

# Test Report


Customer Atlantechs Limited


Tests ECE R14 – SBA Pull Tests  
ECE R17 – Energy Dissipation Impact  
Seat Strength Test

Vehicle Land Rover Discovery Vehicle Body

Millbrook Report No. 18/1089

Millbrook Project No. CR0369-001-05

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Senior Engineer

Date: 22<sup>nd</sup> June 2018

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## Executive Summary

This report provides details of the seat belt anchorage pull tests; energy dissipation impact test and seat strength moment arm test which were performed on behalf of Atlantechs Limited on the Land Rover Discovery vehicle body in accordance with ECE R14 and ECE R17 respectively.

The tests were conducted at Millbrook Proving Ground in the safety systems test laboratory between 12<sup>th</sup> June 2018 and 13<sup>th</sup> June 2018.

Test results and details regarding the tests conducted can be found in the body of this report. All tests conducted were performed in accordance with the appropriate regulation.

## Distribution

| Organisation  | Recipient     | Format | Qty |
|---|---------------|--------|-----|
| Atlantechs Limited<br>Building 15<br>The Royal Ordnance Depot<br>Weedon<br>Northants<br>NN7 4PS | G. Bratt      | PDF    | 1   |
| Millbrook Proving Ground Ltd<br>Millbrook<br>Bedford<br>MK45 2JQ                                | Contract file | PDF    | 1   |

## Report Revision History

| Rev. | Revision Description | Date                       | Author | Approver | Pages |
|------|----------------------|----------------------------|--------|----------|-------|
| 0    | Initial release      | 22 <sup>nd</sup> June 2018 | K. Mir | M Shaw   | All   |

# Contents

| Section  | Page Nos. |
|--|-----------|
| Executive Summary.....                         | 2         |
| Distribution.....                              | 3         |
| Report Revision History .....                  | 4         |
| Contents .....                                 | 5         |
| Appendices .....                               | 6         |
| List of Figures .....                          | 7         |
| Objectives .....                               | 8         |
| Conclusions .....                              | 9         |
| Test Facility and Date .....                   | 10        |
| Test Results and Discussion .....              | 11        |
| ECE R14 ISOfix Anchorage Points Pull Test..... | 11        |
| ECE R14 Seatbelt Anchorage Pull Test .....     | 14        |
| ECE R17 Energy Dissipation Impact Tests .....  | 16        |
| ECE R17 Seat Strength Tests .....              | 18        |

## Appendices

Graphical Data

Appendix A

Calibration Certificates

Appendix B

Real Time / High Speed digital films

See "Film" directory on data media

Pre and post-test photographs

See "Stills" directory on data media

## List of Figures

|  |    |
|--|----|
| Figure 1 - C17573A Pre Test .....                              | 11 |
| Figure 2 - C17573A Post Test.....                              | 11 |
| Figure 3 - C17573B Pre Test .....                              | 12 |
| Figure 4 - C17573B Post Test.....                              | 12 |
| Table 1 - C17573A SFAD Displacement .....                      | 13 |
| Table 2 - C17573B SFAD Displacement .....                      | 13 |
| Figure 5 - C17573C Pre Test .....                              | 14 |
| Figure 6 - C17573C Post Test.....                              | 14 |
| Table 3 - C17573C Effective Upper Anchorage Displacement ..... | 15 |
| Figure 7 - C17574A Pre Test .....                              | 16 |
| Table 4 – C17574A Energy Dissipation Test Results .....        | 17 |
| Figure 8- C17574B Pre test .....                               | 18 |
| Table 5 – C17574B Seat strength test results.....              | 19 |

## Objectives

1. To conduct multiple ISOfix pull tests, on the ISOfix anchorage points of the Atlantechs Limited vehicle occupant seat supplied by Atlantechs Limited in accordance with ECE R14 - 07.
2. To conduct seat belt anchorage pull test, to category M1 on the seat belt anchorages of the Land Rover Discovery vehicle body and Atlantechs Limited vehicle occupant seat supplied by Atlantechs Limited in accordance with ECE R14 - 07.
3. To conduct energy dissipation impact test on the head restraints of the Atlantechs Limited vehicle occupant seats supplied by Atlantechs Limited in accordance with ECE R17 - 08.
4. To conduct multiple seat strength tests on the Atlantechs Limited vehicle occupant seats supplied by Atlantechs Limited in accordance with ECE R17 - 08.
5. To provide real time video records of the ECE R14 testing.
6. To provide high speed digital record of the ECE R17 energy dissipation impact test.
7. To provide photographic still records of the testing.



## Conclusions

1. Two ISOfix pull tests (Oblique and forward angles) were conducted on the ISOfix anchorage points of the vehicle occupant seat supplied by Atlantechs Limited in accordance with ECE R14 - 07.
2. A single seat belt anchorage pull test was conducted to category M1 on the seat belt anchorages of the Land Rover Discovery vehicle body and Atlantechs Limited vehicle occupant seat supplied by Atlantechs Limited in accordance with ECE R14 - 07.
3. A single energy dissipation impact test was conducted on the head restraint of the Atlantechs Limited vehicle occupant seats supplied by Atlantechs Limited in accordance with ECE R17 - 08.
4. A single seat strength test was performed, in 3 locations, on the Atlantechs Limited vehicle occupant seat supplied by Atlantechs Limited in accordance with ECE R17 - 08.
5. Real time video records were captured of the ECE R14 testing.
6. High speed digital records were captured of the ECE R17 energy dissipation impact tests.
7. Still photographic records were capturing during the tests described in this report.

## Test Facility and Date

The tests, numbered [C17573A to C17573C](#) and [C17574A to C17574B](#), were performed between Tuesday 12<sup>th</sup> June 2018 and Wednesday 13<sup>th</sup> June 2018 in the [Safety Systems](#) facility at Millbrook Proving Ground Ltd.

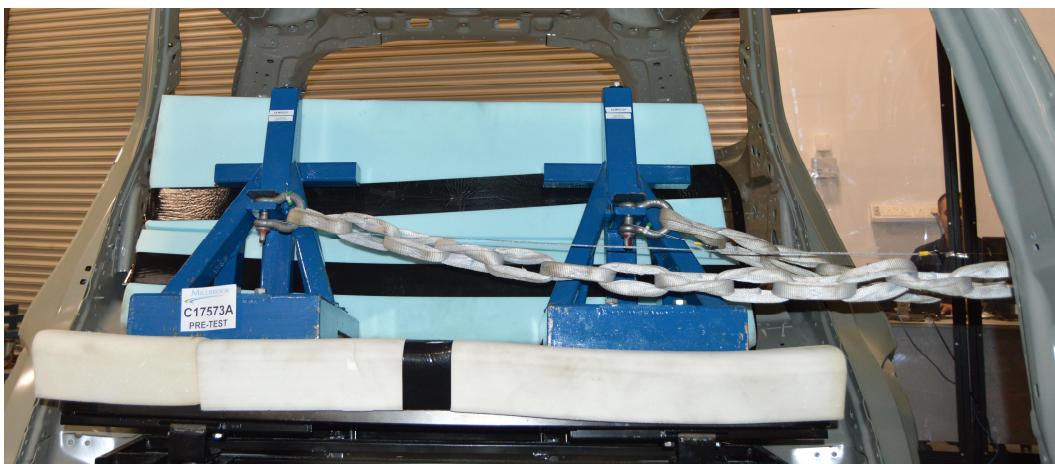
Address: Millbrook Proving Ground Ltd  
Millbrook  
Bedford  
MK45 2JQ  
England

Contact: Mr. Kaasim Mir – Safety Systems Engineer  
Telephone: 01525 842521  
Mobile: 07967 316951  
Email: [kaasim.mir@millbrook.co.uk](mailto:kaasim.mir@millbrook.co.uk)

## Test Results and Discussion

### ECE R14 ISOfix Anchorage Points Pull Test

There were two ISOfix anchorage points pull tests performed. The first of these tests was performed on the Atlantechs Limited vehicle occupant seat supplied by Atlantechs Limited. The Land Rover Discovery vehicle body was placed at an oblique angle (75°). This test was numbered C17573A. An overview of the test set up can be seen in *Figures 1 & 2*.



**Figure 1 - C17573A Pre Test**



**Figure 2 - C17573A Post Test**

The second test was performed on a new Atlantechs Limited vehicle occupant seat using the same Land Rover Discovery vehicle body. This test was numbered C17573B. The vehicle body was placed at a straight ahead angle ( $0^{\circ}$ ) for this test. An overview of the test set up can be seen in *Figures 3 & 4*.



**Figure 3 - C17573B Pre Test**



**Figure 4 - C17573B Post Test**

Displacement transducers were attached to both SFAD's to measure displacement during test. The displacements for both SFAD's during the Oblique and Straight ahead tests can be seen in *Tables 1 & 2*.

**Table 1 - C17573A SFAD Displacement**

|                     | SFAD Displacement (mm) |
|---------------------|------------------------|
| Left Occupant Seat  | 88.57                  |
| Right Occupant Seat | 111.42                 |

**Table 2 - C17573B SFAD Displacement**

|                     | SFAD Displacement (mm) |
|---------------------|------------------------|
| Left Occupant Seat  | 93.14                  |
| Right Occupant Seat | 93.55                  |

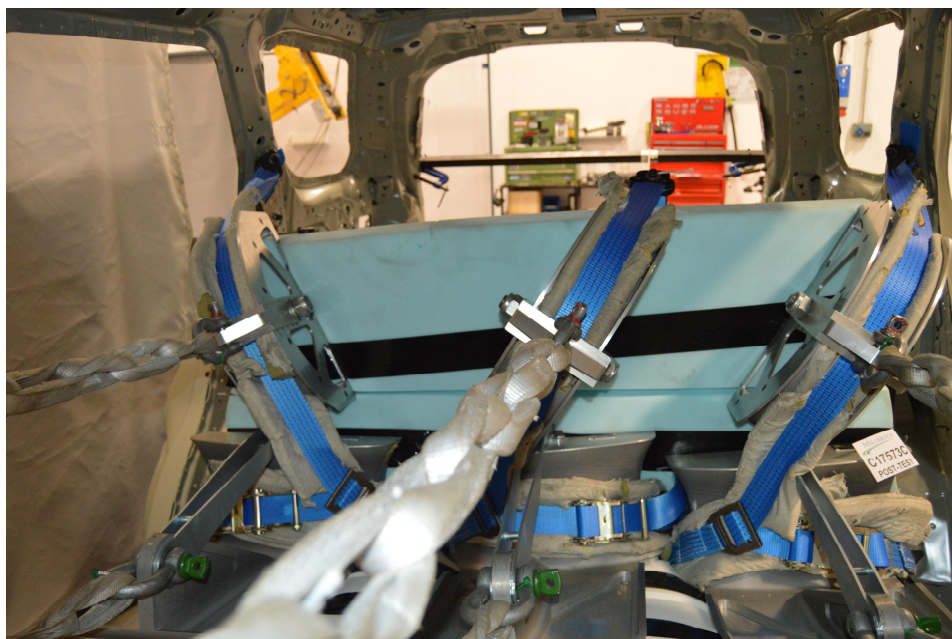
For tests C17573A and C17573B the required loads were met and held for the required amount of time as specified in ECE R14 – 07.

## ECE R14 Seatbelt Anchorage Pull Test

A single seat belt anchorage pull test was performed. The test was performed on the Atlantechs Limited vehicle occupant seat supplied by Atlantechs Limited fitted inside the Land Rover Discovery vehicle body supplied by Atlantechs Limited. This test was numbered C17573C. An overview of the test set up can be seen in *Figures 5 & 6*.



**Figure 5 - C17573C Pre Test**



**Figure 6 - C17573C Post Test**

As the occupant seat has seat belt anchorages mounted on the seat, the displacement of the effective upper anchorage was recorded during the test. This displacement can be seen in *Table 3* below.

**Table 3 - C17573C Effective Upper Anchorage Displacement**

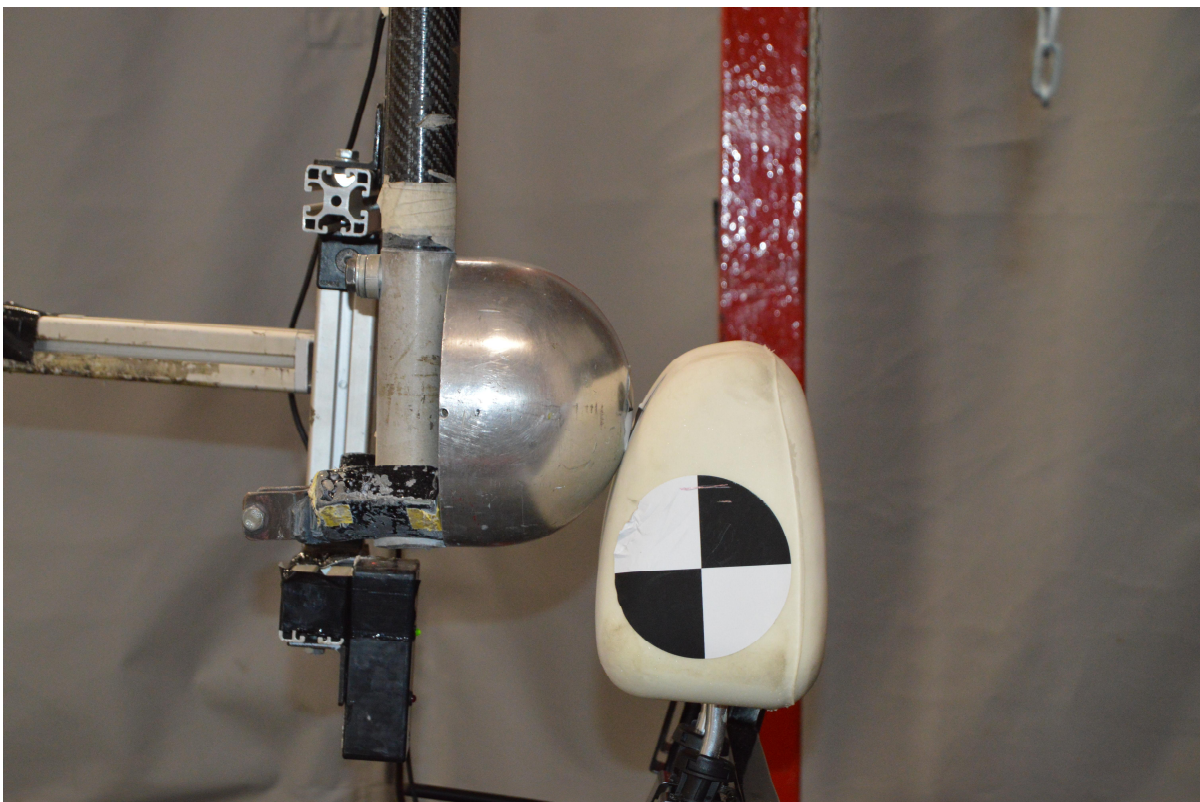
|                      | Effective Upper Anchorage Displacement (mm) |
|----------------------|---|
| Centre Occupant Seat | 358   |

For test C17573C the required loads were met and held for the required amount of time as specified in ECE R14 – 07.

## ECE R17 Energy Dissipation Impact Tests

There was a single energy dissipation impact test conducted on the Atlantechs Limited vehicle occupant seat headrest supplied by Atlantechs Limited.

The test was conducted on the front face of the head restraint fitted to the Atlantechs Limited vehicle occupant seat and was numbered C17574A. An overview of this test set up can be seen in *Figure 7*.



***Figure 7 - C17574A Pre Test***



A summary of results from the ECE R17 energy dissipation impact test can be seen in *Table 4*.

**Table 4 – C17574A Energy Dissipation Test Results**

|         | Impact velocity<br>(km/h) | 3ms Exceedance<br>Value (g) | Peak (g) |
|---------|---------------------------|-----------------------------|----------|
| C17574A | 24.34                     | 16.84                       | 20.31    |

All energy dissipation impacts tests were performed in accordance with and met ECE R17

## ECE R17 Seat Strength Tests

There was a single seat strength test performed on all 3 seating positions simultaneously.

The test was numbered C17574B and was performed on the Atlantechs Limited vehicle occupant seat. An overview of the test set up can be seen in *Figure 8*.



**Figure 8- C17574B Pre test**

A summary of the results from C17574B can be seen in *Table 5*.

**Table 5 – C17574B Seat strength test results**

| Moment Arm Test Results C17574B             |        |        |        |
|---|--------|--------|--------|
| Atlantechs Limited Vehicle Occupant Seat    | LH     | Centre | RH     |
| Back Pan Moment Achieved (daN.m)            | 45.15  | 51.07  | 50.43  |
| Headform Load Target (daN)                  | 53.19  | 52.61  | 51.95  |
| Displacement of headform at 37.3 daN.m (mm) | 59     | 69     | 69     |
| Headform Load Achieved(daN)                 | 58.49  | 61.10  | 56.00  |
| 89daN target, Actual Load achieved (daN)    | 104.39 | 93.50  | 102.60 |
| Headform height from H point (mm)           | 715    | 709    | 718    |

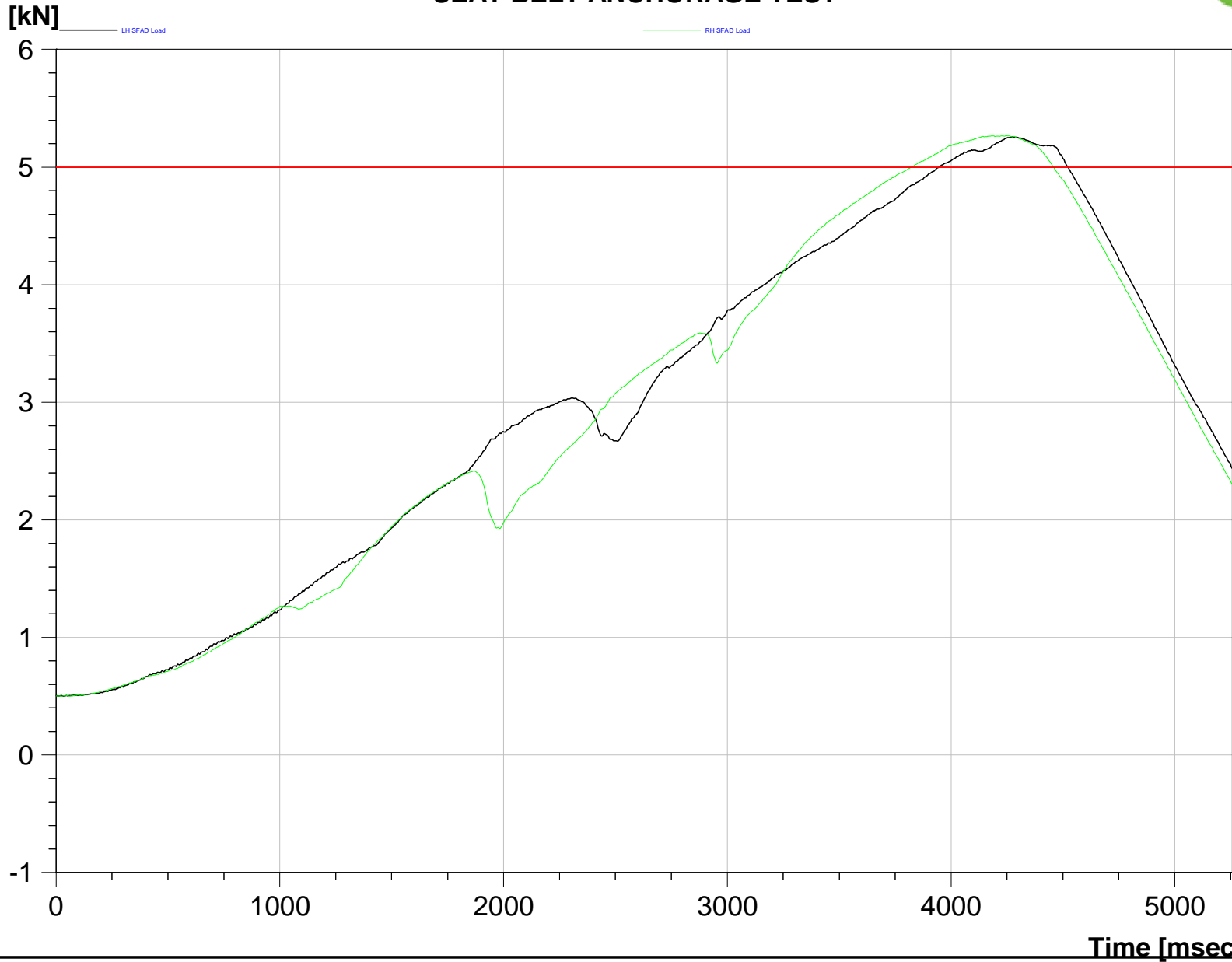
Please Note: Millbrook's data acquisition system runs in kgf or kN, all figures from photos have been converted back N for purpose of table

# Appendix

# A



### SEAT BELT ANCHORAGE TEST



Test No. : C17573A  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Oblique  
Ram Angles : 0.05° 0.01°  
Test Engineers : B. Young  
: K. Mir

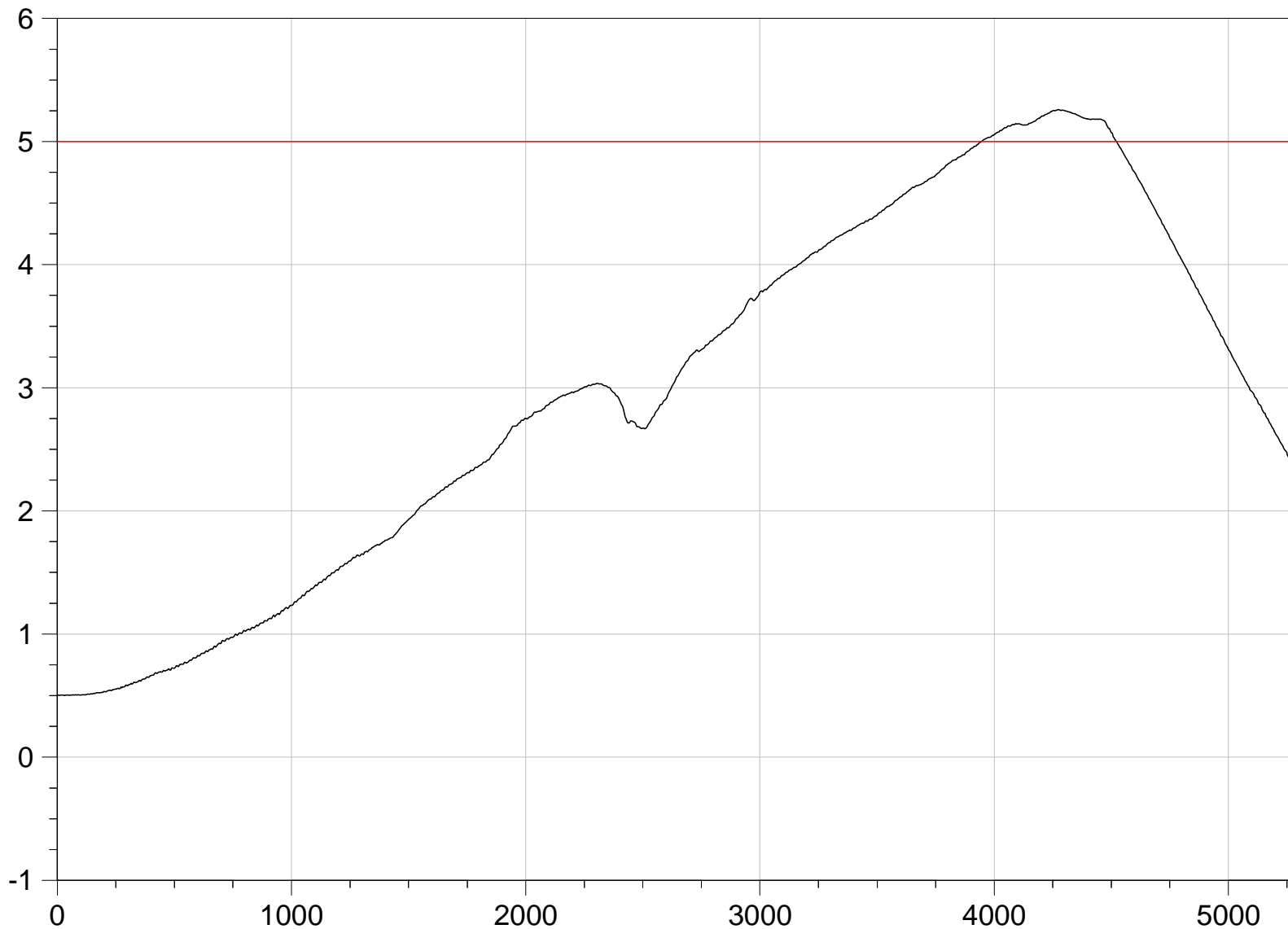
**Load Hold Criteria :**  
Required : 200.00 [ msec ]  
Actual : 576.22 [ msec ]  
Time to Load : 3.95 [ sec ]  
**Load Limits :**  
LH SFAD Load :  
5.00 ± 0.00 daN  
RH SFAD Load :  
5.00 ± 0.00 daN

