

## Report Details

Products tested	VCCR300-xx
Products Description	300W DC-DC power supply.
Design Phase	3 – Verification
Product Serials	
Test Goals	Test according to EN50155:2021 cl. 13.4.10.3 (Shock) & cl. 13.4.10.4 (Functional Vibration)
Test dates	1 <sup>ST</sup> to 25 <sup>TH</sup> April 2023
Report date	28 <sup>TH</sup> April 2023

## Authorisation

Jorge Almendros

28/4/23

Test performed by (Print)

Date

Brian McDonald

28/4/23

Test report written by (Print)

Date

# 1. Objective

Functional vibration and shock testing are mandatory tests required to comply with EN50155 standard. The objective of this report is to show compliance with the requirements of EN50155 clause 13.4.10.3 for shock and 13.4.10.4 for functional vibration.

# 2. Executive summary

Performance tests were carried out on a number of product samples at the Vox Power R&D laboratory and the results recorded. The units were then shipped to a specialist external laboratory to perform the shock and vibration testing according to the relevant EN50155 standard. The samples were then returned to the Vox Power R&D laboratory and the performance tests were repeated and compared with the original results. A visual inspection was also carried out to ensure no mechanical damage had occurred during testing.

The details of the performance tests before and after testing are shown in appendix 1.

The details of the visual inspection are shown in appendix 2.

The details of the external shock and vibration testing are shown in appendix 3.

# 3. Conclusions

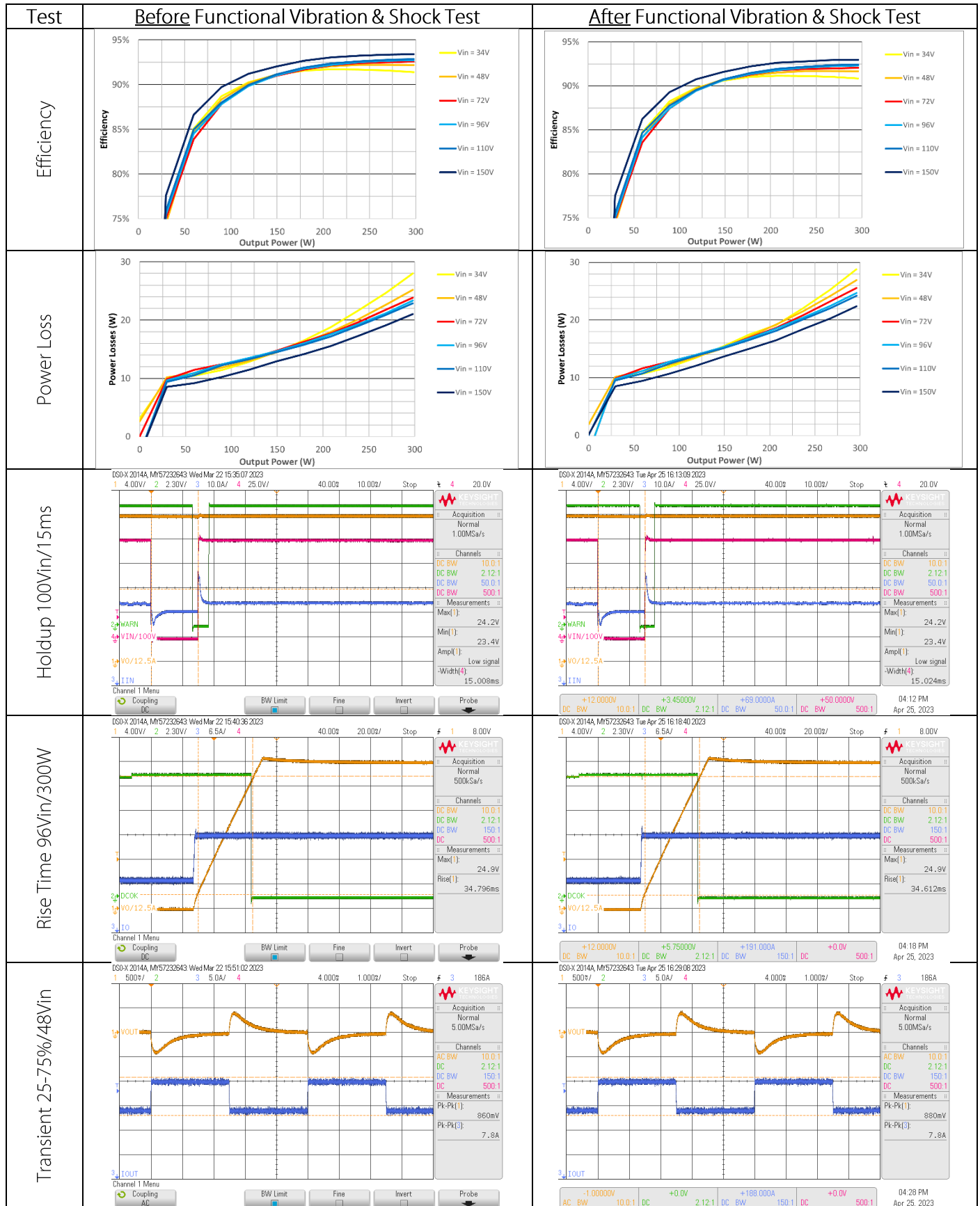
The performance test results for the tested samples before and after the Functional Vibration & Shock tests show no variation in performance.

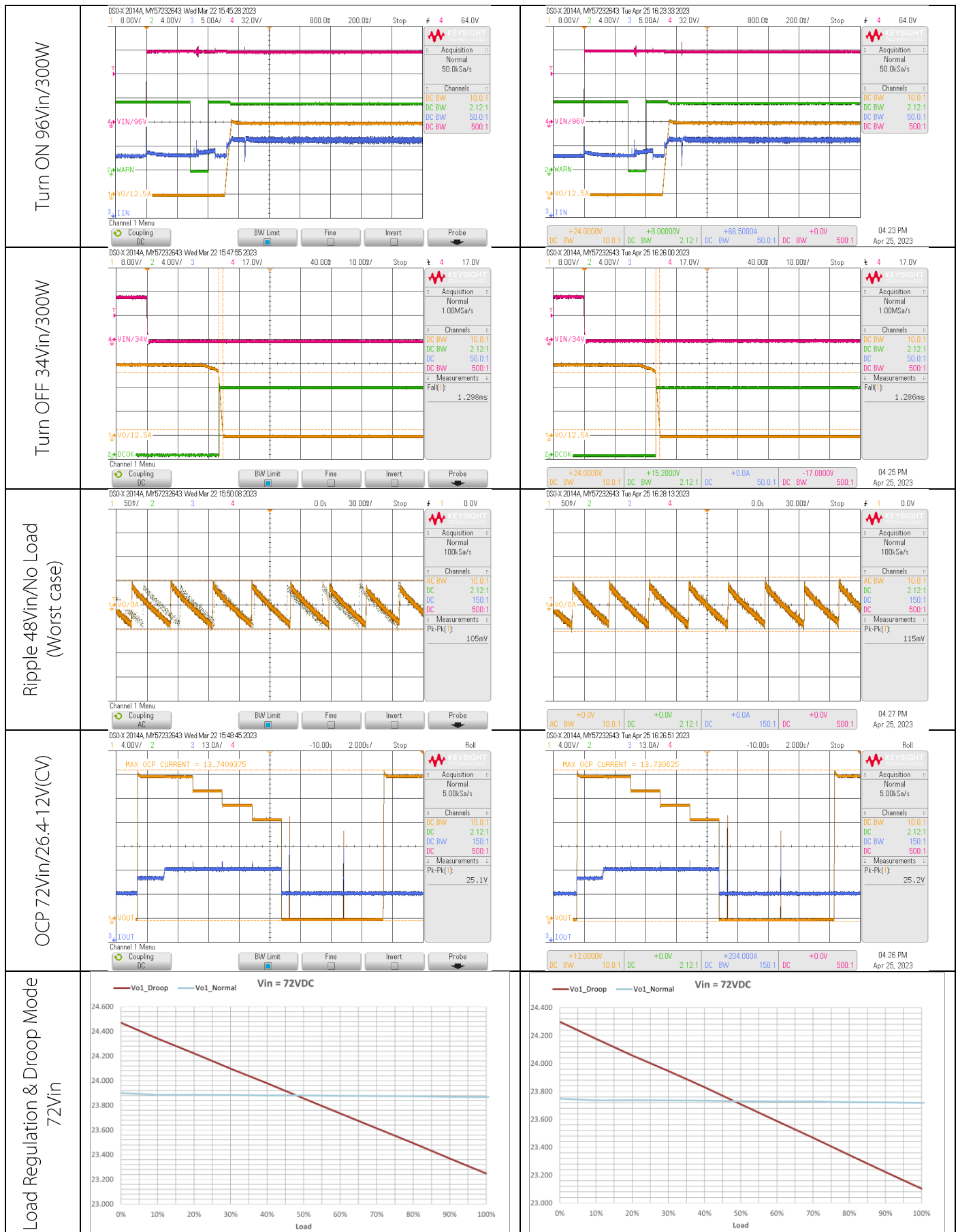
The visual inspection does not show any damage or issues.

It can be concluded that the Functional Vibration & Shock Tests were passed successfully.

# Appendix 1 - Performance Test Results

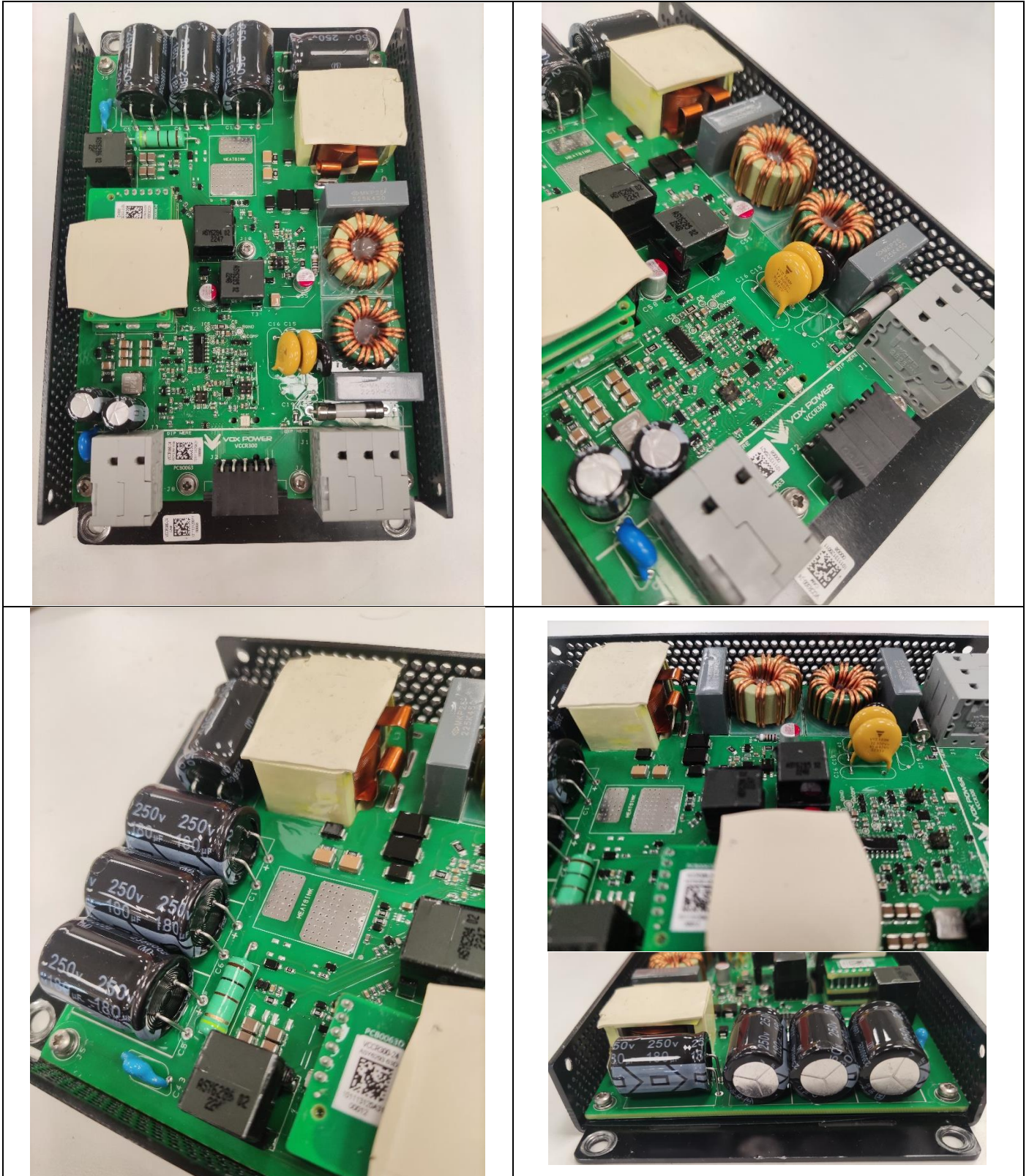
VCCR300-24 Engineering Sample (Functional Vibration & Shock) S/N: 2313C080005





## Appendix 2 - Visual Inspection

VCCR300-24 Engineering Sample (Functional Vibration & Shock) S/N: 2313C080005



## Appendix 3 – Functional Vibration & Shock Testing



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## FUNCTIONAL VIBRATION AND SHOCK TEST REPORT FOR VOX POWER


Author: (Name)	Author: (Signature)	Date:
Daniel Grimes	<i>Daniel Grimes</i>	2023-04-18
Approver: (Name)	Approver: (Signature)	Date:
Mary Dowey	<i>Mary Dowey</i>	2023-04-18

