Dynamic Containment

Testing Guidelines (Consultation Draft)

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Foreword

Please note: this document is a draft version of the testing guidelines for consultation. The content in this document may change may change following the consultation.

This document aims to provide guidance to Dynamic Containment providers to National Grid Electricity System Operator (NGESO). This document covers the testing requirements for pre-qualification assessment and reproving of this service. The tests outlined in the document are to verify that the requirements of the service specified in contract documents can be met. For any further enquires or questions, contact your Account Manager or:

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The test results will be assessed by an Independent Technical Expert (ITE). (See Appendix A)

To complete the pre-qualification requirement, the following information must be submitted to NGESO:

- The test data, in the format outlined in Appendix C
- A report from the ITE, in the format outlined in Appendix E
- A CV, setting out the qualifications and experience of the ITE

Contents

Test Requirements

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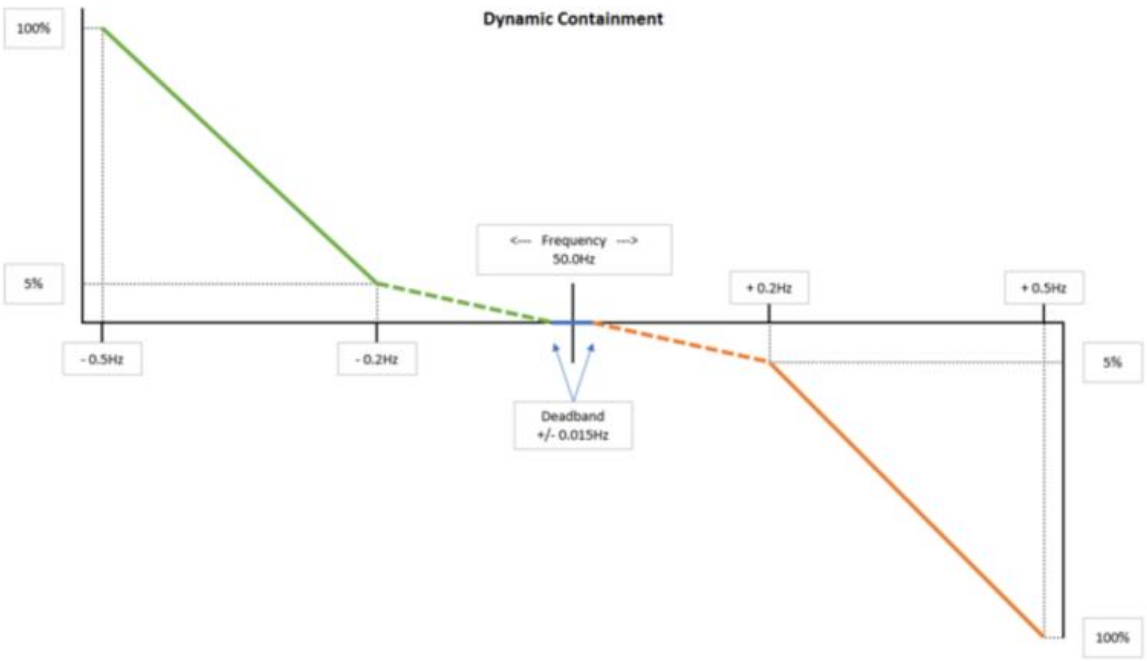
Service description

Dynamic Containment is a fast-acting frequency response service to contain frequency within the statutory range of +/-0.5Hz in the event of a sudden demand or generation loss. The service delivers very quickly and proportionally to frequency deviation.

Table 1- Dynamic Containment Service Specification

Service specification	Details
Deadband delivery	0% (+/- 0.015Hz)
Small linear delivery	Between 0.015Hz and 0.2Hz (maximum of 5% at 0.2Hz)
Knee point activation	+/- 0.2Hz is 5%
Full delivery	+/- 0.5Hz is 100%
Linear delivery knee point	0.2Hz
Full activation	0.5Hz
Full delivery	1s (but no faster than 0.5s)

Figure 1 – Dynamic Containment Delivery Requirements



Dynamic Containment Test Requirements

The Dynamic Containment tests assess the capability of the service provider to deliver dynamic response in accordance with the balancing service contract.

Tests 1, 2 and 3 assess response against injected frequency profiles. Test 4 assesses response whilst connected to live system frequency. The frequency profile can be injected either at site or remotely. The minimum sample rate for all tests is 20Hz. See Appendix B for information on test signals.

Test 1 – Step Test

The purpose of Test 1 is to assess the unit's ability to deliver the required response at discreet frequency deviations.

- The frequency injections to be used are shown in **Figure *2*** and **Table *2*** below.
- Each step is sustained for 180 seconds to verify the response.
- The frequency will then be returned to 50Hz for a minimum of 30 seconds, or until the output is stable, before the next injection is applied.
- Tests 1.1 and 1.2 are designed to ensure that the unit does not provide any response within the deadband.
- The minimum sample rate for Tests 1 is 20Hz.

Pass Criteria for Test 1

- The minimum of the sampled values of active power response within each 3 minute timescale falls within tolerances shown in **Table *3*** and shown graphically in **Figure *3***.
- Delivery of full response of active power due to a change in frequency is as per ***Figure 4*** .
- The Unit should monotonically progress to its required response.
- The standard deviation of load error at steady state over a 3-minute period must not exceed 2.5% of the expected active power response.

Figure 2 - Test 1

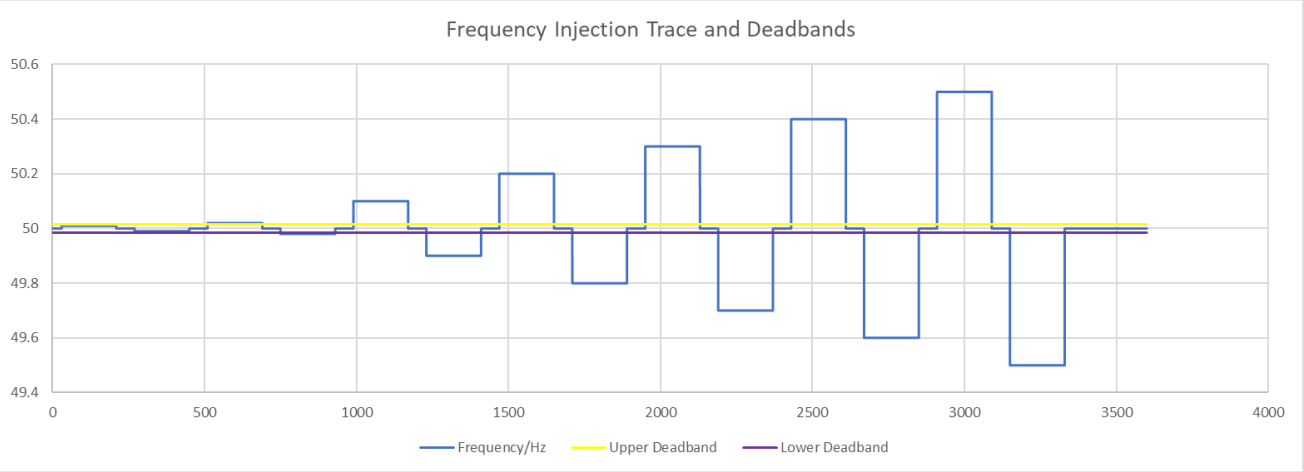


Table 2 - Test 1 Frequency Injection Profile corresponding with times

Test	Parameter	Values					
	Time /s	0	30	30	210	210	240
1.1	Frequency /Hz	50	50	50.01	50.01	50	50
1.2	Frequency /Hz	50	50	49.99	49.99	50	50
1.3	Frequency /Hz	50	50	50.02	50.02	50	50
1.4	Frequency /Hz	50	50	49.98	49.98	50	50
1.5	Frequency /Hz	50	50	50.1	50.1	50	50
1.6	Frequency /Hz	50	50	49.9	49.9	50	50
1.7	Frequency /Hz	50	50	50.2	50.2	50	50
1.8	Frequency /Hz	50	50	49.8	49.8	50	50
1.9	Frequency /Hz	50	50	50.3	50.3	50	50
1.10	Frequency /Hz	50	50	49.7	49.7	50	50
1.11	Frequency /Hz	50	50	50.4	50.4	50	50
1.12	Frequency /Hz	50	50	49.6	49.6	50	50
1.13	Frequency /Hz	50	50	50.5	50.5	50	50
1.14	Frequency /Hz	50	50	49.5	49.5	50	50

Table 3 - Test 1 Frequency Injection and expected response value

Test Number	Frequency Step	Expected Response	Allowable Power Tolerance (% of Expected)
1.1	50.01	0%	n/a
1.2	49.99	0%	n/a
1.3	50.02	0.135%	+/- 3%.
1.4	49.98	0.135%	+/- 3%.
1.5	50.1	2.3%	+/- 3%.
1.6	49.9	2.3%	+/- 3%.
1.7	50.2	5%	+/- 3%.
1.8	49.8	5%	+/- 3%.
1.9	50.3	37%	+/- 3%.
1.10	49.7	37%	+/- 3%.
1.11	50.4	68%	+/- 3%.
1.12	49.6	68%	+/- 3%.
1.13	50.5	100%	+/- 3%.
1.14	49.5	100%	+/- 3%.

Figure 3 Graphical representation of tolerance bands for the expected response at different frequencies – sample chart only

