G59/3-4 Generating Unit Type Test Sheet

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

This Type Test sheet shall be used to record the results of the type testing of Generating Unit between16A 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 G59/3-4			
SSEG Type reference number		Growatt 5500MTLS2018	
Generating Unit technology		Transformer less photovoltaic inverter	
Model Name		Growatt 4200MTL-S, Growatt 5000MTL-S, Growatt 5500MTL-S	
System Supplier name		Growatt New Energy Technology Co., Ltd.	
Address		1st East & 3rd Floor of Building A,Building B,Jiayu Industrial Park,#28,GuangHui Road,LongTeng Community,Shiyan Street,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.	Connection Option		
	5.0	kW single phase, single, split or three phase system	
	N/A	KW three phase	
	N/A	kW two phase in three phase system	
	N/A	kW two phase 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 EREC G59/3.			
Singed	James Wang	On behalf of	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:			

Growatt 4200MTL-S, Growatt 5000MTL-S, Growatt 5500MTL-S
The model Growatt 5500MTL-S is as the representative test models in this report.

G59/3-4 Type Verification Test 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 61000-3-12

Generating Unit rating per phase (rpp)			5.0	kVA	Harmonic % =Measured Value (Amps) x 23/rating per phase (kVA)	
Harmonic	At 45-55% of rated output		100% of rated output		Limit in BS EN 61000-3-12	
	Measured Value MV in Amps	%	Measured Value MV in Amps	%	1 phase	3 phase
2	0.02	0.183	0.01	0.046	8%	8%
3	0.22	2.018	0.33	1.524	21.6%	Not stated
4	0.06	0.550	0.08	0.370	4%	4%
5	0.1	0.917	0.11	0.508	10.7%	10.7%
6	0.02	0.183	0.02	0.092	2.67%	2.67%
7	0.06	0.550	0.06	0.277	7.2%	7.2%
8	0.01	0.092	0.02	0.092	2%	2%
9	0.05	0.459	0.05	0.231	3.8%	Not stated
10	0.01	0.092	0.01	0.046	1.6%	1.6%
11	0.04	0.367	0.04	0.185	3.1%	3.1%
12	0	0.000	0	0.000	1.33%	1.33%
13	0.03	0.275	0.04	0.185	2%	2%
THD%（At 100% rated output）			1.752		23%	13%
PWHD(%)（At 100% rated output）			1.76		23%	22%

Generating Unit tested to BS EN 61000-3-2						
Generating 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	0.02	0.015	0.01	0.007	1.080	
3	0.22	0.162	0.33	0.243	2.300	
4	0.06	0.044	0.08	0.059	0.430	
5	0.1	0.074	0.11	0.081	1.140	
6	0.02	0.015	0.02	0.015	0.300	
7	0.06	0.044	0.06	0.044	0.770	
8	0.01	0.007	0.02	0.015	0.230	
9	0.05	0.037	0.05	0.037	0.400	
10	0.01	0.007	0.01	0.007	0.184	
11	0.04	0.029	0.04	0.029	0.330	
12	0	0.000	0	0.000	0.153	
13	0.03	0.022	0.04	0.029	0.210	
14	0	0.000	0.01	0.007	0.131	
15	0.03	0.022	0.03	0.022	0.150	
16	0.01	0.007	0.01	0.007	0.115	
17	0.02	0.015	0.03	0.022	0.132	
18	0.01	0.007	0.01	0.007	0.102	
19	0.02	0.015	0.03	0.022	0.118	
20	0.02	0.015	0.01	0.007	0.092	
21	0.02	0.015	0.03	0.022	0.107	0.160
22	0.01	0.007	0	0.000	0.084	
23	0.02	0.015	0.01	0.007	0.098	0.147
24	0.02	0.015	0.01	0.007	0.077	
25	0.02	0.015	0.02	0.015	0.090	0.135
26	0.01	0.007	0	0.000	0.071	
27	0.01	0.007	0.02	0.015	0.083	0.124
28	0	0.000	0	0.000	0.066	
29	0.02	0.015	0.01	0.007	0.078	0.117
30	0.01	0.007	0.01	0.007	0.061	
31	0.01	0.007	0.02	0.015	0.073	0.109
32	0.01	0.007	0	0.000	0.058	
33	0.01	0.007	0.01	0.007	0.068	0.102
34	0.01	0.007	0.01	0.007	0.054	

