Documentation

Tests Windshield Mounting

according to

Federal Motor Vehicle Safety Standard

49 CFR 571.212

(FMVSS 212)

This test report is for documentation of measuring results only and shall not be deemed legally binding within the German StVZO/EG-FGV.
1. Introduction

This test report describes the test of the windshield retention for motor vehicles during a crash-test.

Upon request of the applicant, TÜV Rheinland Kraftfahrt GmbH has tested PETEC screen bonding products used for the fixation of a windshield in a vehicle with regard to the FMVSS 212.

The tests were conducted to determine if the screen bonding products meet the requirements specified under item 3. of this test report.

1.1. Name and address of the applicant : PETEC Verbindungstechnik GmbH
Wüstenbuch 26
D-96132 Schlüsselfeld

1.2. Name and address of the manufacturer : PETEC Verbindungstechnik GmbH
Wüstenbuch 26
D-96132 Schlüsselfeld

2. Description of the test object

Technical description : The tests were performed on a Ford Mondeo 4 door saloon with twin airbags. The vehicle was soaked prior to the windshield installation and stored 40 min after the installation at an average temperature of 23°C and a relative humidity of 50%. The installation was carried out by 24 Screen Savers Ltd. according to the PETEC installation procedure (see Appendix 2, Appendix 3 and Appendix 4).

Characteristics : Right hand driven vehicle with driver and passenger airbag system. 50% Hybrid-III Dummy on driver and passenger side.

Test vehicle : Ford Mondeo 4 door saloon
VIN: WF05XXGBB56P67719
Test weight in test condition including 93% fuel, nominal fluids and 2 occupants 1.849,5 kg

The vehicle was subjected to a 100% frontal impact by being propelled into an immovable crash block at 48,6 km/h, as per FMVSS 212 Section 5 (≥ 48 km/h).
The crash test dummies were restrained by means of the vehicle’s seat belts and the airbags were triggered by the impact.

The vehicle was impacted within 1 hour after the windscreen was fitted.

Specimen description and part numbers: PETEC WINDSHIELD ADHESIVE Art.-No. 83310 and 83400 (batch 84675), PETEC Primer (Art.-No. 82410, 82330 and 82430) (on blank metal only and all over the contact area on the glass) & Aktivator (Art.-No. 82230) (Manufacturer documentation see Appendix 2, Appendix 3 and Appendix 4).

3. Test basis and test equipment

3.1. Test basis

3.2. Testing device (s),
Crash-test laboratory and climatic chamber of:
HORIBA MIRA Ltd.
Watling Street
Nuneaton
Warwickshire CV10 0TU
England

Used equipment and calibration see Appendix 1

4. Description of the test

4.1. Date of the test : 2017-11-30
4.2. Place of the test : Nuneaton, England
4.3. Scope of the test : The objective of the tests was to verify if the test object is able to guaranty the retention of the vehicle windshield during a crash.
5. Test results

Windshield periphery:

<table>
<thead>
<tr>
<th></th>
<th>Right side</th>
<th></th>
<th>Left side</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre test measurement</td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>Right side</td>
<td>2090</td>
<td></td>
<td>2090</td>
<td></td>
<td>4180</td>
<td></td>
</tr>
<tr>
<td>Left side</td>
<td>2090</td>
<td></td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
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<tr>
<td>Total</td>
<td>4180</td>
<td>mm</td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>Post test measurement</td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>Right side</td>
<td>2090</td>
<td></td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>Left side</td>
<td>2090</td>
<td>mm</td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>Total</td>
<td>4180</td>
<td></td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
</tr>
</tbody>
</table>

Width of molding 38 mm

Temperature of the windshield molding during test 20 °C

Area of retention failures: no failures occurred

Remarks: none

Fotos: see Appendix 1

The test object is able to guaranty the retention of the vehicle windshield during a crash according to FMVSS 212 Section 5.
6. Appendices

1. MIRA test Result report MIRA-1215763 03 page 1 to 33
2. Manufacturers documentation PETEC WINDSHIELD ADHESIVE Art.-No. 83310 and 83400 page 1 to 3
   (Revision 16.11.2018)
3. Manufacturers documentation PRIMER WS PETEC Primer Art.-No. 82410, 82330 and 82430 page 1 and 2
   (Revision 16.11.2018)
4. Manufacturers documentation ACTIVATOR Aktivator (Art.-No. 82230) page 1 and 2
   (Revision 23.10.2018)

The test report contains page 1 to 5 and Appendices 1 to 4.

It is only permitted to publish this report formal and in content unchanged and completely including all appendices except with the approval of the testing laboratory TÜV Rheinland Kraftfahrt GmbH, Am Grauen Stein, 51105 Cologne in writing.

Cologne, 2019-01-29

rg

Rudolf Gerlach
Technical Expert
Test Results

S9109 Windscreen Retention Test 1 Hour Soak

Customer: Thomas Kügel
PETEC Verbindungstechnik GmbH
Wüstenbuch 26
96132 Schlüsselfeld
Germany
Thomas.Kuegel@petec.de

Contact: William Martin
HORIBA MIRA Ltd
Safety Development Dept
Watling Street
Nuneaton
Warwickshire
CV10 0TU, UK
+44(0)24 7635 5000

Test Date(s): 30 November 2017
Witnesses: Rudolf Gerlach - TUV Rheinland

Test Objective / Method / Specification No

To assess windscreen bonding product performance according to FMVSS212. Vehicle was soaked at 23°C and 50% relative humidity. The test was conducted 1 hour after the windscreen was fitted. MIRA Test Number S9109.

Specimen Description / Part No(s)

PETEC Glass Bonding Sealant PETEC Scheibenkleber, PETEC Multiaktiv Primer and PETEC Aktivator

<table>
<thead>
<tr>
<th>Part Description</th>
<th>Part Number</th>
<th>Date Received</th>
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<tbody>
<tr>
<td>PETEC Scheibenkleber</td>
<td>83310 - 83400</td>
<td>27 &amp; 28/11/17</td>
</tr>
<tr>
<td>PETEC Multiaktiv Primer</td>
<td>82330 / 82410 / 82430</td>
<td>27 &amp; 28/11/17</td>
</tr>
<tr>
<td>PETEC Aktivator</td>
<td>82230</td>
<td>27 &amp; 28/11/17</td>
</tr>
</tbody>
</table>

Test vehicle:
- Make: Ford
- Model: Mondeo
- Drive hand: RH Drive
- VIN: WF05XXGBB56P67719

Test Results Summary

Results only relate to items tested. The subject was tested in accordance with the test specification with or without deviation. The acceptance criteria of the test specification were:

| Met | Not Met | See comments |

Prepared By: William Martin
Crash Test Engineer

Approved By: Colin Smith
Head of Crash

Date: 03/12/18

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Tel: +44 (0)24 7635 5000 · Fax: +44 (0)24 7635 8000 Registered in England No 9626352 · VAT Registration GB 100 1464 84

Tests marked “Not UKAS Accredited” in this report are not included in the UKAS Accreditation Schedule for this laboratory. Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.
Test Results Detail

The test vehicle was soaked at a 1 hour average temperature of 23°C and relative humidity 50% after windscreen installation, which was carried out by 24 Screen Savers Ltd. It was then subjected to a 100% frontal impact by being propelled into a rigid crash block at 30mph (48km/h), as described in FMVSS212 Section 5. The ATDs were restrained by the vehicle’s standard seat belts and the airbags triggered by the vehicle standard system.