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## CONTRACT INFORMATION

<b>Customer:</b>	Vox Power
<b>PO Number:</b>	PO: 10914
<b>Contact Name:</b>	Brian McDonald
<b>Customer Address:</b>	Vox Power Ltd Unit 2, Redcow Interchange Estate Ballymount Dublin 22, D22 Y8H2, Ireland
<b>Test Specimen:</b>	P/N: VCCR300-24 S/N: 2313C0E0005
<b>Specimen Receipt Date:</b>	2023-03-30
<b>Date of Test:</b>	2023-04-12 to 2023-04-13
<b>Date of Report:</b>	Iss 01: 2023-04-18
<b>Test Method to be Used:</b>	Testing was carried out according to IEC 61373:2010: Clause 8 for functional random vibration testing and Clause 10 for shock testing, as per the customers specification: VCCR300 external environmental test plan.
<b>Any Deviation from Test Method:</b>	For shock testing, the test specimen was subjected to the longitudinal axes test severity (highest severity) in all three axes, at the request of Brian McDonald via email on Sat 01/04/2023 11:15AM
<b>Results summary:</b>	Testing was carried out as per customer's specification without witnessing. No determination on the pass/fail of the test specimen has been made.
<b>Customer onsite representatives:</b>	None
<p>All testing is carried out in compliance with the requirements and specifications detailed above, and the results apply to the specimen tested. Opinions and interpretations are not given by Resonate Testing Ltd.</p> <p>Testing was carried out on these test specimen only and provides no verification for the performance of other items in the same batch, or production run.</p>	



 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <b>Vibration and Shock</b>	Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved
---	---	--


## CONTENTS

<b>CONTRACT INFORMATION .....</b>	<b>2</b>
<b>CONTENTS .....</b>	<b>3</b>
<b>LIST OF FIGURES AND TABLES .....</b>	<b>4</b>
<b>REVISION HISTORY .....</b>	<b>5</b>
<b>1 TEST SPECIMEN .....</b>	<b>6</b>
<b>2 TEST SPECIFICATION .....</b>	<b>7</b>
2.1 General .....	7
2.2 Environmental Conditions .....	7
2.3 Functional Random Vibration Test .....	7
2.4 Shock Test .....	9
2.5 Functional Test .....	10
<b>3 TEST EQUIPMENT AND INSTRUMENTATION .....</b>	<b>11</b>
3.1 Test Laboratory .....	11
3.2 Test Equipment .....	11
3.3 Fixturing .....	12
3.4 Test Instrumentation .....	13
3.4.1 Control Accelerometers .....	13
3.4.2 Traceability .....	14
<b>4 PROCEDURE .....</b>	<b>15</b>
4.1 Vibration and Shock Testing .....	15
<b>5 TEST RESULTS .....</b>	<b>17</b>
5.1 Functional Random Vibration Test .....	17
5.2 Shock Test .....	18
<b>6 QUALITY ASSURANCE .....</b>	<b>34</b>
<b>7 SUMMARY .....</b>	<b>34</b>

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <h1 style="text-align: center;">Vibration and Shock</h1>	Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved
---	---	--


## LIST OF FIGURES AND TABLES

Figure 1: Test specimen and principal axis directions .....	6
Figure 2: Extract from IEC 61373-2010 – Category 1 class B body-mounted ASD spectrum - functional random vibration test .....	8
Figure 3: Representative attachment of test specimen to fixture.....	12
Figure 4: Location of control accelerometers for functional random vibration testing – Location for all axes [RA00612 and RA00613] .....	13
Figure 5: location of control accelerometer for shock testing – Location for all axes [RA00613].....	14
Figure 6: Representative test set-up – Functional random vibration test.....	15
Figure 7: Representative test set-up – Shock test .....	16
Figure 8: Functional random vibration control plot – Vertical axis .....	19
Figure 9: Functional random vibration control plot – Longitudinal axis.....	20
Figure 10: Functional random vibration control plot in – Transverse axis .....	21
Figure 11: Output Voltage – Vertical axis functional random vibration test .....	22
Figure 12: Output Voltage – Longitudinal axis functional random vibration test .....	23
Figure 13: Output Voltage – Transverse axis functional random vibration test.....	24
Figure 14: Shock test response – Shock 1 of 6 – Vertical axis positive .....	25
Figure 15: Shock test response – Shock 6 of 6 – Vertical axis negative.....	26
Figure 16: Shock test response – Shock 1 of 6 – Longitudinal axis positive .....	27
Figure 17: Shock test response – Shock 6 of 6 – Longitudinal axis negative .....	28
Figure 18: Shock test response – Shock 1 of 6 – Transverse axis positive .....	29
Figure 19: Shock test response – Shock 6 of 6 – Transverse axis negative.....	30
Figure 20: Output Voltage – Vertical axis shock test .....	31
Figure 21: Output Voltage – Longitudinal axis shock test .....	32
Figure 22: Output Voltage – Transverse axis shock test .....	33
Table 1: Shock test severity .....	9
Table 2: Vibration equipment specification.....	11
Table 3: List of instrumentation used .....	14
Table 4: Vibration test status – Functional random vibration test.....	17
Table 5: Functional random vibration test control reference .....	17
Table 6: Shock test status – Shock test .....	18
Table 7: Shock test control reference .....	18

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <b>Vibration and Shock</b>	Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved
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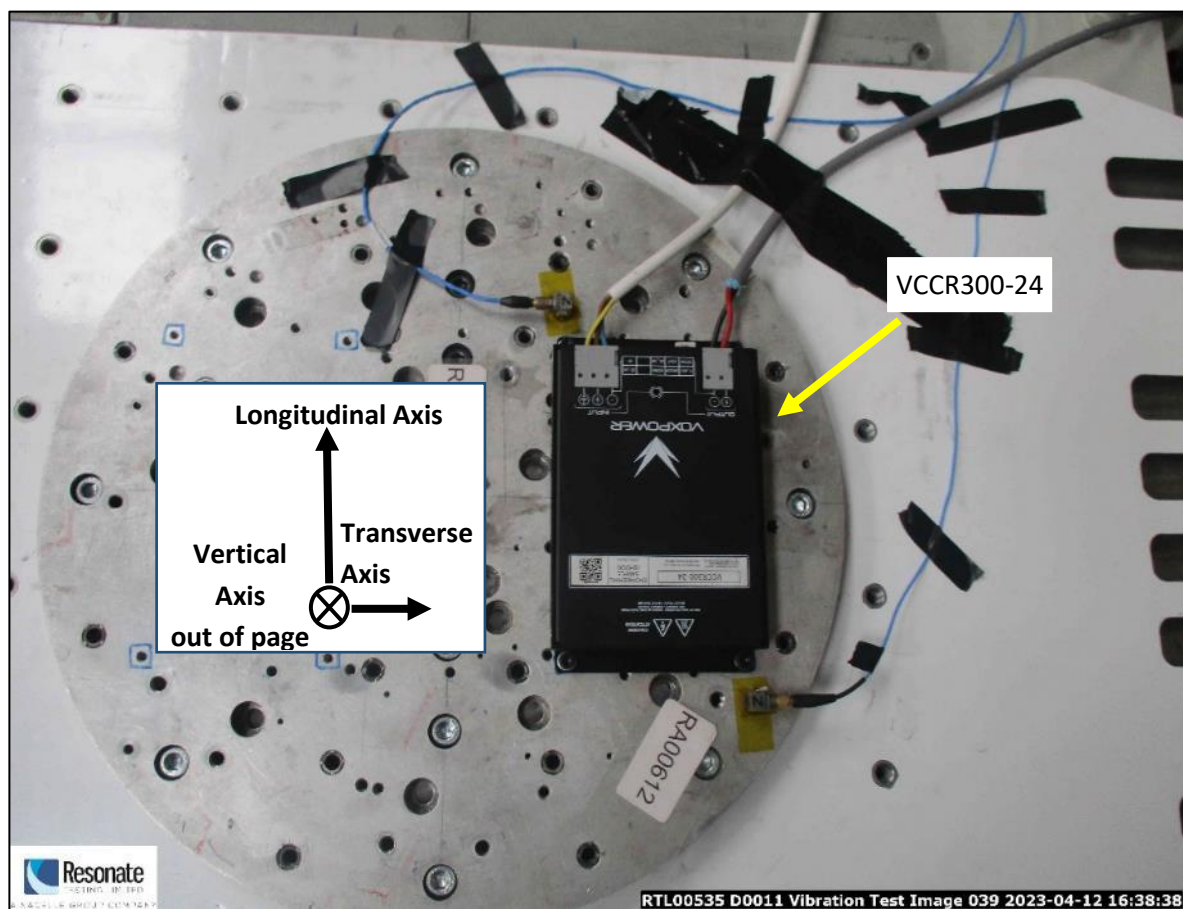
## REVISION HISTORY

REV.	Reason for change, section updated	Approved By	DATE
1	INITIAL RELEASE	M. Dowey	2023-04-18

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <h1 style="text-align: center;">Vibration and Shock</h1>	Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved
---	---	--

## 1 Test Specimen

<b>Customer Description:</b>	Conduction cooled power supply VCCR300 series
<b>Customer Unique ID:</b>	P/N: VCCR300-24; S/N: 2313C0E0005
<b>Condition on receipt:</b>	Suitable for testing
Testing was carried out on these test specimen only and provides no verification for the performance of other items in the same batch, or production run.	



**Figure 1: Test specimen and principal axis directions**

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <b>Vibration and Shock</b>	Record No: RTL00535 D0011 Rev No: 1 2023-04-18 Document Status: Approved
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## 2 Test Specification

### 2.1 General

Testing was carried out in accordance with the customers' requirements as specified in:

<b>Document reference:</b>	Testing was carried out according to IEC 61373:2010: Clause 8 for functional random vibration testing and Clause 10 for shock testing, as per the customers specification: VCCR300 external environmental test plan.
<b>Date of receipt:</b>	Received via email from Brian McDonald on Monday 2023-03-13 at 11:54am and additional email on Sat 01/04/2023 11:15am defining levels.

### 2.2 Environmental Conditions

The test was carried out under standard laboratory conditions:

Temperature: +15 to +35°C.

Relative Humidity: Not greater than 85%.

Ambient Pressure: 84 to 107 kPa (equivalent to +5,000 to -1,500 ft) (+1525 to -460m).

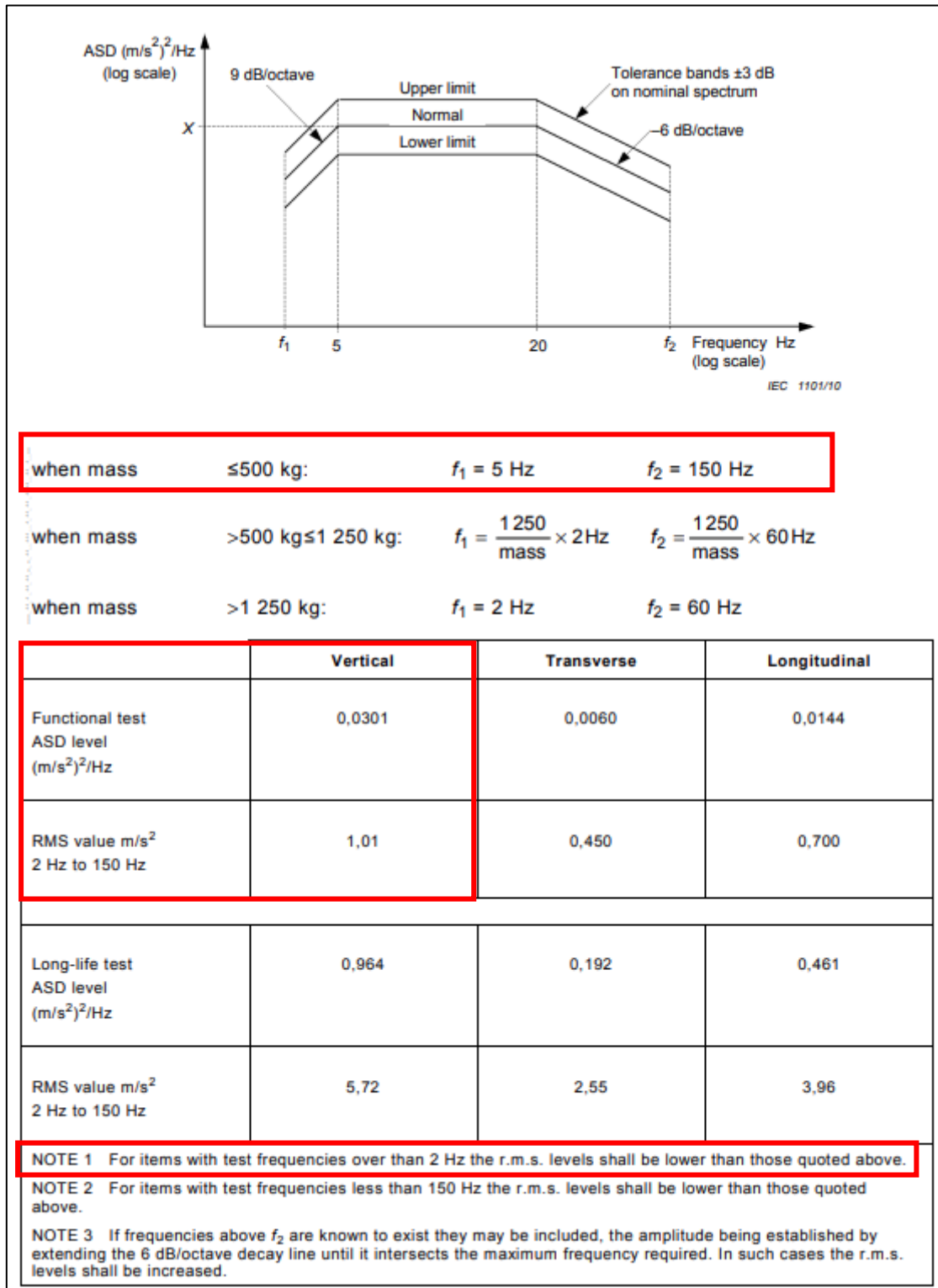
### 2.3 Functional Random Vibration Test

The test specimen was subjected to a random vibration profile in each orthogonal axes, for a duration of 10 minutes, in accordance with the customer's test specification.

For all three axes, the vertical test level (highest level) was used as per the customer's request as the orientation of which the test specimen is installed is undefined, *'the test shall be carried out in the three axes with the r.m.s value given for the vertical axes'*, this is line with section 8.1 of IEC 61373:2010.