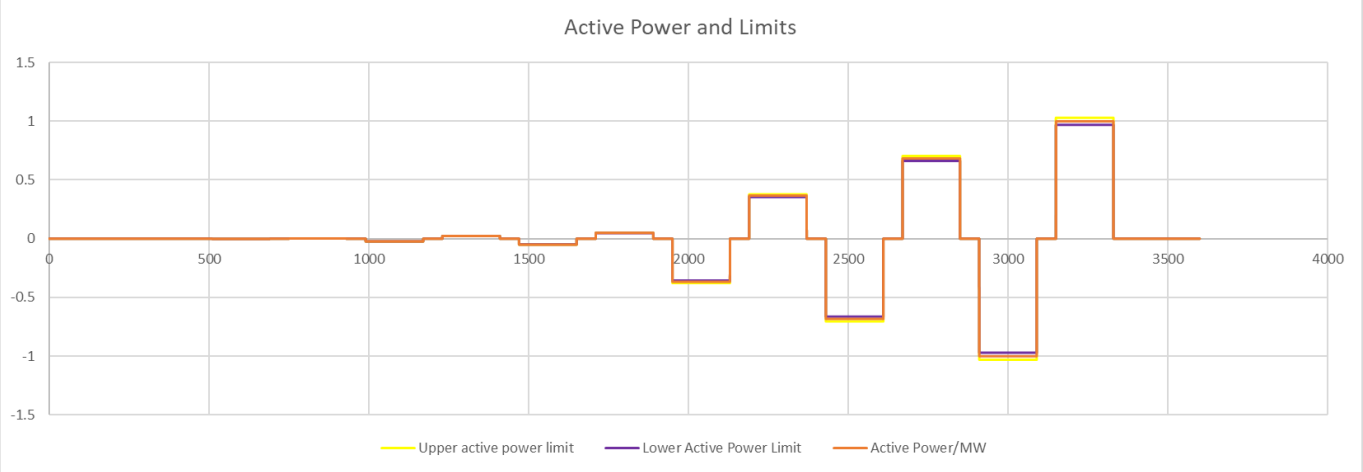
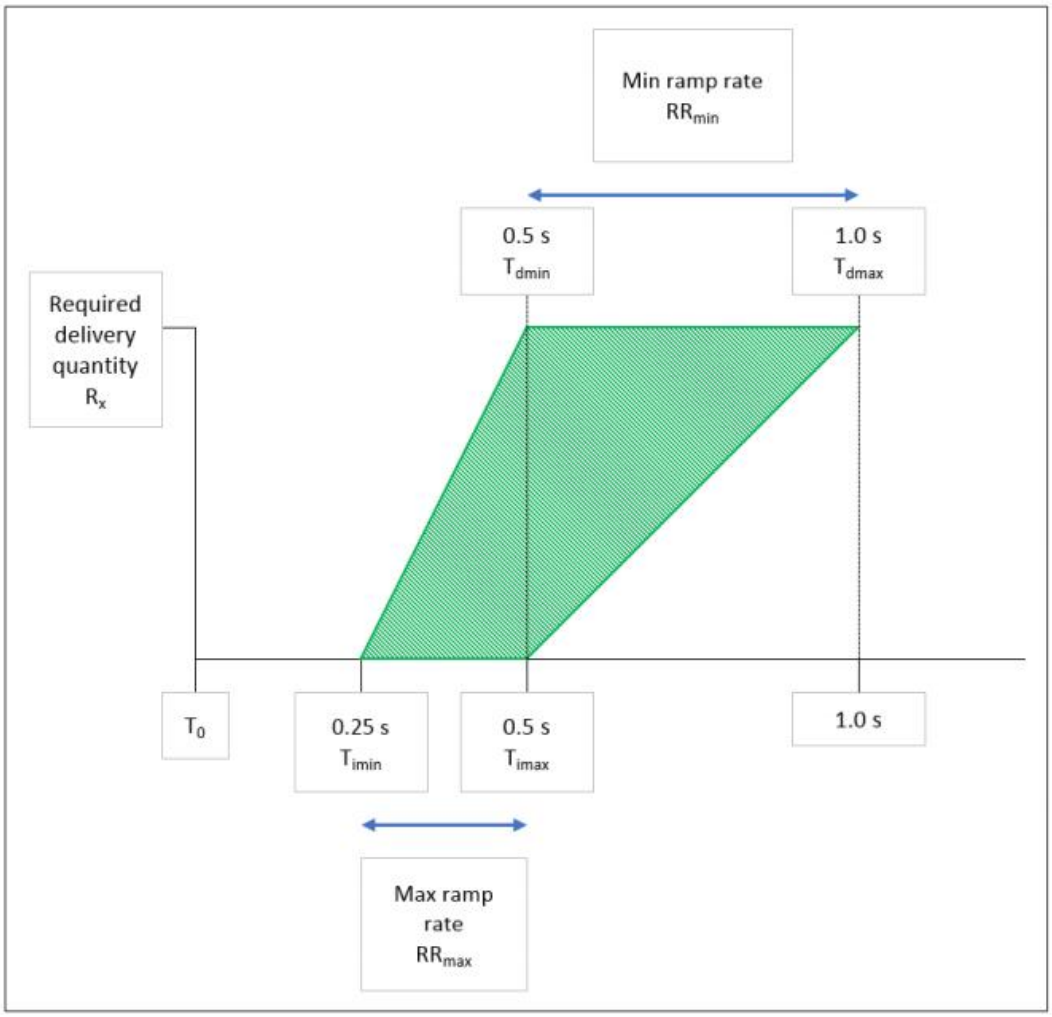


Figure 4 – Graphical representation of timescales in which response should be delivered



Test 2 – Frequency Sweep Test

Test 2 assesses the unit's performance against a varying frequency over the entire performance envelope.

- The frequency injections to be used are shown in Figures 5 and 6 and Table 4 below.
- The minimum sample rate for Tests 2.1 and 2.2 is 20Hz.

Pass Criteria for Tests 2.1 and 2.2

- Delay in response following a change in frequency should be ≥0.25s and ≤0.5s.
- For Test 2.1 and 2.2, active power response is within the tolerances in **Figure 7/Figure 8 and**
- **Table 5**

Figure 5 - Test 2.1

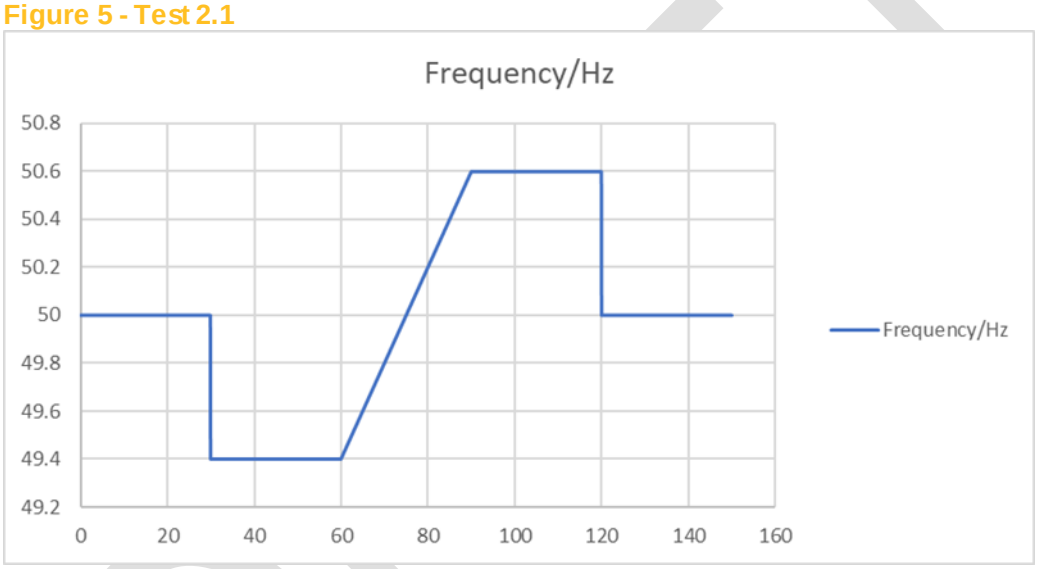


Figure 6 - Test 2.2

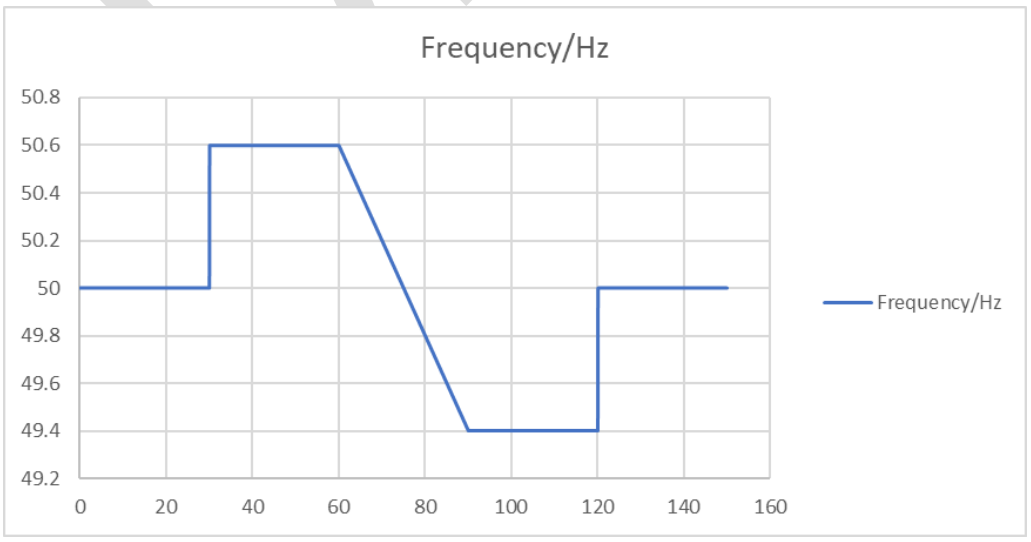


Table 4 - Test 2 Frequency Injection Profiles

Time /s	Injected Frequency /Hz	
	Test 2.1	Test 2.2
0	50	50
30	50	50
30	49.4	50.6
60	49.4	50.6
65	49.6	50.4
70	49.8	50.2
75	50	50
80	50.2	49.8
85	50.4	49.6
90	50.6	49.4
120	50.6	49.4
120	50	50
150	50	50