### Test Conditions

<table>
<thead>
<tr>
<th>Tyre Pressure (bar)</th>
<th>Front</th>
<th>Rear</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.4</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Vehicle modifications

Steering Column

Windows

Seatbelt Height Adjust

Doors

Parking Brake

Ignition

Seat Adjustment - Driver

Seat adjustment – Passenger

Restraint system specification

<table>
<thead>
<tr>
<th>Vehicle mass details</th>
<th>Front (kg)</th>
<th>Rear (kg)</th>
<th>Total (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unloaded vehicle mass</td>
<td>944.5</td>
<td>554</td>
<td>1498.5</td>
</tr>
<tr>
<td>Test Weight (in test condition, including 93% fuel, nominal fluids, instrumentation, ballast and 2 occupants)</td>
<td>994.5</td>
<td>855</td>
<td>1849.5</td>
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</table>

### Assessment against Legislative Criteria

| Impact Velocity (Target 48.3 +1/-0 km/h) | 48.6 km/h | Complied |
| Impact Alignment (target <5°. Approx. ± 235mm for 2700mm wheelbase) | 9 mm left | Complied |
| Performance assessment: (Max 25% detachment on each side of windscreen perimeter) | LH perimeter 0% | Complied |
|                                      | RH perimeter 0% | Complied |
Test Equipment

Rigid Barrier with plywood facing
2x Hybrid III 50%ile ATDs (Anthropomorphic Test Devices) – un-instrumented for ballast only
Measurement equipment as listed in Appendix 6
6 high speed digital cameras

Attachments

Appendix 1 - Test Photographs
Appendix 2 - Quality Assurance of Measurements
Appendix 1  Test Photographs

Photo 1
LH General view – Pre-Test

Photo 2
LH General view – Post-Test
Photo 3
Front view – Pre-Test

Photo 4
Front view – Post-Test
Photo 5
RH General view – Pre-Test

Photo 6
RH General view – Post-Test
Photo 7
Close front view of LH A-pillar / windscreen LH edge – Post-Test

Photo 8
Close front view of RH A-pillar / windscreen RH edge – Post-Test
Photo 9
Close front view of header rail / windscreen top edge – Post-Test

Photo 10
Close front view of scuttle / windscreen lower edge – Post-Test
Photo 11
Post-test LHF ATD side view – Post-Test

Photo 12
Post-test RHF ATD side view – Post-Test
Appendix 2  Quality Assurance of Measurements

All instrumentation, high speed images and associated analysis contained in this report conforms to the requirements within SAE J211 July 2007.

The test equipment is checked on a regular schedule to traceable standards in an International Assurance of Measurements (QAM) procedure. Each item of equipment is issued with a QAM number.

The numbers for the equipment used in these tests were:-

<table>
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<tr>
<th>Item</th>
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<td>N/A</td>
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<tr>
<td>ATD Identification – RHF HIII 50%ile No 270</td>
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<tr>
<td>Weigh Scales</td>
<td>38720-23 38724-27</td>
<td>29/06/2018 20/08/2018</td>
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<td>5m Steel Tape Measure</td>
<td>34848</td>
<td>07/11/2022</td>
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<td>Digital Level</td>
<td>33520</td>
<td>18/01/2018</td>
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<td>Stop Watch</td>
<td>34851 38460</td>
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<td>Tyre Pressure gauge</td>
<td>39679</td>
<td>09/03/2018</td>
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<td>Impact Speed Measure (fixed)</td>
<td>8167</td>
<td>26/02/2018</td>
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<td>Impact speed measure (mobile)</td>
<td>17921</td>
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<td>39704-07, 39785-88</td>
<td>03/01/2018</td>
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<tr>
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<td>18/08/2018 19/01/2018</td>
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<td>32ch Thermocouple Amplifier</td>
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<tr>
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<td>2</td>
<td>F02 LH View – Front Half of Vehicle</td>
<td>37924</td>
<td>13/07/2018</td>
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<tr>
<td>3</td>
<td>F06 RH View – Whole Vehicle</td>
<td>37938</td>
<td>17/08/2018</td>
</tr>
<tr>
<td>4</td>
<td>F07 RH View – Front Half of Vehicle</td>
<td>37922</td>
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<td>5</td>
<td>F14 Overhead View – Whole Vehicle</td>
<td>37919</td>
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<tr>
<td>6</td>
<td>F11 Front View – Front Half of Vehicle</td>
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Channel Sample Rate: N/A
Weigh Scales

CALIBRATION CERTIFICATE

Issued by HORIBA MIRA Ltd

Issue date: 29 Jun 2017  Cert No: 33720170017

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<td>Address:</td>
<td>Wallingford, NN17 3JP,</td>
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<td></td>
<td>UK</td>
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<td>0387761-038773</td>
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<td>Date received:</td>
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Manufacturer: Intercomp
Model: 173127-WPC
Description: Weigh Scales
Serial No: D216MC19068
Calibration Date: 29 Jun 2017
Calibration Procedure: QA4296/C97
Equipment used: Page 2.5
Measurement Results: Page 2.5
Measurement Uncertainty: Page 2.5

Condition of Instrument: Used, in good condition.

- Within specification on receipt, at the points measured subject to the measurement uncertainty: Yes
- Adjusted during calibration: No
- Repaired prior to or during calibration: No
- Other specification on completion, at the points measured subject to the measurement uncertainty: Yes

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long-term stability or environmental performance of the instrument. All measurements detailed within this Calibration Certificate relate only to the instrument detailed above on the dates specified.

The instrument was allowed to stabilise in an environment of 20°C ± 2°C and 50% RH ± 2% RH, for a minimum of 12 hours before commencing the calibration. The electrical supply within the laboratory is 240 VAC ± 15 Volts and 50 Hz ± 0.5 Hz with a total harmonic distortion of less than 5%.

This instrument was calibrated by comparison with force measurement reference standards using a MIRA procedure, where the instrument has an electrical output and this has been calibrated, the output has been measured using electrical reference standards.

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of 3, providing a level of confidence of approximately 99%.

---

Test Results: Page 11 of 33
PETEC Verbindungstechnik GmbH
Commercial in Confidence
# CALIBRATION CERTIFICATE

**Issued by HORIBA MIRA Ltd**

**Issue date:** 20 Aug 2017  
**Cert No:** 36724170817

---

**Manufacturer:** Intercomp  
**Model:** 170127-WPG

<table>
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<th>Measurement Uncertainty</th>
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<td>Q301MC11003</td>
<td>20 Aug 2011</td>
<td>QA4293/C/C7</td>
<td>Pages 2 to 5</td>
<td>Pages 2 to 5</td>
<td>Pages 2 to 5</td>
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**Condition of Instrument:** Used, in good condition

- Within specification on receipt, all points measured subject to the measurement uncertainty: Yes
- Adjusted during calibration: No
- Repaired prior to or during calibration: No
- Within specification on completion, all points measured subject to the measurement uncertainty: Yes

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long term stability or environmental performance of the instrument. All measurements detailed within this calibration certificate relate only to the instrument detailed above on the dates specified.

The instrument was allowed to stabilise in an environment of 21°C ± 2°C and 50% RH ± 5% RH, for a minimum of 12 hours before commencing the calibration. The electrical supply within the laboratory is 240 V, ± 15 Volts and 50 Hz ± 0.5 Hz with a total harmonic distortion of less than 3%.

This instrument was calibrated by comparison with force measurement reference standards using a MIRA procedure. Where the instrument has an electrical output and has been calibrated, the output has been measured using electrical reference standards.

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

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5m Steel Tape Measure

CALIBRATION CERTIFICATE

Issued by HORIBA MIRA Ltd
Issue date: 03 Nov 2017 Cert No.: 34646161017

Manufacturer: Assdit
Model: 33QG-6019
Description: 5m Steel Tape Measure
Serial No: --
Calibration Date: 08 Nov 2017

Equipment used:
Measurement Results: Page 2
Measurement Uncertainty: Page 2

Condition of Instrument: Used, in good condition

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implications regarding the long term stability or environmental performance of the instrument. All measurements detailed within this Calibration Certificate relate only to the instrument detailed above on the date specified.

The instrument was calibrated in an environment of 20°C ± 2°C and 50%RH ± 2%RH, for a minimum of 12 hours before commencing the calibration. The electrical supply within the laboratory is 240 Volts ± 15 Volts and 50 Hz ± 0.5Hz with no total harmonic distortion of less than 3%.

This instrument was calibrated by comparison with national measurement reference standards using a MIRA procedure which incorporates limits based on the tolerances contained in document NIST Handbook 44 section 3.52.
Digital Level

**CALIBRATION CERTIFICATE**

Issued by HORIBA MIRA Ltd
Issue date: 19 Jan 2017   Cert No: 33520130117

**Client:** Test Operations FG

**Address:** Warring Street, Nuneaton

**Manufacturer:** Smarttool

**Model:** --

**Address:** Nuneaton

**Description:** Digital Level

**Serial No.:** --

**Date received:** 13 Jan 2017

**Description:** Digital Level

**Condition of Instrument:** Used, in good condition

**Serial No.:** --

**Date received:** 13 Jan 2017

**Calibration Date:** 18 Jan 2017

**Calibration Procedure:** OA3128/C03

**Measurement Results:** Page 2

**Measurement Uncertainty:** Page 2

---

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long term stability or environmental performance of the instrument. All measurements detailed within this Calibration Certificate relate only to the instrument detailed above on the date specified.

