TYPE TEST SHEET(refer to Form A2-3):

Tests for Type A Inverter Connected Power Generating Modules – test record:

1. Operating Range: Tests should be carried with the **Power Generating Module** operating at **Registered Capacity** and connected to a suitable test supply, grid simulation set or load bank. The power supplied by the primary source shall be kept stable within ± 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.

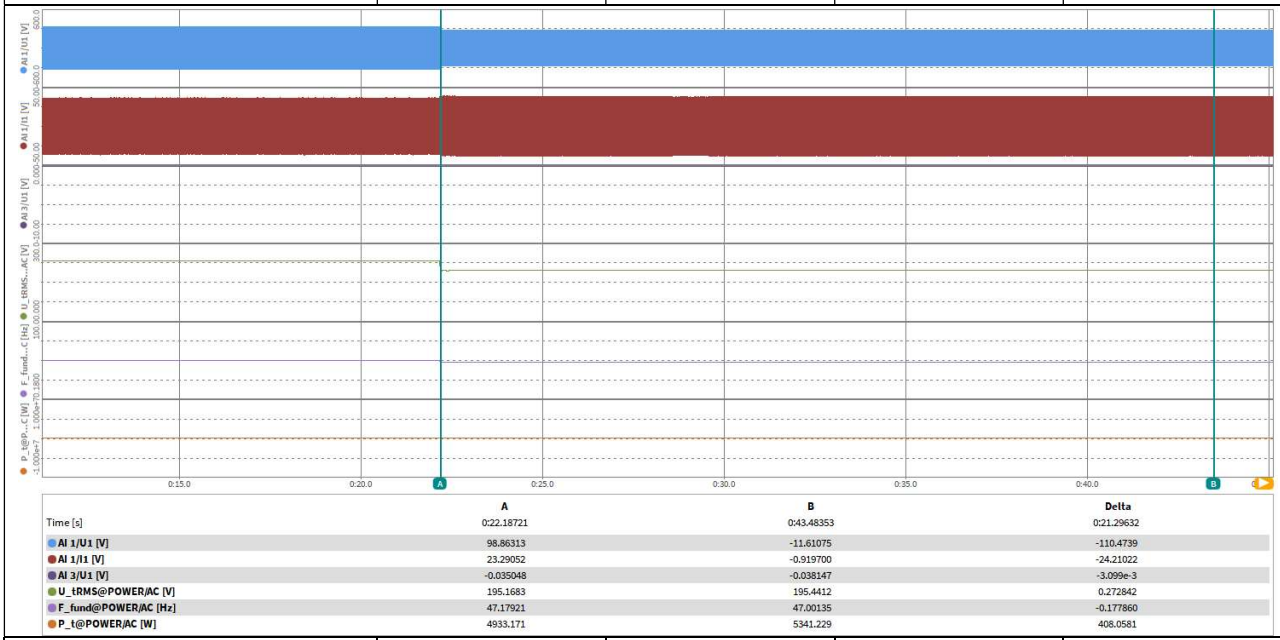
In case of a full converter **Power Park Module** (eg wind) the primary source and the prime mover **Inverter**/rectifier may be replaced by a DC source.

Pass or failure of the test should be indicated in the fields below (right hand side), for example with the statement “Pass”, “No disconnection occurs”, etc. Graphical evidence is preferred.

Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.

ASW6000H-S2

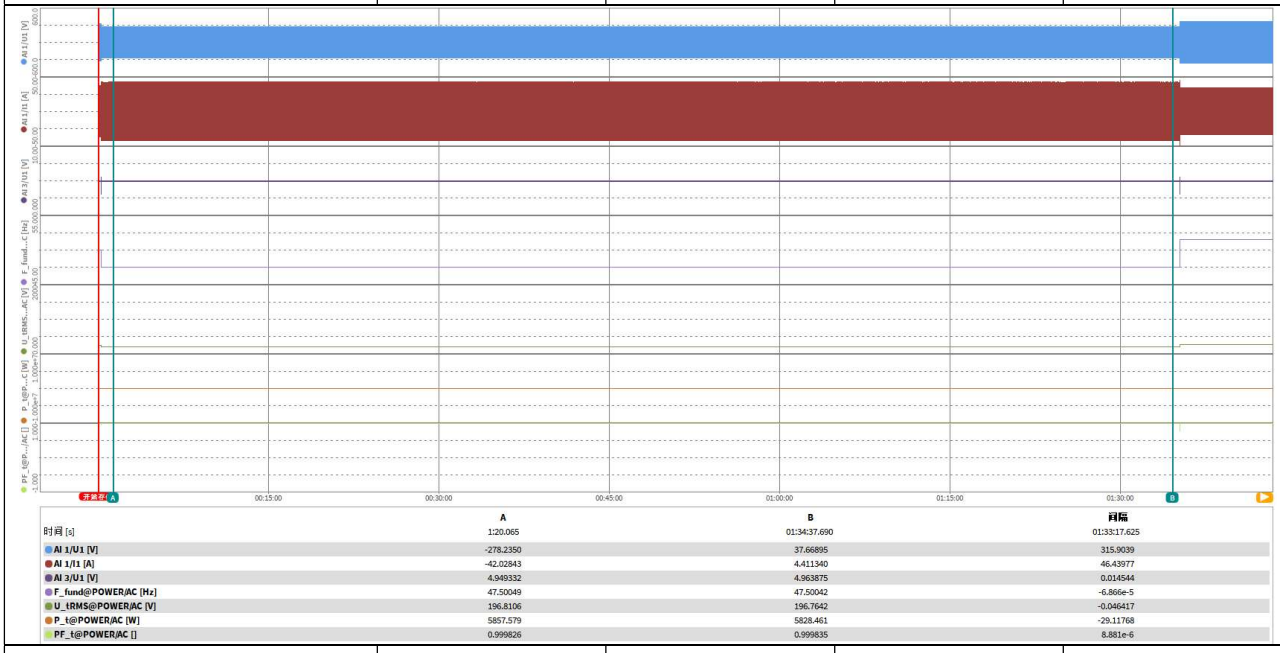
	Frequency (Hz)	Voltage (V)	Active power (kW)	Pass or failure
Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47 Hz, **Power Factor** = 1, Period of test 20 s	47.00	195.44	5.341	Pass



Time [s]	A 0:22.18721	B 0:43.48353	Delta 0:21.29632
AI 1/U1 [V]	98.86313	-11.61075	-110.4739
AI 1/I1 [V]	23.29052	-0.919700	-24.21022
AI 3/U1 [V]	-0.035048	-0.038147	-3.099e-3
U_tRMS@POWER/AC [V]	195.1683	195.4412	0.272842
F_fund@POWER/AC [Hz]	47.17921	47.00135	-0.177860
P_t@POWER/AC [W]	4933.171	5341.229	408.0581

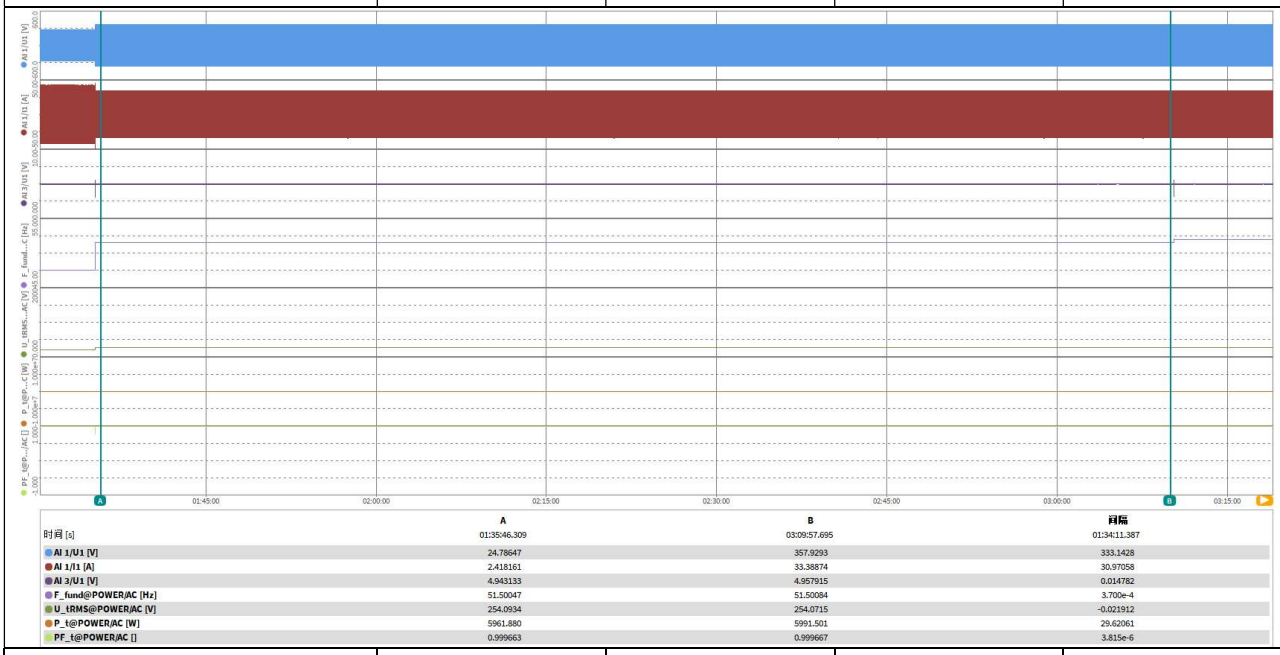
Test 2	47.5	196.74	5.828	Pass

Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes				



	A	B	间隔
时间 [s]	1:20.065	01:34:37.690	01:33:17.625
AI 1/U1 [V]	-278.2350	37.66895	315.9039
AI 1/I1 [A]	-42.02843	4.411340	46.43977
AI 3/U1 [V]	4.949332	4.963875	0.014544
F_fund@POWER/AC [Hz]	47.50049	47.50042	-6.866e-5
U_tRMS@POWER/AC [V]	196.8106	196.7642	-0.046417
P_t@POWER/AC [W]	5857.579	5828.461	-29.11768
PF_t@POWER/AC []	0.999826	0.999835	8.881e-6

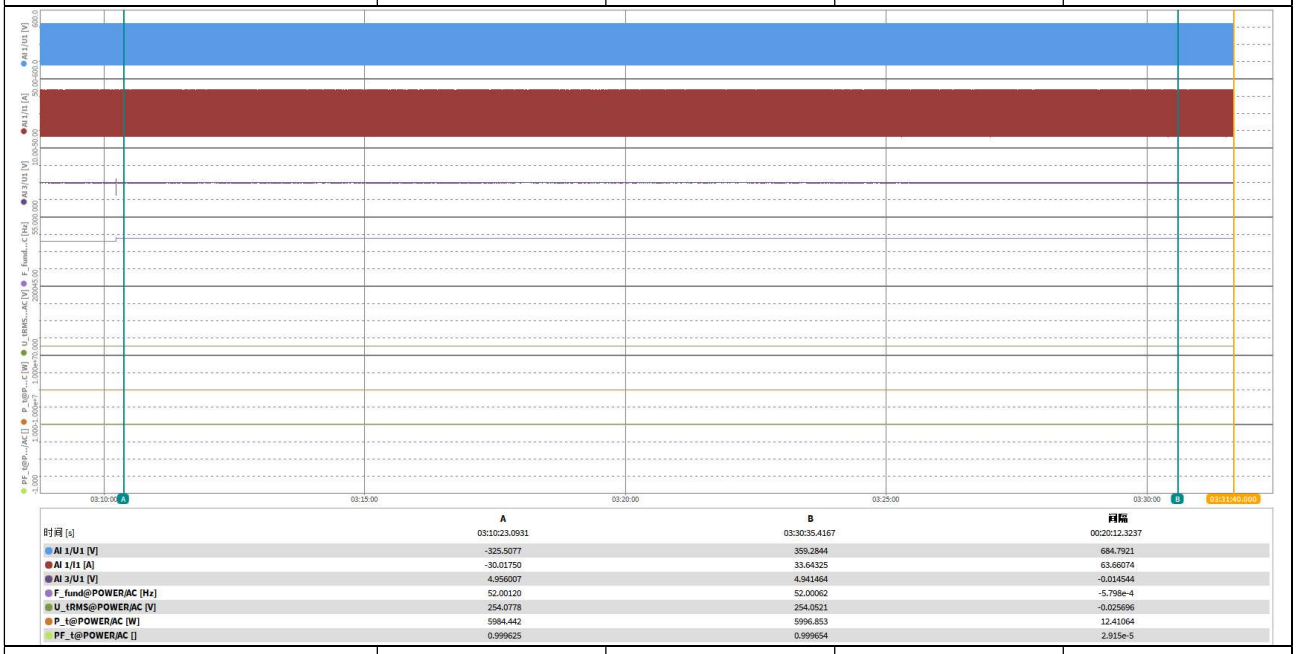
Test 3 Voltage = 110% of nominal (253 V), Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	51.5	254.07	5.991	Pass



	A	B	间隔
时间 [s]	01:35:46.309	03:09:57.695	01:34:11.387
AI 1/U1 [V]	24.78647	357.9293	333.1428
AI 1/I1 [A]	2.418161	33.38874	30.97058
AI 3/U1 [V]	4.943133	4.957915	0.014782
F_fund@POWER/AC [Hz]	51.50047	51.50084	3.700e-4
U_tRMS@POWER/AC [V]	254.0934	254.0715	-0.021912
P_t@POWER/AC [W]	5961.880	5991.501	29.62061
PF_t@POWER/AC []	0.999663	0.999667	3.815e-6

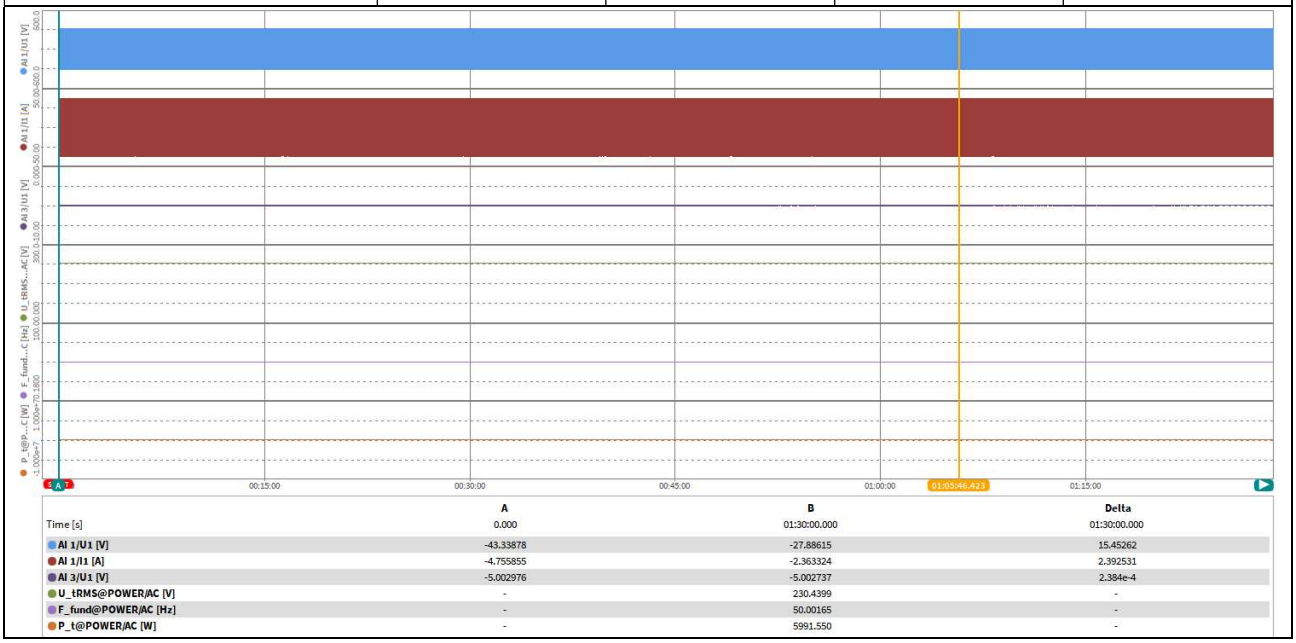
Test 4 Voltage = 110% of nominal	52	254.05	5.996	Pass