Plot Date : 06/15/2018 at 15:28:08



### LH SFAD Load

[m/s]



Test No. : C17573A  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Oblique  
Ram Angles : 0.05° 0.01°  
Test Engineers : B. Young  
: K. Mir

Time at Load : 576.22 msec  
Time to Load : 3945.34 msec  
Load Limit : 5.00 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)

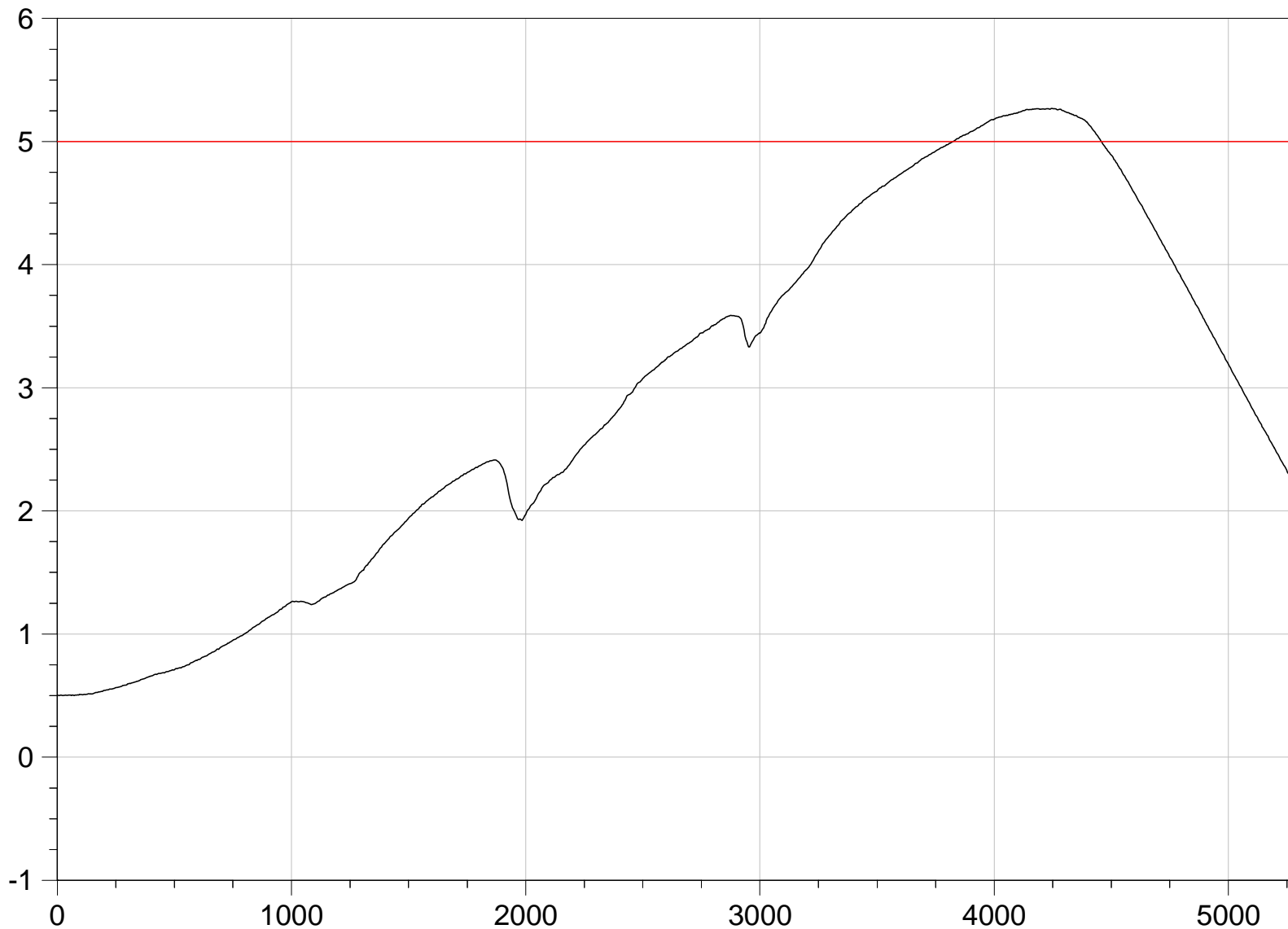
Max Value : 5.26 kN [4276.0 msec]  
Min Value : -0.01 kN [-106524.0 msec]  
Plot Date : 06/15/2018 at 15:28:39

Time [msec]



### RH SFAD Load

[m/s]



Test No. : C17573A  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Oblique  
Ram Angles : 0.05° 0.01°  
Test Engineers : B. Young  
: K. Mir

Time at Load : 633.85 msec  
Time to Load : 3823.41 msec  
Load Limit : 5.00 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)

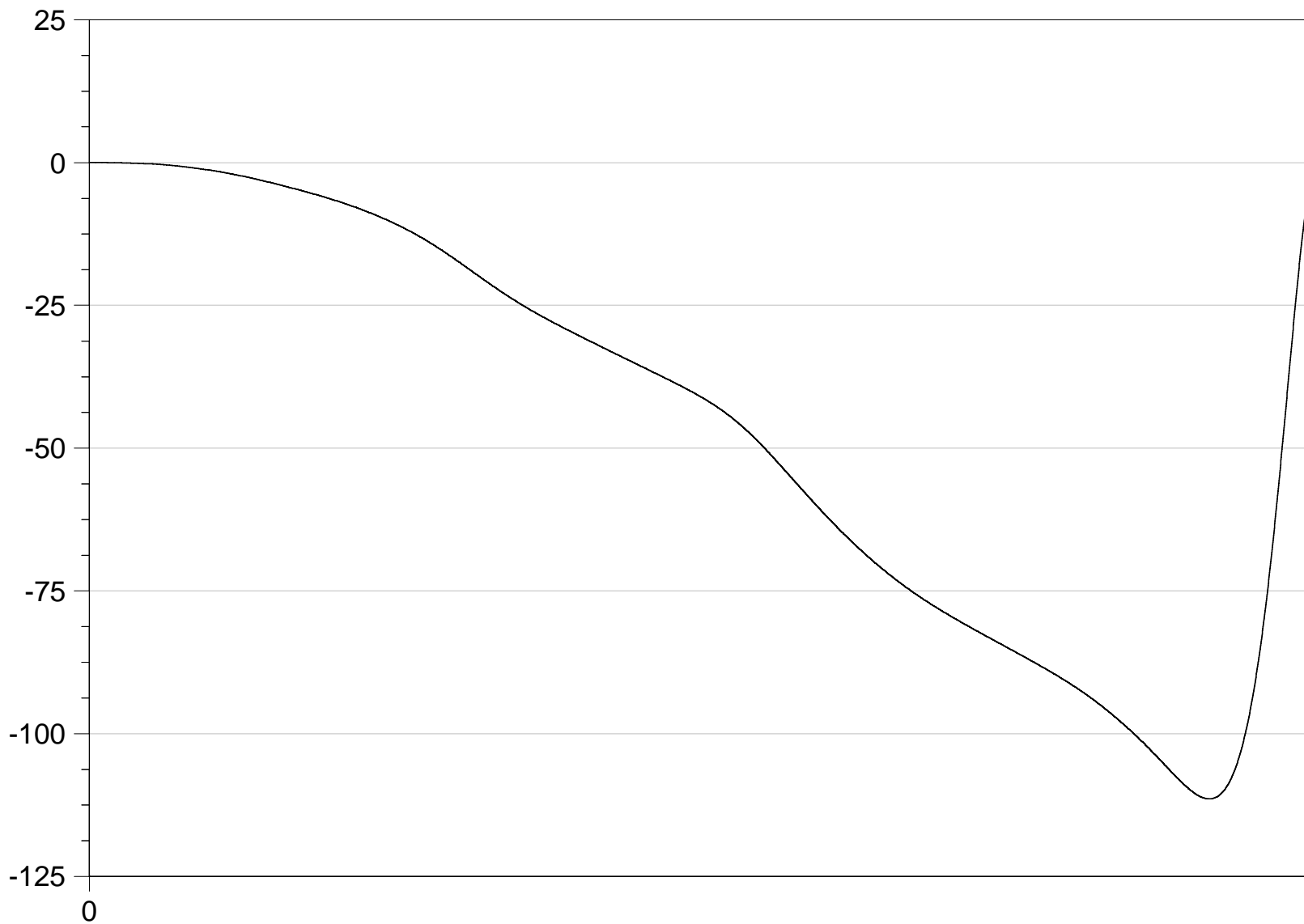
Max Value : 5.27 kN [4244.0 msec]  
Min Value : -0.01 kN [-100372.0 msec]  
Plot Date : 06/15/2018 at 15:28:39

Time [msec]



### RH SFAD Displacement

[mm]



Test No. : C17573A  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Oblique  
Ram Angles : 0.05° 0.01°  
Test Engineers : B. Young  
: K. Mir

Max Value : 0.04mm  
Min Value : -111.42mm  
Plot Date : 15/06/2018 at 15:39:24

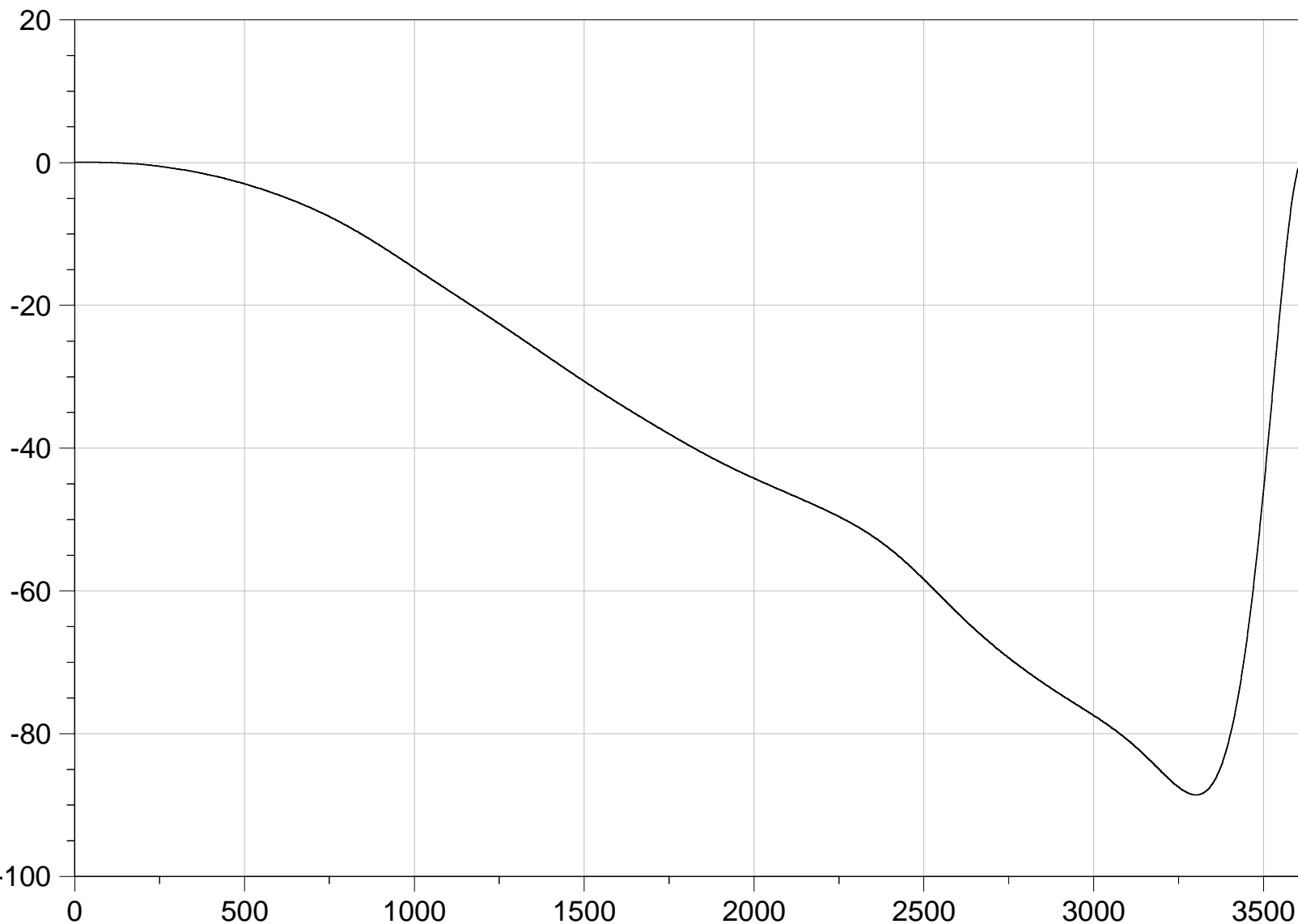
Time [msec]





### LH SFAD Displacement

[mm]



Test No. : C17573A  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Oblique  
Ram Angles : 0.05° 0.01°  
Test Engineers : B. Young  
: K. Mir

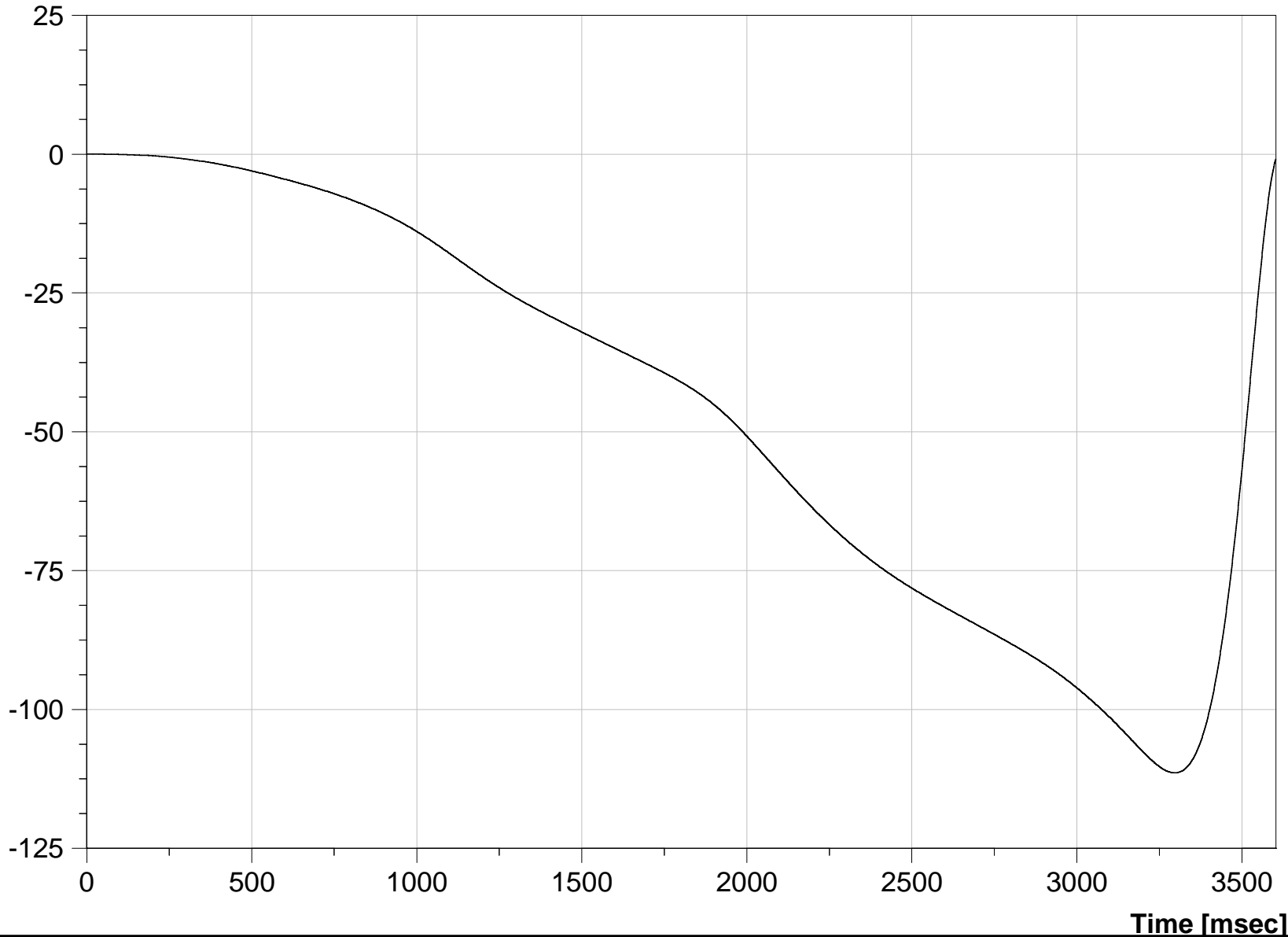
Max Value : 0.06mm  
Min Value : -88.57mm  
Plot Date : 15/06/2018 at 15:43:48

Time [msec]



### RH SFAD Displacement

[mm]

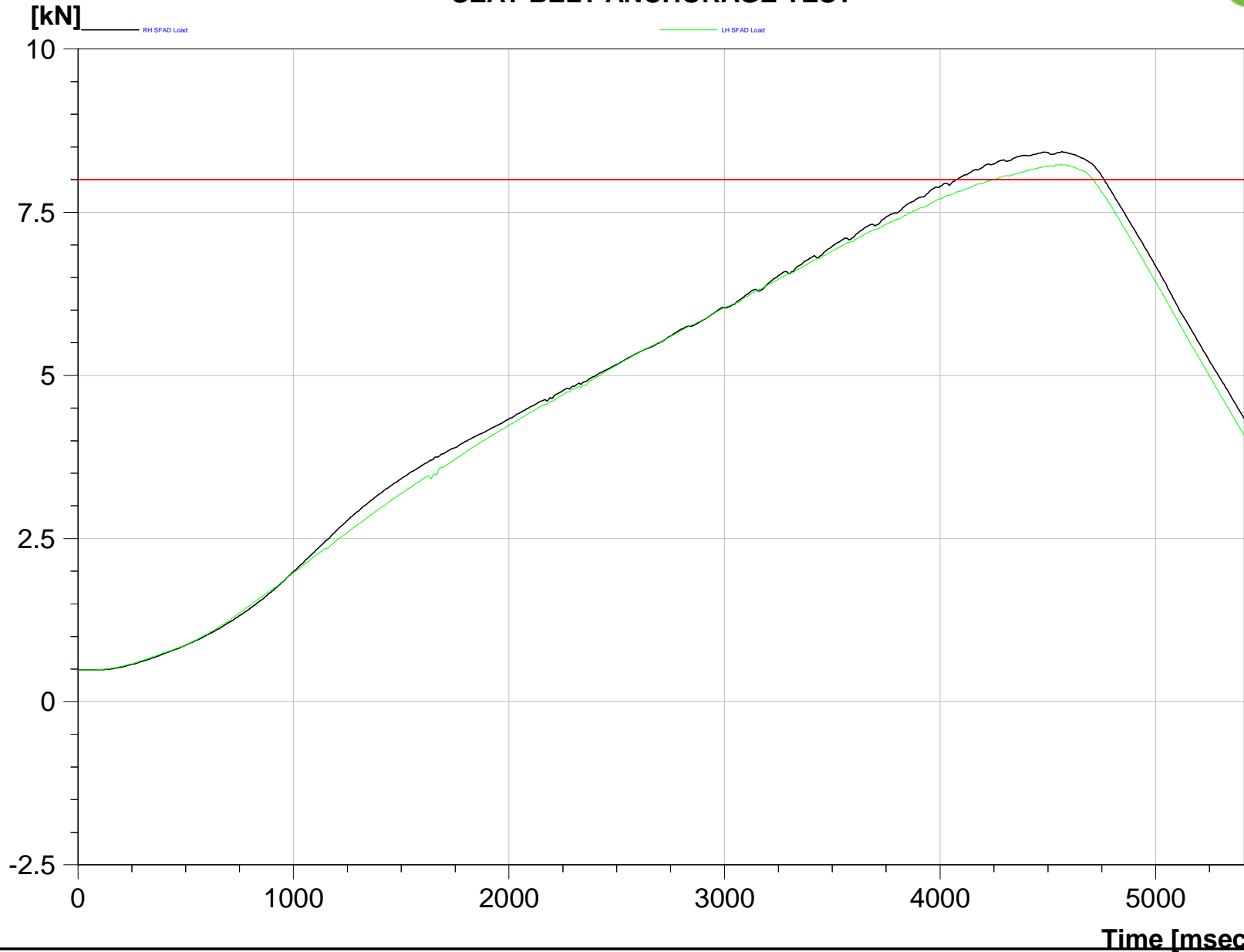


Test No. : C17573A  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Oblique  
Ram Angles : 0.05° 0.01°  
Test Engineers : B. Young  
: K. Mir

Max Value : 0.04mm  
Min Value : -111.42mm  
Plot Date : 15/06/2018 at 15:44:24



### SEAT BELT ANCHORAGE TEST



Test No. : C17573B  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Forward  
Ram Angles : 8.00° 8.30°  
Test Engineers : B. Young  
: K. Mir