The instrument was allowed to acclimatise in an environment of 20°C ± 2°C and 50% RH ± 2% RH, for a minimum of 12 hours before commencing the calibration. The execution time for the calibration is 240 ± 15 minutes and 30 ± 1.5% with a total uncertainty of less than 3%.

Instrument calibrated by comparison with angular reference standards using MIRA Procedure CA3128/C.

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of 1.2, providing a level of confidence of approximately 95%.

---

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Test Results: Page 14 of 33
Commercial in Confidence
PETEC Verbindungstechnik GmbH
### CALIBRATION CERTIFICATE

**Issued by MIRA Ltd**

**Issue date:** 18 May 2015  **Cert No:** 3848230315

---

**Stop Watch**

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<th>Manufacturer</th>
<th>Model</th>
<th>Description</th>
<th>Serial No</th>
<th>Calibration Date</th>
<th>Calibration Procedure</th>
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<td>RS</td>
<td>611-1818</td>
<td>Stop Watch</td>
<td>—</td>
<td>19 May 2016</td>
<td>QA2113/C/02</td>
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</table>

**Equipment used:**

**Measurement Results:** Page 2  **Measurement Uncertainty:** Page 2

**Condition of instrument:**

- Within specification on receipt at the points measured subject to the measurement uncertainty: Yes
- Adjusted prior to or during calibration: No
- Repaired prior to or during calibration: No
- Within specification on completion at the points measured subject to the measurement uncertainty: Yes

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long term stability or environmental performance of the instrument. All measurements detailed within this Calibration Certificate relate only to the instrument detailed above on the dates specified.

The instrument was allowed to acclimatise in an environment of 20°C ± 2°C and 50%RH ± 2.5%RH, for a minimum of 12 hours before commencing the calibration. The electrical supply within the laboratory is 240 Volts ± 16 Volts and 50 Hz ± 0.5Hz with a total harmonic distortion of less than 3%.

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CALIBRATION CERTIFICATE

Issued by HORIBA MIRA Ltd
Issue date: 16 Dec 2015 Cert No: 3-6351251115

Client: Mechanical Engineering FG
Section: Braking
Address: Wavell Street
Nunnamin
Warwickshire

Manufacturer: RS
Model: 639-3259
Description: Digital Stop watch
Serial No: --
Calibration Date: 15 Dec 2015
Calibration Procedure: GA2113/C02
Equipment used: Page 2
Measurement Results: Page 2
Measurement Uncertainty: Page 2

Condition of Instrument: Used, in good condition

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long term stability or environmental performance of the instrument. All measurements detailed within this Calibration Certificate relate only to the instrument detailed above on the dates specified.

The instrument was allowed to acclimatise in an environment of 20°C ± 2°C and 50%RH ± 5%RH, for a minimum of 12 hours before commencing the calibration. The electrical supply within the laboratory is 240 V, 15 Volts and 30 Hz ± 0.5 Hz with a total harmonic distortion of less than 3%.

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of 1.2, providing a level of confidence of approximately 98%.

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CALIBRATION CERTIFICATE

Issued by HORIBA MIRA Ltd

Issue date: 09 Mar 2017 Cert No: 38879-00117

Tyre Pressure Gauge

Test Report No. 185XS0225-00
S9109 Windscreen Retention Test 1 Hour Soak

Appendix 1

Tyre Pressure Gauge

Test Report No. 185XS0225-00
Appendix 1

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long term stability or environment performance of the instrument. Any uncertainties detailed within this Calibration Certificate relate only to the instrument detailed above on the dates specified.

The instrument was calibrated in an environment of 20°C ± 2°C and ±0.01 bar ± 0.1%Rh, in a minimum of 12 hours before commencing the calibration. The electrical supply within the laboratory is 240V ± 10V and DC ±12V ± 2% with a total harmonic distortion of less than 3%.

This instrument was calibrated by comparison with pressure measurement reference standards using a MIRA procedure which incorporates limits based on the applicable standard, BS EN 12665:1999.

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of ±2, providing a level of confidence of approximately 95%.

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9 Beam Speed Measurement Laser

CALIBRATION CERTIFICATE

Issued by HORIBA MIRA Ltd

issue date: 19 Apr 2017  Gear No: 0816/180417

Client: Test Operations FC
Section: Safety, Clean Off-Board Instruments
Address: Watling Street

Manufacturer: MIRA
Model: —
Description: 9 Beam Speed Measurement Sys
Serial No: —
Calibration Date: 20 Apr 2017
Calibration Procedure: QA2361/C/03
Equipment used: —
Measurement Results: Pages 2 to 4
Measurement Uncertainty: Page 6

Condition of Instrument: Used, in good condition

Within specification on receipt, at the points measured subject to the measurement uncertainty
No
Adjusted during calibration
No
Reported prior to or during calibration
Yes
Within specification on completion, at the points measured subject to the measurement uncertainty
No

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long-term stability or environmental performance of the instrument. All measurements detailed within this Calibration Certificate relate only to the instrument detailed above on the dates specified.

The instrument was allowed to acclimatise in an environment of 20°C ± 2°C and 50% RH ± 2% RH, for a minimum of 12 hours before commencing the calibration. The electrical supply to the laboratory is 240 Volts ± 15 Volts and 50 Hz ± 0.5Hz with a total harmonic distortion of less than 3%.

The speed measurement system was calibrated by comparison with distance and time measurement reference standards using a MIRA procedure which incorporates limits based on client requirements detailed in the test report for service document C020712012A.

The calibration certificate includes the laser speed measurements taken after repair.

Laser speed set C1 still does not conform to specification.

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

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Appendix 1
Mobile Speed Measurement Laser

CALIBRATION CERTIFICATE

Issued by HORIBA MIRA Ltd

Issue date: 21 Jun 2017  Cert No: 17S8220317

Client: Test Operations FG

Section: Safety Crash Off Board Instruments

Address: Welting Street, Nuneaton

Manufacturer: MIRA

Model: TDS28

Description: Vehicle Speed Measurement Unit, Cable & Frame

Serial No: --

Calibration Date: 31 Aug 2017

Calibration Procedure: QA5971C053

Equipment used: Page 2

Date received: 25 Mar 2017

Measurement Results: Page 2

Measurement Uncertainty: Page 2

MIRA ID: Q17980 to Q17981

Dallas ID:

Condition of Instrument: Used, in good condition

- Within specification on receipt, at the points measured subject to the measurement uncertainty: Yes
- Adjusted during calibration: No
- Reverified prior to or during calibration: No
- Within specification on completion, at the points measured subject to the measurement uncertainty: Yes

The recorded values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long term stability or environmental performance of the instrument. All measurements detailed within this Calibration Certificate relate only to the instrument detailed above on the date specified.

The instrument was allowed to acclimatise in an environment of 20°C ± 2°C and 50%RH ± 20%RH for a minimum of 12 hours before commencing the calibration. The electrical supply within the laboratory is 240VAC ± 10VAC and 50 Hz ± 0.5 Hz, with a total harmonic distortion of less than 5%.

This instrument was calibrated by comparison with time and displacement measurement reference standards using MIRA procedure which incorporates limits based on client requirements. These requirements are specified in document CR22597G0126.

This certificate includes all component parts list.

This certificate is a replacement for Certificate number 17S86220317.

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

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Test Results : Page 19 of 33

Commercial in Confidence
Climatic Temperature Probes

CERTIFICATE OF CALIBRATION
ISSUED BY: Universal Instrument Services Ltd.

Date of Calibration: 3rd January 2017
Date of Issue: 17th January 2017
Certificate Number: 09041454

Customer: HORIBA MIRA LIMITED
Unit 60 The Whitley Estate, Cambridge Rd,
Woodhams, Lincoln LEE 6RF
Tel: 0116 275 0125 Fax: 0116 275 0262
Email: sales@universalco.uk

Manufacturer: Not Known
Description: T-Type Thermocouple
Model: T-TYPE
Serial No.: 009104
Asset No.: C361304
Order No.: 261520
Date Received: 18th December 2018

CONDITION OF UNIT UNDER TEST
The Thermocouple was visually inspected prior to calibration

ADDITIONAL COMMENTS

STABILITY
The readings given are the results at the time of calibration and do not carry any implication regarding the long term stability of the unit under test.

