

accredited by the / *akkreditiert durch die***Deutsche Akkreditierungsstelle GmbH**as calibration laboratory in the / *als Kalibrierlaboratorium im***Deutschen Kalibrierdienst**Deutsche  
Akkreditierungsstelle  
D-K-15140-01-00Calibration certificate  
*Kalibrierschein*Calibration mark  
*Kalibrierzeichen*

1715154

D-K-

15140-01-00

12/2017

<b>Object</b> <i>Gegenstand</i>	Cup Anemometer
<b>Manufacturer</b> <i>Hersteller</i>	Thies Clima D-37083 Göttingen
<b>Type</b> <i>Typ</i>	4.3351.10.000
<b>Serial number</b> <i>Fabrikat/Serien-Nr.</i>	12179346
<b>Customer</b> <i>Auftraggeber</i>	HydroWind BVBA B-1850 Grimbergen (Brussels)
<b>Order No.</b> <i>Auftragsnummer</i>	Email 2017-11-20, Wery
<b>Project No.</b> <i>Projektnummer</i>	VT171188
<b>Number of pages</b> <i>Anzahl der Seiten</i>	4
<b>Date of Calibration</b> <i>Datum der Kalibrierung</i>	15.12.2017

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.*

This calibration certificate may not be reproduced other than in full except with the permission of both the German Accreditation Body and the issuing laboratory. Calibration certificates without signature are not valid. This calibration certificate has been generated electronically.

*Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Deutschen Akkreditierungsstelle als auch des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit. Dieser Kalibrierschein wurde elektronisch erzeugt.*

Date  
*Datum*

15.12.2017

Head of the calibration laboratory  
*Leiter des Kalibrierlaboratoriums*

Dipl. Phys. Dieter Westermann

Person in charge  
*Bearbeiter*

Techniker Dirk Henniges

**Calibration object**  
*Kalibriergegenstand*

Cup Anemometer

**Calibration procedure**  
*Kalibrierverfahren*

- Deutsche WindGuard Wind Tunnel Services: VA Anemometerkalibrierung
- Based on following standards:
- MEASNET ANEMOMETER CALIBRATION PROCEDURE Version 2 / 2009
- IEC 61400-12-1:2017 Power performance measurements of electricity producing wind turbines
- IEC 61400-12-2:2013 Power performance of electricity producing wind turbines based on nacelle anemometry
- ISO 3966:2008 Measurement of fluid in closed conduits
- ISO 16622:2002 Meteorology - Sonic anemometers/thermometers

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

Wind tunnel of Deutsche WindGuard WindTunnel Services GmbH, Varel

**Test conditions**  
*Messbedingungen*

wind tunnel area	10000 cm <sup>2</sup>
anemometer frontal area	230 cm <sup>2</sup>
diameter of mounting pipe	34 mm
blockage ratio <sup>1)</sup>	0.023 [-]
software version	7.7

<sup>1)</sup> Due to the special construction of the test section no blockage correction is necessary.

**Ambient conditions**  
*Umgebungsbedingungen*

air temperature	20.7 °C ± 0.1 °C
air pressure	995.0 hPa ± 0.3 hPa
relative air humidity	34.3 % ± 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*

-

## Calibration result

Kalibrierergebnis

Sensor	Tunnel Speed	Uncertainty
Hz	m/s	m/s
81.573	3.956	0.050
122.686	5.860	0.051
165.994	7.859	0.051
209.959	9.883	0.051
254.143	11.892	0.051
295.462	13.821	0.051
338.008	15.786	0.053
316.369	14.792	0.053
275.530	12.893	0.053
231.268	10.858	0.052
187.124	8.861	0.051
145.051	6.920	0.051
102.034	4.928	0.050

File: 1715154

## Statistical analysis

Slope	0.04603 (m/s)/(Hz) $\pm$ 0.00006 (m/s)/(Hz)
Offset	0.2207 m/s $\pm$ 0.012 m/s
Standard error (Y)	0.013 m/s
Correlation coefficient	0.99999