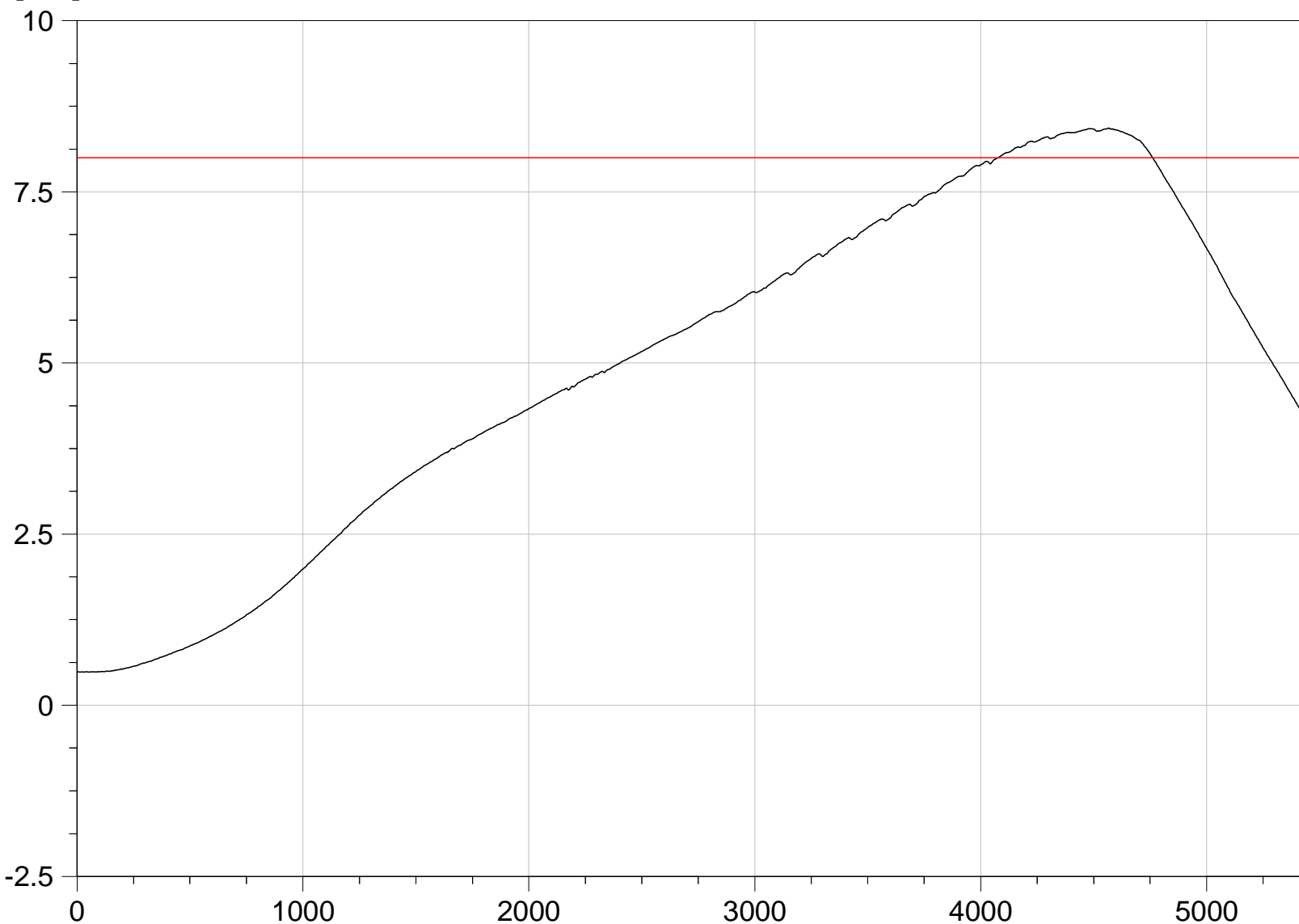
**Load Hold Criteria :**  
Required : 200.00 [ msec ]  
Actual : 463.18 [ msec ]  
Time to Load : 4.25 [ sec ]  
**Load Limits :**  
RH SFAD Load :  
8.00 ± 0.00 daN  
LH SFAD Load :  
8.00 ± 0.00 daN

Plot Date : 06/15/2018 at 16:05:38



### RH SFAD Load

[m/s]



Test No. : C17573B  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Forward  
Ram Angles : 8.00° 8.30°  
Test Engineers : B. Young  
: K. Mir

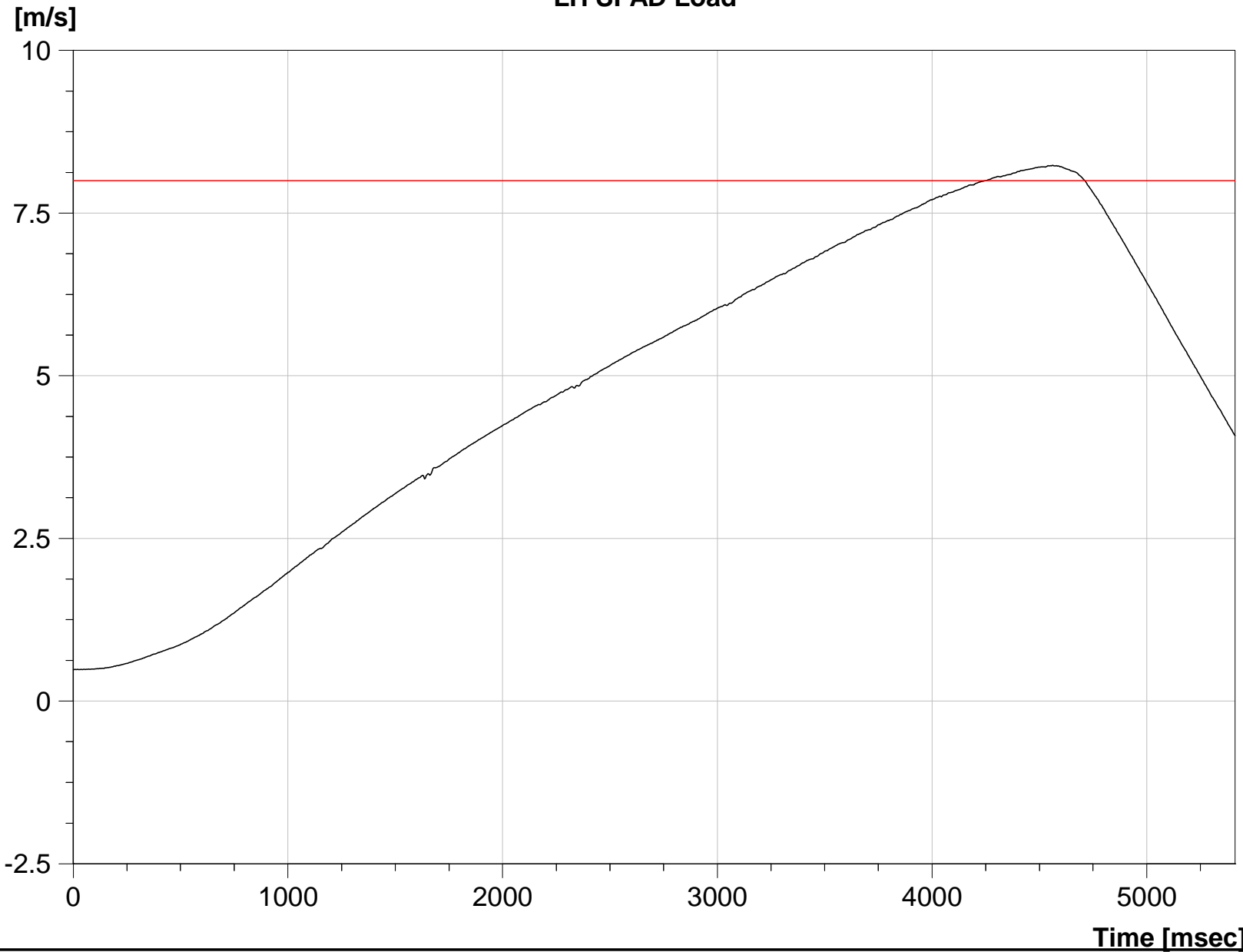
Time at Load : 682.85 msec  
Time to Load : 4078.03 msec  
Load Limit : 8.00 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)

Max Value : 8.43 kN [4568.0 msec]  
Min Value : -0.01 kN [-280780.0 msec]  
Plot Date : 06/15/2018 at 16:08:13

Time [msec]



### LH SFAD Load



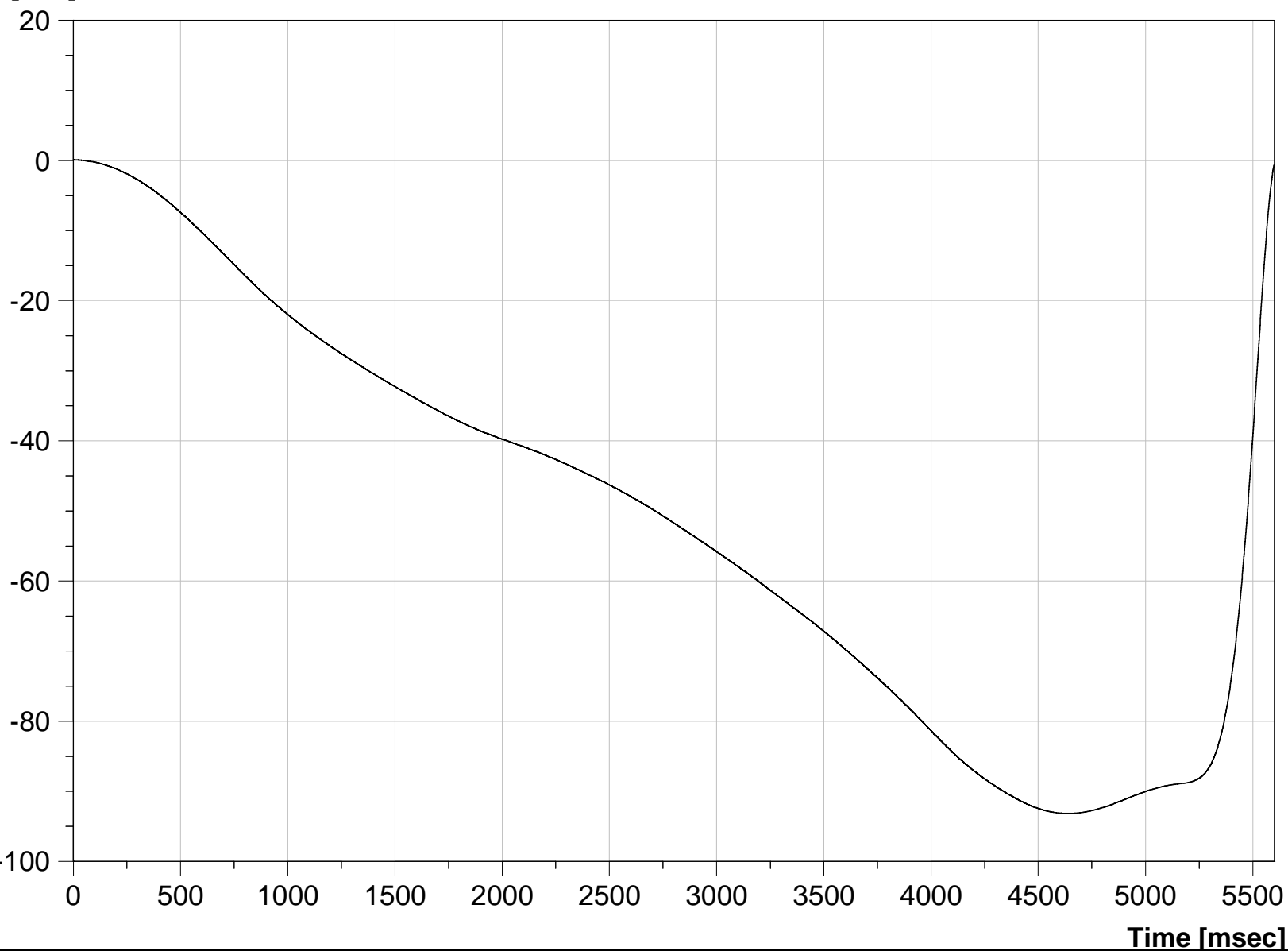
Test No. : C17573B  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Forward  
Ram Angles : 8.00° 8.30°  
Test Engineers : B. Young  
: K. Mir

Time at Load : 463.18 msec  
Time to Load : 4247.68 msec  
Load Limit : 8.00 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)  
Max Value : 8.23 kN [4564.0 msec]  
Min Value : -0.01 kN [-297172.0 msec]  
Plot Date : 06/15/2018 at 16:08:13



### LH SFAD Displacement

[mm]



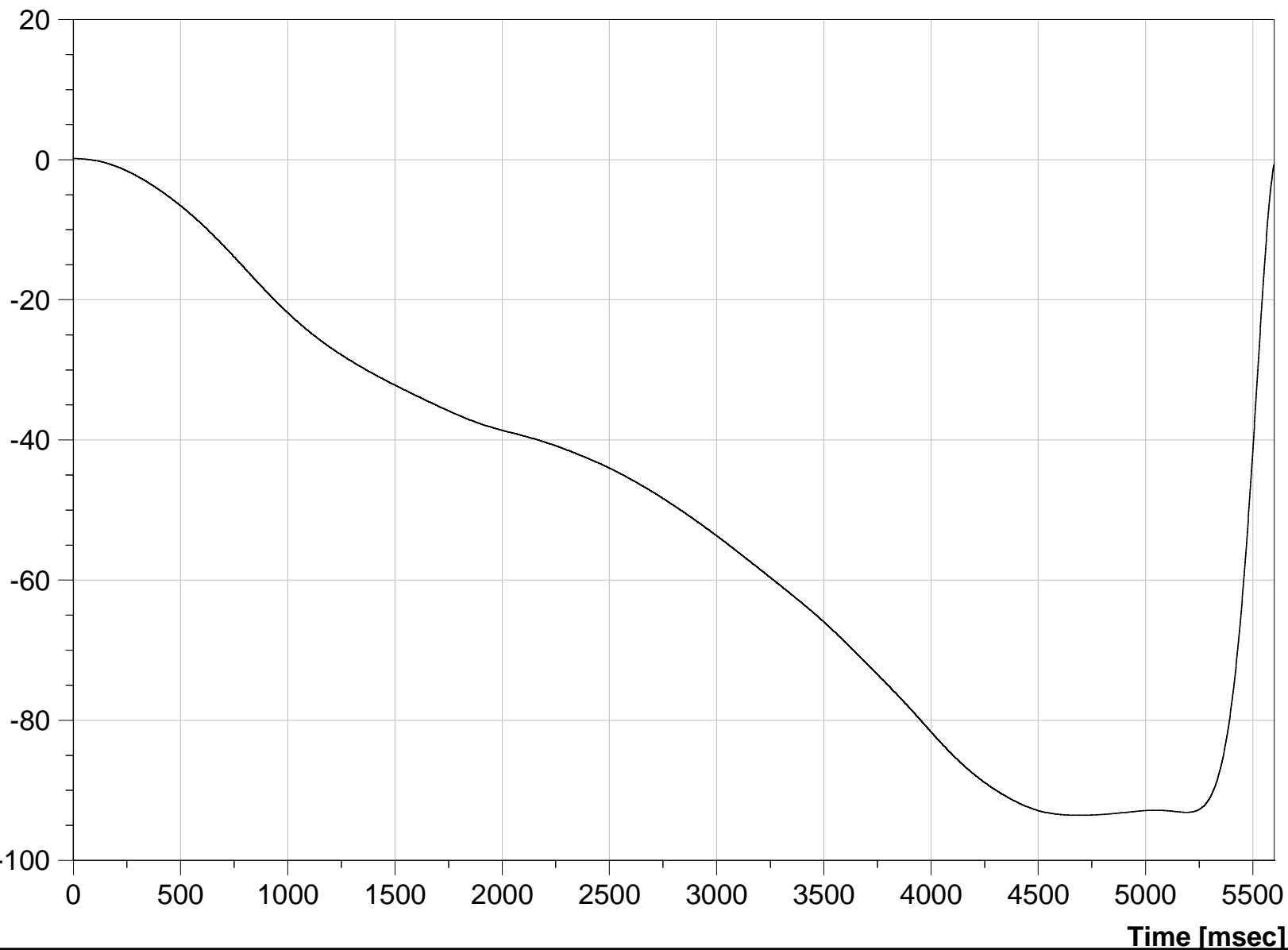
Test No. : C17573B  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Forward  
Ram Angles : 8.00° 8.30°  
Test Engineers : B. Young  
: K. Mir

Max Value : 0.13mm  
Min Value : -93.14mm  
Plot Date : 15/06/2018 at 15:59:23



### RH SFAD Displacement

[mm]

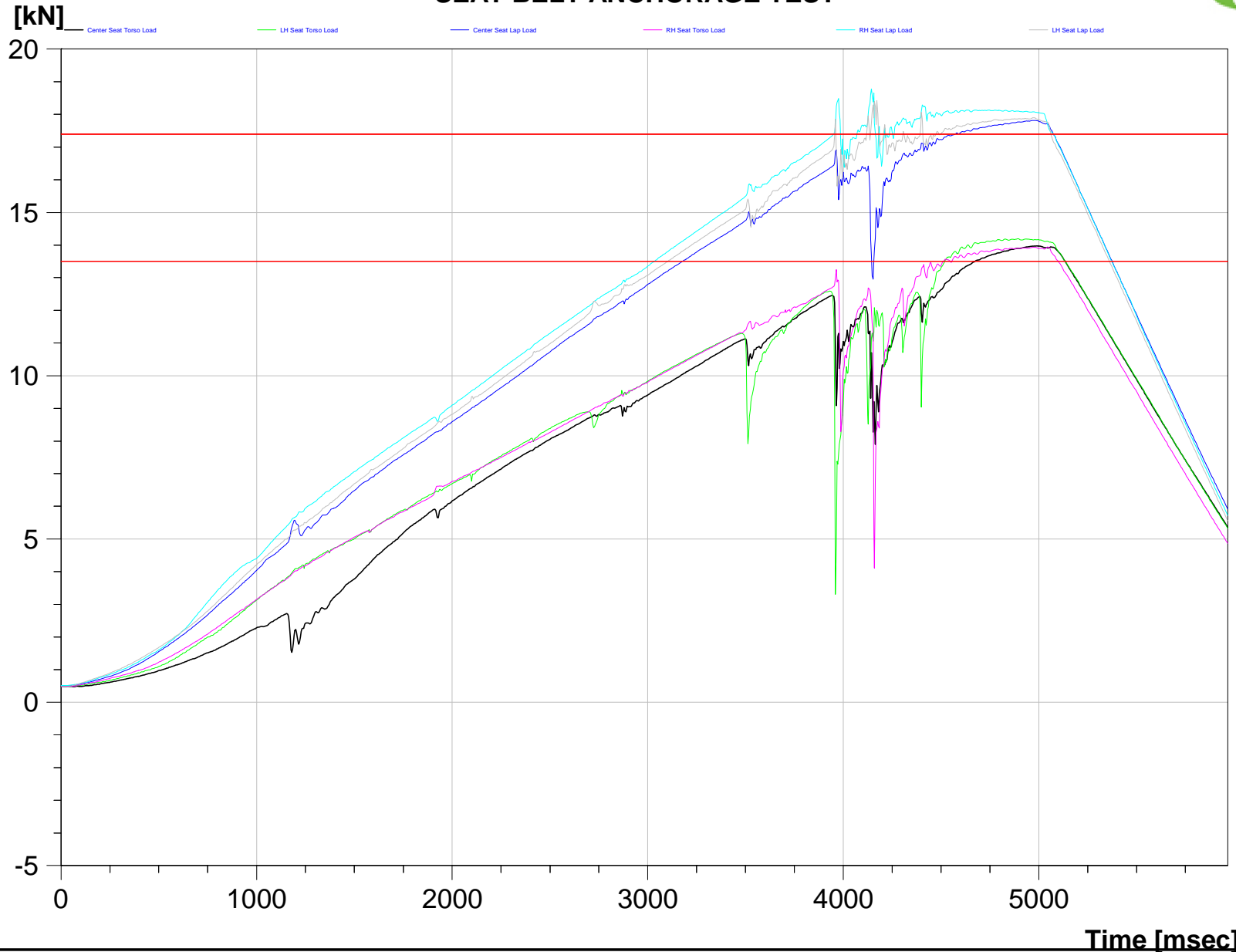


Test No. : C17573B  
Customer : Atlantechs  
: Seating  
Test Date : 12-Jun-2018  
Test Type : ECE R14 (M1)  
: ISOFix Forward  
Ram Angles : 8.00° 8.30°  
Test Engineers : B. Young  
: K. Mir

Max Value : 0.18mm  
Min Value : -93.55mm  
Plot Date : 15/06/2018 at 16:00:23



# SEAT BELT ANCHORAGE TEST

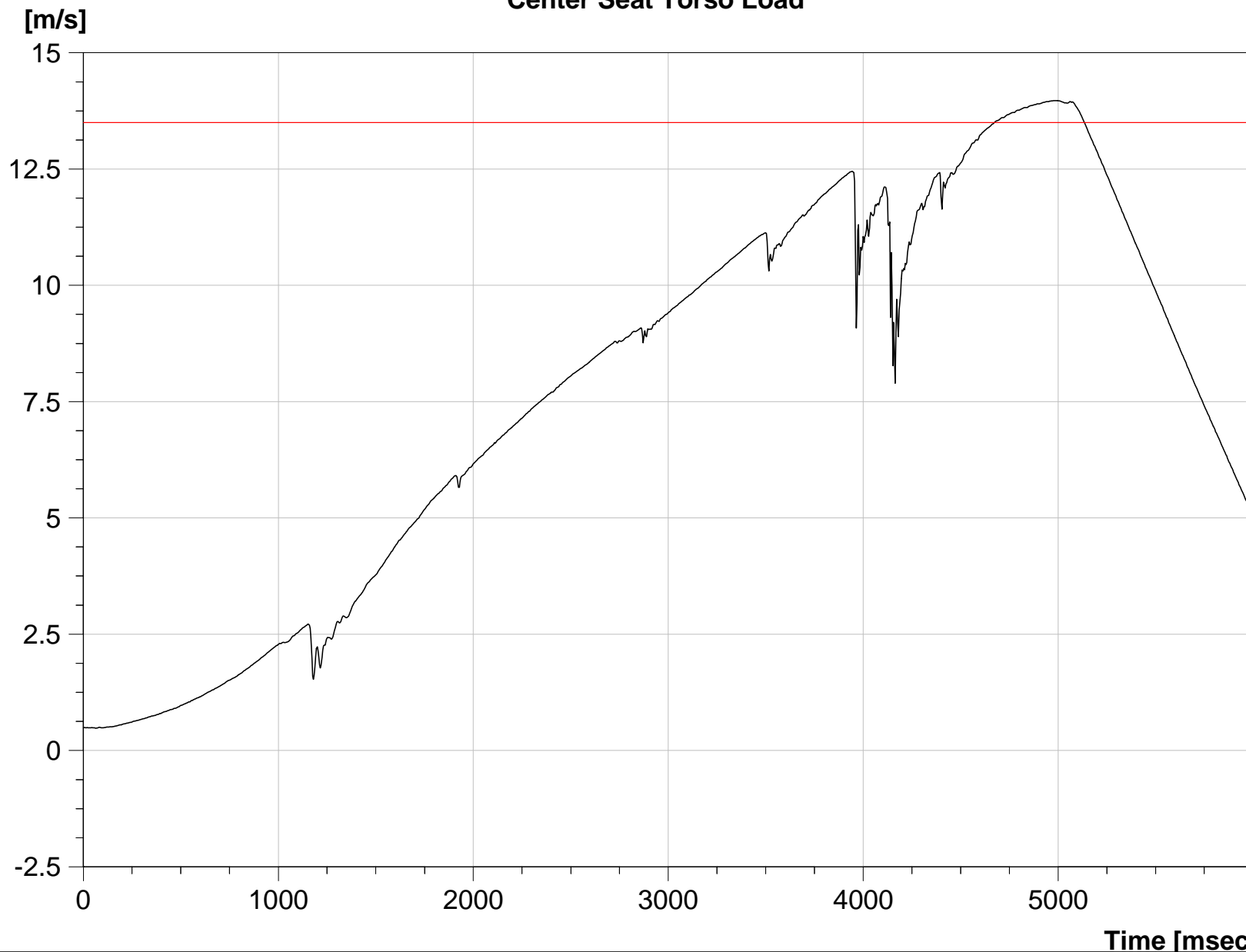


Test No. : C17573C  
Customer : Atlantechs  
: Seating  
Test Date : 13-Jun-2018  
Test Type : ECE R14 (M1)  
: Row 2 SBA  
Seat Mass : 60kg  
Ram Angles :  
9.80° 10.9° 10.4°  
8.10° 10.0° 8.40°  
Displacements : 358mm  
**Load Hold Criteria :**  
Required : 200.00 [ msec ]  
Actual : 460.85 [ msec ]  
Time to Load : 4.68 [ sec ]  
**Load Limits :**  
Center Seat Torso Load :  
13.50 ± 0.00 daN  
LH Seat Torso Load :  
13.50 ± 0.00 daN  
Center Seat Lap Load :  
17.40 ± 0.00 daN  
RH Seat Torso Load :  
13.50 ± 0.00 daN  
RH Seat Lap Load :  
17.40 ± 0.00 daN  
LH Seat Lap Load :  
17.40 ± 0.00 daN  
Plot Date : 06/18/2018 at 07:50:31