The test specimen mass was less than 500kg, therefore the functional random vibration test was carried out to the requirements detailed in Figure 2.

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**Figure 2: Extract from IEC 61373-2010 – Category 1 class B body-mounted ASD spectrum - functional random vibration test**

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <b>Vibration and Shock</b>	Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved
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## 2.4 Shock Test

The test specimen was subjected to shock testing in each orthogonal axes, in accordance with the customer's test specification.

For all three axes, the longitudinal test severity (highest severity) was used as per the customer request. The shock test was carried out to the requirements detailed in Table 1.

**Table 1: Shock test severity**

Peak acceleration (m/s <sup>2</sup> )	Nominal duration (ms)
50	30
<b>3 shocks positive and negative per axis</b>	



 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <b>Vibration and Shock</b>	Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved
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## 2.5 Functional Test

During the random vibration and shock testing, the test specimen was functional with the output voltage being monitored throughout testing, under the instruction of the customer by Resonate Testing staff, to ensure that the output voltage lies within  $\pm 1V$  of the initial output voltage.

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <b>Vibration and Shock</b>	Record No: RTL00535 D0011 Rev No: 1 2023-04-18 Document Status: Approved
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### 3 Test Equipment and Instrumentation


#### 3.1 Test Laboratory

<b>Laboratory Address:</b>	Resonate Testing Limited Unit 1 Bridge Technology Park Carnagat Lane Carnagat Newry BT35 8XF
<b>Test Technician:</b>	Daniel Grimes
<b>Customer Onsite representatives:</b>	None

#### 3.2 Test Equipment

Testing was carried out using the equipment outlined in the following specification (See Table 2).

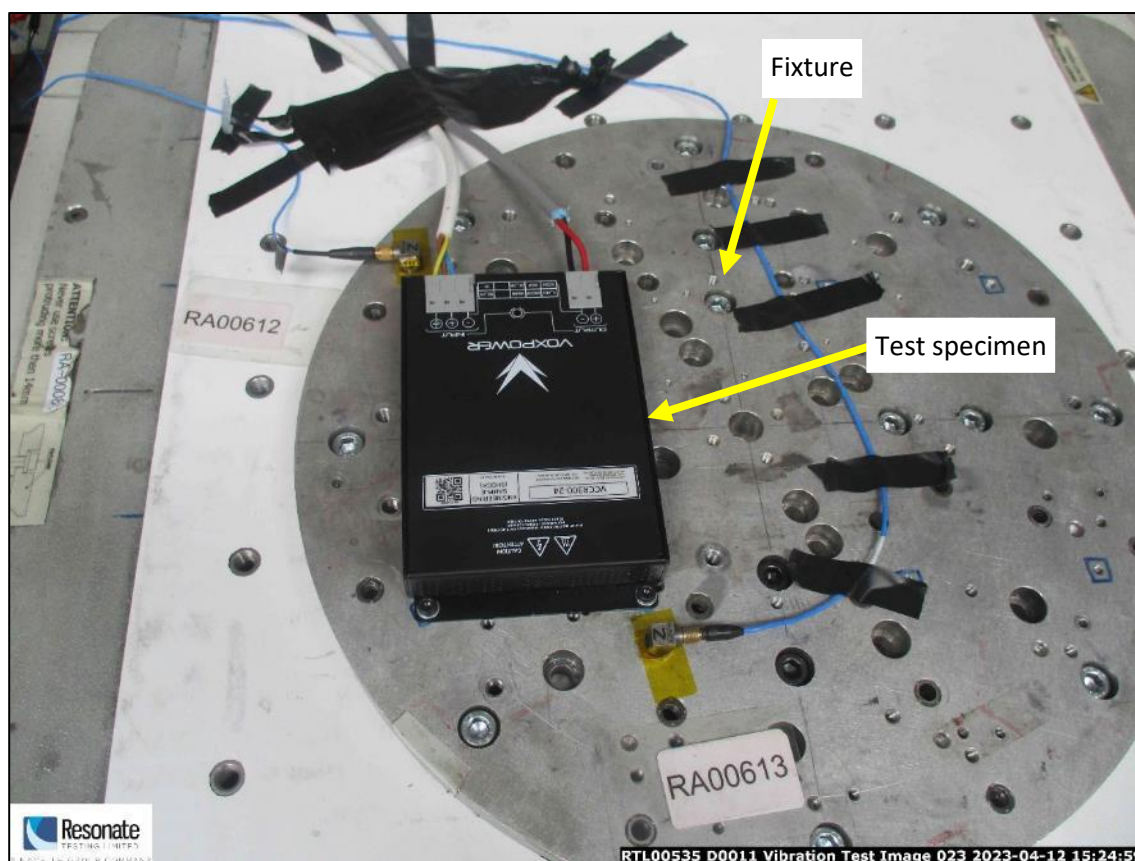
**Table 2: Vibration equipment specification**

Shaker		
	Manufacturer:	IMV Corporation
	Model:	EM2605
	Frequency range:	5-2600 Hz
	Serial No:	51000167
	Max. Force:	Sine 54 kN
		Random 54 kN rms
		Shock 112 kN
	Max. Acceleration:	Sine 857 m/s <sup>2</sup>
		Random 600 m/s <sup>2</sup>
		Shock 1777 m/s <sup>2</sup>
	Max. Velocity:	Sine 2.4 m/s
		Shock 3.5 m/s
	Max. Displacement:	Sine (peak to peak) 100 mm

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <h1 style="text-align: center;">Vibration and Shock</h1>	Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved
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### 3.3 Fixturing

The test specimen was fixed so that the vibration and shock motion was parallel to each of its three major orthogonal axes. The test specimen was attached to the test fixture, using four M5 bolts with washers and torqued to 6.6 Nm as shown in Figure 3.



**Figure 3: Representative attachment of test specimen to fixture**

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <h1 style="text-align: center;">Vibration and Shock</h1>	Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved
---	---	--

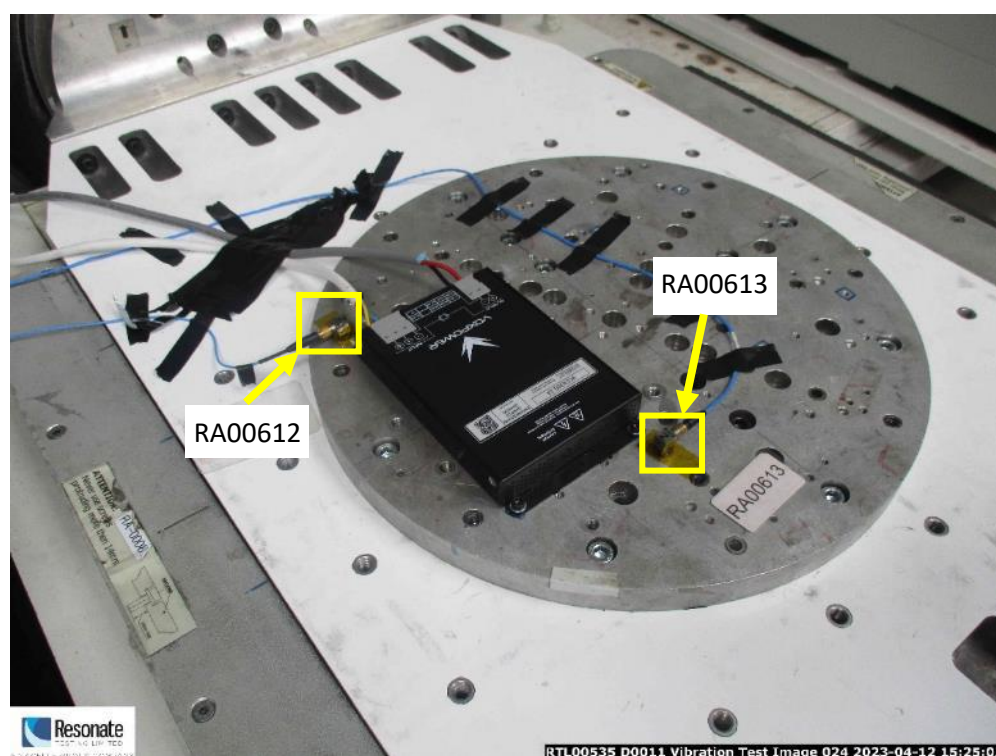
## 3.4 Test Instrumentation

### 3.4.1 Control Accelerometers

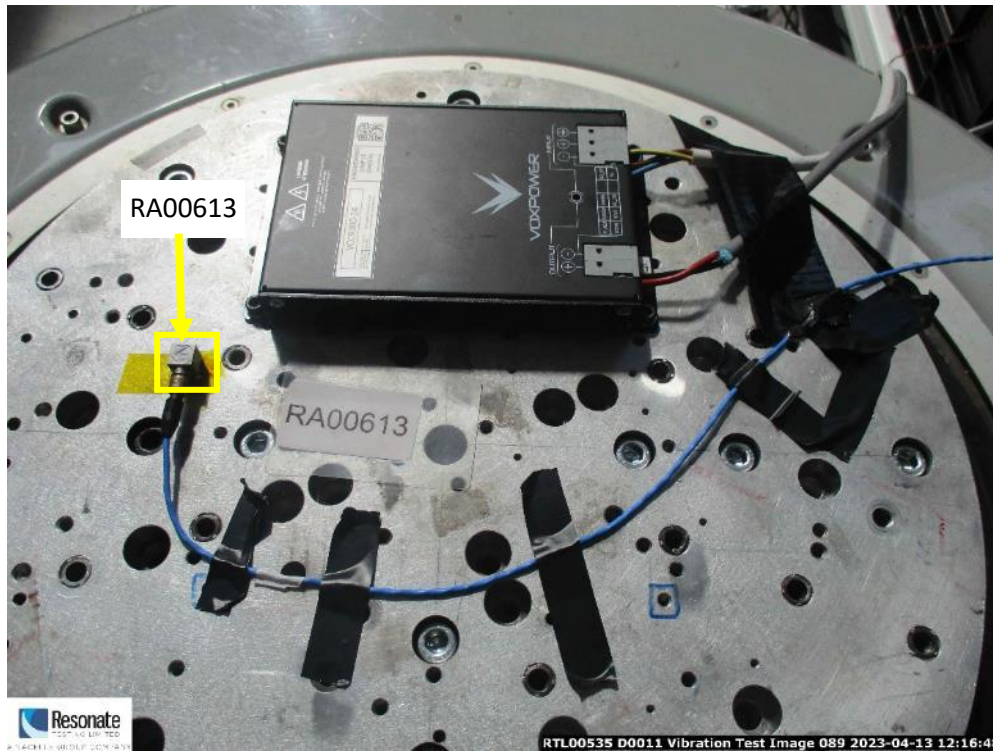
The control accelerometer(s) were attached to the test fixture as near as practicable to the test specimen's mounting locations for each axis of test, as shown in Figure 4.

Only one control accelerometer was used for shock testing. The location of this accelerometer is shown in Figure 5.

Where more than one accelerometer has been used, the average of the accelerometer signals has been used for control. APSD plots and acceleration time history plots are given to demonstrate that the control levels meet the test level requirements – See Section 5.



**Figure 4: Location of control accelerometers for functional random vibration testing – Location for all axes [RA00612 and RA00613]**



**Figure 5: location of control accelerometer for shock testing – Location for all axes [RA00613]**

### 3.4.2 Traceability

All equipment has been calibrated as required using standards traceable to National or International standards.

**Table 3: List of instrumentation used**

Ref No:	Serial No:	Use	Type:	Cal Status:	Cal Expiry:	Accuracy %
RA00085	51000167	Control	Controller	Calibrated	2023-11-02	± 1.88
RA00612	LW251435	Control	Tri-axial	Calibrated	2023-06-15	± 1.61
RA00613	LW251487	Control	Tri-axial	Calibrated	2023-06-15	± 1.77
RA00079	6WT3D26	Monitoring output voltage	Datalogger	Calibrated	2023-11-18	± 0.19



## 4 Procedure

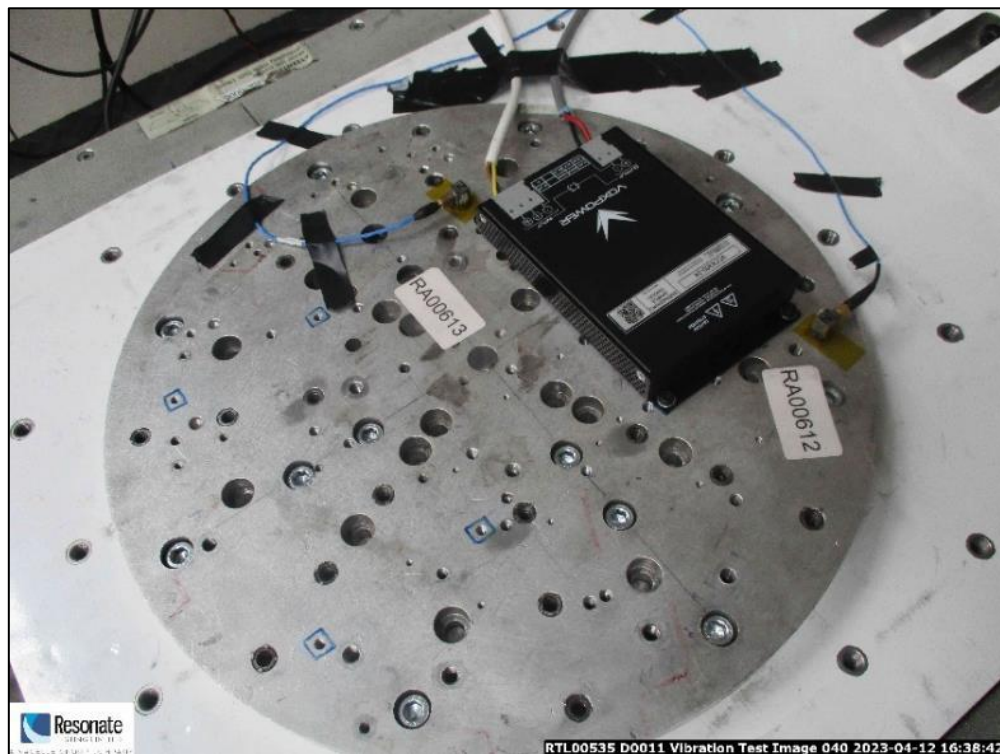
### 4.1 Vibration and Shock Testing

The test specimen was subjected to random vibration and shock testing in each of the three orthogonal axes, in accordance with the customer's specification.

