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Deutsche  
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D-K-15140-01-00

Calibration certificate  
Kalibrierschein

Calibration mark  
Kalibrierzeichen

1710696
D-K- 15140-01-00
02/2017

<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>	02175508
<b>Customer</b> <i>Auftraggeber</i>	HydroWind BVBA B-1850 Grimbergen (Brussels)
<b>Order No.</b> <i>Auftragsnummer</i>	Email 2017-02-06, Wery
<b>Project No.</b> <i>Projektnummer</i>	VT170257
<b>Number of pages</b> <i>Anzahl der Seiten</i>	4
<b>Date of Calibration</b> <i>Datum der Kalibrierung</i>	09.02.2017

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Date  
Datum

09.02.2017

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: 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 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	7.64

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

**Ambient conditions**  
*Umgebungsbedingungen*

air temperature	19.9 °C ± 0.1 °C
air pressure	1031.3 hPa ± 0.3 hPa
relative air humidity	29.5 % ± 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
82.633	4.008	0.050
123.619	5.903	0.050
166.930	7.911	0.051
211.505	9.932	0.051
255.279	11.943	0.051
297.217	13.876	0.052
340.664	15.841	0.052
317.507	14.852	0.052
276.382	12.934	0.052
231.676	10.890	0.051
188.345	8.886	0.051
145.918	6.947	0.050
102.927	4.977	0.050

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## Statistical analysis

Slope	0.04591 (m/s)/(Hz) $\pm$ 0.00007 (m/s)/(Hz)
Offset	0.2368 m/s $\pm$ 0.016 m/s
Standard error (Y)	0.016 m/s
Correlation coefficient	0.999987

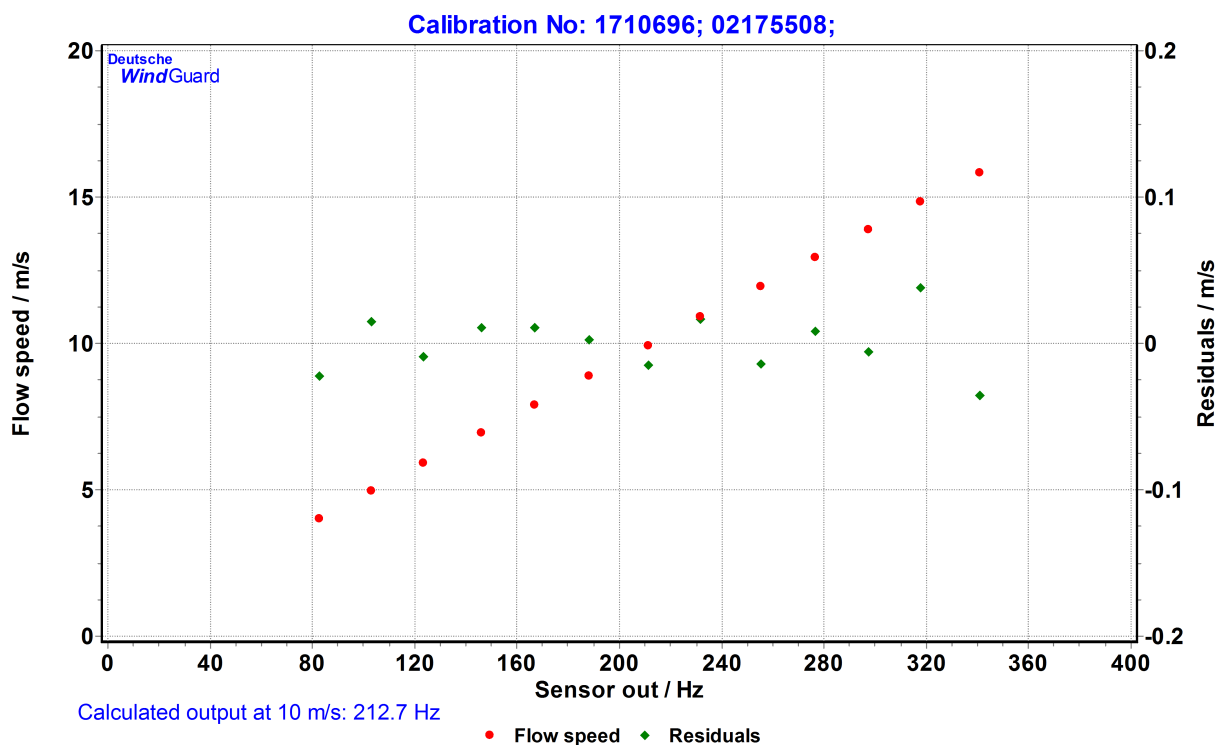
## Remarks

The calibrated sensor complies with the demanded linearity of MEASNET



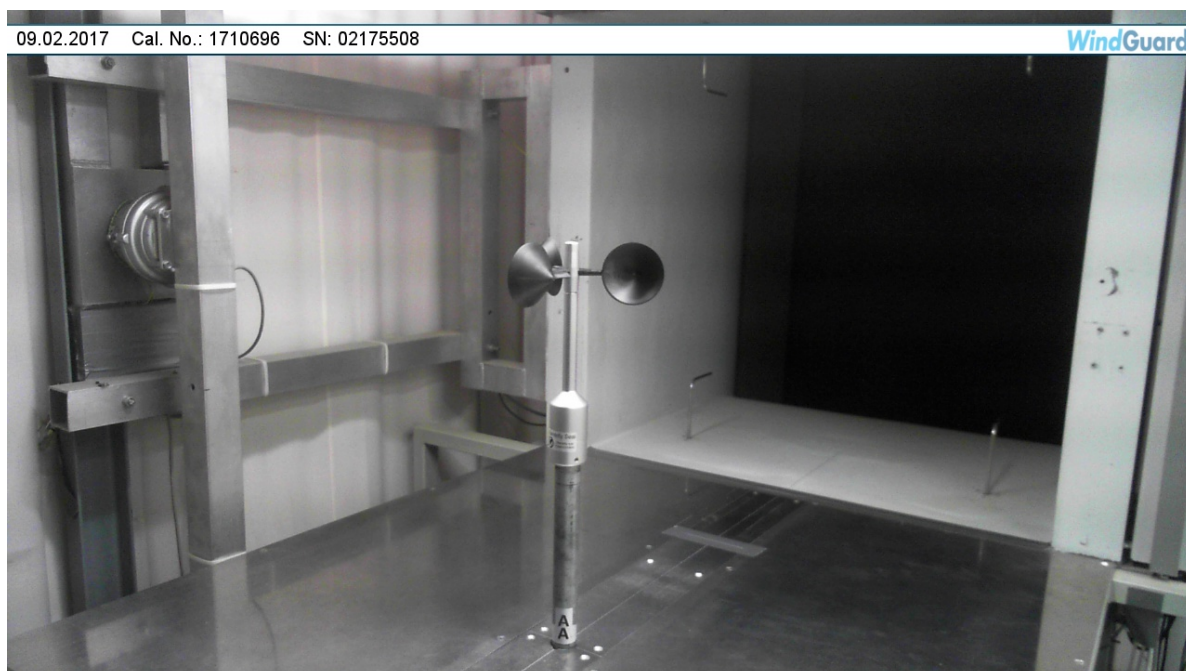
### Graphical representation of the result

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.