### Center Seat Torso Load

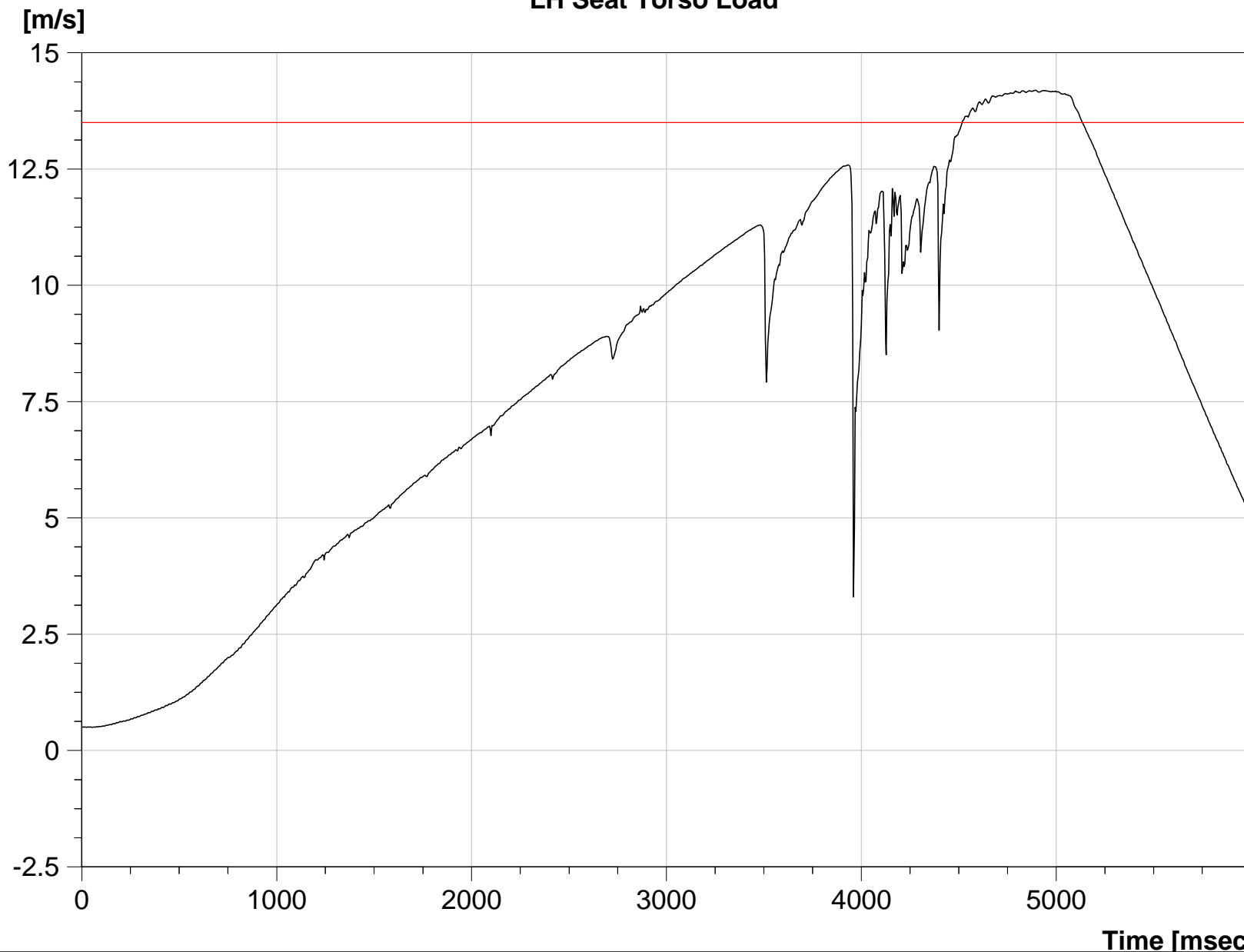


Test No. :C17573C  
Customer :Atlantechs  
:Seating  
Test Date :13-Jun-2018  
Test Type :ECE R14 (M1)  
:Row 2 SBA  
Seat Mass :60kg  
Ram Angles :  
9.80° 10.9° 10.4°  
8.10° 10.0° 8.40°  
Displacements :358mm  
Test Engineers :B. Young  
:K. Mir

Time at Load : 460.85 msec  
Time to Load : 4673.56 msec  
Load Limit : 13.50 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)  
Max Value : 13.97 kN [4980.0 msec]  
Min Value : -0.03 kN [-236424.0 msec]  
Plot Date : 06/18/2018 at 07:51:05



### LH Seat Torso Load

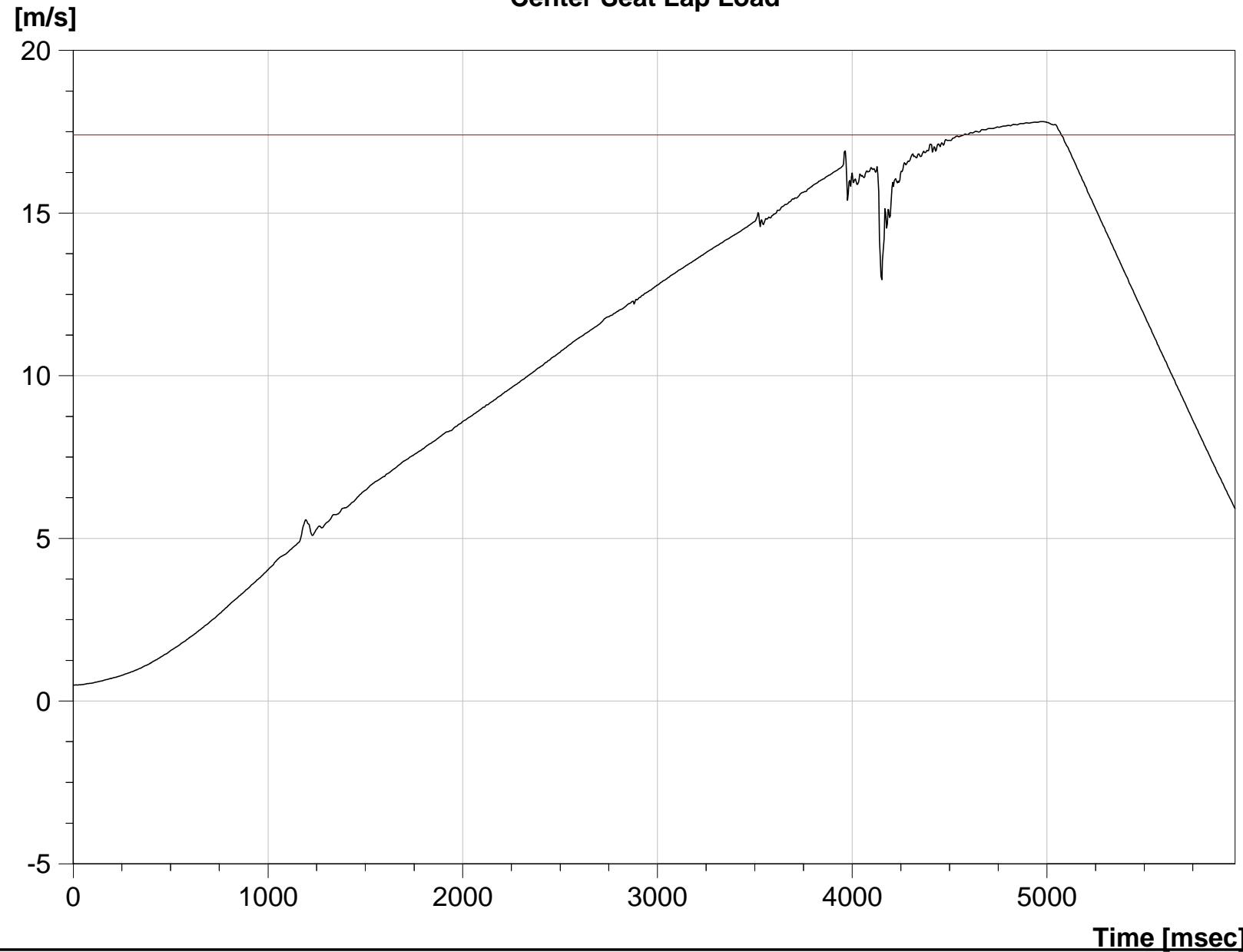


Test No. : C17573C  
Customer : Atlantechs  
: Seating  
Test Date : 13-Jun-2018  
Test Type : ECE R14 (M1)  
: Row 2 SBA  
Seat Mass : 60kg  
Ram Angles :  
9.80° 10.9° 10.4°  
8.10° 10.0° 8.40°  
Displacements : 358mm  
Test Engineers : B. Young  
: K. Mir

Time at Load : 616.40 msec  
Time to Load : 4518.05 msec  
Load Limit : 13.50 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)  
Max Value : 14.19 kN [4896.0 msec]  
Min Value : -0.01 kN [-270036.0 msec]  
Plot Date : 06/18/2018 at 07:51:06



### Center Seat Lap Load

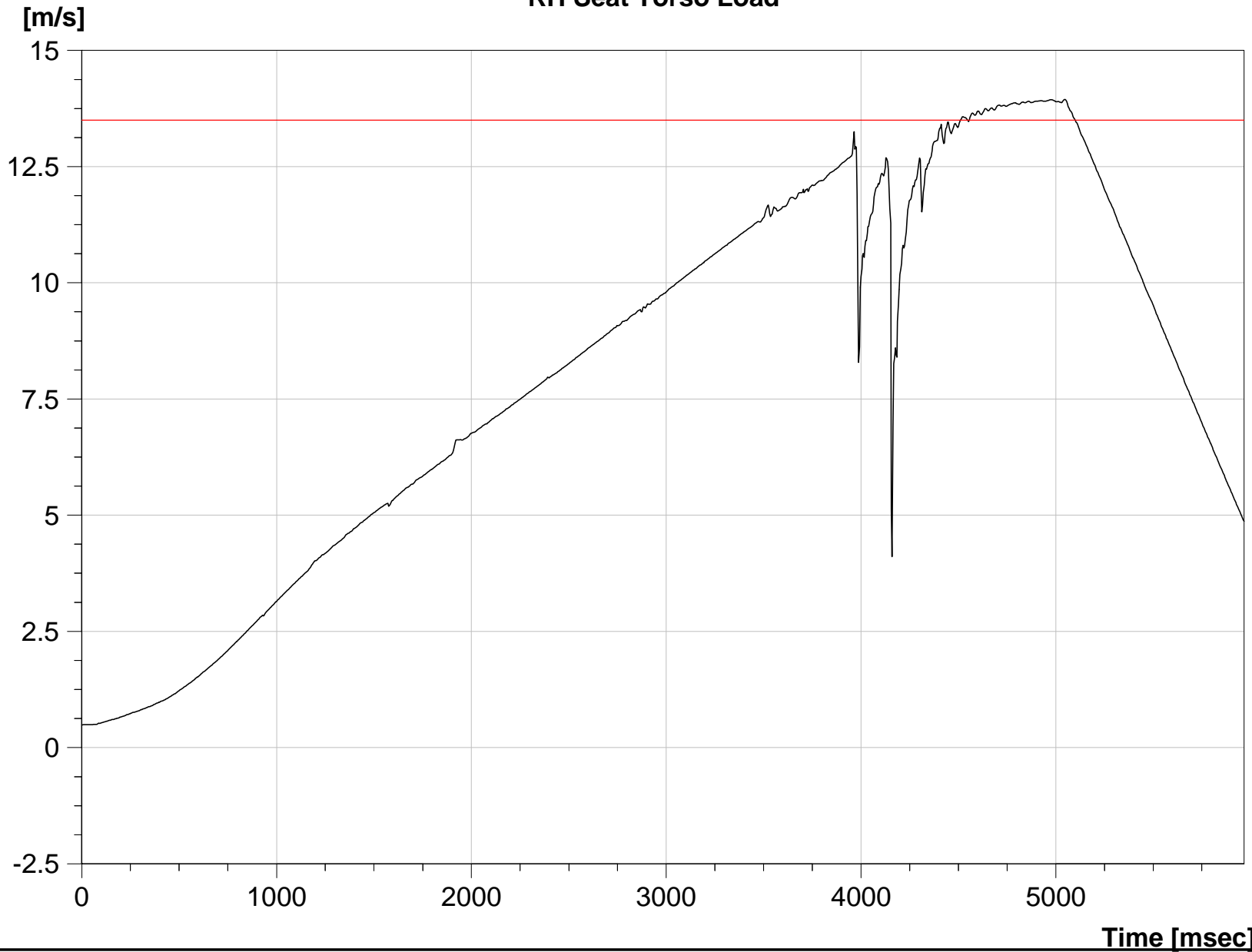


Test No. : C17573C  
Customer : Atlantechs  
: Seating  
Test Date : 13-Jun-2018  
Test Type : ECE R14 (M1)  
: Row 2 SBA  
Seat Mass : 60kg  
Ram Angles :  
9.80° 10.9° 10.4°  
8.10° 10.0° 8.40°  
Displacements : 358mm  
Test Engineers : B. Young  
: K. Mir

Time at Load : 503.00 msec  
Time to Load : 4571.43 msec  
Load Limit : 17.40 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)  
Max Value : 17.81 kN [4976.0 msec]  
Min Value : -0.01 kN [-256044.0 msec]  
Plot Date : 06/18/2018 at 07:51:06



### RH Seat Torso Load



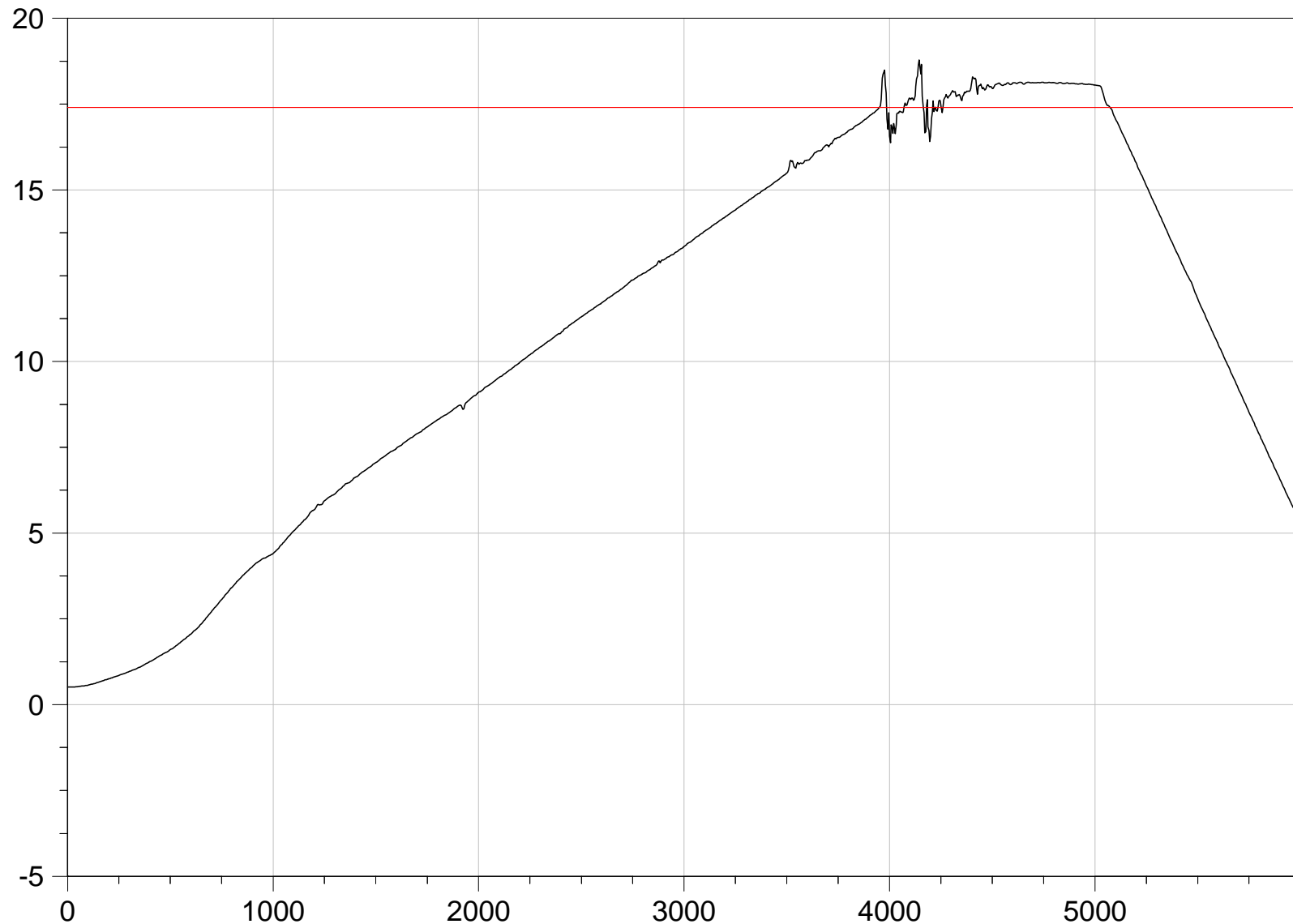
Test No. : C17573C  
Customer : Atlantechs  
: Seating  
Test Date : 13-Jun-2018  
Test Type : ECE R14 (M1)  
: Row 2 SBA  
Seat Mass : 60kg  
Ram Angles :  
9.80° 10.9° 10.4°  
8.10° 10.0° 8.40°  
Displacements : 358mm  
Test Engineers : B. Young  
: K. Mir

Time at Load : 543.13 msec  
Time to Load : 4555.99 msec  
Load Limit : 13.50 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)  
Max Value : 13.94 kN [5044.0 msec]  
Min Value : -0.06 kN [-234516.0 msec]  
Plot Date : 06/18/2018 at 07:51:07



### RH Seat Lap Load

[m/s]



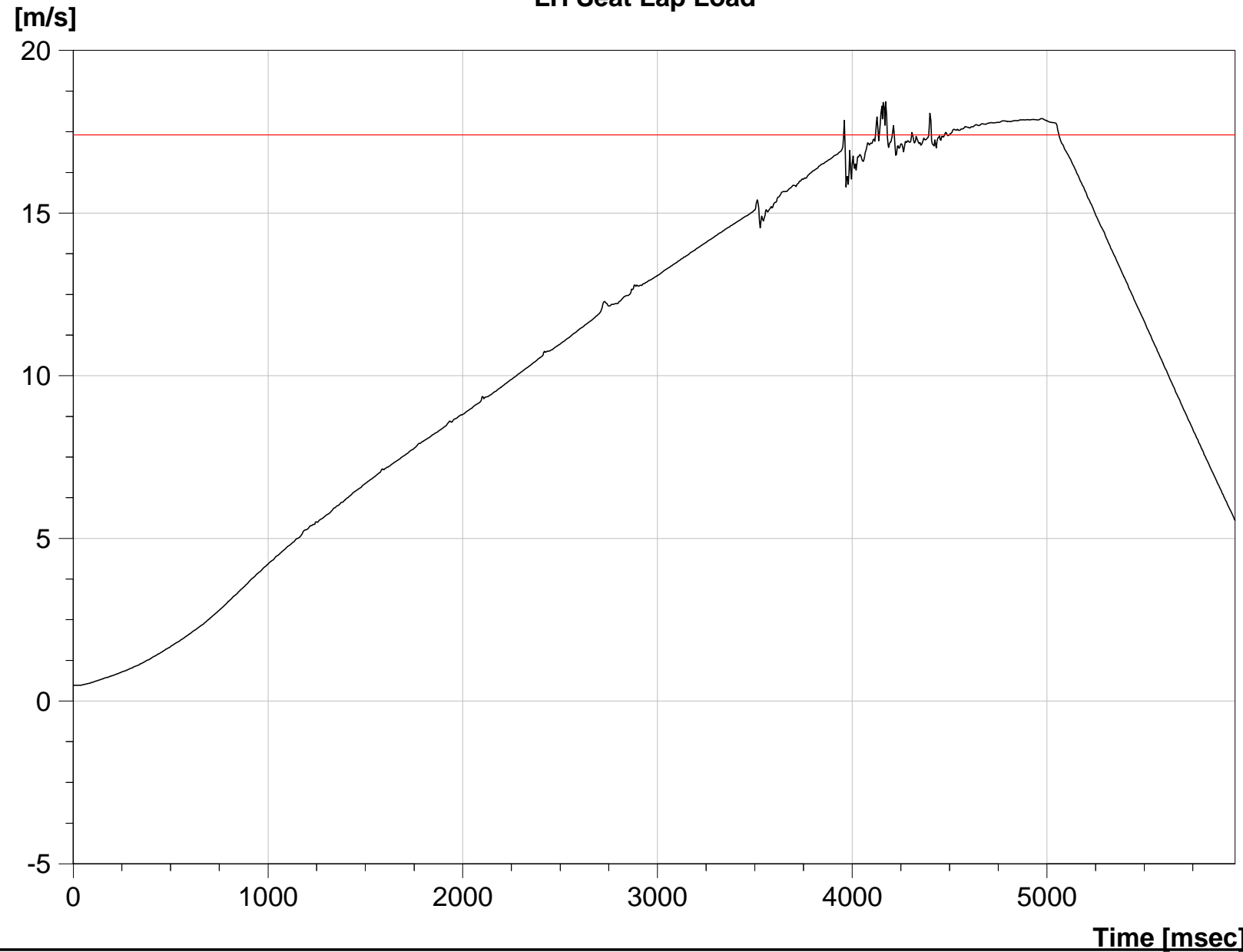
Test No. : C17573C  
Customer : Atlantechs  
: Seating  
Test Date : 13-Jun-2018  
Test Type : ECE R14 (M1)  
: Row 2 SBA  
Seat Mass : 60kg  
Ram Angles :  
9.80° 10.9° 10.4°  
8.10° 10.0° 8.40°  
Displacements : 358mm  
Test Engineers : B. Young  
: K. Mir

Time at Load : 813.44 msec  
Time to Load : 4259.79 msec  
Load Limit : 17.40 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)  
Max Value : 18.79 kN [4144.0 msec]  
Min Value : -0.01 kN [-275520.0 msec]  
Plot Date : 06/18/2018 at 07:51:07

Time [msec]



