G98/1-2 Type Test Verification Report

Inverter Model	ATM-3K-TLS, ATM-3K-TL, ATM-4K-TL		
Manufacturer Reference number			
Micro-generator technology	Hybrid inverter		
Manufacturer name	Aton Green Storage SpA		
Registered office address	Via Nuova Circonvallazione, 57/B - 47923 Rimini (RN), Italy		
Operational headquarters address	Via Guido Rossa, 5 – 41057 Spilamberto (MO), Italy		
Tel	+3959783939	**Fax**	+3959784323
E:mail	a.ferrero@atonstorage.com	**Web site**	www.atonstorage.com

Maximum rated capacity	**Connection Option**	
	3	**kW single phase**
	3.68	**kW single phase**

Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above Type Tested reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98.

Signed	Mr. Ettore Uguzzoni 	**On behalf of**	Aton Green Storage SpA

The tests were carried out by personnel with sufficient technical competence at:
- the internal laboratories of the Company that produces the Equipment Under Test on behalf of the Manufacturer and with the Manufacturer's brand: Jiangsu GoodWe Power Supply Technology Co., Ltd. - No. 90 Zijin Road, Suzhou New District, Jiangsu, PRC;
- or at external laboratories identified by Jiangsu GoodWe Power Supply Technology Co., Ltd.

All organizations involved in the tests keep copies of all records of the tests and results.

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** (e.g. 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	Result Pass
Test 2 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Result Pass
Test 3 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Result Pass

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).	**Pass**

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

Micro-generator rating per phase (rpp)			kW		NV=MV*3.68/rpp	
	At 45-55% of Registered Capacity		100% of Registered Capacity			
Harmonic	Measured Value (MV) in Amps	Normalized Value (NV) in Amps	Measured Value (MV) in Amps	Normalized Value (NV) in Amps	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2nd	0.0404	0.0496	0.0817	0.1002	1.080	
3rd	0.1058	0.1298	0.0814	0.0999	2.300	
4th	0.0204	0.0250	0.0101	0.0124	0.430	
5th	0.0842	0.1033	0.0769	0.0943	1.140	
6th	0.0139	0.0171	0.0237	0.0291	0.300	
7th	0.0573	0.0703	0.0784	0.0962	0.770	
8th	0.0033	0.0041	0.0122	0.0150	0.230	

9th	0.0273	0.0335	0.0567	0.0696	0.400	
10th	0.0095	0.0116	0.0168	0.0206	0.184	
11th	0.0084	0.0104	0.0483	0.0593	0.330	
12th	0.0046	0.0056	0.0137	0.0168	0.153	
13th	0.0070	0.0086	0.0340	0.0417	0.210	
14th	0.0029	0.0036	0.0080	0.0099	0.131	
15th	0.0148	0.0181	0.0178	0.0218	0.150	
16th	0.0024	0.0029	0.0067	0.0082	0.115	
17th	0.0252	0.0309	0.0158	0.0194	0.132	
18th	0.0033	0.0041	0.0044	0.0054	0.102	
19th	0.0291	0.0357	0.0080	0.0099	0.118	
20th	0.0038	0.0047	0.0032	0.0039	0.092	
21th	0.0239	0.0294	0.0022	0.0027	0.107	0.160
22th	0.0042	0.0051	0.0040	0.0049	0.084	
23th	0.0230	0.0283	0.0055	0.0068	0.098	0.147
24th	0.0028	0.0034	0.0020	0.0024	0.077	
25th	0.0237	0.0291	0.0114	0.0140	0.090	0.135
26th	0.0026	0.0032	0.0027	0.0033	0.071	
27th	0.0198	0.0243	0.0110	0.0135	0.083	0.124
28th	0.0023	0.0029	0.0038	0.0047	0.066	
29th	0.0150	0.0184	0.0118	0.0144	0.078	0.117
30th	0.0021	0.0025	0.0021	0.0025	0.061	
31th	0.0130	0.0160	0.0152	0.0187	0.073	0.109
32th	0.0022	0.0027	0.0024	0.0029	0.058	
33th	0.0116	0.0142	0.0158	0.0194	0.068	0.102
34th	0.0030	0.0037	0.0021	0.0026	0.054	
35th	0.0120	0.0148	0.0158	0.0193	0.064	0.096
36th	0.0035	0.0043	0.0028	0.0035	0.051	
37th	0.0129	0.0158	0.0157	0.0193	0.061	0.091
38th	0.0049	0.0060	0.0022	0.0027	0.048	
39th	0.0153	0.0188	0.0167	0.0205	0.058	0.087
40th	0.0062	0.0076	0.0027	0.0033	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 in the box below.

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).	**Pass**

	Starting			**Stopping**			**Running**	
	d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	Pst	Plt 2 hours
Measured Values at test impedance	0	0	0	0	0	0	0.07	0.07
Normalised to standard impedance	0	0	0	0	0	0	0.0859	0.0859
Limits set under BS EN 61000-3-2	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65

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.

For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalized values where the power factor of the generation output is 0.98 or above.

Normalized value = Measured value × reference source resistance/measured source resistance at test point × 3.68/rating per phase.