ACREDITATIONS
UIS is accredited by UKAS to BS EN 11035:1995 to undertake the calibration presented in this certificate.

ENVIRONMENT
The instrument was calibrated in our laboratory with the ambient conditions stated on the results page.

PROCEDURE
UIS procedure CPT. 5.5

UNCERTAINTIES
The reported expanded uncertainty is based on a basic uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

TEST EQUIPMENT USED

<table>
<thead>
<tr>
<th>Asset No.</th>
<th>Description</th>
<th>Certificate No.</th>
<th>Expiry Date</th>
</tr>
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<tbody>
<tr>
<td>T01.96</td>
<td>Hart 1560 Super-Thermocouple II</td>
<td>JKEF 011303</td>
<td>15/04/2017</td>
</tr>
<tr>
<td>T0201</td>
<td>Tip of 96 Sided Resistor 25 gauge</td>
<td>JKEF 071304</td>
<td>04/11/2019</td>
</tr>
<tr>
<td>T0202</td>
<td>PRT (25 gauge)</td>
<td>JKEF 071304</td>
<td>14/07/2017</td>
</tr>
<tr>
<td>T0247</td>
<td>PRT (25 gauge)</td>
<td>JKEF 071304</td>
<td>14/07/2017</td>
</tr>
<tr>
<td>D2205</td>
<td>PRT (25 gauge)</td>
<td>JKEF 071304</td>
<td>12/07/2017</td>
</tr>
<tr>
<td>D2220</td>
<td>Fluke 1900A 2400 Multimeter</td>
<td>JKEF 071304</td>
<td>29/07/2017</td>
</tr>
</tbody>
</table>

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides confidence of measurement to the Customer of units and/or to units of measurement realized at the National Physical Laboratory or other recognized national testing laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.
ADDITONAL COMMENTS

STABILITY
The readings given are the results of the time of calibration and do not carry any implication regarding the long term stability of the unit under test.

ACCREDIATIONS
UIS is accredited by UKAS to BS EN 17025:2005 to undertake the calibration presented in this certificate.

ENVIRONMENT
The instrument was calibrated in our laboratory under the ambient conditions stated on the results page.

PROCEDURE
UIS procedure CP7.5.3

UNCERTAINTIES
The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

TEST EQUIPMENT USED

<table>
<thead>
<tr>
<th>Description</th>
<th>Certificate No.</th>
<th>Expiry date</th>
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<tbody>
<tr>
<td>TEC1000 Super Thermocouple</td>
<td>17006-004</td>
<td>21/03/2017</td>
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<tr>
<td>Trilux Mid-Range 50 ohms</td>
<td>UKAS 0200-104</td>
<td>09/03/2017</td>
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<td>PRT (25 ohms)</td>
<td>UKAS 47036</td>
<td>14/07/2017</td>
</tr>
<tr>
<td>PRT (25 ohms)</td>
<td>UKAS 47036</td>
<td>14/07/2017</td>
</tr>
<tr>
<td>PRT (25 ohms)</td>
<td>UKAS 47036</td>
<td>14/07/2017</td>
</tr>
<tr>
<td>PRT (25 ohms)</td>
<td>UKAS 47036</td>
<td>14/07/2017</td>
</tr>
<tr>
<td>TEC1000 50-258 Multiplexer</td>
<td>UKAS 473-08</td>
<td>25/03/2017</td>
</tr>
</tbody>
</table>

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides liability of measurement to the 50% of the uncertainty of measurement as defined at the National Physical Laboratory and other recognized national measurement institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.
CERTIFICATE OF CALIBRATION

ISSUED BY: Universal Instrument Services Ltd.

Data of Calibration: 3rd January 2017
Date of Issue: 5th January 2017
Certificate Number: Q048450

Customer: HORIBA MIRA LIMITED

Manufacturer: Not Known
Description: T-Type Thermocouple
Model: T-Type
Serial No.: Q30760
Access No.: Q30760
Owner No.: 269263
Date Received: 10th December 2015

CONDITION OF UNIT UNDER TEST
The Thermocouple was visually inspected prior to calibration.

ADDITIONAL COMMENTS

STABILITY
The readings given are the results of the time of calibration and do not carry any implication regarding the long term stability of the unit under test.

ACCREDITATIONS
UKAS accredited to BS EN 17025:2009 to undertake the calibration presented in this certificate.

ENVIRONMENT
The instrument was calibrated in our laboratory with the ambient conditions stated on the results page.

PROCEDURE
UKAS procedure OP25:0:0.

UNCERTAINTIES
The specified expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of 2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

TES" EQUIPMENT USED

<table>
<thead>
<tr>
<th>Asset No.</th>
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<tbody>
<tr>
<td>U156</td>
<td>Hart 1569 Super-Thermometer II</td>
<td>296305</td>
<td>21/04/2017</td>
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<tr>
<td>U491</td>
<td>Thokley 50 Ohm Resistor 25 ohms</td>
<td>UKAS 554594</td>
<td>23/04/2017</td>
</tr>
<tr>
<td>160062</td>
<td>PRT (25 ohms)</td>
<td>UKAS 474738</td>
<td>14/04/2017</td>
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<td>160260</td>
<td>PRT (25 ohms)</td>
<td>UKAS 554742</td>
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<td>160510</td>
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<td>PRT (25 ohms)</td>
<td>UKAS 472202</td>
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<td>160703</td>
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<td>UKAS 472246</td>
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<td>160705</td>
<td>PRT (25 ohms)</td>
<td>UKAS 474712</td>
<td>21/04/2017</td>
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</table>

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides necessary compliance with EN standards and is in accordance with the requirements of the National Physical Laboratory and recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.
CERTIFICATE OF CALIBRATION

ISSUED BY: Universal Instrument Services Ltd.

Date of Calibration: 16 January 2017
Date of issue: 19 January 2017
Certificate Number: C0018457

Customer: HORIBA MIRA LIMITED
147 WATLING STREET
MINEHEAD
SOMERSET TA24 6TE
Order Ref: 38437

Manufacturer: Not Known
Model: TT Thermocouple
Serial No: C9657
Asset: Q9755
Order No: 201620
Date Received: 16-12-2016

EXPLANATION OF UNIT UNDER TEST
The Thermocouple was wired incorrectly prior to calibration

YESS

ADDITIONAL COMMENTS

STABILITY
The readings given are the results at the time of calibration and do not carry any implication regarding the long term stability of the unit referred to.

ACCREDIATIONS
This is accredited by UKAS to BS EN 17025:2005

ENVIRONMENT
The equipment was calibrated in our laboratory with the ambient conditions stated on the report.

PROCEDURE
LAB procedure CFT 5.2

UNCERTAINTIES
The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty expansion has been carried out in accordance with UKAS requirements.

TEST EQUIPMENT USED

<table>
<thead>
<tr>
<th>Asset No.</th>
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<tbody>
<tr>
<td>ID3130</td>
<td>TA1505 Super-thermometer II</td>
<td>268398</td>
<td>21-MAR-2017</td>
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<tr>
<td>ID0551</td>
<td>Timing Test Circuit 28 ohms</td>
<td>268395</td>
<td>05-JUL-2016</td>
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<tr>
<td>ID2652</td>
<td>PRT (25 ohms)</td>
<td>UKAS 369204</td>
<td>14-JUL-2017</td>
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<tr>
<td>ID2456</td>
<td>PRT (25 ohms)</td>
<td>UKAS 4701</td>
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<td>ID3254</td>
<td>PRT (25 ohms)</td>
<td>UKAS 4720</td>
<td>12-JUL-2017</td>
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<td>ID3245</td>
<td>PRT (25 ohms)</td>
<td>UKAS 4740</td>
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<td>ID0216</td>
<td>Fluke 188-IR3 Multi Meter</td>
<td>UKAS 4748</td>
<td>20-FEB-2017</td>
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</table>

This certificate is issued in accordance with the laboratory accredited to and is compliant with the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units derived from the national measurement standards at the National Physical Laboratory or other recognised national metrology institutes. This equipment may not be reproduced without the prior written approval of the issuing laboratory.

