

ATTESTATION OF CONFORMITY

Issued to: Afore New Energy Technology (Shanghai) Co., Ltd.
Build No.7, 333 Wanfang Road, Minhang District, Shanghai, China

For the product: Hybrid inverter



Trade name:

Type/Model: AF3K-SL, AF3K-SH, AF3.6K-SL, AF3.6K-SH

Ratings: See Annex

Manufactured by: Afore New Energy Technology (Shanghai) Co., Ltd.
Build No.7, 333 Wanfang Road, Minhang District, Shanghai, China

Requirements: Engineering Recommendation G98 Issue 1 – Amendment 4: 2019

This Attestation is granted on account of an examination by DEKRA, the results of which are laid down in a confidential file no 6098057.52.

The examination has been carried out on one single specimen or several specimens of the product, submitted by the manufacturer. The Attestation does not include an assessment of the manufacturer's production. Conformity of his production with the specimen tested by DEKRA is not the responsibility of DEKRA.

Arnhem, 10 March 2021

Number: 6098057.03AOC

DEKRA Testing and Certification (Shanghai) Ltd.

Kreny Lin
Certification Manager

A handwritten signature in black ink, appearing to read "Kreny Lin". The signature is written in a cursive, flowing style.

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Page 1 of 14

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Annex to 6098057.03AOC

Ratings of the products:

AF3K-SL:

PV input: Max. 580 Vdc, MPPT voltage range: 50-550 Vdc, max 20*2 A, Isc PV: 26*2 A

AC Output & AC input: 230 Vac, 50 Hz, Nominal 3000 VA, rated 13 A, max 15 A

Battery voltage operation range: 40-60 Vdc, Rated voltage: 48 Vdc, Max charge and discharge current: 60 A, Max charge power & discharge power: 3000 W

EPS output: 230 Vac, rated power 3000 VA, rated current 13 A

AF3K-SH:

PV input: Max. 580 Vdc, MPPT voltage range: 50-550 Vdc, max 20*2 A, Isc PV: 26*2 A

AC Output & AC input: 230 Vac, 50 Hz, Nominal 3000 VA, rated 13 A, max 15A

Battery voltage operation range: 85-360 Vdc, Rated voltage: 288 Vdc, Max charge and discharge current: 30 A, Max charge power & discharge power: 6000 W/3000 W

EPS output: 230 Vac, rated power 3000 VA, rated current 13 A

AF3.6K-SL:

PV input: Max. 580 Vdc, MPPT voltage range: 50-550 Vdc, max 20*2 A, Isc PV: 26*2 A

AC Output & AC input: 230 Vac, 50 Hz, Nominal 3600 VA, rated 16 A, max 18.5 A

Battery voltage operation range: 40-60 Vdc, Rated voltage: 48 V, Max charge and discharge current: 66 A, Max charge power & discharge power: 3600 W

EPS output: 230 Vac, rated power 3600 VA, rated current 16 A

AF3.6K-SH:

PV input: Max. 580 Vdc, MPPT voltage range: 50-550 Vdc, max 20*2 A, Isc PV: 26*2 A

AC Output & AC input: 230 Vac, 50 Hz, Nominal 3600 VA, rated 16 A, max 18.5 A

Battery voltage operation range: 85-360 Vdc, Rated voltage: 288 V, Max charge and discharge current: 30 A, Max charge power & discharge power: 7000 W/3600 W

EPS output: 230 Vac, rated power 3600 VA, rated current 16 A

G98/1-4 Form C: Type Verification Test Report

Extract form test report number.:

6098057.52

Operating Range: This test should be carried out as specified in EN 50438 D.3.1.

Active Power shall be recorded every second. The tests will verify that the **Micro-generator** can operate within the required ranges for the specified period of time.

The **Interface Protection** shall be disabled during the tests.

In case of a PV **Micro-generator** the PV primary source may be replaced by a **DC** source.

In case of a full converter **Micro-generator** (eg wind) the primary source and the prime mover **Inverter/rectifier** may be replaced by a **DC** source.

In case of a DFIG **Micro-generator** the mechanical drive system may be replaced by a test bench motor.