Figure 7 - Test 2.1 Tolerance - sample

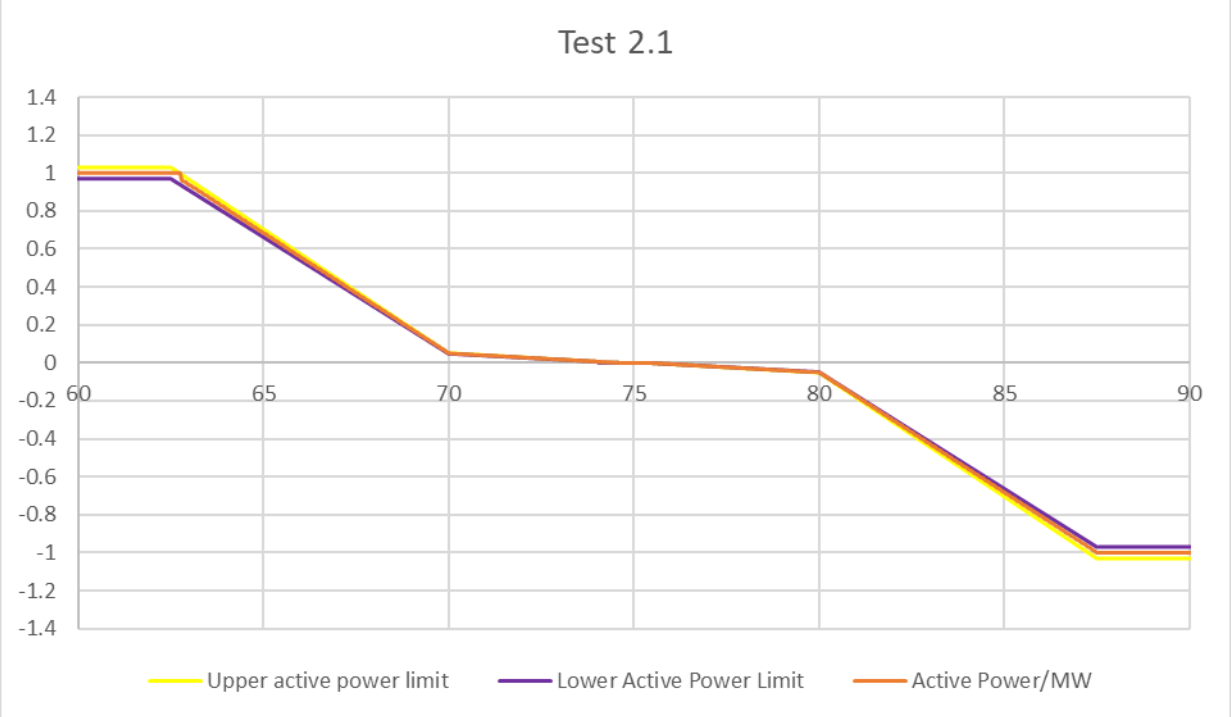


Figure 8 - Test 2.2 Tolerance - sample

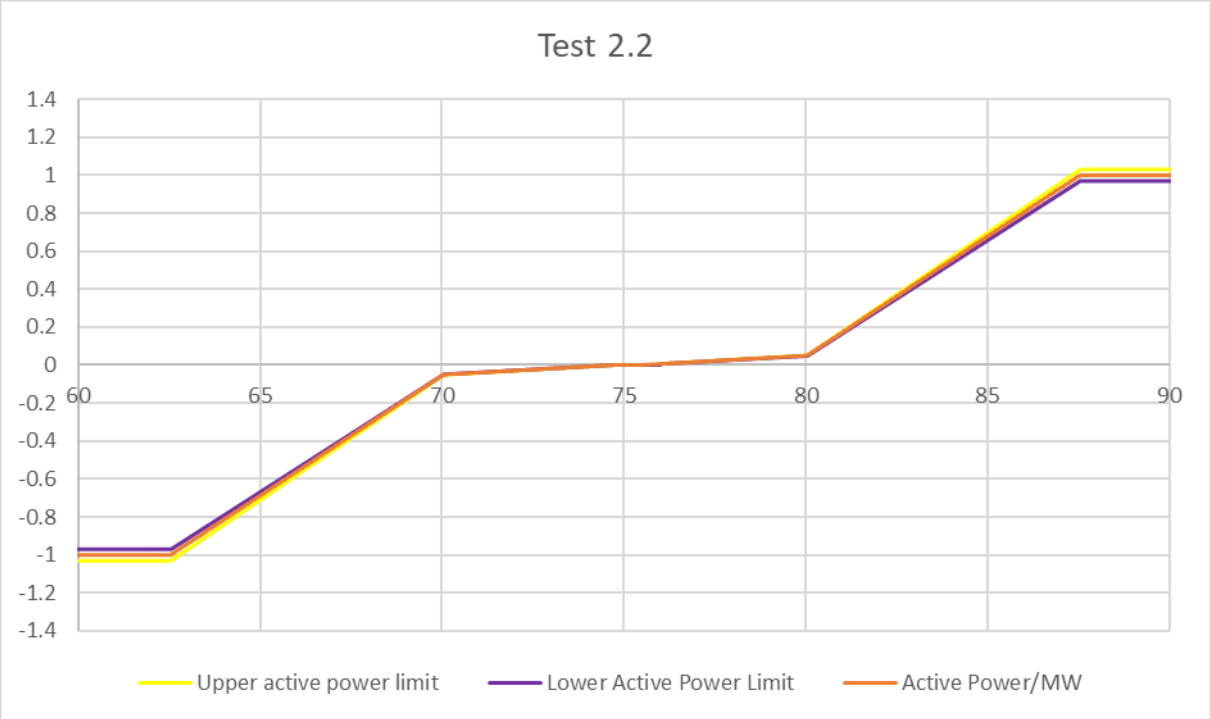


Table 5 - **Test 2.1b and 2.2b Sweep Test tolerances**

	Test 2.1b		Test 2.2b	
	Negative Active Power Gradient		Positive Active Power Gradient	
Time/s	Expected Percentage Active Power Response/%	Tolerance (% of Expected)	Expected Percentage Active Power Response/%	Tolerance (% of Expected)
62.5	100.0	+/- 3%.	-100.0	+/- 3%.
64.5	74.7	+/- 3%.	-74.7	+/- 3%.
65	68.3	+/- 3%.	-68.3	+/- 3%.
67.5	36.7	+/- 3%.	-36.7	+/- 3%.
70	5.0	+/- 3%.	-5.0	+/- 3%.
72.5	2.3	+/- 3%.	-2.3	+/- 3%.
75	0.0	0%	0.0	0%
77.5	-2.3	+/- 3%.	2.3	+/- 3%.
80	-5.0	+/- 3%.	5.0	+/- 3%.
82.5	-36.7	+/- 3%.	-36.7	+/- 3%.
85	-68.3	+/- 3%.	-68.3	+/- 3%.
87.5	-100.0	+/- 3%.	100.0	+/- 3%.
89.5	-100.0	+/- 3%.	100.0	+/- 3%.

Test 3 Duration Test

Test 3 assesses the unit's ability to sustain full response for 15 minutes.

- Operation will be tested at ±100% of capability to ensure the system is compliant.
- This is carried out by a frequency step of ±0.6Hz onto the system for 15 minutes.
- The frequency injection profiles are shown in Figures 9 and 10 and Tables 6 and 7.

Pass criteria for test 3:

- The standard deviation of load error at steady state over a 900 second period must not exceed 2.5% of the maximum contracted active power.
- Sustain response for 15 minutes.

Figure 9 Test 3.1 Injection Profile

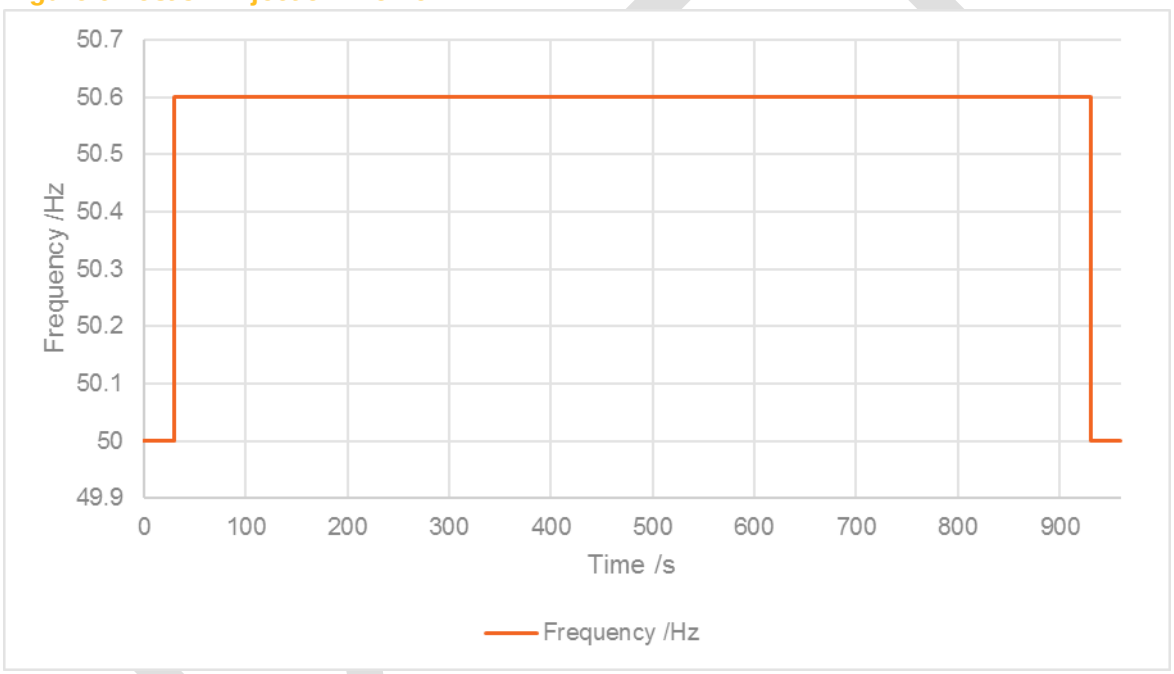


Figure 10 Test 3.2 Injection Profile

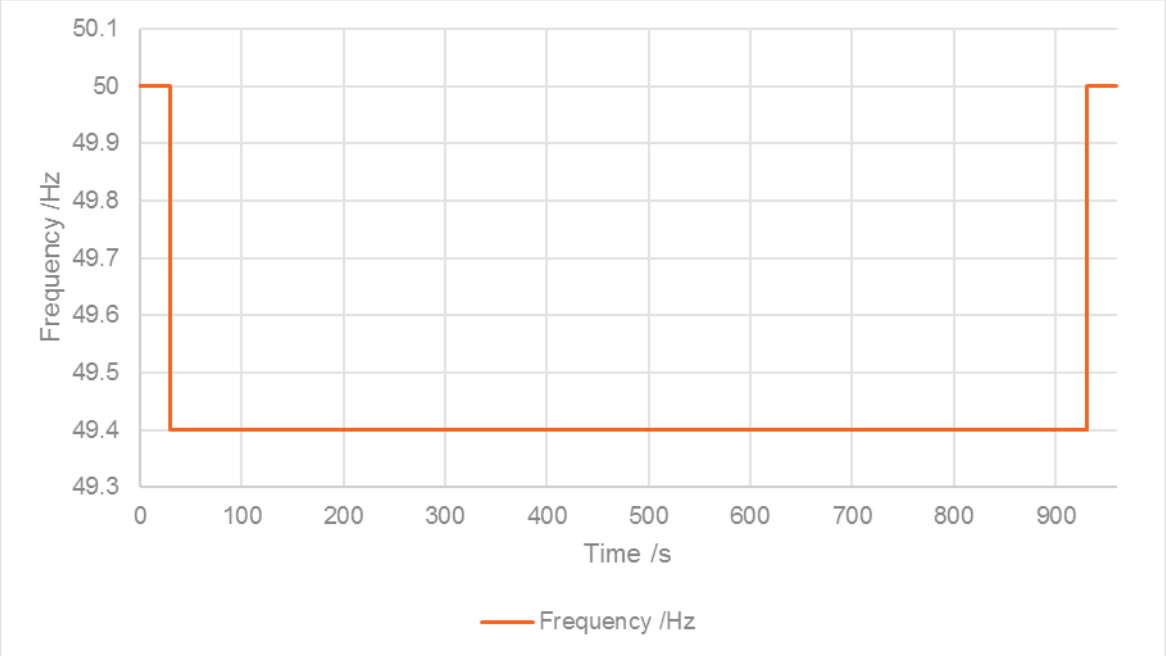


Table 6: Test 3.1 Frequency Injection Table Corresponding with times

	Test 3.1 Frequency injection table					
Time /s	0	30	30	930	930	960
Frequency /Hz	50	50	50.6	50.6	50	50

Table 7: Test 3.2 Frequency Injection Table Corresponding with times

	Test 3.2 Frequency injection table					
Time /s	0	30	30	930	930	960
Frequency /Hz	50	50	49.4	49.4	50	50