PETEC Verbindungstechnik GmbH
Commercial in Confidence
CERTIFICATE OF CALIBRATION

ISSUED BY: Universal Instrument Services Ltd.

Late of calibration: 3rd January 2017
Date of issue: 5th January 2017
Certificate Number: 00043450

Universal

UNIVERSAL INSTRUMENT SERVICES LTD.
Unit 48, The Wadling Estate, Cambridge Road,
Winfield, Luton, Bedfordshire, LU2 0SR
Tel: 01525 678921 Fax: 01525 675 6212
Website: www.universal.com
Email: sales@universal.com

DRIVER: HORIBA MIRA LIMITED
WATLING STREET
WARRINGTON
WA1 4AS
Operator: XT
Our Ref: 591430

MANUFACTURER: Not Known
DESCRIPTION: T-Type Thermocouple
MODEL: T-Type
Serial No: Q68765
Asset No: Q68765
Order No: 200028
Date Received: 18th December 2015

CONDITION OF UNIT UNDER TEST
The Thermocouple was visually inspected prior to calibration

ADDITIONAL COMMENTS

STABILITY
The readings given are the results at the time of calibration and do not carry any implication regarding the long term stability of the individual test.

ACCREDITATIONS
JIS is accredited by UKAS to BS EN 17025:2005 to undertake the calibration process as stated in this certificate.

ENVIRONMENT
The instrument was calibrated in our laboratory with theambient conditions stated on the reverse page.

PROCEDURE
Uses software CalTest 5.0

UNCERTAINTIES
The recorded expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2 providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

TEST EQUIPMENT USED

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<tr>
<th>Asset No.</th>
<th>Description</th>
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<th>Expiry date</th>
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<tr>
<td>101501</td>
<td>PT1000 Sper-thermocouple I</td>
<td>2093/19</td>
<td>22/02/2021</td>
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<tr>
<td>D301</td>
<td>PRT (20 cm)</td>
<td>UKAS 300190</td>
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<tr>
<td>D3032</td>
<td>PT1 (20 cm)</td>
<td>UKAS G70002</td>
<td>14/2/2017</td>
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<td>D3250</td>
<td>PT1 (25 cm)</td>
<td>UKAS 30022</td>
<td>14/2/2017</td>
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<td>D3245</td>
<td>PT2 (25 cm)</td>
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<td>D3275</td>
<td>PT2 (50 cm)</td>
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</table>

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides evidence of measurement traceability to the SI system of units and the primary measurement standards at the National Physical Laboratory or other recognized national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the testing laboratory.
CERTIFICATE OF CALIBRATION

ISSUED BY: Universal Instrument Services Ltd.

Universal

UNIVERSAL INSTRUMENT SERVICES LTD.
Unit 69, The Whistle Estate, Cambridge Road,
Wheatley, Oxfordshire OX8 5HF
Tel: 0118 276 6220 Fax: 0118 276 6222
Website: www.ui-s.com
Email: sales@ui-s.com

Customer: HORIBA MIRA LIMITED

Manufacturer: Not Known

Date of Issue: 03 January 2012
Date of Expiry: 03 January 2013
Certificate Number: 20045458

Condition of Unit Under Test
The instrument was visually inspected prior to calibration

Yes/No: Yes

Additional Comments

Stability
The readings given are the results at the time of calibration and do not apply any implication regarding the long-term stability of the instrument tested.

Accreditations
UKAS accredited to BS EN 17025:2005 to undertake the calibration presented in this certificate.

Environment
The instrument was calibrated in our laboratory with the ambient conditions stated on the reverse page.

Procedure
UKAS procedure OPF 0.6.

Uncertainty
The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of 2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Test Equipment Used

<table>
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<tr>
<th>Asset No.</th>
<th>Description</th>
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<th>Expiry date</th>
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<tbody>
<tr>
<td>134106</td>
<td>Haake 105C super-thermometer I</td>
<td>265385</td>
<td>24-MAR-2017</td>
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<tr>
<td>134201</td>
<td>RTD (50 ohms)</td>
<td>UKAS 42094</td>
<td>24-MAR-2017</td>
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<tr>
<td>134302</td>
<td>RTD (50 ohms)</td>
<td>UKAS 42095</td>
<td>24-MAR-2017</td>
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<td>135000</td>
<td>RTD (50 ohms)</td>
<td>UKAS 42096</td>
<td>24-MAR-2017</td>
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<td>137000</td>
<td>RTD (50 ohms)</td>
<td>UKAS 42097</td>
<td>24-MAR-2017</td>
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<td>133245</td>
<td>RTD (28 ohms)</td>
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<td>133775</td>
<td>Fluke 1798-B 2016 Wllsweerter</td>
<td>UKAS 42099</td>
<td>24-MAR-2017</td>
</tr>
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</table>

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides evidence of measurement traceability to the National Physical Laboratory and is recognised across the world.

Test Results: Page 25 of 33
CERTIFICATE OF CALIBRATION

Date of Calibration: 3rd January 2017
Date of Issue: 5th January 2017
Certificate Number: DLK48522

Manufacturer: Not Known
Model: T-TYPE
Serial No: 256757
Order No: 266759
Date Received: 10th December 2014

CONDITION OF UNIT UNDER TEST

Yes

ADDITIONAL COMMENTS

STABILITY

All readings given are the results of the time of calibration and do not carry any implication regarding the long-term stability of the unit under test.

ACCRÉDATIONS

UIS is accredited by UKAS to BS EN 17025:2005 to undertake the calibration presented in this certificate.

ENVIRONMENT

The instrument was calibrated in our laboratory with ambient conditions stated on the results page.

PROCEDURE

UIS procedure GPRL 0.5

UNCERTAINTY

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

TEST EQUIPMENT USED

<table>
<thead>
<tr>
<th>Asset No.</th>
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<tr>
<td>125424</td>
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<td>UKAS U021024</td>
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<tr>
<td>110366</td>
<td>Tinsley ESU Pressure 25 ohms</td>
<td>UKAS U021024</td>
<td>01 July 2017</td>
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<tr>
<td>110362</td>
<td>PRT (25 ohms)</td>
<td>UKAS U021024</td>
<td>01 July 2017</td>
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<tr>
<td>100265</td>
<td>PRT (25 ohms)</td>
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<td>100266</td>
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<td>100276</td>
<td>RTM-1995-2SB Multipliers</td>
<td>UKAS U021024</td>
<td>01 July 2017</td>
</tr>
</tbody>
</table>

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides measurability of the system of unit of a set of measurement results of the National Physical Laboratory of other internationally recognized measurement laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Test Results : Page 26 of 33

Commercial in Confidence
CERTIFICATE OF CALIBRATION

ISSUED BY: Universal Instrument Services Ltd.

Date of Calibration: 31st January 2017
Date of issue: 31st January 2017
Certificate Number: 00049451

Customer: HORIBA MIRA LIMITED
Address: Watling Street, Maryon
Customer Ref: 014-37

Manufacturer: Not Known
Model: T-type
Serial No.: Q35Y65
Asset No.: Q35Y65
Order No.: 015625
Date Received: 15th December 2016

CONDITION OF UNIT UNDER TEST
The Thermocouple was visually inspected prior to calibration

ADDITIONAL COMMENTS

STABILITY
The readings given are the results at the time of calibration and do not carry any implication regarding the long-term stability of the unit under test.

ACCRREDITATION
UKAS accredited to BS EN 17025:2005 to undertake the calibration presented in this certificate

ENVIRONMENT
The instrument was calibrated in our laboratory with the ambient conditions stated on the results page

PROCEDURE
UKAS procedure CP7.6.8

UNCERTAINTY
The quoted expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty statement has been calculated in accordance with UKAS requirements.