Test 1
 Voltage = 85% of nominal (195.5 V)
 Frequency = 47.5 Hz
 Power factor = 1
 Period of test 90 minutes

Test 2
 Voltage = 110% of nominal (253 V).
 Frequency = 51.5 Hz
 Power factor = 1
 Period of test 90 minutes

Test 3
 Voltage = 110% of nominal (253 V).
 Frequency = 52.0 Hz
 Power factor = 1
 Period of test 15 minutes

Test 1 **P**

Model: AF3.6K-SL

Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (W)	Measured Power factor	Test Time (Minutes)
195.49	47.50	3609.50	0.9996	90

Test 2 **P**

Model: AF3.6K-SL

Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (W)	Measured Power factor	Test Time (Minutes)
253.11	51.50	3730.03	0.9996	90

Test 3 **P**

Model: AF3.6K-SL

Voltage (V)	Frequency (Hz)	Power (W)	Power factor	Time (Minutes)
252.98	52.00	3705.65	0.9996	15

Power Quality – Harmonics: These tests should be carried out as specified in BS EN 61000-3-2. The chosen test should be undertaken with a fixed source of energy at two power levels a) between 45 and 55% and b) at 100% of Registered Capacity . The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).						P	
Micro-generator tested to BS EN 61000-3-2							
Model: AF3.6K-SL							
Micro-generator rating per phase (rpp)			3.6	kW		$NV = MV * 3.68 / rpp$	
Harmonic	At 45-55% of Registered Capacity		100% of Registered Capacity		Limit in BS EN 61000-3-2 in Amps		Higher limit for odd harmonics 21 and above
	Measured Value (MV) in Amps	Normalised Value (NV) in Amps	Measured Value (MV) in Amps	Normalised Value (NV) in Amps			
2	0.032	0.033	0.040	0.041	1.080		
3	0.076	0.078	0.234	0.239	2.300		
4	0.005	0.005	0.006	0.006	0.430		
5	0.030	0.031	0.093	0.095	1.140		
6	0.006	0.006	0.006	0.006	0.300		
7	0.016	0.016	0.048	0.049	0.770		
8	0.006	0.006	0.007	0.007	0.230		
9	0.014	0.014	0.032	0.033	0.400		
10	0.006	0.006	0.006	0.006	0.184		
11	0.008	0.008	0.017	0.017	0.330		
12	0.006	0.006	0.007	0.007	0.153		
13	0.007	0.007	0.017	0.017	0.210		
14	0.006	0.006	0.006	0.006	0.131		
15	0.006	0.006	0.009	0.009	0.150		
16	0.005	0.005	0.006	0.006	0.115		
17	0.006	0.006	0.008	0.008	0.132		
18	0.005	0.005	0.006	0.006	0.102		
19	0.005	0.005	0.007	0.007	0.118		
20	0.005	0.005	0.006	0.006	0.092		
21	0.005	0.005	0.008	0.008	0.107	0.160	
22	0.005	0.005	0.007	0.007	0.084		
23	0.005	0.005	0.007	0.007	0.098	0.147	
24	0.005	0.005	0.006	0.006	0.077		
25	0.005	0.005	0.007	0.007	0.090	0.135	
26	0.005	0.005	0.007	0.007	0.071		
27	0.005	0.005	0.007	0.007	0.083	0.124	
28	0.005	0.005	0.007	0.007	0.066		
29	0.005	0.005	0.008	0.008	0.078	0.117	
30	0.004	0.004	0.007	0.007	0.061		

31	0.004	0.004	0.007	0.007	0.073	0.109
32	0.004	0.004	0.007	0.007	0.058	
33	0.005	0.005	0.007	0.007	0.068	0.102
34	0.004	0.004	0.008	0.008	0.054	
35	0.004	0.004	0.008	0.008	0.064	0.096
36	0.004	0.004	0.008	0.008	0.051	
37	0.004	0.004	0.008	0.008	0.061	0.091
38	0.004	0.004	0.008	0.008	0.048	
39	0.004	0.004	0.008	0.008	0.058	0.087
40	0.004	0.004	0.008	0.008	0.046	

Note: the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2.

Power Quality – Harmonics: These tests should be carried out as specified in BS EN 61000-3-2. The chosen test should be undertaken with a fixed source of energy at two power levels a) between 45 and 55% and b) at 100% of **Registered Capacity**. The test requirements are specified in Annex A1 A.1.3.1 (**Inverter** connected) or Annex A2 A.2.3.1 (Synchronous).

