amps	%	1 phase
2	0.091	0.85%	0.157	0.73%	1.080
3	0.158	1.48%	0.309	1.44%	2.300
4	0.018	0.17%	0.027	0.13%	0.430
5	0.063	0.59%	0.074	0.35%	1.140
6	0.019	0.18%	0.023	0.11%	0.300
7	0.055	0.51%	0.076	0.36%	0.770
8	0.011	0.10%	0.007	0.03%	0.230
9	0.039	0.36%	0.052	0.24%	0.400
10	0.009	0.08%	0.011	0.05%	0.184
11	0.045	0.42%	0.044	0.21%	0.330
12	0.012	0.11%	0.016	0.07%	0.153
13	0.034	0.32%	0.036	0.17%	0.210
14	0.031	0.29%	0.055	0.26%	0.131
15	0.072	0.67%	0.085	0.40%	0.150
16	0.053	0.50%	0.064	0.30%	0.115
17	0.062	0.58%	0.074	0.35%	0.132
18	0.053	0.49%	0.061	0.29%	0.102
19	0.054	0.51%	0.065	0.30%	0.118
20	0.046	0.43%	0.054	0.25%	0.092
21	0.055	0.51%	0.064	0.30%	0.107
22	0.041	0.38%	0.048	0.22%	0.084
23	0.049	0.46%	0.057	0.27%	0.098
24	0.043	0.40%	0.049	0.23%	0.077
25	0.043	0.40%	0.051	0.24%	0.090
26	0.038	0.36%	0.044	0.20%	0.071
27	0.045	0.42%	0.052	0.24%	0.083
28	0.034	0.31%	0.039	0.18%	0.066
29	0.041	0.38%	0.047	0.22%	0.078
30	0.036	0.34%	0.041	0.19%	0.061
31	0.036	0.34%	0.042	0.20%	0.073
32	0.033	0.31%	0.037	0.17%	0.058

33	0.039	0.37%	0.044	0.21%	0.068
34	0.029	0.27%	0.033	0.15%	0.054
35	0.035	0.33%	0.040	0.19%	0.064
36	0.032	0.30%	0.036	0.17%	0.051
37	0.032	0.30%	0.036	0.17%	0.061
38	0.029	0.27%	0.032	0.15%	0.048
39	0.035	0.33%	0.039	0.18%	0.058
40	0.026	0.24%	0.029	0.14%	0.046
THD[1]	0.221	2.89%	0.355	2.13%	5%
PWHD[2]	0.438	2.19%	0.596	2.98%	23%

[1] THD = Total Harmonic Distortion
[2] PWHD = Partial Weighted Harmonic Distortion

3. Power Quality – Voltage fluctuations and Flicker:								
	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2h
Measured Values	0.31%	0.31%	0ms	0.34%	0.26%	0ms	0.021	0.021
Normalised impedance	0.31%	0.31%	0ms	0.34%	0.26%	0ms	0.021	0.021
Limit	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65

Test Impedance	R	0.4	Ω	Xl	0.25	Ω
Standard Impedance	R	0.4	Ω	Xl	0.25	Ω
Max. Impedance	R	N/A	Ω	Xl	N/A	Ω

4. Power quality – DC injection:				
Output power	20%	50%	75%	100%
Test value(A)	23.8mA	27.1mA	31.2mA	34.8mA
Test value(%)	0.11%	0.12%	0.14%	0.16%
Limit	0.25%	0.25%	0.25%	0.25%

5. Power Factor:			
Voltage	0.94 p.u (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured Value	0.999	0.999	0.999
Power Factor Limit	>0.95	>0.95	>0.95

6. Protection – Frequency tests:

	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Status
UF 1	47.5 Hz	20 s	47.52Hz	20.03s	47.7 Hz/30 s	No trip
UF 2	47 Hz	0.5 s	46.96Hz	0.53s	47.2 Hz/19.5 s	No trip
					46.8 Hz /0.45 s	No trip
OF	52 Hz	0.5 s	52.03Hz	0.53s	51.8 Hz/120.0 s	No trip
					52.2 Hz/0.45 s	No trip

Note. For frequency trip tests the frequency required to trip is the setting ± 0.1 Hz. 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 ± 0.2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

7. Protection – Voltage tests:

	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage/time	Status
UV	184 V	2.5 s	183.8V	2.53s	188 V/5.0 s	No trip
					180 V/2.45 s	No trip
OV 1	262.2 V	1.0 s	262.5V	1.04s	258.2 V/5.0 s	No trip
OV 2	273.7 V	0.5 s	274.2V	0.54s	269.7 V/0.95 s	No trip
					277.7 V/0.45 s	No trip