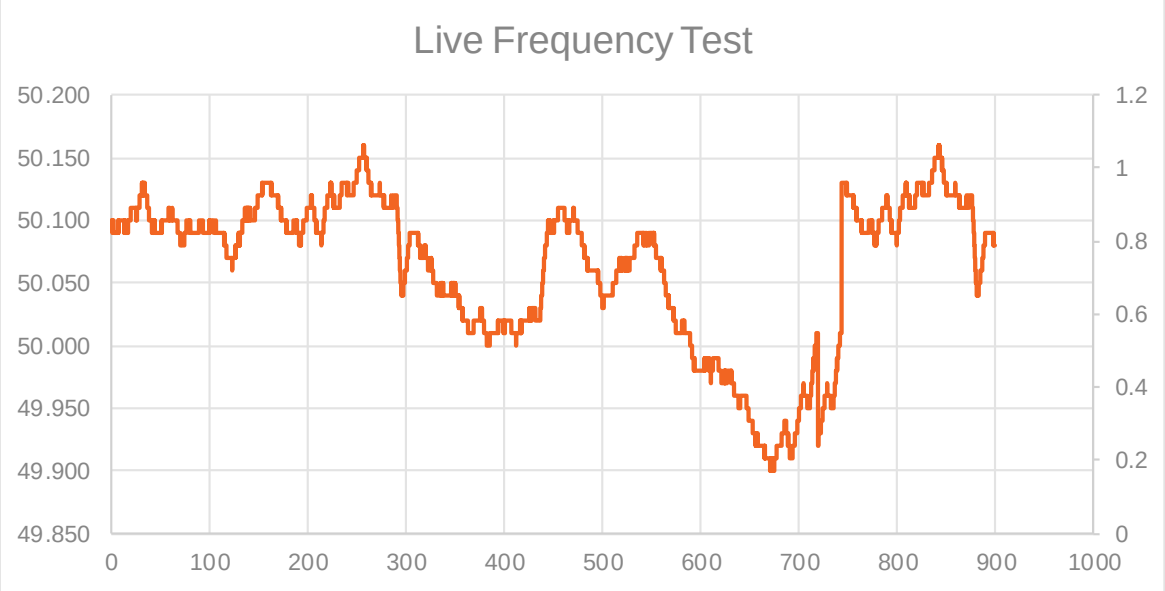
Test 4 – Live System Frequency Response Test

Test 4 assesses the unit's response to system frequency in a live environment. The minimum sample rate for this test is 20Hz and duration is 15 minutes where system frequency and active power response will be recorded. As part of test 4, you are required to provide evidence that the protection settings are in line with the grid code (+/- of 5% of 50Hz).

Pass Criteria for Test 4

- Provide an active power response consistent with the contracted performance within timescales.
- Provide evidence protection setting comply with grid code.

Figure 11 - Sample System Frequency



Appendices

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Appendix A - Independent Technical Expert (ITE)

The Dynamic Containment test results will be assessed by an **Independent Technical Expert** (ITE) who will prepare a **Test Certificate.** The following definitions shall apply:

Group means, for any person, another person who is the direct or indirect **Holding Company** of that person and any **Subsidiary** of that **Holding Company**.

Holding Company means, in relation to a company, any other company in respect of which it is a **Subsidiary**.

Independent Technical Expert means an experienced technical expert with expertise in the operation of demand side response (DSR) or generating units or electricity Interconnectors (as the case may be), **Independent** of the prospective response provider, engaged by the prospective response provider at its expense to carry out a technical assessment and prepare a **Test Certificate.**

Independent means, for any technical expert and the applicable prospective response provider, that the technical expert is:

(a) not in the same **Group** as the prospective response provider; and
(b) neither engaged on terms, nor party to any other arrangements, which could allow the prospective response provider or any member of its **Group** to exercise undue influence on any assessment of the **Test Certificate** prepared by that technical expert or otherwise compromise the objectivity of any such assessment and test certificate to the **Required Technical Standard**.

Required Technical Standard means, with respect to any assessment and **Test Certificate** prepared by an **Independent Technical Expert** that:

(a) to the best of the **Independent Technical Expert**'s knowledge and belief all information provided in it is accurate, complete and not misleading; and
(b) any opinions or forecasts in the assessment have been conservatively prepared on assumptions which it considers to be fair and reasonable.

Subsidiary means a subsidiary within the meaning of section 1159 of the Companies Act 2006 (but relation to an Interconnector, or shareholder in such provider, subsection (1)(a) of that section shall apply as if a "majority of the voting rights" included 50% only of those rights)

Test Certificate means a certificate in the form set out in Appendix E (dynamic) prepared by an **Independent Technical Expert**.

Appendix B – Test Signals

The limits of error and minimum sample rates for testing are shown below in **Table 8**. All success criteria are subject to the stated limit of error/accuracy threshold.

Table 8 - Limits of error and minimum sample rates for Dynamic Service Testing

	Limit of error/ Accuracy threshold	Minimum Sample rate Test 1	Minimum Sample rate Tests 2 and 3
Frequency (Hz)	±0.01 Hz	20Hz	20Hz
Active Power (MW)	Please see pass criteria	20Hz	20Hz

Simulations / simulated tests are not permitted. Each test submitted must record real time data from the plant and sites under test: The test data submitted must come from the specific site to be contracted; substituted data will not be accepted. Test results much not be changed before submission for analysis.

Test Signals

In ALL cases, the data should record ALL required signals for at least 30 seconds BEFORE the application of the frequency injection signal and for at least 30 seconds AFTER the completion of the test.

For ALL services, the data for the following signals will need to be provided

a) Time
b) Active Power
c) System Frequency or Injected frequency as appropriate
d) Any other relevant signals that may affect the success criteria such as Relay Logic for non-dynamic.

Appendix C - Dynamic Containment Test Data Format

Figure 12 - Sample Dynamic Containment Test Data Format

Provider	Company Name	
Dae	xx-xx-xxxx	
Test	1	
Service	Dynamic Containment	
Location	AA	
Site	AA	
Time	Injected Frequency/Hz	Measured Power/MW
0	50	0
0.05	50	0
0.1	50	0
0.15	50	0
0.2	50	0
0.25	50	0
0.3	50	0
0.35	50	0
0.4	50	0
0.45	50	0
0.5	50	0
0.55	50	0
0.6	50	0
0.65	50	0
0.7	50	0
0.75	50	0
0.8	50	0
0.85	50	0
0.9	50	0
0.95	50	0
1	50	0

Further columns can be added to include data for several sites if required.

For Test 4 replace 'Injected Frequency' with 'Measured Frequency'.

Appendix D – Dynamic Containment Test Assessment

Excel Analysis Tool published with User Guide.

See Test certificate template in Appendix E for further guidance.

Appendix E – Dynamic Containment Test Certificate Template

Please use this Test Certificate format and submit to NGESO, along with the test data and CV of the ITE employed by the prospective response provider.

Prospective Response Provider Company Details

Contracted company name	
Primary contact name	
Contact number/s	
Email address	

Contract Details

Contract ID	
Service type, e.g. Static or Dynamic	
Asset type, e.g. diesel generator, battery etc	
Unit make up, e.g. single or aggregated	*Describe here what is included in this test e.g. Single asset, group of assets, asset/s being assessed within an existing Unit.*
Aggregation methodology (if appropriate)	
Unit location / ID	
Contract signed date	
Service start date	
Test date	

Dynamic Service Details (*example here is for a 5MW Unit*)

Deadband	**±0.015Hz**
Response / MW	5

Test Results

Further relevant test description/commentary here

Table 1 – Contracted vs Actual Response Values

Frequency Deviation /Hz	Tolerance	Primary / MW	
		Contracted	Actual
-0.5	+/- 3%.	5.0	5.0
-0.4	+/- 3%.	3.4	3.4
-0.3	+/- 3%.	1.8	1.8
-0.2	+/- 3%.	0.25	0.25
-0.1	+/- 3%.	0.1	0.1
-0.02	+/- 3%.	0.007	0.007
-0.01	n/a	0.0	0.0
0	n/a	0.0	0.0
0.01	n/a	0.0	0.0
0.02	+/- 3%.	-0.007	-0.007
0.1	+/- 3%.	-0.1	-0.1
0.2	+/- 3%.	-0.25	-0.25
0.3	+/- 3%.	-1.8	-1.8
0.4	+/- 3%.	-3.4	-3.4
0.5	+/- 3%.	-5.0	-5.0

Test	Pass Criteria	Pass/Fail	Comment
1	Minimum of the sampled values of active power response within each 3 minute timescale fall within tolerances	Pass	Note result here (See Figure …)
1	Delay in response following a change of frequency is between 0.25 and 0.5 seconds		
1	Delivery of active power due to a change in frequency is occurs between 0.5 and 1 seconds	Pass	Note result here.
1	The Unit should monotonically progress to its required response	Pass	Refer to figures below
1	The standard deviation of load error at steady state over a 3 minute period must not exceed 2.5% of the expected active power response	Pass	Standard deviation is assessed from 10 seconds until 3 minutes after the frequency step.
2.1 2.2	A noticeable change in power in the correct direction is observed	Pass	

Test	Pass Criteria	Pass/Fail	Comment
	and is equal to the total maximum contracted value.		
2.1 2.2	Active power response is within the allowed tolerances.	Pass	Show in figure below with tolerance bands overlaid.
2.1 2.2	Delay in response following a change of frequency is between 0.25 and 0.5 seconds		
3	Response is sustained for 15 minutes	Pass	Refer to figures
3	The standard deviation of load error at steady state over a 900 second period must not exceed 2.5% of the maximum contracted active power.	Pass	Standard deviation is assessed from 10 seconds until 900 seconds after the frequency step.
4	Provide an active power response consistent with the contracted performance timescales.	Pass	Figure should show the active power close to the 'Expected Active Power value' line plotted on the graph.
	Overall Test Result	**PASS**	

Test Result Graphs

Plot frequency injection and active power response vs time for each test.

