

## 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. 13.4.10.2 (Simulated Long Life Test) |
| 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

Simulated long life vibration testing is a mandatory test required to comply with EN50155 standard. The objective of this report is to show compliance with the requirements of EN50155 clause 13.4.10.2 for simulated long life vibration test.

# 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 simulated long life 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

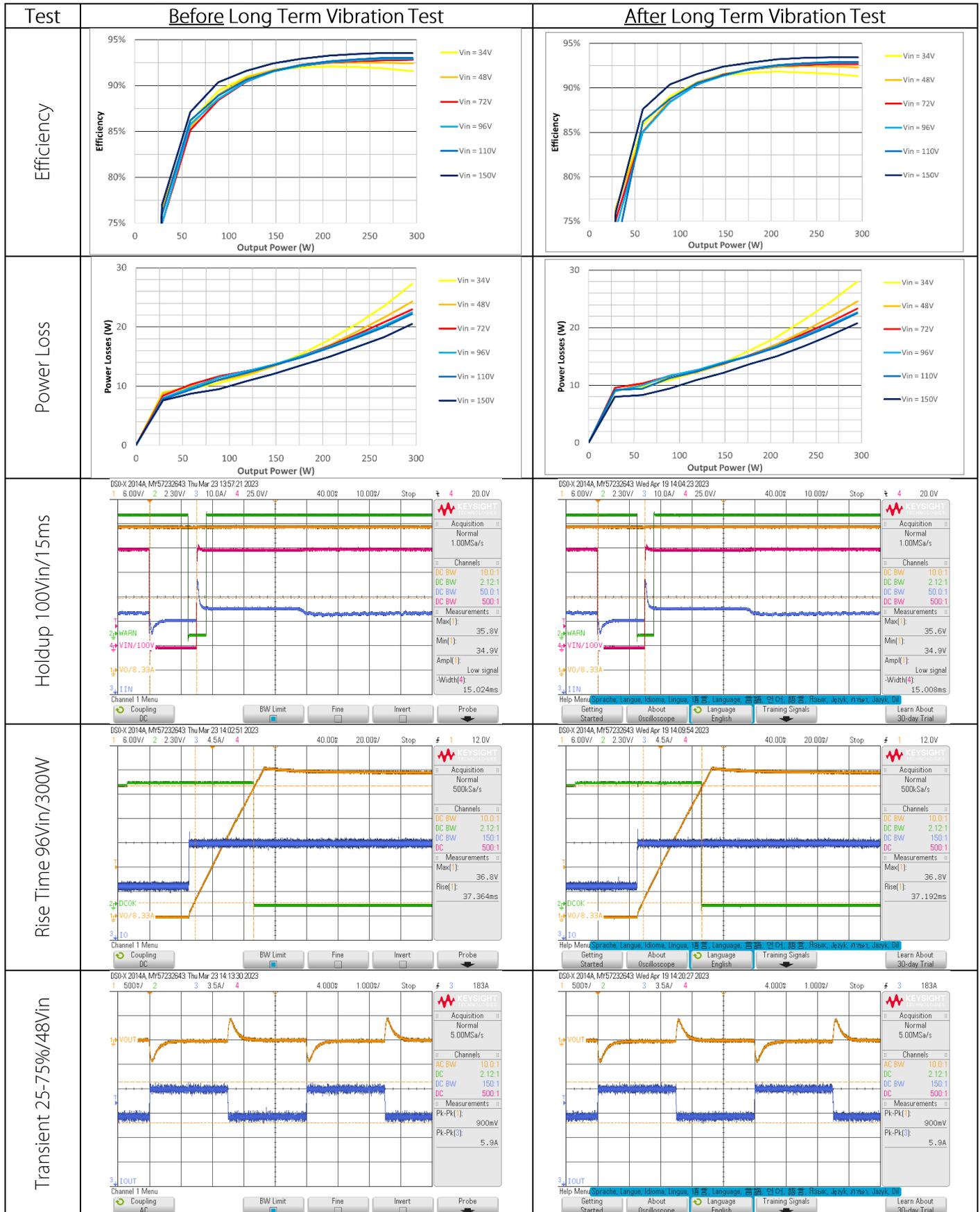
The performance test results for the tested samples before and after the simulated long life vibration test show no variation in performance.

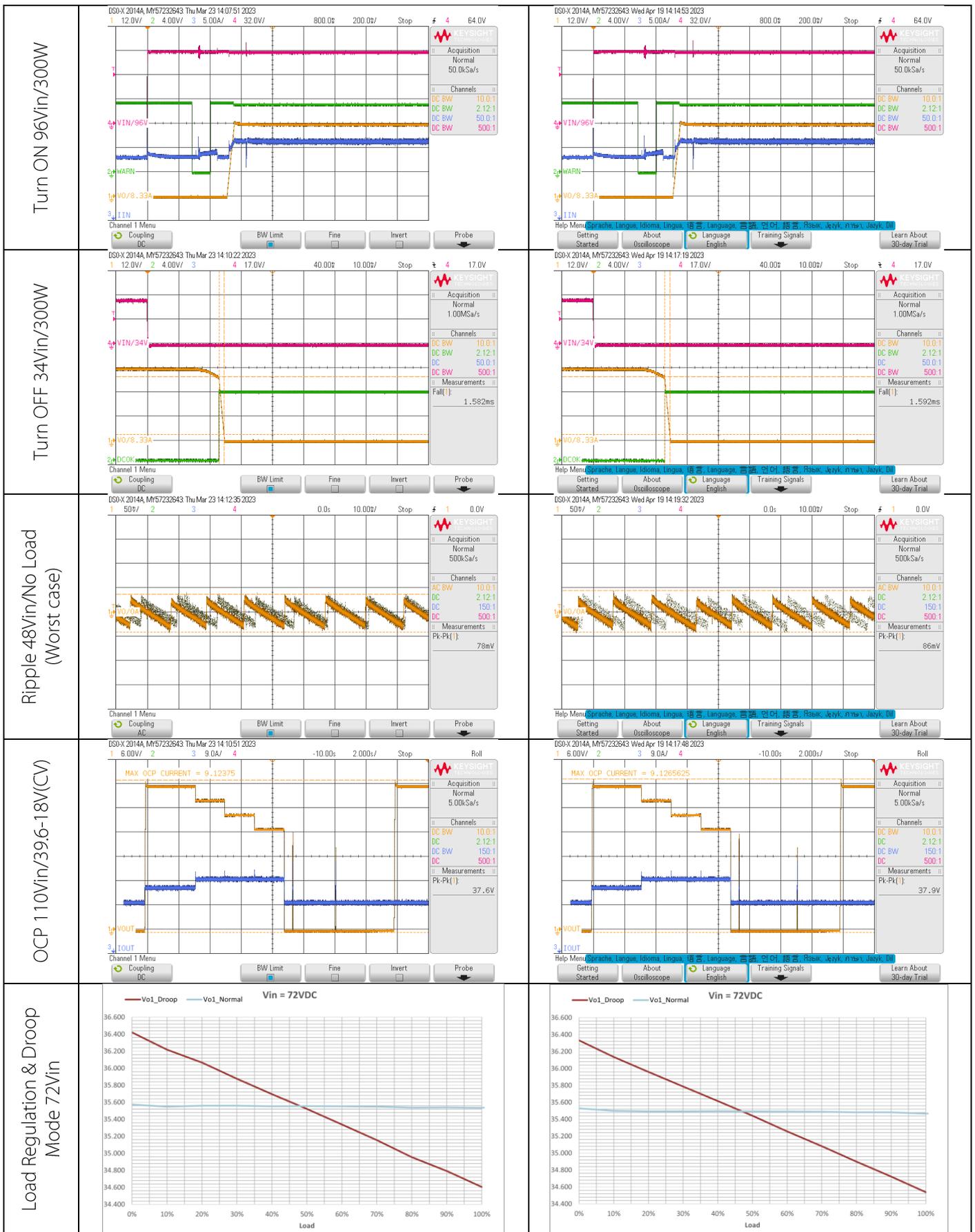
The visual inspection does not show any damage or issues.