Note for Voltage tests the Voltage required to trip is the setting ±3.45 V. 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 ±4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

8. Protection – Loss of Mains test: PV Inverter: Complete test power and imbalance (Test 22, 12, 5, 31, 21 & 10) – ensure trip time is within limit of 0.5s in accordance with BS EN 62116.						
The following sub set 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% P Test 5	33% +5% Q Test 31	66% +5% Q Test 21	100% +5% P Test 10
Trip time. Limit 0.5s	0.31s	0.28s	0.23s	0.32s	0.30s	0.24s

Loss of Mains Protection, Vector Shift Stability test. This test should be carried out in accordance with Annex A.7.1.2.6.			
	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
Loss of Mains Protection, RoCoF Stability test: This test should be carried out in accordance with Annex A.7.1.2.6.			
Ramp range	Test frequency ramp	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hzs^{-1}	2.1 s	No trip
51.0 Hz to 49.0 Hz	-0.95 Hzs^{-1}	2.1 s	No trip

9. Limited Frequency Sensitive Mode – Over frequency test: The test should be carried out using the specific threshold frequency of 50.4 Hz and Drop of 10%.							
1. Measurement a) to g): Active power output =100% PEmax S=5% (40% PEmax / Hz), threshold frequency for start/return: 50.4Hz							
Frequency	50.00Hz	50.45Hz	50.70Hz	51.15Hz	50.70Hz	50.45Hz	50.00Hz
Calculated P	3600W	3240W	2880W	2232W	2880W	3240W	3600W
Measured P	3558W	3210W	2849W	2330W	2799W	3193W	3550W
ΔP（%）	N/A	0.69%	0.53%	0.50%	0.83%	0.92%	N/A
2. Measurement a) to g): Active power output 60% after freezing = 100% PEmax S=5% (40% PEmax / Hz), threshold frequency for start/return: 50.4Hz							
Frequency	50.00Hz	50.45Hz	50.70Hz	51.15Hz	50.70Hz	50.45Hz	50.00Hz
Calculated P	2160W	2088W	1728W	1080W	1728W	2088W	2160W
Measured P	2134W	2095W	1739W	1090W	1740W	2073W	2168W
ΔP（%）	N/A	0.19%	0.31%	0.28%	0.33%	-0.42%	N/A
Limit ΔP/P1min:	± 10 % of PEmax						

10. Power output with falling frequency test: This test should be carried out in accordance with EN 50438 Annex D.3.2 active power feed-in at under-frequency.			
Test sequence	Measured active power output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	3588 W	50.01 Hz	4500 W
Test b) Point between 49.5 Hz and 49.6 Hz	3580 W	50.01 Hz	4500 W
Test c) Point between 47.5 Hz and 47.6 Hz	3585 W	50.01 Hz	4500 W

11. Fault level contribution: These tests shall be carried out in accordance with EREC G98 Annex A.7.1.5.		
For **Inverter** output		
Time after fault	Volts	Amps
20ms	52.2V	29.9A
100ms	51.7V	0A
250ms	51.3V	0A
500ms	51.3V	0A
Time to trip	0.062s	In seconds

12. Protection – Re-connection timer			
Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1.			
Setting		Measured delay	
30s		32s	
1.16 pu (266.2V)	0.78 pu (180.0V)	47.4 Hz	52.1 Hz
Not reconnect	Not reconnect	Not reconnect	Not reconnect

13. Self-Monitoring solid state switching: No specified test requirements. Refer to Annex A.7.1.7.	
It has been verified that in the event of the solid state switching device failing to disconnect the **Power Park Module**, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.	NA

14. Logic Interface
Excess PV production not used in the installation will be stored in the battery. The battery will be used to power loads in the installation when PV production is not present. Any further excess PV will be exported to the Grid (if DC coupled). An RS485 terminal interface is available for local commands to control the unit. LED Screen is integrated as a logic interface.

15. Cyber Security
The system has no open ports, no generic passwords and all communication between the cloud

and the module are cyber protected to using SSL Level 2 technology. Any software updates via the cloud are protected to ISO27000 Standards. The device complies with all applicable data protection and privacy legislation in force from time to time in the UK including the General Data Protection Regulation ((EU) 2016/679); the Data Protection Act 2018. This includes the Data Protection, Privacy and Electronic Communications (Amendments etc.) (EU Exit) Regulations 2019, as amended and the DPA (the UK GDPR) and any other UK or European Union legislation applicable in the UK relating to personal data and all other legislation and regulatory requirements.