### LH Seat Lap Load

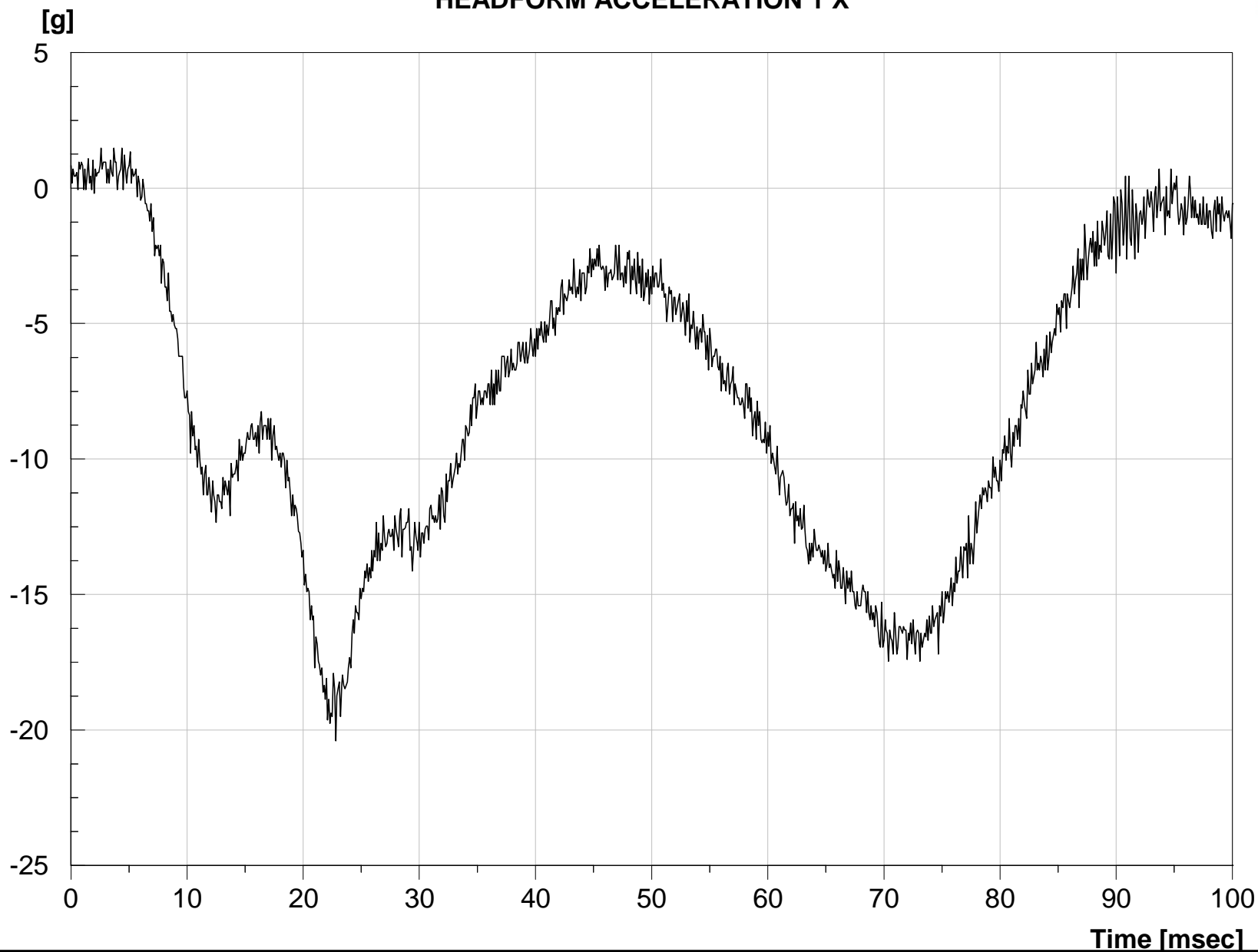


Test No. : C17573C  
Customer : Atlantechs  
: Seating  
Test Date : 13-Jun-2018  
Test Type : ECE R14 (M1)  
: Row 2 SBA  
Seat Mass : 60kg  
Ram Angles :  
9.80° 10.9° 10.4°  
8.10° 10.0° 8.40°  
Displacements : 358mm  
Test Engineers : B. Young  
: K. Mir

Time at Load : 564.15 msec  
Time to Load : 4498.17 msec  
Load Limit : 17.40 ± 0.00 daN  
Filter : CFC 1000 (SAE J211)  
Max Value : 18.42 kN [4172.0 msec]  
Min Value : -0.01 kN [-265636.0 msec]  
Plot Date : 06/18/2018 at 07:51:08



### HEADFORM ACCELERATION 1 X



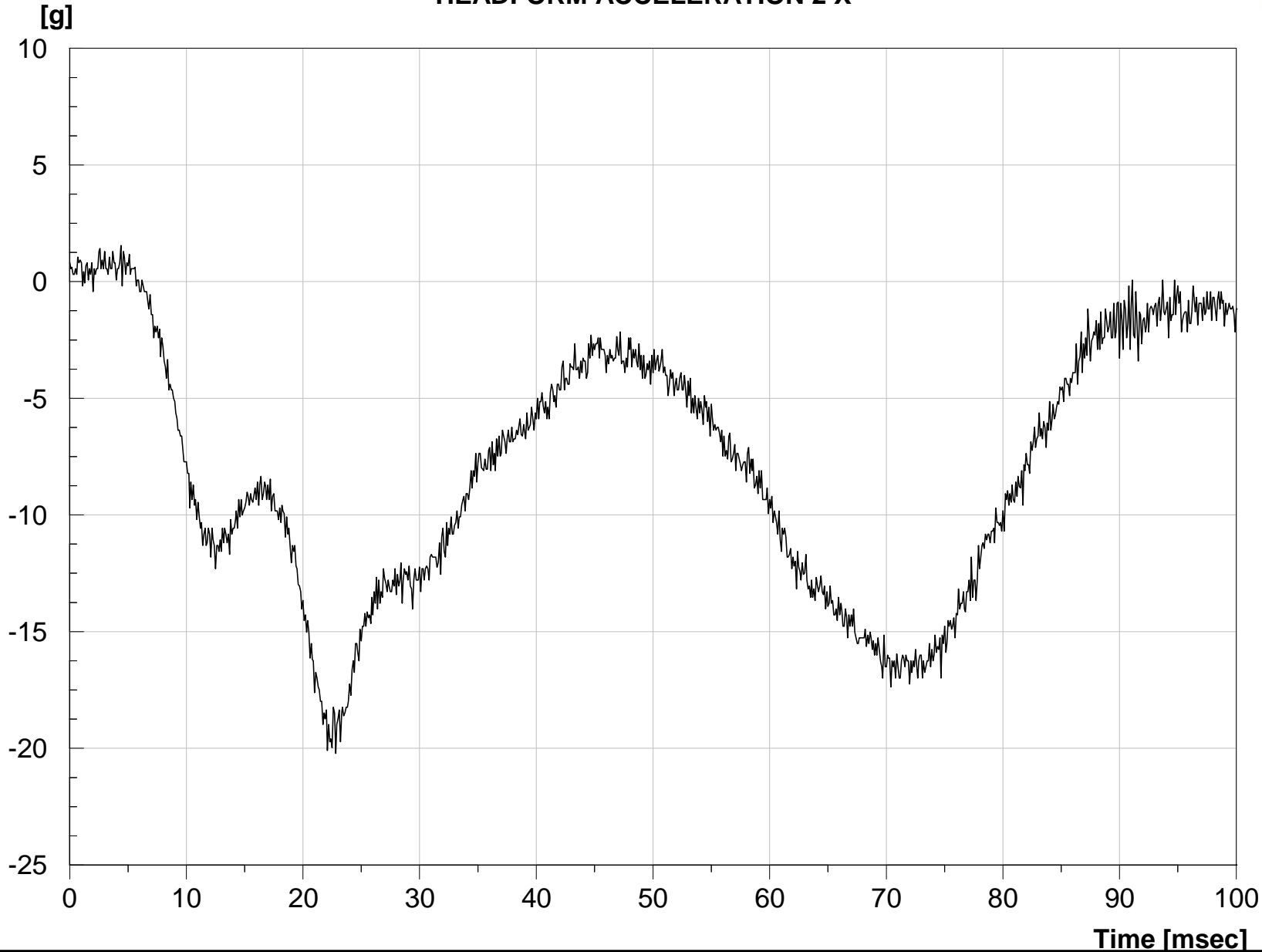
Test Nos. :C17574A  
Customer :Atlantech  
:Seating  
Test Date :13-Jun-18  
Test Type :ECE R17  
:Energy  
:Dissipation  
Impact Point :Front of  
:Head Restraint  
Material Cover :Leather  
Impact Speed :24.34km/h  
Test Engineers :B. Young  
:K. Mir

Filtered at : CFC 1000 (SAE J211)

Max Value : 3.13 g  
Min Value : -20.40 g  
Plot Date : 18/06/2018 at 07:58:22



### HEADFORM ACCELERATION 2 X



Test Nos. :C17574A  
Customer :Atlantech  
:Seating  
Test Date :13-Jun-18  
Test Type :ECE R17  
:Energy  
:Dissipation  
Impact Point :Front of  
:Head Restraint  
Material Cover :Leather  
Impact Speed :24.34km/h  
Test Engineers :B. Young  
:K. Mir

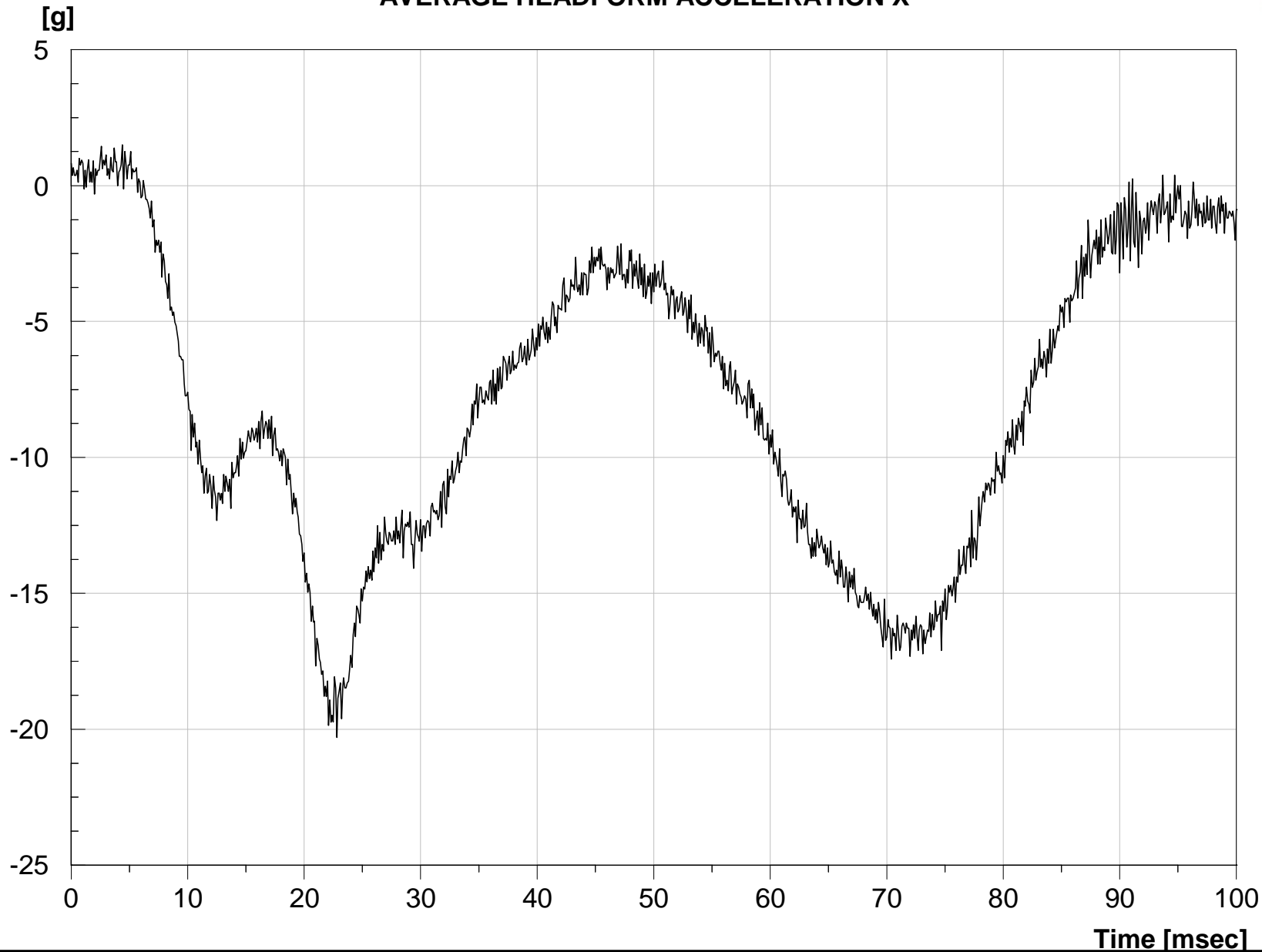
Filtered at : CFC 1000 (SAE J211)

Max Value : 6.49 g  
Min Value : -20.21 g  
Plot Date : 18/06/2018 at 07:58:42





### AVERAGE HEADFORM ACCELERATION X



Test Nos. :C17574A  
Customer :Atlantech  
:Seating  
Test Date :13-Jun-18  
Test Type :ECE R17  
:Energy  
:Dissipation  
Impact Point :Front of  
:Head Restraint  
Material Cover :Leather  
Impact Speed :24.34km/h  
Test Engineers :B. Young  
:K. Mir

3ms Max Value(One Peak)= 16.84 g  
from 21.17 ms to 24.2 ms

Filtered at : CFC 600 (SAE J211)

Max Value : 4.49 g  
Min Value : -20.31 g  
Plot Date : 18/06/2018 at 07:58:43

# Appendix B

# Sensor Calibration Report



Print Date: 29 Sep 2017

|              |                |                   |              |
|--------------|----------------|-------------------|--------------|
| Device No    | 36-9898-R6     | Calibration Date  | 14 Sept 2017 |
| Description  | Load Cell SBA  | Calibration Due   | 14 Sept 2018 |
| Department   | Crash Systems  | Range (Min)       | 0            |
| Manufacturer | Graham & White | Range (Max)       | 50           |
| Model        | CMZ5000        | Engineering Units | kN           |
| Serial No    | 9898-R6        | Output Units      | mV           |
| Comments     | Tension R1     | Calibration Notes | Cal to 30 kN |

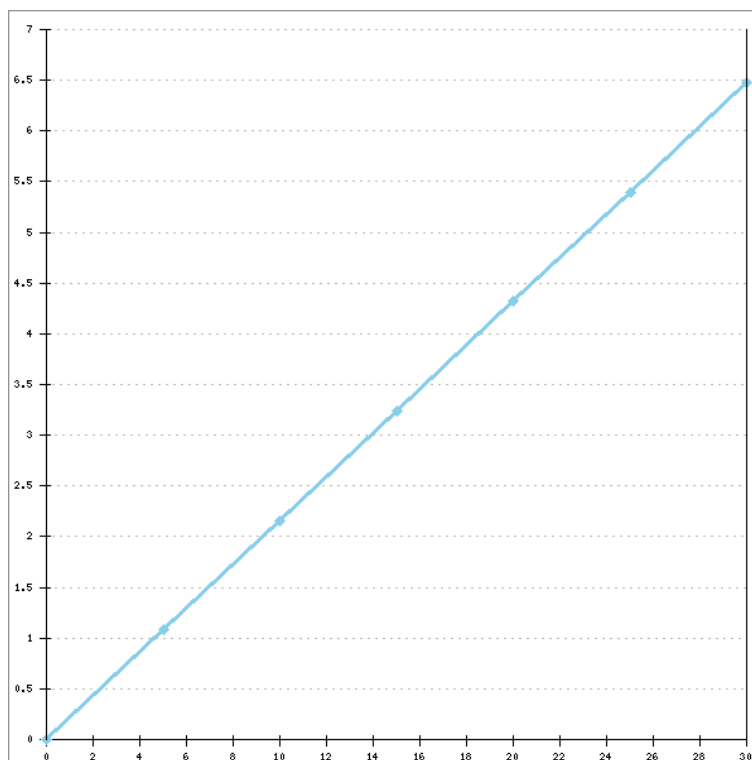
|                          |                   |                         |                         |
|--------------------------|-------------------|-------------------------|-------------------------|
| Procedure                | INW011            | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 5 V               | Calibrated By           | AV                      |
| Temperature              | 20.2 °C           | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 52.6 %            | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar              | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                 | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.0433989 mV/V/kN | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %              | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | 0.1878 mV    | Sensitivity          | 0.0431877 mV/V/kN |
| High Cal     | 0.0096413 mV | KT Gain              | 476.0142          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 1                 |
| Shunt        | 43.779       | Emulation Resistance | 368.698 Ω         |

## Graph Data

| Input  | Output |
|--------|--------|
| 0.000  | 0.000  |
| 5.000  | 1.078  |
| 10.000 | 2.156  |
| 15.000 | 3.236  |
| 20.000 | 4.320  |
| 25.000 | 5.395  |
| 30.000 | 6.478  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 29 Sep 2017

|              |                |                   |              |
|--------------|----------------|-------------------|--------------|
| Device No    | 36-4855-R5     | Calibration Date  | 14 Sept 2017 |
| Description  | Load Cell SBA  | Calibration Due   | 14 Sept 2018 |
| Department   | Crash Systems  | Range (Min)       | 0            |
| Manufacturer | Graham & White | Range (Max)       | 50           |
| Model        | ITS5000        | Engineering Units | kN           |
| Serial No    | 4855-R5        | Output Units      | mV           |
| Comments     | Tension R2     | Calibration Notes | Cal to 30 kN |

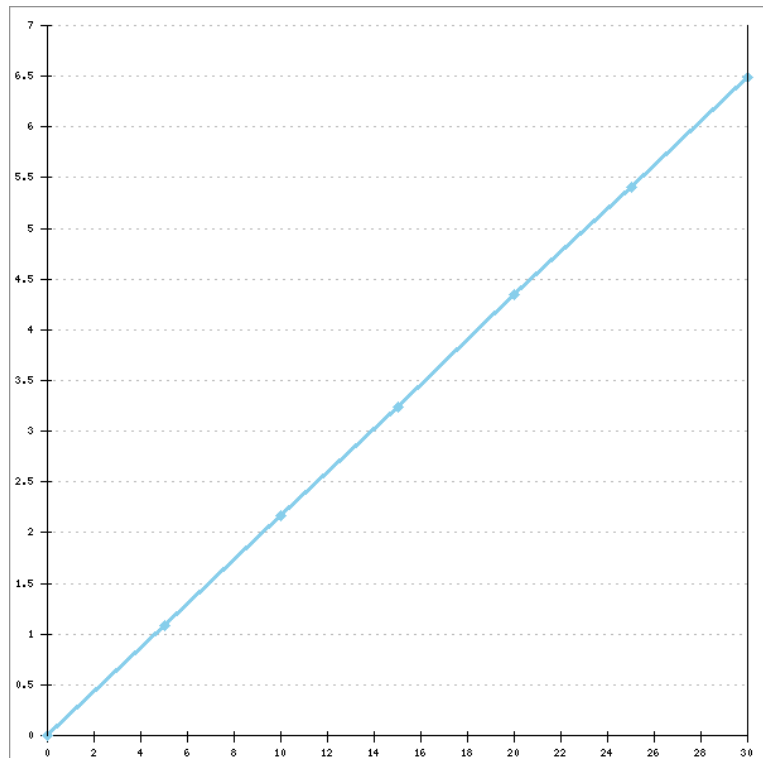
|                          |                   |                         |                         |
|--------------------------|-------------------|-------------------------|-------------------------|
| Procedure                | INW011            | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 5 V               | Calibrated By           | AV                      |
| Temperature              | 20.0 °C           | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 52.6 %            | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar              | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                 | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.0430891 mV/V/kN | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %              | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | -0.00972 mV  | Sensitivity          | 0.0432616 mV/V/kN |
| High Cal     | 0.0093441 mV | KT Gain              | 481.0869          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999995          |
| Shunt        | 43.243       | Emulation Resistance | 353.694 Ω         |

## Graph Data

| Input  | Output |
|--------|--------|
| 0.000  | 0.000  |
| 5.000  | 1.081  |
| 10.000 | 2.162  |
| 15.000 | 3.238  |
| 20.000 | 4.342  |
| 25.000 | 5.403  |
| 30.000 | 6.486  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 15 Jun 2018

|              |                   |                   |              |
|--------------|-------------------|-------------------|--------------|
| Device No    | 36-2579-R7        | Calibration Date  | 14 Sept 2017 |
| Description  | Load Cell SBA     | Calibration Due   | 14 Sept 2018 |
| Department   | Crash Systems     | Range (Min)       | 0            |
| Manufacturer | Proctor & Chester | Range (Max)       | 50           |
| Model        | CMZ5000           | Engineering Units | kN           |
| Serial No    | 2579-R7           | Output Units      | mV           |
| Comments     | Tension R4        | Calibration Notes | Cal to 30 kN |

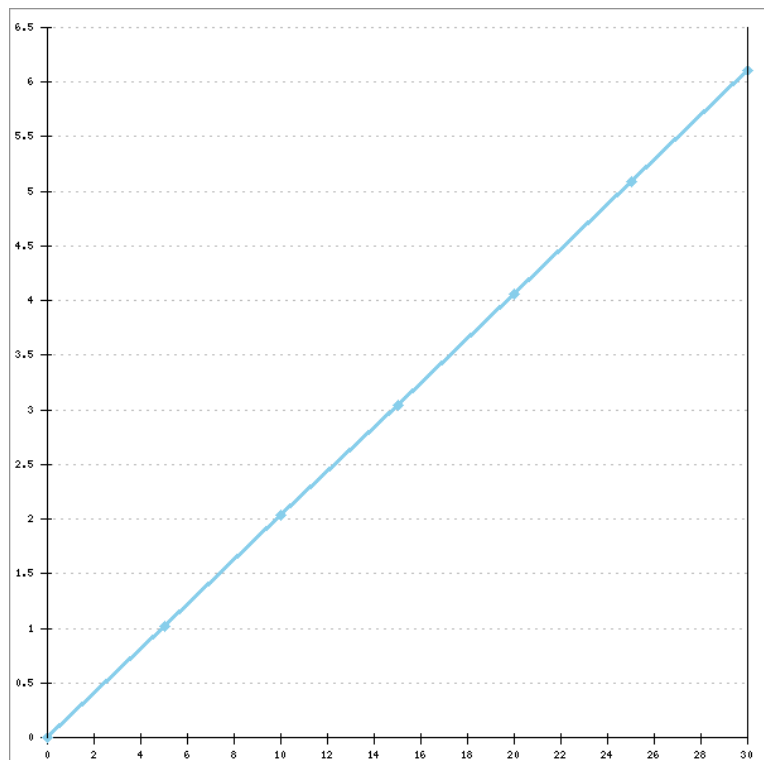
|                          |                   |                         |                         |
|--------------------------|-------------------|-------------------------|-------------------------|
| Procedure                | INW011            | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 5 V               | Calibrated By           | AV                      |
| Temperature              | 20.2 °C           | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 54.8 %            | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar              | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                 | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.0406270 mV/V/kN | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %              | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | -0.8410 mV   | Sensitivity          | 0.0407134 mV/V/kN |
| High Cal     | 0.0085511 mV | KT Gain              | 479.1261          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999997          |
| Shunt        | 46.138       | Emulation Resistance | 376.844 Ω         |

## Graph Data

| Input  | Output |
|--------|--------|
| 0.000  | 0.000  |
| 5.000  | 1.018  |
| 10.000 | 2.036  |
| 15.000 | 3.040  |
| 20.000 | 4.063  |
| 25.000 | 5.089  |
| 30.000 | 6.110  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 2 Oct 2017

|              |               |                   |              |
|--------------|---------------|-------------------|--------------|
| Device No    | 36-37317      | Calibration Date  | 14 Sept 2017 |
| Description  | Load Cell SBA | Calibration Due   | 14 Sept 2018 |
| Department   | Crash Systems | Range (Min)       | 0            |
| Manufacturer | Zemic         | Range (Max)       | 50           |
| Model        | H3-C3-5.0t    | Engineering Units | kN           |
| Serial No    | P2C037317     | Output Units      | mV           |
| Comments     | Tension R8    | Calibration Notes | Cal to 30 kN |