P

Micro-generator tested to BS EN 61000-3-2

Model: AF3K-SL

Micro-generator rating per phase (rpp)		3.0	kW		NV=MV*3.68/rpp	
Harmonic	At 45-55% of Registered Capacity		100% of Registered Capacity		Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
	Measured Value (MV) in Amps	Normalised Value (NV) in Amps	Measured Value (MV) in Amps	Normalised Value (NV) in Amps		
2	0.021	0.021	0.041	0.042	1.080	
3	0.060	0.061	0.201	0.205	2.300	
4	0.005	0.005	0.009	0.009	0.430	
5	0.022	0.022	0.079	0.081	1.140	
6	0.005	0.005	0.008	0.008	0.300	
7	0.014	0.014	0.040	0.041	0.770	
8	0.004	0.004	0.009	0.009	0.230	
9	0.011	0.011	0.027	0.028	0.400	
10	0.004	0.004	0.008	0.008	0.184	
11	0.006	0.006	0.016	0.016	0.330	
12	0.004	0.004	0.008	0.008	0.153	
13	0.005	0.005	0.015	0.015	0.210	
14	0.004	0.004	0.008	0.008	0.131	
15	0.005	0.005	0.010	0.010	0.150	
16	0.004	0.004	0.008	0.008	0.115	
17	0.004	0.004	0.009	0.009	0.132	

18	0.004	0.004	0.008	0.008	0.102	
19	0.004	0.004	0.009	0.009	0.118	
20	0.004	0.004	0.009	0.009	0.092	
21	0.004	0.004	0.009	0.009	0.107	0.160
22	0.004	0.004	0.008	0.008	0.084	
23	0.004	0.004	0.009	0.009	0.098	0.147
24	0.004	0.004	0.008	0.008	0.077	
25	0.004	0.004	0.008	0.008	0.090	0.135
26	0.004	0.004	0.008	0.008	0.071	
27	0.004	0.004	0.008	0.008	0.083	0.124
28	0.004	0.004	0.008	0.008	0.066	
29	0.004	0.004	0.009	0.009	0.078	0.117
30	0.003	0.003	0.008	0.008	0.061	
31	0.003	0.003	0.008	0.008	0.073	0.109
32	0.003	0.003	0.008	0.008	0.058	
33	0.003	0.003	0.008	0.008	0.068	0.102
34	0.003	0.003	0.008	0.008	0.054	
35	0.003	0.003	0.008	0.008	0.064	0.096
36	0.003	0.003	0.008	0.008	0.051	
37	0.003	0.003	0.008	0.008	0.061	0.091
38	0.003	0.003	0.008	0.008	0.048	
39	0.003	0.003	0.008	0.008	0.058	0.087
40	0.002	0.002	0.009	0.009	0.046	

Note: the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2.

Power Quality – Voltage fluctuations and Flicker: These tests should be undertaken in accordance with EREC G98 Annex A1 A.1.3.3 (Inverter connected) or Annex A2 A.2.3.3 (Synchronous).								P
Model: AF3.6K-SL								
	Starting			Stopping			Running	
	d max	d c	d(t)	d max	d c	d(t)	P _{st}	P _{It} 2 hours
Measured Values at test impedance	0.38%	0.15	0	0.53%	0.12	0	0.18	0.15
Normalised to standard impedance	0.38%	0.15	0	0.53%	0.12	0	0.18	0.15
Normalised to required maximum impedance	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Limits set	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65

under BS EN 61000-3-3		500m s		500m s		
Test Impedance	R	0.24	Ω	X	0.15	Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω
Maximum Impedance	R	N/A	Ω	X	N/A	Ω

*Applies to three phase and split single phase **Micro-generators**.

^ Applies to single phase **Micro-generators** and **Micro-generators** using two phases on a three phase system.

Normalised value = Measured value*reference source resistance/measured source resistance at test point.

Single phase units reference source resistance is 0.4 Ω

Two phase units in a three phase system reference source resistance is 0.4 Ω .

Two phase units in a split phase system reference source resistance is 0.24 Ω .

Three phase units reference source resistance is 0.24 Ω .

Where the power factor of the output is under 0.98 then the X to R ratio of the test impedance should be close to that of the Standard Impedance.

The stopping test should be a trip from full load operation.

The duration of these tests need to conform to the particular requirements set out in the testing notes for the technology under test. Dates and location of the test need to be noted below.

