13.1 GENERATING UNIT TYPE TEST SHEET

Type Tested Generating Unit (>16A per phase but ≤ 50 kW 3 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 Units** supplier declaration of compliance with the requirements of Engineering Recommendation G59/3

Type Tested reference number		Fronius Symo 20.0-3-M	
Generating Unit technology		IGBT power modules, transformerless	
System Supplier name		Fronius International GmbH	
Address		*Guenter Fronius Str 1* *4600 Wels-Thalheim, Austria*	
Tel	*+43-7242-241-0*	Fax	*+43-7242-241-224*
E:mail	*pv@fronius.com*	Web site	www.fronius.com

Maximum export capacity, use separate sheet if more than one connection option.	--	kW single phase, single, split or three phase system
	20.0	kW three phase
	--	kW two phases in three phase system
	--	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		On behalf of	Fronius International GmbH

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 assessment with regards to harmonics. Generating Units with emissions close to the limits laid down in BE 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)			6,67	kVA	Harmonic % = Measured Value (Amps) x 23/rating per phase (kVa)	
Harmonic	At 45-55% of rated output		100% of rated output		Limit BS EN 61000-3-12	
	Measured Value MV in Amps	%	Measured Value MV in Amps		Measured Value MV in Amps	%
2	0.093	0.321	0.082	2	0.093	0.321
3	0.099	0.342	0.115	3	0.099	0.342
4	0.028	0.097	0.035	4	0.028	0.097
5	0.159	0.547	0.203	5	0.159	0.547
6	0.016	0.056	0.018	6	0.016	0.056
7	0.065	0.225	0.072	7	0.065	0.225
8	0.026	0.091	0.019	8	0.026	0.091
9	0.058	0.201	0.086	9	0.058	0.201
10	0.014	0.048	0.012	10	0.014	0.048
11	0.047	0.160	0.047	11	0.047	0.160
12	0.019	0.066	0.020	12	0.019	0.066
13	0.091	0.314	0.117	13	0.091	0.314
THD	0.92%	-	1.13%	THD	0.92%	-
PWHD	1.60%	-	2.45%	PWHD	1.60%	-

Power Quality. Voltage fluctuations and Flicker. The tests should be carried out on a single Generating Unit. Results should be normalized 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								
Normalised to standard impedance	0.2	2.15	0	0.050	2	0.000	0.375	0,360
Normalised to required maximum impedance								
Limits set under BS EN 61000-3-2	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65

Test Impedance	R		Ω	XI		Ω
Standard Impedance	R	0.4	Ω	XI	0.25	Ω
Maximum Impedance	R		Ω	XI		Ω

*Applies to three phase and split single phases **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 value 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

Singe phase units reference source resistance is 0.4Ω

Two phase units in a three phase system reference source resistance is 0.4Ω

Two phase units in a split phase system reference source resistance is 0.24Ω

Three phase units reference source resistance is 0.24Ω

Where the power factor of the output is under 0.98 then the XI 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		Test end	
Test location	Fronius R&D Laboratories, Fronius International GmbH, Guenter Fronius Str 1, A-4600 Wels-Thalheim, Austria		

Power quality. DC injection. The tests should be carried out on a single **Generating Unit**. Tests are to be carried out at 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	12.7mA	13.9mA	14.6mA	
as % of rated AC current	0.04%	0.05%	0.05%	
Limit	0.25%	0.25%	0.25%	

Power quality. Power factor. The tests should be carried out on a single **Generating Unit**. Tests are to be carried out at three voltage levels and at full output. Voltage can 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	0.997	0.998	0.997	
Limit	>0.95	>0.95	>0.95	

Protection. Frequency tests

Function	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency		Frequency	Time delay
U/F stage 1	47.5Hz	20s	47.446Hz	20.030s	47.7Hz 25s	No trip occurred
U/F stage 2	47Hz	0.5s	46.972Hz	0.538s	47.2Hz 19.98s	No trip occurred
					46.8Hz 0.48s	No trip occurred
O/F stage 1	51.5Hz	90s	51.590 Hz	90.018s	51.3Hz 95s	No trip occurred
O/F stage 2	52Hz	0.5s	52.069Hz	0.548s	51.8Hz 89.98s	No trip occurred
					52.2Hz 0.48s	No trip occurred

Note. For Frequency tests the Frequency required to trip is the setting ±1Hz. In order to measure the time delay a larger deviation than the minimum required to operate the protection 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"	
	Voltage	Time delay	Voltage		Voltage	Time delay
U/V stage 1	200.1V	2.5s	197.38V	2.573s	204.1V 3.5s	No trip occurred
U/V stage 2	184V	0.5s	181.71V	0.543s	188V 2.48s	No trip occurred
					180V 0.48s	No trip occurred
O/V stage 1	262.2V	1.0s	263.34V	1.048s	258.2V 2.0s	No trip occurred
O/V stage 2	273.7V	0.5s	275.02V	0.541s	269.7V 0.98s	No trip occurred
					277.7V 0.48s	No trip occurred

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 protection. 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 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 0.5s	0.246s	0.246s	0.053s	0.500s	0.500s	0.460s

Note. For technologies which have a substantial shot 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	--

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	--	--	--	--	--	--

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 occurred
Negative Vector Shift	50.5Hz	-9 degrees		No trip occurred
Positive Frequency drift	49.5Hz	+0.19Hz/s $^{-1}$	51.5Hz	No trip occurred
Negative Frequency drift	50.5Hz	-0.19Hz/s $^{-1}$	47.5Hz	No trip occurred

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.			
20s	25s		At 266.2V	At 196.1V	At 47.4Hz	At 51.6Hz
Confirmation that the **Generating Unit** does not re-connect.			No re-connect occurred	No re-connect occurred	No re-connect occurred	No re-connect occurred

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	12.7V	32.2A
Initial Value of aperiodic current	A	--	100ms	9.38V	25.4A
Initial symmetrical short-circuit current*	I_k	--	250ms	8.80V	16.5A
Decaying (aperiodic) component of short circuit current*	i_{DC}	--	500ms	8.55V	12.1A
Reactance/Resistance Ratio of source*	X/R	--	Time to trip	66.1ms	In milliseconds

For rotating machines and linear piston machines the test should produce a 0s – 2s plot of the sort 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/or 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 (because electro-mechanical relays are used)

Additional comments