35	0	0.000	0.01	0.007	0.064	0.096
36	0	0.000	0.01	0.007	0.051	
37	0.01	0.007	0.01	0.007	0.061	0.091
38	0.01	0.007	0	0.000	0.048	
39	0.01	0.007	0	0.000	0.058	0.087
40	0	0.000	0.01	0.007	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}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{lt} 2 hours
Measured Values at test impedance	1.09	0.05	0	1.09	0.24	0	0.20	0.14
Normalised to standard impedance	1.08	0.05	0	1.08	0.25	0	0.21	0.15
Normalised to required maximum impedance	4%	3.3 %	3.3 % 500ms	4%	3.3 %	3.3 % 500ms	1.0	0.65
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	0.24	Ω	XI	0.15	Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	XI	0.15 * 0.25 ^	Ω
Maximum Impedance	R		Ω	XI		Ω

* Applies to three phase and split single phase Generating Units

^ Applies to single phase Generating Units and Generating Units 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 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.

Test start date	25,June,2018	Test end date	25,June,2018
Test location	Growatt R&D Test Lab		

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 5kW single phase inverter has a current output of21.7A so DC limit is 54.3mA

Test power level	10%	55%	100%
Recorded value in Amps	21.5mA	25.1mA	26.7mA
as % of rated AC current	0.10%	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.

Test voltage	216.2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test.
Measured value	0.998	0.998	0.998	
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	47.51Hz	20.06s	47.7Hz/25s	N o Trip
O/F stage 2	52Hz	0.5s	47.01Hz	0.54s	47.2Hz/19.98s	N o Trip
					46.8Hz/0.48s	N o Trip
U/F stage 1	47.5Hz	20s	51.5 Hz	90.06s	51.3Hz/95s	N o Trip
U/F stage 2	47Hz	0.5s	52.0 Hz	0.53s	51.8Hz/89.98s	N o Trip
					52.2Hz/0.48s	N o 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.
The requirement is specified in section 5.3.1, test procedure in Annex A or B 1.3.2

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	262.78V	1.052s	258.2V/2.0s	N o Trip
O/V stage 2	273.7V	0.5s	274V	0.574s	269.7V/0.98s	N o Trip
					277.7V/0.48s	N o Trip
U/V stage 1	200.1V	2.5s	200.55V	2.522s	204.1V/3.5s	N o Trip
U/V stage 2	184V	0.5s	184.5V	0.583s	188V/2.48s	N o Trip
					180V/0.48s	N o 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.

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

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 0.5 seconds	0.29s	0.32s	0.32s	0.29s	0.32s	0.28s

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	33%	66%	100%	33%	66%	100%

imbalance	-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	0.25s	0.31s	0.32s	0.28s	0.32s	0.28s

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	+50 degrees		N o Trip
Negative Vector Shift	50.5Hz	-50 degrees		N o Trip
Positive Frequency drift	49.0Hz	$+0.95Hzs^{-1}$	51.0Hz	N o Trip
Negative Frequency drift	51.0Hz	$-0.95Hzs^{-1}$	49.0Hz	N o 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			
60s	61s	At 266.2V	At 196.1V	At 47.4Hz	At 51.6Hz
Confirmation that the **Generating Unit** does not re-connect		yes	yes	yes	yes

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	28A
Initial Value of aperiodic current	A	/	100ms	77.3V	22.5A

Initial symmetrical short-circuit current*	I_k	/	250ms	76.9V	16.5A
Decaying (aperiodic) component of short circuit current*	i_{DC}	/	500ms	73.5V	8.9A
Reactance/Resistance Ratio of source*	*X/R*	/	Time to trip	0.15s	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					

e) **Self Monitoring solid state switching**	YES/NA
It has been verified that in the event of the solid state switching device failing to disconnect the **Generating Unit**, the voltage on the output side of the switching device is reduced to a value below 50 Volts within 0.5 seconds	NA

Additional comments