13.1 Generating Unit Type Test Sheet

Type Tested Generating Unit (>16A per phase but ≤50 kW 3 phase or 17kW 1 phase)

TYPE TEST SHEET

This Type Test sheet shall be used to record the results of the type testing of Generating Unit between 16A per phase and 17kW per phase maximum output at 230V (17kW limit single phase, 34kW limit split phase, 50kW limit 3 phase) It includes the **Generating Unit**s supplier declaration of compliance with the requirements of Engineering Recommendation G59/3			
Type Tested reference number		Growatt5000MTL	
Generating Unit technology		Grid-tied photovoltaic Inverter	
System supplier name		Shenzhen Growatt New Energy Technology Co., Ltd.	
Address		1st East & 3rd Floor, Jiayu Industrial Zone,Xibianling, Shangwu Village, Shiyan, Baoan District, Shenzhen, P.R. China	
Tel	+ 86 755 2951 5888	Fax	+ 86 755 2747 2131
E:mail	info@ginverter.com	Web site	www.ginverter.com
Maximum export capacity, use separate sheet if more than one connection option.	5.0	kW single phase, single, split or three phase system	
	NA	kW three phase	
	NA	kW two phases in three phase system	
	NA	kW two phases split phase system	
System supplier declaration. - I certify on behalf of the company named above as a supplier of a **Generating Unit**, that all products supplied by the company with the above Type Test 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 G59/3.			
Signed	James Wang	On behalf of	Shenzhen Growatt New Energy Technology Co., Ltd.
Note that testing can be done by the manufacturer of an individual component, by an external test house, or by the supplier of the complete system, or any combination of them as appropriate. Where parts of the testing are carried out by persons or organisations other than the supplier then the supplier shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests. The family product model is made by the following products: Growatt3600MTL Growatt4200MTL Growatt4600MTL Growatt5000MTL The model Growatt 5000 MTL is as the representative test models in this report.			

Power Quality. Harmonics.
These tests should be carried out as specified in 61000-3-12 or 61000-3-2. Only one set of tests is required and the **Manufacturer** should decide which one to use and complete the relevant table. 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 maximum export capacity.
The test should be carried out on a single **Generating Unit.** The results need to comply with the limits of table 2 of BS EN 61000-3-12 for single phase equipment, to table 3 of BS EN 61000-3-12 for three phase equipment or to table 1 of BS EN 61000-3-2 if that standard is used.
Note that Generating Units meeting the requirements of BS EN 61000-3-2 will need no further assesment with regards to harmonics. Generating Units 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 **Generating Unit** in order to accept the connection to a **DNO**'s network.

Generating Unit tested to BS EN 61000-3-2				
Generator Unit rating per phase (rpp)		5.0 kW		
Harmonic	At 45-55% of rated output	100% of rated output		
	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	0.076	0.09	1.080	
3	0.147	0.153	2.300	
4	0.017	0.028	0.430	
5	0.089	0.088	1.140	
6	0.009	0.015	0.300	
7	0.059	0.052	0.770	
8	0.008	0.012	0.230	
9	0.045	0.041	0.400	
10	0.01	0.012	0.184	
11	0.033	0.031	0.330	
12	0.012	0.014	0.153	
13	0.025	0.029	0.210	
14	0.012	0.016	0.131	
15	0.025	0.025	0.150	
16	0.011	0.018	0.115	
17	0.022	0.03	0.132	
18	0.012	0.018	0.102	
19	0.018	0.032	0.118	
20	0.01	0.018	0.092	
21	0.015	0.039	0.107	0.160
22	0.007	0.018	0.084	
23	0.013	0.031	0.098	0.147
24	0.006	0.016	0.077	
25	0.013	0.029	0.090	0.135
26	0.006	0.013	0.071	
27	0.011	0.021	0.083	0.124
28	0.005	0.012	0.066	
29	0.011	0.026	0.078	0.117
30	0.006	0.011	0.061	
31	0.01	0.021	0.073	0.109
32	0.006	0.008	0.058	
33	0.011	0.02	0.068	0.102
34	0.006	0.008	0.054	
35	0.01	0.015	0.064	0.096
36	0.006	0.007	0.051	
37	0.01	0.011	0.061	0.091
38	0.005	0.006	0.048	
39	0.009	0.009	0.058	0.087

40	0.005	0.006	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.
The tests should be carried out on a single **Generating Unit.** 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.

