

# G99/1-3 Type Test Verification Report

<b>Inverter Model</b>		ATG-5K-TL	
<b>Manufacturer Reference number</b>			
<b>Micro-generator technology</b>		Hybrid inverter	
<b>Manufacturer name</b>		Aton Green Storage SpA	
<b>Registered office address</b>		Via Nuova Circonvallazione, 57/B - 47923 Rimini (RN), Italy	
<b>Operational headquarters address</b>		Via Guido Rossa, 5 – 41057 Spilamberto (MO), Italy	
<b>Tel</b>	+3959783939	<b>Tel</b>	+3959783939
<b>E:mail</b>	a.ferrero@atonstorage.com	<b>E:mail</b>	a.ferrero@atonstorage.com
<b>Maximum rated capacity</b>	<b>Connection Option</b>		
	5	<b>kW single phase</b>	
<p>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 G99.</p>			
<b>Signed</b>	Mr. Ettore Uguzzoni 	<b>On behalf of</b>	Aton Green Storage SpA
<p>The tests were carried out by personnel with sufficient technical competence at:</p> <ul style="list-style-type: none"> <li>- 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;</li> <li>- or at external laboratories identified by Jiangsu GoodWe Power Supply Technology Co., Ltd.</li> </ul> <p>All organizations involved in the tests keep copies of all records of the tests and results.</p>			

**1. Operating Range:** Two tests should be carried with the Power Generating Module operating at Registered Capacity and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within  $\pm 5\%$  of the apparent power value set for the entire duration of each test sequence.

Frequency, voltage and Active Power measurements at the output terminals of the Power Generating Module shall be recorded every second. The tests will verify that the Power Generating Module 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 Power Park Module the PV primary source may be replaced by a DC source.

In case of a full converter Power Park Module (eg wind) the primary source and the prime mover Inverter/rectifier may be replaced by a DC source.

Test 1 Voltage = 85% of nominal (195.5 V) Frequency = 47 Hz Power factor = 1 Period of test 20s	Result Pass
Test 2 Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	Result Pass
Test 3 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Result Pass
Test 4 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Result Pass

<b>2. Power Quality – Harmonics:</b> For Power Generating Modules of Registered Capacity of less than 75 A per phase (ie 50 kW) the test requirements are specified in Annex A.7.1.5. These tests should be carried out as specified in BS EN 61000-3-12 The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 610000-3-12 for three phase equipment. Power Generating Modules with emissions close to the limits laid down in BS EN 61000-3-12 may require the installation of a transformer between 2 and 4 times the rating of the Power Generating Module in order to accept the connection to a Distribution Network. For Power Generating Modules of Registered Capacity of greater than 75 A per phase (ie 50 kW) the installation must be designed in accordance with EREC G5.					<b>Pass</b>	
Power Generating Module tested to BS EN 61000-3-12						
Micro-generator rating per phase (rpp)			kVA		Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
At 45-55% of Registered Capacity			100% of Registered Capacity			
Harmonic	Measured Value (MV) in Amps	%	Measured Value (MV) in Amps	%	1 phase	3 phase
2nd	0.162	0.81%	0.317	1.59%	8%	8%
3rd	0.089	0.45%	0.089	0.45%	21.6%	Not stated
4th	0.016	0.08%	0.027	0.14%	4%	4%
5th	0.064	0.32%	0.075	0.38%	10.7%	10.7%
6th	0.019	0.10%	0.022	0.11%	2.67%	2.67%
7th	0.066	0.33%	0.066	0.33%	7.2%	7.2%
8th	0.010	0.05%	0.007	0.04%	2%	2%
9th	0.049	0.25%	0.051	0.26%	3.8%	Not stated
10th	0.008	0.04%	0.010	0.05%	1.6%	1.6%
11th	0.045	0.23%	0.044	0.22%	3.1%	3.1%
12th	0.012	0.06%	0.015	0.08%	1.33%	1.33%
13th	0.033	0.17%	0.036	0.18%	2%	2%
THD12	0.221	1.11%	0.355	1.77%	23%	13%
PWHD13	0.438	2.19%	0.596	2.98%	23%	22%

<b>3. Power Quality – Voltage fluctuations and Flicker:</b>							<b>Pass</b>	
<p>For Power Generating Modules of Registered Capacity of less than 75 A per phase (ie 50 kW) these tests should be undertaken in accordance with Annex A.7.1.4.3. Results should be normalised to a standard source impedance, or if this results in figures above the limits set in BS EN 61000-3-11 to a suitable Maximum Impedance.</p> <p>For Power Generating Modules of Registered Capacity of greater than 75 A per phase (ie 50 kW) the installation must be designed in accordance with EREC P28.</p>								
	<b>Starting</b>			<b>Stopping</b>			<b>Running</b>	
	d <sub>max</sub>	d <sub>c</sub>	d <sub>(t)</sub>	d <sub>max</sub>	d <sub>c</sub>	d <sub>(t)</sub>	Pst	Plt 2 hours
Measured Values at test impedance	0.44	0.04	0	0.48	0.05	0	0.19	0.17
Normalised to standard impedance	0.352	0.032	0	0.384	0.04	0	0.152	0.136
Limits set under BS EN 61000-3-2	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	6.5
<p>Applies to three phase and split single phase Micro-generators.</p> <p>^ Applies to single phase Micro-generators and Micro-generators using two phases on a three phase system.</p> <p>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.</p> <p><b>Normalized value = Measured value × reference source resistance/measured source resistance at test point × 3.68/rating per phase.</b></p> <p>Single phase units reference source resistance is 0.4 Ω</p> <p>Two phase units in a three phase system reference source resistance is 0.4 Ω.</p> <p>Two phase units in a split phase system reference source resistance is 0.24 Ω.</p> <p>Three phase units reference source resistance is 0.24 Ω.</p> <p>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.</p> <p>The stopping test should be a trip from full load operation.</p> <p>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.</p>								

