G59/3 TYPE TEST VERIFICATION REPORT

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		ZDNY-TL10000/ZDNY-TL12000 ZDNY-TL15000/ZDNY-TL17000	
Generating Unit technology		Photovoltaic Grid-tied inverter	
System supplier name		Solax power Co., Ltd	
Address		Room 220, West Buliding A, National University Science and Technology Park of Zhejiang University 525, Xixi Rd, Hangzhou, Zhejiang Province, China, 310007	
Tel	+86(0571)-87979860	Fax	+86(0571)-89988190
E:mail	info@soalxpower.com	Web site	www.solaxpower.com

Maximum export capacity, use separate sheet if more than one connection option.	10	kW three phase
	12	kW three phase
	15	kW three phase
	17	kW three phase

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	Guo Huawei	On behalf of	Solax power 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.

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

ZDNY-TL17000

Generating Unit rating per phase (rpp)			5.67	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	0.1452	0.5893%	0.0758	0.3077%	8%	8%
3	0.1265	0.5134%	0.0812	0.3296 %	21.6%	Not stated
4	0.0577	0.2342%	0.0942	0.3823 %	4%	4%
5	0.2933	1.1905%	0.3643	1.4786%	10.7%	10.7%
6	0.0160	0.0649%	0.0146	0.0593 %	2.67%	2.67%
7	0.1383	0.5613%	0.1400	0.5682%	7.2%	7.2%
8	0.0330	0.1339%	0.0348	0.1412%	2%	2%
9	0.0975	0.3957%	0.0610	0.2476 %	3.8%	Not stated
10	0.0090	0.0365%	0.0182	0.0739 %	1.6%	1.6%
11	0.0925	0.3754%	0.0943	0.3827%	3.1%	3.1%
12	0.0106	0.0430%	0.0141	0.0572 %	1.33%	1.33%
13	0.0986	0.4002%	0.1274	0.5171%	2%	2%
THD		4.2089%		2.2703%	23%	13%
PWHD		7.8723%		3.0350%	23%	22%

ZDNY-TL15000						
Generating Unit rating per phase (rpp)			5	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	0.0421	0.1935%	0.0618	0.2843%	8%	8%
3	0.0158	0.0725%	0.0216	0.0993%	21.6%	Not stated
4	0.0199	0.0914%	0.0201	0.0926%	4%	4%
5	0.2294	1.0550%	0.2377	1.0933%	10.7%	10.7%
6	0.0127	0.0586%	0.0099	0.0454%	2.67%	2.67%
7	0.1487	0.6840%	0.1474	0.6778%	7.2%	7.2%
8	0.0142	0.0652%	0.0086	0.0396%	2%	2%
9	0.0154	0.0710%	0.0095	0.0439%	3.8%	Not stated
10	0.0148	0.0683%	0.0082	0.0378%	1.6%	1.6%
11	0.0918	0.4225%	0.1019	0.4686%	3.1%	3.1%
12	0.0050	0.0229%	0.0080	0.0368%	1.33%	1.33%
13	0.0681	0.3132%	0.0745	0.3425%	2%	2%
THD		2.9214%		1.5573%	23%	13%
PWHD		3.3260%		2.2807%	23%	22%

ZDNY-TL12000						
Generating Unit rating per phase (rpp)			4	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	0.0164	0.0944%	0.0296	0.1703%	8%	8%

3	0.0261	0.1499%	0.0295	0.1696%	21.6%	Not stated
4	0.0082	0.0474%	0.0108	0.0619%	4%	4%
5	0.2210	1.2706%	0.2331	1.3405%	10.7%	10.7%
6	0.0052	0.0298%	0.0075	0.0430%	2.67%	2.67%
7	0.1531	0.8801%	0.1772	1.0190%	7.2%	7.2%
8	0.0094	0.0541%	0.0050	0.0289%	2%	2%
9	0.0123	0.0708%	0.0081	0.0468%	3.8%	Not stated
10	0.0087	0.0499%	0.0044	0.0254%	1.6%	1.6%
11	0.0675	0.3880%	0.0907	0.5213%	3.1%	3.1%
12	0.0083	0.0478%	0.0051	0.0295%	1.33%	1.33%
13	0.0559	0.3214%	0.0807	0.4638%	2%	2%
THD		3.4860%		2.0118%	23%	13%
PWHD		4.1152%		3.2938%	23%	22%