(253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes				

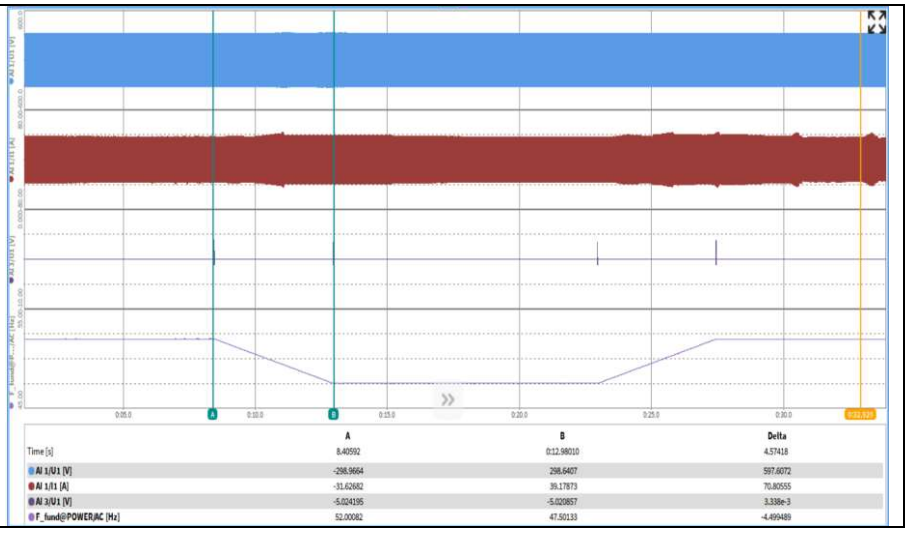


	A	B	间隔
时间 [s]	03:10:23.0931	03:30:35.4167	00:20:12.3237
AI 1/U1 [V]	-325.5077	359.2844	684.7921
AI 1/I1 [A]	-30.01750	33.64325	63.66074
AI 3/U1 [V]	4.956007	4.941464	-0.014544
F_fund@POWER/AC [Hz]	52.00120	52.00062	-5.798e-4
U_tRMS@POWER/AC [V]	254.0778	254.0521	-0.025696
P_t@POWER/AC [W]	5984.442	5996.853	12.41064
PF_t@POWER/AC []	0.999825	0.999654	2.915e-5

Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, **Power Factor** = 1, Period of test 90 minutes	50	230.44	5.991	Pass



Time [s]	A 0.000	B 01:30:00.000	Delta 01:30:00.000
AI 1/U1 [V]	-43.33878	-27.88615	15.45262
AI 1/I1 [A]	-4.755855	-2.363324	2.392531
AI 3/U1 [V]	-5.002976	-5.002737	2.384e-4
U_tRMS@POWER/AC [V]	-	230.4399	-
F_fund@POWER/AC [Hz]	-	50.00165	-
P_t@POWER/AC [W]	-	5991.550	-

Test 6 RoCoF withstand Confirm that the **Power Generating Module** is capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500 ms. Note that this is not expected to be demonstrated on site.	

2. Power Quality – Harmonics:

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, and measurements for the 2nd – 13th harmonics should be provided. 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. For three phase **Power Generating Modules**, measurements for all phases should be provided.

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.

The rating of the **Power Generating Module** (per phase) should be provided below, and the Total Harmonic Distortion (THD) and Partial Weighted Harmonic Distortion (PWHD) should be provided at the bottom of this section.

Power Generating Module tested to BS EN 61000-3-12

ASW6000H-S2								
Power Generating Module rating per phase (rpp)			6	kVA			Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).								
Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase(%)	3 phase(%)
2	0.0116	--	--	0.0446	--	--	8.00	8.00
3	0.0734	--	--	0.2811	--	--	21.60	Not stated
4	0.0162	--	--	0.0619	--	--	4.00	4.00
5	0.0029	--	--	0.0112	--	--	10.70	10.70

6	0.0420	--	--	0.1611	--	--	2.67	2.67
7	0.0167	--	--	0.0639	--	--	7.20	7.20
8	0.0051	--	--	0.0195	--	--	2.00	2.00
9	0.0287	--	--	0.1100	--	--	3.80	Not stated
10	0.0313	--	--	0.1199	--	--	1.60	1.60
11	0.0382	--	--	0.1463	--	--	3.10	3.10
12	0.0425	--	--	0.1629	--	--	1.33	1.33
13	0.0492	--	--	0.1885	--	--	2.00	2.00
14	0.0132	--	--	0.0506	--	--	--	--
15	0.0313	--	--	0.1198	--	--	--	--
16	0.0187	--	--	0.0716	--	--	--	--
17	0.0293	--	--	0.1121	--	--	--	--
18	0.0115	--	--	0.0439	--	--	--	--
19	0.0229	--	--	0.0878	--	--	--	--
20	0.0046	--	--	0.0176	--	--	--	--
21	0.0179	--	--	0.0685	--	--	--	--
22	0.0037	--	--	0.0142	--	--	--	--
23	0.0174	--	--	0.0666	--	--	--	--
24	0.0035	--	--	0.0133	--	--	--	--
25	0.0153	--	--	0.0586	--	--	--	--
26	0.0032	--	--	0.0121	--	--	--	--
27	0.0152	--	--	0.0582	--	--	--	--
28	0.0045	--	--	0.0173	--	--	--	--
29	0.0136	--	--	0.0519	--	--	--	--
30	0.0030	--	--	0.0115	--	--	--	--
31	0.0113	--	--	0.0433	--	--	--	--
32	0.0024	--	--	0.0093	--	--	--	--
33	0.0103	--	--	0.0393	--	--	--	--
34	0.0024	--	--	0.0091	--	--	--	--
35	0.0105	--	--	0.0401	--	--	--	--
36	0.0014	--	--	0.0054	--	--	--	--
37	0.0090	--	--	0.0346	--	--	--	--
38	0.0017	--	--	0.0064	--	--	--	--
39	0.0077	--	--	0.0295	--	--	--	--
40	0.0014	--	--	0.0055	--	--	--	--
THD	--	--	--	0.545	--	--	23	13

PWHD	--	--	--	1.212	--	--	23	22
Harmonic	100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase(%)	3 phase(%)
2	0.0464	--	--	0.1777	--	--	8.00	8.00
3	0.0791	--	--	0.3031	--	--	21.60	Not stated
4	0.0117	--	--	0.0448	--	--	4.00	4.00
5	0.0051	--	--	0.0197	--	--	10.70	10.70
6	0.0458	--	--	0.1756	--	--	2.67	2.67
7	0.0158	--	--	0.0604	--	--	7.20	7.20
8	0.0125	--	--	0.0480	--	--	2.00	2.00
9	0.0455	--	--	0.1742	--	--	3.80	Not stated
10	0.0163	--	--	0.0623	--	--	1.60	1.60
11	0.0674	--	--	0.2584	--	--	3.10	3.10
12	0.0343	--	--	0.1316	--	--	1.33	1.33
13	0.0870	--	--	0.3332	--	--	2.00	2.00
14	0.0247	--	--	0.0945	--	--	--	--
15	0.0598	--	--	0.2292	--	--	--	--
16	0.0123	--	--	0.0469	--	--	--	--
17	0.0272	--	--	0.1043	--	--	--	--
18	0.0220	--	--	0.0842	--	--	--	--
19	0.0260	--	--	0.0995	--	--	--	--
20	0.0125	--	--	0.0478	--	--	--	--
21	0.0198	--	--	0.0757	--	--	--	--
22	0.0067	--	--	0.0259	--	--	--	--
23	0.0140	--	--	0.0535	--	--	--	--
24	0.0056	--	--	0.0216	--	--	--	--
25	0.0113	--	--	0.0433	--	--	--	--
26	0.0055	--	--	0.0210	--	--	--	--
27	0.0097	--	--	0.0373	--	--	--	--
28	0.0051	--	--	0.0196	--	--	--	--
29	0.0109	--	--	0.0416	--	--	--	--
30	0.0040	--	--	0.0151	--	--	--	--
31	0.0104	--	--	0.0399	--	--	--	--
32	0.0041	--	--	0.0157	--	--	--	--

33	0.0080	--	--	0.0307	--	--	--	--
34	0.0031	--	--	0.0119	--	--	--	--
35	0.0065	--	--	0.0251	--	--	--	--
36	0.0040	--	--	0.0153	--	--	--	--
37	0.0058	--	--	0.0222	--	--	--	--
38	0.0039	--	--	0.0149	--	--	--	--
39	0.0058	--	--	0.0224	--	--	--	--
40	0.0025	--	--	0.0096	--	--	--	--
THD	--	--	--	0.712	--	--	23	13
PWHD	--	--	--	1.430	--	--	23	22
Remark: I_{ref}=26.1 A								

3. Power Quality – Voltage fluctuations and Flicker:

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.

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.

The standard test impedance is 0.4 Ω for a single phase **Power Generating Module** (and for a two phase unit in a three phase system) and 0.24 Ω for a three phase **Power Generating Module** (and for a two phase unit in a split phase system). Please ensure that both test and standard impedance are completed on this form. If the test impedance (or the measured impedance) is different to the standard impedance, it must be normalised to the standard impedance as follows (where the **Power Factor** of the generation output is 0.98 or above):

d max normalised value = (Standard impedance / Measured impedance) x Measured value.

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.

The stopping test should be a trip from full load operation.

The duration of these tests needs to comply with the particular requirements set out in the testing notes for the technology under test.

The test date and location must be declared.

ASW6000H-S2								
	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	0.74	0.32	0	0.78	0.45	0	0.24	0.105

Normalised to standard impedance	0.74	0.32	0	0.78	0.45	0	0.24	0.105
Normalised to required maximum impedance	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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	X	0.25	Ω
Standard Impedance	R	0.4 ^	Ω	X	0.25 ^	Ω
Maximum Impedance	R	N/A	Ω	X	N/A	Ω

^ Applies to single phase **Power Generating Module** and **Power Generating Modules** using two phases on a three phase system.

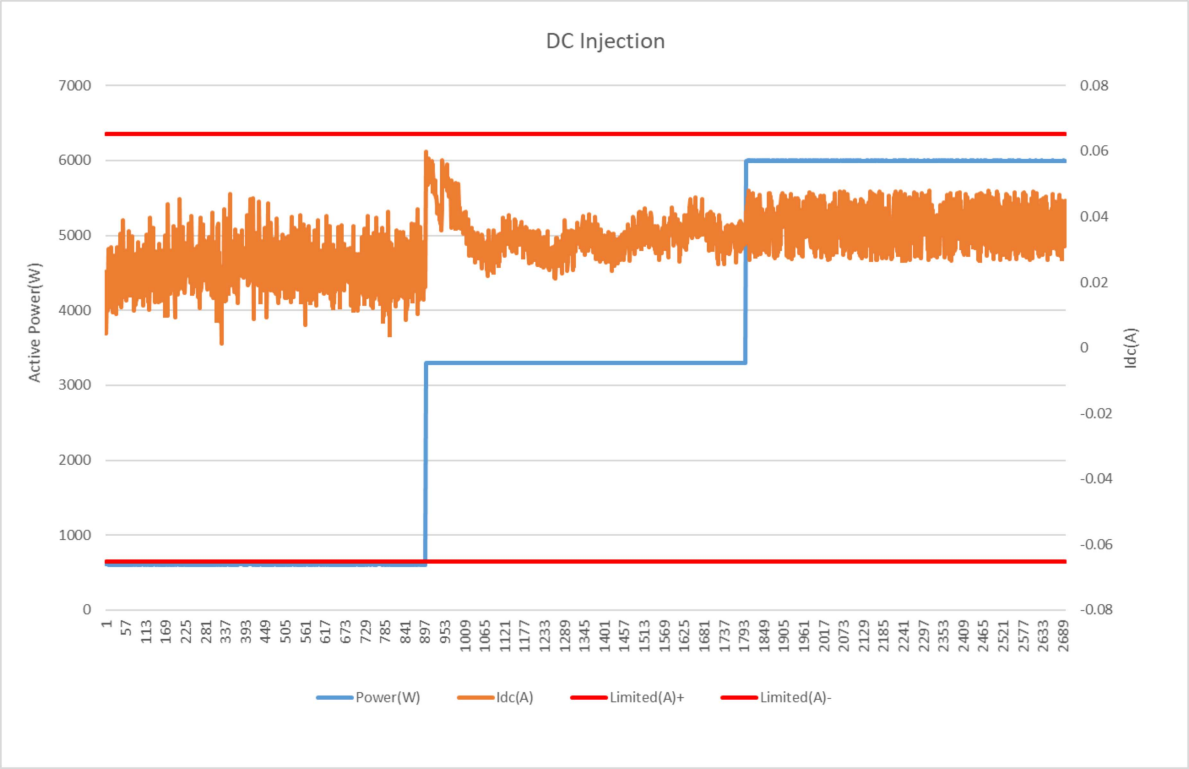
4. Power quality. DC injection. The tests should be carried out on a single **Generating Unit**. Tests are to be carried out at three defined power levels ±5%. At 230 V a 50 kW three phase **Inverter** has a current output of 217 A so DC limit is 543 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4.

The % DC injection ("as % of rated AC current" below) is calculated as follows:

% DC injection = Recorded DC value in Amps / Base current

where the base current is the **Registered Capacity** (W) / Vphase. The % DC injection should not be greater than 0.25%.