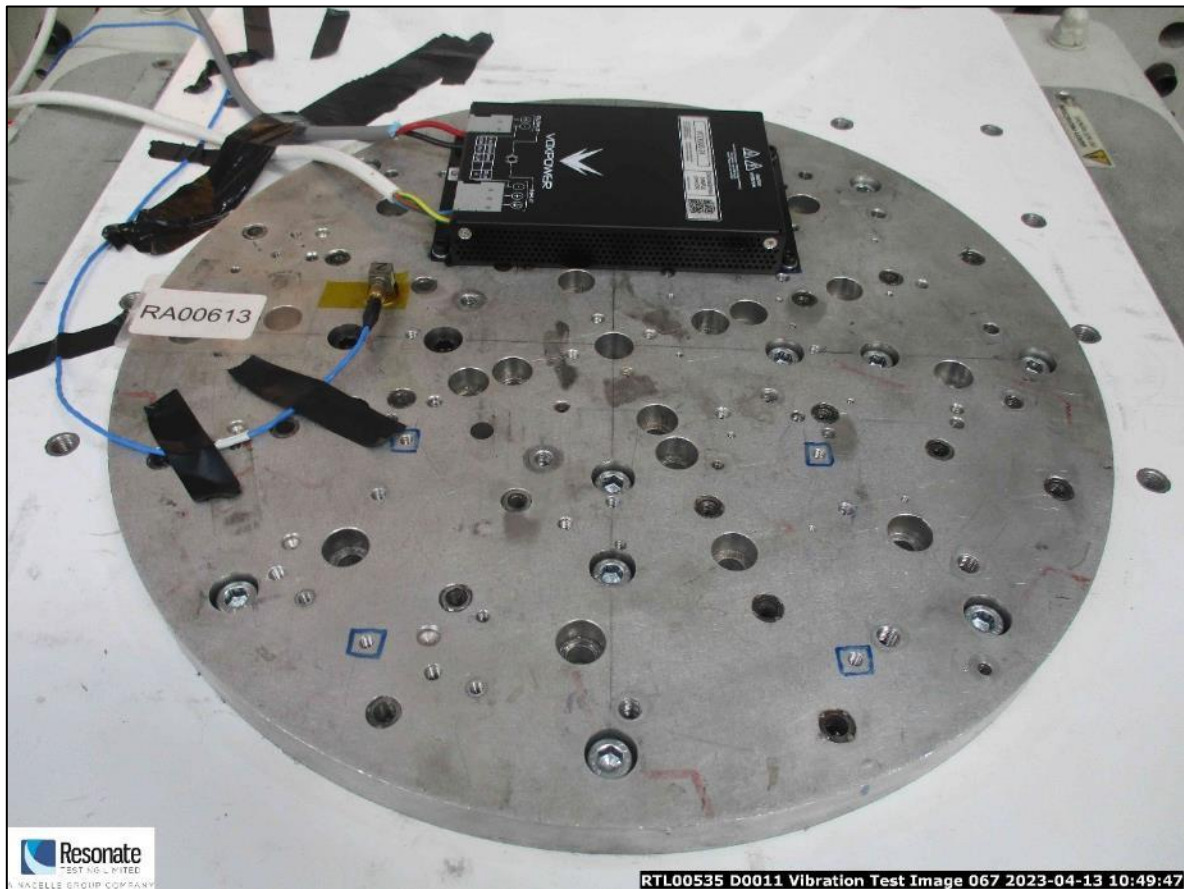
Below is the order of which testing was carried out.

1. Vertical axis, functional random vibration testing – 10 minutes
2. Longitudinal axis, functional random vibration testing – 10 minutes
3. Transverse axis, functional random vibration testing – 10 minutes
4. Transverse axis, shock testing – Three shocks positive followed by three shocks negative
5. Longitudinal axis, shock testing – Three shocks positive followed by three shocks negative
6. Vertical axis, shock testing – Three shocks positive followed by three shocks negative

Representative photographs of the test setup for each test are shown in Figure 6 and Figure 7.




**Figure 6: Representative test set-up – Functional random vibration test**



**Figure 7: Representative test set-up – Shock test**



 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <b>Vibration and Shock</b>	Record No: RTL00535 D0011 Rev No: 1 2023-04-18 Document Status: Approved
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## 5 Test Results

### 5.1 Functional Random Vibration Test

The test specimen completed the random vibration tests in accordance with the customer specification in each of the three orthogonal axes as defined in Table 5. Note the vertical level (highest levels) were run in all three axes.

Test statuses are captured in Table 4. Vibration control spectra from the random vibration tests are shown in Figure 8 to Figure 10.

Plots of the output voltage which was monitored for each axis are shown in Figure 11 to Figure 13.

**Table 4: Vibration test status – Functional random vibration test**

	Vertical axis	Longitudinal axis	Transverse axis
<b>Start</b>	12/04/2023 11:06:27	12/04/2023 15:47:06	12/04/2023 16:47:13
<b>End</b>	12/04/2023 11:18:59	12/04/2023 15:58:09	12/04/2023 16:58:10
<b>Status</b>	Excitation is completed. (Test time is completed.)	Excitation is completed. (Test time is completed.)	Excitation is completed. (Test time is completed.)
<b>Reference</b>	0.9897 m/s <sup>2</sup> rms	0.9956 m/s <sup>2</sup> rms	0.9956 m/s <sup>2</sup> rms
<b>Response</b>	1.0006 m/s <sup>2</sup> rms	1.0058 m/s <sup>2</sup> rms	0.9976 m/s <sup>2</sup> rms
<b>Elapsed time</b>	00:10:00	00:10:00	00:10:00
<b>Alarm</b>	OK	OK	OK
<b>Abort</b>	OK	OK	OK

**Table 5: Functional random vibration test control reference**

Control Reference			
Acceleration		0.996 m/s2 rms	
Velocity		0.013 m/s rms	
Displacement		0.310 mm rms	
Break point PSD			
No.	Frequency(Hz)	Level/Slope	
1	5.00	3.010e-2	(m/s2) 2/Hz
2	20.00	3.010e-2	(m/s2) 2/Hz
3	150.00	-6.00	dB/octave
Tolerance			
Abort upper(dB) Abort lower(dB) Abort A.B.W. (Hz) Alarm			
upper(dB) Alarm lower(dB) Alarm A.B.W. (Hz)			
6.00		-6.00 5.00	
3.00	-3.00	5.00	
Extended tolerance( 0 items)			

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <b>Vibration and Shock</b>	Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved
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## 5.2 Shock Test

The test specimen completed the shock testing in accordance with the customer specification in each of the three orthogonal axes as defined in Table 7. Note the longitudinal levels (highest levels) were run in all three axes.

Test statuses are captured in Table 6. Acceleration time history plots from the shock tests are shown in Figure 14 to Figure 19.

Plots of the output voltage which was monitored for each axis are shown in Figure 20 to Figure 22.

**Table 6: Shock test status – Shock test**

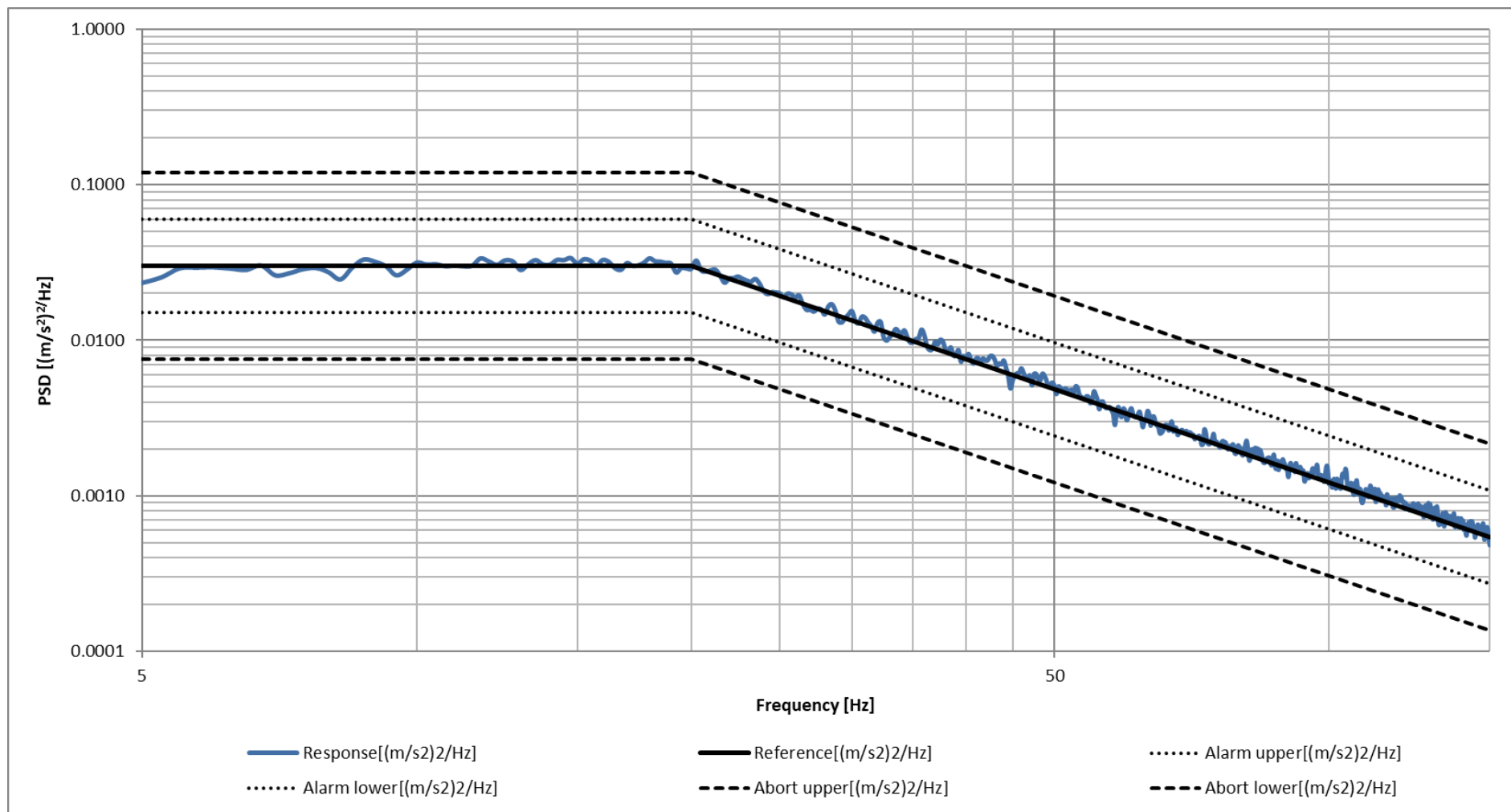
	Vertical axis	Longitudinal axis	Transverse axis
<b>Start</b>	13/04/2023 12:32	13/04/2023 11:35	13/04/2023 10:58
<b>End</b>	13/04/2023 12:34	13/04/2023 11:42	13/04/2023 10:59
<b>Status</b>	Excitation is completed. (Test time is completed.)	Excitation is completed. (Test time is completed.)	Excitation is completed. (Test time is completed.)
<b>Number of Shocks</b>	3 positive 3 negative	3 positive 3 negative	3 positive 3 negative

**Table 7: Shock test control reference**

Reference		
Reference waveform type	Classical Shock	
Waveform type	Half-sine	
Sampling frequency	1024.00 Hz	
Peak amplitude	50.0 m/s <sup>2</sup>	
Pulse width	30.0 ms	
Pulse position	0.0 %	
Rest time:Pre-pulse	0.0 ms	
Rest time:Post-pulse	0.0 ms	
Tolerance type	IEC (JIS C) 60068-2-27	
Compensation wave	Asymmetry	
Compensation wave type	Type4	
Peak level:Pre-pulse	90.0 %	
Peak level:Post-pulse	90.0 %	
Total length	499.0234 ms (512 points)	
	Min.	Max.
Acceleration	-8.1638 m/s <sup>2</sup>	50.0 m/s <sup>2</sup>
Velocity	-0.4756 m/s	0.4755 m/s
Displacement	-10.6302 mm	8.7279 mm