TEST EQUIPMENT USED

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<td>Tinsley B24 Hanger 200 chans.</td>
<td>UKAS 05/1334</td>
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<td>RUT 20 chans.</td>
<td>UKAS 47039</td>
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<td>D2208</td>
<td>PRF 20 chans.</td>
<td>UKAS 47042</td>
</tr>
<tr>
<td>D2249</td>
<td>PRT 20 chans.</td>
<td>UKAS 47016</td>
</tr>
<tr>
<td>D2245</td>
<td>PRT 20 chans.</td>
<td>UKAS 47020</td>
</tr>
<tr>
<td>D2276</td>
<td>RUT 20 chans.</td>
<td>UKAS 47012</td>
</tr>
</tbody>
</table>

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides a level of confidence of measurement to the G5 system of units and also to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced except in full, except with the prior written consent of the testing laboratory.
CERTIFICATE OF CALIBRATION

Issued by

ABSOLUTE CALIBRATION LIMITED

Date of Issue: 10 August 2017
Certificate Number: 0420328

Absolute Calibration Limited
14 Muntz Estate, Portchester
Hampshire, England, PO16 9XD
Telephone 023-92321712
Facsimile 023-92210004
Service Freephone 0800-92337100
www.absolute-cal.co.uk

Description: TEMPERATURE/HUMIDITY SENSOR AND ACTIVE ADAPTOR
Manufacturer: ROTRONIC
Type Number: HYGROCLIP & MCK-20-XX-D1V-2
Serial Number: 00250069
Customer: HORIBA MIRA LIMITED
WATING STREET
NUNEATON
WARW CKSHIRE

Instrument Received Date: 02 August 2017
Order Number: 271823
Customer Reference: Q31965
Laboratory Temperature: (20.0 ± 3.0) °C
Laboratory Humidity: (65 ± 20) %rh
Calibration Procedure: CP 112
Calibration Engineer: G Peterlendi
Calibration Date: 19 August 2017

This Report Contains:
- Recorded results with no adjustments
- Pre and post adjustment results
- Post repair results
- Results recorded at Customer site

The certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurements to the SI system of units and sets units of measurement agreed by the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.
CERTIFICATE OF CALIBRATION

issued by

ABSOLUTE CALIBRATION LIMITED

DATE OF ISSUE  18 August 2017  CERTIFICATE NUMBER  0420384

Absolute Calibration Limited
14 Milton Estate, Forton Road
Hampshire, England, PO16 8RD
Telephone 023-92221712
Facsimile 023-92210334
Service Facsimile 023-922210334
www.absolute-cal.co.uk

Description: TEMPERATURE/HUMIDITY SENSOR AND ACTIVE ADAPTOR
Manufacturer: ROTRONIC
Type Number: HYGROCLIP & WOK-20-XX-010V-2
Serial Number: 60250328
Customer: HORIBA MIRA LIMITED
WATLING STREET
NUNEATON
WARWICKSHIRE

Instrument Receipt Date: 02 August 2017
Order Number: 271663
Customer Reference: Q31995
Laboratory Temperature: (20.0 ± 3.0) °C
Laboratory Humidity: (55 ± 10) %rh
Calibration Procedure: CP 112
Calibration Engineer: S Patacconi
Calibration Date: 16 August 2017

This Report Contains
Recorded results with no adjustments □
Pre and post adjustment results □
Post repair results □
Results recorded at Customer site □

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CERTIFICATE OF CALIBRATION

Issued by:

ABSOLUTE CALIBRATION LIMITED

DATE OF ISSUE: 19 January 2017
CERTIFICATE NUMBER: 0418513

Absolute Calibration Limited
14 Muri's Estate, Horsham, West Sussex, England, PO16 9RD
Telephone: 023 9223 2171/2
Fax: 023 9221 0234
Service: Freephone: 023 9223 2100
www.absolutecal.co.uk

Description:
THERMOCYRHOMETER PROBE AND ACTIVE ADAPTOR

Manufacturer:
ROTRINIC

Type Number:
HYGROCLIP & MOX-20-XX-010M-V.2

Serial Number:
55466265

Customer:
HORIBA MIRA LIMITED
WALING STREENT
NUNEAMON
WARWICKSHIRE

Instrument Receipt Date:
17 January 2017

Order Number:
204316

Customer Reference:
Q319677

Laboratory Temperature:
(20.0 ± 3.0) °C

Laboratory Humidity:
(55 ± 20) %RH

Calibration Procedure:
CP 112

Calibration Engineer:
S Patelmend

Calibration Date:
10 January 2017

This Report Contains:
 Recorded results with no adjustments:

Pre and post adjustment results:

Post repair results:

Results reported at Customer site:

This certificate is issued in accordance with the laboratory calibration statement of the United Kingdom Accreditation Service. A laboratory is a body capable of measurement to the standards given in the Guide to the Expression of Uncertainty in Measurement. This certificate may not be reproduced except in full, by the holder. For details see the note of the bearing seal.

[Stamp]

Signature:
Lisa Croll

Page 1 of 2 Pages
CERTIFICATE OF CALIBRATION
Issued by
ABSOLUTE CALIBRATION LIMITED
DATE OF ISSUE 19 January 2017 CERTIFICATE NUMBER 0016612

Absolute Calibration Limited
14 Muriel's Estate, Porthcress, Hampshire, England, PO16 9RE
Telephone 023-92321712
Fax: 023-92321003
Service Fax: 023 92321000
www.absolute-cal.co.uk

Description: THERMOHYGROMETER PROBE AND ACTIVE ADAPTOR
Manufacturer: ROTRONIC
Type Number: HYGROCLIP & MOK 20-XX-010/2
Serial Number: 62650104
Customer: HORIBA MIRA LIMITED
WATLING STREET
NUNEATON
WARWICKSHIRE

Instrument Receipt Date: 17 January 2017
Order Number: 264316
Customer Reference: GS1998
Laboratory Temperature: (20.0 ± 3.0) ºC
Laboratory Humidity: (55 ± 20) %rh
Calibration Procedure: CP 112
Calibration Engineer: S. Patacchi
Calibration Date: 15 January 2017

This Report Contains
- Recorded results with no adjustments □
- Pre and post adjustment results □
- Post repair results □
- Reports recorded at Customer site □

This certificate is issued in accordance with the calibration requirements of the International Organization for Standardization (ISO) 17025:2005. The certificate is valid for the stated period of time and is subject to the conditions stated on the reverse. The certificate is issued in accordance with the requirements of the calibration laboratory or other organization, as applicable. The certificate may not be reproduced in whole or in part without the prior written approval of the issuing laboratory.
32ch Thermocouple Amplifier

CALIBRATION CERTIFICATE

Issued by HORIBA MIRA Ltd

Issue date: 34 Jan 2017  Cert No: 30279191216

Client: Test Operators FG
Section: Vehicle Env & Aero,
Address: Welling Street
Nuneaton
Warwickshire

Manufacturer: National Institute
Model: SCA-1102

Description: 32ch Thermocouple Amplifier
Serial No: 1825718
Calibration Date: 04 Jan 2017
Calibration Procedure: QA0253/002

Equipment used:
Measurement Results:
Measurement Uncertainty:

Date received: 18 Dec 2016
Dallas ID:

Condition of Instrument: Used, In good condition

Within specification on receipt, at the points measured subject to the measurement uncertainty: Yes
Adjusted during calibration: No
Revised prior to or during calibration: No
Within specification on completion, at the points measured subject to the measurement uncertainty: Yes

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long term stability or environmental performance of the instrument. All measurements detailed within this Calibration Certificate relate only to the instrument detailed above on the dates specified.

The instrument was allowed to stabilize in an environment of 20°C ± 2°C and 60%RH ± 2%RH, for a period of 12 hours before commencing the calibration. The electrical supply within the laboratory is 240V ± 15 Volts and 50Hz ± 0.5Hz with a total harmonic distortion of less than 2%.

This instrument was calibrated by comparison with electrical measurement reference standards using a MIRA procedure which incorporates limits based on client requirements. These requirements are specified in document QC.1562002A

The instrument uncertainty is based on a standard uncertainty multiplied by a coverage factor of 2.5 providing a level of confidence of approximately 95%.

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CALIBRATION CERTIFICATE

Issued by HORIBA MIRA Ltd

Issue date: 05 Jan 2017  Cert No : 34000560117

Climatic Chamber Controller

Manufacturer: MIRA
Model: M013678
Description: Climatic Chamber Controller
Serial No: 01023
Calibration Date: 05 Jan 2017
Calibration Procedure: QA0321/01
Equipment used: Pages 5
Measurement Results: Pages 2 & 3
Measurement Uncertainty: Page 5

Condition of Instrument: Used in good condition

Within specification on receipt, at the points measured subject to the measurement uncertainty: Yes

Adjusted during calibration: No

Repaired prior to or during calibration: No

Within specification on completion, at the points measured subject to the measurement uncertainty: Yes

The reported values are the result of measurements taken at the time of calibration within the environment stated and do not carry any implication regarding the long term stability or environmental performance of the instrument. All measurements detailed within this Calibration Certificate relate only to the instrument detailed above on the dates specified.