Figure 1 – Test 1 Frequency Injection

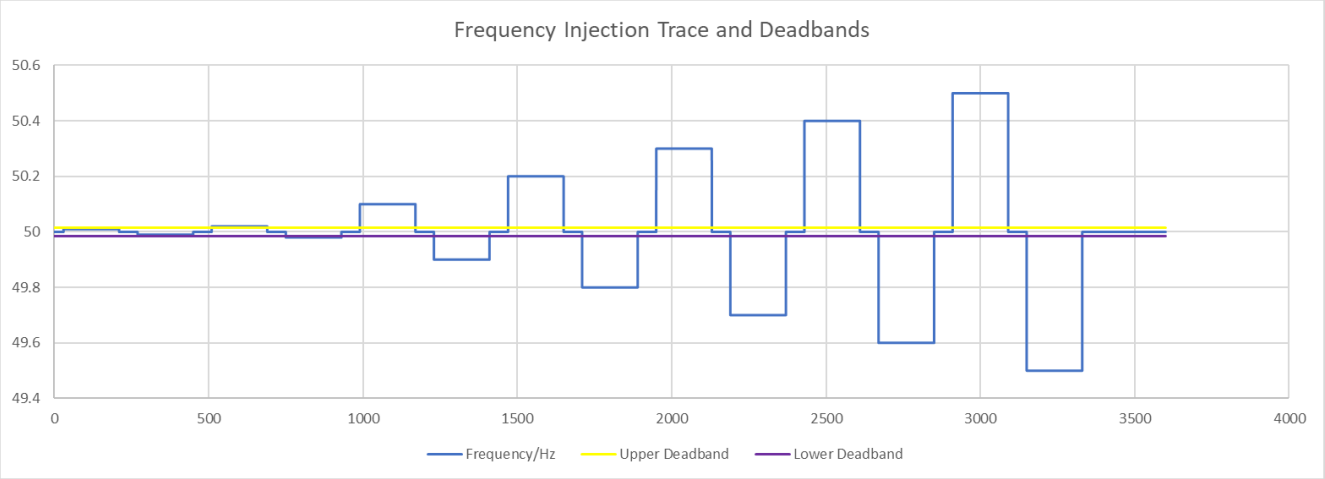


Figure 2 – Test 1 Active Power Response

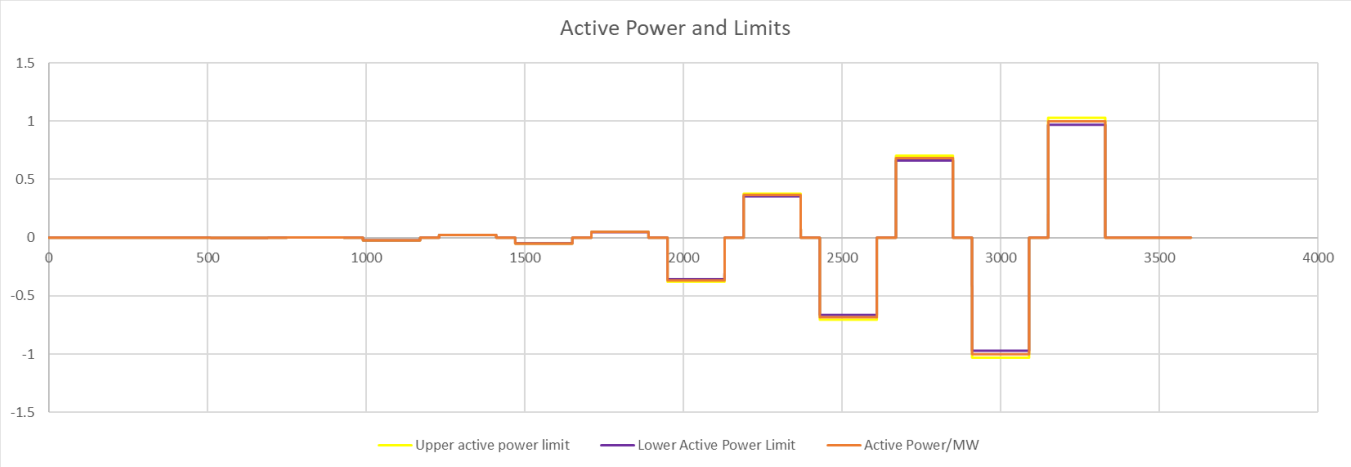


Figure 3 – Test 1.1

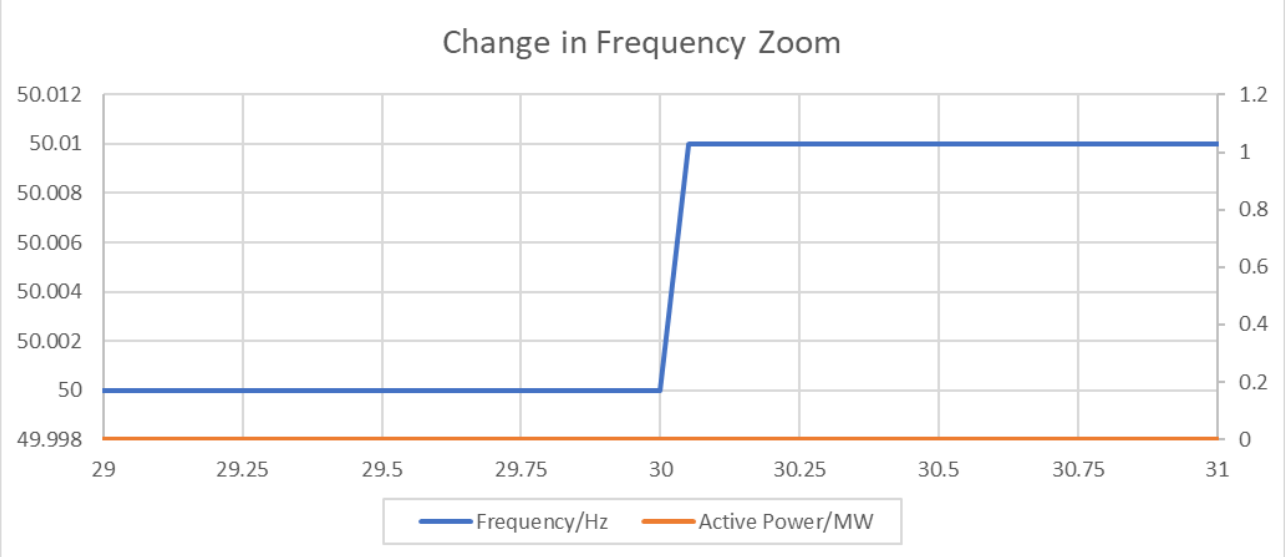


Figure 4 – Test 1.2

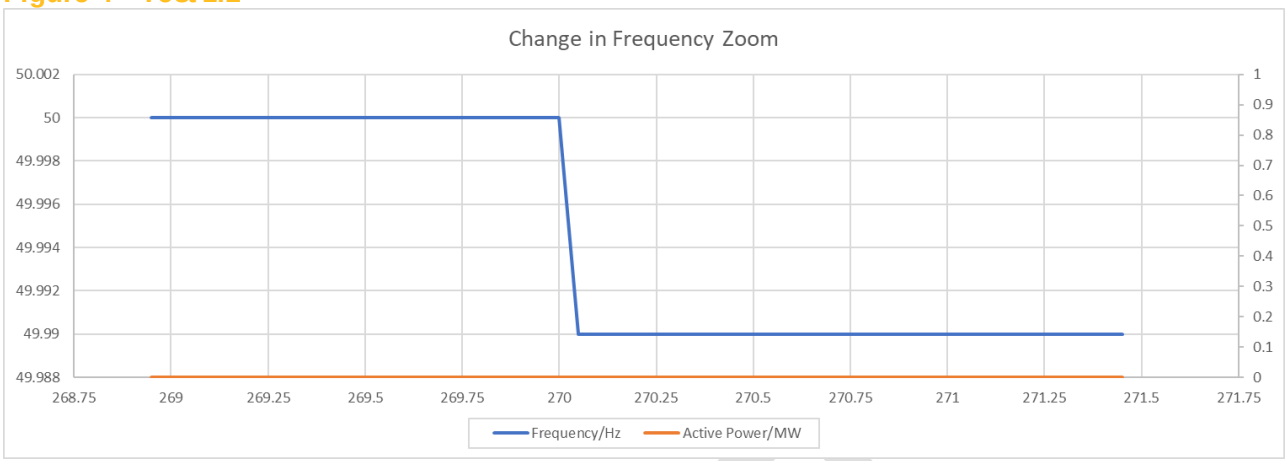


Figure 5 – Test 1.3

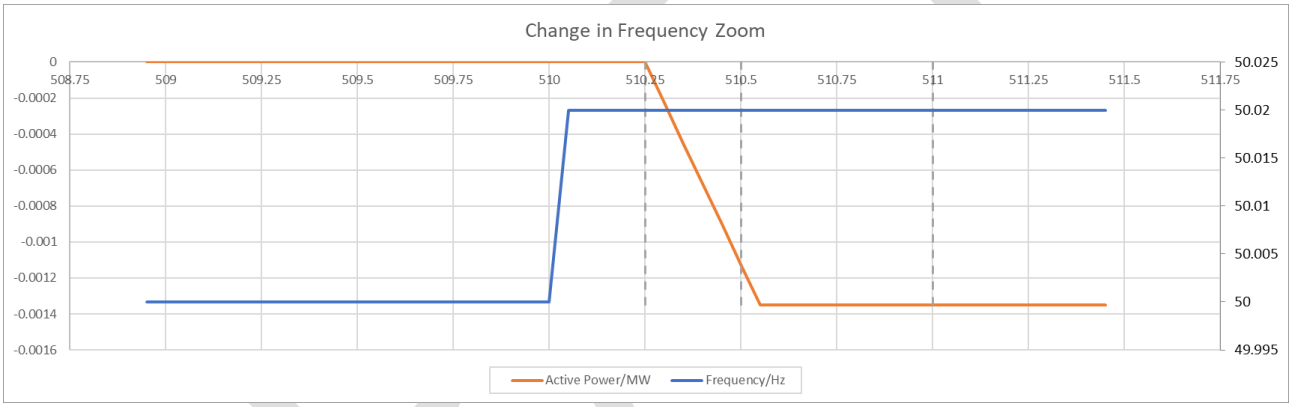


Figure 6 – Test 1.4

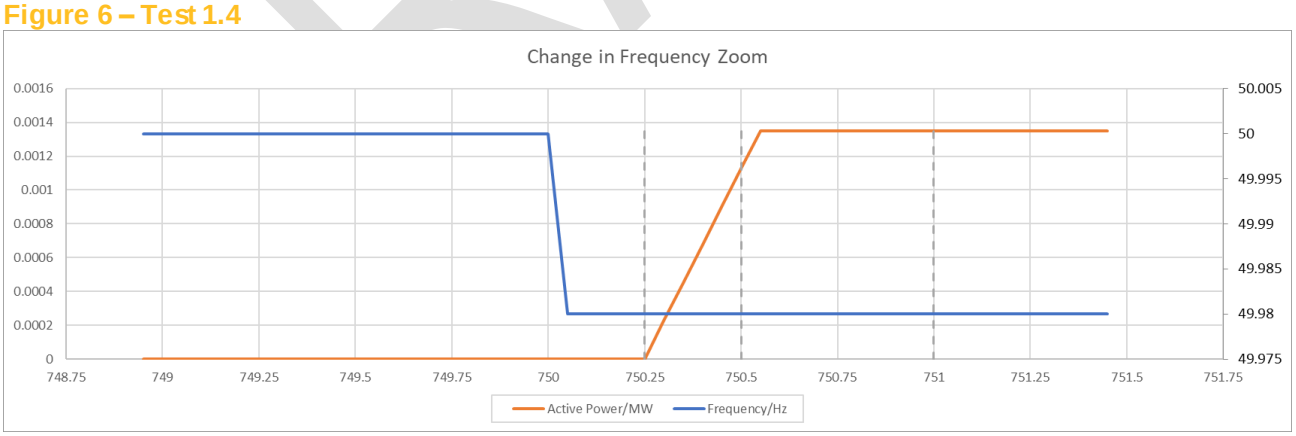


Figure 7 – Test 1.5

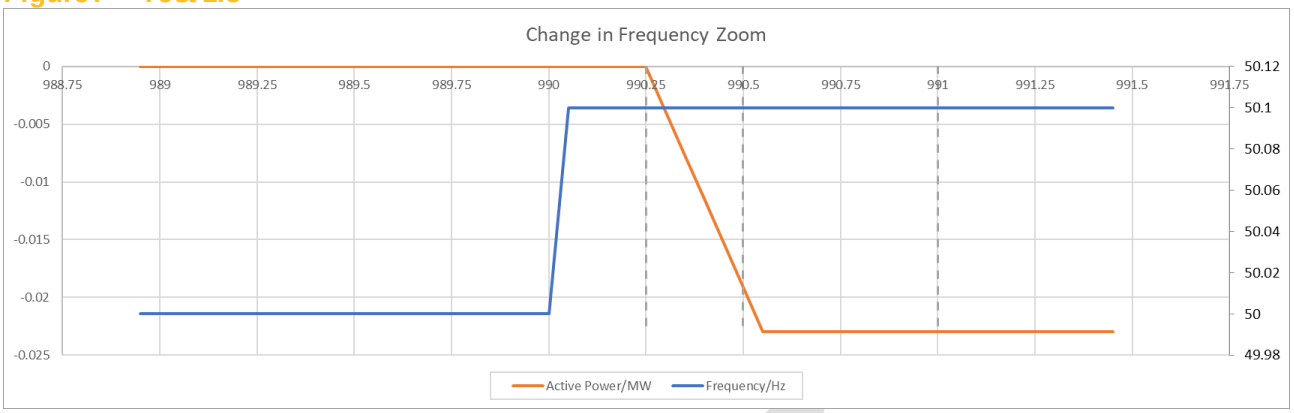


Figure 8 – Test 1.6

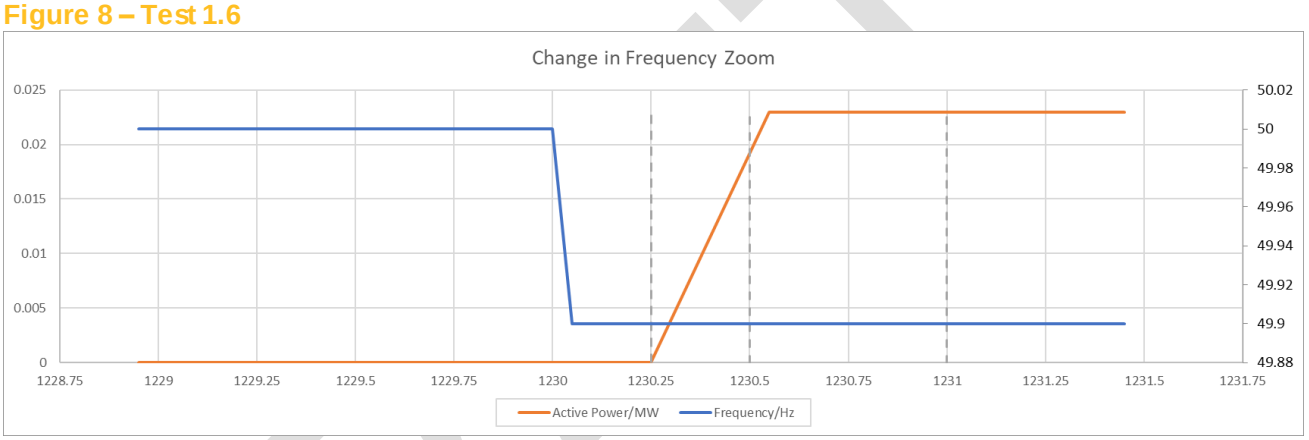


Figure 9 – Test 1.7

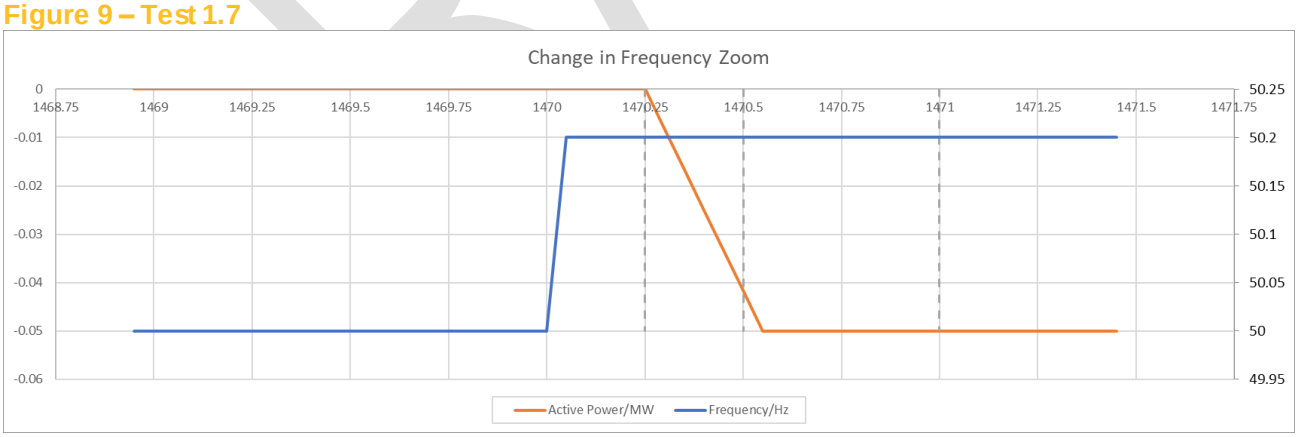