ASW6000H-S2			
Test power level	10%	55%	100%
Recorded value (A)	0.047	0.059	0.047
As % of rated AC current	0.18	0.02	0.18
Limit %	0.25	0.25	0.25
Remark: Ir=26.1 A			



5. Power Factor: The tests should be carried out on a single **Power Generating Module**. Tests are to be carried out at three voltage levels and at **Registered Capacity** and the measured **Power Factor** must be greater than 0.95 to pass. Voltage to be maintained within ±1.5% of the stated level during the test. These tests should be undertaken in accordance with Annex A.7.1.4.2. Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.			
ASW6000H-S2			
Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	0.9999	0.9999	0.9999
Power Factor Limit	>0.95	>0.95	>0.95

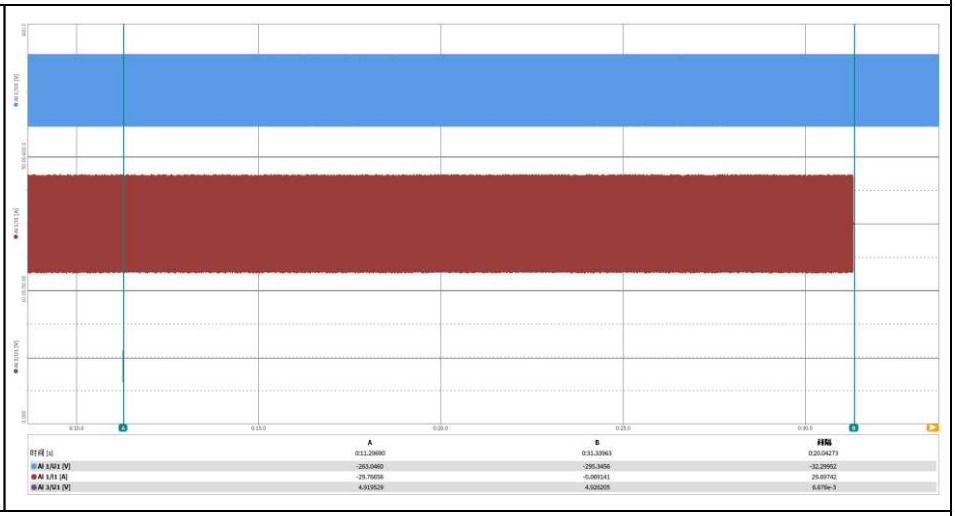
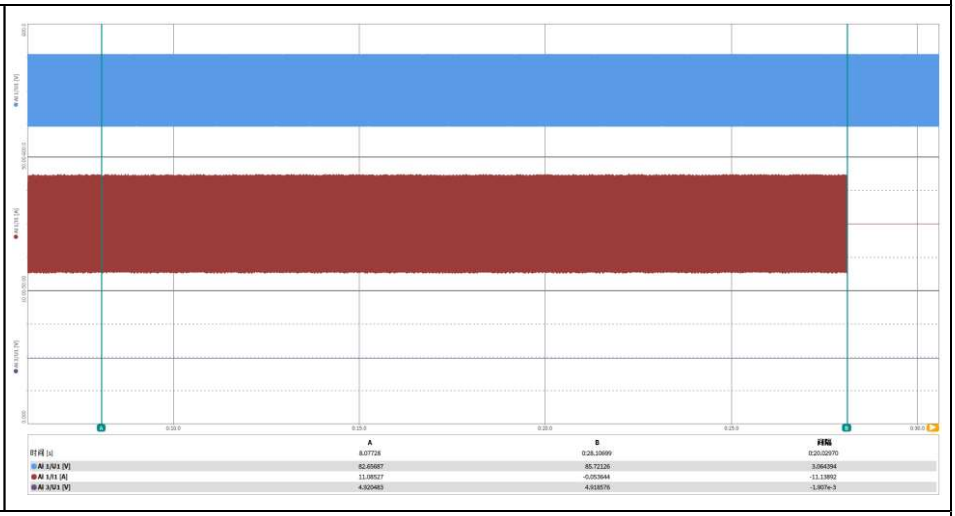
6. Protection – Frequency tests: These tests should be carried out in accordance with the Annex A.7.1.2.3. For trip tests, frequency and time delay should be stated. For “no trip tests”, “no trip” can be stated.

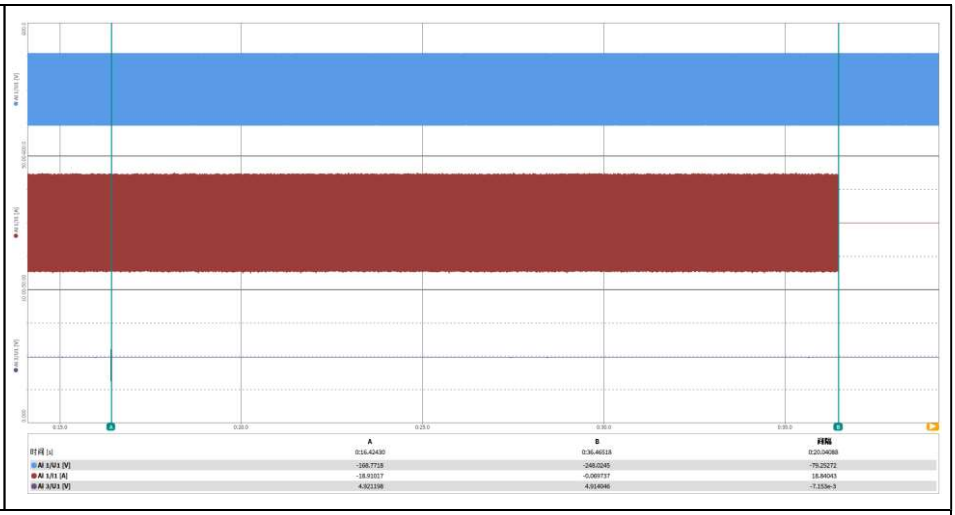
ASW6000H-S2						
-25°C						
Function	Setting		Trip test		“No trip tests”	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip

U/F stage 1	47.5Hz	20s	47.46Hz	20.04s	47.7Hz / 30 s	No trip
U/F stage 2	47Hz	0.5s	47.00Hz	0.55s	47.2Hz / 19.5 s	No trip
					46.8Hz / 0.45 s	No trip
OF	52Hz	0.5s	52.01Hz	0.56s	51.8Hz / 120 s	No trip
					52.2Hz / 0.45 s	No trip
Note. For frequency trip tests the frequency required to trip is the setting ± 0,1 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 ± 0,2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.						
+25°C						
Function	Setting		Trip test		“No trip tests”	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip
U/F stage 1	47.5Hz	20s	47.47Hz	20.02s	47.7Hz / 30 s	No trip
U/F stage 2	47Hz	0.5s	46.96Hz	0.56s	47.2Hz / 19.5 s	No trip
					46.8Hz / 0.45 s	No trip
OF	52Hz	0.5s	52.00Hz	0.55s	51.8Hz / 120 s	No trip
					52.2Hz / 0.45 s	No trip
Note. For frequency trip tests the frequency required to trip is the setting ± 0,1 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 ± 0,2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.						
+60°C						
Function	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip
U/F stage 1	47.5Hz	20s	47.47Hz	20.04s	47.7Hz / 30 s	No trip
U/F stage 2	47Hz	0.5s	47.00Hz	0.55s	47.2Hz / 19.5 s	No trip
					46.8Hz / 0.45 s	No trip
OF	52Hz	0.5s	52.00Hz	0.56s	51.8Hz / 120 s	No trip
					52.2Hz / 0.45 s	No trip
Note. For frequency trip tests the frequency required to trip is the setting ± 0,1 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 ± 0,2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.						
Test data record for frequency protection measurement and tripping time						

Iteration	Measured trip frequency (Hz)	Deviation from nominal value (%)	Limit (%)
Under frequency stage 1			
1@-25°C	47.46	-0.08	± 0.2
2@+25°C	47.47	-0.06	± 0.2
3@+60°C	47.47	-0.06	± 0.2
Verification of disconnecting time			

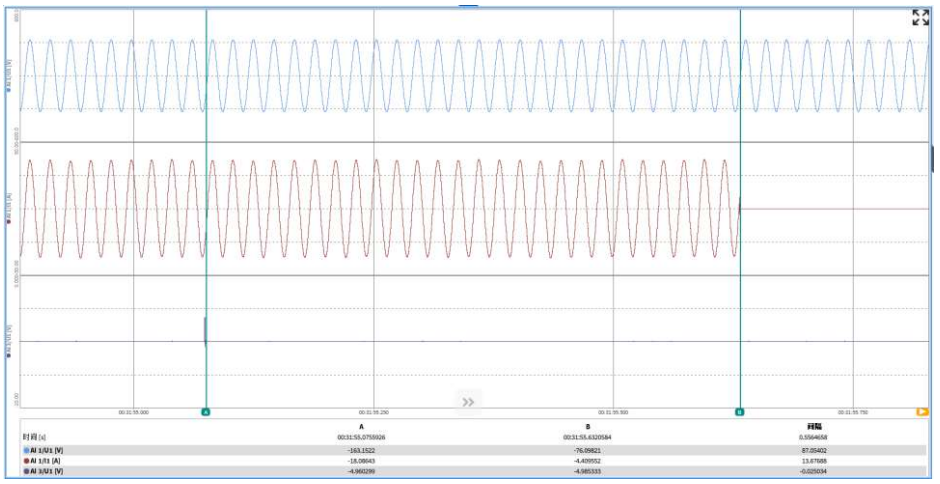
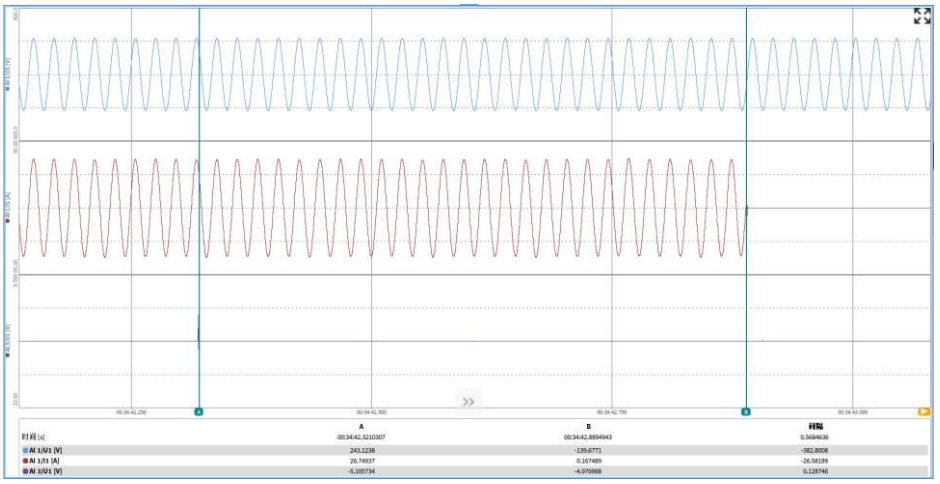
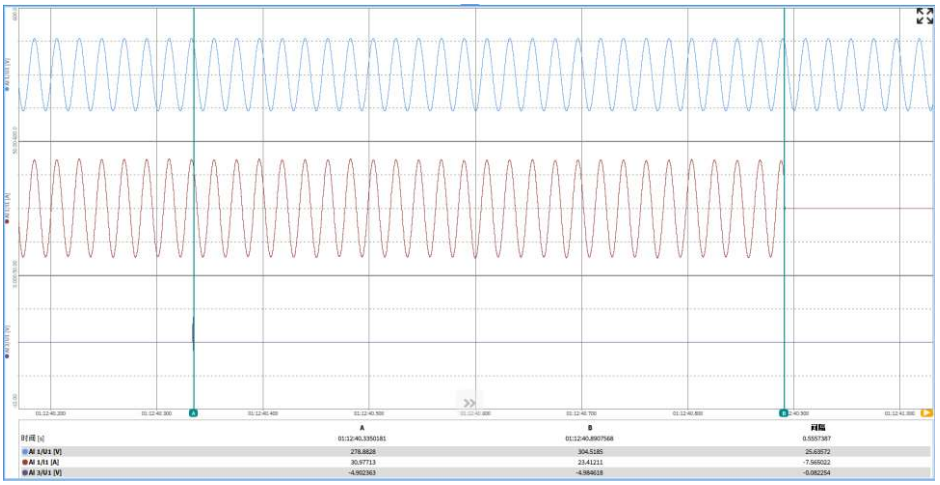
Iteration	Disconnection time (s)	Oscilloscope recorded waveforms
Under frequency stage 1@-25°C		
1. 47.8Hz— 47.2Hz (UF st1 trip setting minus 0.3Hz)	20.04s	
Under frequency stage 1@+25°C		
1. 47.8Hz— 47.2Hz (UF st1 trip setting minus 0.3Hz)	20.02s	
Under frequency stage 1@+60°C		

1. 47.8Hz— 47.2Hz (UF st1 trip setting minus 0.3Hz)	20.04s	

No trip tests - U/F stage 1			
Frequency	Hold on time	Confirm no trip	
47.7Hz (U/F st1 trip setting plus 0.2Hz)	30 s	no trip	

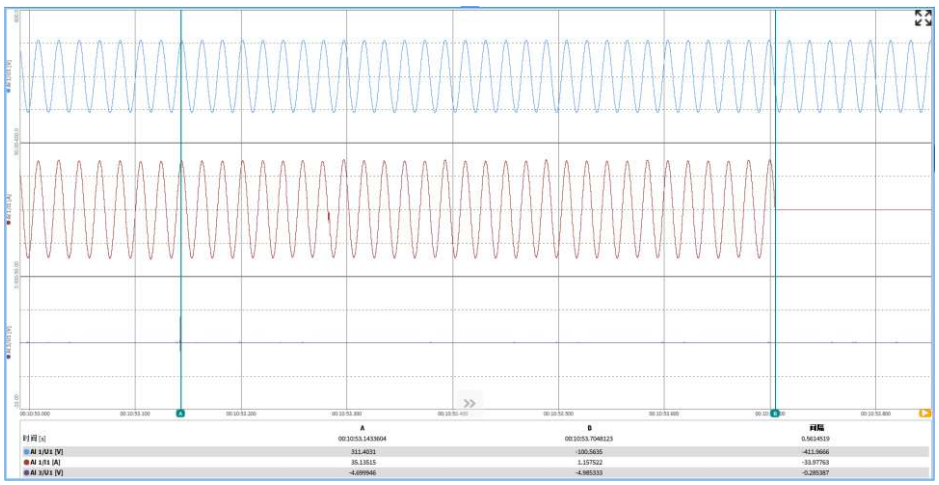
Iteration	Measured trip frequency (Hz)	Deviation from nominal value (%)	Limit (%)
Under frequency stage 2			
1@-25°C	47.00	0	± 0.2
2@+25°C	46.96	-0.08	± 0.2
3@+60°C	47.00	0	± 0.2

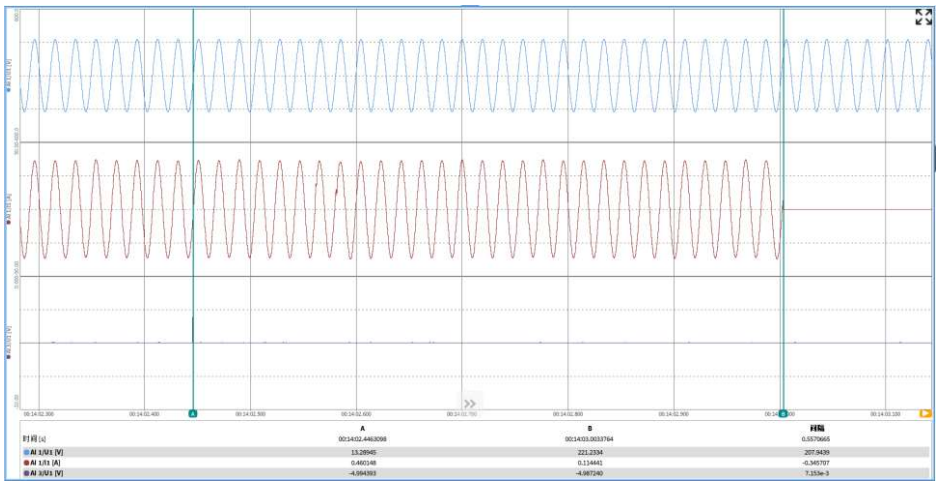
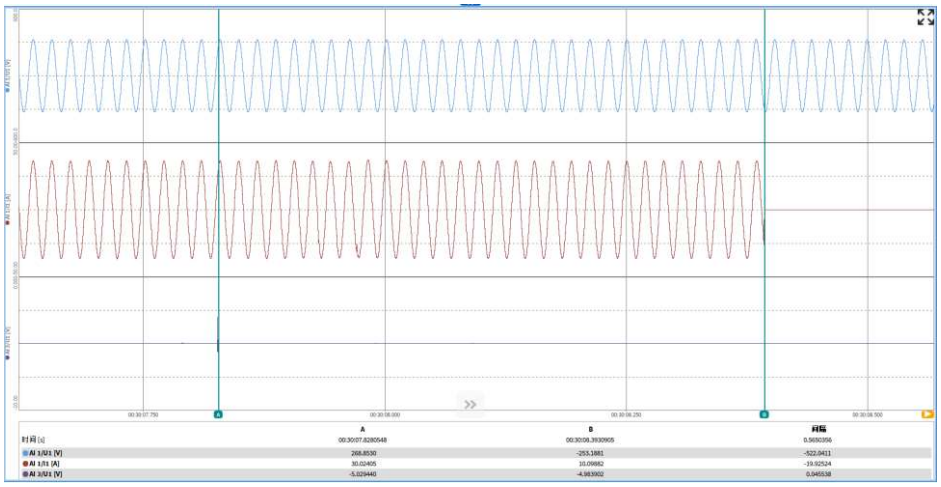
Verification of disconnecting time		
Iteration	Disconnection time (s)	Oscilloscope recorded waveforms
Under frequency stage 2@-25°C		