It can be concluded that the simulated long life vibration test was passed successfully.

# Appendix 1 - Performance Test Results

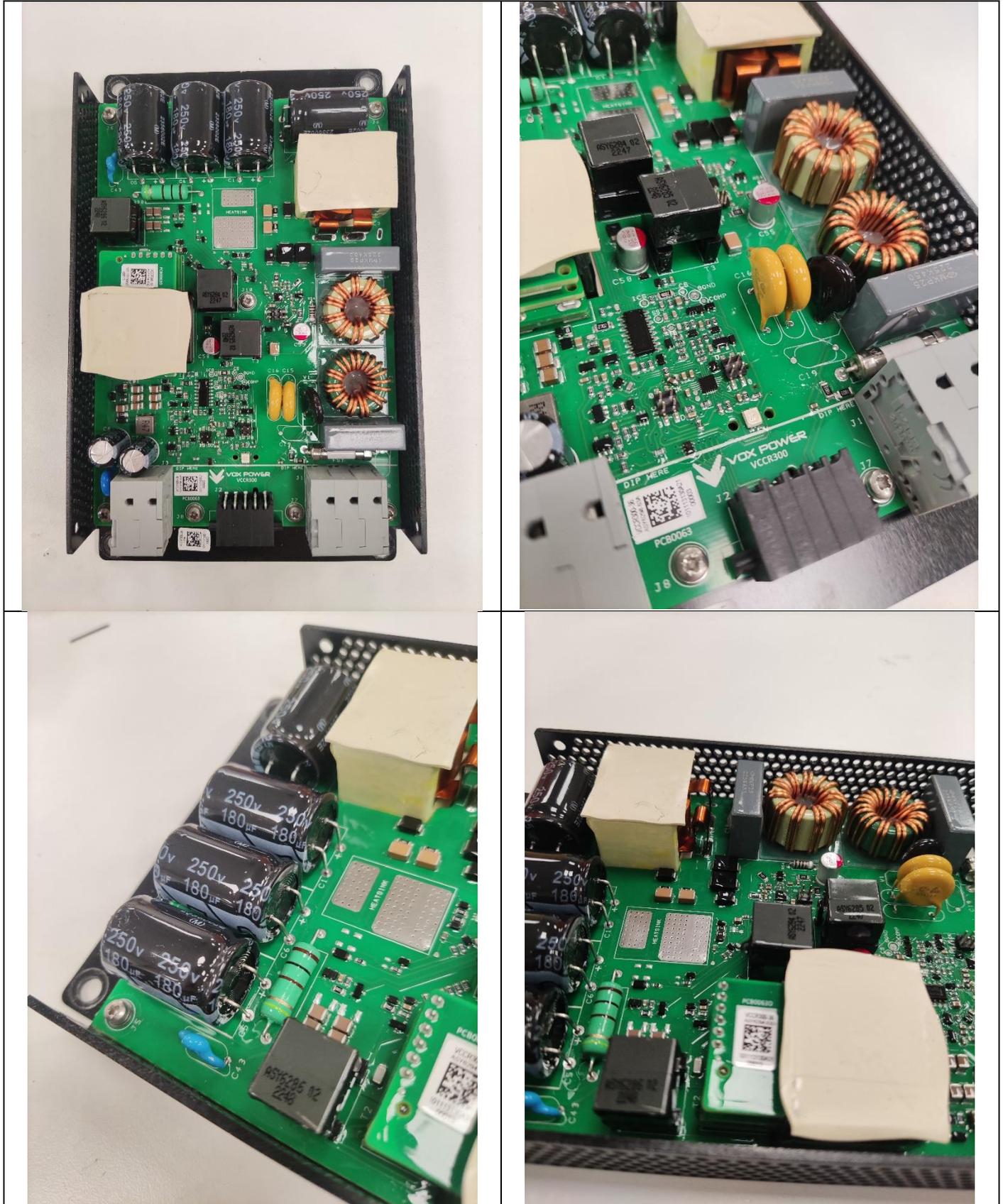
VCCR300-36 Engineering Sample (Long Term Vibration) S/N: 2313C080003

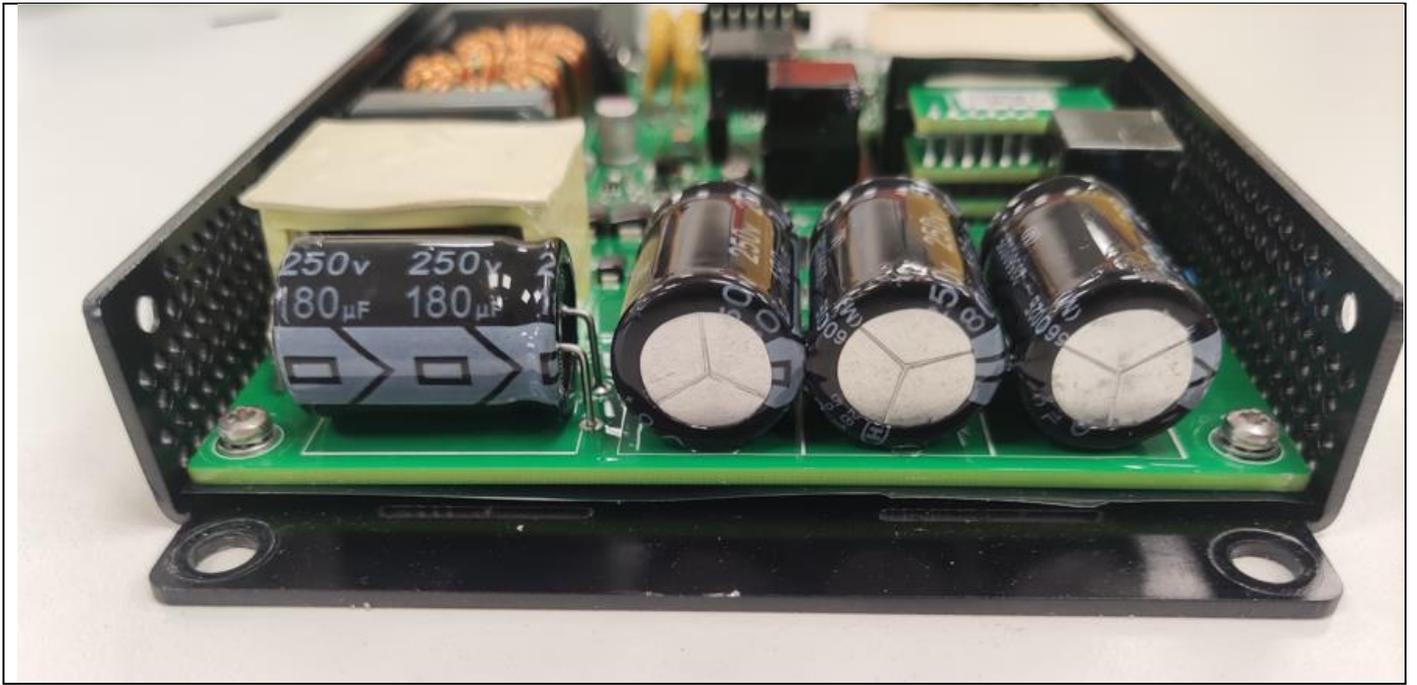




# Appendix 2 - Visual Inspection

VCCR300-36 Engineering Sample (Long Term Vibration) S/N: 2313C080003

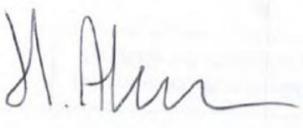




# Appendix 3 – Simulated Long Life Vibration Test

## LONG TERM VIBRATION TEST REPORT FOR VOX POWER

### TEST REPORT

| Author: (Name)   | Author: (Signature)   | Date:      |
|------------------|---|------------|
| Hayley Alcorn    |   | 2023-04-18 |
| Approver: (Name) | Approver: (Signature)   | Date:      |
| Mary Dowey       |  | 2023-04-18 |

## 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<br>Unit 2, Redcow Interchange Estate<br>Ballymount<br>Dublin 22, D22 Y8H2, Ireland  |
| <b>Test Specimen:</b>   | P/N: VCCR300-48, VCCR300-36<br>S/N: 2313C0E0004, 2313C0E0003  |
| <b>Specimen Receipt Date:</b>   | 2023-03-30  |
| <b>Date of Test:</b>  | 2023-04-04 to 2023-04-05  |
| <b>Date of Report:</b>  | Iss 01: 2023-04-18  |
| <b>Test Method to be Used:</b>  | Testing was carried out according to EN 61373:2010, Clause 9 as per VCCR300 external environmental test plan.   |
| <b>Any Deviation from Test Method:</b>  | Due to an error in programming the long-term vibration test, the test specimens underwent an over test at 55.0361 m/s <sup>2</sup> RMS for 3 minutes and 54 seconds in the vertical axis. The error was caught and the programme corrected. The test was restarted and carried out with the defined levels.<br><br>For all three axes, the test specimens were subjected to the vertical test level (highest level) per customer request. |
| <b>Results summary:</b>   | Testing was carried out as per customer's specification without witnessing. No determination on the pass/fail of the test specimens 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 specimens tested. Opinions and interpretations are not given by Resonate Testing Ltd.</p> <p>Testing was carried out on these test specimens only and provides no verification for the performance of other items in the same batch, or production run.</p> |   |

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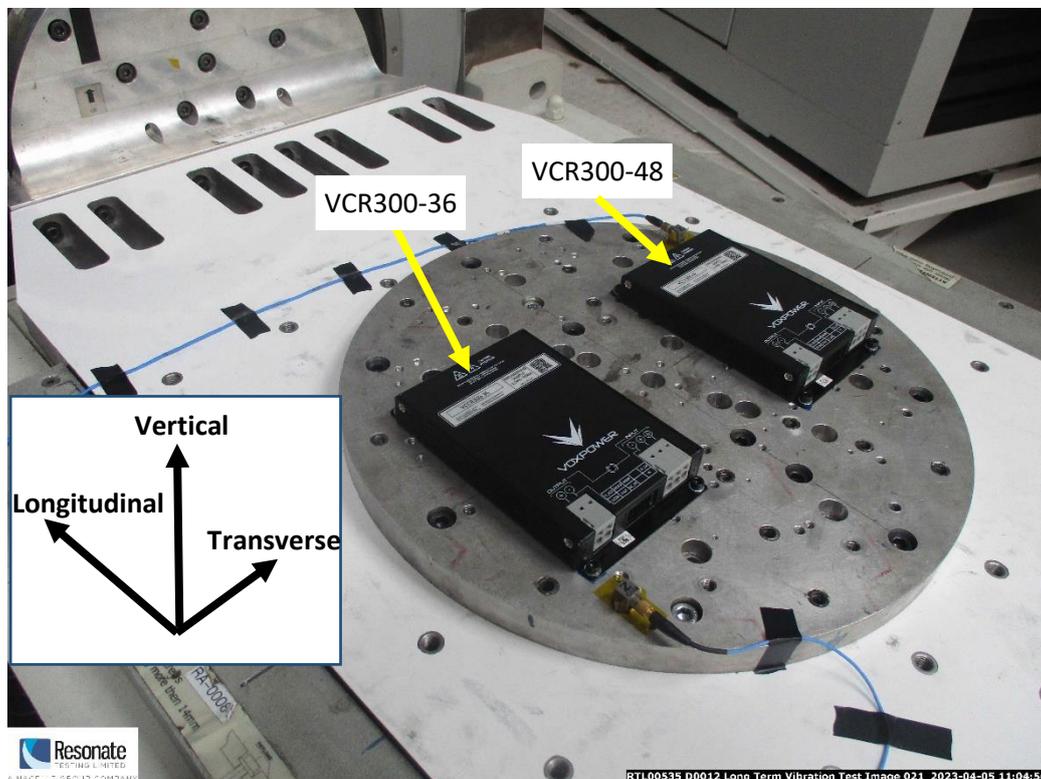
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## 1 Test Specimen

|                              |  |
|------------------------------|--|
| <b>Customer Description:</b> | Conduction cooled power supply VCCR300 series                |
| <b>Customer Unique ID:</b>   | P/N: VCCR300-48, VCCR300-36<br>S/N: 2313C0E0004, 2313C0E0003 |
| <b>Condition on receipt:</b> | Suitable for testing   |

Testing was carried out on these test specimens 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**

## 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 EN 61373:2010, Clause 9 as per 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 Long Term Random Vibration Profile

The test specimens were subjected to a long term random vibration test carried out in each orthogonal axes, in accordance with the customer's test specification, for a duration of five hours. For all three axes, the vertical test level (highest level) was used per customer request. The random vibration test was carried out to the requirements detailed in Table 1.

**Table 1: Long term random vibration profile**

| Frequency                          | ASD level (m/s <sup>2</sup> ) <sup>2</sup> /Hz |
|------------------------------------|--|
| 5                                  | 0.964  |
| 20                                 | 0.964  |
| 150                                | -6 dB/octave                                   |
| <b>RMS (m/s<sup>2</sup>): 5.72</b> |  |

### 3 Test Equipment and Instrumentation

#### 3.1 Test Laboratory

|   |  |
|---|--|
| <b>Laboratory Address:</b>              | Resonate Testing Limited<br>Unit 1<br>Bridge Technology Park<br>Carnagat Lane<br>Carnagat<br>Newry<br>BT35 8XF |
| <b>Test Technician:</b>                 | Conor Barry, Hayley Alcorn   |
| <b>Customer Onsite representatives:</b> | None   |

#### 3.2 Test Equipment

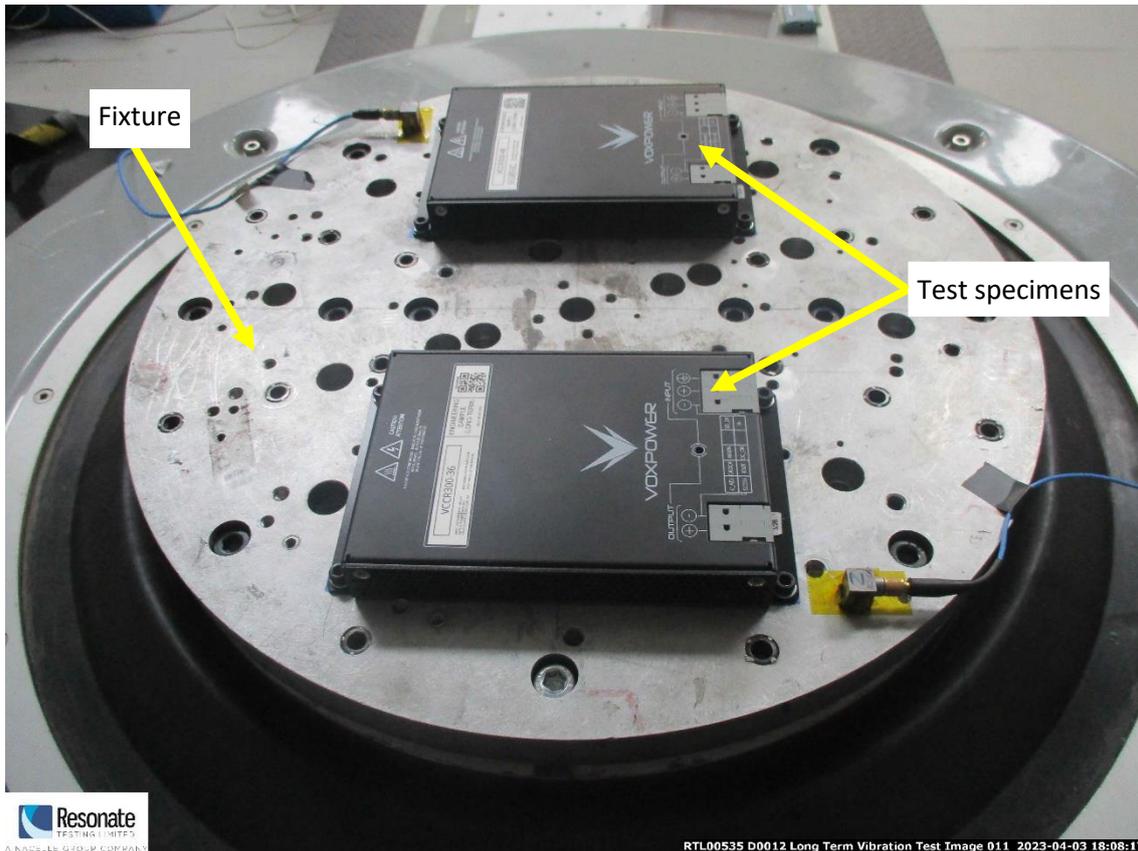
Testing was carried out using the equipment outlined in the following specification (See Table 2).

**Table 2: Vibration equipment specification**

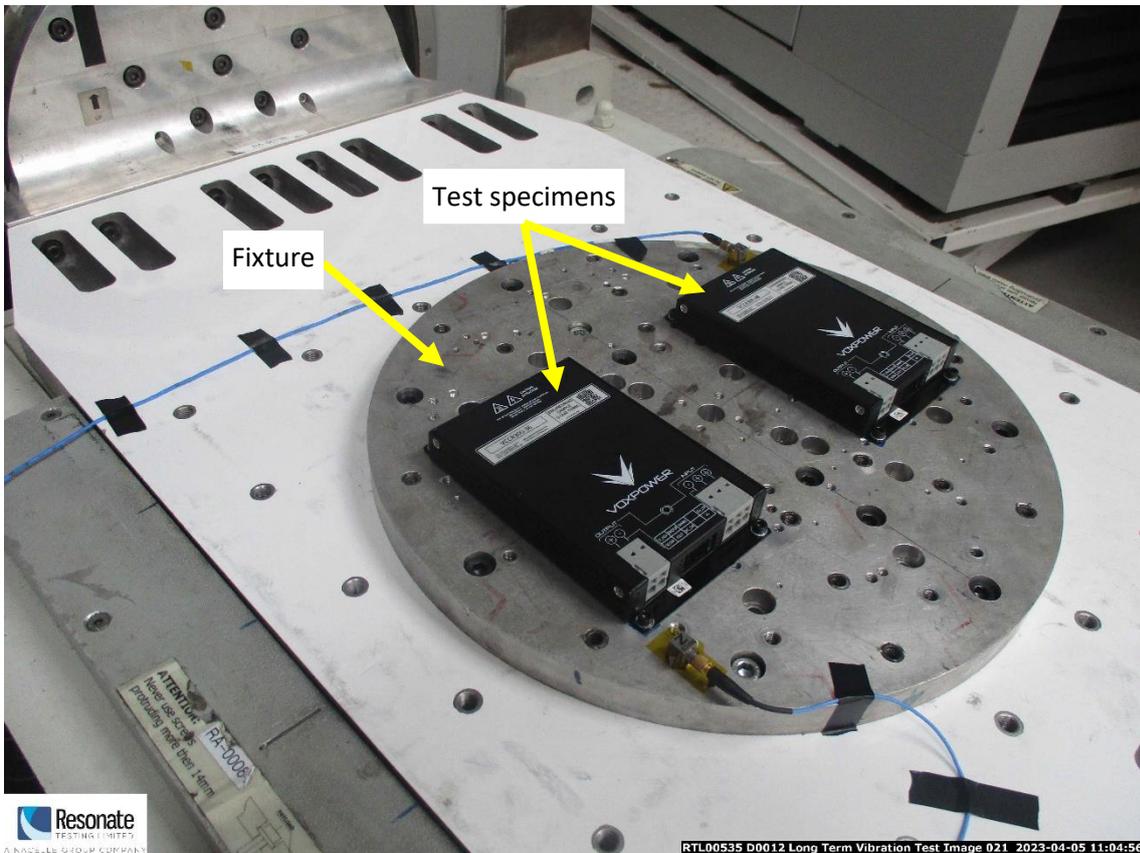
| Shaker  |                     |                 |                       |
|---|---------------------|-----------------|-----------------------|
|  | Manufacturer:       | IMV Corporation |                       |
|   | Model:              | EM2605          |                       |
|   | Frequency 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          |                       |

### 3.3 Fixturing

The test specimens were fixed so that the vibration motion was parallel to each of their three major orthogonal axes. The test specimens were attached to the test fixture as shown in Figure 2 and Figure 3 using four M5 bolts with washers and torqued to 6.6 Nm.



**Figure 2: Attachment of test specimens to fixture – Vertical**



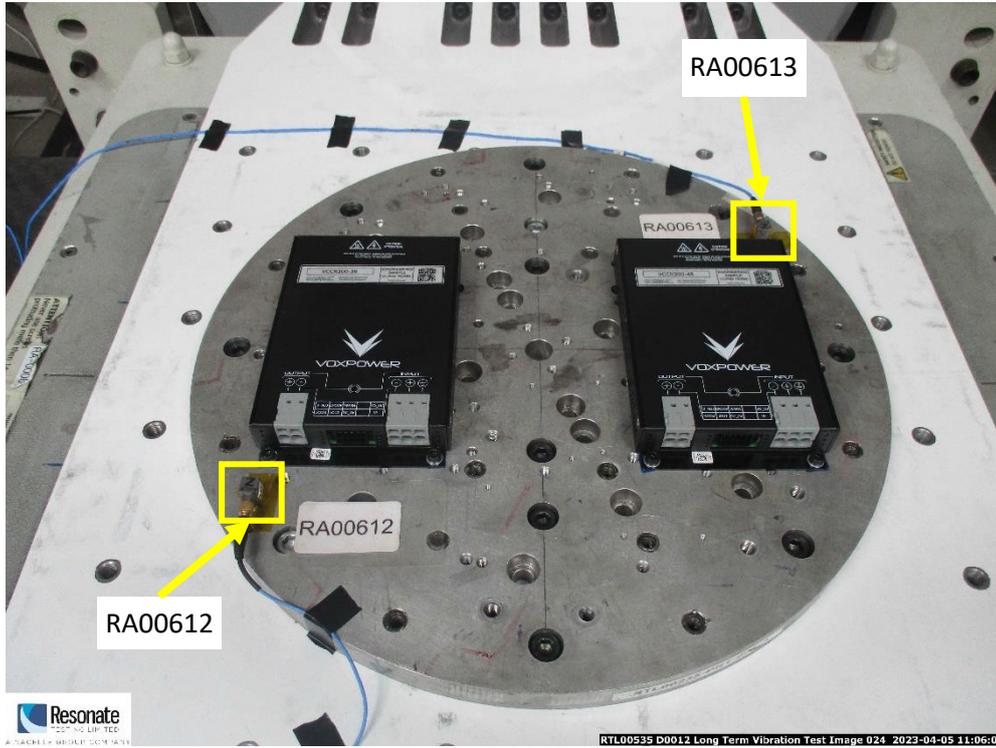
**Figure 3: Attachment of test specimens to fixture – Horizontal**

### 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, shown in Figure 4.

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



**Figure 4: Location of control accelerometers – Location for both axes [RA00612 and 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     |

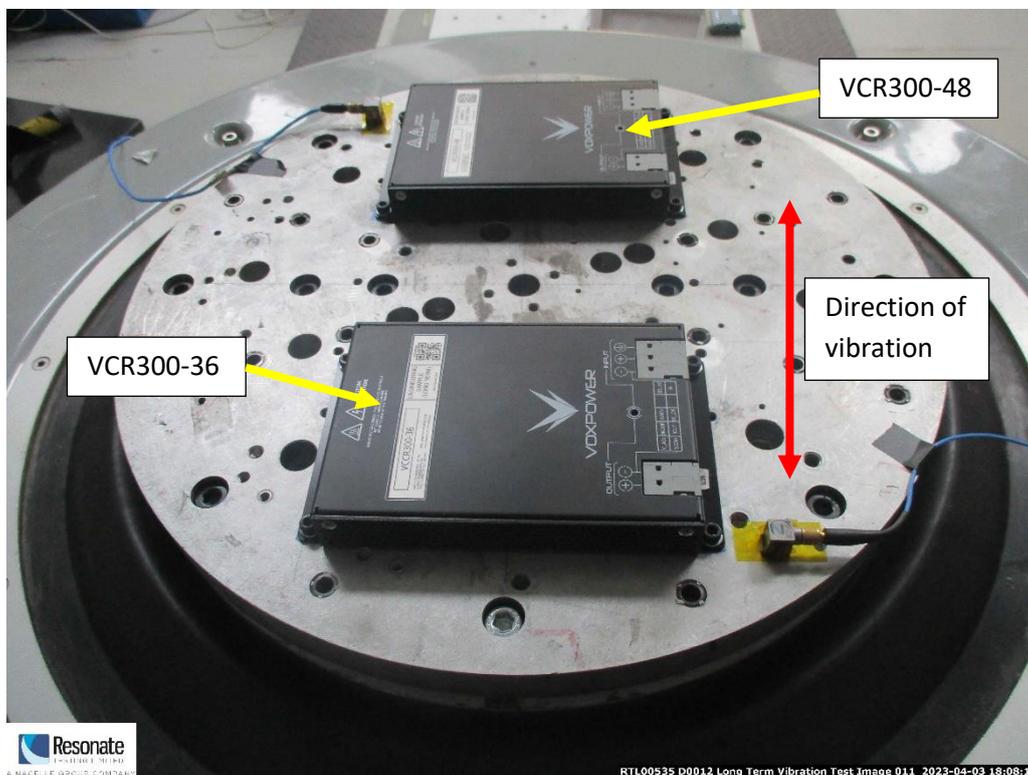
## 4 Procedure

### 4.1 Vibration Testing

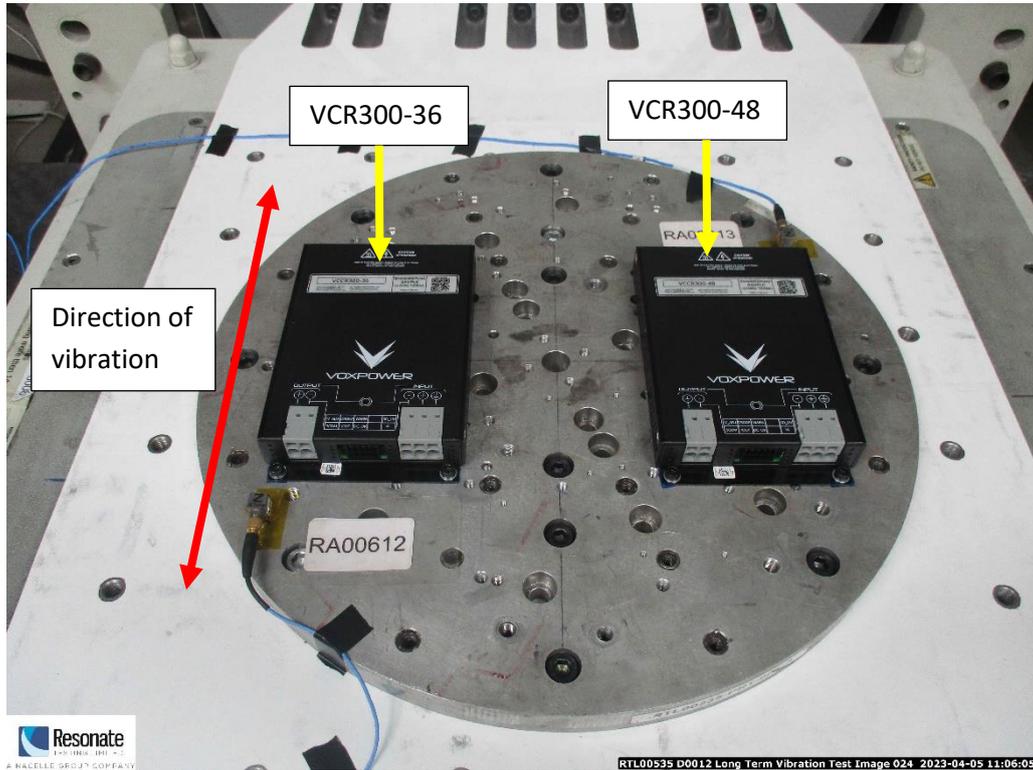
The test specimens were subjected to a long term random vibration profile in each of the three orthogonal axes for a duration of 5 hours, in accordance with the customer's specification.

Due to an error in programming for the long-term vibration test, the test specimens underwent an over test at 55.0361 m/s<sup>2</sup> RMS for 3 minutes and 54 seconds in the vertical axis, rather than the 5.72m/s<sup>2</sup> RMS requested. The error was caught and the programme corrected. The test was restarted and carried out with the defined levels for a further duration of 5 hours.

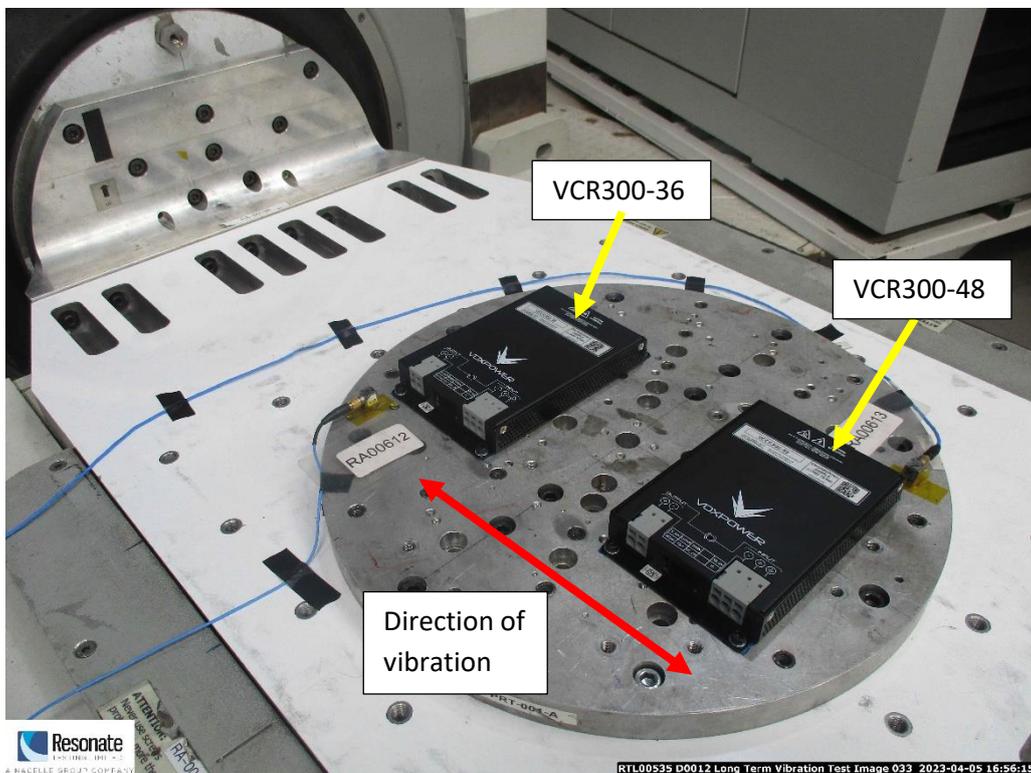
Photographs of the test setup in each axis are shown in Figure 5 to Figure 7.



**Figure 5: Vertical axis test set-up**



**Figure 6: Longitudinal axis test set-up**



**Figure 7: Transverse axis test set-up**

## 5 Test Results

### 5.1 Random Vibration Test

The test specimens completed the 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.

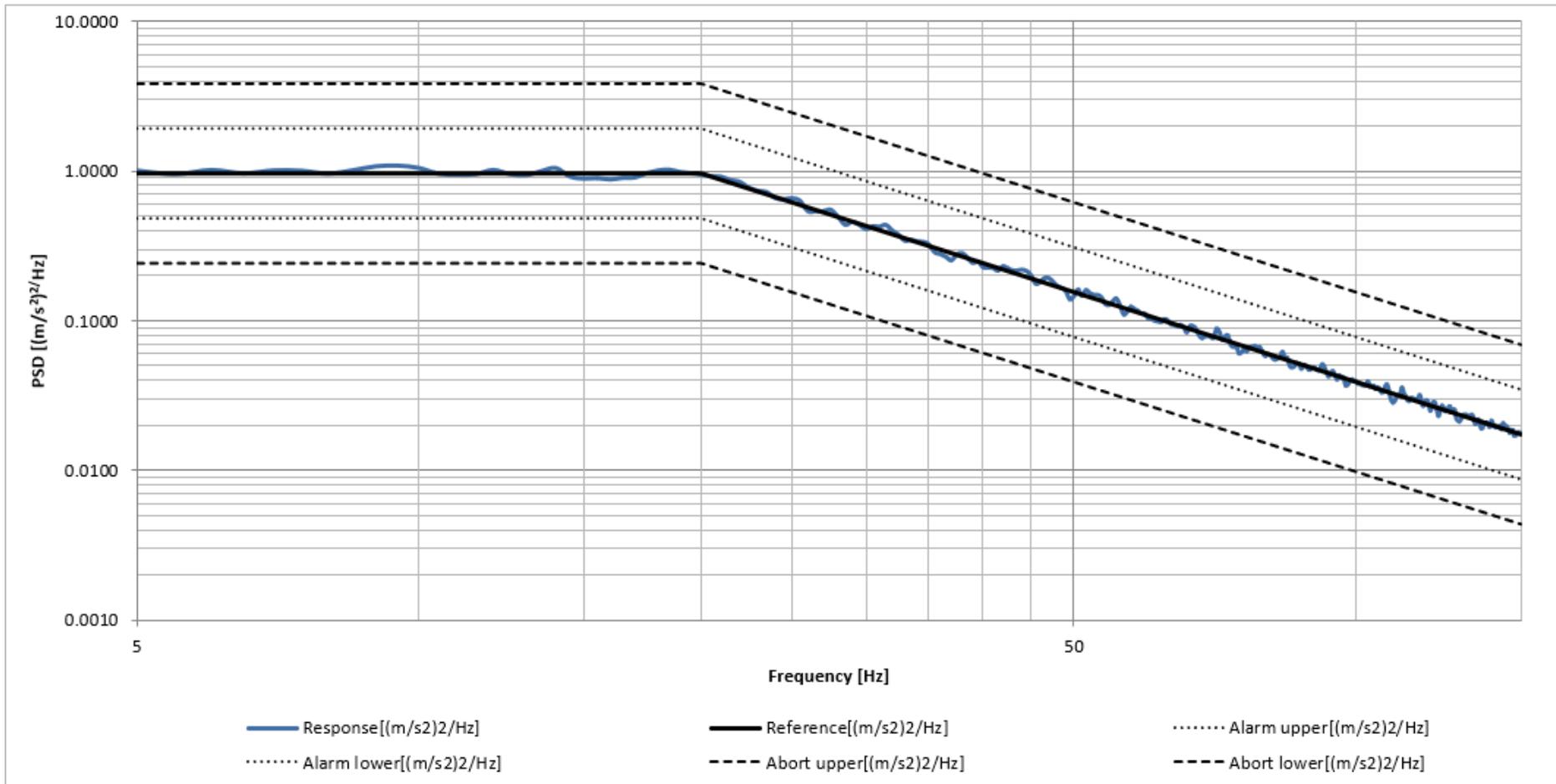
Test statuses are captured in Table 4. Vibration control spectra from the random vibration tests are shown in Figure 8 to Figure 10.

**Table 4: Vibration test status – Random vibration test**

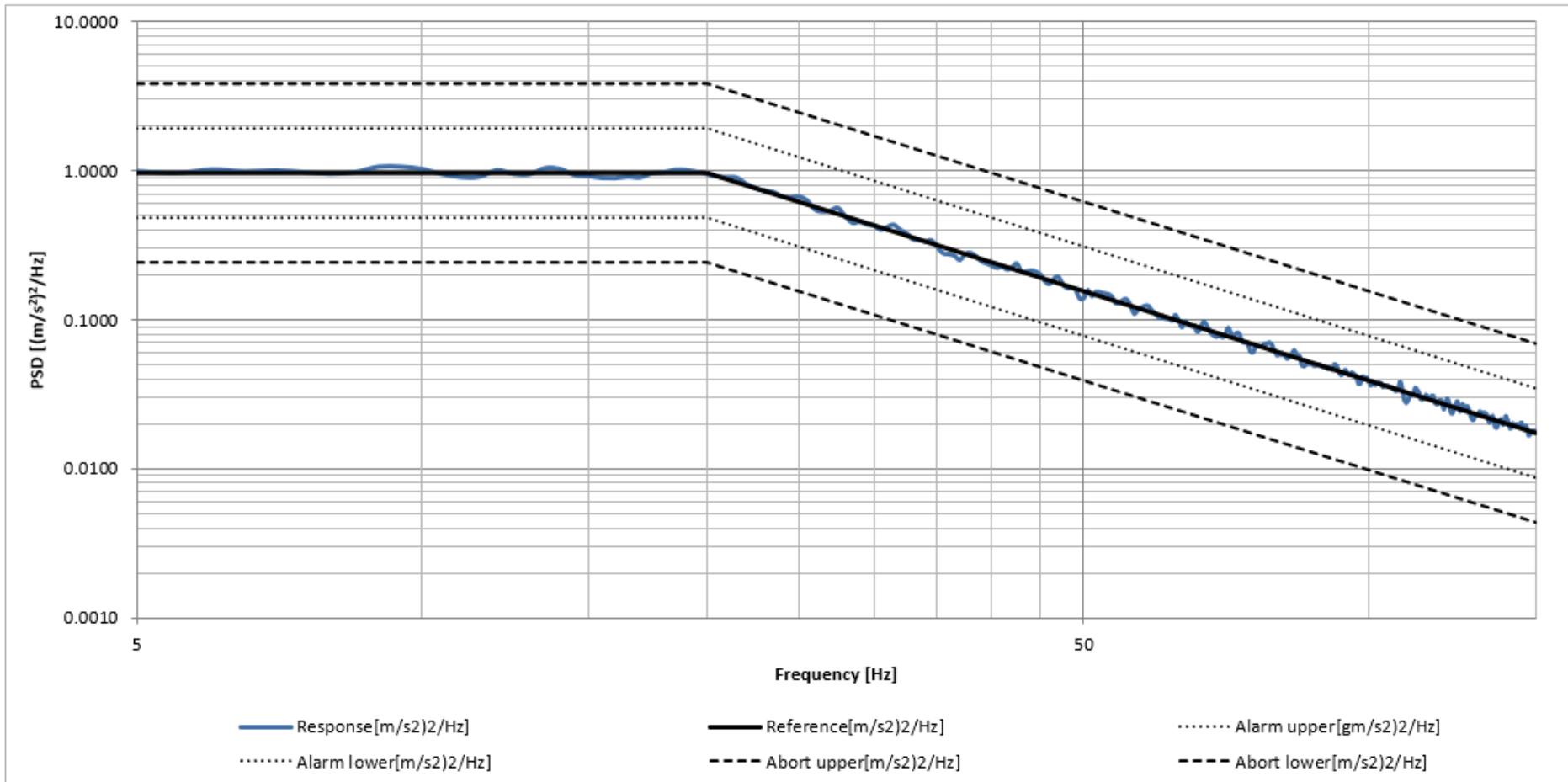
|                     | Vertical axis   | Longitudinal axis                                     | Transverse axis                                       |
|---------------------|---|---|---|
| <b>Start</b>        | 04/04/2023 11:51:13                                   | 05/04/2023 11:11:40                                   | 05/04/2023 17:39:20                                   |
| <b>End</b>          | 04/04/2023 16:53:14                                   | 05/04/2023 16:13:38                                   | 05/04/2023 22:41:19                                   |
| <b>Status</b>       | Excitation is completed.<br>(Test time is completed.) | Excitation is completed.<br>(Test time is completed.) | Excitation is completed.<br>(Test time is completed.) |
| <b>Reference</b>    | 5.6121 m/s <sup>2</sup> rms                           | 5.6121 m/s <sup>2</sup> rms                           | 5.6121 m/s <sup>2</sup> rms                           |
| <b>Response</b>     | 5.6436 m/s <sup>2</sup> rms                           | 5.6339 m/s <sup>2</sup> rms                           | 5.6478 g rms  |
| <b>Elapsed time</b> | 05:00:00  | 05:00:00  | 05:00:00  |
| <b>Alarm</b>        | OK  | OK  | OK  |
| <b>Abort</b>        | OK  | OK  | OK  |

**Table 5: Random vibration test control reference**

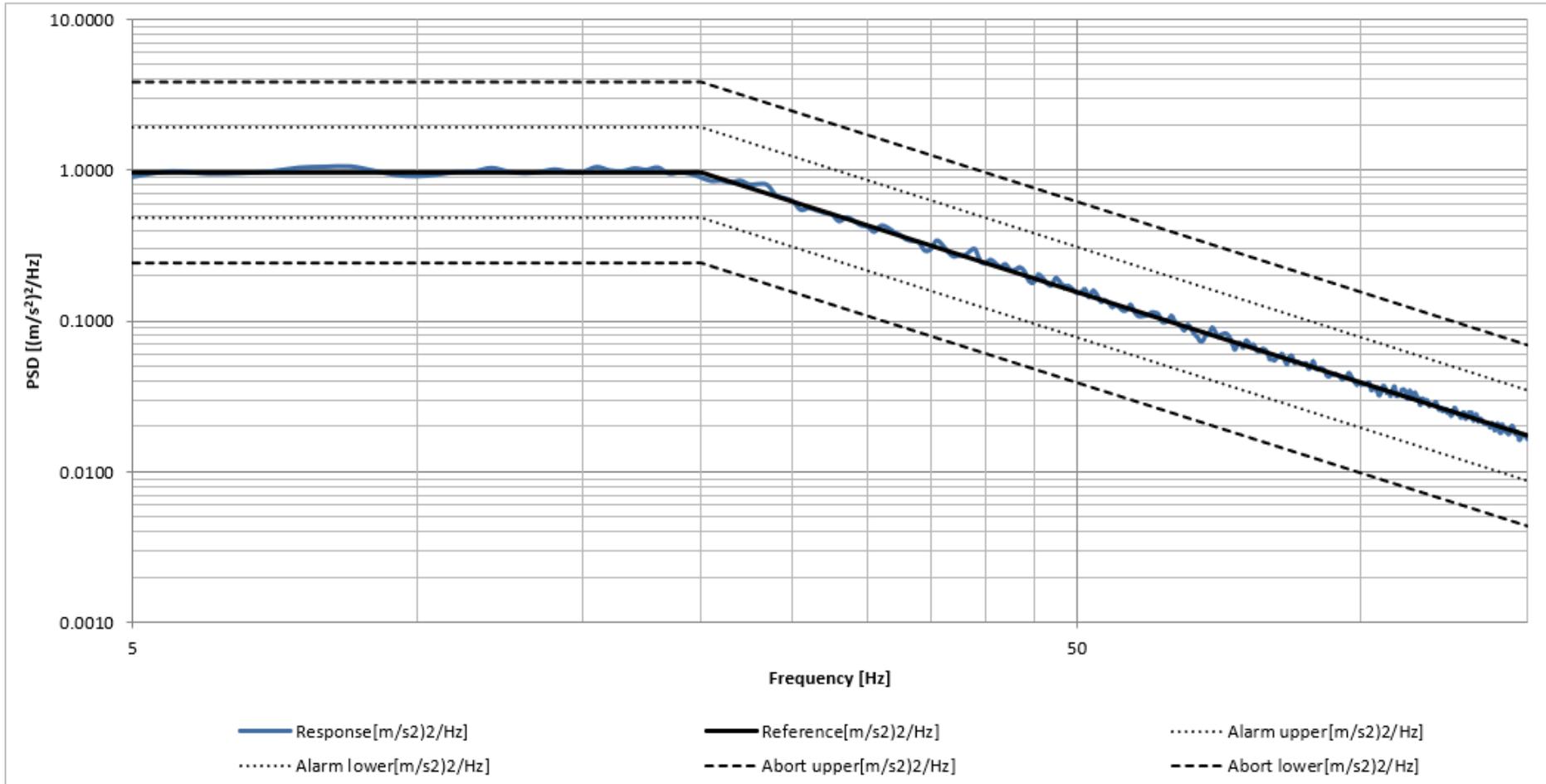
|   |                            |             |                                      |      |      |
|---|----------------------------|-------------|--------------------------------------|------|------|
| Control Reference   |                            |             |                                      |      |      |
| Acceleration  | 5.612 m/s <sup>2</sup> rms |             |                                      |      |      |
| Velocity  | 0.068 m/s rms              |             |                                      |      |      |
| Displacement  | 1.515 mm rms               |             |                                      |      |      |
| Break point PSD   |                            |             |                                      |      |      |
| No.   | Frequency (Hz)             | Level/Slope |                                      |      |      |
| 1   | 5.00                       | 0.9640      | (m/s <sup>2</sup> ) <sup>2</sup> /Hz |      |      |
| 2   | 20.00                      | 0.9640      | (m/s <sup>2</sup> ) <sup>2</sup> /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) |                            |             |                                      |      |      |
| -3.00   | 6.00                       | 5.00        | -6.00                                | 5.00 | 3.00 |
| Extended tolerance( 0 items)  |                            |             |                                      |      |      |



**Figure 8: Long term random vibration control plot in vertical axis**



**Figure 9: Long term random vibration control plot in longitudinal axis**



**Figure 10: Long term random vibration control plot in transverse axis**

|  |   |  |
|--|---|--|
|  <p><b>Resonate</b><br/>TESTING LIMITED<br/>A NACELLE GROUP COMPANY</p> | <p>Test Report<br/><b>Vibration</b></p> | <p>Record No: <b>RTL00535 D0012</b><br/>Rev No: 1 2023-04-18<br/>Document Status: Approved</p> |
|--|---|--|

## 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 tests were carried out in all three orthogonal axes in accordance with the customer specification. The test specimens were not operational during testing.

Due to an error in programming the long-term vibration test, the test specimens underwent an over test at 55.0361 m/s<sup>2</sup> RMS for 3 minutes and 54 seconds in the vertical axis, rather than the 5.72 m/s<sup>2</sup> requested. The error was caught and the programme corrected. The test was restarted and carried out with the defined levels for a further duration of 5 hours.

For all three axes, the test specimens were subjected to the vertical test level (highest level) per customer request, for the duration required by the test specification. The plots of the control spectra have been provided to show that the test requirements have been adhered to.

**End of Report**