Test Report  
**Vibration and Shock**

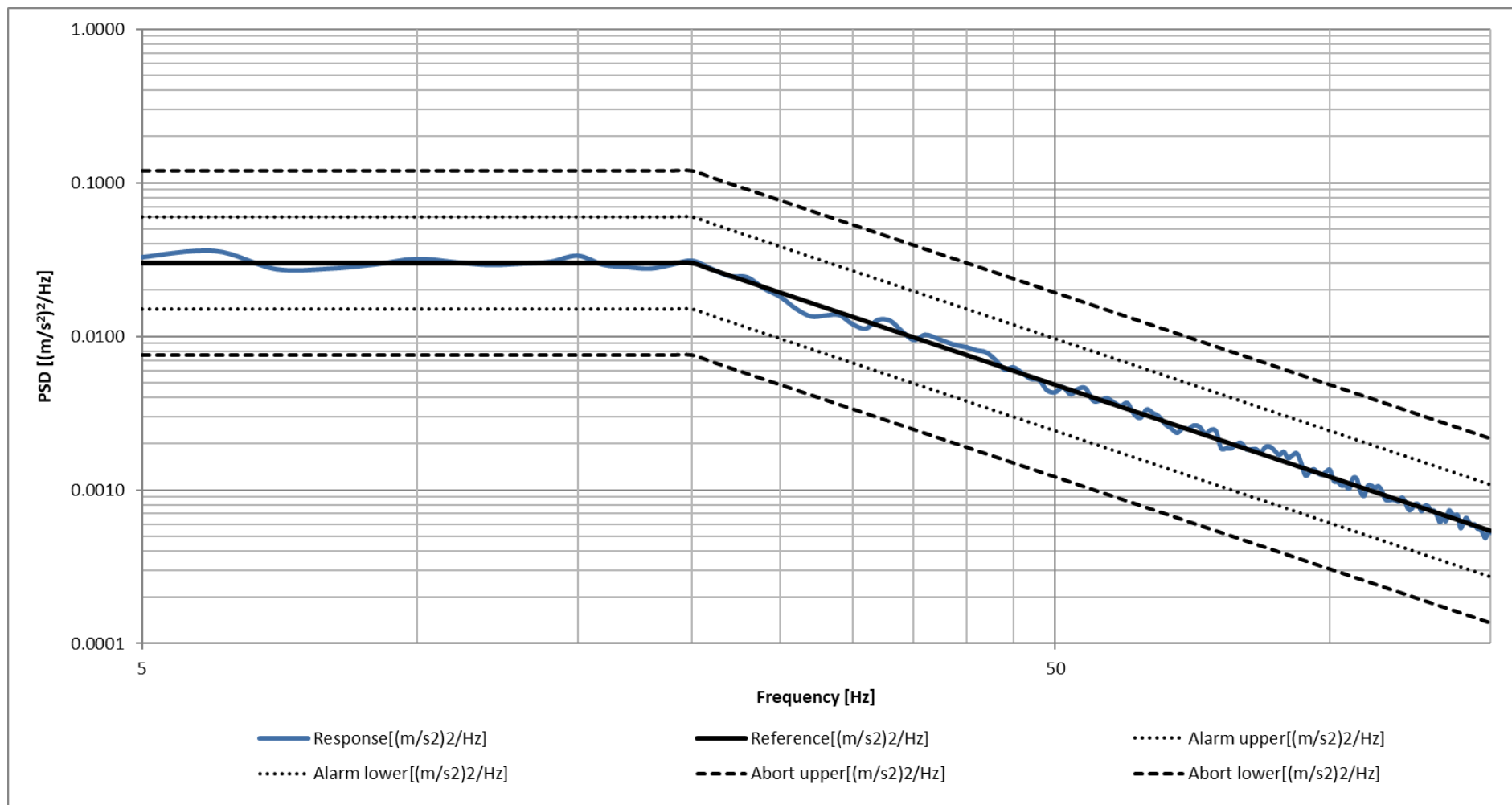
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Rev No: 1 2023-04-18  
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**Figure 8: Functional random vibration control plot – Vertical axis**

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**Vibration and Shock**

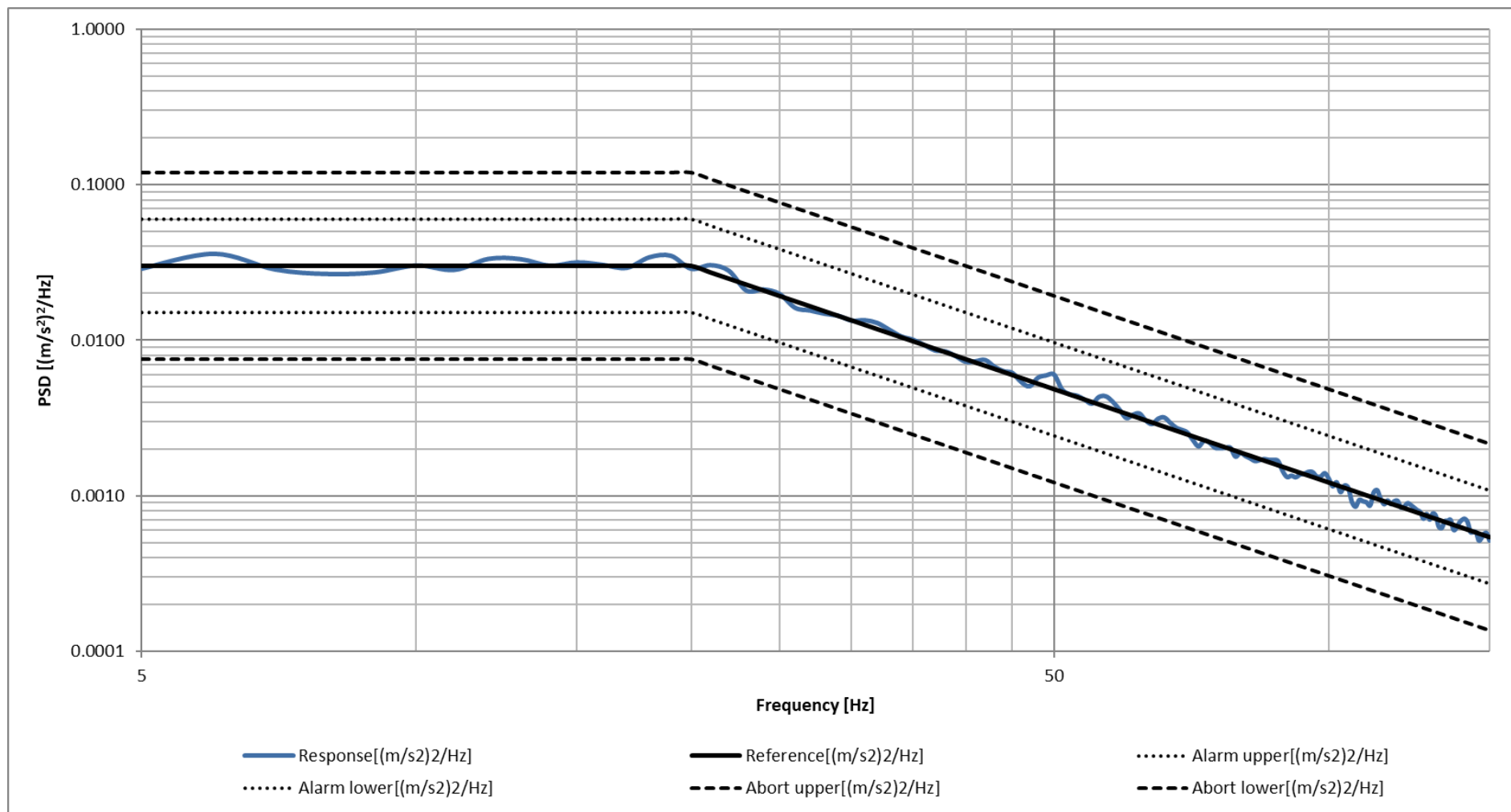
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**Figure 9: Functional random vibration control plot – Longitudinal axis**

Test Report  
**Vibration and Shock**

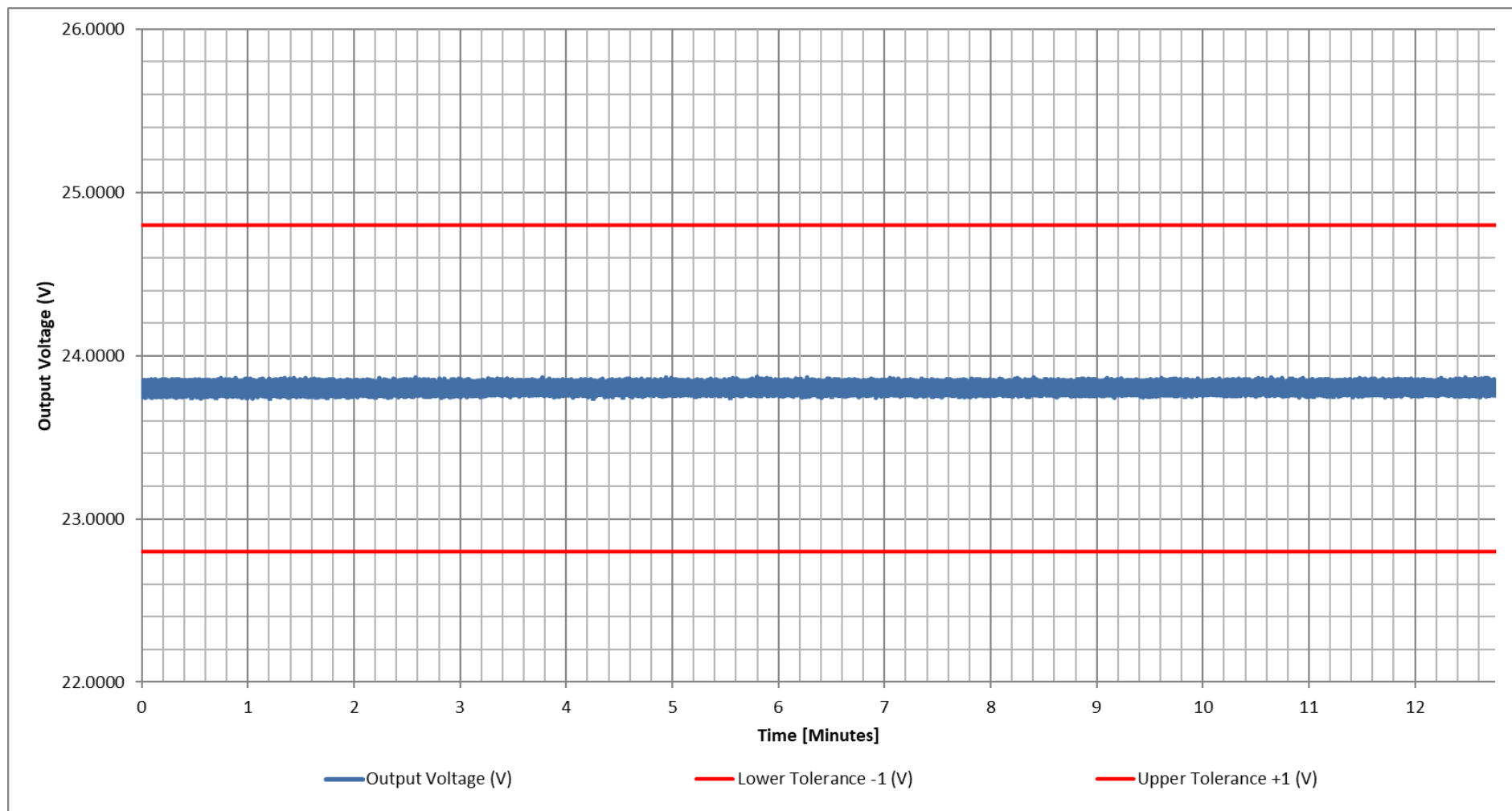
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**Figure 10:Functional random vibration control plot in – Transverse axis**

Test Report  
**Vibration and Shock**

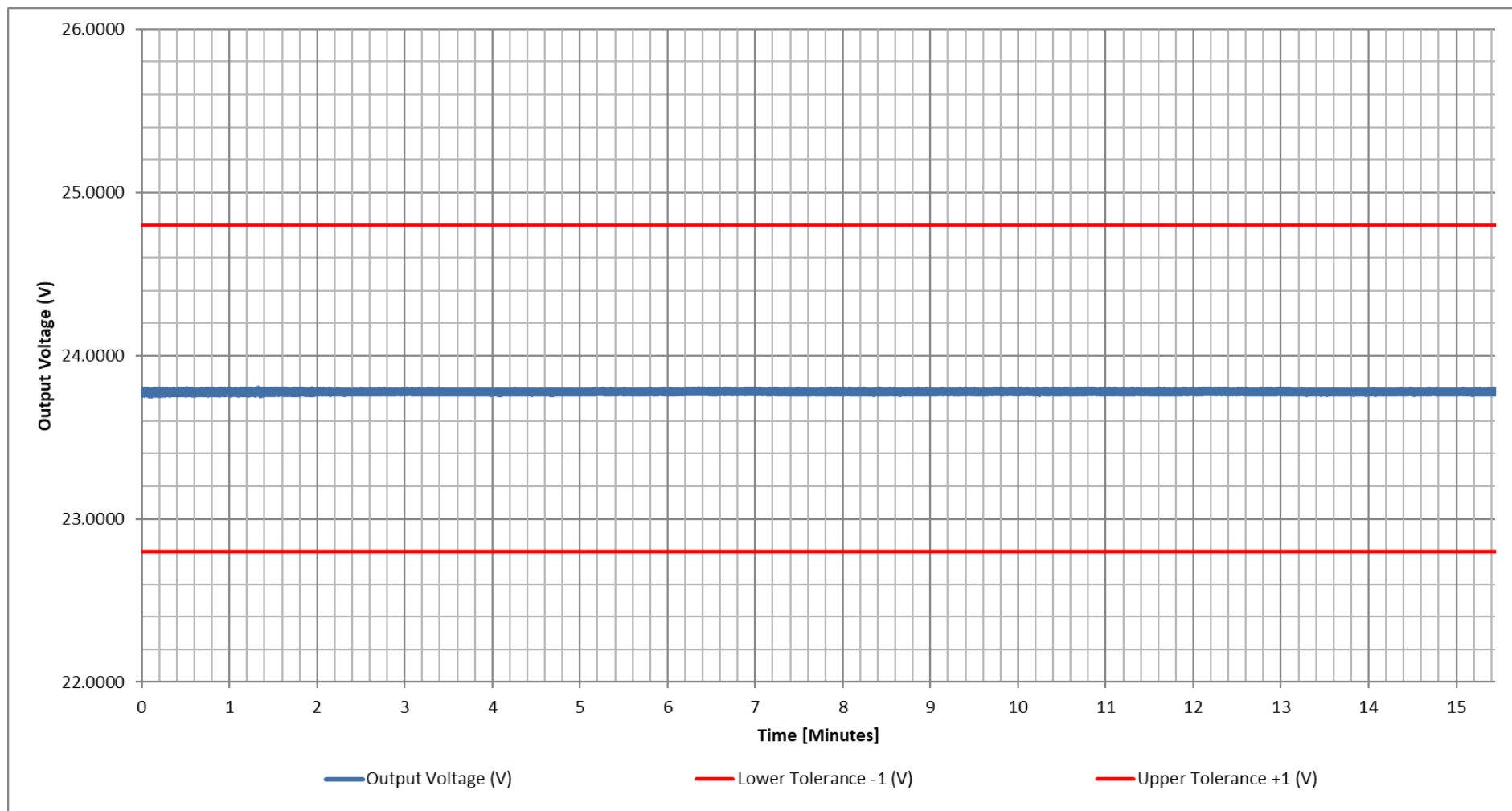
Record No: RTL00535 D0011  
Rev No: 1 2023-04-18  
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**Figure 11: Output Voltage – Vertical axis functional random vibration test**