1. 47.3Hz—46.7Hz (UF st2 trip setting minus 0.3Hz)	0.55s	
Under frequency stage 2@+25°C		
1. 47.3Hz—46.7Hz (UF st2 trip setting minus 0.3Hz)	0.56s	
Under frequency stage 2@+60°C		
1. 47.3Hz—46.7Hz (UF st2 trip setting minus 0.3Hz)	0.55s	

No trip tests - U/F stage 2		
Frequency	Hold on time	Confirm no trip
47.2Hz (U/F st2 trip setting plus 0.2Hz)	19.5 s	no trip
46.8Hz (U/F st2 trip setting minus 0.2Hz)	0.45 s	no trip

Iteration	Measured trip frequency (Hz)	Deviation from nominal value (%)	Limit (%)
Over frequency			
1@-25°C	52.01	0.02	± 0.2
2@+25°C	52.00	0	± 0.2
3@+60°C	52.00	0	± 0.2

Verification of disconnecting time		
Iteration	Disconnection time (s)	Oscilloscope recorded waveforms
Over frequency stage 1@-25°C		
1. 51.7Hz—52.3Hz (OF trip setting plus 0.3Hz)	0.56s	
Over frequency stage 1@+25°C		

1. 51.7Hz—52.3Hz (OF trip setting plus 0.3Hz)	0.55s	
Over frequency stage 1@+60°C		
1. 51.7Hz—52.3Hz (OF trip setting plus 0.3Hz)	0.56s	

No trip tests - O/F		
Frequency	Hold on time	Confirm no trip
51.8Hz (O/F trip setting minus 0.2Hz)	120 s	no trip
52.2Hz (O/F trip setting plus 0.2Hz)	0.45 s	no trip
Remark:		

Calibration and Accuracy Tests									
ASW6000H-S2									
(-25°C)									
Setting	Time Delay	Pickup Frequency				Relay Operating Time			
Over Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit
52 Hz	0.5 s	51.90 Hz	52.01 Hz	52.10 Hz	Pass	51.7-52.3 Hz	0.50 s	0.56 s	0.60 s
Stage 1 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit
47.5 Hz	20 s	47.40 Hz	47.46 Hz	47.60 Hz	Pass	47.8-47.2 Hz	20.0 s	20.04 s	20.1 s
Stage 2 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit
47 Hz	0.5 s	46.90 Hz	47.00 Hz	47.10 Hz	Pass	47,3-46,7 Hz	0.50 s	0.55 s	0.60 s
(+25°C)									
Setting	Time Delay	Pickup Frequency				Relay Operating Time			
Over Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit
52 Hz	0.5 s	51.90 Hz	52.00 Hz	52.10 Hz	Pass	51.7-52.3 Hz	0.50 s	0.55 s	0.60 s
Stage 1 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit
47.5 Hz	20 s	47.40 Hz	47.47 Hz	47.60 Hz	Pass	47.8-47.2 Hz	20.0 s	20.02 s	20.1 s
Stage 2 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit
47 Hz	0.5 s	46.90 Hz	46.96 Hz	47.10 Hz	Pass	47.3-46.7 Hz	0.50 s	0.56 s	0.60 s
(+60°C)									
Setting	Time Delay	Pickup Frequency				Relay Operating Time			
Over Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit
52 Hz	0.5 s	51.90 Hz	52.00 Hz	52.10 Hz	Pass	51.7-52.3 Hz	0.50 s	0.56 s	0.60 s
Stage 1 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit
47.5 Hz	20 s	47.40 Hz	47.47 Hz	47.60 Hz	Pass	47.8-47.2	20.0 s	20.04 s	20.1 s

						Hz			
Stage 2 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit
47 Hz	0.5 s	46.90 Hz	47.00 Hz	47.10 Hz	Pass	47,3-46,7 Hz	0.50 s	0.55 s	0.60 s

7. Protection – Voltage tests: These tests should be carried out in accordance with Annex A.7.2.2.2. For trip tests, voltage and time delay should be stated. For “no trip tests”, “no trip” can be stated.

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-25°C(LV protection)

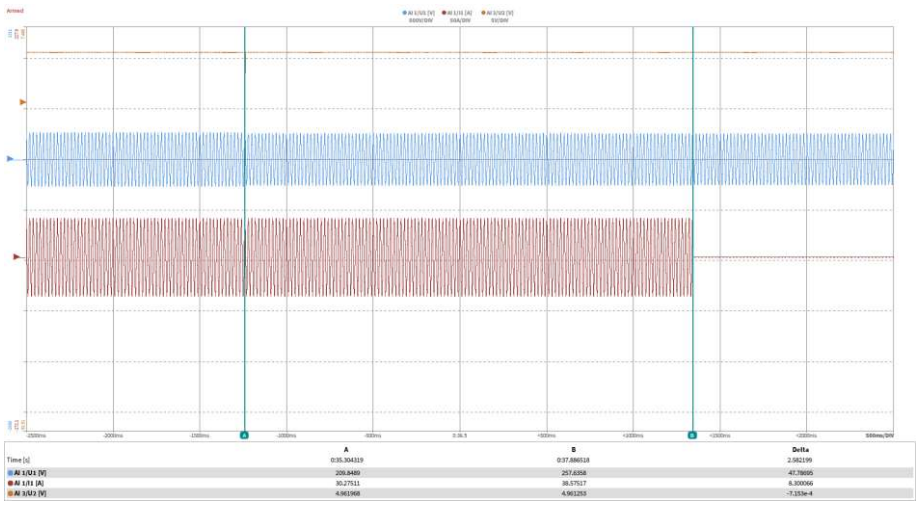
Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	$V_{\varphi-N}$:184 V (0.8pu)	2.5s	183.1V	2.58s	$V_{\varphi-N}$: 188 V / 5 s	No trip
					$V_{\varphi-N}$: 180 V / 2.45 s	No trip
O/V stage 1	$V_{\varphi-N}$:262.2 V (1.14pu)	1.0s	262.3V	1.08s	$V_{\varphi-N}$: 258.2 V / 5 s	no trip
O/V stage 2	$V_{\varphi-N}$:273.7 V (1.19pu)	0.5s	273.3V	0.53s	$V_{\varphi-N}$: 269.7 V / 0.95 s	No trip
					$V_{\varphi-N}$: 277.7 V / 0.45 s	No trip

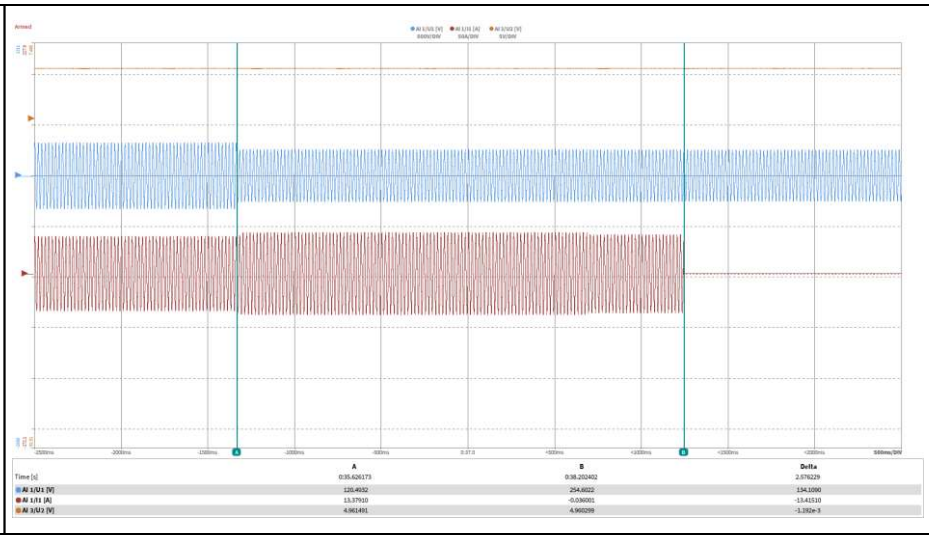
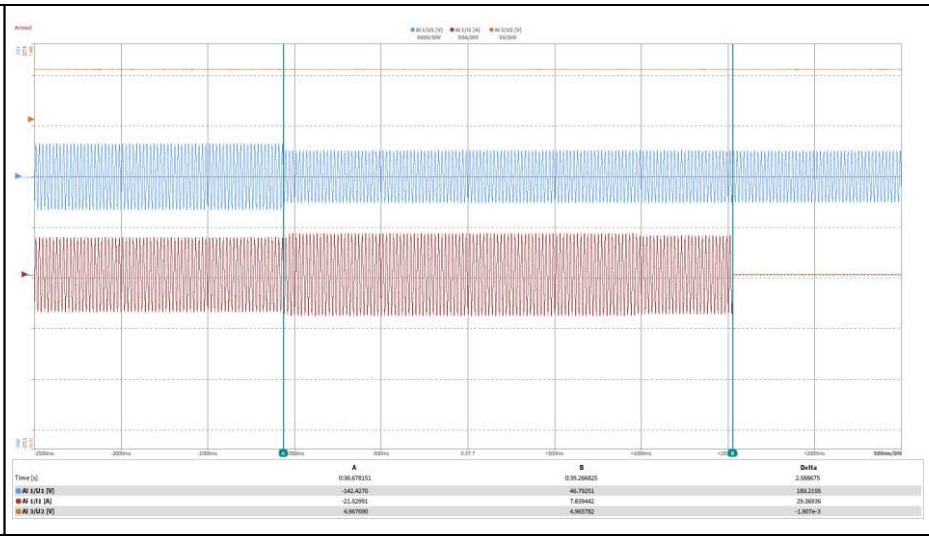
Note for Voltage tests the Voltage required to trip is the setting ±1.5% Vn. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting >±1.5% Vn and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

+25°C(LV protection)

Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	$V_{\varphi-N}$:184 V (0.8pu)	2.5s	182.6V	2.57s	$V_{\varphi-N}$: 188 V	No trip

					/ 5 s	
					$V_{\varphi-N}$: 180 V / 2.45 s	No trip
O/V stage 1	$V_{\varphi-N}$:262.2 V (1.14pu)	1.0s	262.8V	1.07s	$V_{\varphi-N}$: 258.2 V / 5 s	no trip
O/V stage 2	$V_{\varphi-N}$:273.7 V (1.19pu)	0.5s	272.9V	0.56s	$V_{\varphi-N}$: 269.7 V / 0.95 s	No trip
					$V_{\varphi-N}$: 277.7 V / 0.45 s	No trip
Note for Voltage tests the Voltage required to trip is the setting ±1.5% Vn. 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 >±1.5% Vn and for the relevant times as shown in the table above to ensure that the protection will not trip in error.						
+60°C(LV protection)						
Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	$V_{\varphi-N}$:184 V (0.8pu)	2.5s	182.5V	2.58s	$V_{\varphi-N}$: 188 V / 5 s	No trip
					$V_{\varphi-N}$: 180 V / 2.45 s	No trip
O/V stage 1	$V_{\varphi-N}$:262.2 V (1.14pu)	1.0s	261.7V	1.08s	$V_{\varphi-N}$: 258.2 V / 5 s	no trip
O/V stage 2	$V_{\varphi-N}$:273.7 V (1.19pu)	0.5s	273.6V	0.51s	$V_{\varphi-N}$: 269.7 V / 0.95 s	No trip
					$V_{\varphi-N}$: 277.7 V / 0.45 s	No trip
Note for Voltage tests the Voltage required to trip is the setting ±1.5% Vn. 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 >±1.5% Vn and for the relevant times as shown in the table above to ensure that the protection will not trip in error.						

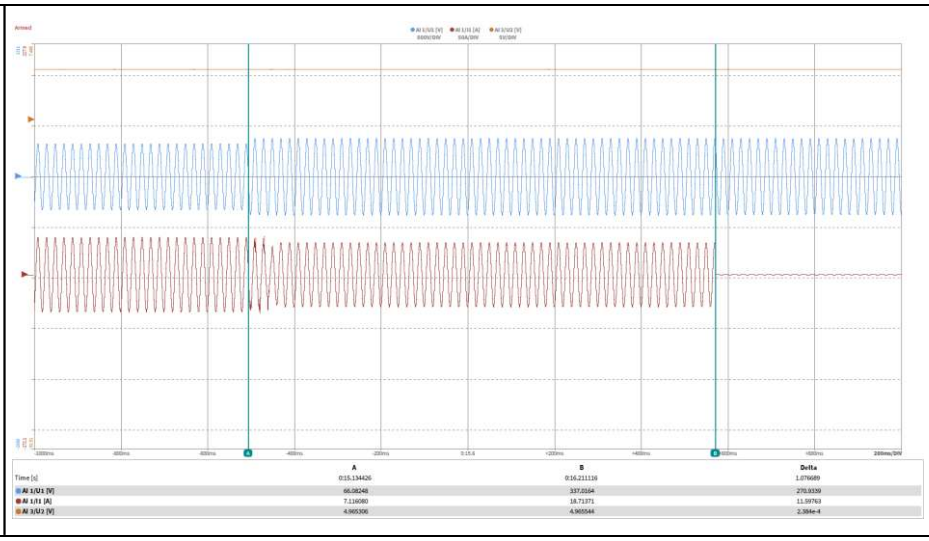
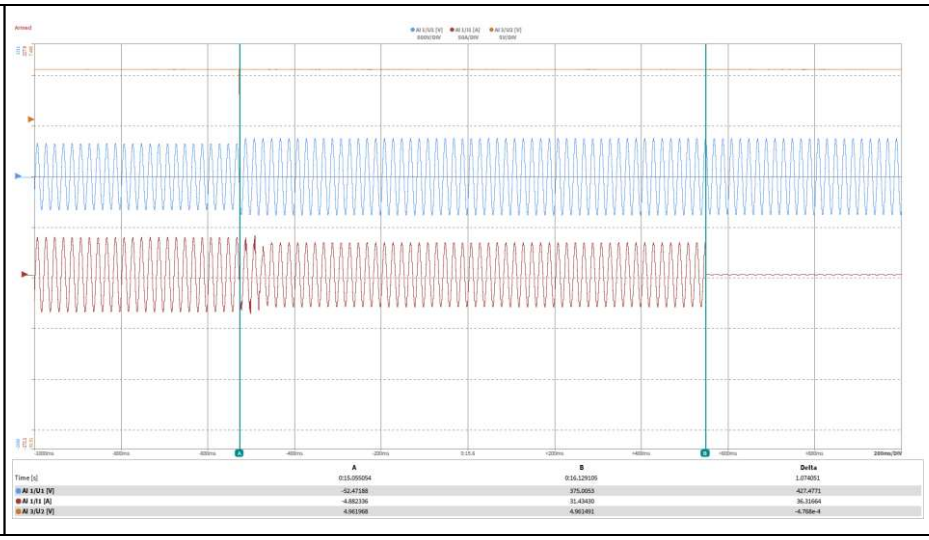
Test data record for frequency protection measurement and tripping time			
Iteration	Measured voltage(V) and deviation from nominal value (%)		
	Phase L-N (V)	Deviation (%Un)	Deviation limit (%Un)
Under voltage			
1 - $V_{\varphi-N}$ @-25°C	183.1	-0.39	± 1.5
1 - $V_{\varphi-N}$ @+25°C	182.6	-0.61	± 1.5
1 - $V_{\varphi-N}$ @+60°C	182.5	-0.65	± 1.5
Verification of disconnecting time			
Iteration	Disconnection time (s)	Oscilloscope recorded waveforms	
Under voltage			
L-N@-25°C:			
1. 188V—180V (trip setting minus 4V)	2.58s		
L-N@+25°C:			

