# Deutsche WindGuard
# Wind Tunnel Services GmbH, Varel

**DEUTSCHE**
**WINDGUARD**

accredited by the / *akkreditiert durch die*

# Deutsche Akkreditierungsstelle GmbH

as calibration laboratory in the / *als Kalibrierlaboratorium im*

# Deutschen Kalibrierdienst

**DKD**

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Deutsche
Akkreditierungsstelle
D-K-15140-01-00

Calibration certificate
*Kalibrierschein*

Calibration mark
*Kalibrierzeichen*

| 1536183 |
|---|
| **D-K-15140-01-00** |
| 12/2015 |

| | |
|---|---|
| **Object** <br> *Gegenstand* | Cup Anemometer |
| **Manufacturer** <br> *Hersteller* | Thies Clima <br> D-37083 Göttingen |
| **Type** <br> *Typ* | 4.3351.10.000 |
| **Serial number** <br> *Fabrikat/Serien-Nr.* | 11159432 |
| **Customer** <br> *Auftraggeber* | Ammonit Measurement GmbH <br> D-10997 Berlin |
| **Order No.** <br> *Auftragsnummer* | L 23677 |
| **Project No.** <br> *Projektnummer* | VT150935 |
| **Number of pages** <br> *Anzahl der Seiten* | 4 |
| **Date of Calibration** <br> *Datum der Kalibrierung* | 05.12.2015 |

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).
The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates. The user is obliged to have the object recalibrated at appropriate intervals.

*Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).*
*Die DAkkS ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.*

| Date <br> *Datum* | Head of the calibration laboratory <br> *Leiter des Kalibrierlaboratoriums* | Person in charge <br> *Bearbeiter* |
|---|---|---|
| 05.12.2015 | Dipl. Phys. Dieter Westermann | Techniker Dirk Henninges |

| | |
|---|---|
| **Calibration object**<br>*Kalibriergegenstand* | Cup Anemometer |

**Calibration procedure**
*Kalibrierverfahren*

• Deutsche WindGuard Wind Tunnel Services: QM-KL-AK-VA
Based on following standards:
• MEASNET: Anemometer calibration procedure
• IEC 61400-12-1: Power performance measurements of electricity producing wind turbines
• IEC 61400-12-2: Power performance of electricity producing wind turbines based on nacelle anemometry
• ISO 3966: Measurement of fluid in closed conduits
• ISO 16622: Meteorology - Sonic anemometers/thermometers

**Place of calibration**
*Ort der Kalibrierung*

Windtunnel of Deutsche WindGuard WindTunnel Services GmbH, Varel

**Test conditions**
*Messbedingungen*

| | |
|---|---|
| wind tunnel area | 10000 cm² |
| anemometer frontal area | 230 cm² |
| diameter of mounting pipe | 34 mm |
| blockage ratio [1] | 0.023 [-] |
| software version | 7.64 |

[1] Due to the special construction of the test section no blockage correction is necessary.

**Ambient conditions**
*Umgebungsbedingungen*

| | |
|---|---|
| air temperature | 21.1 °C ± 0.1 °C |
| air pressure | 1016.2 hPa ± 0.3 hPa |
| relative air humidity | 42.0 % ± 2.0 % |

**Measurement uncertainty**
*Messunsicherheit*

The expanded uncertainty assigned to the measurement results is obtained by multiplying the standard uncertainty by the coverage factor k = 2. It has been determined in accordance with DAkkS-DKD-3. The value of the measurand lies within the assigned range of values with a probability of 95%.
The reference flow speed measurement is traceable to the German NMI (Physikalisch-Technische Bundesanstalt) standard for flow speed. It is realized by using a PTB owned and calibrated Laser Doppler Anemometer (Standard Uncertainty 0.2 %, k=2)