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				**Pass**
Test level power	20%	50%	75%	100%
Recorded value in Amps	0.02699	0.003028	0.005647	0.007719
As % of rated AC current	0.204%	0.0229%	0.03928%	0.0582%
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 ±1.5% of the stated level during the test.			**Pass**
	216.2 V	230 V	253 V
20% of Registered Capacity	0.9624	0.9557	0.9587
50% of Registered Capacity	0.9954	0.9556	0.9937
75% of Registered Capacity	0.9961	0.9972	0.997
100% of Registered Capacity	0.996	0.9967	0.9969
Limit	>0.95	>0.95	>0.95

Protection. Frequency test 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)					**Pass**	
Function	Setting		Trip test		No trip test	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47.5 Hz	20 s	47.49	20.3	47.7Hz / 30s	no trip
U/F stage 2	47 Hz	0.5 s	47	0.628	47.2Hz / 19.5s	no trip
					46.8Hz / 0.45s	no trip
O/F stage 1	52 Hz	0.5 s	52	0.628	51.8Hz / 120s	no trip
					52.2Hz / 0.45s	no trip
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 test The requirement is specified in section 5.3.1, test procedure in Annex A or B 1.3.2					**Pass**	
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage 1	184 V	2.5 s	183.18	2.64	188V / 5s	no trip
					180V / 2.45s	no trip
O/V stage 1	262.2 V	1.0 s	262.1	1.124	258.2V 5.0s	no trip
O/V stage 2	273.7 V	0.5 s	273.72	0.64	269.7V 0.95s	no trip
					277.7V 0.45s	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.						

Protection. Loss of Mains test

For PV Inverters shall be tested in accordance with BS EN 62116. Other Inverters should be tested in accordance with EN 50438 Annex D.2.5 at 10%, 55% and 100% of rated power.

For **Inverters** tested to BS EN 62116 the following sub set of tests should be recorded in the following table.

Test Power	33%	66%	100%	33%	66%	100%
Balancing load on islanded network	-5% Q Test 22	-5% Q Test 12	-5% P Test 5	+5% Q Test 31	+5% Q Test 21	+5% P Test 10
Trip time. Limit is 0.5s	0.120s	0.093s	0.124s	0.111s	0.121s	0.091s

For other Inverters should be tested in accordance with EN 50438 Annex D.2.5 at 10%, 55% and 100% of rated power. the following sub set of tests should be recorded in the following table

For Multi phase Micro-generators confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.

To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.

Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
Trip time. Ph1	NA	NA	NA	NA	NA	NA
Trip time. Ph2	NA	NA	NA	NA	NA	NA
Trip time. Ph3	NA	NA	NA	NA	NA	NA

Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies

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).			**Pass**
	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49Hz	+50 degrees	no trip
Negative Vector Shift	50.5Hz	- 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).			**Pass**
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95Hz/sec	2.1 s	no trip
51.0 Hz to 49.0 Hz	-0.95Hz/sec	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%.				**Pass**
Test sequence at Registered Capacity >80%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00 Hz ±0.01 Hz	3082	50	3194	
Step b) 50.45 Hz ±0.05 Hz	3058	50.45	3171	15.57%
Step c) 50.70 Hz ±0.10 Hz	2903	50.7	2994	19.37%
Step d) 51.15 Hz ±0.05 Hz	2620	51.15	2701	19.99%
Step e) 50.70 Hz ±0.10 Hz	2902	50.7	2993	19.47%
Step f) 50.45 Hz ±0.05 Hz	3059	50.45	3173	14.93%
Step g) 50.00 Hz ±0.01 Hz	3083	50	3193	
Test sequence at Registered Capacity 40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00 Hz ±0.01 Hz	1503	50	1553	
Step b) 50.45 Hz ±0.05 Hz	1474	50.45	1537	19.33%
Step c) 50.70 Hz ±0.10 Hz	1310	50.7	1459	21.44%
Step d) 51.15 Hz ±0.05 Hz	1041	50.15	1301	20.53%
Step e) 50.70 Hz ±0.10 Hz	1305	50.7	1452	22.00%
Step f) 50.45 Hz ±0.05 Hz	1474	50.45	1537	19.33%
Step g) 50.00 Hz ±0.01 Hz	1503	50	1551	

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.			**Pass**
Test sequence	Measured **Active Power** Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	3012	50	3303
Test b) Point between 49.5 Hz and 49.6 Hz	3004	49.55	3309
Test c) Point between 47.5 Hz and 47.6 Hz	307	47.55	3301
NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes			

Protection. Re-connection time				**Pass**
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 2.				
Time delay setting				
Measured delay time(s)	At 258.2V	At 204.1V	At 47.6Hz	At 51.9Hz
	48s	48s	48s	48s
Confirmation that the SSEG does not re-connect	At 266.2V	At 196.1V	At 47.4Hz	At 52.1Hz
	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).		**Pass**
For a Inverter SSEG		
Time after fault	Volts	Amps
20ms	-9.837	3.0264
100ms	-5.013	-6.3002
250ms	-6.621	-2.1193
500ms	-1.796	0.132
Time to trip	0.0664	In seconds
Logic Interface.		Yes
Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (Inverter connected).		
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 comments
ATM-3K-TLS, ATM-3K-TL is similar to ATM-4K-TL in circuit and construction except for rating. The test result can refer to ATM-4K-TL