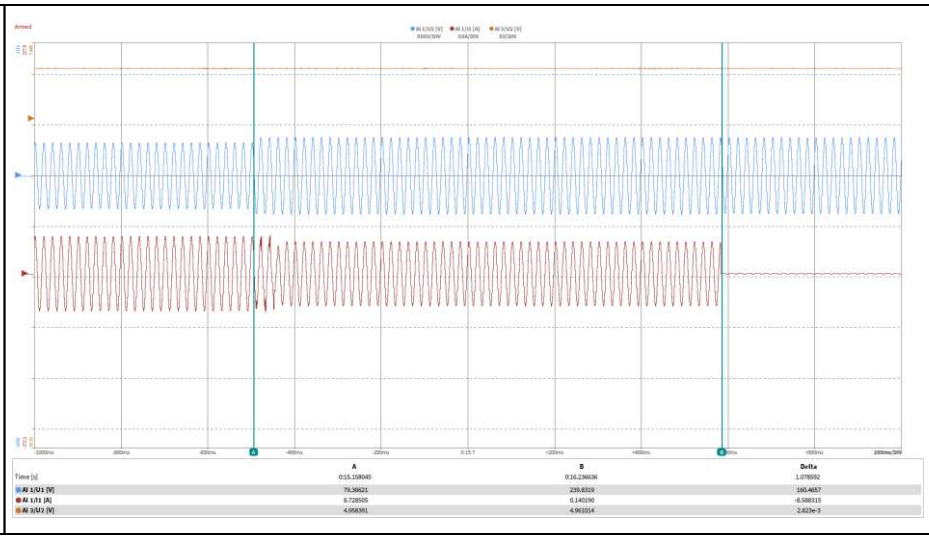
1. 188V—180V (trip setting minus 4V)	2.57s	
L-N@+60°C:		
1. 188V—180V (trip setting minus 4V)	2.58s	

No trip tests - U/V		
voltage	Hold on time	Confirm no trip
$V_{\varphi-N}$: 188V	5s	no trip
$V_{\varphi-N}$: 180V	2.45s	no trip

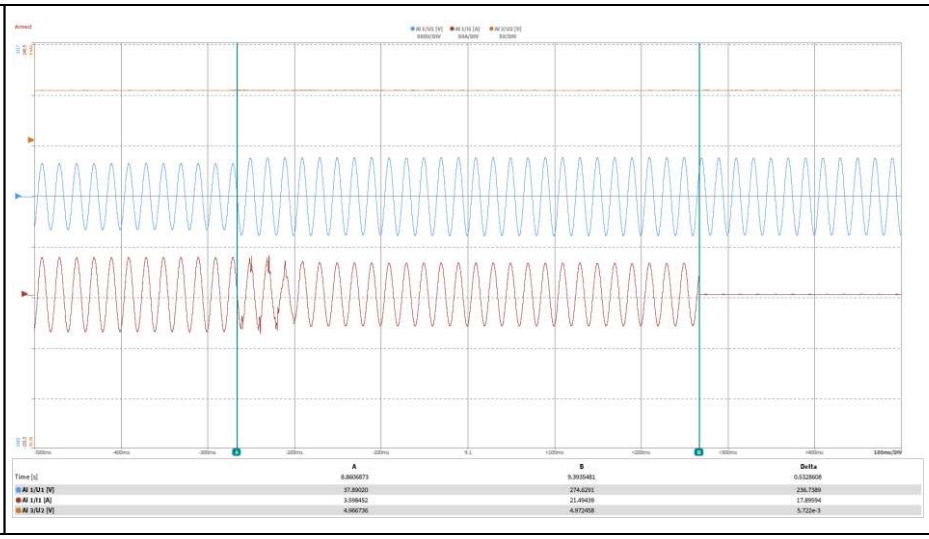
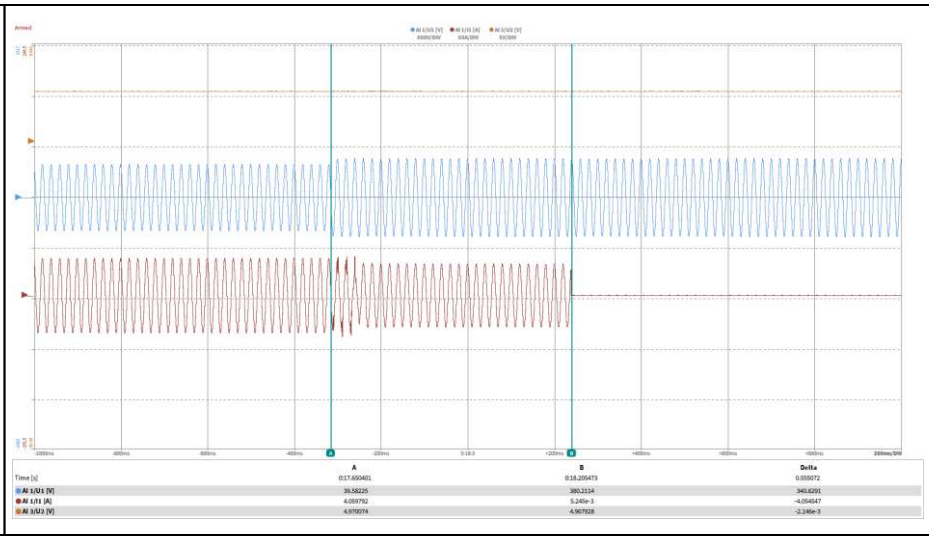
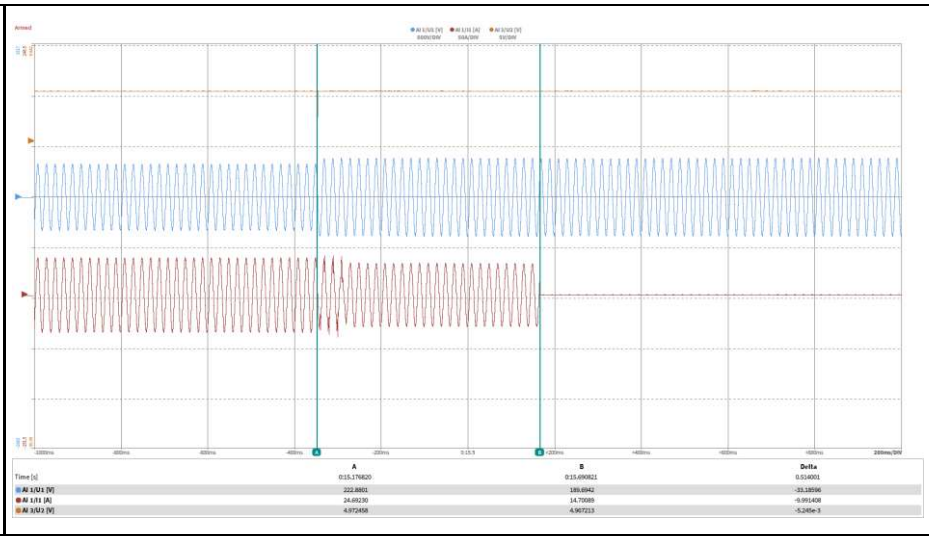
Iteration	Measured voltage(V) and deviation from nominal value (%)		
	Phase L-N (V)	Deviation (%Un)	Deviation limit (%Un)
Over voltage stage 1			

1 - $V_{\varphi-N}$ @-25°C	262.3	0.04	± 1.5
1 - $V_{\varphi-N}$ @+25°C	262.8	0.26	± 1.5
1 - $V_{\varphi-N}$ @+60°C	261.7	-0.22	± 1.5

Verification of disconnecting time		
Iteration	Disconnection time (s)	Oscilloscope recorded waveforms
Over voltage stage 1		
L-N@-25°C:		
1. 258.2V—266.2V (OV st1 trip setting plus 4V)	1.80s	
L-N@+25°C:		
1. 258.2V—266.2V (OV st1 trip setting plus 4V)	1.07s	
L-N@+60°C:		

1. 258.2V—266.2V (OV st1 trip setting plus 4V)	1.08s	

No trip tests - O/V stage 1			
voltage		Hold on time	Confirm no trip
$V_{\varphi-N}$: 258.2V		5s	no trip
Iteration	Measured voltage(V) and deviation from nominal value (%)		
	Phase L-N (V)	Deviation (%Un)	Deviation limit (%Un)
Over voltage stage 2			
1 - $V_{\varphi-N}$ @-25°C	273.3	-0.17	± 1.5
1 - $V_{\varphi-N}$ @+25°C	272.9	-0.35	± 1.5
1 - $V_{\varphi-N}$ @+60°C	273.6	-0.04	± 1.5
Verification of disconnecting time			
Iteration	Disconnection time (s)	Oscilloscope recorded waveforms	
Over voltage stage 2			
L-N@-25°C:			

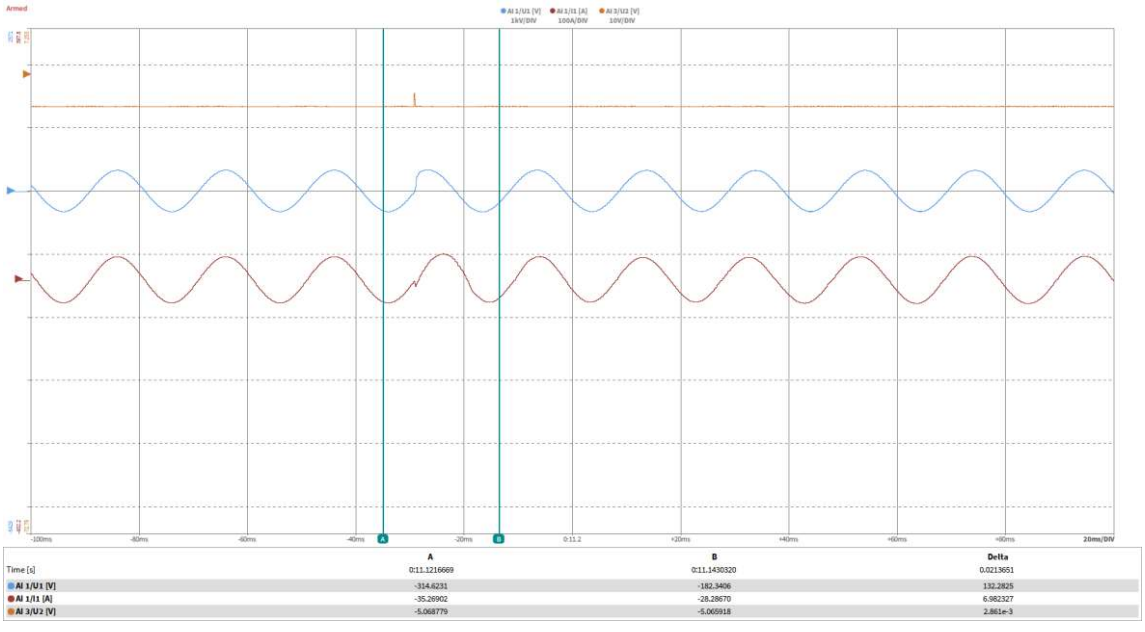
1. 269.7V—277.7V (OV st2 trip setting plus 4V)	0.53s	
L-N@+25°C:		
1. 269.7V—277.7V (OV st2 trip setting plus 4V)	0.56s	
L-N@+60°C:		
1. 269.7V—277.7V (OV st2 trip setting plus 4V)	0.51s	

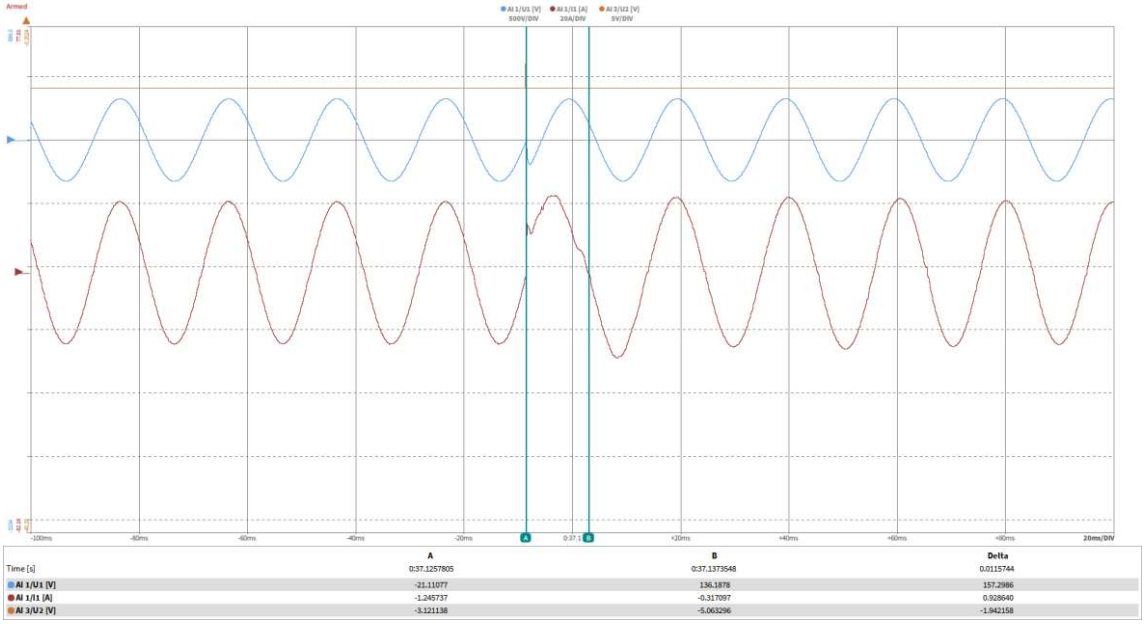
No trip tests - O/V stage 2		
voltage	Hold on time	Confirm no trip
$V_{\varphi-N}$: 269.7 V	0.95s	no trip
$V_{\varphi-N}$: 277.7 V	0.45s	no trip
Remark:		