This calibration was performed at the client's site.

This instrument was calibrated by comparison with Temperature measurement reference standards using a MIRA procedure which incorporates limits based on client requirements as specified in document CW00032615A.

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of 2, providing a level of confidence of approximately 95%.

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TC02228 Issue 23

Test Results : Page 33 of 33
Commercial in Confidence
WINDSHIELD ADHESIVE „SCHEIBENKLEBER“ Art.-Nr. 83310 + 83400

is an ambient moisture curing one-component polyurethane sealant. 
Passes crash test (FMVSS 212) with security dual air bags after 1 hour.

AREAS OF APPLICATIONS:
can be used to bond windshield and side windows of cars with or without a primer. For other applications, refer to our technical service. Using a primer or not depends of the quality of the substrates (refer to Instructions for use).

TECHNICAL DATA:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Thixotropic paste</td>
</tr>
<tr>
<td>Color</td>
<td>Black</td>
</tr>
<tr>
<td>Density at 20°C</td>
<td>1.23 ± 0.02</td>
</tr>
<tr>
<td>Application temperature</td>
<td>5 to 35 °C</td>
</tr>
<tr>
<td>Skin formation time at 23 °C and 50 % HR</td>
<td>25 to 40 min</td>
</tr>
<tr>
<td>Cure time at 23 °C and 50 % HR</td>
<td>&gt; 3.5 mm/24 h</td>
</tr>
<tr>
<td>Shore A hardness (internal method IT-20 after ISO 868 - 3 seconds)</td>
<td>60 to 65</td>
</tr>
<tr>
<td>Shearing resistance at 5 h at 23 °C and 50 % HR (FORD SAE J 1529)</td>
<td>&gt; 0.9 MPa (&gt; 130 psi)</td>
</tr>
<tr>
<td>Shearing resistance at 7 d at 23 °C and 50 % HR (Ford SAE J 1529)</td>
<td>&gt; 3.5 MPa (&gt; 500 psi)</td>
</tr>
<tr>
<td>Water and salt spray resistance</td>
<td>Excellent</td>
</tr>
<tr>
<td>Specific data</td>
<td>Elongation at break (ISO 37) : &gt; 700 %</td>
</tr>
<tr>
<td></td>
<td>Modulus at break (ISO 37) : approx. 7.5 MPa</td>
</tr>
<tr>
<td></td>
<td>Tear strength (ISO 34) : approx. 30 N/mm</td>
</tr>
<tr>
<td></td>
<td>Crash test (standard FMVSS 212) with security dual air bags: resists after 1 hour at 23 °C and 50 % RH</td>
</tr>
</tbody>
</table>

INSTRUCTIONS FOR USE:

Substrate preparation:
The substrates must be clean, even, dry and free of dust. Carefully respect the evaporation times of the solvents. When using solvents, extinguish all sources of ignition and carefully follow the safety and handling instructions given by the manufacturer. In case of windshield replacement, it is not necessary to completely remove the old sealant; simply trim it off, leaving a 1 to 2 mm thickness. There is no compatibility problem applying fresh polyurethane sealant to old polyurethane sealant. Rub down any rusted area. Clean bare areas of the body before applying the PETEC Primer (Art.-Nr. 82410 / 82330 / 82430). Never clean the old sealant with a solution containing alcohol.
The windshield has to be treated as follows:

**RAW GLASS:**

PETEC instructions: Aktivator (Art.-Nr. 82230) / PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) / Windshield sealant (Art.-Nr. 83310 / 83400).

Clean with Aktivator (Art.-Nr. 82230) according to the WOWO (wipe on/wipe off) method with a clean, dry and lint-free cloth (wipe as soon as the solvent is evaporated, i.e. 30 to 60 seconds after application). As the activator is very sensitive to humidity, the bottle must be closed immediately after use. If it is cloudy, do not use it.

For this application, it is possible to use single-use impregnated wipes (kit containing an impregnated wipe and a dry wipe for WOWO).

Let dry between 10 to 60 minutes after application according to temperature.

In case of excessive drying time, repeat a second time.

Then apply a thin and uniform film of Primer (Art.-Nr. 82410 / 82330 / 82430) with an applicator pad (or a 10 ml tube with single-use foam sponge applicator) in order to form a homogeneous film.

Homogenize the product before application.

Shake until agitator ball is moving. Shake another 30 seconds. Close the bottle immediately after use.

Any contact with humidity will make the primer cure. For this reason, the product must be used within 24 hours after opening the bottle.

Let dry between 15 and 60 minutes according to temperature before application of the sealant.

**WINDSHIELD WITH CERAMIC FRIT:**

PETEC instructions: Cleaning cloth 82111 / Aktivator (Art.-Nr. 82230) / PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) / Windshield sealant (Art.-Nr. 83310 / 83400).

Bonding may be performed with or without primer.

Bonding without PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) must be performed on a windshield with ceramic frit ensuring optimum and uniform opacity to UV and with no silicone residue.

Non compliance with these conditions may cause partial or total loss of adhesion of the sealant on the windshield.

Degrease with Cleaning cloth 82111, abrade with PETEC Multi Cleaner (Art.-Nr. 82100 oder 82200 in order to avoid orange peel effect likely to occur in presence of traces of silicone), degrease a second time with heptane or MEK and respect a drying time of 10 minutes.

Apply Aktivator (Art.-Nr. 82230) according to the method described for raw glass.

Let dry between 10 and 60 minutes before the next step:

- if ceramic frit is sufficiently opaque, application of the sealant;
- if ceramic frit is not sufficiently opaque, application of PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) with an applicator pad (or a 10 ml tube with single-use foam sponge applicator) followed by a waiting time of 15 to 60 minutes before application of the sealant.

- ENCAPSULATED WINDSHIELD: degrease if needed with Cleaning cloth 82111 or acetone (do not use alcohol) and respect a 10 minutes drying time, then apply PETEC Primer (Art.-Nr. 82410 / 82330 / 82430)

- WINDSHIELD COATED WITH A PRIMER: degrease with Cleaning cloth 82111 or acetone. After about 10 minutes, apply PETEC Primer (Art.-Nr. 82410 / 82330 / 82430)

For other types of substrates, refer to our technical service.

**Bonding:**

The sealant “Scheibenkleber” can be applied with a hand or pneumatic gun.

The triangle-shaped form of the joint is determined by the nozzle.

If applied in cold weather, store the packagings at about 20 °C before use.

The windshield must be applied and pressed before the end of the skinning time.

Do not apply in the presence of cured or non-cured silicones or hybrid sealants (MS, SPUR or STPE).

Do not apply at temperatures lower than 5 °C.

Note: all times described in the above instructions are valuable for a minimum temperature of 15 °C. In case of lower temperatures (between 5 and 15 °C), drying times must be twice longer.
Cleaning:
Uncured sealant can be cleaned up with PETEC Multi Cleaner (Art.-Nr. 82100 oder 82200) or acetone. After curing, abrasion is necessary.

Drive-away time for a car:
60 minutes with air bag

Storage and shelf life
12 months in closed original packaging stored in dry premises at a temperature lower than 25 °C. If necessary, gently warm the product before use until it reaches a suitable temperature. Storage at a temperature over 25 °C will decrease the shelf life of the sealant.

Packaging
310 ml aluminium cartridges;
400 and 600 ml sausages
Contact us for other packaging options.

Provisional technical data sheet

The technical data contained herein is based on our present knowledge and experience and we cannot be held liable for any errors, inaccuracies, omissions or editorial failings that result from technological changes or research between the date of issue of this document and the date the product is acquired. Before using the product, the user should carry out any necessary tests in order to ensure that the product is suitable for the intended application. Moreover, all users should contact the seller or the manufacturer of the product for additional technical information concerning its use if they think that the information in their possession needs to be clarified in any way, whether for normal use or a specific application of our product. Our guarantee applies within the context of the statutory regulations and provisions in force, current professional standards and in accordance with the stipulations set out in our general sales conditions. The information detailed in the present technical data sheet is given by way of indication and is not exhaustive. The same applies to any information provided verbally by telephone to any prospective or existing customer.
PRIMER

PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) is an isocyanate and solvent-based primer specially developed to improve the adhesion and maximize the bonding of sealants on low surface energy substrates used in the transportation market and more specifically the glass bonding. This all-in-one primer is also compatible with all PETEC polyurethane and hybrid sealants.