Test Report  
**Vibration and Shock**

Record No: RTL00535 D0011  
Rev No: 1 2023-04-18  
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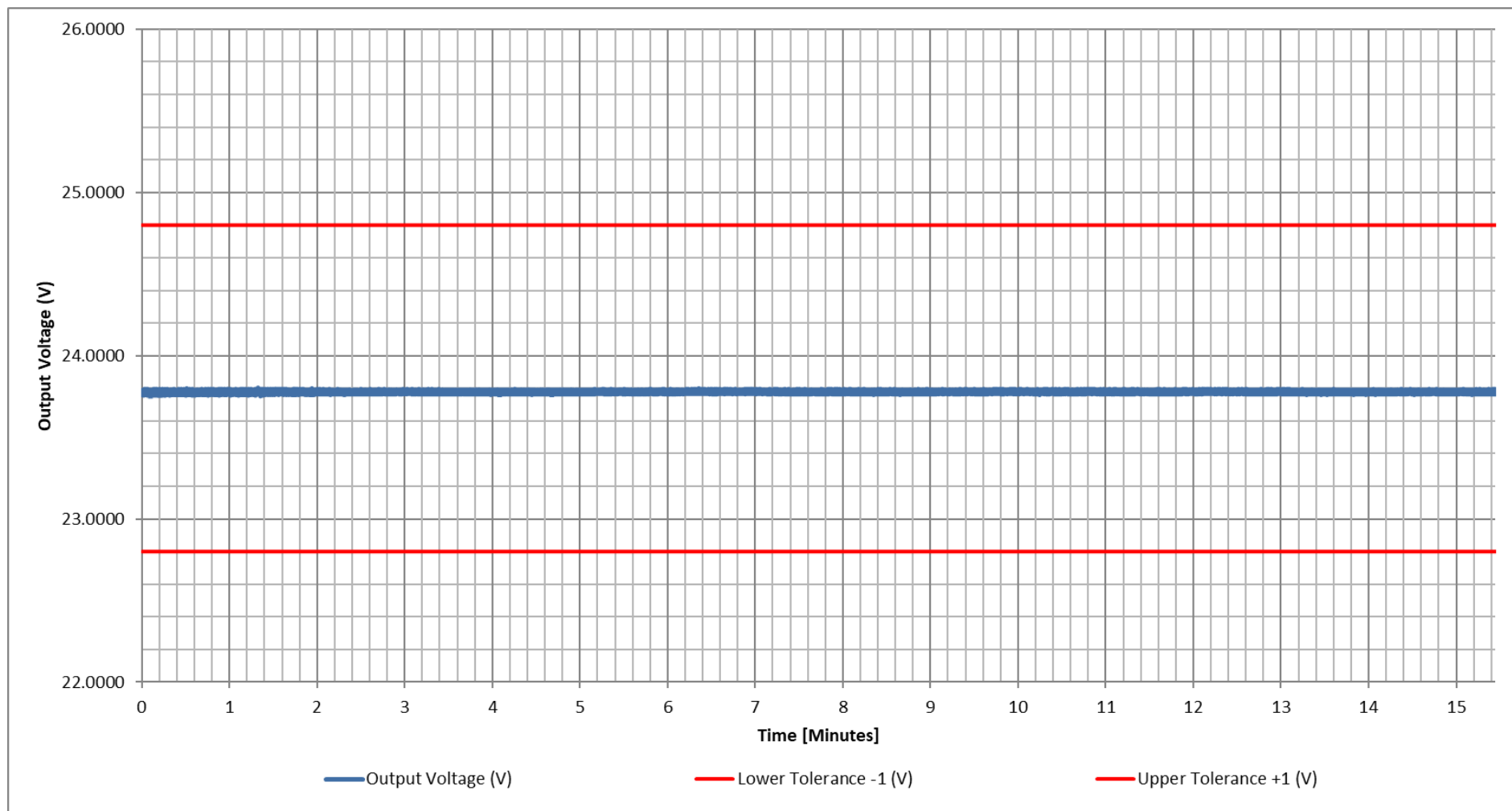


**Figure 12: Output Voltage – Longitudinal axis functional random vibration test**



Test Report  
**Vibration and Shock**

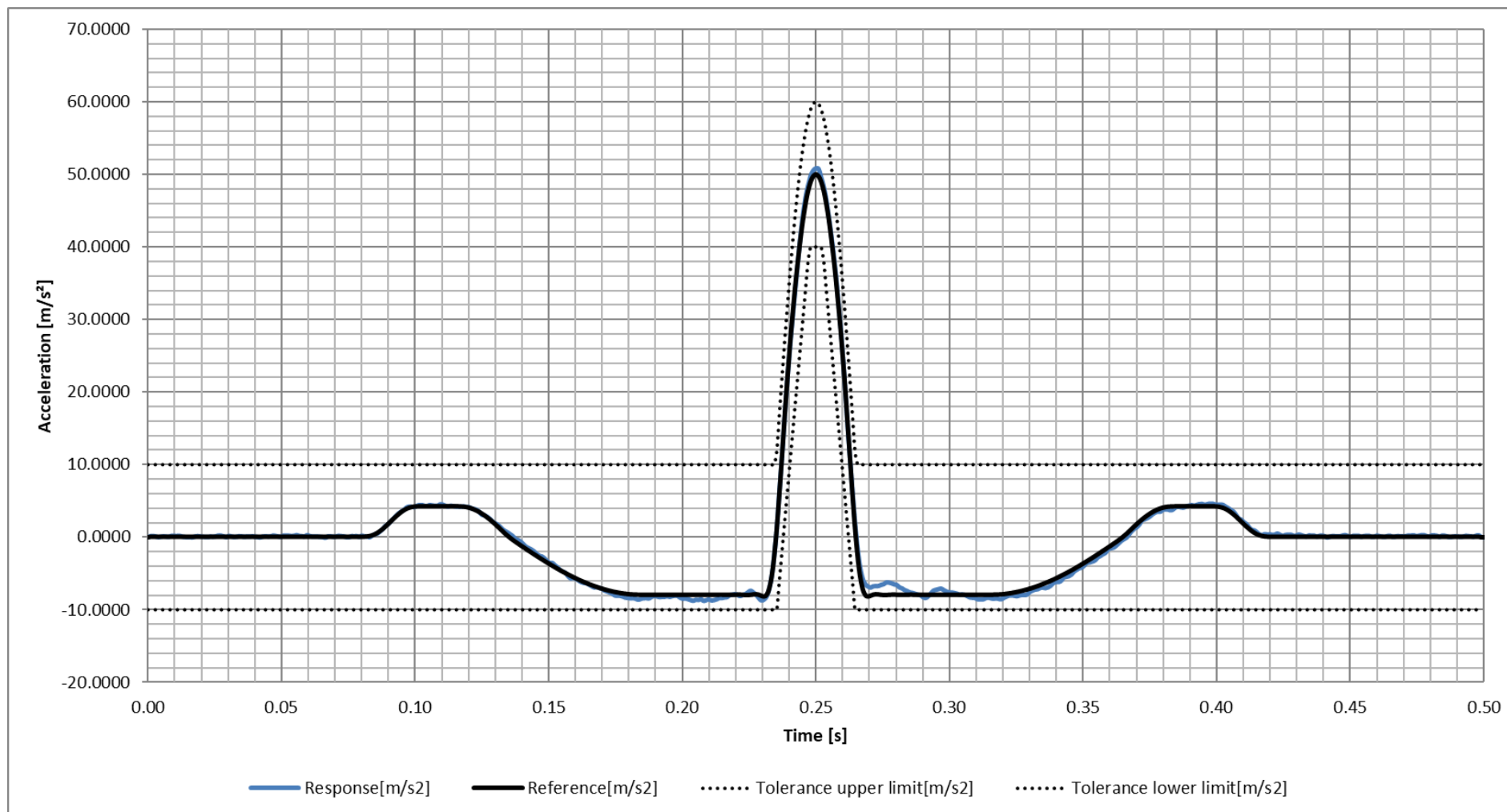
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**Figure 13: Output Voltage – Transverse axis functional random vibration test**

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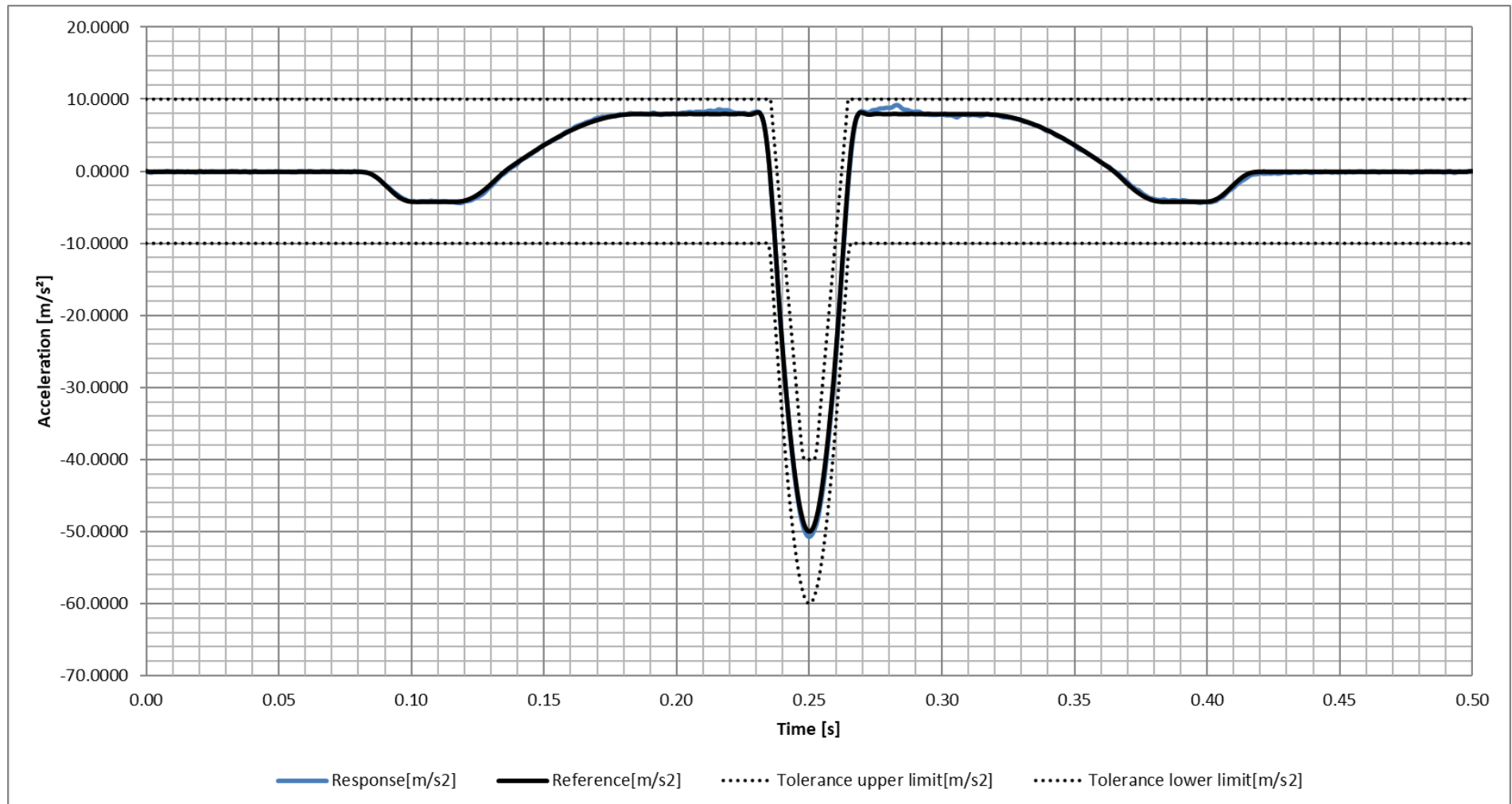
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Rev No: 1 2023-04-18  
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**Figure 14: Shock test response – Shock 1 of 6 – Vertical axis positive**