Power quality – DC injection: This test should be carried out in accordance with EN 50438 Annex D.3.10					P
Model: AF3.6K-SL					
Test power level	20%	50%	75%	100%	
Recorded value in Amps	0.022	0.024	0.023	0.025	
as % of rated AC current	0.14%	0.15%	0.15%	0.16%	
Limit	0.25%	0.25%	0.25%	0.25%	

Power quality – DC injection: This test should be carried out in accordance with EN 50438 Annex D.3.10					P
Model: AF3K-SL					
Test power level	20%	50%	75%	100%	
Recorded value in Amps	0.019	0.018	0.019	0.021	
as % of rated AC current	0.15%	0.14%	0.15%	0.16%	
Limit	0.25%	0.25%	0.25%	0.25%	

Power Quality – Power factor: This test shall be carried out in accordance with EN 50538 Annex D.3.4.1 but with nominal voltage -6% and +10%. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.				P
Model: AF3.6K-SL				
Voltage	216.2 V	230 V	253 V	
20% of Registered Capacity	0.9965	0.9943	0.9890	
50% of Registered Capacity	0.9996	0.9994	0.9978	
75% of Registered Capacity	0.9997	0.9996	0.9989	
100% of Registered Capacity	0.9994	0.9996	0.9989	
Limit	>0.95	>0.95	>0.95	

Power Quality – Power factor: This test shall be carried out in accordance with EN 50538 Annex D.3.4.1 but with nominal voltage -6% and +10%. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.				P
Model: AF3K-SL				
Voltage	216.2 V	230 V	253 V	
20% of Registered Capacity	0.9961	0.9945	0.9889	
50% of Registered Capacity	0.9996	0.9994	0.9978	
75% of Registered Capacity	0.9997	0.9996	0.9990	
100% of Registered Capacity	0.9994	0.9996	0.9990	
Limit	>0.95	>0.95	>0.95	

Protection – Frequency tests: These tests should be carried out in accordance with EN 50438 Annex D.2.4 and the notes in EREC G98 Annex A1 A.1.2.3 (Inverter connected) or Annex A2 A.2.2.3 (Synchronous)						P
Model: AF3.6K-SL						
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 s	47.48 Hz	20.2 s	47.7 Hz 30 s	No trip

U/F stage 2	47 Hz	0.5 s	46.98 Hz	0.536 s	47.2 Hz 19.5 s	No trip
					46.8 Hz 0.45 s	No trip
O/F	52.0Hz	0.5s	52.02 Hz	0.546 s	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.

Protection – Voltage tests: These tests should be carried out in accordance with EN 50438 Annex D.2.3 and the notes in EREC G98 Annex A1 A.1.2.2 (Inverter connected) or Annex A2 A.2.2.2 (Synchronous)	P
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Model: AF3.6K-SL

Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	184.0V	2.5 s	180.8 V	2.504 s	188 V 5.0 s	No trip
					180 V 2.45 s	No trip
O/V stage 1	262.2V	1.0 s	265.5 V	1.048 s	258.2 V 5.0 s	No trip
O/V stage 2	273.7V	0.5 s	277.1 V	0.544 s	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.

For Inverters tested to BS EN 62116 the following sub set of tests should be recorded in the following table.						P
Model: AF3.6K-SL						
Test Power and imbalance	33% -5% Q	66% -5% Q	100% -5% P	33% +5% Q	66% +5% Q	100% +5% P
Trip time Limit is 0.5 s	90.8 ms	81.2 ms	74.8 ms	81.6 ms	81.6 ms	72.8 ms

Protection – Frequency change, Vector Shift Stability test: This test should be carried out in accordance with EREC G98 Annex A1 A.1.2.6 (Inverter connected) or Annex A2 A.2.2.6 (Synchronous).				P
Model: AF3.6K-SL				
Vector Shift	Start Frequency	Change	Confirm no trip	
Positive Vector Shift	49.0 Hz	+50 degrees	No trip	
Negative Vector Shift	50.0 Hz	- 50 degrees	No trip	

Protection – Frequency change, RoCoF Stability test: The requirement is specified in section 11.3, test procedure in Annex A.1.2.6 (Inverter connected) or Annex A2 A.2.2.6 (Synchronous).				P
Model: AF3.6K-SL				
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	