Figure 10 – Test 1.8

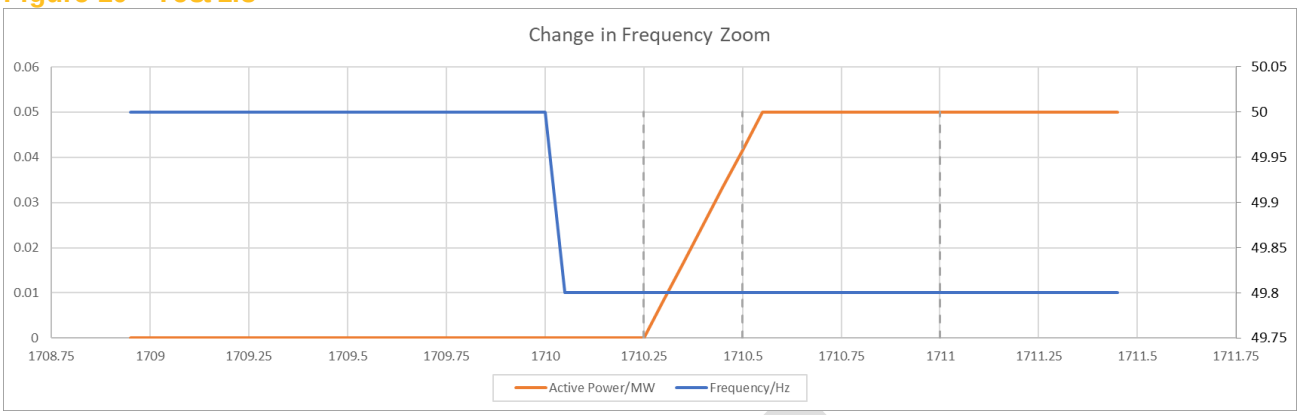


Figure 11 – Test 1.9

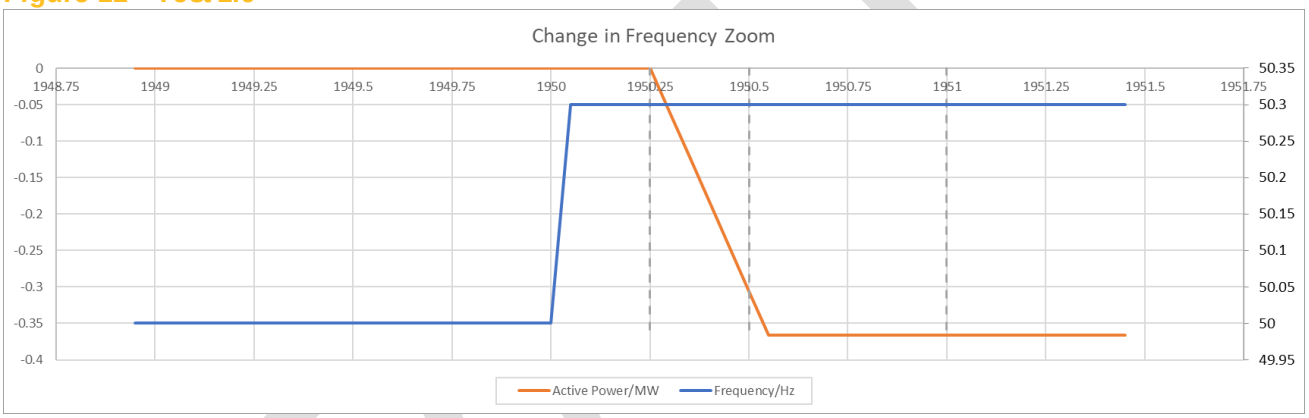


Figure 12 – Test 1.10

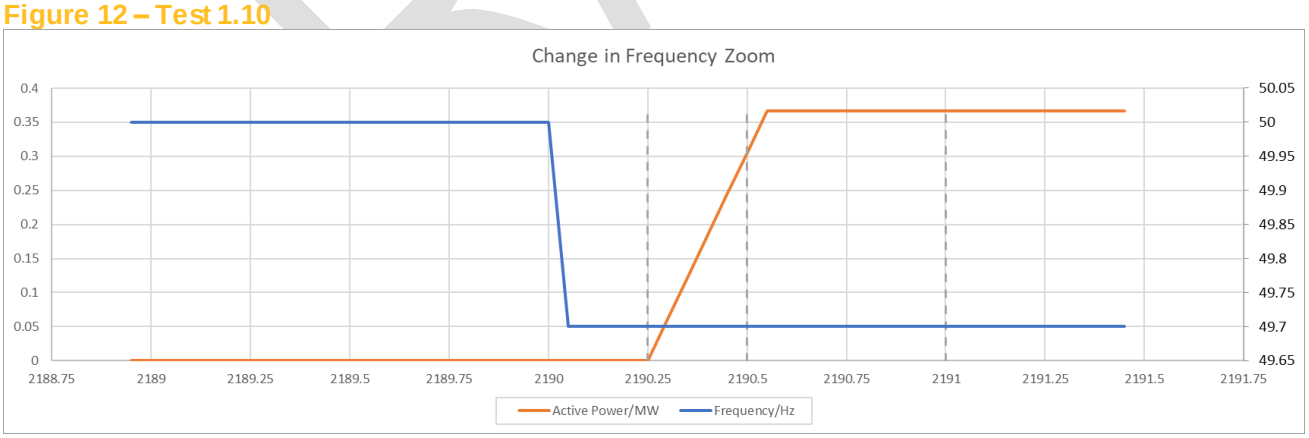


Figure 13 – Test 1.11

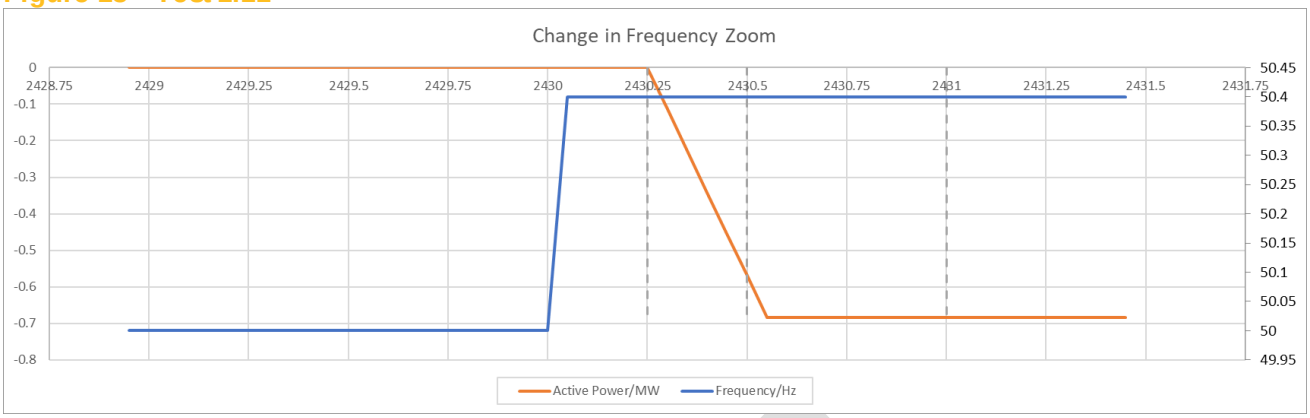


Figure 14 – Test 1.12

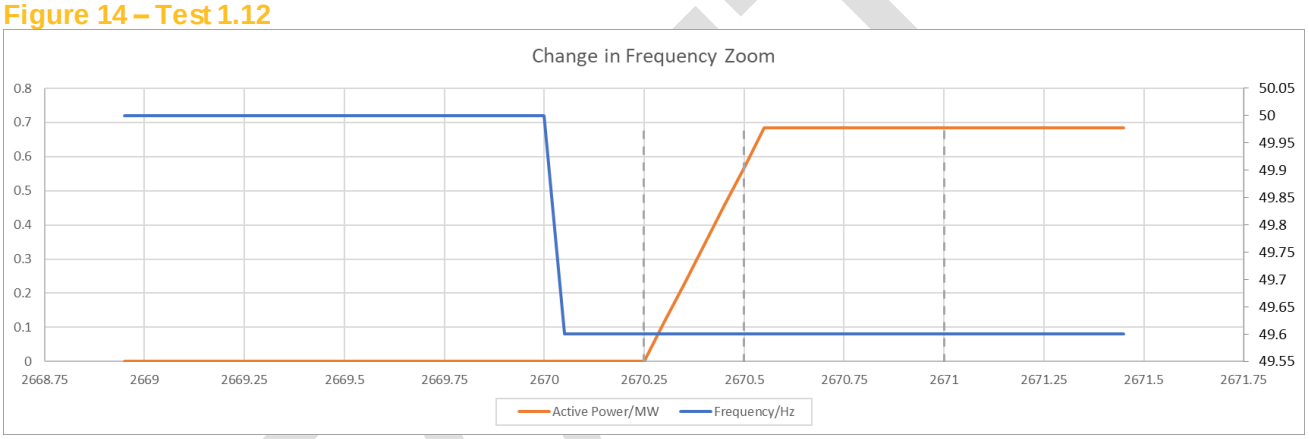


Figure 15 – Test 1.13

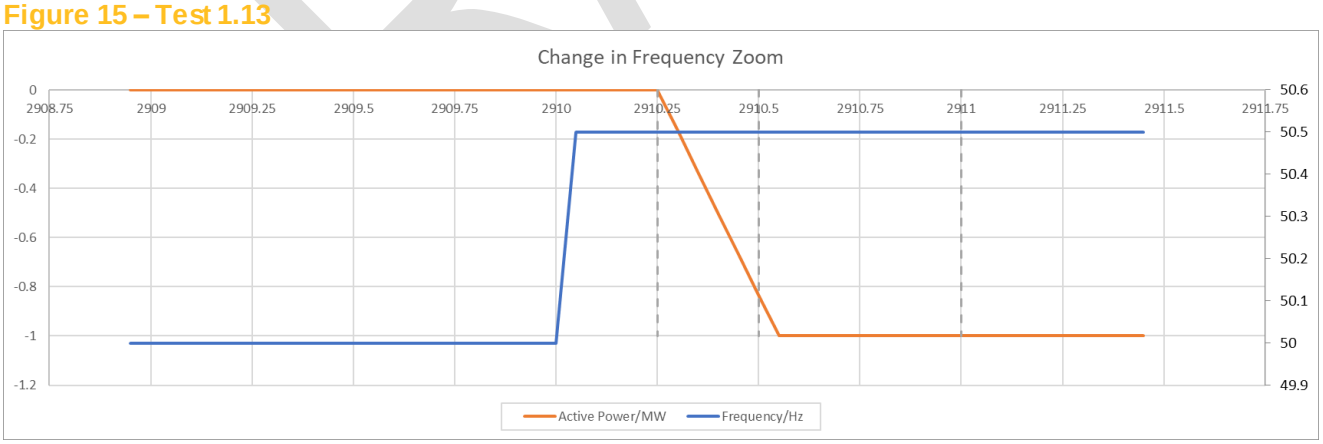


Figure 16 – Test 1.14

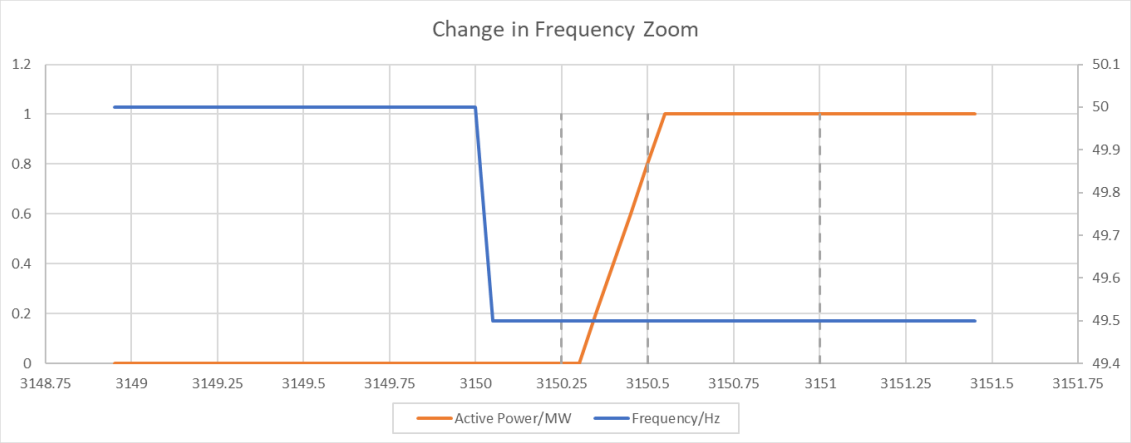


Figure 17 – Test 2.1

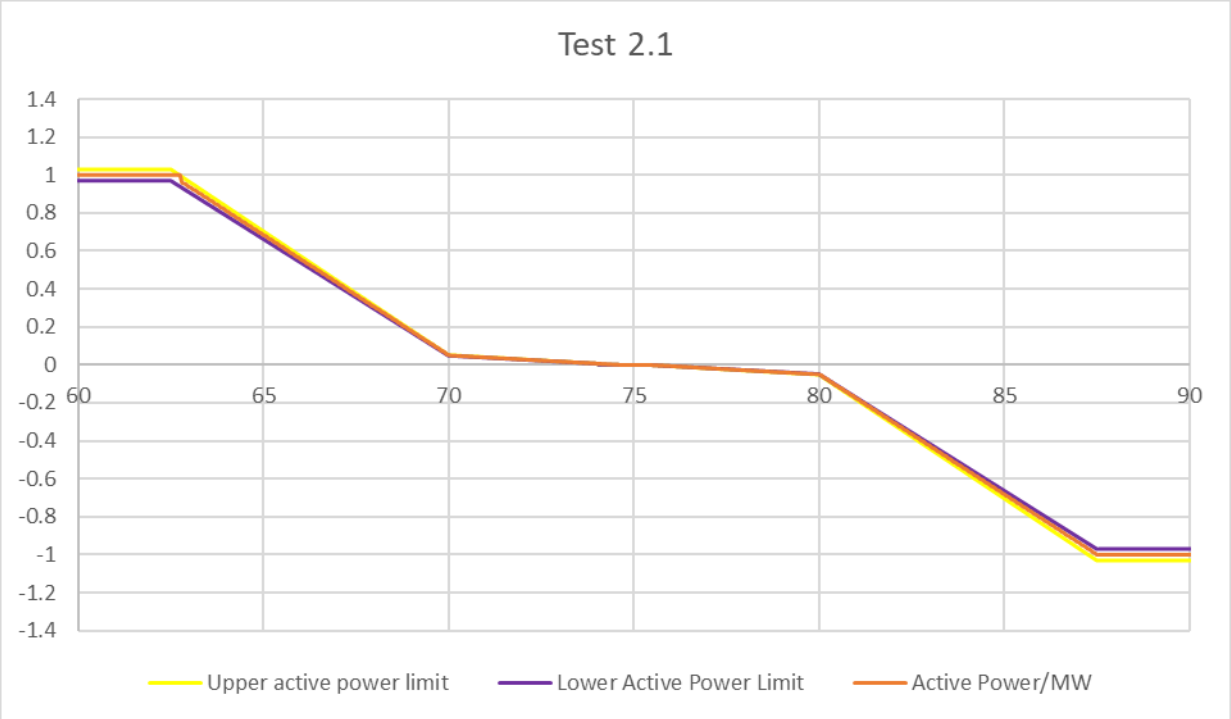


Figure 18 – Test 2.1 – An Active power changes occurs within 0.25s<t<0.5s