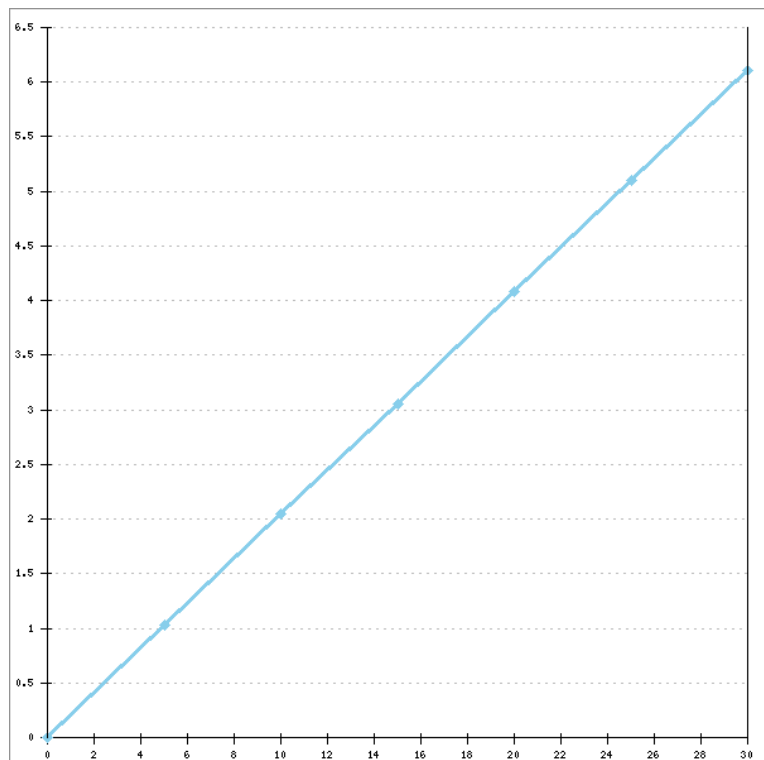
|                          |                   |                         |                         |
|--------------------------|-------------------|-------------------------|-------------------------|
| Procedure                | INW011            | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 5 V               | Calibrated By           | AV                      |
| Temperature              | 20.2 °C           | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 54.8 %            | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar              | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                 | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.0408617 mV/V/kN | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %              | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | -0.0598 mV   | Sensitivity          | 0.0407199 mV/V/kN |
| High Cal     | 0.0093772 mV | KT Gain              | 476.8465          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999996          |
| Shunt        | 46.351       | Emulation Resistance | 386.392 Ω         |

## Graph Data

| Input  | Output |
|--------|--------|
| 0.000  | 0.000  |
| 5.000  | 1.026  |
| 10.000 | 2.047  |
| 15.000 | 3.056  |
| 20.000 | 4.086  |
| 25.000 | 5.101  |
| 30.000 | 6.105  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 2 Oct 2017

|              |                |                   |              |
|--------------|----------------|-------------------|--------------|
| Device No    | 36-4851-R1     | Calibration Date  | 14 Sept 2017 |
| Description  | Load Cell SBA  | Calibration Due   | 14 Sept 2018 |
| Department   | Crash Systems  | Range (Min)       | 0            |
| Manufacturer | Graham & White | Range (Max)       | 50           |
| Model        | ITS5000        | Engineering Units | kN           |
| Serial No    | 4851-R1        | Output Units      | mV           |
| Comments     | Tension R5     | Calibration Notes | Cal to 30 kN |

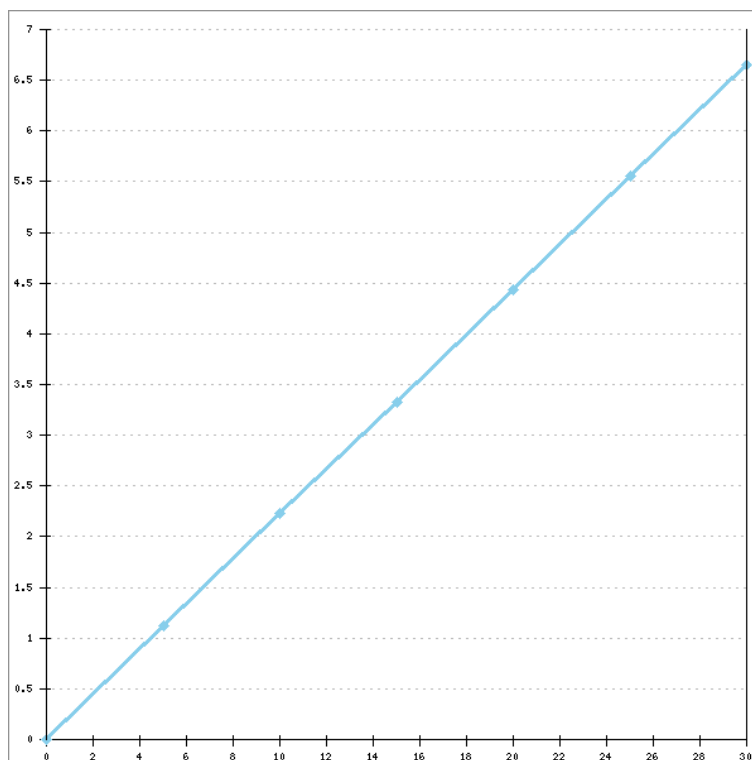
|                          |                   |                         |                         |
|--------------------------|-------------------|-------------------------|-------------------------|
| Procedure                | INW011            | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 5 V               | Calibrated By           | AV                      |
| Temperature              | 20.0 °C           | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 52.6 %            | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar              | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                 | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.0442639 mV/V/kN | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %              | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | -0.1131 mV   | Sensitivity          | 0.0443364 mV/V/kN |
| High Cal     | 0.0093306 mV | KT Gain              | 476.5081          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999999          |
| Shunt        | 42.600       | Emulation Resistance | 353.916 Ω         |

## Graph Data

| Input  | Output |
|--------|--------|
| 0.000  | 0.000  |
| 5.000  | 1.118  |
| 10.000 | 2.224  |
| 15.000 | 3.325  |
| 20.000 | 4.435  |
| 25.000 | 5.551  |
| 30.000 | 6.652  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 2 Oct 2017

|              |               |                   |              |
|--------------|---------------|-------------------|--------------|
| Device No    | 36-37470      | Calibration Date  | 14 Sept 2017 |
| Description  | Load Cell SBA | Calibration Due   | 14 Sept 2018 |
| Department   | Crash Systems | Range (Min)       | 0            |
| Manufacturer | Zemic         | Range (Max)       | 50           |
| Model        | H3-C3-5.0t    | Engineering Units | kN           |
| Serial No    | P2C037470     | Output Units      | mV           |
| Comments     | Tension R6    | Calibration Notes | Cal to 30 kN |

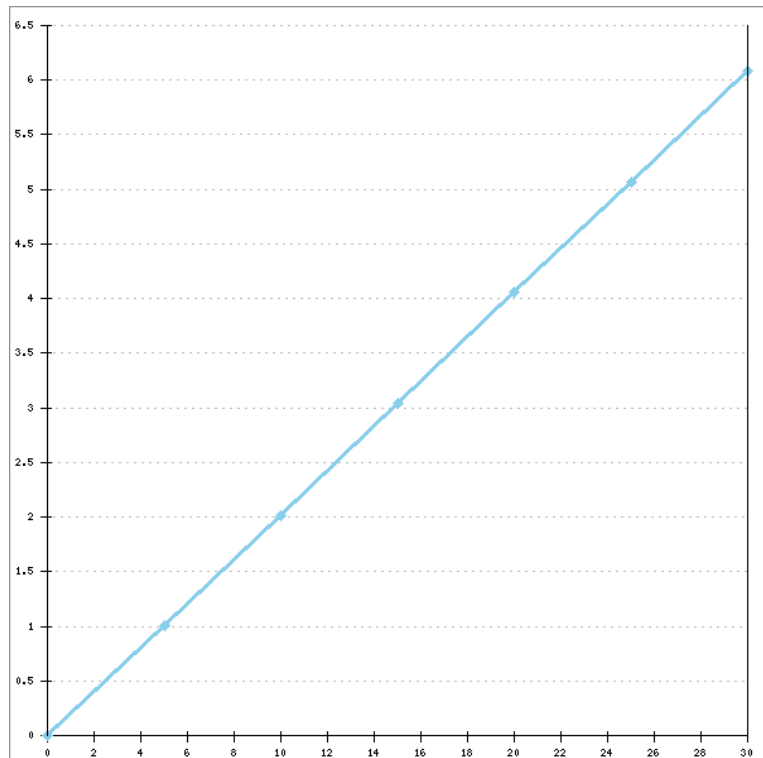
|                          |                   |                         |                         |
|--------------------------|-------------------|-------------------------|-------------------------|
| Procedure                | INW011            | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 5 V               | Calibrated By           | AV                      |
| Temperature              | 20.2 °C           | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 52.6 %            | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar              | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                 | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.0406419 mV/V/kN | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %              | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | -0.0686 mV   | Sensitivity          | 0.0406253 mV/V/kN |
| High Cal     | 0.0093838 mV | KT Gain              | 476.0696          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999997          |
| Shunt        | 46.535       | Emulation Resistance | 381.25 Ω          |

## Graph Data

| Input  | Output |
|--------|--------|
| 0.000  | 0.000  |
| 5.000  | 1.002  |
| 10.000 | 2.015  |
| 15.000 | 3.037  |
| 20.000 | 4.056  |
| 25.000 | 5.071  |
| 30.000 | 6.086  |

## Calibration Graph





# Sensor Calibration Report



Print Date: 2 Oct 2017

|              |                |                   |              |
|--------------|----------------|-------------------|--------------|
| Device No    | 36-4852-R2     | Calibration Date  | 14 Sept 2017 |
| Description  | Load Cell SBA  | Calibration Due   | 14 Sept 2018 |
| Department   | Crash Systems  | Range (Min)       | 0            |
| Manufacturer | Graham & White | Range (Max)       | 50           |
| Model        | ITS5000        | Engineering Units | kN           |
| Serial No    | 4852-R2        | Output Units      | mV           |
| Comments     | Tension R7     | Calibration Notes | Cal to 30 kN |

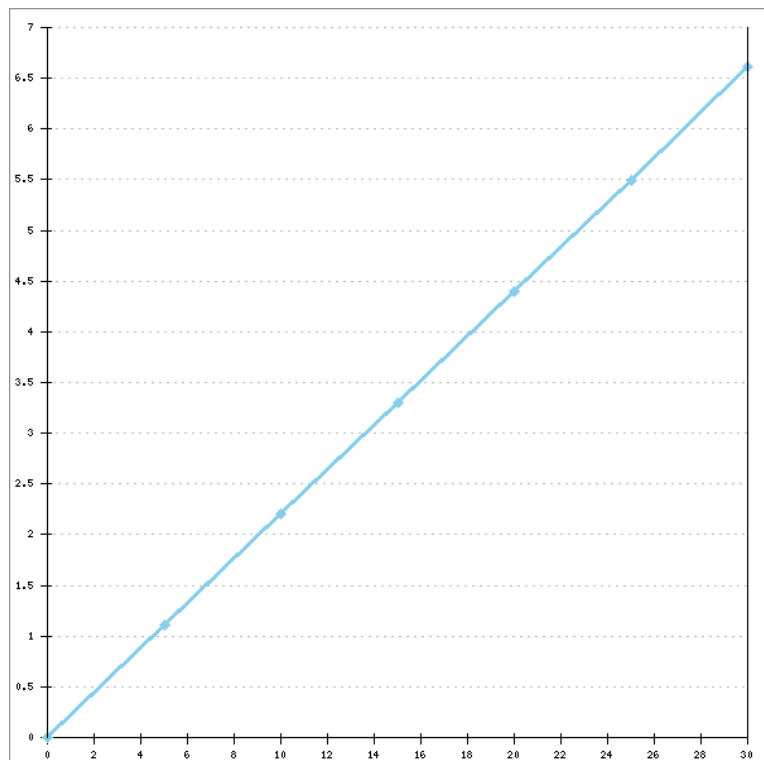
|                          |                   |                         |                         |
|--------------------------|-------------------|-------------------------|-------------------------|
| Procedure                | INW011            | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 5 V               | Calibrated By           | AV                      |
| Temperature              | 20.0 °C           | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 52.6 %            | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar              | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                 | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.0437773 mV/V/kN | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %              | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | -1.2021 mV   | Sensitivity          | 0.0440539 mV/V/kN |
| High Cal     | 0.0082635 mV | KT Gain              | 475.4057          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999997          |
| Shunt        | 42.973       | Emulation Resistance | 354.33 Ω          |

## Graph Data

| Input  | Output |
|--------|--------|
| 0.000  | 0.000  |
| 5.000  | 1.104  |
| 10.000 | 2.200  |
| 15.000 | 3.300  |
| 20.000 | 4.400  |
| 25.000 | 5.499  |
| 30.000 | 6.616  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 2 Oct 2017

|              |               |                   |              |
|--------------|---------------|-------------------|--------------|
| Device No    | 36-37424      | Calibration Date  | 14 Sept 2017 |
| Description  | Load Cell SBA | Calibration Due   | 14 Sept 2018 |
| Department   | Crash Systems | Range (Min)       | 0            |
| Manufacturer | Zemic         | Range (Max)       | 50           |
| Model        | H3-C3-5.0t    | Engineering Units | kN           |
| Serial No    | P2C037424     | Output Units      | mV           |
| Comments     | Tension R8    | Calibration Notes | Cal to 30 kN |

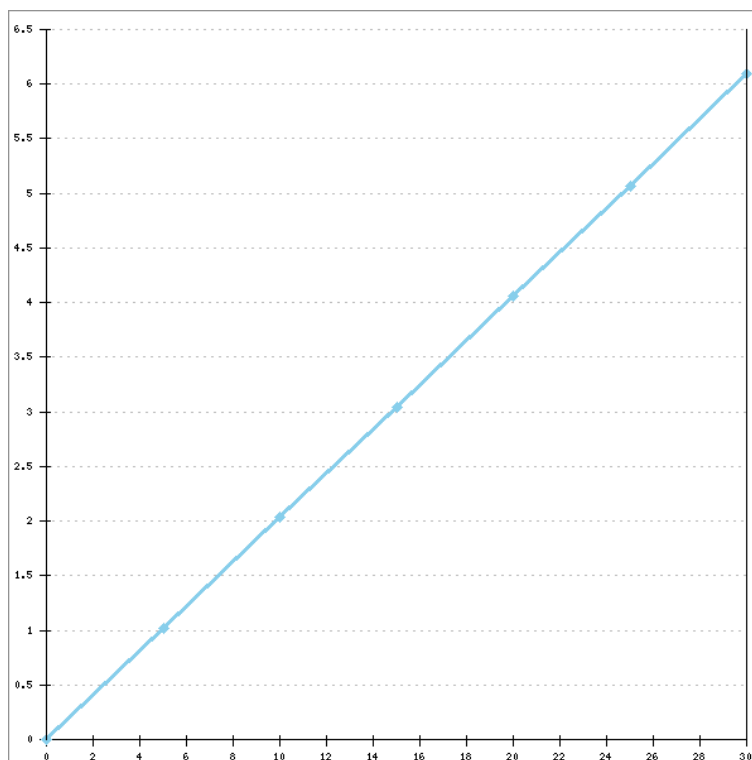
|                          |                   |                         |                         |
|--------------------------|-------------------|-------------------------|-------------------------|
| Procedure                | INW011            | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 5 V               | Calibrated By           | AV                      |
| Temperature              | 20.2 °C           | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 52.5 %            | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar              | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                 | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.0406419 mV/V/kN | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %              | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | -0.0834 mV   | Sensitivity          | 0.0405657 mV/V/kN |
| High Cal     | 0.0093588 mV | KT Gain              | 476.5838          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999997          |
| Shunt        | 46.553       | Emulation Resistance | 381.794 Ω         |

## Graph Data

| Input  | Output |
|--------|--------|
| 0.000  | 0.000  |
| 5.000  | 1.021  |
| 10.000 | 2.035  |
| 15.000 | 3.041  |
| 20.000 | 4.061  |
| 25.000 | 5.065  |
| 30.000 | 6.094  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 6 Oct 2017

|              |              |                   |             |
|--------------|--------------|-------------------|-------------|
| Device No    | 21-0302-46   | Calibration Date  | 02 Aug 2017 |
| Description  | Angle Meter  | Calibration Due   | 02 Aug 2018 |
| Department   | Crash Sled   | Range (Min)       | -90         |
| Manufacturer | RS           | Range (Max)       | 90          |
| Model        | 667-3916     | Engineering Units | Deg         |
| Serial No    | 150401-00302 | Output Units      | Deg         |
| Comments     |              | Calibration Notes | Tilt Table  |

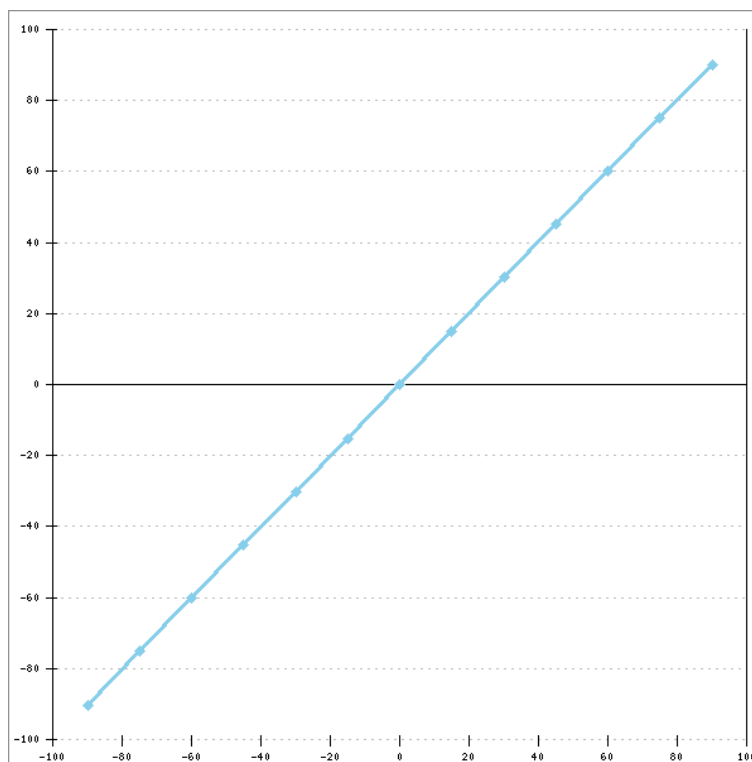
|                          |         |                         |                          |
|--------------------------|---------|-------------------------|--------------------------|
| Procedure                | INW004  | Calibration Uncertainty | 0.25761% min 0.69646 Deg |
| Supply Voltage           | 1 V     | Calibrated By           | AV                       |
| Temperature              | 19.8 °C | Calibration Equipment 1 | 50-8894-07               |
| Humidity                 | 59.3 %  | Calibration Equipment 2 |                          |
| Barometric Pressure      | mBar    | Calibration Equipment 3 |                          |
| Amplifier Gain           | 1       | Calibration Equipment 4 |                          |
| Manufacturer Sensitivity | 1       | Calibration Equipment 5 |                          |
| Tolerance                | ±1 %    | Calibration Equipment 6 |                          |

|              |           |                      |           |
|--------------|-----------|----------------------|-----------|
| Low Cal      | -0.084 mV | Sensitivity          | 1.0021978 |
| High Cal     | 0.09 mV   | KT Gain              | 10.0000   |
| Cal Resistor | k         | Correlation          | 0.999999  |
| Shunt        | 89.803    | Emulation Resistance | 90        |

## Graph Data

| Input   | Output  |
|---------|---------|
| -90.000 | -90.250 |
| -75.000 | -75.200 |
| -60.000 | -60.200 |
| -45.000 | -45.300 |
| -30.000 | -30.200 |
| -15.000 | -15.200 |
| 0.000   | -0.100  |
| 15.000  | 15.000  |
| 30.000  | 30.100  |
| 45.000  | 45.100  |
| 60.000  | 60.100  |
| 75.000  | 75.000  |
| 90.000  | 90.050  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 2 Oct 2017

|              |                        |                   |              |
|--------------|------------------------|-------------------|--------------|
| Device No    | 17-0619-23             | Calibration Date  | 28 Sept 2017 |
| Description  | Elect Servo Controller | Calibration Due   | 28 Sept 2018 |
| Department   | Crash Systems          | Range (Min)       | 0            |
| Manufacturer | Tiab                   | Range (Max)       | 25           |
| Model        | TP6844                 | Engineering Units | kN           |
| Serial No    | 00619                  | Output Units      | kN           |
| Comments     |                        | Calibration Notes | Ch1          |

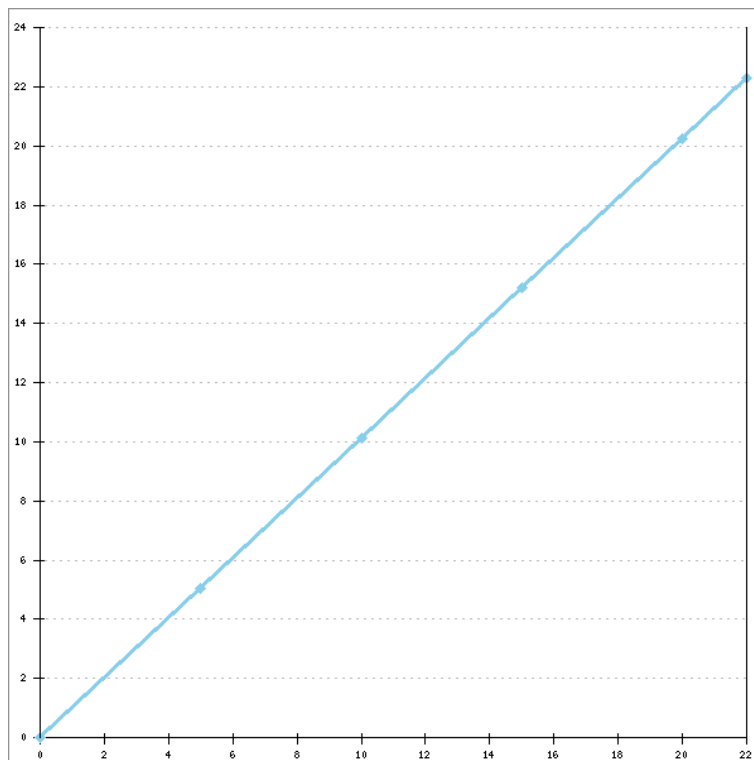
|                          |         |                         |                         |
|--------------------------|---------|-------------------------|-------------------------|
| Procedure                | INW009  | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 1 V     | Calibrated By           | Dept                    |
| Temperature              | 20.2 °C | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 71.6 %  | Calibration Equipment 2 | 46-1971-64              |
| Barometric Pressure      | mBar    | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1       | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 1       | Calibration Equipment 5 |                         |
| Tolerance                | ±0.5 %  | Calibration Equipment 6 |                         |

|              |          |                      |           |
|--------------|----------|----------------------|-----------|
| Low Cal      | 0 mV     | Sensitivity          | 1.0131922 |
| High Cal     | 0.025 mV | KT Gain              | 36.0000   |
| Cal Resistor | Dept k   | Correlation          | 1         |
| Shunt        | 24.674   | Emulation Resistance | 10        |

## Graph Data

| Input  | Output |
|--------|--------|
| 0.000  | 0.000  |
| 5.000  | 5.052  |
| 10.000 | 10.118 |
| 15.000 | 15.187 |
| 20.000 | 20.261 |
| 22.000 | 22.283 |

## Calibration Graph



# Sensor Calibration Report



Print Date: 2 Oct 2017

|              |                    |                   |             |
|--------------|--------------------|-------------------|-------------|
| Device No    | SP042              | Calibration Date  | 05 Jan 2017 |
| Description  | Disp Transd String | Calibration Due   | 05 Jan 2018 |
| Department   | Crash              | Range (Min)       | 0           |
| Manufacturer | Graham & White     | Range (Max)       | 1000        |
| Model        | 1850-040           | Engineering Units | mm          |
| Serial No    | 13008-004          | Output Units      | mV          |
| Comments     | DTS                | Calibration Notes |             |