Test Report  
**Vibration and Shock**

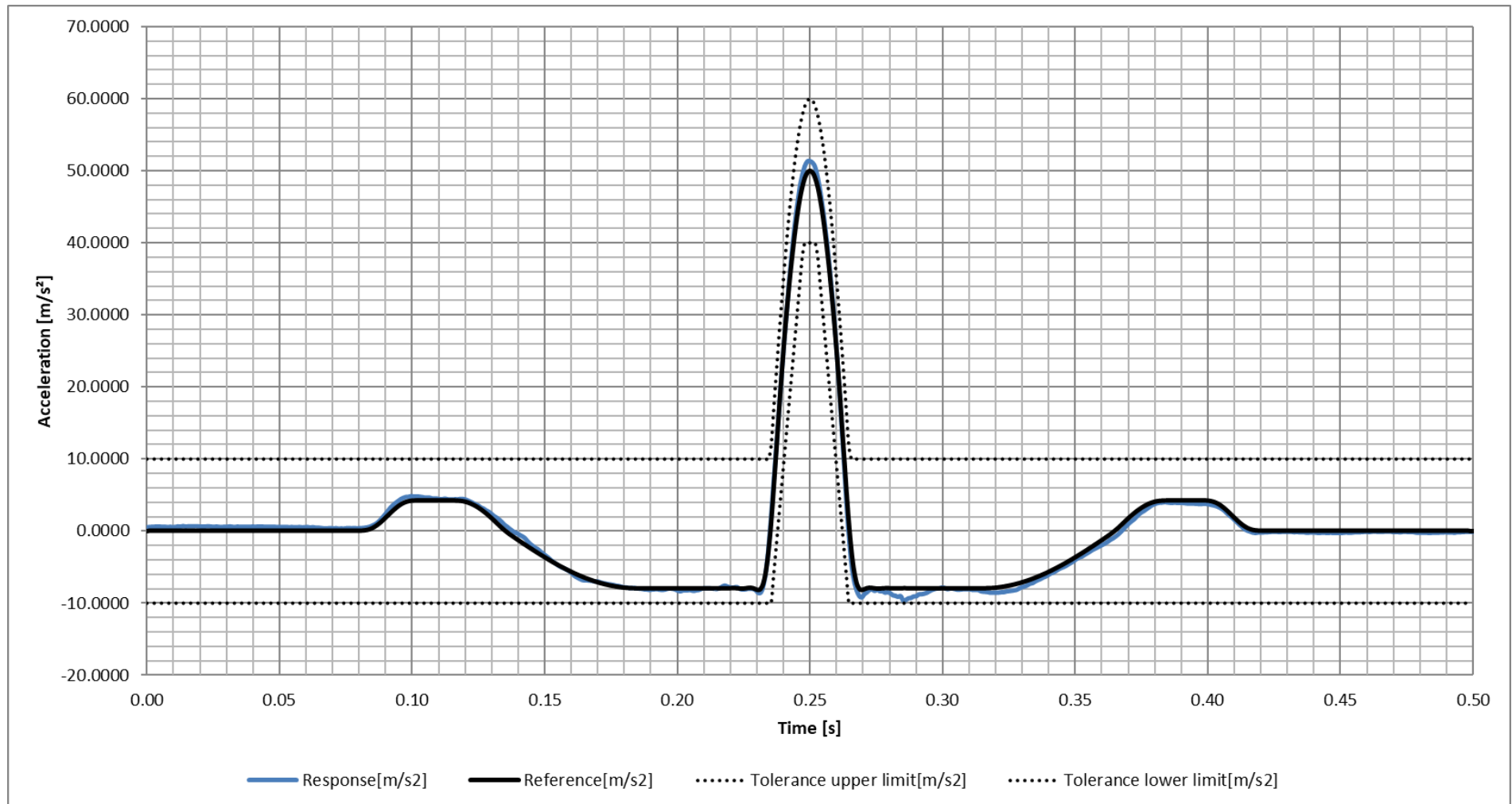
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**Figure 15: Shock test response – Shock 6 of 6 – Vertical axis negative**

Test Report  
**Vibration and Shock**

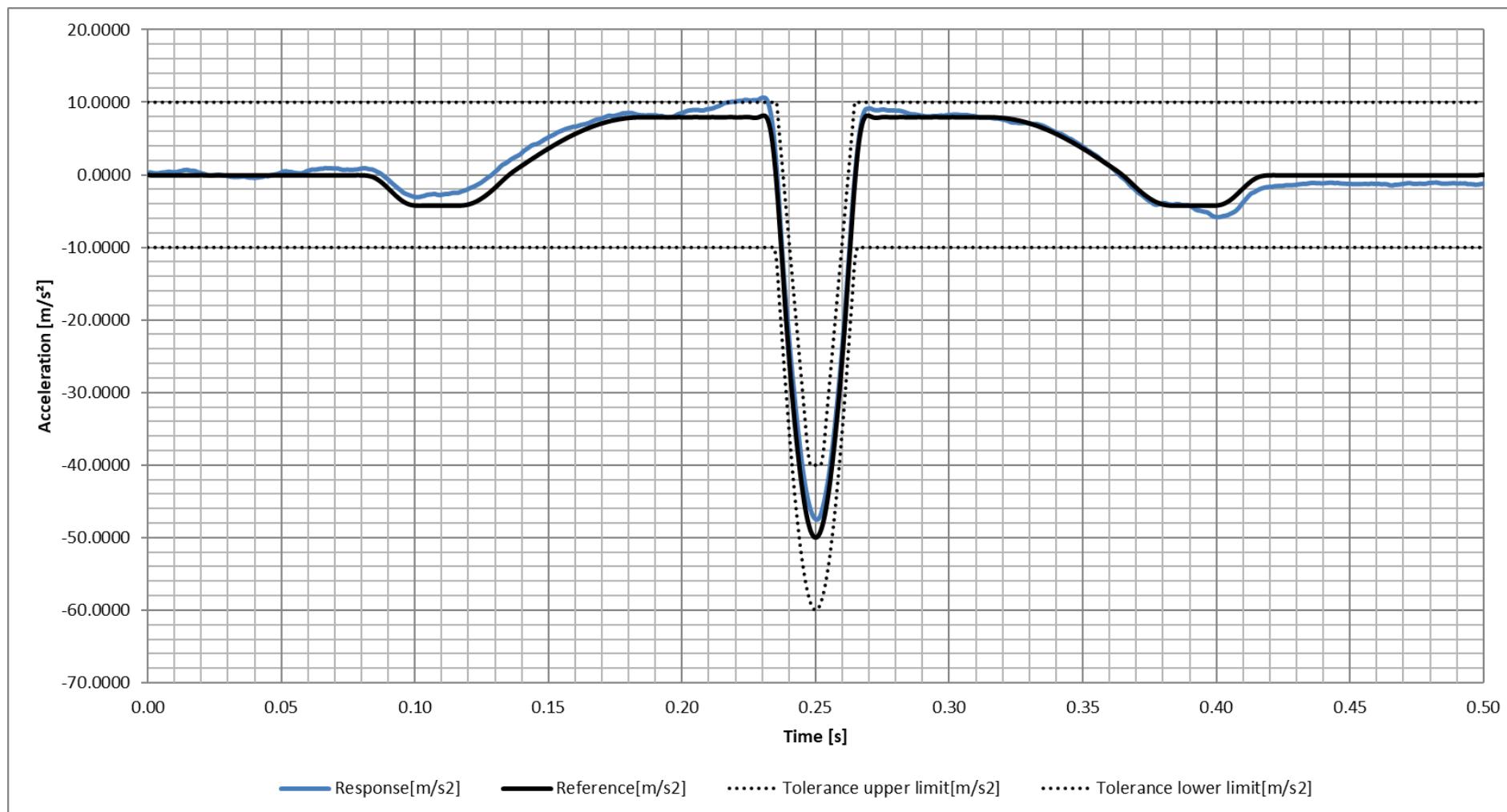
Record No: RTL00535 D0011  
Rev No: 1 2023-04-18  
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**Figure 16: Shock test response – Shock 1 of 6 – Longitudinal axis positive**

Test Report  
**Vibration and Shock**

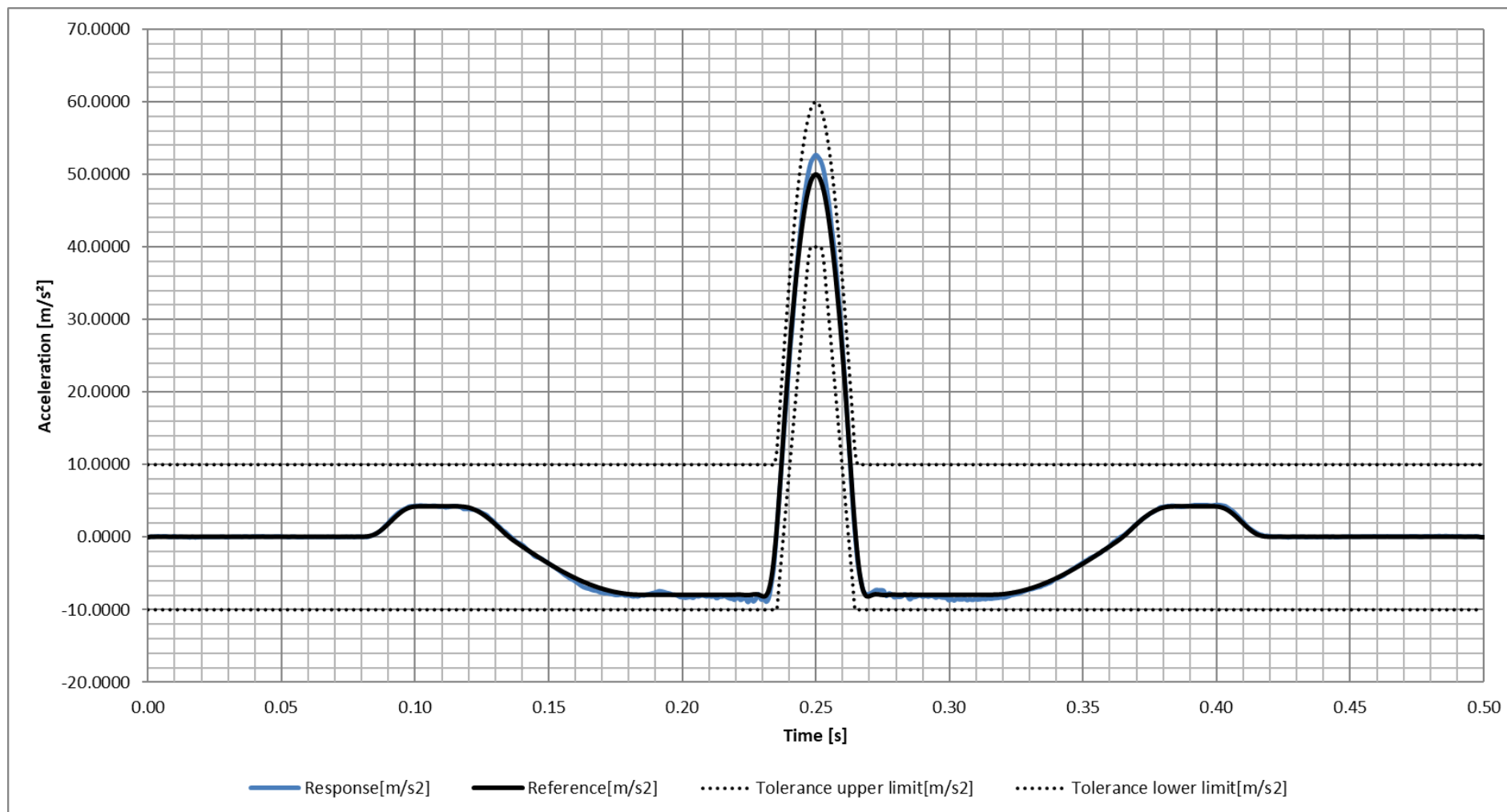
Record No: RTL00535 D0011  
Rev No: 1 2023-04-18  
Document Status: Approved



**Figure 17: Shock test response – Shock 6 of 6 – Longitudinal axis negative**

Test Report  
**Vibration and Shock**

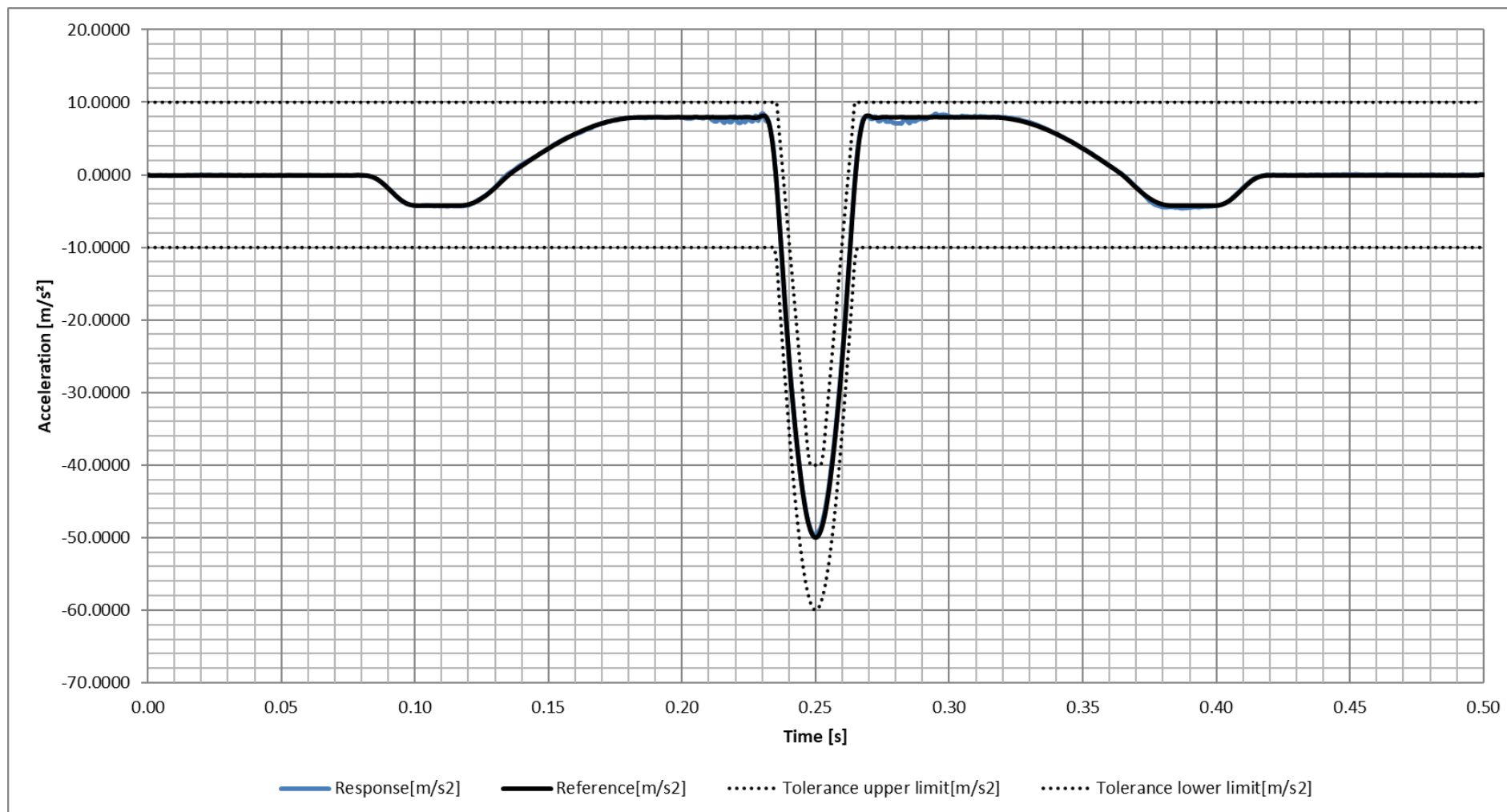
Record No: RTL00535 D0011  
Rev No: 1 2023-04-18  
Document Status: Approved