Calibration and Accuracy Tests											
ASW6000H-S2											
(-25°C)											
Phase	Setting	Time Delay	**Pickup Voltage**				**Relay Operating Time**				
Stage 1 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L-N	262.2 V	1.0 s	258.7 V	262.3 V	265.6 V	Pass	262.2 V	1.0 s	1.08 s	1.1 s	Pass
Stage 2 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L-N	273.7V	0.5 s	270.2 V	273.3 V	277.1 V	Pass	273.7 V	0.5 s	0.53 s	0.6 s	Pass
Under Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L-N	184 V	2.5 s	180.5 V	183.1 V	187.4 V	Pass	184 V	2.50 s	2.58 s	2.60 s	Pass
(+25°C)											
Phase	Setting	Time Delay	**Pickup Voltage**				**Relay Operating Time**				
Stage 1 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L-N	262.2 V	1.0 s	258.7 V	262.8 V	265.6 V	Pass	262.2 V	1.0 s	1.07 s	1.1 s	Pass
Stage 2 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L-N	273.7V	0.5 s	270.2 V	272.9 V	277.1 V	Pass	273.7 V	0.5 s	0.56 s	0.6 s	Pass
Under Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L-N	184 V	2.5 s	180.5 V	182.6 V	187.4 V	Pass	184 V	2.50 s	2.57 s	2.60 s	Pass
(+60°C)											

Phase	Setting	Time Delay	Pickup Voltage				Relay Operating Time				
Stage 1 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L-N	262.2 V	1.0 s	258.7 V	261.7 V	265.6 V	Pass	262.2 V	1.0 s	1.08 s	1.1 s	Pass
Stage 2 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L-N	273.7V	0.5 s	270.2 V	273.6 V	277.1 V	Pass	273.7 V	0.5 s	0.51 s	0.6 s	Pass
Under Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L-N	184 V	2.5 s	180.5 V	182.5 V	187.4 V	Pass	184 V	2.50 s	2.58 s	2.60 s	Pass

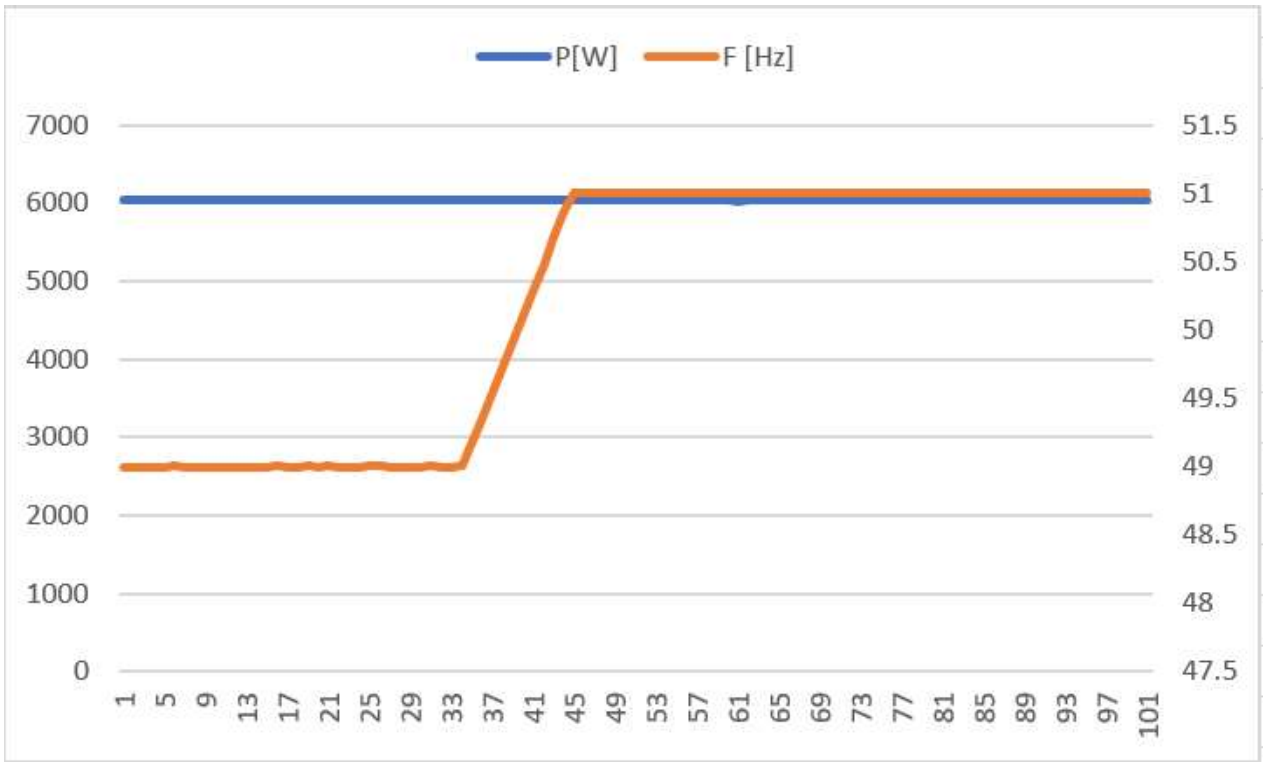
8. Protection – Loss of Mains test: These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4.						
ASW6000H-S2						
These tests should be carried out in accordance with the Annex A.7.1.2.3.						
Test Power and imbalance	33% -5% Q Test 22	66% -5% Q Test 12	100% -5%P Test 5	33% +5% Q Test 31	66% +5% Q Test 21	100% +5% P Test 10
Trip time. Limit is 0.5 s	0.169	0.211	0.220	0.240	0.194	0.187

Loss of Mains Protection, Vector Shift Stability test. This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip under positive / negative vector shift.			
ASW6000H-S2			
	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees	No trip
			
Negative Vector Shift	50.5 Hz	- 50 degrees	No trip

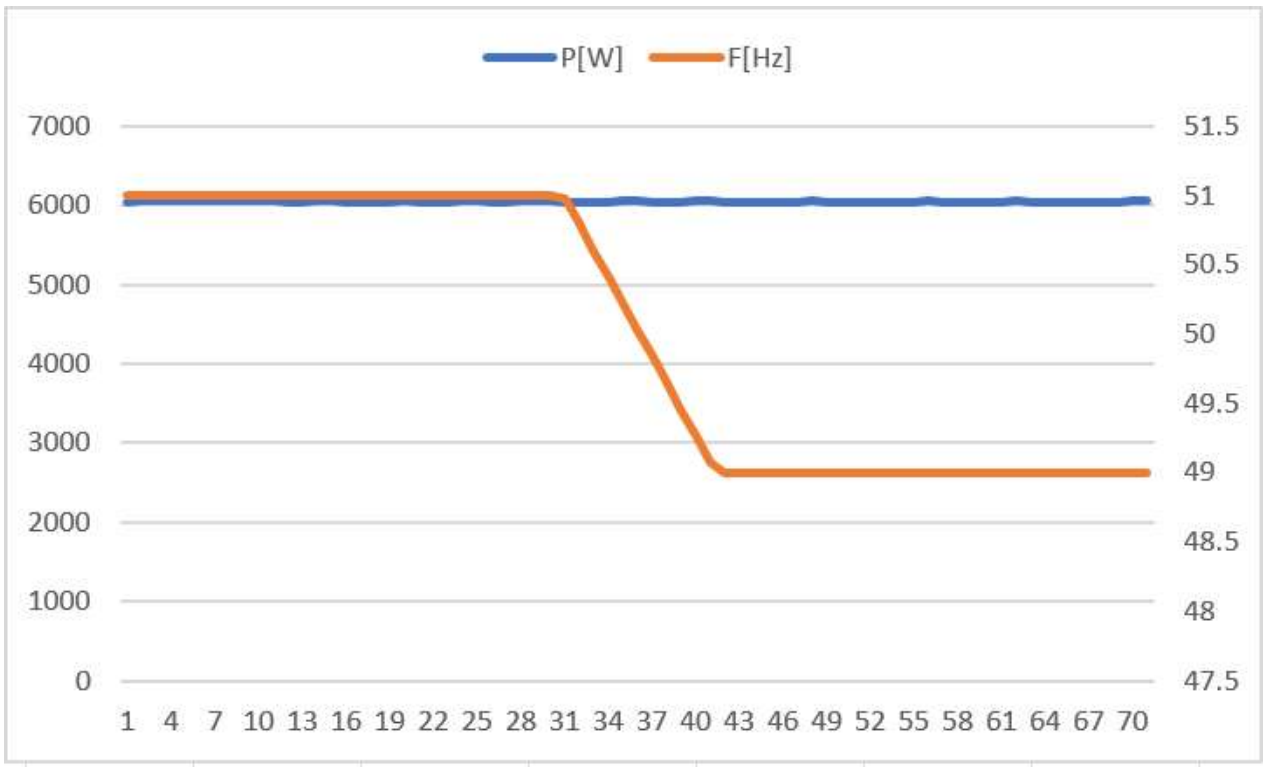


Loss of Mains Protection, RoCoF Stability test: This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip for the duration of the ramp up and ramp down test.

ASW6000H-S2			
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0Hz to 51.0Hz	+0.95 Hzs^{-1}	2.1 s	No trip



51.0Hz to 49.0Hz	-0.95 Hzs^{-1}	2.1 s	No trip



Remark: clause 11.2.2 is taken into consideration

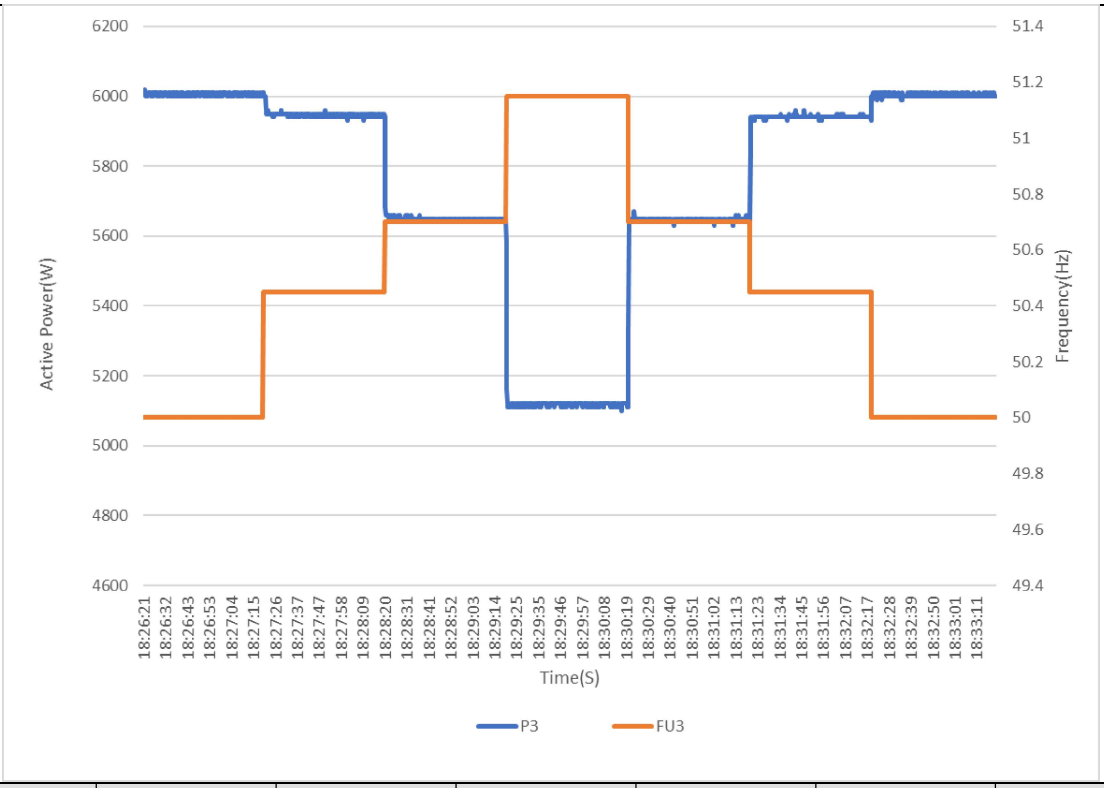
9. Limited Frequency Sensitive Mode – Over frequency test: The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%.

This test should be carried out in accordance with Annex A.7.1.3, which also contains the measurement tolerances.

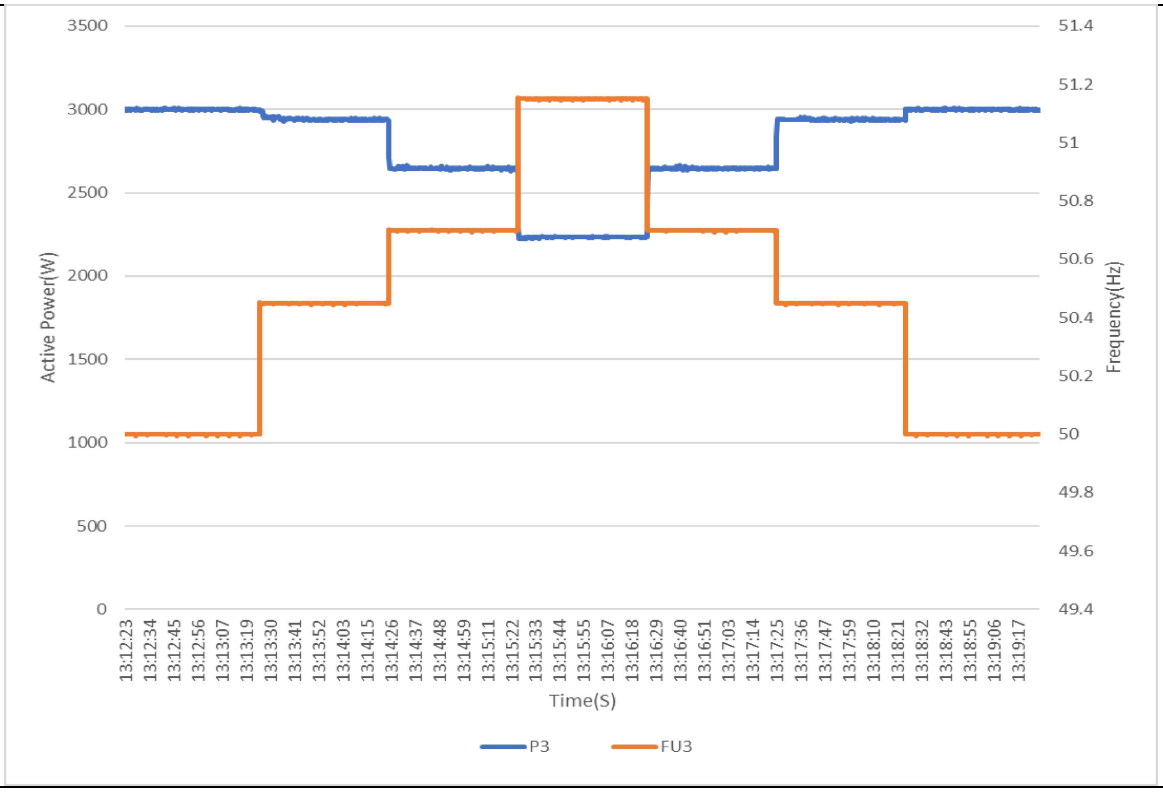
ASW6000H-S2

Active Power response to rising frequency/time plots are attached if frequency injection tests are undertaken in accordance with Annex A.7.2.4.	**Yes**

Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output (W)	**Δ Active Power** achieved within 10s (**%Pmax**)	**Required Δ Active Power** achieved within 10s **(%Pmax)**	Frequency (Hz)	Primary Power Source	**droop %**
Step a) 50.00Hz ±0.01Hz	6005	-	-	50.00	PV simulator (100%Pn)	-
Step b) 50.45Hz ±0.05Hz	5947	-	-	50.45		-
Step c) 50.70Hz ±0.10Hz	5651	4.93	≥3%	50.70		10.13
Step d) 51.15Hz ±0.05Hz	5117	8.89	≥5%	51.15		10.12
Step e) 50.70Hz ±0.10Hz	5647	8.83	≥3%	50.70		10.00
Step f) 50.45Hz ±0.05Hz	5940	-	-	50.45		-
Step g) 50.00Hz ±0.01Hz	6002	-	-	50.00		-



Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output (W)	**Δ Active Power** achieved within 10s (**%Pmax**)	**Required Δ Active Power** achieved within 10s **(%Pmax)**	Frequency (Hz)	Primary Power Source	**droop %**
Step a) 50.00Hz ±0.01Hz	3000	-	-	50.00	PV simulator (50%Pn)	-
Step b) 50.45Hz ±0.05Hz	2942	-	-	50.45		-
Step c) 50.70Hz ±0.10Hz	2645	4.95	≥3%	50.70		10.10
Step d) 51.15Hz ±0.05Hz	2234	6.85	≥5%	51.15		11.86
Step e) 50.70Hz ±0.10Hz	2644	6.83	≥3%	50.70		10.07
Step f) 50.45Hz ±0.05Hz	2939	-	-	50.45		-
Step g) 50.00Hz ±0.01Hz	3000	-	-	50.00		-



Remark: clause 11.2.4 is taken into consideration

10. Protection – Re-connection timer.

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. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Power Generating Module** does not reconnect at the voltage and frequency settings below; a statement of "no reconnection" can be made.