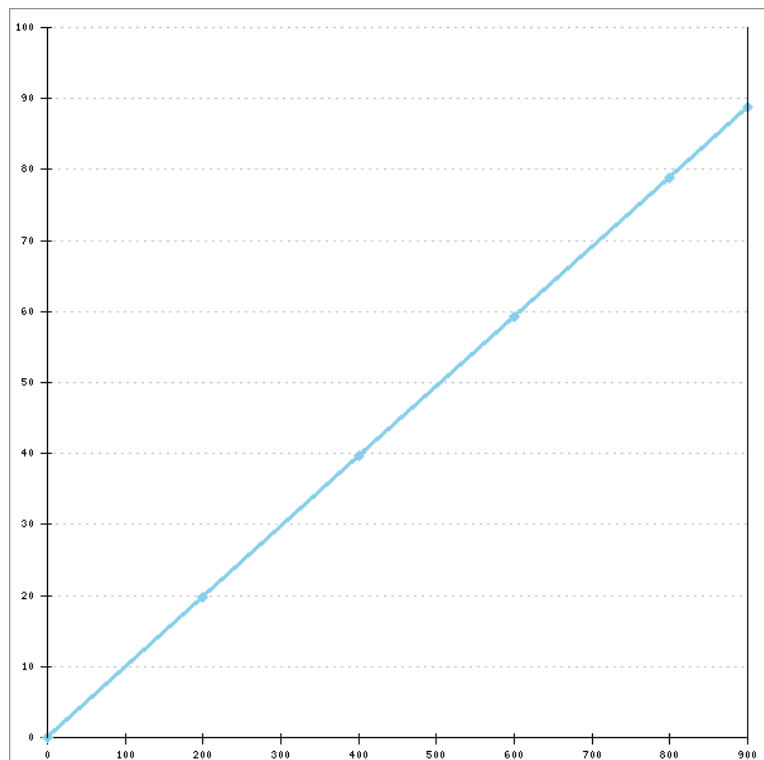
|                          |                  |                         |                         |
|--------------------------|------------------|-------------------------|-------------------------|
| Procedure                | INW006           | Calibration Uncertainty | 0.04050% min 0.41274 mm |
| Supply Voltage           | 5 V              | Calibrated By           | BM                      |
| Temperature              | 21.3 °C          | Calibration Equipment 1 | 49-MPG173               |
| Humidity                 | 30.8 %           | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar             | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.019616 mV/V/mm | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %             | Calibration Equipment 6 |                         |

|              |            |                      |                   |
|--------------|------------|----------------------|-------------------|
| Low Cal      | -41.129 mV | Sensitivity          | 0.0197098 mV/V/mm |
| High Cal     | 1.74680 mV | KT Gain              | 2.5169            |
| Cal Resistor | 4.99 kΩ    | Correlation          | 0.999997          |
| Shunt        | 18142.561  | Emulation Resistance | 23731.02 Ω        |

## Graph Data

| Input   | Output |
|---------|--------|
| 0.000   | 0.000  |
| 200.000 | 19.823 |
| 400.000 | 39.614 |
| 600.000 | 59.306 |
| 800.000 | 78.912 |
| 900.000 | 88.705 |

## Calibration Graph



# Sensor Calibration Report



Print Date: 2 Oct 2017

|              |                    |                   |             |
|--------------|--------------------|-------------------|-------------|
| Device No    | SP027              | Calibration Date  | 05 Jan 2017 |
| Description  | Disp Transd String | Calibration Due   | 05 Jan 2018 |
| Department   | Crash Sled         | Range (Min)       | 0           |
| Manufacturer | Graham & White     | Range (Max)       | 1000        |
| Model        | 1850-040           | Engineering Units | mm          |
| Serial No    | 12754-003          | Output Units      | mV          |
| Comments     | DTS                | Calibration Notes |             |

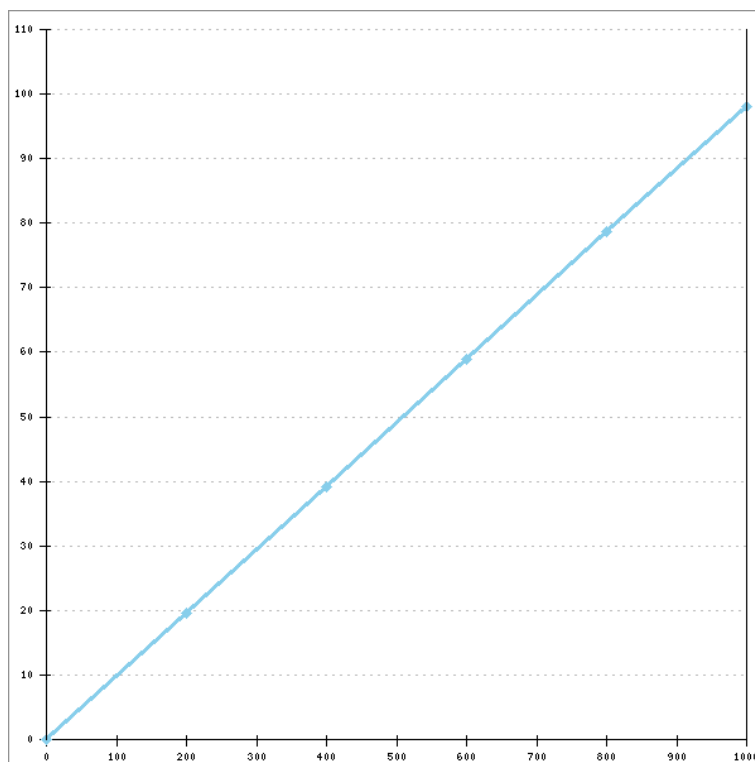
|                          |                 |                         |                         |
|--------------------------|-----------------|-------------------------|-------------------------|
| Procedure                | INW006          | Calibration Uncertainty | 0.04050% min 0.41274 mm |
| Supply Voltage           | 5 V             | Calibrated By           | BM                      |
| Temperature              | 21.3 °C         | Calibration Equipment 1 | 49-MPG173               |
| Humidity                 | 30.8 %          | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar            | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1               | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.01976 mV/V/mm | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %            | Calibration Equipment 6 |                         |

|              |            |                      |                   |
|--------------|------------|----------------------|-------------------|
| Low Cal      | -49.670 mV | Sensitivity          | 0.0196499 mV/V/mm |
| High Cal     | 1.74506 mV | KT Gain              | 2.5073            |
| Cal Resistor | 4.99 kΩ    | Correlation          | 0.999997          |
| Shunt        | 18267.052  | Emulation Resistance | 23759.72 Ω        |

## Graph Data

| Input    | Output |
|----------|--------|
| 0.000    | 0.000  |
| 200.000  | 19.535 |
| 400.000  | 39.201 |
| 600.000  | 58.991 |
| 800.000  | 78.684 |
| 1000.000 | 98.102 |

## Calibration Graph



# Sensor Calibration Report



Print Date: 8 Nov 2017

|              |               |                   |             |
|--------------|---------------|-------------------|-------------|
| Device No    | 54-MPG247     | Calibration Date  | 11 Jul 2017 |
| Description  | Disp Tape     | Calibration Due   | 11 Jul 2018 |
| Department   | Crash Systems | Range (Min)       | 0           |
| Manufacturer | Kennedy Tools | Range (Max)       | 3           |
| Model        | KEN-536-1830K | Engineering Units | m           |
| Serial No    | 54-MPG247     | Output Units      | m           |
| Comments     |               | Calibration Notes |             |

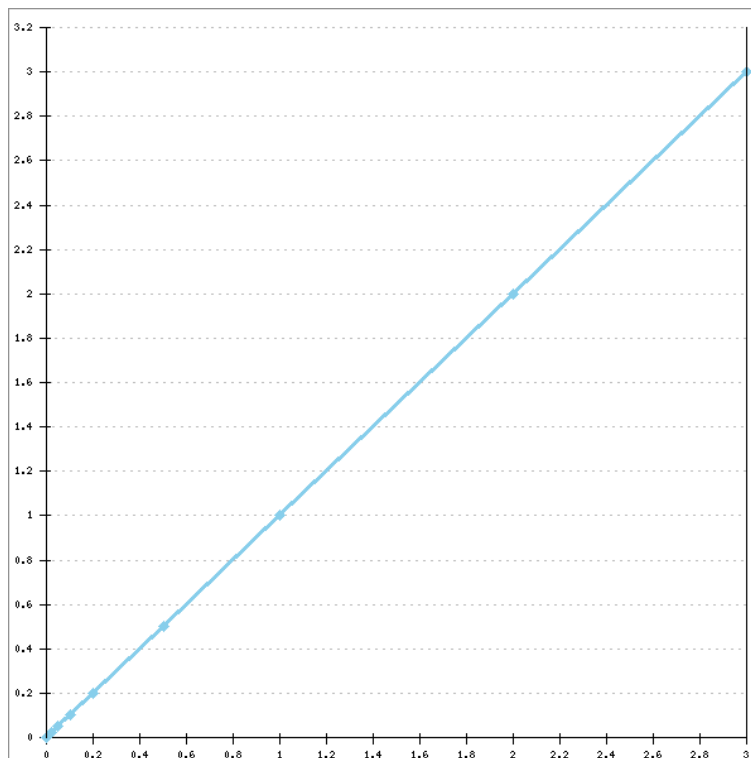
|                          |         |                         |                         |
|--------------------------|---------|-------------------------|-------------------------|
| Procedure                | INW006  | Calibration Uncertainty | 0.0139% min 0.0000962 m |
| Supply Voltage           | 1 V     | Calibrated By           | TM                      |
| Temperature              | 20.3 °C | Calibration Equipment 1 | 49-MPG072               |
| Humidity                 | 62.8 %  | Calibration Equipment 2 |                         |
| Barometric Pressure      | mBar    | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1       | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 1.0000  | Calibration Equipment 5 |                         |
| Tolerance                | ±1 %    | Calibration Equipment 6 |                         |

|              |          |                      |           |
|--------------|----------|----------------------|-----------|
| Low Cal      | 0 mV     | Sensitivity          | 1.0000000 |
| High Cal     | 0.003 mV | KT Gain              | 300.0000  |
| Cal Resistor | k        | Correlation          | 1         |
| Shunt        | 3.000    | Emulation Resistance | 30        |

## Graph Data

| Input | Output |
|-------|--------|
| 0.000 | 0.000  |
| 0.010 | 0.010  |
| 0.020 | 0.020  |
| 0.050 | 0.050  |
| 0.100 | 0.100  |
| 0.200 | 0.200  |
| 0.500 | 0.500  |
| 1.000 | 1.000  |
| 2.000 | 2.000  |
| 3.000 | 3.000  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 26 Mar 2018

|              |             |                   |             |
|--------------|-------------|-------------------|-------------|
| Device No    | B62750      | Calibration Date  | 07 Dec 2017 |
| Description  | Accel       | Calibration Due   | 07 Dec 2018 |
| Department   | Crash ATD   | Range (Min)       | -2000       |
| Manufacturer | Endevco     | Range (Max)       | 2000        |
| Model        | 7264B-2000T | Engineering Units | g           |
| Serial No    | B62750      | Output Units      | mV          |
| Comments     |             | Calibration Notes | Screw Clamp |

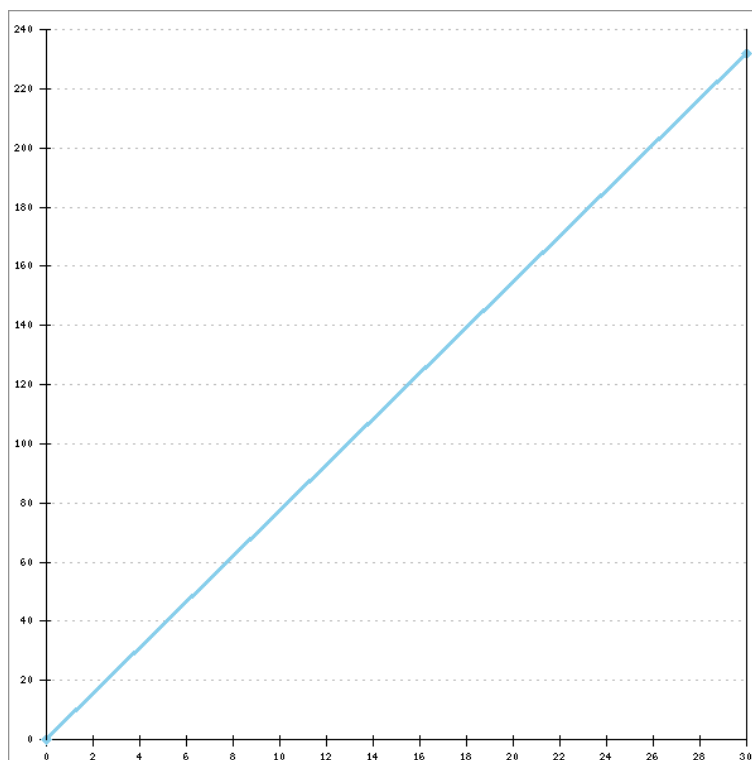
|                          |                |                         |                       |
|--------------------------|----------------|-------------------------|-----------------------|
| Procedure                | INW003         | Calibration Uncertainty | 1.20796% min 0.0248 g |
| Supply Voltage           | 5 V            | Calibrated By           | VM                    |
| Temperature              | 20.6 °C        | Calibration Equipment 1 | 50-CB37-36            |
| Humidity                 | 40.3 %         | Calibration Equipment 2 | 50-9081-24            |
| Barometric Pressure      | mBar           | Calibration Equipment 3 | 50-EE01-35            |
| Amplifier Gain           | 100.6638       | Calibration Equipment 4 | 50-2689-96            |
| Manufacturer Sensitivity | 0.02178 mV/V/g | Calibration Equipment 5 | 51-8135-55            |
| Tolerance                | ±2.5 %         | Calibration Equipment 6 | 50-4154-97            |

|              |            |                      |                  |
|--------------|------------|----------------------|------------------|
| Low Cal      | 848.05 mV  | Sensitivity          | 0.0217026 mV/V/g |
| High Cal     | 3.58545 mV | KT Gain              | 165.4808         |
| Cal Resistor | 23.2 kΩ    | Correlation          | 1                |
| Shunt        | 250.601    | Emulation Resistance | 514.676 Ω        |

## Graph Data

| Input  | Output  |
|--------|---------|
| 0.000  | 0.000   |
| 30.000 | 231.719 |

## Calibration Graph





# Sensor Calibration Report



Print Date: 26 Mar 2018

|              |             |                   |             |
|--------------|-------------|-------------------|-------------|
| Device No    | B66822      | Calibration Date  | 07 Dec 2017 |
| Description  | Accel       | Calibration Due   | 07 Dec 2018 |
| Department   | Crash Cal   | Range (Min)       | -2000       |
| Manufacturer | Endevco     | Range (Max)       | 2000        |
| Model        | 7264B-2000T | Engineering Units | g           |
| Serial No    | B66822      | Output Units      | mV          |
| Comments     | 630Hz,23k2  | Calibration Notes | Screw Clamp |

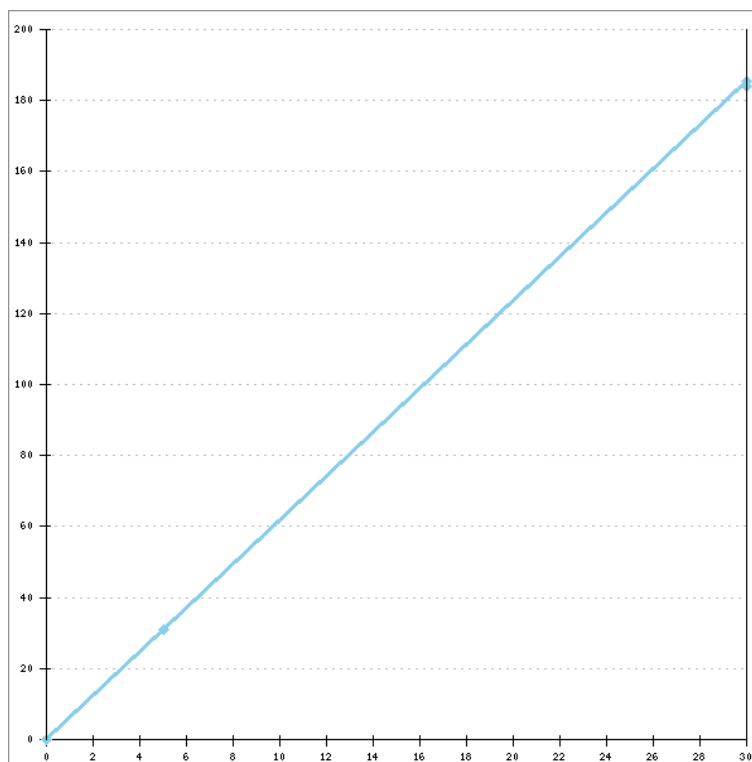
|                          |                  |                         |                       |
|--------------------------|------------------|-------------------------|-----------------------|
| Procedure                | INW003           | Calibration Uncertainty | 1.20796% min 0.0248 g |
| Supply Voltage           | 5 V              | Calibrated By           | VM                    |
| Temperature              | 20.4 °C          | Calibration Equipment 1 | 50-CB37-36            |
| Humidity                 | 40.1 %           | Calibration Equipment 2 | 50-9081-24            |
| Barometric Pressure      | mBar             | Calibration Equipment 3 | 50-EE01-35            |
| Amplifier Gain           | 100.6638         | Calibration Equipment 4 | 50-2689-96            |
| Manufacturer Sensitivity | 0.0172684 mV/V/g | Calibration Equipment 5 | 51-8135-55            |
| Tolerance                | ±2.5 %           | Calibration Equipment 6 | 50-4154-97            |

|              |            |                      |                  |
|--------------|------------|----------------------|------------------|
| Low Cal      | 2570.14 mV | Sensitivity          | 0.0172848 mV/V/g |
| High Cal     | 5.30656 mV | KT Gain              | 165.5400         |
| Cal Resistor | 3F kΩ      | Correlation          | 0.999977         |
| Shunt        | 314.539    | Emulation Resistance | 514.676 Ω        |

## Graph Data

| Input  | Output  |
|--------|---------|
| 0.000  | 0.000   |
| 5.000  | 31.125  |
| 30.000 | 185.493 |
| 30.000 | 183.907 |

## Calibration Graph



# Sensor Calibration Report



Print Date: 26 Mar 2018

|              |            |                   |             |
|--------------|------------|-------------------|-------------|
| Device No    | B66858     | Calibration Date  | 11 Oct 2017 |
| Description  | Accel      | Calibration Due   | 11 Oct 2018 |
| Department   | Crash      | Range (Min)       | -2000       |
| Manufacturer | Endevco    | Range (Max)       | 2000        |
| Model        | 7264B-2000 | Engineering Units | g           |
| Serial No    | B66858     | Output Units      | mV          |
| Comments     |            | Calibration Notes | Screw Clamp |

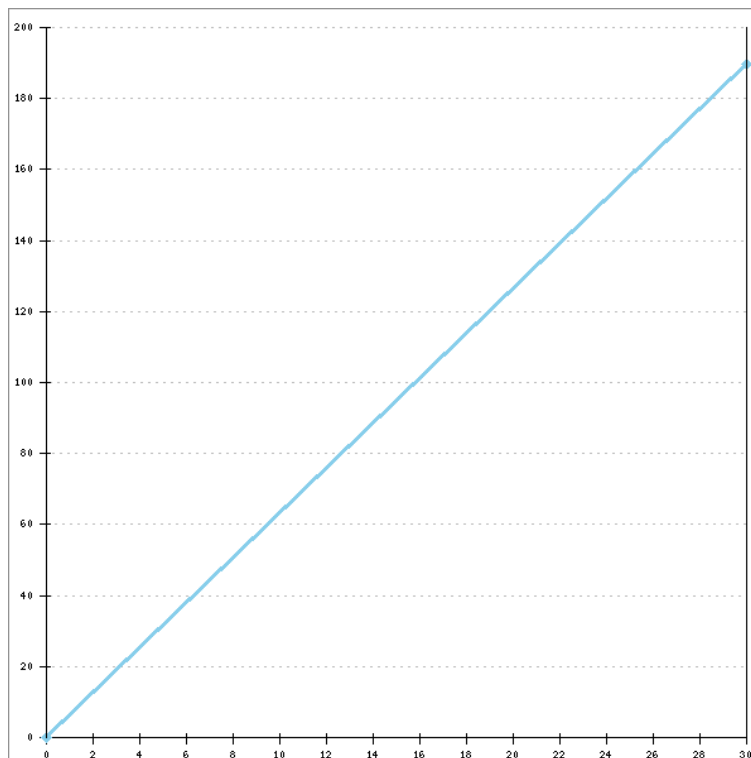
|                          |                  |                         |                       |
|--------------------------|------------------|-------------------------|-----------------------|
| Procedure                | INW003           | Calibration Uncertainty | 1.20796% min 0.0248 g |
| Supply Voltage           | 5 V              | Calibrated By           | RS                    |
| Temperature              | 20.5 °C          | Calibration Equipment 1 | 50-CB37-36            |
| Humidity                 | 62.5 %           | Calibration Equipment 2 | 50-9081-24            |
| Barometric Pressure      | mBar             | Calibration Equipment 3 | 50-EE01-35            |
| Amplifier Gain           | 100.6838         | Calibration Equipment 4 | 50-2689-96            |
| Manufacturer Sensitivity | 0.0176862 mV/V/g | Calibration Equipment 5 | 51-8135-55            |
| Tolerance                | ±2.5 %           | Calibration Equipment 6 | 50-4154-97            |

|              |            |                      |                  |
|--------------|------------|----------------------|------------------|
| Low Cal      | 993.20 mV  | Sensitivity          | 0.0177561 mV/V/g |
| High Cal     | 3.72871 mV | KT Gain              | 165.6280         |
| Cal Resistor | 23.2 kΩ    | Correlation          | 1                |
| Shunt        | 306.027    | Emulation Resistance | 514.5 Ω          |

## Graph Data

| Input  | Output  |
|--------|---------|
| 0.000  | 0.000   |
| 30.000 | 189.620 |

## Calibration Graph



# Sensor Calibration Report



Print Date: 26 Mar 2018

|              |            |                   |             |
|--------------|------------|-------------------|-------------|
| Device No    | B66860     | Calibration Date  | 02 Nov 2017 |
| Description  | Accel      | Calibration Due   | 02 Nov 2018 |
| Department   | Crash      | Range (Min)       | -2000       |
| Manufacturer | Endevco    | Range (Max)       | 2000        |
| Model        | 7264B-2000 | Engineering Units | g           |
| Serial No    | B66860     | Output Units      | mV          |
| Comments     |            | Calibration Notes | Screw Clamp |