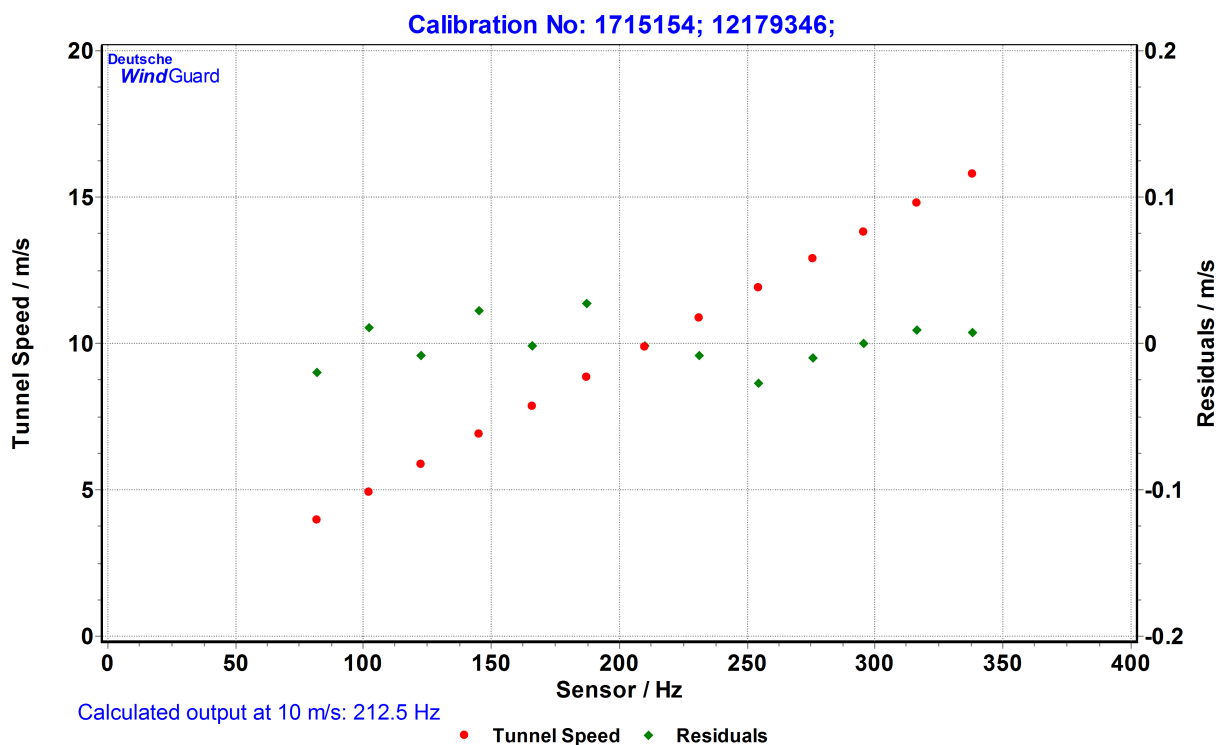
## Remarks

The calibrated sensor complies with the demanded linearity of MEASNET



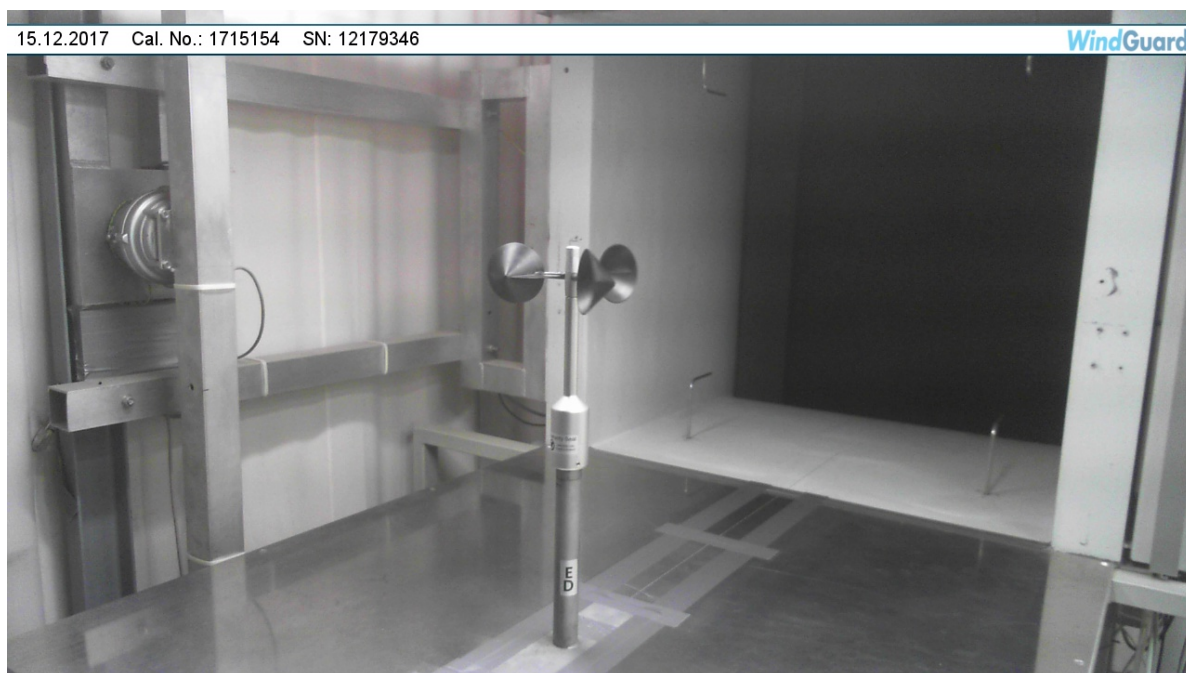
### Graphical representation of the result

Grafische Darstellung des Ergebnisses



### Photo of the measurement setup

Foto des Messaufbaus



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