ASW6000H-S2					
Time delay setting for testing (s)	Measured delay (s)	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
60	67.4*	At 1.16 pu (266.2 V)	At 0.78 pu (180.0 V)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.		No reconnection	No reconnection	No reconnection	No reconnection

Supplementary information:

1. Min. delay time recorded in all cases in above table.

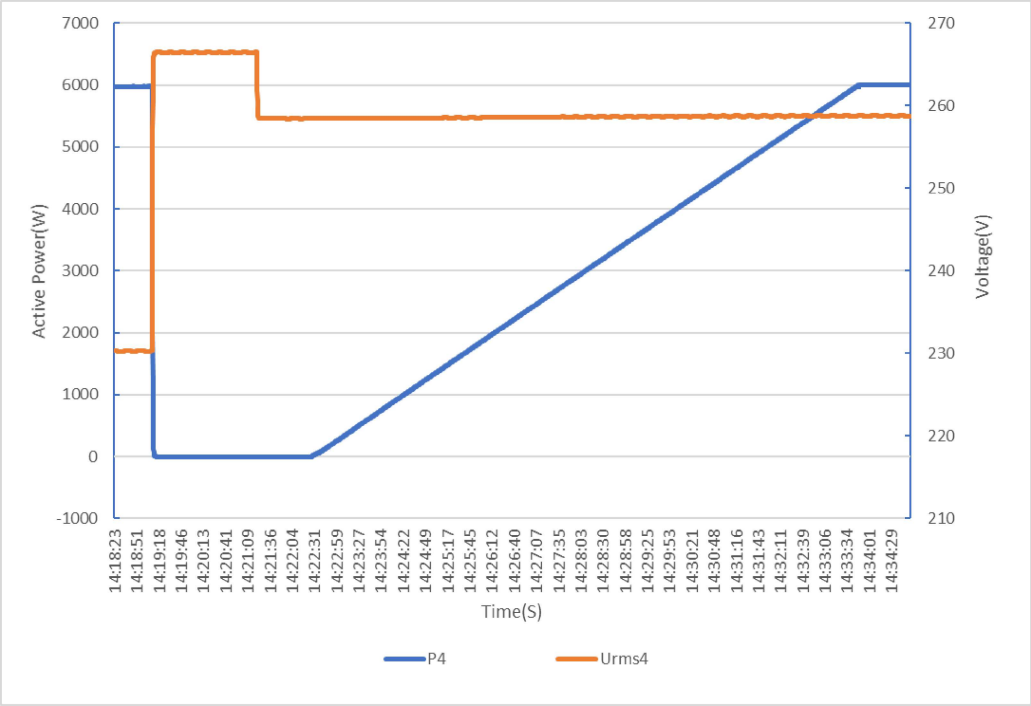
2. "*": Reconnecting time is the sum of waiting time of both the mains voltage and the mains frequency are within the tolerance range(setting 60s) plus additional delay time for all control and adjustment processes safely finished time.

Test data record for reconnection				
Test sequence after trip	connection	Connection allowed	Reconnection time ≥ 20s	Power gradient (% Pn/min)
a) U ≥ (1.14pu + 4V)	No	No	N/A	N/A
b) U ≤ (1.14pu - 4V)	Yes	Yes	Yes	10.0
c) U ≤ (0.8pu - 4V)	No	No	N/A	N/A
d) U ≥ (0.8pu + 4V)	Yes	Yes	Yes	10.0
e) F ≤ 47.4 Hz	No	No	N/A	N/A
f) F ≥ 47.6 Hz	Yes	Yes	Yes	10.0
g) F ≥ 52.1 Hz	No	No	N/A	N/A
h) F ≤ 51.9 Hz	Yes	Yes	Yes	10.0

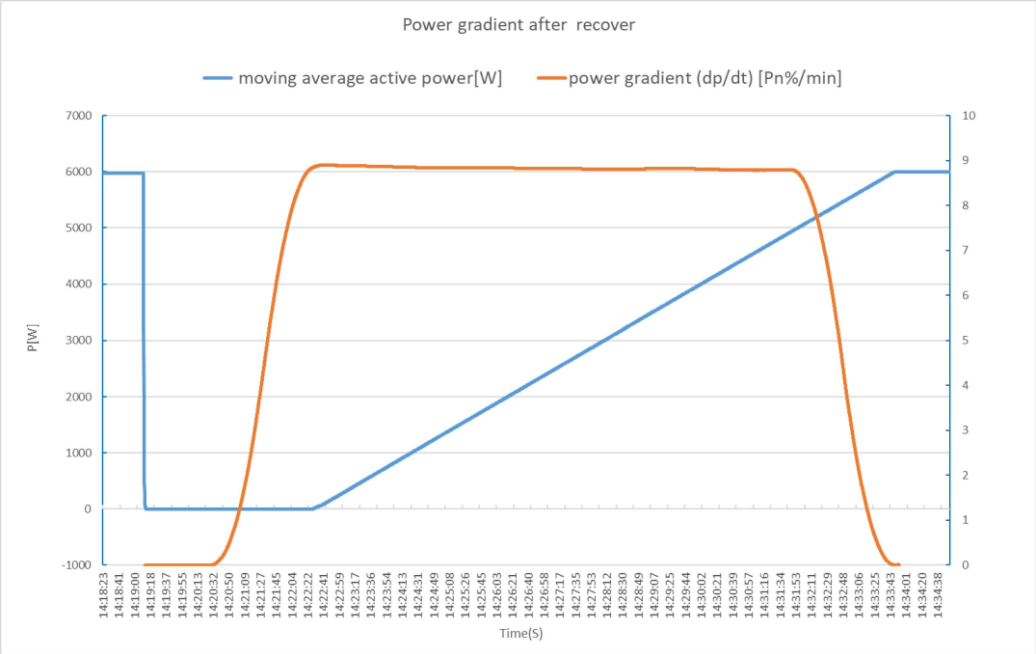
Over voltage

a) U ≥ (1.14pu + 4V) – no reconnection

b) U ≤ (1.14pu - 4V) – reconnection after 67 s



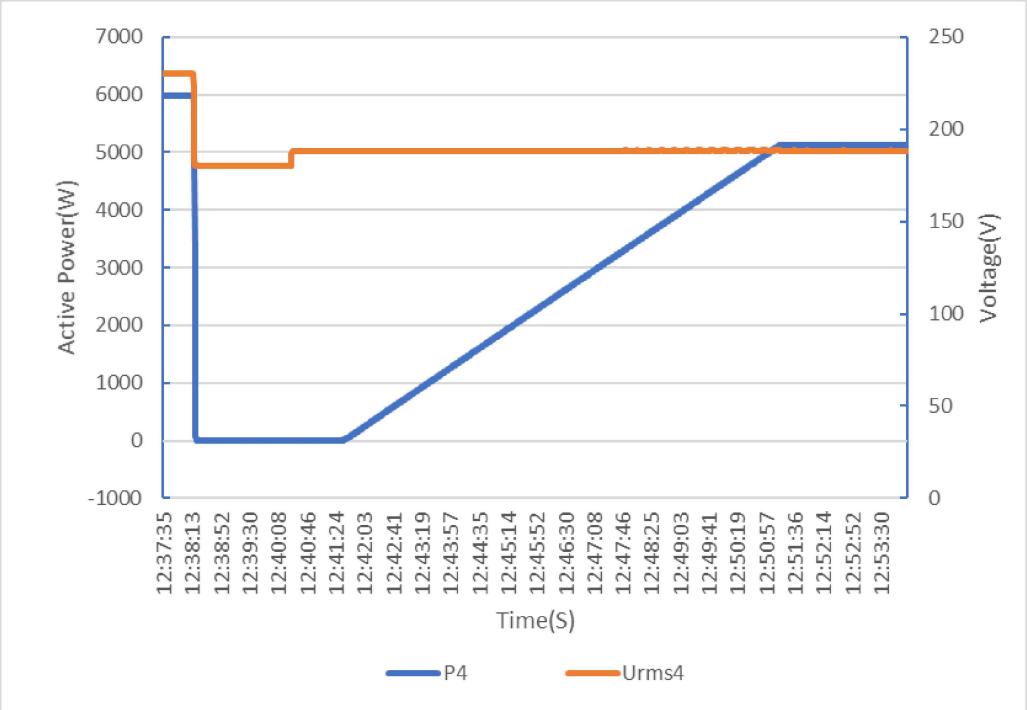
Max. power gradient after reconnection:8.89%Pn/min



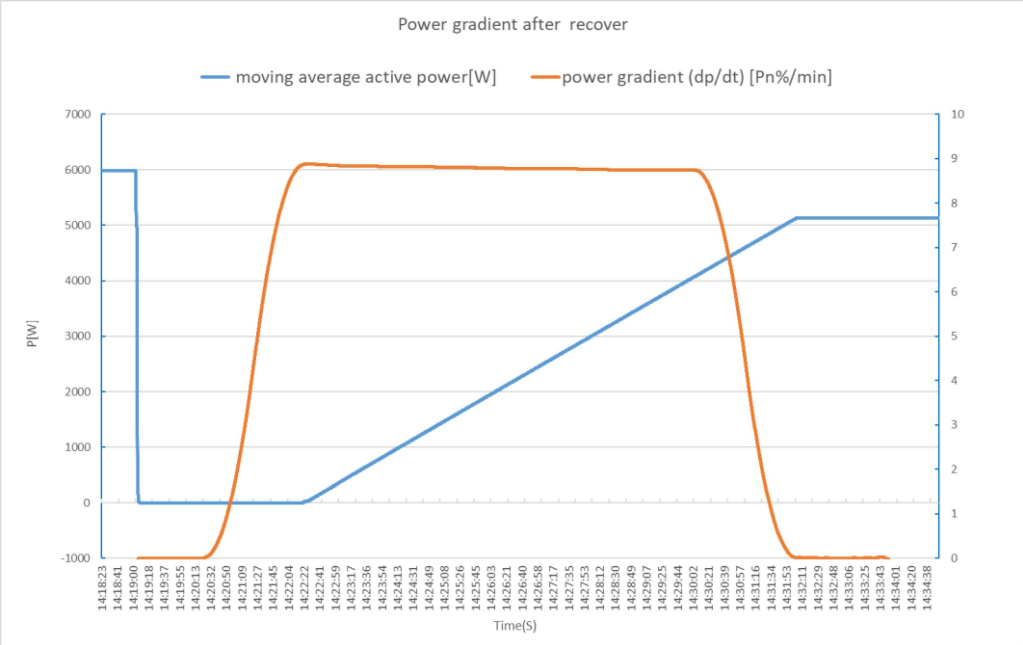
Under voltage

c) U ≤ (0.8pu - 4V) – no reconnection

d) U ≥ (0.8pu + 4V) – reconnection after 67 s



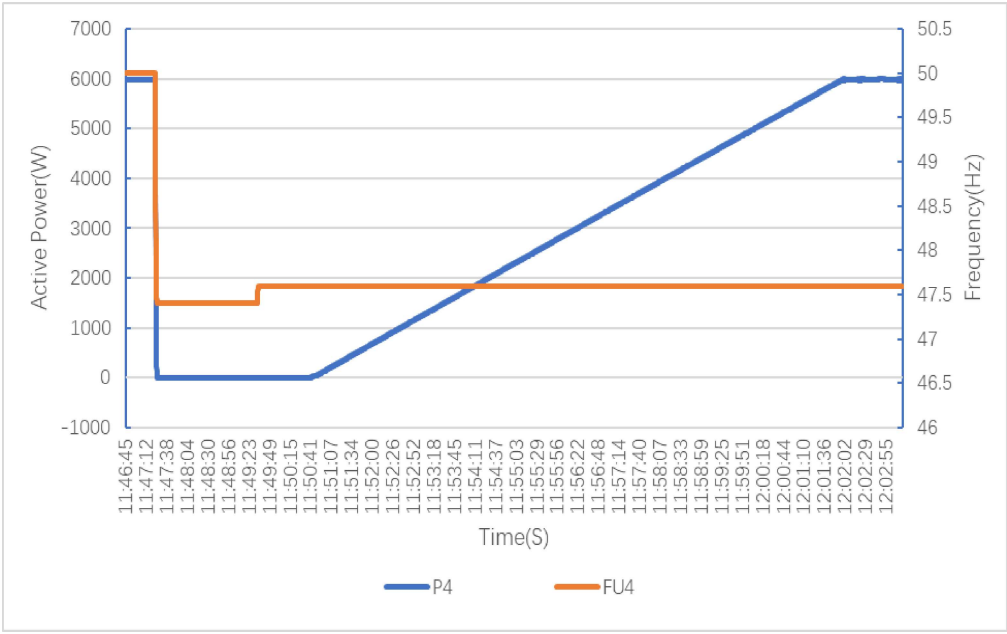
Max. power gradient after reconnection:8.88%Pn/min