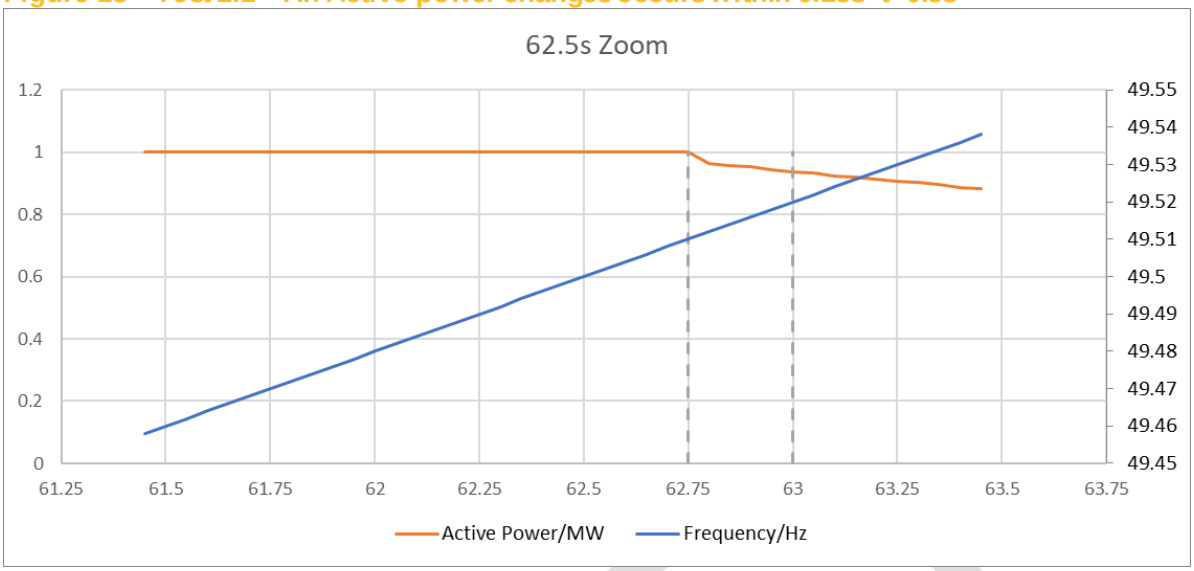


Figure 19 – Test 2.2

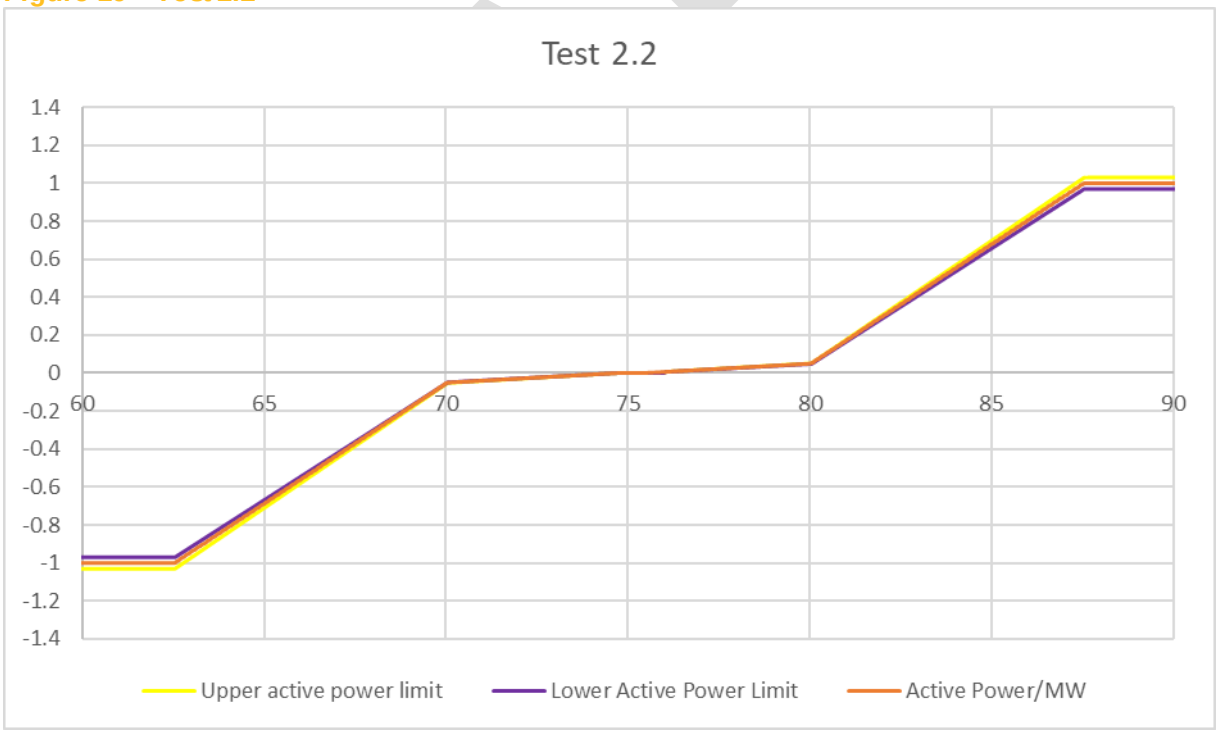


Figure 20 – Test 2.2 – Active power changes occurs within 0.25s<t<0.5s

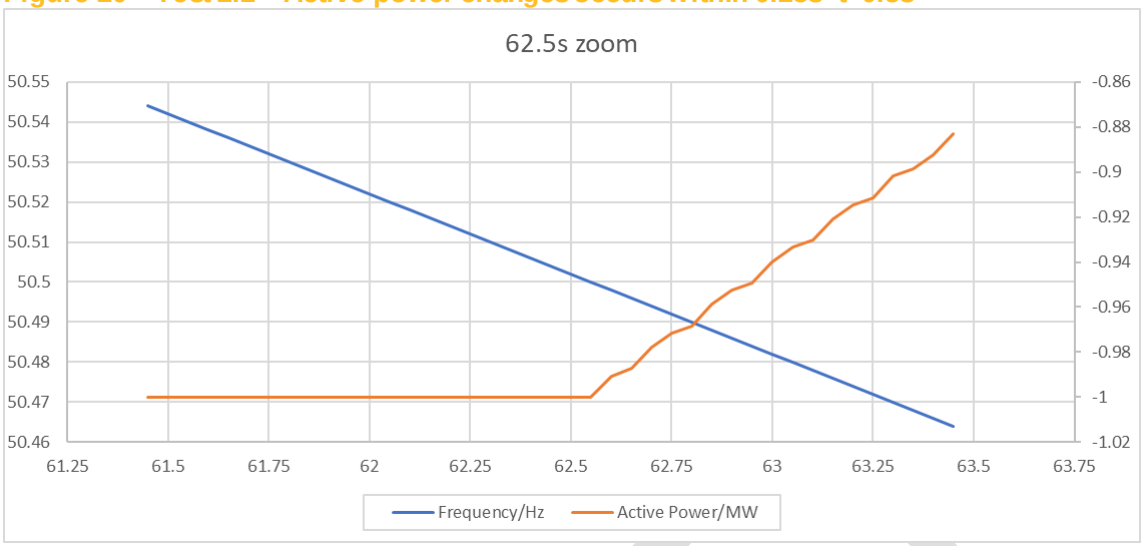


Figure 21 – Test 3.1

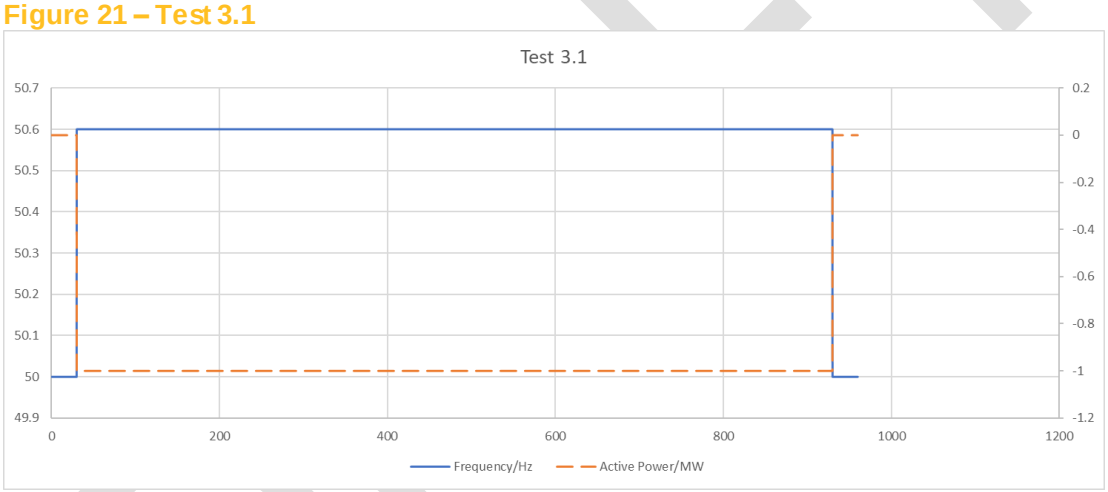


Figure 22 – Test 3.2

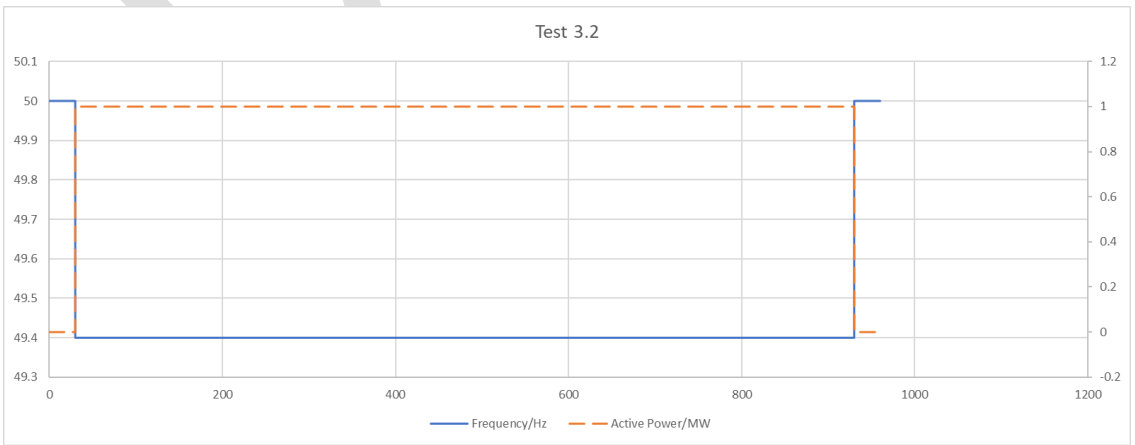
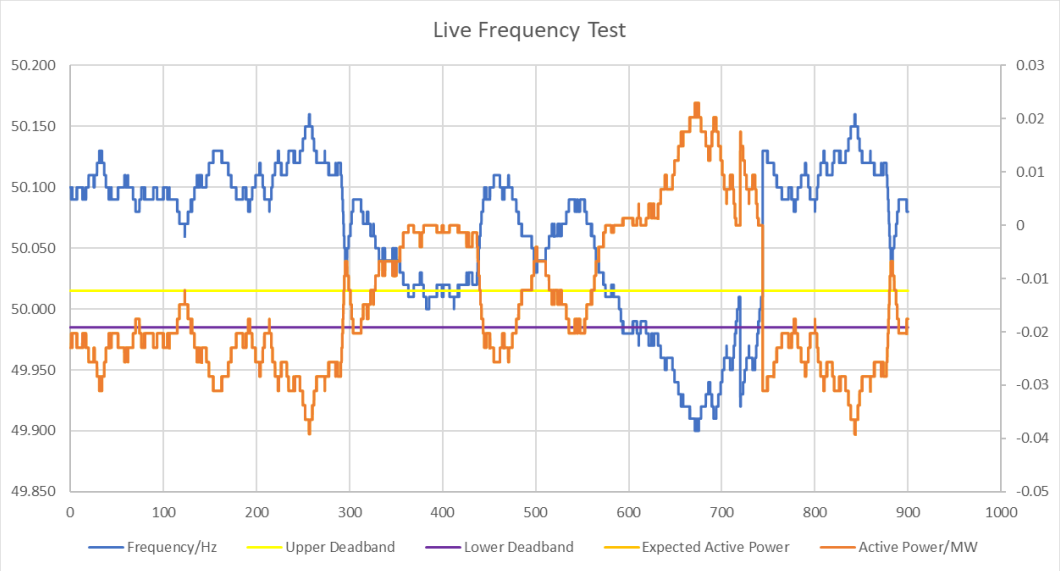


Figure 23 – Test 4



Independent Technical Expert (ITE) Details

Company name
Primary contact name
Contact number /s
Email address
I / We confirm that I / We the following: **(a) I/We am a/are Independent Technical Expert(s) (as defined in Appendix A of the NGESO's prevailing Testing Guidelines);** **(b) I/We have carried out an assessment of the [asset] described above in accordance with the testing guidelines set out in the Testing Guidelines;** **(c) the above details are, to my/our best knowledge and belief, true, accurate, complete and not misleading; and** **(d) the CV attached of my/our experience is to my/our best knowledge and belief, true, accurate, complete and not misleading.**
Signed: Date:

Faraday House, Warwick Technology Park,
Gallows Hill, Warwick, CV346DA

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