AREAS OF APPLICATIONS:
The surface preparation can be made with the PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) either alone or in combination with the Aktivator (Art.-Nr. 82230) to promote adhesion, improve bond durability and provide optimum protection against UV rays on organic or mineral glass.

PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) is used on glass and silk-screened ceramic frit glass for the bonding of windshield or glass (on cars, trains, buses, trucks and specialty vehicles) as well as on vehicle body frames. It acts as a corrosion inhibitor on metal and can be applied on pinchweld scratches and nicks.

PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) is also recommended in the marine industry (for windshield or porthole bonding) to prime acrylic (PMMA) or polycarbonate windows, fiberglass and polyester.

PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) can also be used as a multipurpose primer on many non-porous substrates used in the transportation market, like aluminium, metals, stainless steel, painted surfaces, ABS, wood and PVC).

For applications other than glass bonding, it is recommended to do preliminary adhesion and compatibility tests - contact our technical service.

TECHNICAL DATA:

<table>
<thead>
<tr>
<th>Color</th>
<th>Black</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>DIN cup Ø4 mm, 100 ml: 11 to 14 s</td>
</tr>
<tr>
<td>Density at 20°C</td>
<td>0.95 ± 0.05</td>
</tr>
<tr>
<td>Application temperature</td>
<td>+5°C bis +35°C</td>
</tr>
<tr>
<td>Specific data</td>
<td>Drying time: 10 to 15 min *</td>
</tr>
</tbody>
</table>

* If the temperature is below 20°C, a longer drying time is recommended.

INSTRUCTIONS FOR USE:

Substrates preparation:
The substrates to be treated must be clean, dry, free of dust or grease. Contaminated surfaces must be cleaned beforehand with a solvent-based solution with or without the help of an abrasive like PETEC Multi Cleaner (Art.-Nr. 82100 oder 82200). Let evaporate for 5 minutes before next step.

We preconize to treat the glass with the adhesion promoter AKTIVATOR (Art.-Nr. 82230) see the technical data sheet of the product before applying PETEC Primer (Art.-Nr. 82410 / 82330 / 82430).

Note: when using solvents, extinguish all sources of ignition and carefully follow the safety and handling instructions given by the manufacturer.

Primer application:
To perfectly homogenize the product, shake thoroughly the bottle until agitator ball is moving, then shake additional 30 seconds. Dip a clean felt tip applicator into the bottle, roll it around the edges of the bottle to squeeze out the excess of product.

PETEC Multiaktiv Primer PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) can also be applied with the 10 ml tube with foam applicator. Shake thoroughly the tube for 10 to 15 seconds in order to re-homogenize the product. Exert a uniform and light pressure to get a homogenous and opaque film.

Hermetically seal the container immediately after use as this product is very sensitive to moisture. Any contact with humidity will make the primer cure.

On the glass: after drying (10 to 15 minutes* depending on temperature and moisture conditions) apply the sealant within a one hour deadline, proceeding according to instructions of its technical data sheet. If the deadline is not respected or if the film of primer is contaminated (dust, etc.) lightly sand the primed surface, remove the dust and re-prime with PETEC Primer (Art.-Nr. 82410 / 82330 / 82430).
On the vehicle: a surface treatment with PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) is recommended on pinch-weld parts scratched during disassembling of the windscreen as well as on areas where traces of rust are visible. After abrasion followed by a cleaning (solvent), apply PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) with a clean felt tip applicator to stop corrosion. Respect a drying time of 10 to 15 minutes*.

* If the temperature is below 20°C, a longer drying time is recommended.

Cleaning:
During the few minutes following the application, it is possible to clean with mineral spirits; beyond that time, it is necessary to use a mixture of methylethylketone and toluene or methylethylketone and xylene.

Limitations:
Do not use if an increase in viscosity or a cured film on surface are observed.
Do not apply on frozen surfaces.
Do not apply PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) to the existing trimmed polyurethane bead (windshield replacement).
Do not reuse the felt tip applicator.
Do not re-dip the felt tip applicator in the bottle (pollution).

CONSUMPTION
Consumption is dependent on the nature of the substrates. Count 80 to 100 ml/m² on glass.

STORAGE AND SHELF LIFE
12 months in original and unopened packaging stored between 5 and 25°C.
PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) should be used during the month following the opening of the bottle. This time is reduced if the packaging remains opened or is not closed properly, and more so if temperature and humidity are high.
PETEC Primer (Art.-Nr. 82410 / 82330 / 82430) in tube is intended for single use only and should be used quickly after opening.

PACKAGING
10 ml tubes
Contact us for other packaging options.

SAFETY
Professional use.
Read the material safety data sheet before use.
Wearing safety glasses and gloves mandatory.

Provisional technical data sheet

The technical data contained herein is based on our present knowledge and experience and we cannot be held liable for any errors, inaccuracies, omissions or editorial failings that result from technological changes or research between the date of issue of this document and the date the product is acquired. Before using the product, the user should carry out any necessary tests in order to ensure that the product is suitable for the intended application. Moreover, all users should contact the seller or the manufacturer of the product for additional technical information concerning its use if they think that the information in their possession needs to be clarified in any way, whether for normal use or a specific application of our product. Our guarantee applies within the context of the statutory regulations and provisions in force, current professional standards and in accordance with the stipulations set out in our general sales conditions. The information detailed in the present technical data sheet is given by way of indication and is not exhaustive. The same applies to any information provided verbally by telephone to any prospective or existing customer.
AKTIVATOR

is an organic solvent-based solution specially developed to improve the adhesion of sealants on substrates used in the automotive industry and more specifically the windows bonding.

AREAS OF APPLICATIONS:

AKTIVATOR (Art.-Nr. 82230) is intended for professional use as an adhesion promoter of polyurethane sealants in windshield replacement with or without the use of a black primer.

AKTIVATOR (Art.-Nr. 82230) can also be used on many non-porous substrates (aluminium, metals, painted surfaces, organic and mineral glass of automotive quality).

It is recommended to check the adhesion and the compatibility of the AKTIVATOR (Art.-Nr. 82230) in the terms of use on the site.

For other applications, contact our technical service.

TECHNICAL DATA:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Transparent, colorless, extremely fluid liquid</td>
</tr>
<tr>
<td>Density at 20°C</td>
<td>0.73 ± 0.02</td>
</tr>
<tr>
<td>Application temperature</td>
<td>5 to 35°C</td>
</tr>
<tr>
<td>Specific data</td>
<td>Drying time: 10 minutes *</td>
</tr>
</tbody>
</table>

* If the temperature is below 20°C, this time will be increased.

INSTRUCTIONS FOR USE:

Substrates preparation:

The substrates to be treated must be clean, dry free of dust or grease.

Contaminated surfaces must be cleaned beforehand with a solvent-based solution.

Let evaporate for 5 minutes before applying AKTIVATOR (Art.-Nr. 82230).

Note: when using solvents, extinguish all sources of ignition and carefully follow the safety and handling instructions given by the manufacturer.

Application:

Shake the bottle before use.

Close it immediately after use as this product is very sensitive to moisture.

Do not use if a change of the appearance is observed (presence of particles, cloudy solution, change of color).

AKTIVATOR (Art.-Nr. 82230) can be applied using a felt tip applicator or a lint cloth, in a single pass in order to apply a thin and uniform layer.

After drying (10 minutes * depending on temperature and moisture conditions), apply sealant within a one hour deadline following the instructions of its technical datasheet.

Do not apply with a brush, roller or by spraying.

* If the temperature is below 20°C, this time will be increased.

CONSUMPTION:
Consumption is dependent on the nature of the substrates.

**STORAGE AND SHELF LIFE:**
12 months in the original, hermetically sealed and unopened packaging between 5 and 25°C. AKTIVATOR (Art.-Nr. 82230) should be used during the month following the opening of the bottle. This time is reduced if the packaging remains opened or is not closed properly and more so if temperature and humidity are high.

**PACKAGING:**
30 ml aluminium bottles. Contact us for other packaging options.

**SAFETY:**
Professional use. Read the material safety data sheet before use. Wearing gloves mandatory.

Provisional technical data sheet

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