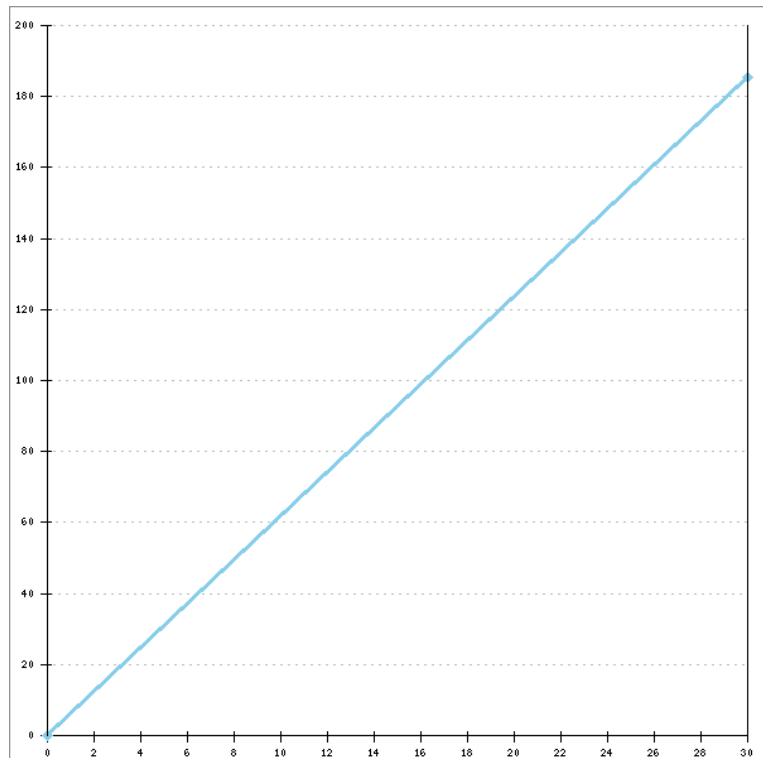
|                          |                  |                         |                       |
|--------------------------|------------------|-------------------------|-----------------------|
| Procedure                | INW003           | Calibration Uncertainty | 1.20796% min 0.0248 g |
| Supply Voltage           | 5 V              | Calibrated By           | AV                    |
| Temperature              | 20.0 °C          | Calibration Equipment 1 | 50-CB37-36            |
| Humidity                 | 49.0 %           | Calibration Equipment 2 | 50-9081-24            |
| Barometric Pressure      | mBar             | Calibration Equipment 3 | 50-EE01-35            |
| Amplifier Gain           | 100.6638         | Calibration Equipment 4 | 50-2689-96            |
| Manufacturer Sensitivity | 0.0172562 mV/V/g | Calibration Equipment 5 | 51-8135-55            |
| Tolerance                | ±2.5 %           | Calibration Equipment 6 | 50-4154-97            |

|              |            |                      |                  |
|--------------|------------|----------------------|------------------|
| Low Cal      | 2958.58 mV | Sensitivity          | 0.0173495 mV/V/g |
| High Cal     | 5.69779 mV | KT Gain              | 165.3714         |
| Cal Resistor | 23.2 kΩ    | Correlation          | 1                |
| Shunt        | 313.686    | Emulation Resistance | 519.834 Ω        |

## Graph Data

| Input  | Output  |
|--------|---------|
| 0.000  | 0.000   |
| 30.000 | 185.241 |

## Calibration Graph



# Sensor Calibration Report



Print Date: 15 Feb 2018

|              |                   |                   |             |
|--------------|-------------------|-------------------|-------------|
| Device No    | 36-3788           | Calibration Date  | 18 Jan 2018 |
| Description  | Load Cell         | Calibration Due   | 18 Jan 2019 |
| Department   | Crash Systems     | Range (Min)       | 0           |
| Manufacturer | Proctor & Chester | Range (Max)       | 500         |
| Model        | FZ601             | Engineering Units | Kg          |
| Serial No    | 13788             | Output Units      | mV          |
| Comments     |                   | Calibration Notes | Tension     |

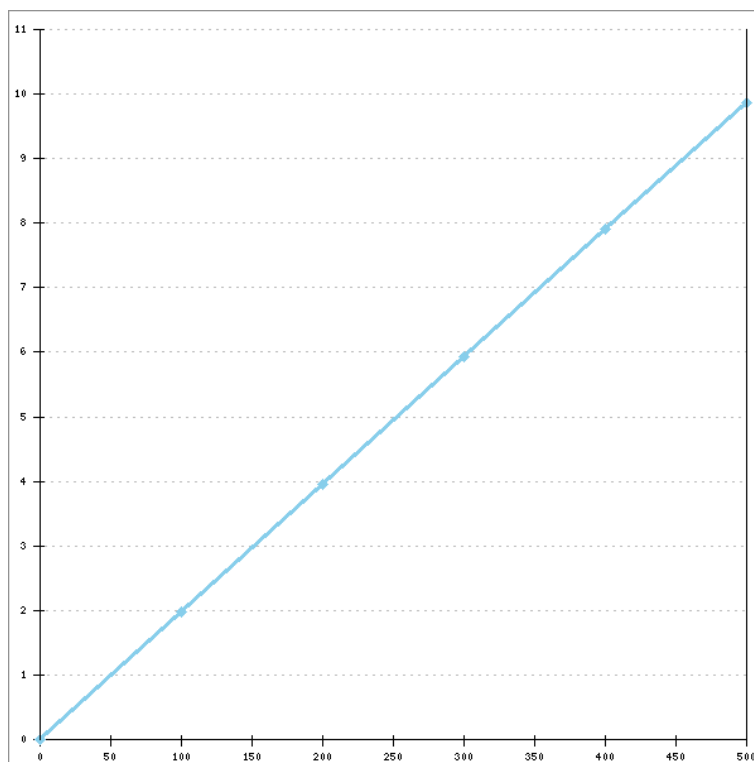
|                          |                 |                         |                         |
|--------------------------|-----------------|-------------------------|-------------------------|
| Procedure                | INW011          | Calibration Uncertainty | 0.12254% min 0.11547 Kg |
| Supply Voltage           | 5 V             | Calibrated By           | VM                      |
| Temperature              | 20.6 °C         | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 35.3 %          | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar            | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1               | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.00397 mV/V/Kg | Calibration Equipment 5 |                         |
| Tolerance                | ±2 %            | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | 0.3992 mV    | Sensitivity          | 0.0039463 mV/V/Kg |
| High Cal     | 0.0098882 mV | KT Gain              | 474.2333          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999999          |
| Shunt        | 480.910      | Emulation Resistance | 390.05 Ω          |

## Graph Data

| Input   | Output |
|---------|--------|
| 0.000   | 0.000  |
| 100.000 | 1.986  |
| 200.000 | 3.953  |
| 300.000 | 5.927  |
| 400.000 | 7.901  |
| 500.000 | 9.868  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 15 Feb 2018

|              |               |                   |                |
|--------------|---------------|-------------------|----------------|
| Device No    | 36-2685-26    | Calibration Date  | 07 Aug 2017    |
| Description  | Load Cell     | Calibration Due   | 07 Aug 2018    |
| Department   | Crash Systems | Range (Min)       | 0              |
| Manufacturer | Straingauge   | Range (Max)       | 2000           |
| Model        | AW2000        | Engineering Units | Kg             |
| Serial No    | A32685        | Output Units      | mV             |
| Comments     |               | Calibration Notes | Tension 3/4BSW |

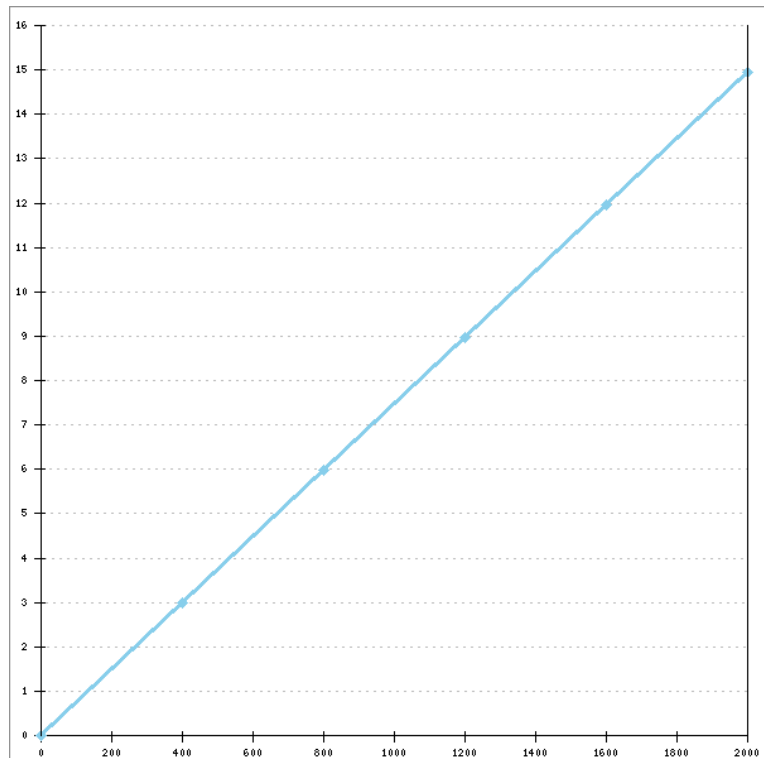
|                          |                  |                         |                         |
|--------------------------|------------------|-------------------------|-------------------------|
| Procedure                | INW011           | Calibration Uncertainty | 0.12254% min 0.11547 Kg |
| Supply Voltage           | 5 V              | Calibrated By           | VM                      |
| Temperature              | 20.2 °C          | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 65.2 %           | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar             | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.001493 mV/V/Kg | Calibration Equipment 5 |                         |
| Tolerance                | ±2 %             | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | 0.0171 mV    | Sensitivity          | 0.0014933 mV/V/Kg |
| High Cal     | 0.0094546 mV | KT Gain              | 476.8212          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 1                 |
| Shunt        | 1263.946     | Emulation Resistance | 380.916 Ω         |

## Graph Data

| Input    | Output |
|----------|--------|
| 0.000    | 0.000  |
| 400.000  | 2.989  |
| 800.000  | 5.976  |
| 1200.000 | 8.958  |
| 1600.000 | 11.951 |
| 2000.000 | 14.933 |

## Calibration Graph



# Sensor Calibration Report



Print Date: 15 Feb 2018

|              |                   |                   |             |
|--------------|-------------------|-------------------|-------------|
| Device No    | 36-3746           | Calibration Date  | 18 Jan 2018 |
| Description  | Load Cell         | Calibration Due   | 18 Jan 2019 |
| Department   | Crash Systems     | Range (Min)       | 0           |
| Manufacturer | Proctor & Chester | Range (Max)       | 500         |
| Model        | FZ601             | Engineering Units | Kg          |
| Serial No    | 13746             | Output Units      | mV          |
| Comments     |                   | Calibration Notes | Tension     |

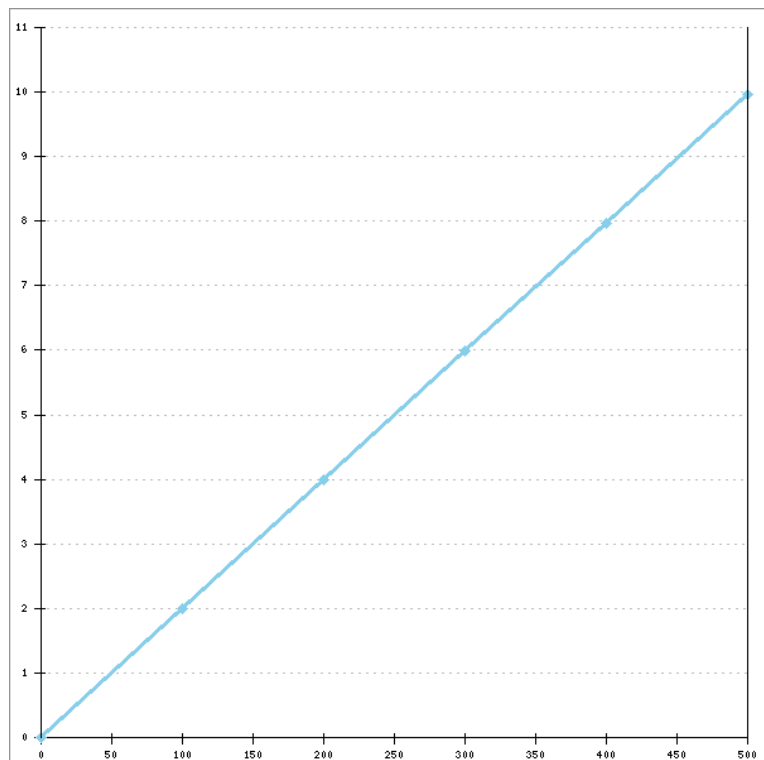
|                          |                  |                         |                         |
|--------------------------|------------------|-------------------------|-------------------------|
| Procedure                | INW011           | Calibration Uncertainty | 0.12254% min 0.11547 Kg |
| Supply Voltage           | 5 V              | Calibrated By           | VM                      |
| Temperature              | 20.6 °C          | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 35.3 %           | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar             | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.003993 mV/V/Kg | Calibration Equipment 5 |                         |
| Tolerance                | ±2 %             | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | 0.0454 mV    | Sensitivity          | 0.0039860 mV/V/Kg |
| High Cal     | 0.0094362 mV | KT Gain              | 479.1924          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 1                 |
| Shunt        | 471.186      | Emulation Resistance | 384.626 Ω         |

## Graph Data

| Input   | Output |
|---------|--------|
| 0.000   | 0.000  |
| 100.000 | 1.999  |
| 200.000 | 3.985  |
| 300.000 | 5.986  |
| 400.000 | 7.971  |
| 500.000 | 9.968  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 15 Feb 2018

|              |                   |                   |                       |
|--------------|-------------------|-------------------|-----------------------|
| Device No    | 36-14916          | Calibration Date  | 07 Aug 2017           |
| Description  | Load Cell Washer  | Calibration Due   | 07 Aug 2018           |
| Department   | Crash Systems     | Range (Min)       | 0                     |
| Manufacturer | Proctor & Chester | Range (Max)       | 500                   |
| Model        | Washer            | Engineering Units | Kg                    |
| Serial No    | 14916             | Output Units      | mV                    |
| Comments     |                   | Calibration Notes | Calibrate with washer |

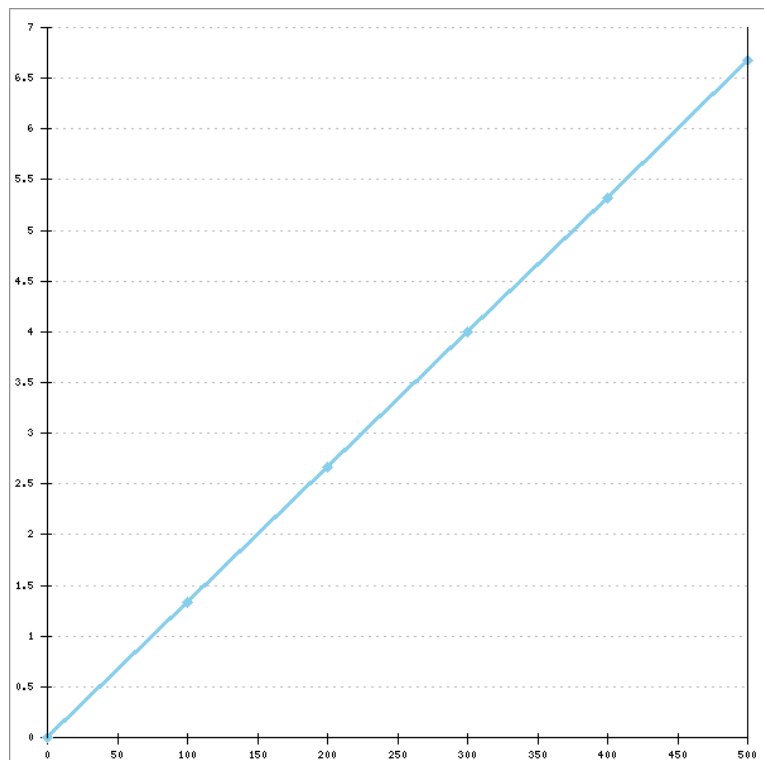
|                          |                 |                         |                         |
|--------------------------|-----------------|-------------------------|-------------------------|
| Procedure                | INW011          | Calibration Uncertainty | 0.12254% min 0.11547 Kg |
| Supply Voltage           | 5 V             | Calibrated By           | VM                      |
| Temperature              | 20.2 °C         | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 56.1 %          | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar            | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1               | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.00263 mV/V/Kg | Calibration Equipment 5 |                         |
| Tolerance                | ±2 %            | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | 3306 mV      | Sensitivity          | 0.0026658 mV/V/Kg |
| High Cal     | 0.0191587 mV | KT Gain              | -1.3691           |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999998          |
| Shunt        | -246594.297  | Emulation Resistance | 708.714 Ω         |

## Graph Data

| Input   | Output |
|---------|--------|
| 0.000   | 0.000  |
| 100.000 | 1.334  |
| 200.000 | 2.662  |
| 300.000 | 3.994  |
| 400.000 | 5.323  |
| 500.000 | 6.670  |

## Calibration Graph



# Sensor Calibration Report



Print Date: 15 Feb 2018

|              |                   |                   |             |
|--------------|-------------------|-------------------|-------------|
| Device No    | 36-14914          | Calibration Date  | 22 Nov 2017 |
| Description  | Load Cell Washer  | Calibration Due   | 22 Nov 2018 |
| Department   | Crash Systems     | Range (Min)       | 0           |
| Manufacturer | Proctor & Chester | Range (Max)       | 5           |
| Model        | Washer            | Engineering Units | kN          |
| Serial No    | 14914             | Output Units      | mV          |
| Comments     |                   | Calibration Notes |             |

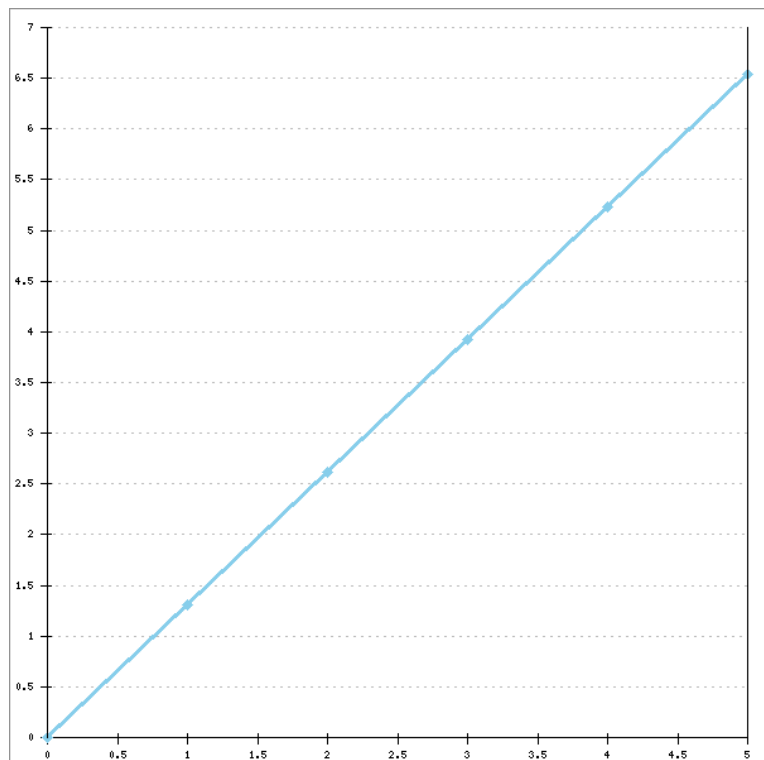
|                          |                   |                         |                         |
|--------------------------|-------------------|-------------------------|-------------------------|
| Procedure                | INW011            | Calibration Uncertainty | 0.12254% min 0.11547 kN |
| Supply Voltage           | 5 V               | Calibrated By           | AV                      |
| Temperature              | 20.3 °C           | Calibration Equipment 1 | 50-0878-98              |
| Humidity                 | 51.5 %            | Calibration Equipment 2 | 50-8662-40              |
| Barometric Pressure      | mBar              | Calibration Equipment 3 |                         |
| Amplifier Gain           | 1                 | Calibration Equipment 4 |                         |
| Manufacturer Sensitivity | 0.2615863 mV/V/kN | Calibration Equipment 5 |                         |
| Tolerance                | ±2 %              | Calibration Equipment 6 |                         |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | -0.4991 mV   | Sensitivity          | 0.2615863 mV/V/kN |
| High Cal     | 0.0183093 mV | KT Gain              | 239.2548          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 1                 |
| Shunt        | 14.380       | Emulation Resistance | 708.004 Ω         |

## Graph Data

| Input | Output |
|-------|--------|
| 0.000 | 0.000  |
| 1.000 | 1.308  |
| 2.000 | 2.612  |
| 3.000 | 3.923  |
| 4.000 | 5.235  |
| 5.000 | 6.538  |

## Calibration Graph





# Sensor Calibration Report



Print Date: 22 Jun 2018

|              |                  |                   |             |
|--------------|------------------|-------------------|-------------|
| Device No    | 36-85377         | Calibration Date  | 13 Jun 2018 |
| Description  | Load Cell Washer | Calibration Due   | 13 Jun 2019 |
| Department   | VMG              | Range (Min)       | 0           |
| Manufacturer | MSI Sensors      | Range (Max)       | 80          |
| Model        | FMT12            | Engineering Units | kN          |
| Serial No    | 85377            | Output Units      | mV          |
| Comments     | 10V              | Calibration Notes | 1 kN        |

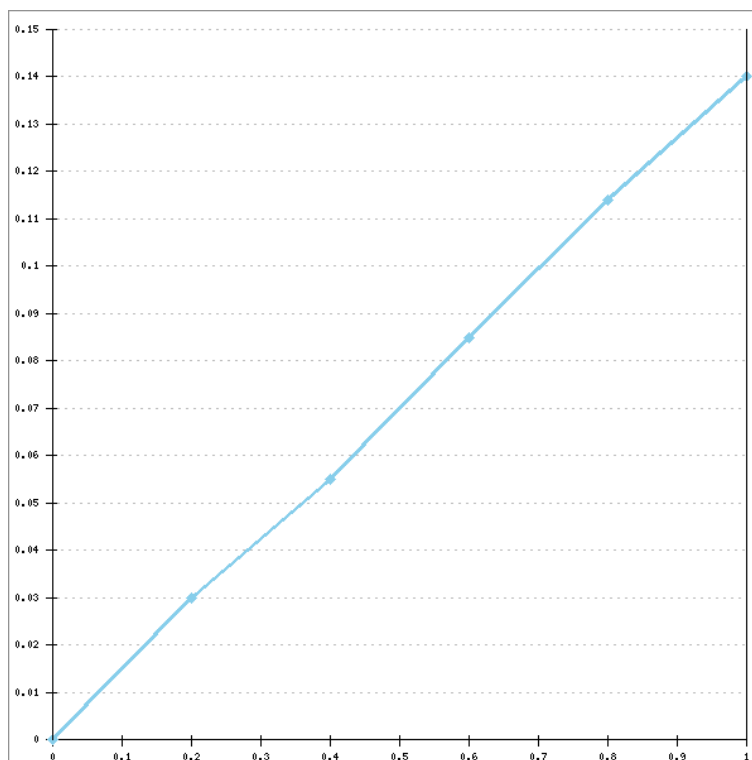
|                          |                  |                         |                        |
|--------------------------|------------------|-------------------------|------------------------|
| Procedure                | INW011           | Calibration Uncertainty | 0.94642% min 0.1514 kN |
| Supply Voltage           | 5 V              | Calibrated By           | RS                     |
| Temperature              | 20.6 °C          | Calibration Equipment 1 | 50-0878-98             |
| Humidity                 | 54.3 %           | Calibration Equipment 2 | 50-8662-40             |
| Barometric Pressure      | mBar             | Calibration Equipment 3 |                        |
| Amplifier Gain           | 1                | Calibration Equipment 4 |                        |
| Manufacturer Sensitivity | 0.024260 mV/V/kN | Calibration Equipment 5 |                        |
| Tolerance                | ±2 %             | Calibration Equipment 6 |                        |

|              |              |                      |                   |
|--------------|--------------|----------------------|-------------------|
| Low Cal      | -0.0258 mV   | Sensitivity          | 0.0280257 mV/V/kN |
| High Cal     | 0.0180894 mV | KT Gain              | 248.4102          |
| Cal Resistor | 46.4 kΩ      | Correlation          | 0.999783          |
| Shunt        | 129.276      | Emulation Resistance | 702.938 Ω         |

## Graph Data

| Input | Output |
|-------|--------|
| 0.000 | 0.000  |
| 0.200 | 0.030  |
| 0.400 | 0.055  |
| 0.600 | 0.085  |
| 0.800 | 0.114  |
| 1.000 | 0.140  |

## Calibration Graph



**End of Report**