<b>4. Power quality. DC injection</b>				<b>Pass</b>
This test should be carried out in accordance with EN 50438 Annex D.3.10				
Test level power	10%	55%	100%	
Recorded value in Amps	0.0025	0.0016	0.004	
As % of rated AC current	0.0125%	0.008%	0.020%	
Limit	0.25%	0.25%	0.25%	

<b>5. Power Quality. Power factor</b>				<b>Pass</b>
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.				
	216.2 V	230 V	253 V	
20% of Registered Capacity	0.9644	0.9580	0.9785	
50% of Registered Capacity	0.9964	0.9956	0.9937	
75% of Registered Capacity	0.9987	0.9986	0.9980	
100% of Registered Capacity	0.9990	0.9991	0.9990	
Limit	>0.95	>0.95	>0.95	

<b>6. Protection. Frequency test</b>						<b>Pass</b>
These tests should be carried out in accordance with the Annex A.7.1.2.3.						
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 Hz	20.23s	47.7Hz / 25s	no trip
U/F stage 2	47 Hz	0.5 s	47.00 Hz	0.65s	47.2Hz / 19.98s	no trip
					46.8Hz / 0.48s	no trip
O/F stage 1	52 Hz	0.5 s	52.01 Hz	0.64s	51.8Hz / 89.98s	no trip
					52.2Hz / 0.48s	no trip
<p>Note. For frequency trip tests the frequency required to trip is the setting <math>\pm 0.1</math> 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 <math>\pm 0.2</math> Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.</p>						

<b>7. Protection. Voltage test</b>						<b>Pass</b>
These tests should be carried out in accordance with Annex A.7.1.2.2						
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	185.3V	2.63s	188V / 3.5s	no trip
					180V / 2.48s	no trip
O/V stage 1	262.2 V	1.0 s	261.9V	1.11s	258.2V 2.0s	no trip
O/V stage 2	273.7 V	0.5 s	273.2V	0.642s	269.7V 0.98s	no trip
					277.7V 0.48s	no trip
Note for Voltage tests the Voltage required to trip is the setting $\pm 3.45$ 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 $\pm 4$ V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.						

<b>8. Protection. Loss of Mains test</b>						
These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4.						
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 is 0.5s	0.0868s	0.0998s	0.145s	0.110s	0.1304s	0.1512s

<b>Protection – Frequency change, Vector Shift Stability test:</b> 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).				<b>Pass</b>
	Start Frequency	Change	Confirm no trip	
Positive Vector Shift	49Hz	+50 degrees	no trip	
Negative Vector Shift	50.5Hz	- 50degrees	no trip	

<b>Protection – Frequency change, RoCoF Stability test:</b> 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).				<b>Pass</b>
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	
Ramp range	Test frequency ramp:	Trip time limit	Trip time	
49.0 Hz to 51.0 Hz	+1Hz/sec	0.5s	0.780s	
51.0 Hz to 49.0 Hz	-1Hz/sec	0.5s	0.800s	

<b>9. Limited Frequency Sensitive Mode – Overfrequency test:</b> 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 <b>Droop</b> of 10%.				<b>Pass</b>
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	5051	50	5271	
Step b) 50.45 Hz ±0.05 Hz	4983	50.45	5203	27.20%
Step c) 50.70 Hz ±0.10 Hz	4756	50.7	4956	19.67%
Step d) 51.15 Hz ±0.05 Hz	4284	51.15	4459	20.45%
Step e) 50.70 Hz ±0.10 Hz	4757	50.7	4957	19.60%
Step f) 50.45 Hz ±0.05 Hz	5000	50.45	5217	20.40%
Step g) 50.00 Hz ±0.01 Hz	5052	50	5274	
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	2530	50	2639	
Step b) 50.45 Hz ±0.05 Hz	2467	50.45	2576	25.20%
Step c) 50.70 Hz ±0.10 Hz	2230	50.7	2324	20.00%
Step d) 51.15 Hz ±0.05 Hz	1758	51.15	1836	20.59%
Step e) 50.70 Hz ±0.10 Hz	2227	50.7	2321	20.20%
Step f) 50.45 Hz ±0.05 Hz	2474	50.45	2584	22.40%
Step g) 50.00 Hz ±0.01 Hz	2525	50	2634	

<b>10. Protection. Re-connection time</b>				<b>Pass</b>
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.				
Time delay setting				
Measured delay time(s)	At 258.2V	At 204.1V	At 47.6Hz	At 51.9Hz
	47s	47.4s	47.4s	46.4s
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

<b>11. Fault level contribution:</b> 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).		<b>Pass</b>
For Inverter output		
Time after fault	Volts	Amps
20ms	3.464	8.1878
100ms	6.544	-10.8917
250ms	2.849	-5.2014
500ms	-2.695	-0.8449
Time to trip	59.2ms	In seconds

<b>12. Self-Monitoring solid state switching:</b> 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 <b>Power Park Module</b> , the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.	N/A

<b>13. Wiring functional tests:</b> If required by para 15.2.1.	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	N/A

<b>14. Logic Interface (input port).</b>	
Confirm that an input port is provided and can be used to shut down the module.	Pass

<b>Additional comments</b>
NA