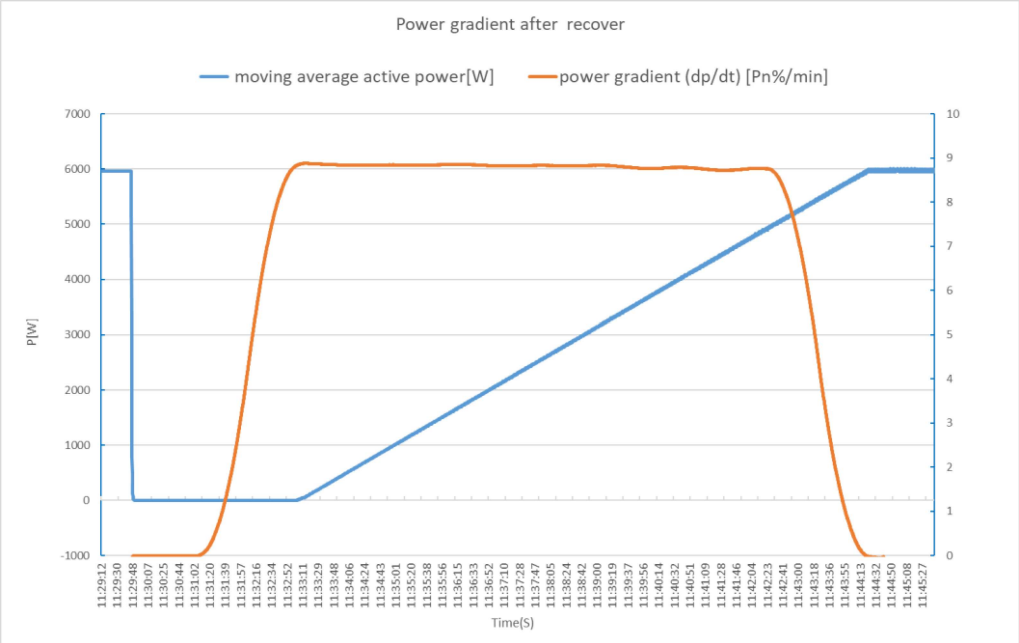
Under frequency

e) F < 47.4 Hz – no reconnection

f) F ≥ 47.6 Hz – reconnection after 67.4 s



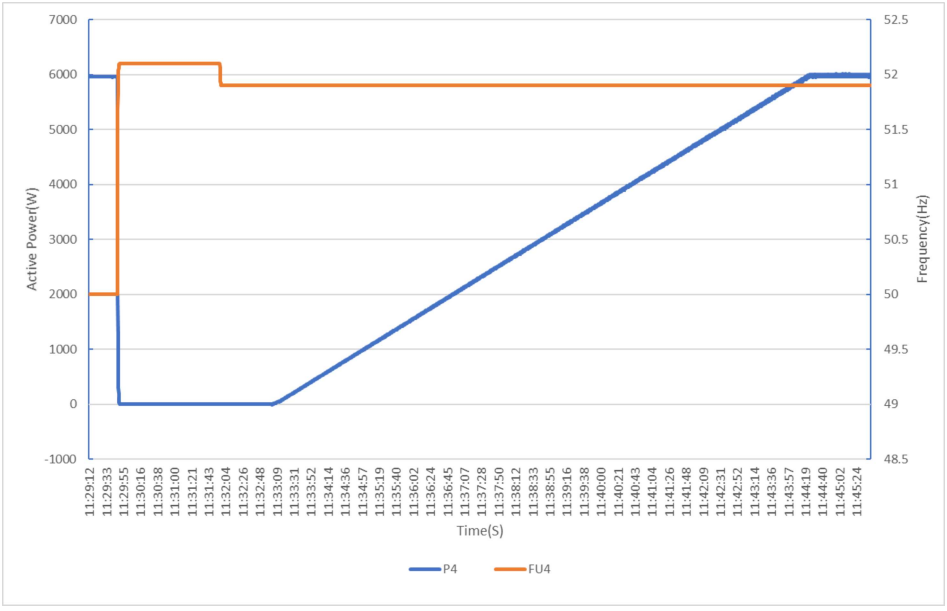
Max. power gradient after reconnection: 8.87%Pn/min



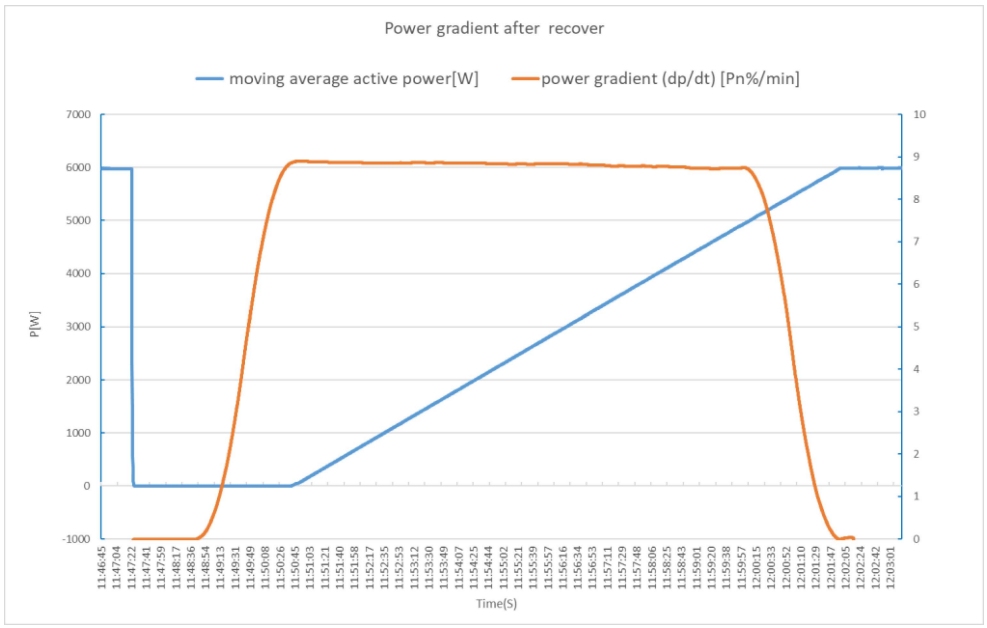
Over frequency

g) F > 52.1 Hz – no reconnection

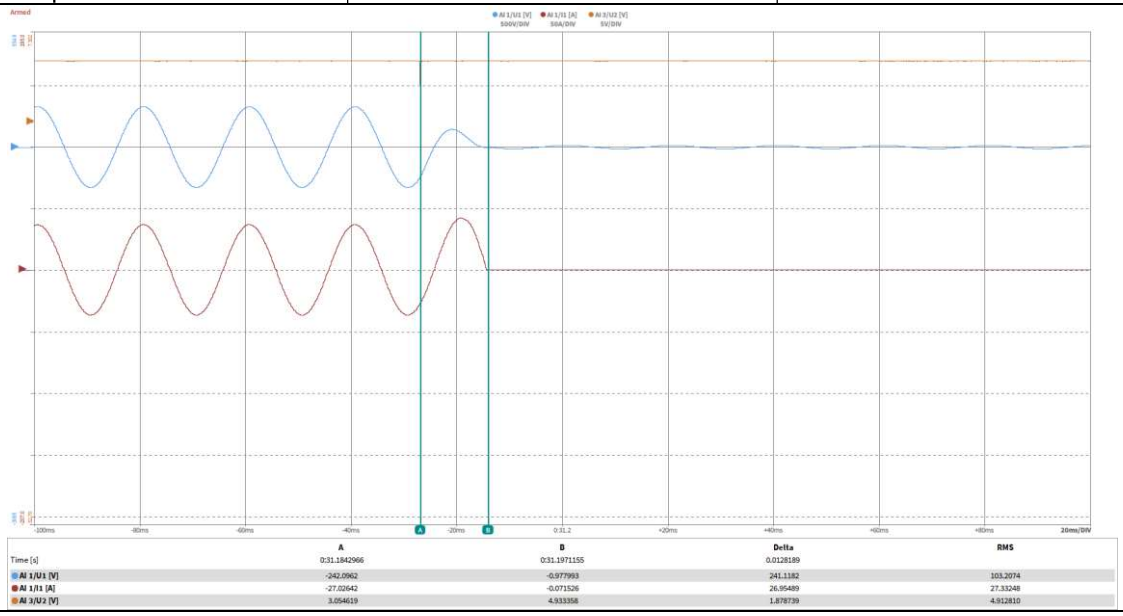
h) F ≤ 51.9 Hz – reconnection after 66.2 s



Max. power gradient after reconnection: 8.89%Pn/min


Power gradient after recover
moving average active power[W]
power gradient (dp/dt) [Pn%/min]
P[W]
Time(S)

11. Fault level contribution: These tests shall be carried out in accordance with EREC G99 Annex A.7.1.5. Please complete each entry, even if the contribution to the fault level is zero.		
ASW6000H-S2		
For an Inverter output		
Time after fault	Volts	Amps
20 ms	10.05 V	0.08 A
100 ms	9.98 V	0.06 A
250 ms	9.98V	0.06A
500 ms	9.98 V	0.05 A
Time to trip	12.82 ms	In seconds



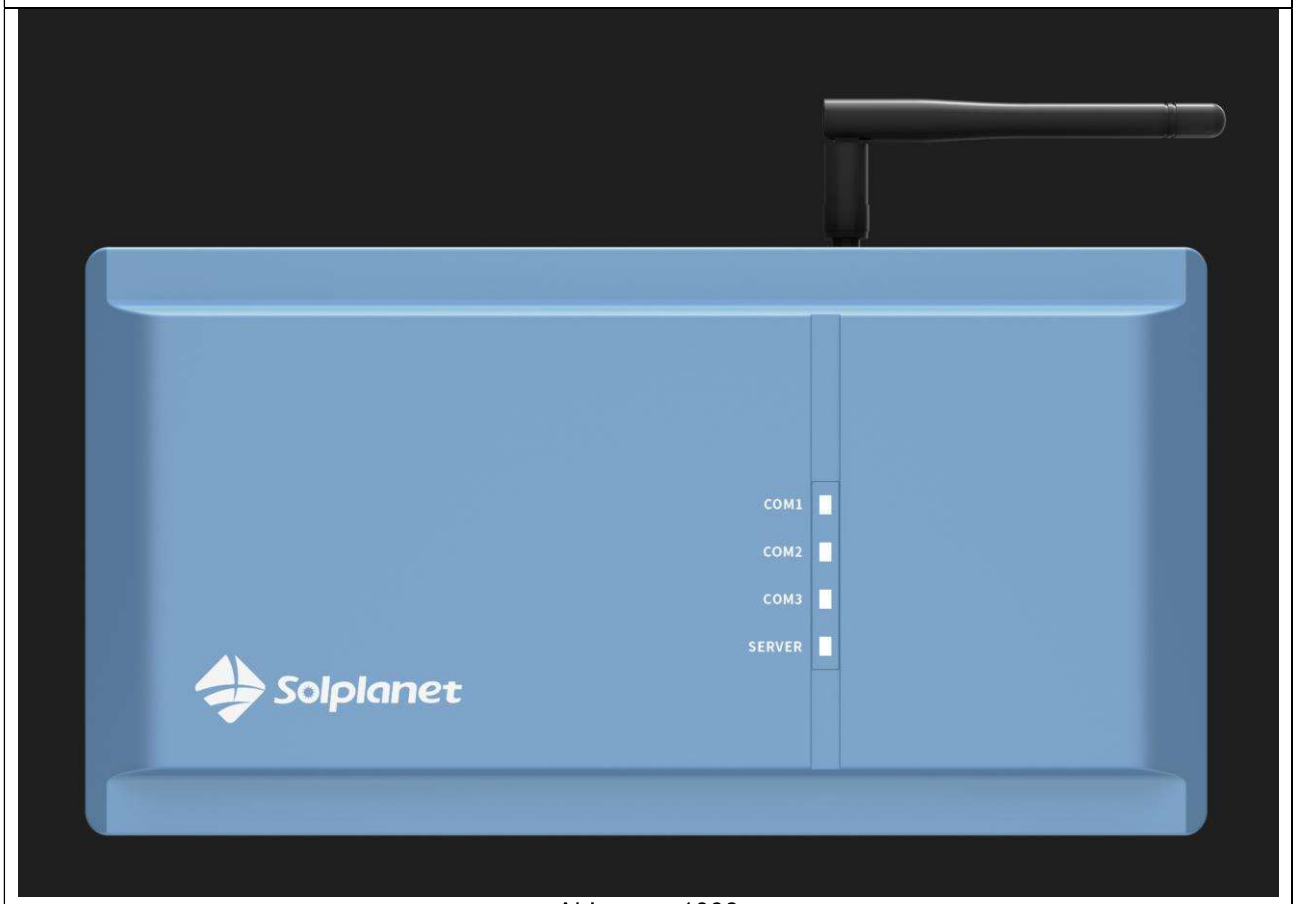
12. Self-Monitoring solid state switching: No specified test requirements. Refer to Annex A.7.1.6.	
It has been verified that in the event of the solid state switching device failing to disconnect the **Power Park Module**, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0. 5 s.	N/A

13. Wiring functional tests: 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

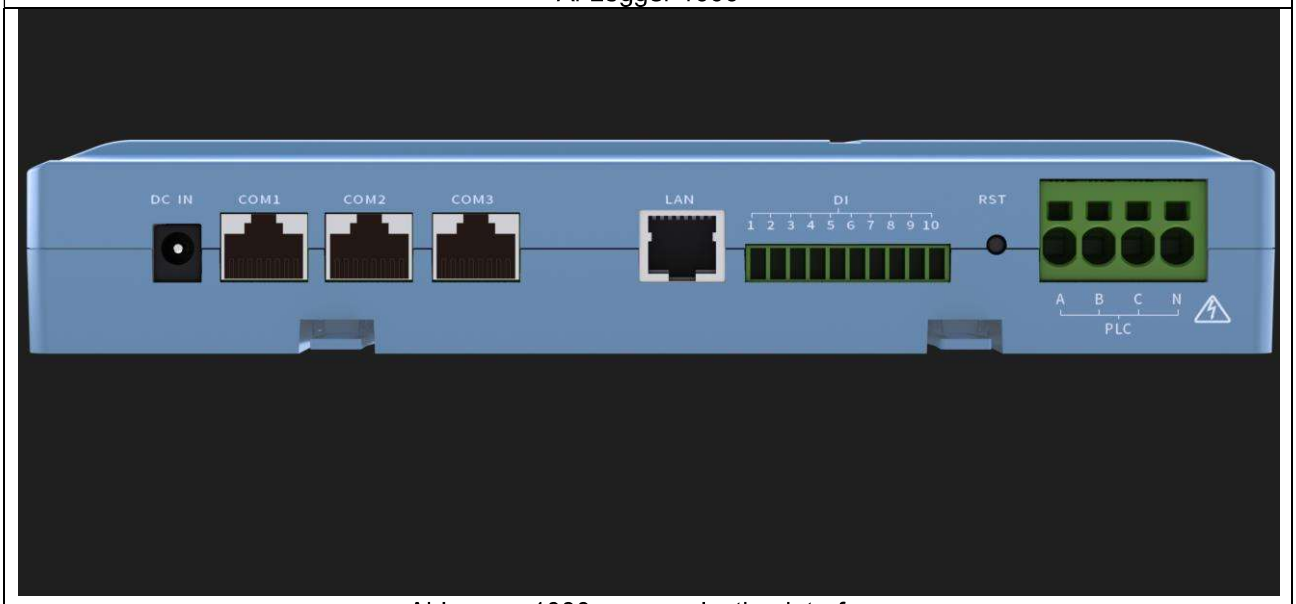
14. Logic interface (input port)	
Confirm that an input port is provided and can be used to shut down the module.	Yes
Provide high level description of logic interface, e.g. details in 11.1.3.1 such as AC or DC signal (the additional comments box below can be used)	Yes

Logic interface are implemented by external devices(model:Ai-Logger 1000).COM1 or 2 or 3 of the external device is connected to COM1 or 2 of the power generation module (Figure 4).
Pin 1 and 10 of the DI port of the external device are connected to the switch or contactor.
When the switch is closed, the generating module can work normally.

When the switch is on, the logical port has a DC voltage of 5V, and the power module reduces the active power to zero within 5 seconds.



Ai-Logger 1000



Ai-Logger 1000 communication interface

Figure 4

15. Cyber security	
Confirm that the Power Generating Module has been designed to comply with cyber security requirements, as detailed in 9.1.7.	Yes