ZDNY-TL10000						
Generating Unit rating per phase (rpp)			3.3	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	0.0421	0.1622%	0.0618	0.2871%	8%	8%
3	0.0158	0.1166%	0.0216	0.2153%	21.6%	Not stated
4	0.0199	0.1208%	0.0201	0.2146%	4%	4%
5	0.2294	1.5644%	0.2377	1.6955%	10.7%	10.7%
6	0.0127	0.0297%	0.0099	0.1918%	2.67%	2.67%
7	0.1487	1.0551%	0.1474	1.1296%	7.2%	7.2%
8	0.0142	0.0407%	0.0086	0.2050%	2%	2%
9	0.0154	0.0897%	0.0095	0.1925%	3.8%	Not stated
10	0.0148	0.0856%	0.0082	0.1974%	1.6%	1.6%
11	0.0918	0.6728%	0.1019	0.7480%	3.1%	3.1%
12	0.0050	0.2588%	0.0080	0.1967%	1.33%	1.33%
13	0.0681	0.6369%	0.0745	0.5445%	2%	2%
THD		3.6214%		2.3573%	23%	13%
PWHD		4.3260%		3.6807%	23%	22%

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	0.40%	0.39%		0.40%	0.39%		0.35	0.26
Normalised to standard impedance	0.40%	0.39%		0.40%	0.39%		0.35	0.26
Normalised to required maximum impedance	0.40%	0.39%		0.40%	0.39%		0.35	0.26
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	0.4	Ω	Xl	0.25	Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	Xl	0.15 * 0.25 ^	Ω
Maximum Impedance	R	0.4	Ω	Xl	0.25	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	2014-11-10	Test end date	2014-11-10
Test location	West Buliding A, National University Science and Technology Park of Zhejiang University 525, Xixi Rd, Hangzhou, Zhejiang Province, China, 310007		

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

ZDNY-TL17000				
Test power level	10%	55%	100%	
Recorded value in Amps	0.0177	0.0183	0.0203	
as % of rated AC current	0.07%	0.07%	0.08%	
Limit	0.25%	0.25%	0.25%	

ZDNY-TL15000				
Test power level	10%	55%	100%	
Recorded value in Amps	0.0023	0.0039	0.0048	
as % of rated AC current	0.01%	0.02%	0.02%	

Limit	0.25%	0.25%	0.25%	
ZDNY-TL12000				
Test power level	10%	55%	100%	
Recorded value in Amps	0.0026	0.0034	0.0055	
as % of rated AC current	0.01%	0.02%	0.03%	
Limit	0.25%	0.25%	0.25%	
ZDNY-TL10000				
Test power level	10%	55%	100%	
Recorded value in Amps	0.0031	0.0044	0.0062	
as % of rated AC current	0.02%	0.03%	0.04%	
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	0.998	0.997	0.996	
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	51.6Hz	90.82s	51.3Hz 95s	No trip
O/F stage 2	52Hz	0.5s	52Hz	0.578s	51.8Hz 89.98s	No trip
					52.2Hz 0.48s	No trip
U/F stage 1	47.5Hz	20s	47.4Hz	20.17s	47.7Hz 25s	No trip
U/F stage 2	47Hz	0.5s	47Hz	0.591s	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	262.2V	1.139s	258.2V 2.0 sec	No trip
O/V stage 2	273.7V	0.5s	273.7V	0.581s	269.7V 0.98s	No trip
					277.7V 0.48s	No trip
U/V stage 1	200.1V	2.5s	200.1V	2.629s	204.1V 3.5s	No trip
U/V stage 2	184V	0.5s	184V	0.557s	188V 2.48s	No trip
					180v	No trip

					0.48 sec	
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.						
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	0.264s	0.312s	0.381s	0.284s	0.352s	0.371s

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.			
30	33	At 266.2V	At 196.1V	At 47.4Hz	At 51.6Hz
Confirmation that the **Generating Unit** does not re-connect		No re-connection	No re-connection	No re-connection	No re-connection

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	85.6	20.4
Initial Value of aperiodic current	A		100ms	85.6	25.8
Initial symmetrical short-circuit current*	I_k		250ms	82.3	23.2
Decaying (aperiodic) component of short circuit current*	i_{DC}		500ms	80.7	21.1
Reactance/Resistance Ratio of source*	$^X/_R$		Time to trip	0.57	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					

d) 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