**Figure 18: Shock test response – Shock 1 of 6 – Transverse axis positive**

Test Report  
**Vibration and Shock**

Record No: RTL00535 D0011  
Rev No: 1 2023-04-18  
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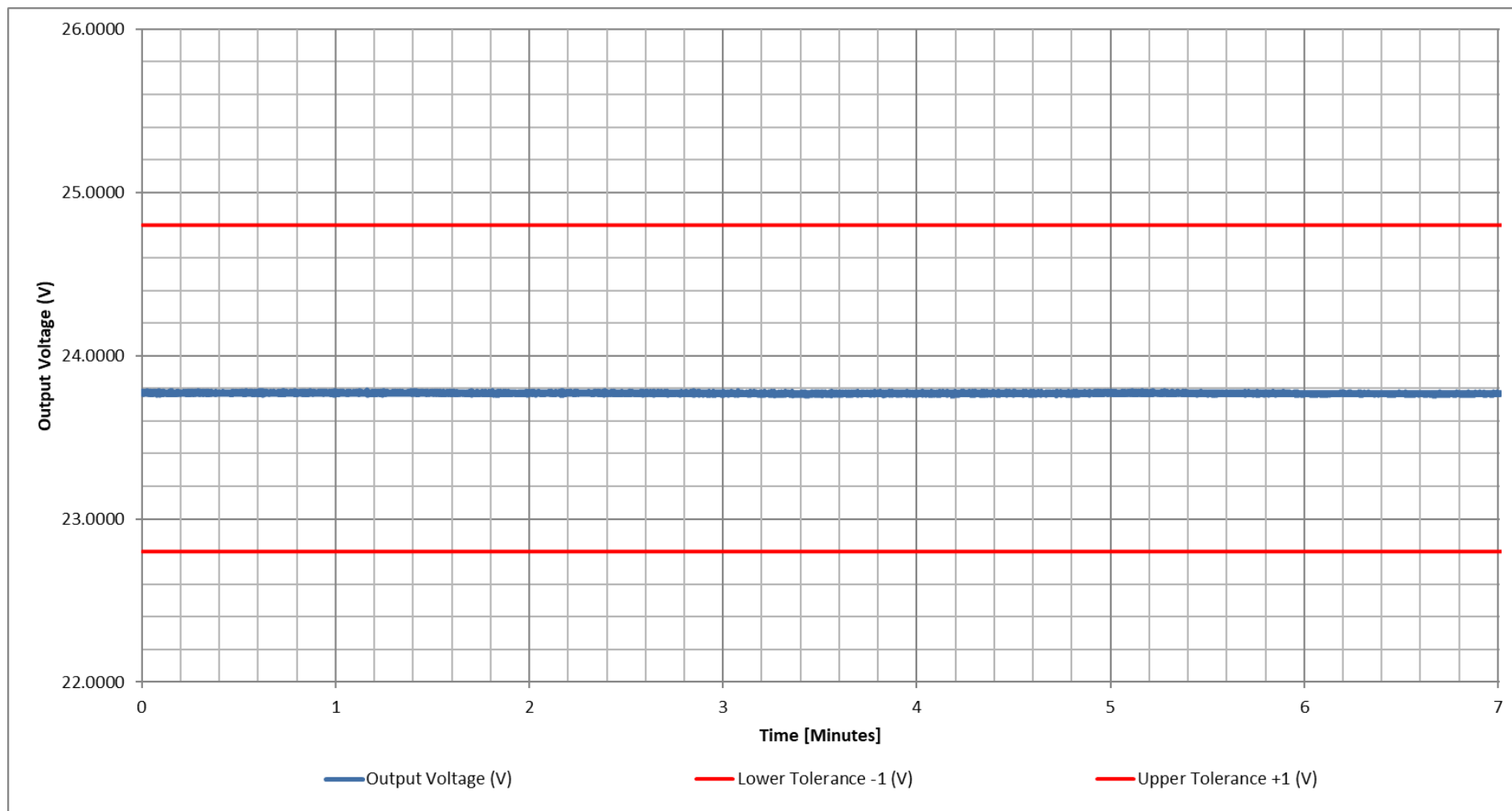


**Figure 19: Shock test response – Shock 6 of 6 – Transverse axis negative**



Test Report  
**Vibration and Shock**

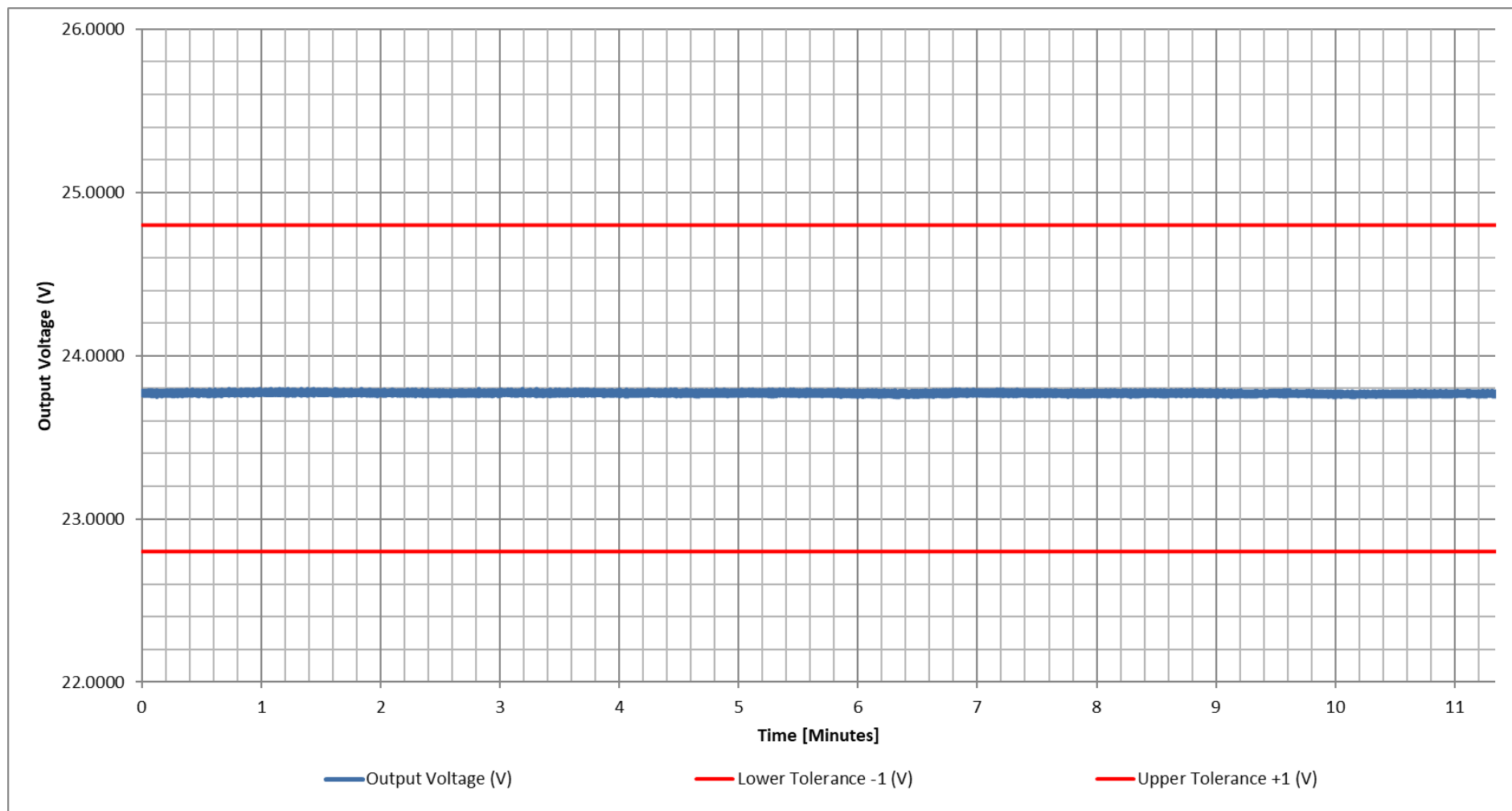
Record No: RTL00535 D0011  
Rev No: 1 2023-04-18  
Document Status: Approved



**Figure 20: Output Voltage – Vertical axis shock test**

Test Report  
**Vibration and Shock**

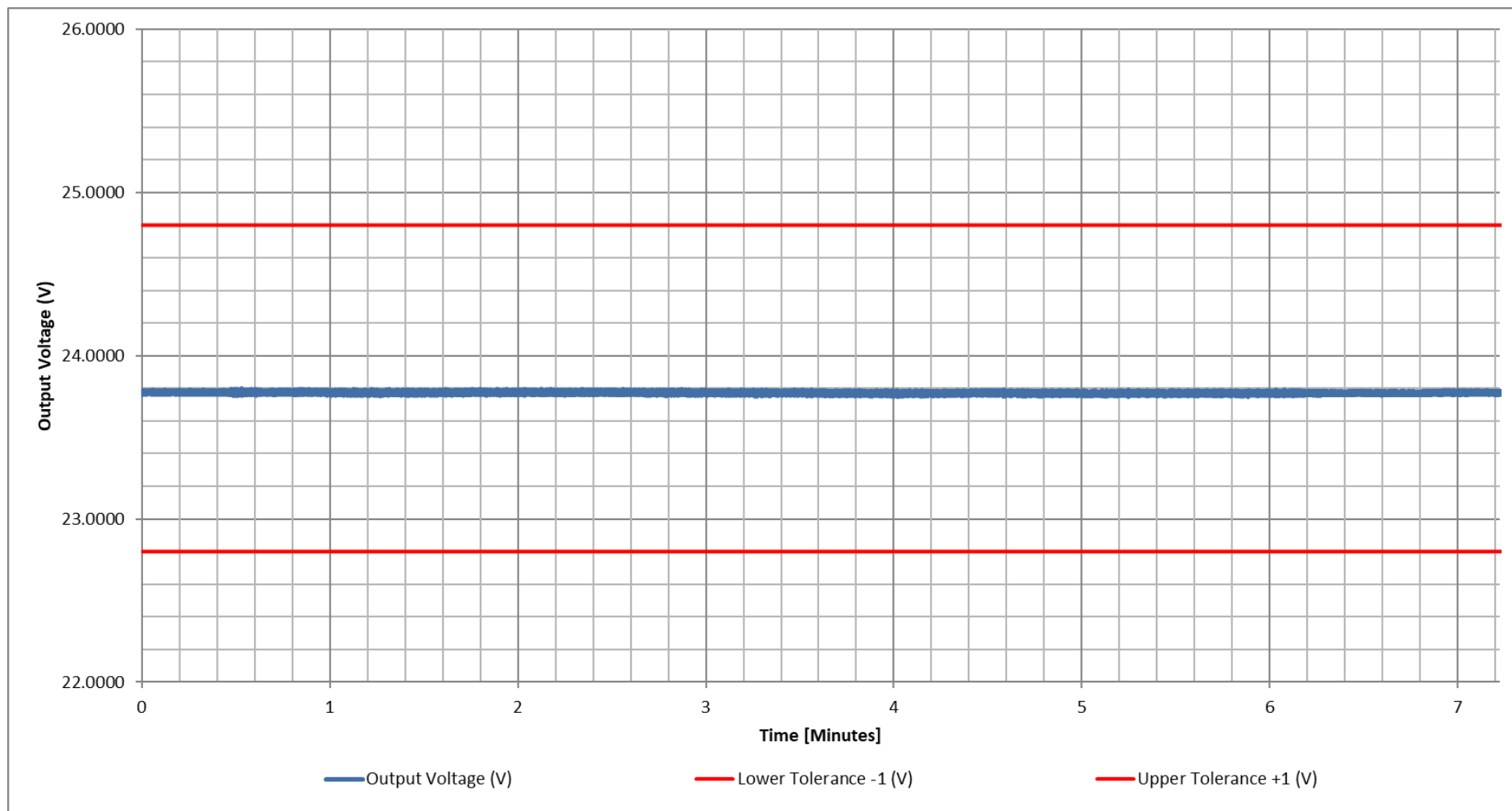
Record No: RTL00535 D0011  
Rev No: 1 2023-04-18  
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**Figure 21: Output Voltage – Longitudinal axis shock test**

Test Report  
**Vibration and Shock**

Record No: RTL00535 D0011  
Rev No: 1 2023-04-18  
Document Status: Approved



**Figure 22: Output Voltage – Transverse axis shock test**

 <b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY	Test Report <b>Vibration and Shock</b>	Record No: RTL00535 D0011 Rev No: 1 2023-04-18 Document Status: Approved
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## 6 Quality Assurance

Our technical competence and quality control arrangements are in accordance with the conditions of our quality management system.

## 7 Summary

Random vibration and shock tests were carried out in all three orthogonal axes in accordance with the customer specification.

During the random vibration and shock testing, the test specimen was functional with the output voltage being monitored throughout testing, under the instruction of the customer by Resonate Testing staff, to ensure that the output voltage lies within  $\pm 1V$  of the initial output voltage.

For all three axes, the test specimen was subjected to the vertical random vibration test level and the longitudinal shock severity as per the customer's request, for the duration required by the test specification.

The plots of the control spectra from the random vibration test and acceleration time histories from the shock test have been provided to show that the test requirements have been adhered to. Output voltage plots from each test have also been provided.

 <p><b>Resonate</b> TESTING LIMITED A NACELLE GROUP COMPANY</p>	<p>Test Report</p> <h1>Vibration and Shock</h1>	<p>Record No: RTL00535 D0011 Rev No: 1    2023-04-18 Document Status: Approved</p>
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End of Report