Limited Frequency Sensitive Mode – Overfrequency test: This test should be carried out in accordance with EN 50438 Annex D.3.3 Power response to over- frequency. The test should be carried out using the specific threshold frequency of 50.4 Hz and Droop of 10%.						P
Model: AF3.6K-SL						
Test sequence at Registered Capacity >80%	Measured Active Power Output	Frequency (Hz)	Droop (%)	Primary Power Source	Active Power Gradient	

Step a) 50.00 Hz ±0.01 Hz	3609.4	50.00	-	Photovoltaic array simulator	-
Step b) 50.45 Hz ±0.05 Hz	3570.7	50.45	9.33		-
Step c) 50.70 Hz ±0.10 Hz	3373.4	50.70	9.18		-
Step d) 51.15 Hz ±0.05 Hz	3059.6	51.15	9.85		-
Step e) 50.70 Hz ±0.10 Hz	3372.5	50.70	9.14		-
Step f) 50.45 Hz ±0.05 Hz	3571.5	50.45	9.52		-
Step g) 50.00 Hz ±0.01 Hz	3609.3	50.00	-		10%
Test sequence at Registered Capacity 40% - 60%	Measured Active Power Output	Frequency (Hz)	$\Delta P_{E60}/P_n$ (%)		Primary Power Source
Step a) 50.00 Hz ±0.01 Hz	1806.9	50.00	-	Photovoltaic array simulator	-
Step b) 50.45 Hz ±0.05 Hz	1786.9	50.45	9.04		-
Step c) 50.70 Hz ±0.10 Hz	1693.7	50.70	9.58		-
Step d) 51.15 Hz ±0.05 Hz	1533.9	51.15	9.93		-
Step e) 50.70 Hz ±0.10 Hz	1689.9	50.70	9.27		-
Step f) 50.45 Hz ±0.05 Hz	1787.9	50.45	9.51		-
Step g) 50.00 Hz ±0.01 Hz	1807.2	50.00	-		10%
Steps as defined in EN 50438					
Assessment criteria					
The test is regarded as passed:					
a) For adjustable micro-generators, if:					
1) the active power drops between the previously mentioned measuring points b) and f) with the set gradient P_M per Hz with an increase in frequency or increases when the frequency decreases once more;					
2) the maximum occurring active power gradient at point j) is less than the configured maximum active power per minute;					
3) the active power value of the set value determined by the gradient characteristic curve does not deviate by more than + 10 % nominal power of the micro-generator;					
4) the settling time is equal or below 2 s with an intentional delay set to zero.					
b) For partly adjustable micro-generators, and non-adjustable micro-generators if:					
1) they behave as described in a) inside their control range and,					
2) outside the control range, the power supplied when leaving the control range remains constant until disconnection. Disconnection shall occur at the latest at f_{max} .					

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.			P
Model: AF3.6K-SL			
Test sequence	Measured Active	Frequency	Primary power source
Test a) 50 Hz \pm 0.01 Hz	3600.0	50.00	Photovoltaic array simulator
Test b) Point between 49.5 Hz and 49.6 Hz	3599.4	49.55	Photovoltaic array simulator
Test c) Point between 47.5 Hz and 47.6 Hz	3599.8	47.55	Photovoltaic array simulator
NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes			

Re-connection timer.				P
Model: AF3.6K-SL				
Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of				
Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 2.		
30 s	31 s	At 266.2 V	At 180.0 V	At 47.4 Hz At 52.1 Hz
Confirmation that the Micro-generator does not re-connect.		No reconnection	No reconnection	No reconnection No reconnection

Fault level contribution: These tests shall be carried out in accordance with EREC G98 Annex A1 A.1.3.5 (Inverter connected) and Annex A2 A.2.3.4 (Synchronous).					P
Model: AF3.6K-SL					
For machines with electro-magnetic output			For Inverter output		
Parameter	Symbol	Value	Time after	Volts	Amps
Peak Short Circuit current	i_p	N/A	20 ms	187.7 V	9.806 A
Initial Value of aperiodic current	A	N/A	100 ms	0.899 V	8.758 A
Initial symmetrical short-circuit	I_k	N/A	250 ms	0	0
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500 ms	0	0
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0.116	In seconds
For rotating machines and linear piston machines the test should produce a 0 s – 2 s plot of the short circuit current as seen at the Micro-generator terminals.					
* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot.					
Logic Interface.					Yes
Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (Inverter connected).					N/A
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 V within 0.5 s.					N/A
Additional comment					
No.					