**Additional remarks**
*Zusätzliche Anmerkungen*

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### Calibration result
*Kalibrierergebnis*

| Sensor out | Tunnel speed | Uncertainty (k=2) |
|---|---|---|
| Hz | m/s | m/s |
| 82.006 | 3.981 | 0.050 |
| 125.234 | 5.982 | 0.050 |
| 168.966 | 7.981 | 0.050 |
| 211.461 | 9.948 | 0.050 |
| 254.251 | 11.939 | 0.051 |
| 299.015 | 13.964 | 0.051 |
| 339.858 | 15.831 | 0.051 |
| 317.861 | 14.863 | 0.051 |
| 276.720 | 12.955 | 0.051 |
| 233.414 | 10.951 | 0.051 |
| 190.114 | 8.977 | 0.051 |
| 147.464 | 6.985 | 0.050 |
| 104.323 | 5.010 | 0.050 |

*File: 1536183*

| **Linear regression analysis** | Slope | 0.04604 (m/s)/(Hz) ±0.00005 (m/s)/(Hz) |
|---|---|---|
| | Offset | 0.2098 m/s ±0.011 m/s |
| | Standard error (Y) | 0.013 m/s |
| | Correlation coefficient | 0.999993 |

**Remarks**  The calibrated sensor complies with the demanded linearity of MEASNET

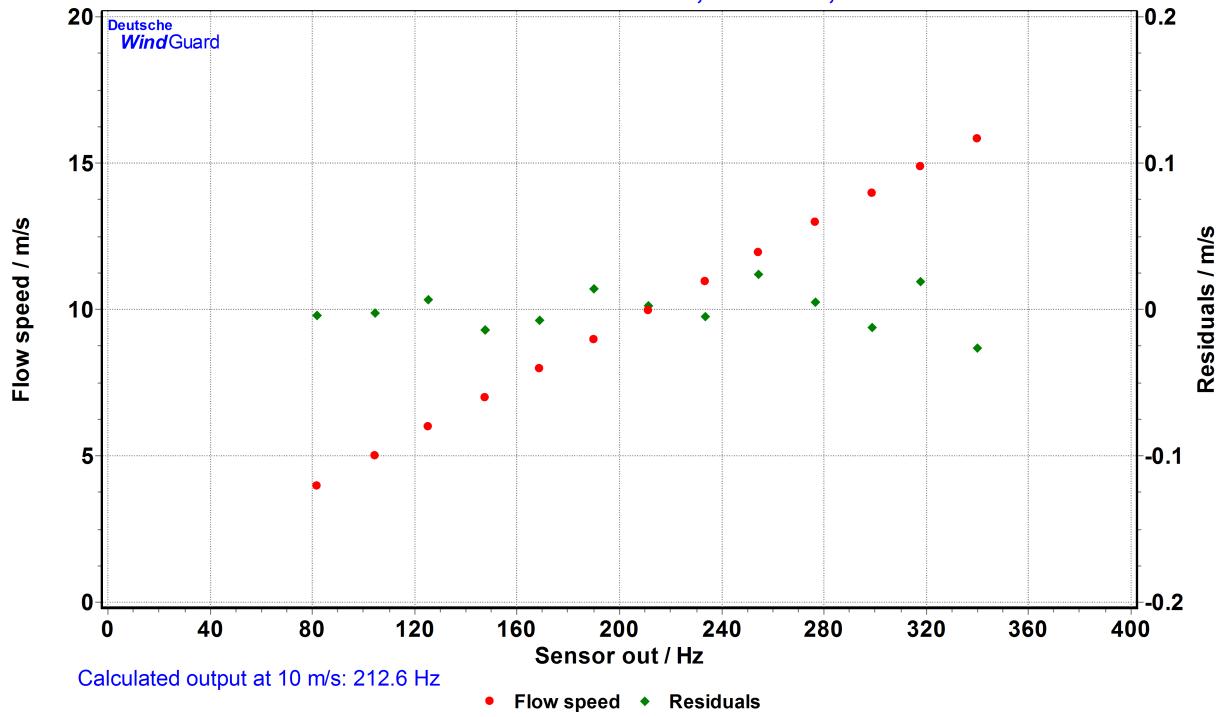Deutsche WindGuard
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**Graphical representation of the result**
*Grafische Darstellung des Ergebnisses*



**Calibration No: 1536183; 11159432;**

Calculated output at 10 m/s: 212.6 Hz

**Photo of the measurement setup**
*Foto des Messaufbaus*



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Remark: The proportions of the set-up may not be true to scale due to imaging geometry.