	Starting			Stopping			Running	
	d max	dc	d(t)	d max	dc	d(t)	P st	P lt 2 hours
Measured Values at test impedance								
Normalised to standard impedance	1.08	0	0	1.08	0	0	0.21	0.15
Normalised to required maximum impedance								
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		Ω	Xl		Ω
Standard Impedance	R	0.24	Ω	Xl	0.15	Ω
Maximum Impedance	R		Ω	Xl		Ω

* Applies to three phase and split single phase **Generating Unit**s
^ Applies to single phase **Generating Unit**s and **Generating Unit**s 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 normalised values where the power factor of the generation output is 0.98 or above.
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 Xl 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 comply with 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

Test start date	2014-3-3	Test end date	2014-3-5
Test location	GROWATT NEWENERGY TECHNOLOGY CO., LTD		

Power quality. DC injection.
The tests should be carried out on a single **Generating Unit** Tests are to be carried out three power defined levels ±5%. At 230V a 2kW single phase inverter has a current output of 8.7A so DC limit is 21.75mA, a 10kW three phase inverter has a current output of 43.5A at 230V so DC limit is 108.75mA

Test power level	10%	55%	100%	
Recorded value in Amps	25.5mA	23.2mA	23.7mA	
as % of rated AC current	0.13%	0.12%	0.12%	
Limit	0.25%	0.25%	0.25%	

Power Quality. Power factor.
The tests should be carried out on a single Generating Unit. Testa are to be carried out at three voltage levels and at full output. Voltage to be maintained within + or – 1.5% of the stated level during the test.

	216.2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within + or – 1.5% of the stated level during the test.
Measured value	0.99	0.99	0.99	
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
O/F stage 1	51.5Hz	90s	51.48Hz	90.06S	51.3Hz 95s	No trip
O/F stage 2	52Hz	0.5s	51.98Hz	0.55S	51.8Hz 89.98s	No trip
					52.2Hz 0.48s	No trip
U/F stage 1	47.5Hz	20s	47.52Hz	20.04S	47.7Hz 25s	No trip
U/F stage 2	47Hz	0.5s	47.02Hz	0.55S	47.2Hz 19.98s	No trip
					46.8 Hz 0.48s	No trip

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

Protection. Voltage tests

Function	Setting		Trip test		"No trip-tests" All phases at same voltage	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
O/V stage 1	262.2V	1.0s	262.9V	1.03S	258.2V 2.0 sec	No trip
O/V stage 2	273.7V	0.5s	272.9V	0.54S	269.7V 0.98s	No trip
					277.7V 0.48s	No trip
U/V stage 1	200.1V	2.5s	199.4V	2.53S	204.1V 3.5s	No trip
U/V stage 2	184V	0.5s	183.7V	0.53S	188V 2.48s	No trip
					180v 0.48 sec	No trip

Note. For voltage tests the voltage required to trip is the setting plus or minus 3.45V. The time delay can be measured at a larger deviation than the minimum required to operate the projection. The No-trip tests need to be carried out at the setting ±4V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

a) Protection. Loss of Mains test and single phase test.

The tests are to be To be carried out at three output power levels plus or minus 5%, an alternative for inverter connected Generating Units can be used instead.

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Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Generating Unit** output	95% of **Generating Unit** output	95% of **Generating Unit** output	105% of **Generating Unit** output	105% of **Generating Unit** output	105% of **Generating Unit** output
Trip time. Limit is 0.5s	/	/	/	/	/	/

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

Indicate additional shut down time included in above results	--s

Note as an alternative, inverters can be tested to 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 is 0.5s	0.309S	0.317S	0.387S	0.322S	0.365S	0.347S

Single phase test for multi phase **Generating Units**. Confirm that when generating in parallel with a network operating at around 50Hz with no network disturbance, that the removal of a single phase connection to the **Generating Unit**, with the remaining phases connected causes a disconnection of the generating unit within a maximum of 1s.

Ph1 removed	Confirm Trip	Ph2 removed	Confirm Trip	Ph3 removed	Confirm Trip

b) Protection. Frequency change, Stability test

	Start Frequency	Change	End Frequency	Confirm no trip
Positive Vector Shift	49.5Hz	+9 degrees		No trip
Negative Vector Shift	50.5Hz	- 9 degrees		No trip
Positive Frequency drift	49.5Hz	+0.19Hzs^{-1}	51.5Hz	No trip
Negative Frequency drift	50.5Hz	-0.19Hzs^{-1}	47.5Hz	No trip

c) **Protection. Re-connection timer**.

The tests should prove that the reconnection sequence starts in no less than 20s for restoration of voltage and frequency to within the stage 1 settings of table 10.5.7.1

Test should prove that the reconnection sequence starts in no less than 20s for restoration of voltage and frequency to within the stage 1 settings of table 10.5.7.1					
Time delay setting (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.			
60	62S	At 266.2V	At 196.1V	At 47.4Hz	At 51.6Hz
Confirmation that the **Generating Unit** does not re-connect		No reconnection	No reconnection	No reconnection	No reconnection

d) 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	--	20ms	81.2V	29.3A
Initial Value of aperiodic current	A	--	100ms	77.3V	22.5A
Initial symmetrical short-circuit current*	I_k	--	250ms	76.9V	16.1A
Decaying (aperiodic) component of short circuit current*	i_{DC}	--	500ms	73.5V	8.6A
Reactance/Resistance Ratio of source*	X/R	--	Time to trip	0.509	In seconds
For rotating machines and linear piston machines the test should produce a 0s – 2s plot of the short circuit current as seen at the **Generating Unit** terminals. * Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot					