



**Sebert Trillingstechniek B.V.**



Report: M25.001-P25.001 One Display Solution  
Date 14 November 2025



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## MIL-STD 810/AECTP 400 Random Vibration and Terminal Peak Sawtooth Shock Tests on a PSM-P86RV1

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**ISO/IEC 17025 Accredited\* and ISTA® Certified Testing Laboratory**

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**Order conformation**

One Display Solution Purchase Order Number ODS20250046

**Present at the tests**

Mr. S. W. van Tongeren of One Display Solution was partially present

**S2T Quotation**

Q25.001

**Certificate number**

C25.001-P25.001 One Display Solution

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**No of pages**

35



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## 1. Introduction

Under contract of One Display Solution at Bodegraven in The Netherlands, AECTP 400 random vibration and terminal saw tooth shock tests have been carried out on PSM-P86RV1 unit. The tests were carried out on 17 to 20 March 2025. All dynamic tests (for example impact and vibration tests) have been carried out under ISO 17025 accreditation and all static tests (for example the ambient test registrations) are not carried out under accreditation. The fixation of the test item to the test equipment has been made by securing the flat metal base of the shock damper base inside a transport frame directly onto the test surface. Transport wheels were removed to improve the transfer of test energy through the test item and create a worst case transportation scenario.

One Display Solution will carry out the final inspection after the complete test sequence. The purpose of the tests is to determine if the test item meets the mechanical stress requirements. In accordance with One Display Solution no acceptance criteria were defined and no preconditioning was carried out. The test results in this report will be related to the tested test item only.

## 2. Test procedure and equipment

### 2.1. General

One test item has been used for the tests, see Table 1 for the details of the test item. The test item which was delivered on 17 March 2025 was checked before starting the test for visual damage and no deviations were found.

Table 1: Test item #1


Product name*	PSM-P86RV1
Product number / SN*	PSM-P86RV1 / ODSPSM2025001
Monitor model / SN*	PHL-86BDL4511D / AU0A2351003926
Decoder model / SN*	VUWALL PAK40-3 / P-11002734
Actuators model / SN*	OKIN-MEGAMAT20MODIFIED / 10032025
Dimensions [LxWxH]	196 x 181 x 96 cm (including test frame)
Weight	264 kg (including test frame)
Figure	#1 #2

\*IFC (Information from Customer)

## 2.2. Test requirements and Test Plan


The following tables (Test A - D) present the test specifications. See Table 2 for the test plan.

Test A: Sea Random vibration test in all direction

Test standard	AECTP 400 (2019) method 401 – Material Transported by Sea
Normative document	MIL-STD 810H
Profile	
Fig. A-6 Frequency/amplitude Break points	
Cross motion	Is not required in specification and therefore will not be measured
Degrees of Freedom	≥ 120 DOF
No spectral lines	≥ 200 lines (or first frequency line is at 0,5 of $F_1$ )
Test duration	60 minutes ( $\approx$ 3 months sea). Total 3 hours ( $\approx$ 9 months sea)
Direction	X, Y and Z
Functional test	No
Control strategy	Multi point weighted average control (When a multi point strategy is not possible, a single control point shall be used)
Remark	This test will be carried out under accreditation

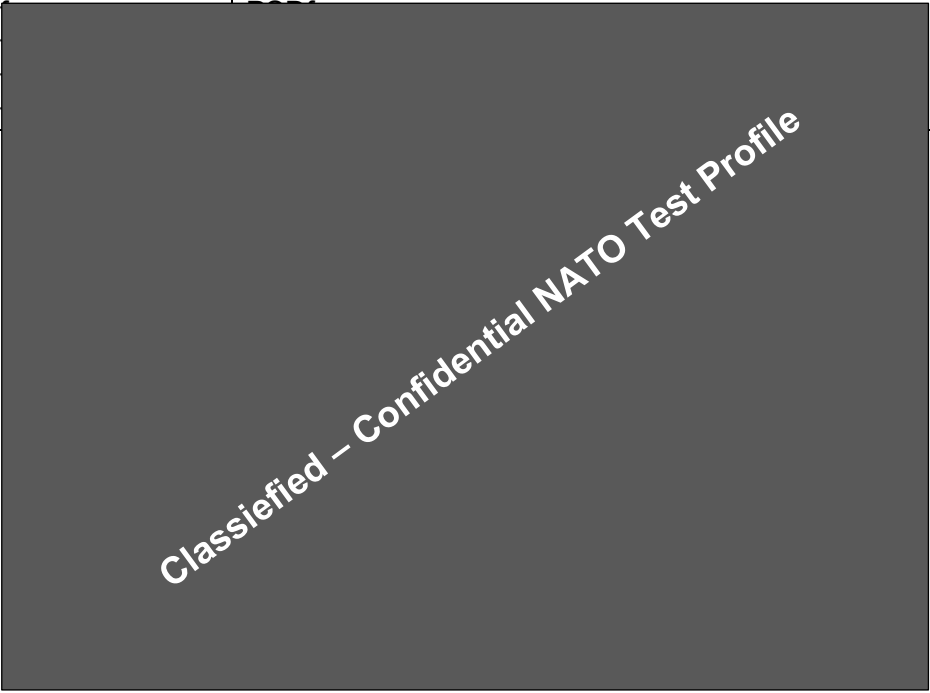
\*Max pitch and roll moment 19.500Nm and Max Yaw moment 250Nm

Test B: Rail Random vibration test in all direction

Test standard	AECTP 400 (2019) method 401 – Material Transported by Rail
Normative document	MIL-STD 810H
Profile	
Fig. A-5 Frequency/amplitude Break points	
Cross motion	Is not required in specification and therefore will not be measured
Degrees of Freedom	≥ 120 DOF
No spectral lines	≥ 200 lines (or first frequency line is at 0,5 of F <sub>1</sub> )
Test duration	60 minutes (≈ 10.000km). Total 3 hours (≈ 30.000km)
Direction	X, Y and Z
Functional test	No
Control strategy	Multi point weighted average control (When a multi point strategy is not possible, a single control point shall be used)
Remark	This test will be carried out under accreditation

\*Max pitch and roll moment 19.500Nm and Max Yaw moment 250Nm

Test C: Common carrier random vibration test (in all direction)

Test standard	AECTP 400 (2019) method 401 – Common Carrier
Normative document	MIL-STD 810H
Profile	
Fig. A-4 Frequency/amplitude Break points	
Cross motion	Is not required in specification and therefore will not be measured
Degrees of Freedom	≥ 120 DOF
No spectral lines	≥ 200 lines (or first frequency line is at 0,5 of F <sub>1</sub> )
Test duration	60 minutes (≈ 1600km). Total 3 hours (≈ 4800km)
Direction	X, Y and Z
Functional test	No
Control strategy	Multi point weighted average control (When a multi point strategy is not possible, a single control point shall be used)
Remark	This test will be carried out under accreditation

\*Max pitch and roll moment 19.500Nm and Max Yaw moment 250Nm

Test D: Transport Shock Test

Test standard	AECTP 400 (2019) method 403 – Shock – Procedure II – Transport Shock Test
Normative document	MIL-STD 810H
Pulse shape	Terminal Peak Sawtooth
Profile*	Classified – Confidential NATO Test Profile
Figure 3 Pulse Configuration and Tolerance Limits	
Pre/post- pulse height	Max 15%
Impact velocity	10 seconds per impact
Number of impacts	2x 66 impacts per direction (total 132 impacts)
Filter	Must be calculated
SRS	Yes
Direction	X+/-, Y+/- and Z+/-
Functional test	No
Control strategy	Multi point weighted average control (When a multi point strategy is not possible, a single control point shall be used)
Remark	This test will be carried out under accreditation

\*Max pitch and roll moment 19.500Nm and Max Yaw moment 250Nm


Table 2: Test plan

Step	Test	Direction
1	A	Horizontal transversal (X)
2	B	Horizontal transversal (X)
3	A	Vertical (Z)
4	B	Vertical (Z)
5	C	Vertical (Z)
6	D	Vertical (Z) +/-
7	A	Horizontal longitudinal (Y)
8	B	Horizontal longitudinal (Y)
9	C	Horizontal longitudinal (Y)
10	D	Horizontal longitudinal (Y) +/-
11	C	Horizontal transversal (X)
12	D	Horizontal transversal (X) +/-

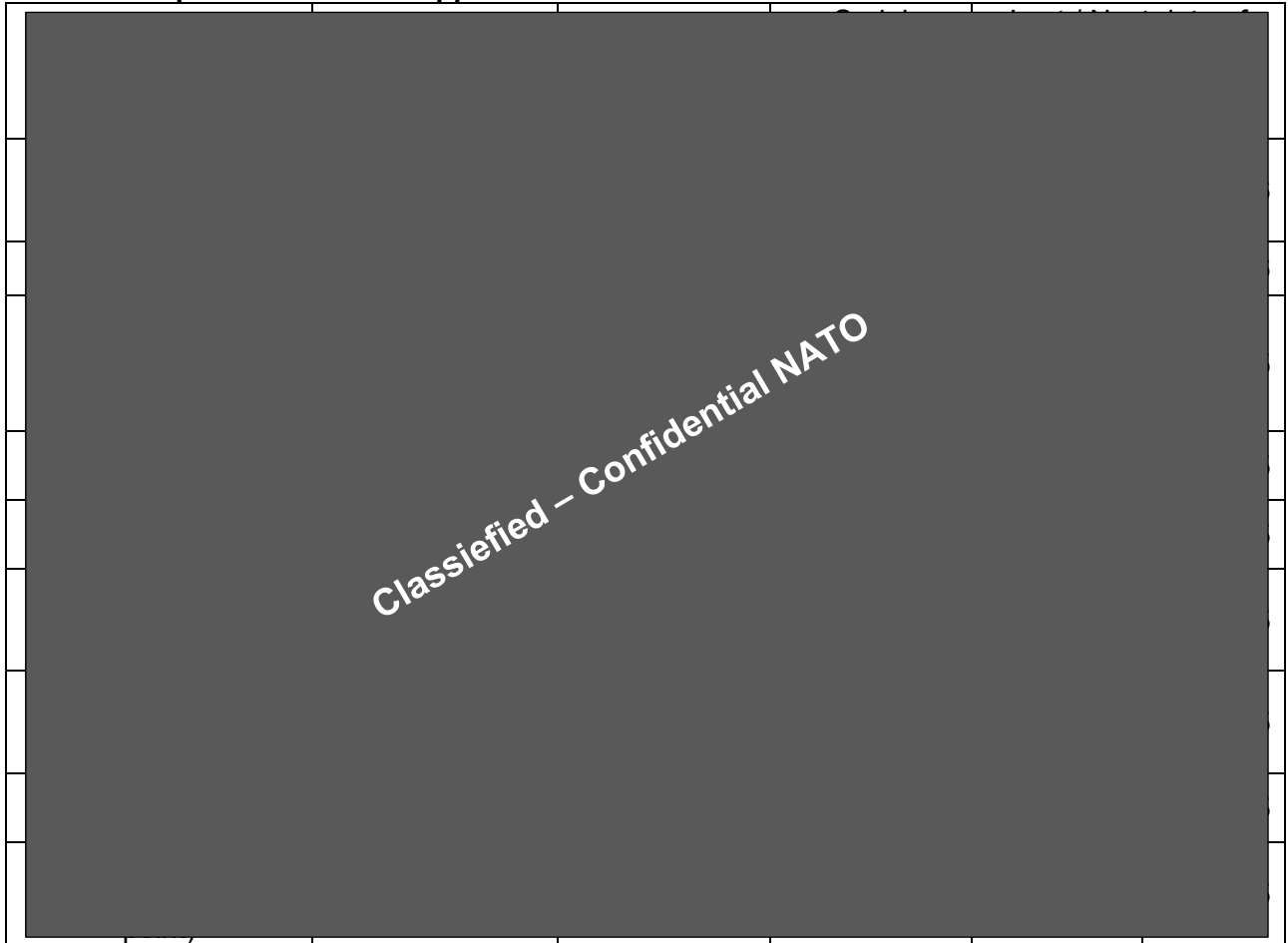
**2.3. Mounting and orientation of the test item**

For tests A to D, the test item was fixed to the test surface by clamping the flat metal base of the shock damper base inside a transport frame directly onto the test surface. Transport wheels were removed to improve the transfer of test energy through the test item and create a worst case transportation scenario. The test item was mounted on the vibration table in the normal orientation with respect to the vertical. The tests were carried out in three mutually perpendicular directions, see Figure #3 for the vertical (Z) direction, see Figure #4 for the horizontal transversal (X) direction and see Figure #5 for the horizontal longitudinal (Y) direction.

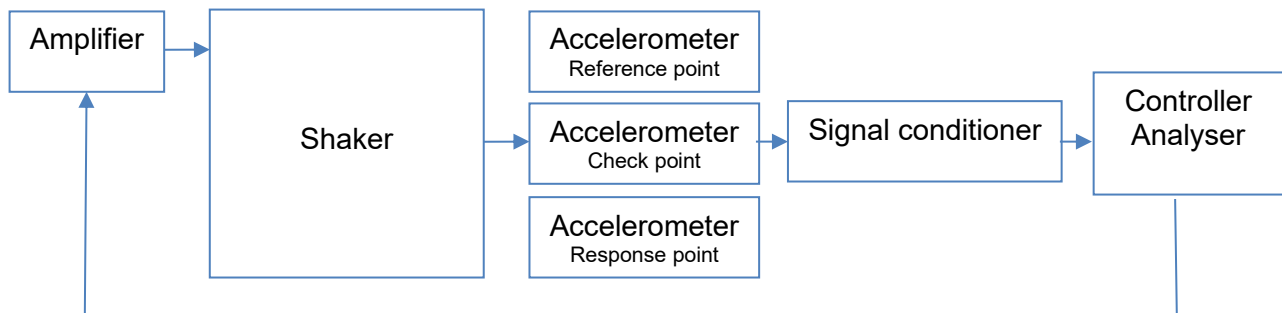




## 2.4. Description of the used apparatus and instrumentation



## 2.5. Sketch of the test A - D configuration



## 2.6. Measurement uncertainty and tolerances

All the measurements were carried out with a signal tolerance includes instrumentation errors lower than 5% according to the standards. The combined standard uncertainty and the expanded uncertainty ( $k=2$ )  $U$  is lower than 10% according. Measurement Uncertainty Calculator form version 25.7. For lower vibration frequency ( $>1 <10\text{Hz}$ ), large size and high mass the signal tolerance is lower than 10%. Temperature and relative humidity are not operational factors.



### 3. Random vibration and terminal peak sawtooth shock tests

#### 3.1. General

The vibration and shock tests were carried out in three mutually perpendicular directions on a shaker.

##### 3.1.1. Test A to C: Random vibration test setup

The vibration tolerance bands at the reference point is within  $\pm 3\text{dB}$ . The initial slope is less than  $+6\text{dB/octave}$  and the final slope is  $-24\text{dB/octave}$ . The used frequency range of the measuring system is 0,5 times the low frequency and 2 times the highest frequency. The frequency response is flat within  $\pm 5\%$  over the test frequency range. The cross-axis motion and the vibration response (investigation) measurements were not carried out. See Table 3 for the used vibration parameters.

Table 3: Random vibration control parameters

S	
C	
M	
M	
M	
L	
L	
A	
D	
S	
D	
F	
S	
D	
C	
C	

Classified – Confidential NATO Test Profile

##### 3.1.2. Test D: Shock test setup

The used peak acceleration tolerance is 0,8 and 1,2 times for the half-sine shock test. The effects of gravity will be considered when considering the altitude of the test. The minimum monitored pulse time for the produced shocks is 6x duration of the nominal pulse. The positive and/or negative peak acceleration at the check point(s), perpendicular to the intended shock direction, does not exceed 30 % of the value of the peak acceleration of the nominal pulse in the intended direction. See Table 5 for the used shock parameters.

Table 4: Shock control parameters

Classified – Confidential NATO Test Profile	
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**3.1.3. Accelerometers location and orientation**

See Table 5 for the location and orientation of the used accelerometers during the tests.

Table 5: Used accelerometers

Test item	Direction		Figure
1	XYZ	Classified – Confidential NATO	#3 - #5
1	XYZ		#3 - #5
1	XYZ		#3 - #5
1	XYZ		#3 - #5



## 3.2. Test Results

### 3.2.1. Test A: Random vibration test result (Sea)

One test item has been used for the random vibration test which was carried out in the three mutually perpendicular directions, see Table 6 for the result summary. See Figure #6 for a typical vibration plot and Figure #7 to #9 for the transmissibility measurements of accelerometer response channels 3 and 4. The natural frequency ( $F_n$ ) of the test item was identified at 8-9Hz, damping started to occur at 12Hz. No visual damage or functional errors were found on the test item after the complete test sequence.

Table 6: Random vibration test result summary

Test item	Direction	Test time [min]	Remarks*
1	Horizontal transversal (X)	60	Pass
1	Vertical (Z)	60	Pass
1	Horizontal longitudinal (Y)	60	Pass

\*Pass and fail remarks refer only to the ability of the test item to complete the test sequence.

### 3.2.2. Test B: Random vibration test result (Rail)

One test item has been used for the random vibration test which was carried out in the three mutually perpendicular directions, see Table 7 for the result summary. See Figure #10 for a typical vibration plot. See Figure #11 to #13 for the transmissibility measurements of accelerometer response channels 3 and 4. The natural frequency ( $F_n$ ) of the test item was identified at 7Hz, damping started to occur at 10Hz. No visual damage or functional errors were found on the test item after the complete test sequence.

Table 7: Random vibration test result summary

Test item	Direction	Test time [min]	Remarks*
1	Horizontal transversal (X)	60	Pass
1	Vertical (Z)	60	Pass
1	Horizontal longitudinal (Y)	60	Pass

\*Pass and fail remarks refer only to the ability of the test item to complete the test sequence.

### 3.2.3. Test C: Random vibration test result (Common carrier)

One test item has been used for the random vibration test which was carried out in the three mutually perpendicular directions, see Table 8 for the result summary. See Figure #14 for a typical vibration plot, see Figure #15 to #17 for the transmissibility measurements of accelerometer response channels 3 and 4. The natural frequency ( $F_n$ ) of the test item was identified at 6Hz, damping started to at 8,5Hz. No visual damage or functional errors were found on the test item after the complete test sequence.



Table 9B: Shock test result summary horizontal longitudinal (Y) direction

Test item		Remarks*
1	Classified – Confidential NATO	Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass

\*Pass and fail remarks refer only to the ability of the test item to complete the test sequence.

Table 9C: Shock test result summary horizontal longitudinal (Y) direction

Test item		Remarks*
1	Classified – Confidential NATO	Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass
1		Pass

\*Pass and fail remarks refer only to the ability of the test item to complete the test sequence.



### 3.3. Final inspection

After the complete test sequence, a visual inspection has been carried out on the test item. See Table 10 for the inspection results.

Table 10: Visual inspection results

Test item	Results and/or remarks	Figure
#1	After all testing had been completed, the display was able to be powered on without error. The display was also able to be raised and lowered by the motorized extendable feet without error.	#25 #29

One Display Solution will carry out the final inspection and report the results after the completed test sequence.

### 3.4. Laboratory ambient (during test)

See Figure #30 for the environmental measurements during the test sequence.

#### 4. Conclusion and remarks

One test item has been subjected to vibration and shock tests according to the normative documents:

- **Department of Defense Test Method Standard - Environmental Engineering Considerations and Laboratory Tests – MIL-STD-810H: 2019**
  - NATO Standard AECTP-400 Mechanical Environment Tests Edition D Version 1 November 2019 - method 401. (Vibration)
  - NATO Standard AECTP-400 Mechanical Environment Tests Edition D Version 1 November 2019 - method 403. (Shock)

See the following table for the summary of the test results:

Test A: Random vibration test Material Transported by Sea	During the random vibration test, the test item was not functional. No visual damage or functional errors were found on the test item after the complete test. <b>This result validates the test items ability to endure sea transportation of 9 months</b>
Test B: Random vibration test Material Transported by Rail	During the random vibration test, the test item was not functional. No visual damage or functional errors were found on the test item after the complete test. <b>This result validates the test items ability to endure rail transportation of 30.000km</b>
Test C: Random vibration test Common carrier	During the random vibration test, the test item was not functional. No visual damage or functional errors were found on the test item after the complete test. <b>This result validates the test items ability to endure transportation by wheeled vehicles predominantly on improved roads by common carrier for 4800km</b>
Test D: Terminal peak sawtooth shock test	During the shock test, the test item was not functional. No visual damage or functional errors were found on the test item after the complete test. <b>This result validates the test items ability to endure the shocks encountered during transportation by road over 5000km and by off-road over 1000km</b>

One Display Solution will carry out the final inspection on the test item after the completed test sequence.

Approved by  
M.J.H. Magendans

Testing carried out by  
R. Morris



Director • Test Specialist

Test Lab Manager



## Figures

Figure 1: Test item

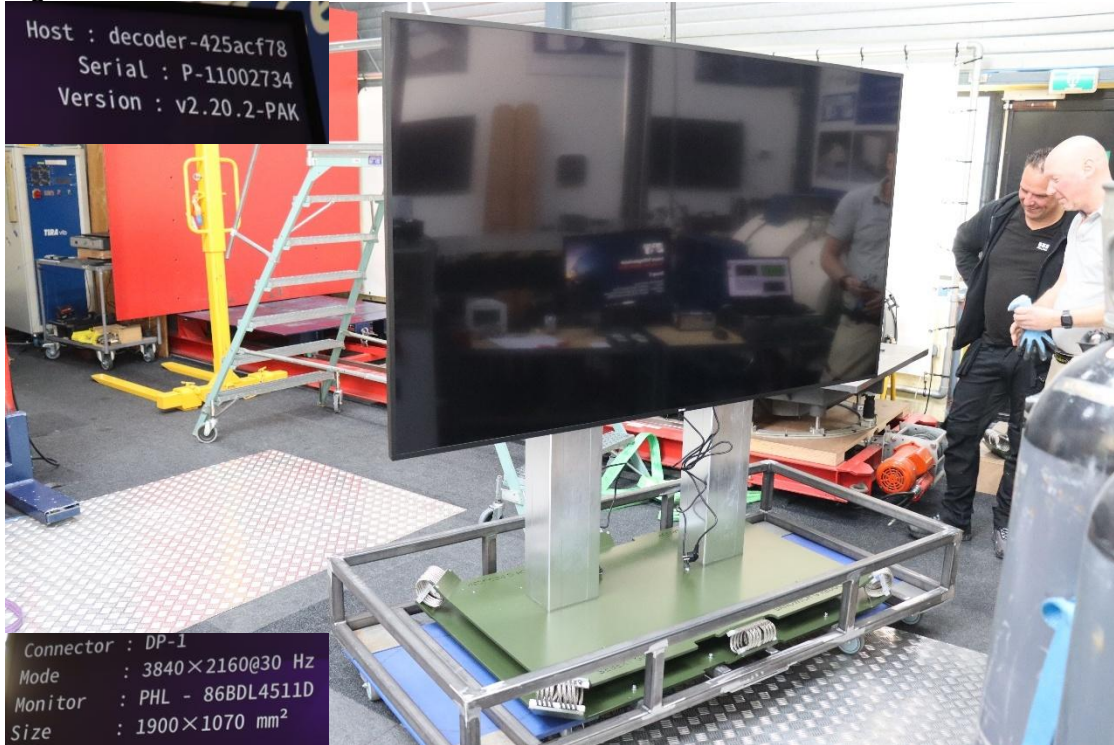


Figure 2: Test item

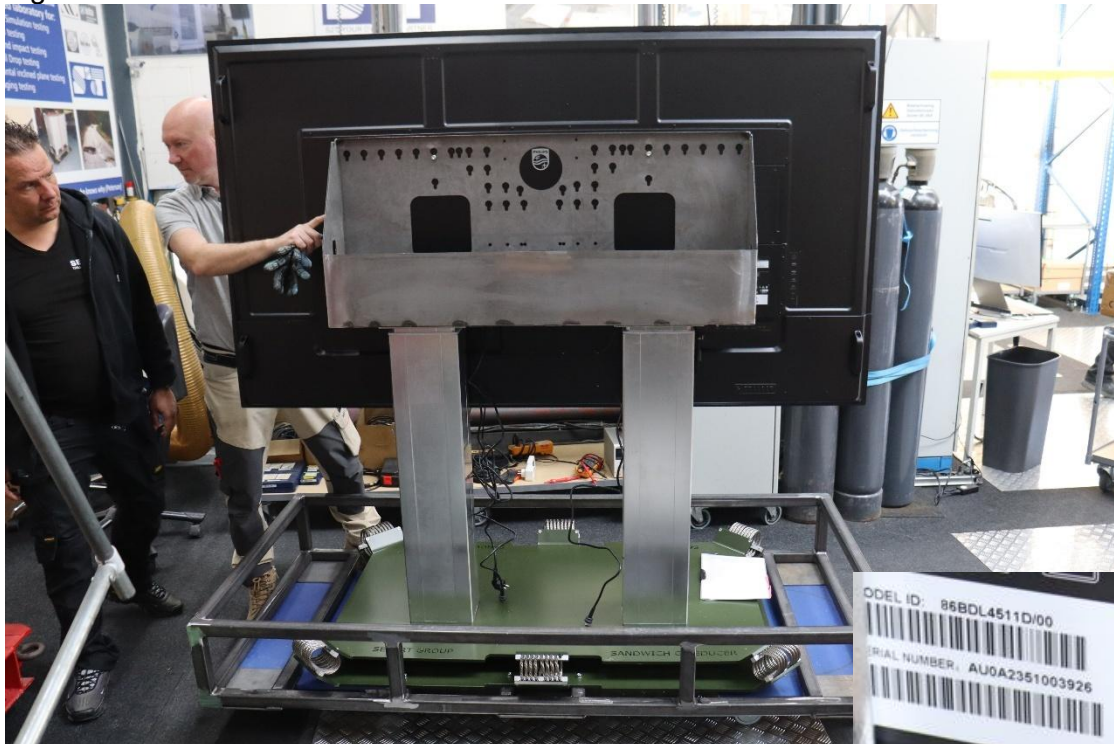


Figure 3: Test direction vertical (Z) and accelerometer location

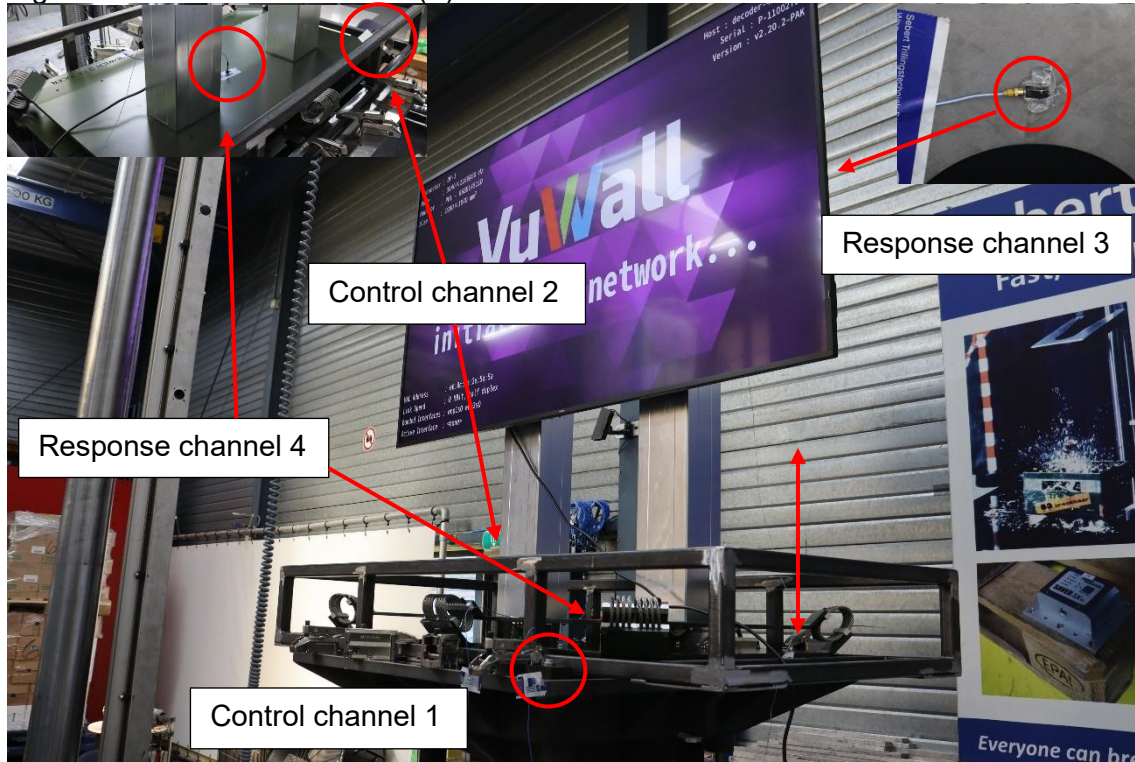


Figure 4: Test direction horizontal transversal (X) and accelerometer location

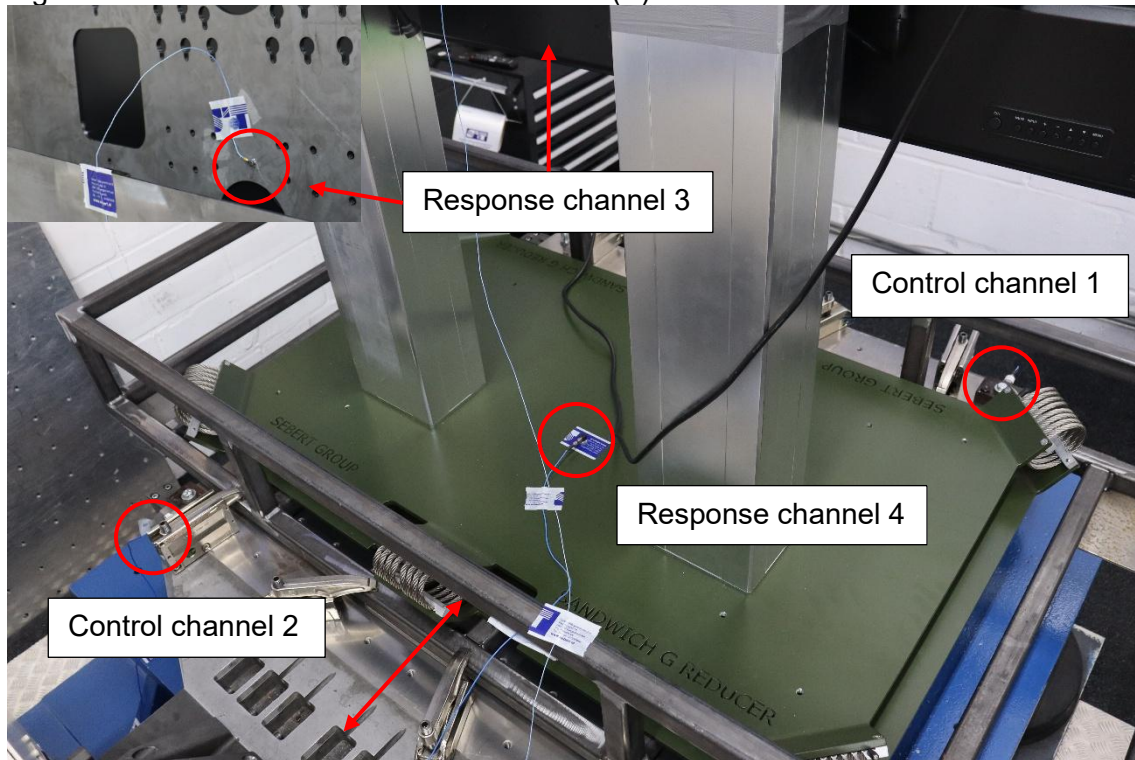


Figure 5: Test direction horizontal longitudinal (Y) and accelerometer location

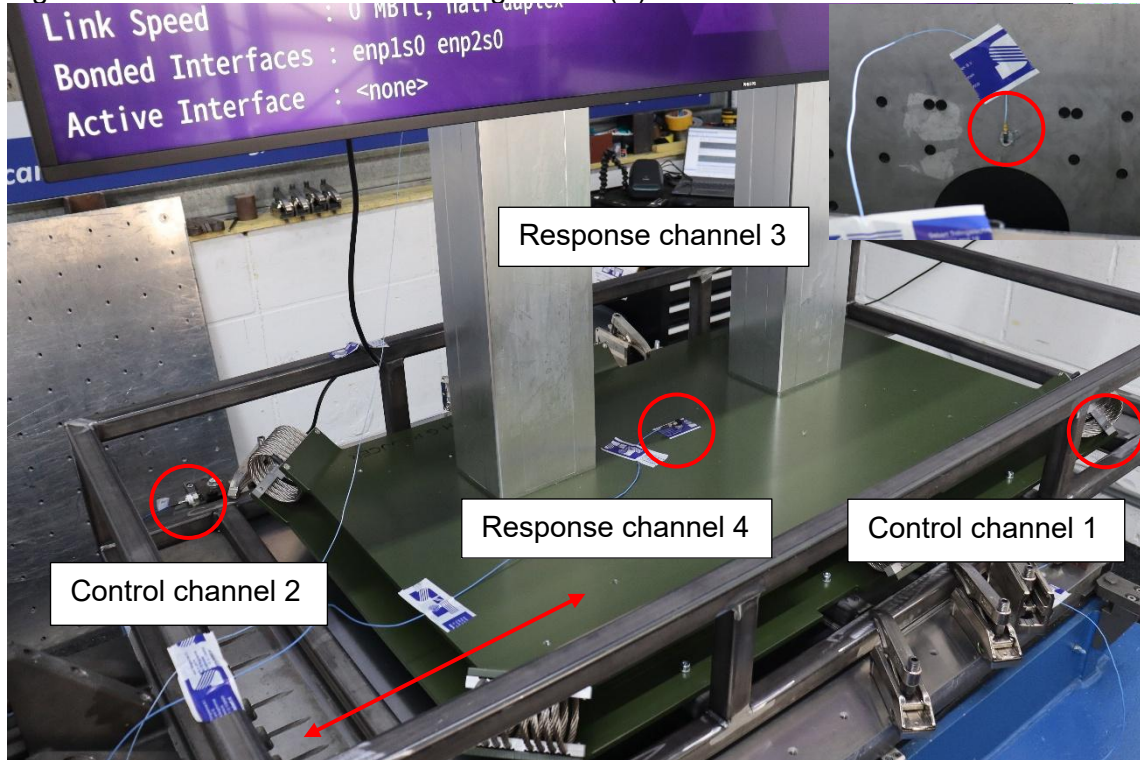
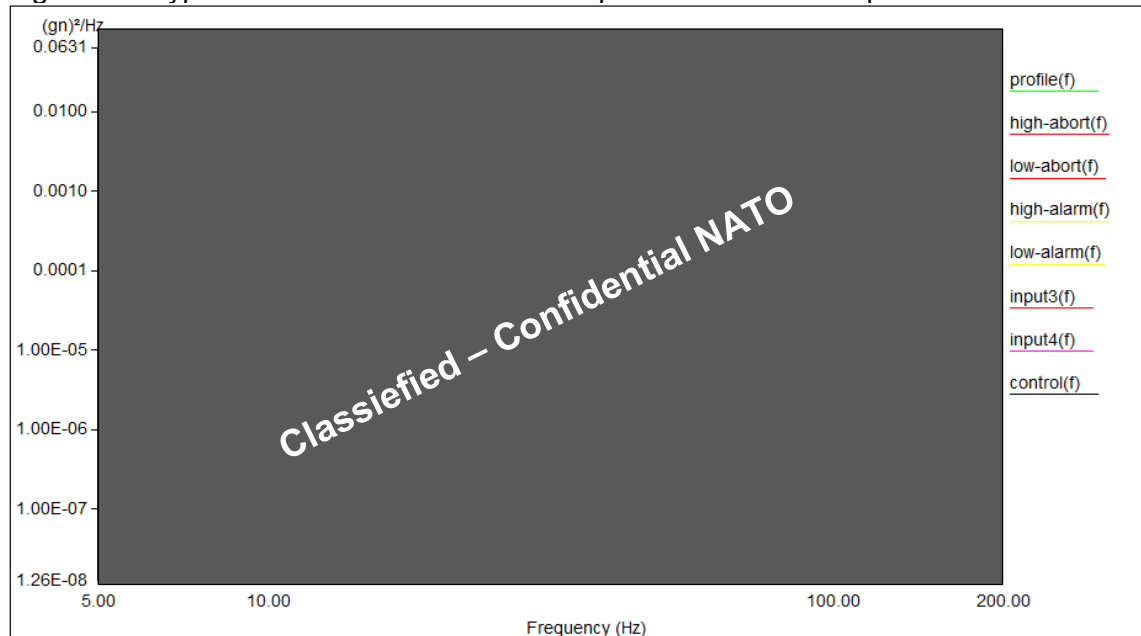


Figure 6: A typical random vibration sea transport simulation PSD plot



Level: 100 %  
 Control RMS: 0.275869 gn Full Level Elapsed Time: 01:00:03 Lines: 400 Frame Time: 1.600000 Seconds  
 Demand RMS: 0.276148 gn Remaining Time: 00:00:00 DOF: 154 dF: 0.625000 Hz

Figure 7: Test A Sea - Transmissibility measurement, input 3 and 4 transversal X

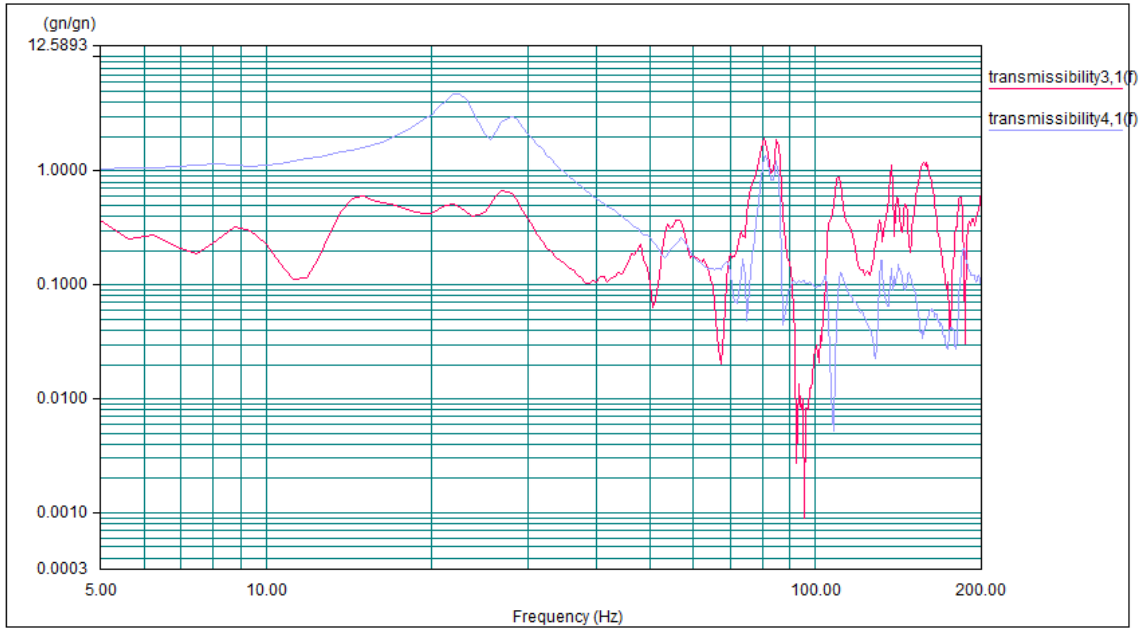


Figure 8: Test A Sea - Transmissibility measurement, input 3 and 4 vertical Z

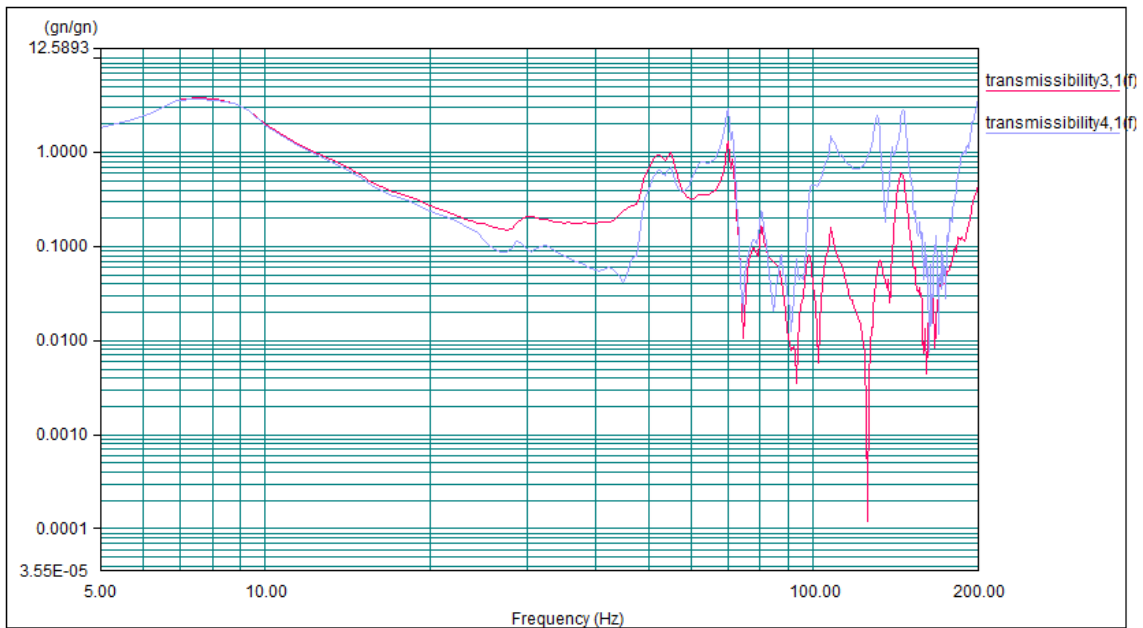


Figure 9: Test A Sea - Transmissibility measurement, input 3 and 4 longitudinal Y

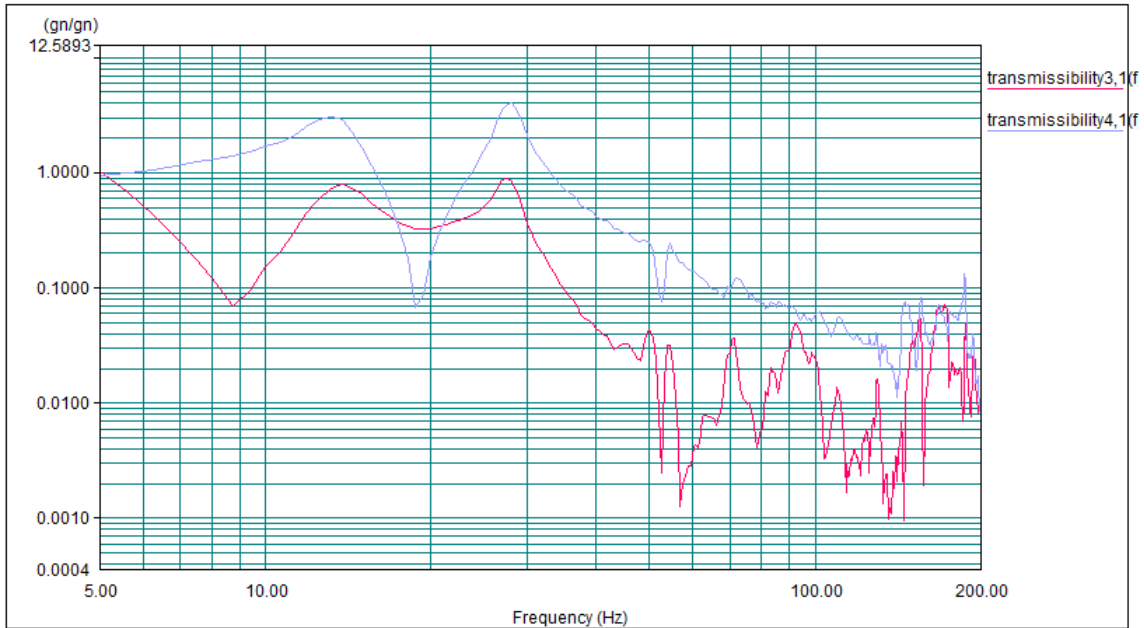
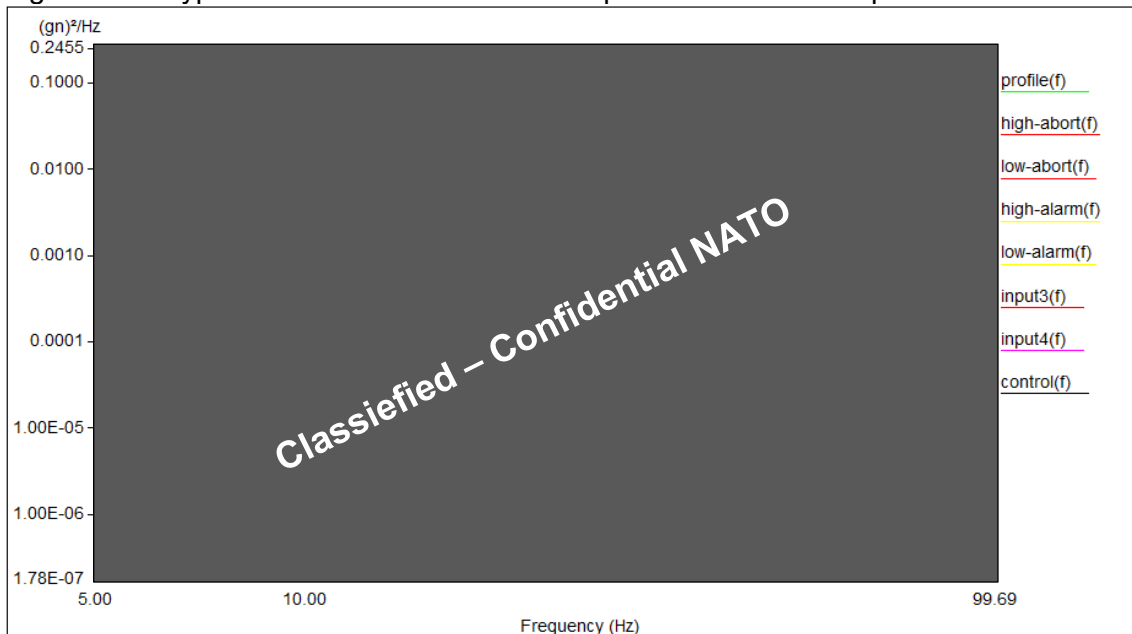


Figure 10: A typical random vibration rail transport simulation PSD plot



Level: 100 %  
 Control RMS: 0.689777 gn Full Level Elapsed Time: 01:00:03 Lines: 800 Frame Time: 3.200000 Seconds  
 Demand RMS: 0.689019 gn Remaining Time: 00:00:00 DOF: 154 dF: 0.312500 Hz

Figure 11: Test B Rail - Transmissibility measurement, input 3 and 4 transversal X

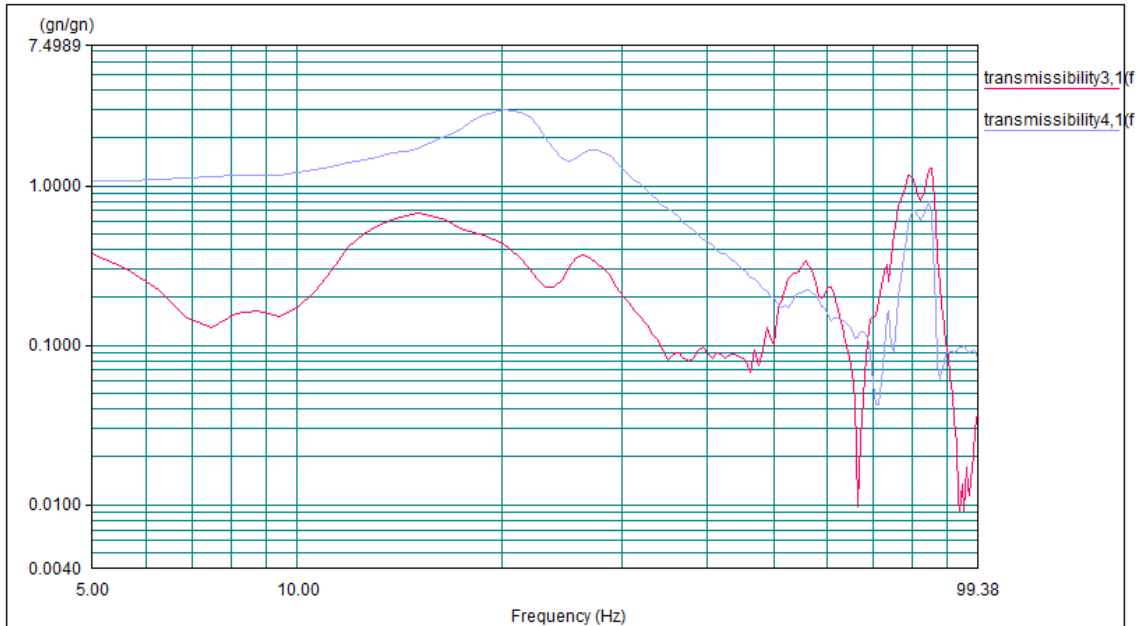


Figure 12: Test B Rail - Transmissibility measurement, input 3 and 4 vertical Z

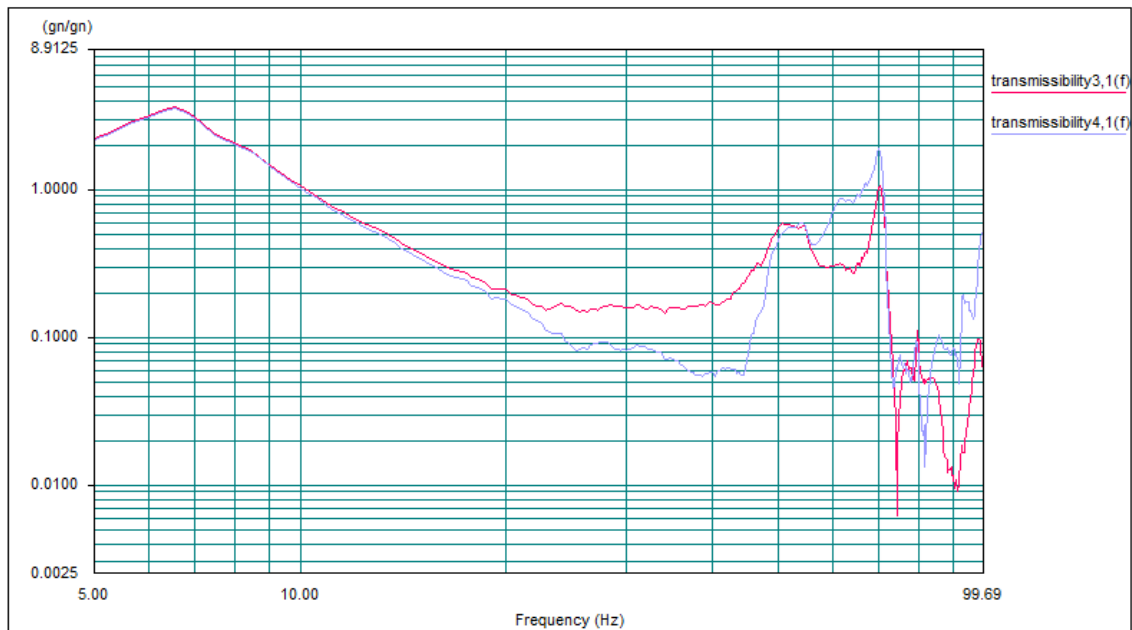




Figure 13: Test B Rail - Transmissibility measurement, input 3 and 4 longitudinal Y

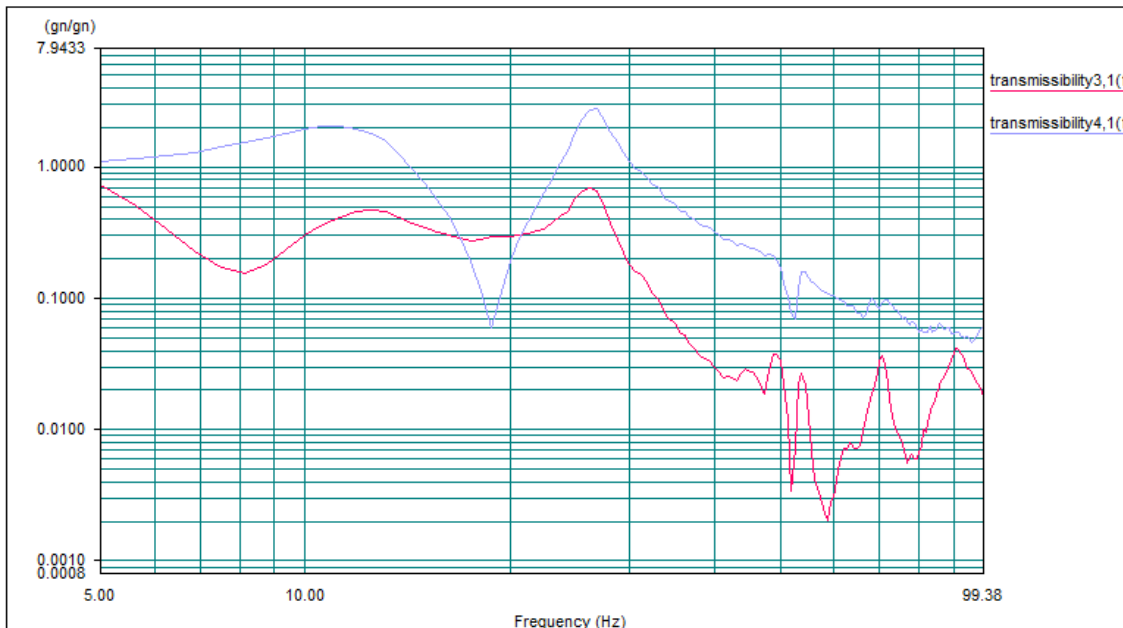
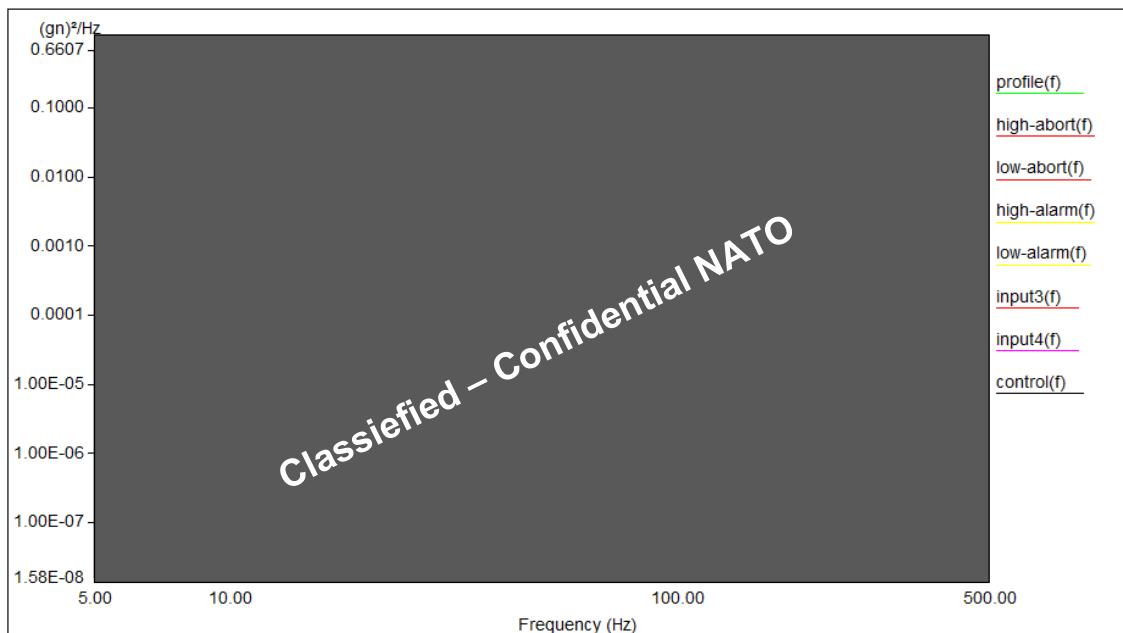


Figure 14: A typical random vibration common carrier transport simulation PSD plot



Level: 100 %  
 Control RMS: 1.168720 gn Full Level Elapsed Time: 01:00:03 Lines: 800 Frame Time: 1.600000 Seconds  
 Demand RMS: 1.162590 gn Remaining Time: 00:00:00 DOF: 154 dF: 0.625000 Hz



Figure 15: Test C - C.Carrier Transmissibility measurement, input 3 and 4 vertical Z

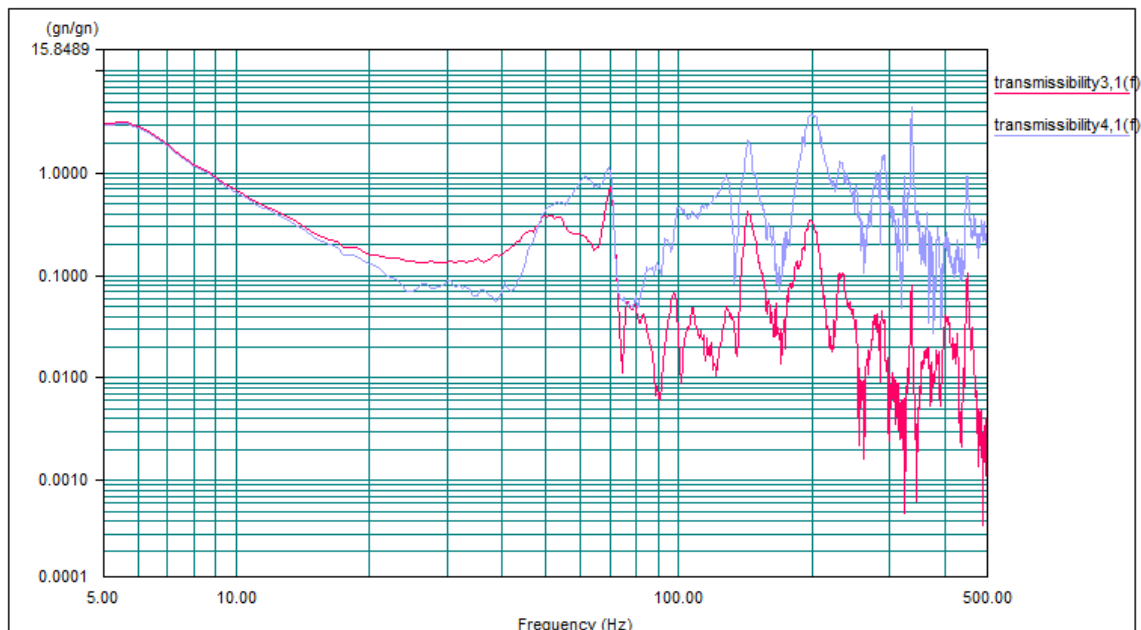


Figure 16: Test C - C.Carrier Transmissibility measurement, input 3 and 4 longitudinal Y

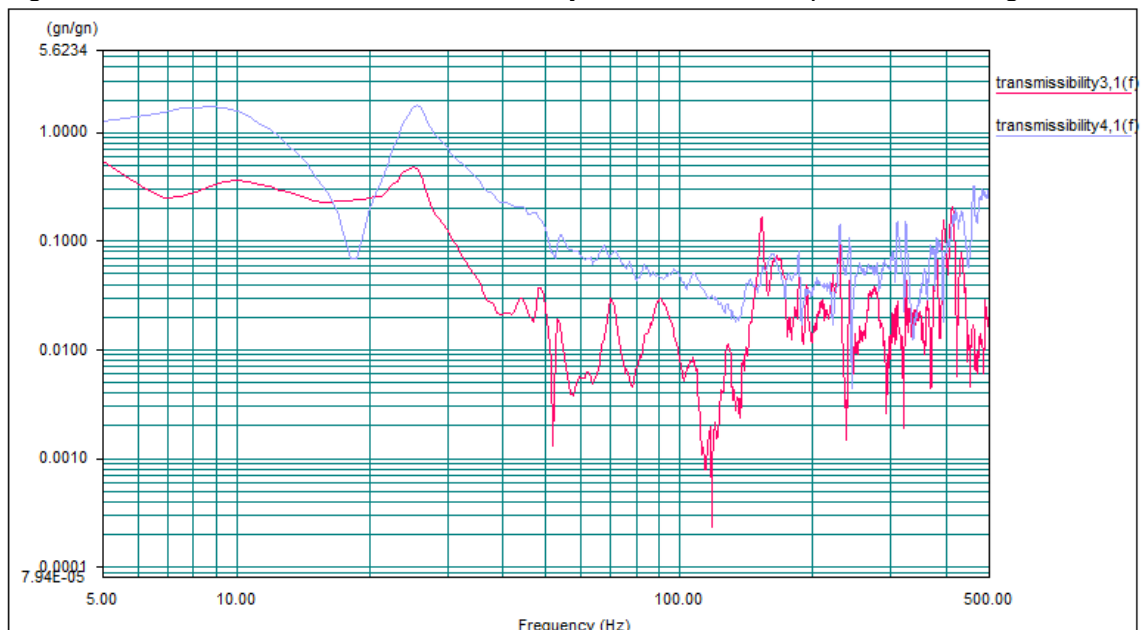




Figure 17: Test C - C.Carrier Transmissibility measurement, input 3 and 4 transversal X

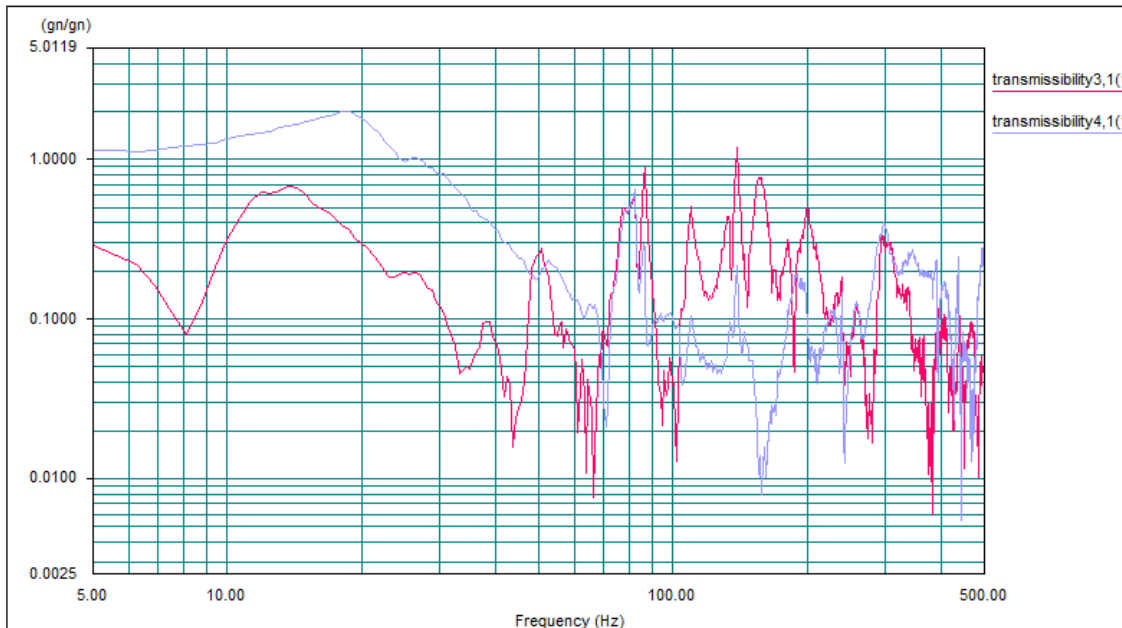


Figure 18: A typical terminal saw tooth shock plot

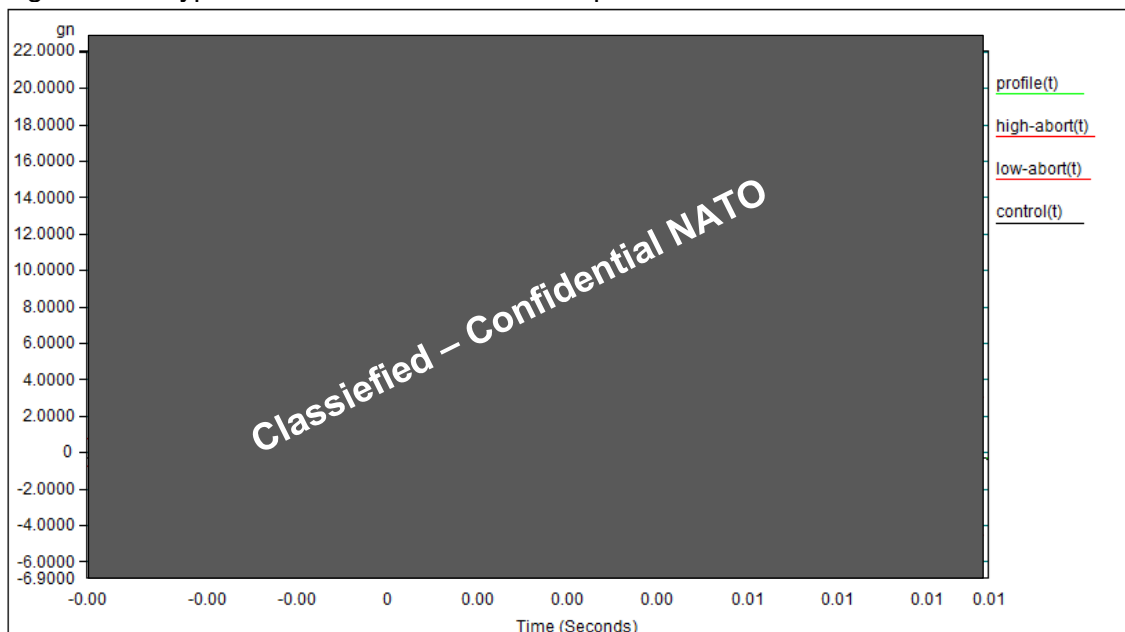




Figure 19:



Figure 20:

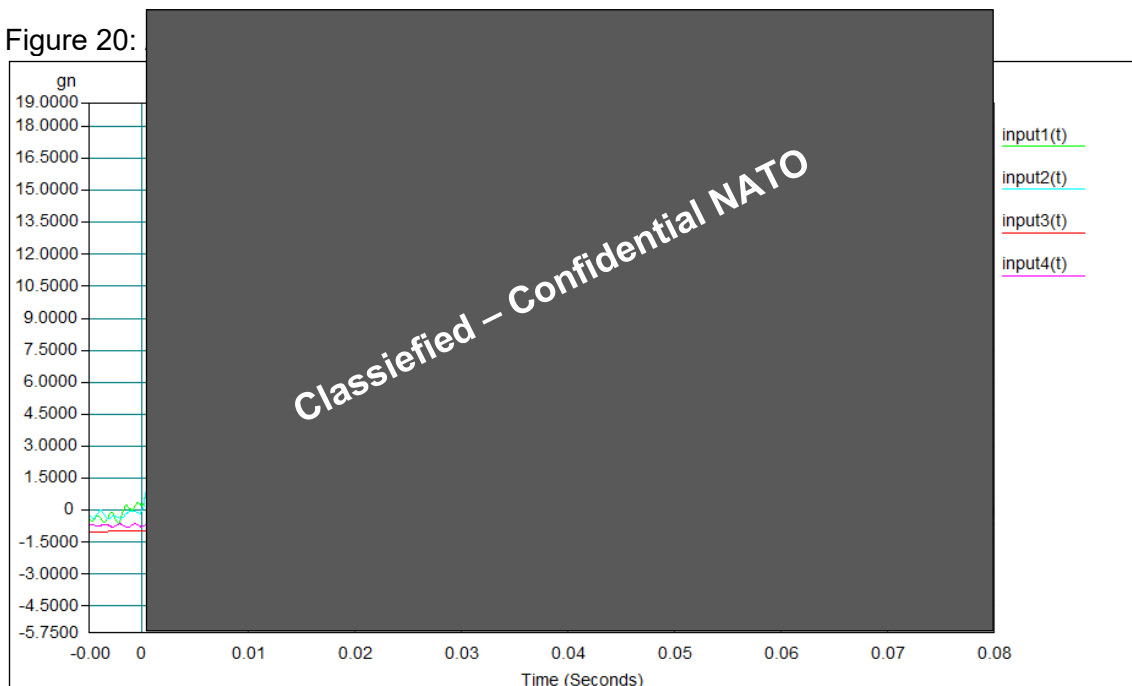




Figure 21:

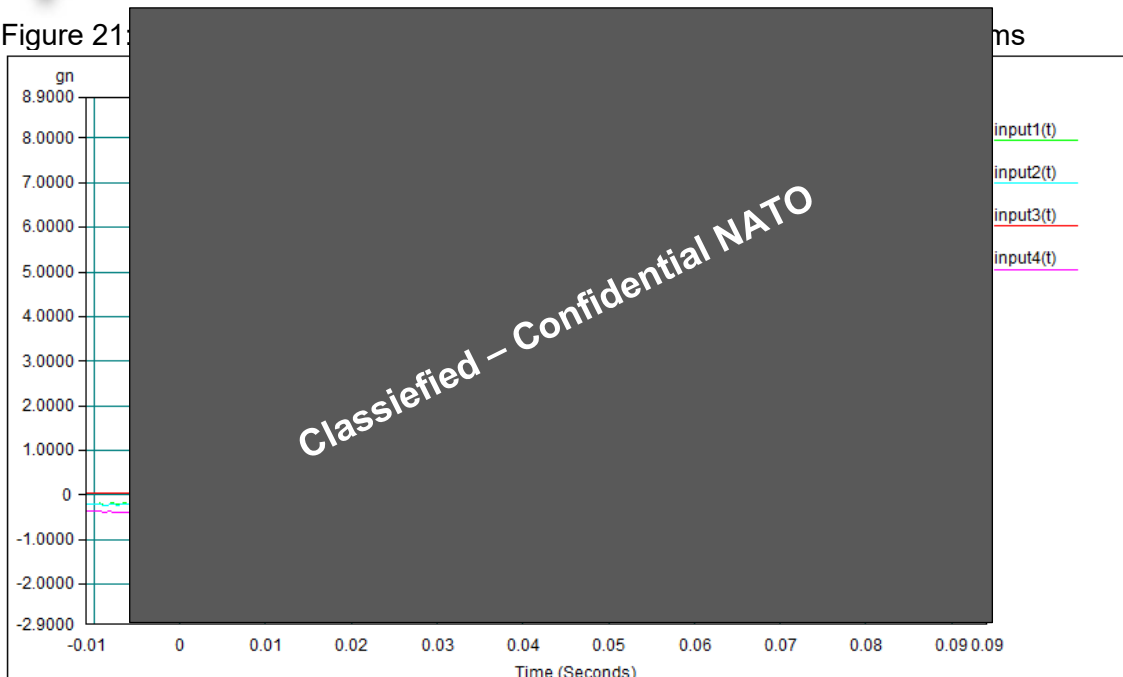


Figure 22:

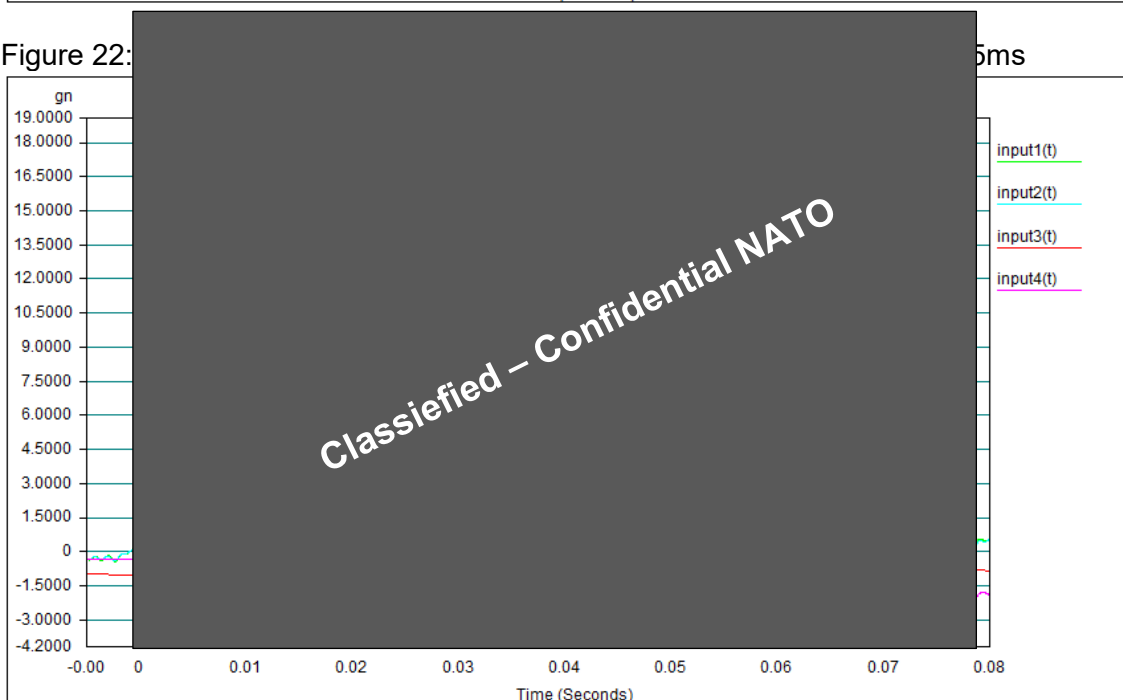


Figure 23:

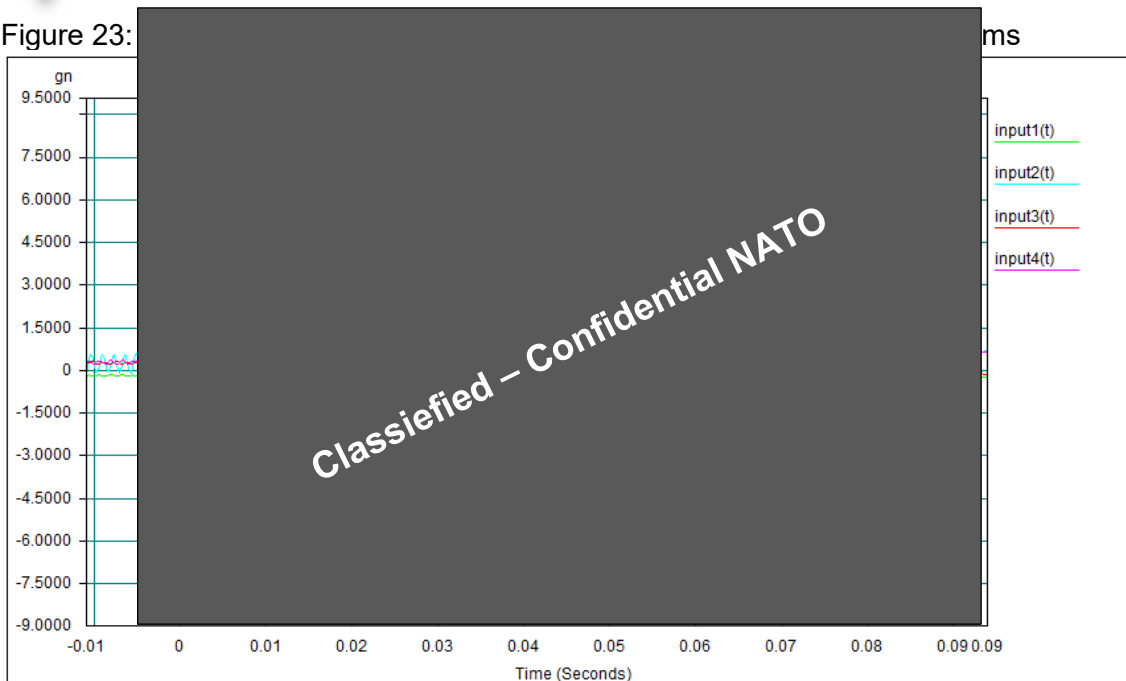


Figure 24:

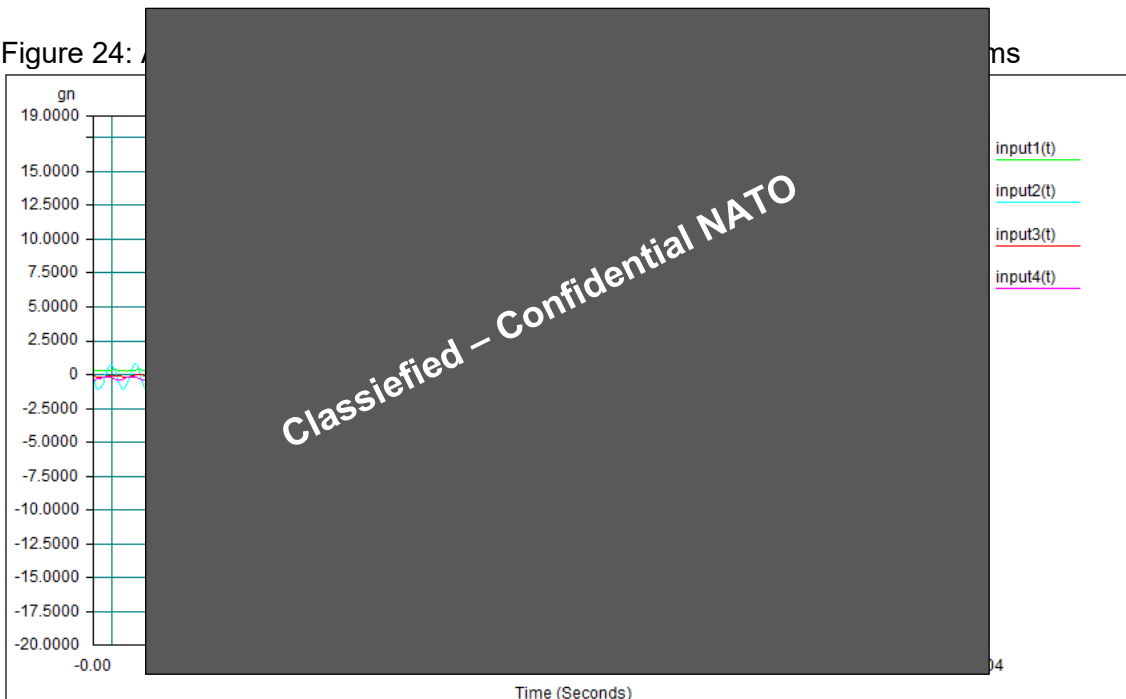


Figure 25: Final inspection



Figure 26: Final inspection






Figure 27: Final inspection

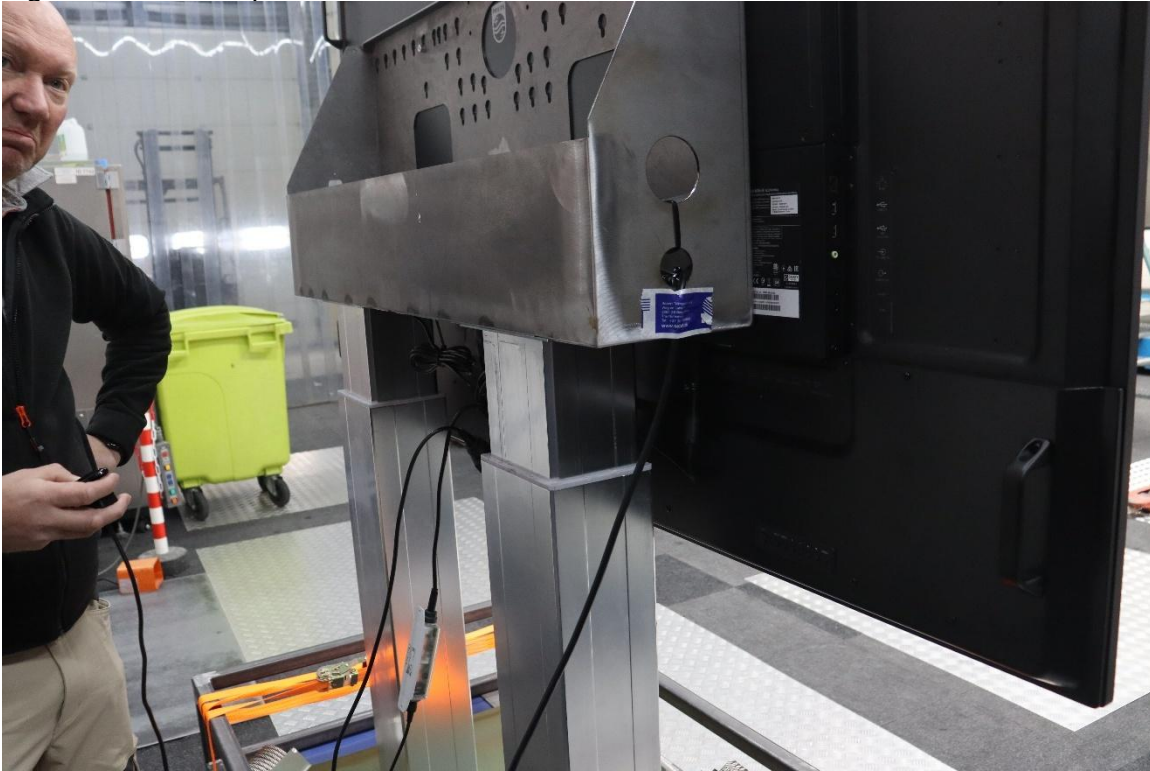


Figure 28: Final inspection

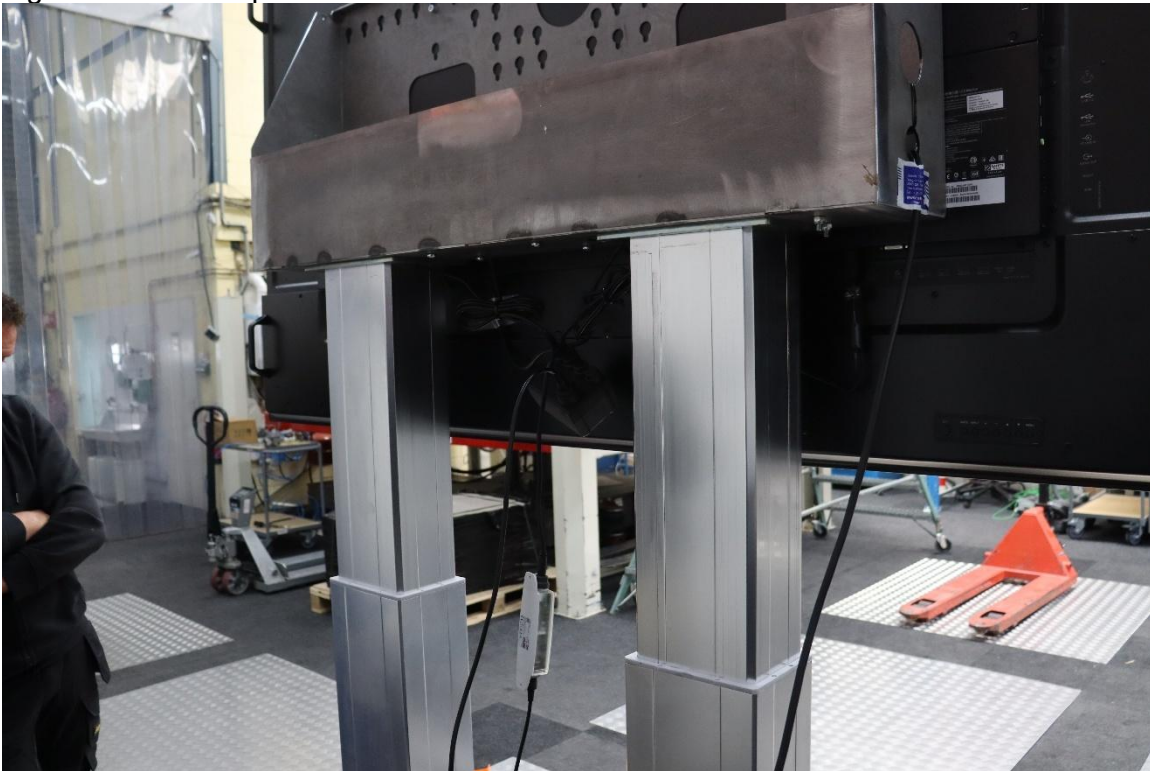


Figure 29: Final inspection

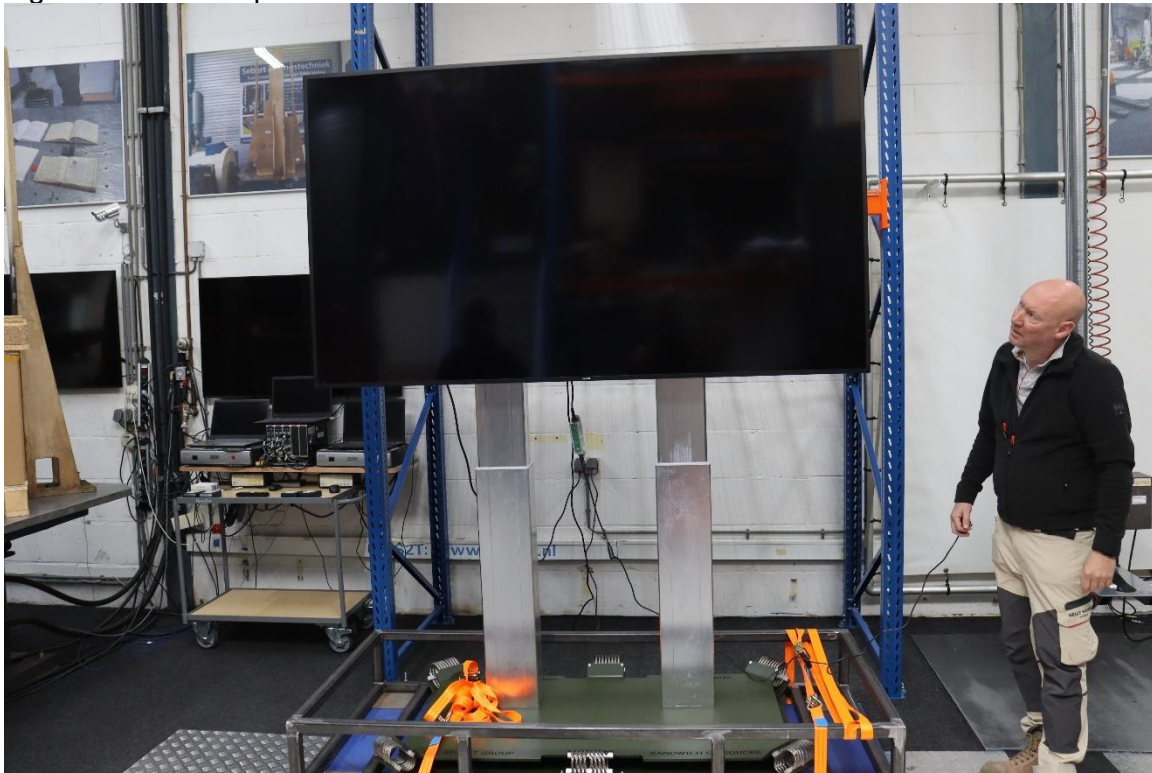
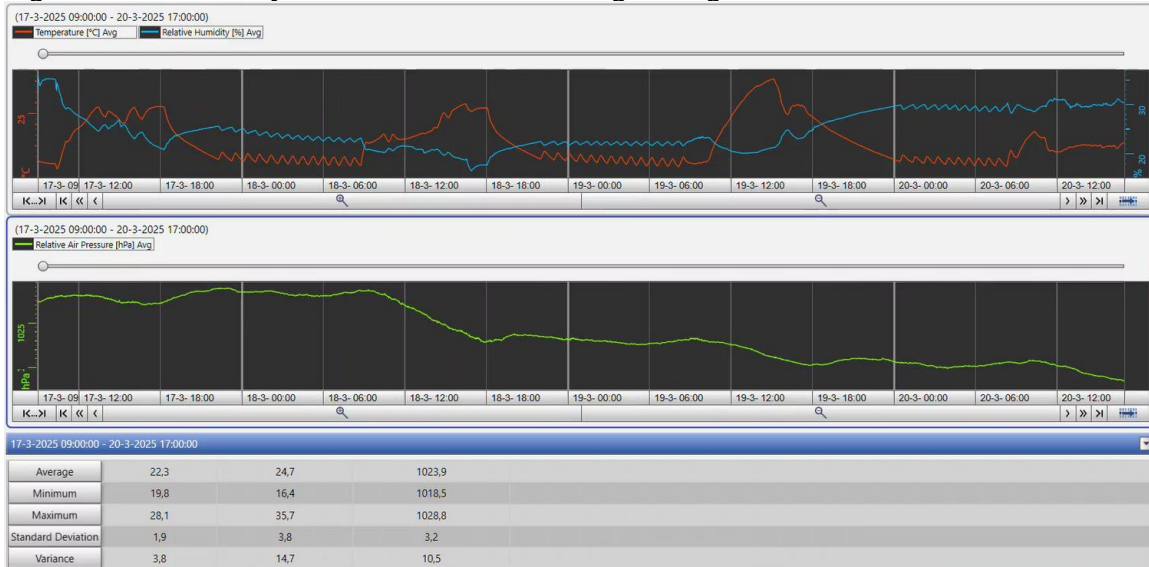


Figure 30: Laboratory ambient conditions during testing



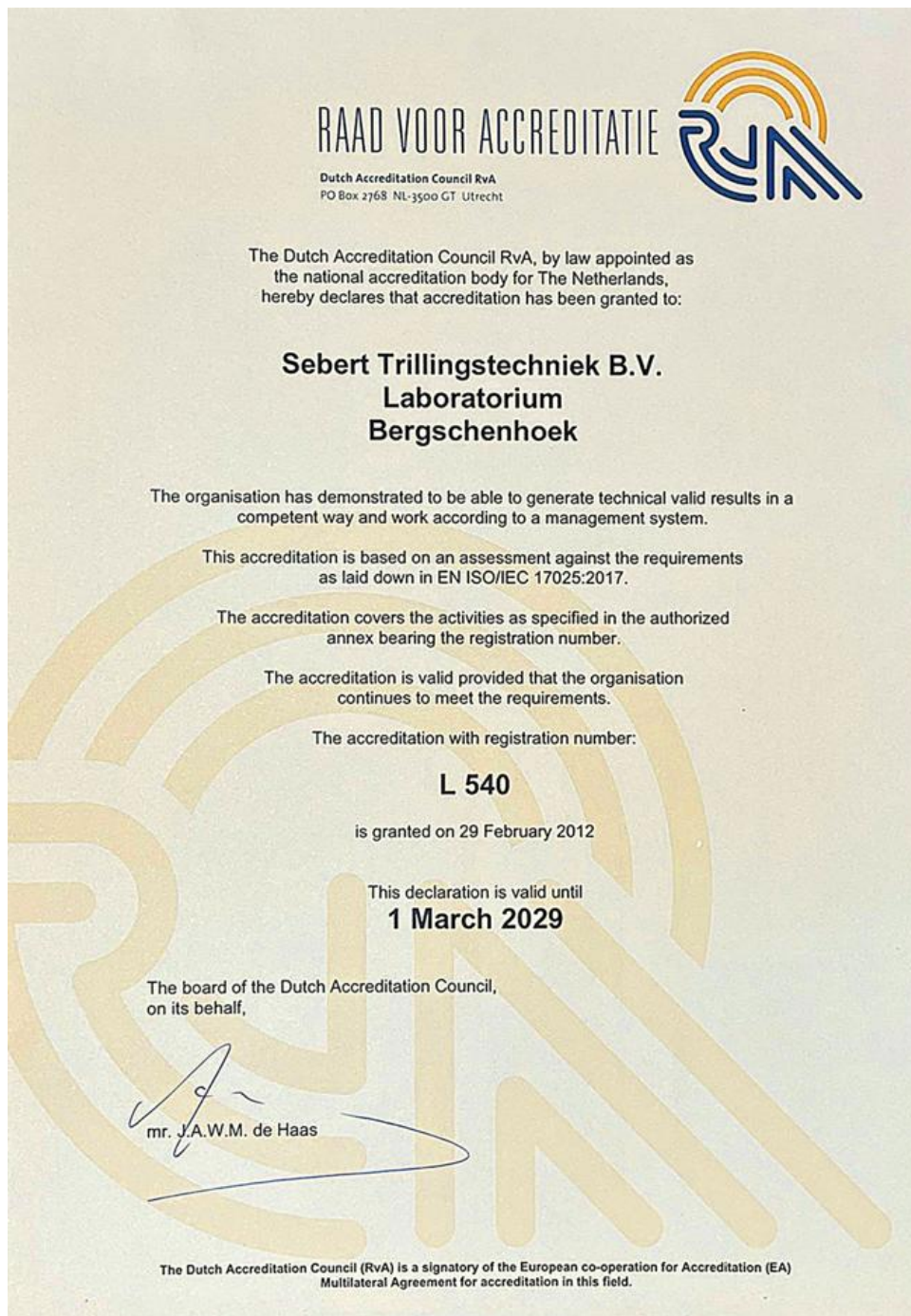


## Abbreviations

Acc	Acceleration
ASD	Acceleration Spectral Density
AvC	Average Control
dB	decibel
DOF	Degrees of Freedom
Drive	Voltage output of the controller used to drive the shaker
DUT	Device under test
Dwell	Endurance test on 'fixed' frequency
Fail	Criteria if the DUT is tested outside the described TS of the normative doc
Fn	Natural frequency
g	Acceleration due to gravity (equal to 9,81 m/s <sup>2</sup> )
Hz	Hertz
IFC	Information from customer
kg	Kilogram
Manuf	Manufacturer
ms	Milliseconds, nominal duration
N	Newton (force)
Oct/min.	Sweep rate
Oper	Operational
Pa	Pressure
Pass	Criteria if the DUT is tested as described in the TS of the required normative doc
PK	Peak
PK-PK	Peak to Peak
PSD	Power Spectral Density
Q	Quality, Sharpness measure of a resonance
Res	Resonance
RS	Resonance Survey
RMS	Root Mean Square
Seq	Sequence
S/N	Serial Number
SRS	Shock Response Spectrum
Sweep	One sweep up or down
TS	Test Specification
V	Voltage



## ISO/IEC 17025 accreditation certificate



ILAC stands for International Laboratory Accreditation Cooperation. The European Union (EU) has entered into mutual recognition agreements (MRAs) with various countries. This means that the countries have to accept each other's products. The technical aspect of the ISO/IEC 17025 standard relates to the use of qualified and experienced staff. All test equipment in our Sebert Trillingstechniek laboratory has been calibrated and checked in accordance with the ISO/IEC 17025 standard. This ensures that the tests, obtained in an independent, professional and objective manner, are extremely reliable

## ISO/IEC 17025 Accredited and ISTA® Certified Testing Laboratory

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