

DEUTSCHER KALIBRIERDIENST **DKD**

Kalibrierlaboratorium für Strömungsgeschwindigkeit von Luft
Calibration laboratory for velocity of air flow

Akkreditiert durch die / *accredited by the*

Akkreditierungsstelle des Deutschen Kalibrierdienstes



DEWI GmbH
 Deutsches Windenergie-Institut



Kalibrierschein
Calibration certificate



Kalibrierzeichen
Calibration label

2000_09
DKD-K-28901
08.10.09

<p>Gegenstand <i>Object</i></p> <p>Hersteller <i>Manufacturer</i></p> <p>Typ <i>Type</i></p> <p>Fabrikat/Serien-Nr. <i>Serial number</i></p> <p>Auftraggeber <i>Customer</i></p> <p>Auftragsnummer <i>Order No.</i></p> <p>Anzahl der Seiten des Kalibrierscheines <i>Number of pages of the certificate</i></p> <p>Datum der Kalibrierung <i>Date of calibration</i></p>	<p>Cup Anemometer</p> <p>Thies Clima D-37083 Göttingen</p> <p>4.3350.10.000</p> <p>body: 0909586 cup: -</p> <p>EKOPOWER NL-5604 CC Eindhoven, NL</p> <p>2000_09</p> <p>3+3</p> <p>08.10.09</p>	<p>Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Der DKD 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. <i>This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The DKD 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.</i></p>
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	<p>Datum <i>Date</i></p> <p>08.10.09</p>	<p>Stellv. Leiter des Kalibrierlaboratoriums <i>Deputy head of the calibration laboratory</i></p> <p></p> <p>Dipl.-Ing. (FH) P. Busche</p>	<p>Bearbeiter <i>Person in charge</i></p> <p></p> <p>R. Kluijn</p>
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Kalibriergesamt Object	Cup Anemometer
Kalibrierverfahren Calibration procedure	MEASNET - Cup Anemometer Calibration Procedure - 9/1997 ISO 3966 – Measurement of fluid in closed conduits – 1977
Ort der Kalibration Place of calibration	Windtunnel of the University of Oldenburg
Meßbedingungen Test conditions	wind tunnel area ¹⁾ 8000 cm ² anemometer frontal area ²⁾ 315 cm ² diameter of mounting pipe ³⁾ 34 mm blockage ratio ⁴⁾ 0.039 [-] blockage correction ⁵⁾ 0.998 [-] tunnel calibration ⁶⁾ 0.999 [-] average DEWI reference ⁷⁾ Thies FC 0503076 : 9.80 m/s present DEWI reference ⁸⁾ 9.78 m/s
Umgebungsbedingungen Ambient conditions	air temperature 19.5 °C ± 1 K air pressure 1015.4 hPa ± 1 hPa relative air humidity 60.0 % ± 6 %
Dateiinformatio File informatio	c:\AK\Kalibrierdaten\Doc\2009\10_2009\2 000_09.doc
Anmerkungen Remarks	-
Auswertesoftware Software versio	LV_Rev.1.6

¹⁾ Nozzle area of the wind tunnel

²⁾ Projected cross sectional area of the anemometer

³⁾ Diameter of the mounting pipe

⁴⁾ Ratio ²⁾ to ¹⁾

⁵⁾ Correction in wind speed due to the blockage effect of the anemometer

⁶⁾ Ratio of wind speed at the anemometer position relative to the wind speed measuring plane

⁷⁾ Long term average value of the reference anemometer

⁸⁾ Current value of the reference anemometer

Messergebnis:

Result:

Strömungs- geschwindigkeit Luft (speed of air flow) m/s	Anzeige Anemometer (anemometer signal) 1/s	Erweiterte Messunsicherheit (expanded uncertainty)* m/s
4.030	78.599	0.10
6.046	120.244	0.10
8.053	162.071	0.10
10.170	206.376	0.10
12.187	248.532	0.10
14.225	291.770	0.10
15.808	325.340	0.11
15.292	314.546	0.10
13.224	270.706	0.10
11.218	228.779	0.10
9.138	185.231	0.10
7.104	142.513	0.10
5.040	99.600	0.10

*) Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor $k=2$ ergibt, wobei die kleinste angebbare Messunsicherheit gemäß DKD-Akkreditierung 0.10 m/s beträgt. Die erweiterte Messunsicherheit wurde gemäß DKD-3 ermittelt. Der Wert liegt mit einer Wahrscheinlichkeit von 95% im zugeordneten Wertintervall.

Der Deutsche Kalibrierdienst ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine. Die weiteren Unterzeichner innerhalb und außerhalb Europas sind den Internetseiten von EA (www.european-accreditation.org) und ILAC (www.ilac.org) zu entnehmen.

*) The expanded uncertainty assigned to the measurement results is obtained by multiplying the standard uncertainty by the coverage factor $k=2$. According to the DKD-accreditation the value for the best measurement capability shall not be smaller than 0.10 m/s. The expanded uncertainty has been determined in accordance with DKD-3. The value of the measurand lies within the assigned range of values with a probability of 95%.

The DKD 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. Further signatory members within Europe and outside of Europe may be extracted from the EA-internet page (www.european-accreditation.org) and the ILAC-internet page (www.ilac.org)

MEASNET Appendix

1. Results

DKD calibration no. 2000_09

type 4.3350.10.000
 serial number 0909586
 cup number -
 date 08.10.09
 file c:\AK\Kalibrierdaten\Doc\2009\10_2009\2000_09.doc

DEWI Version LV_Rev.1.6

air temperature 19.5 °C
 air pressure 1015.4 hPa
 air humidity 60.0 %

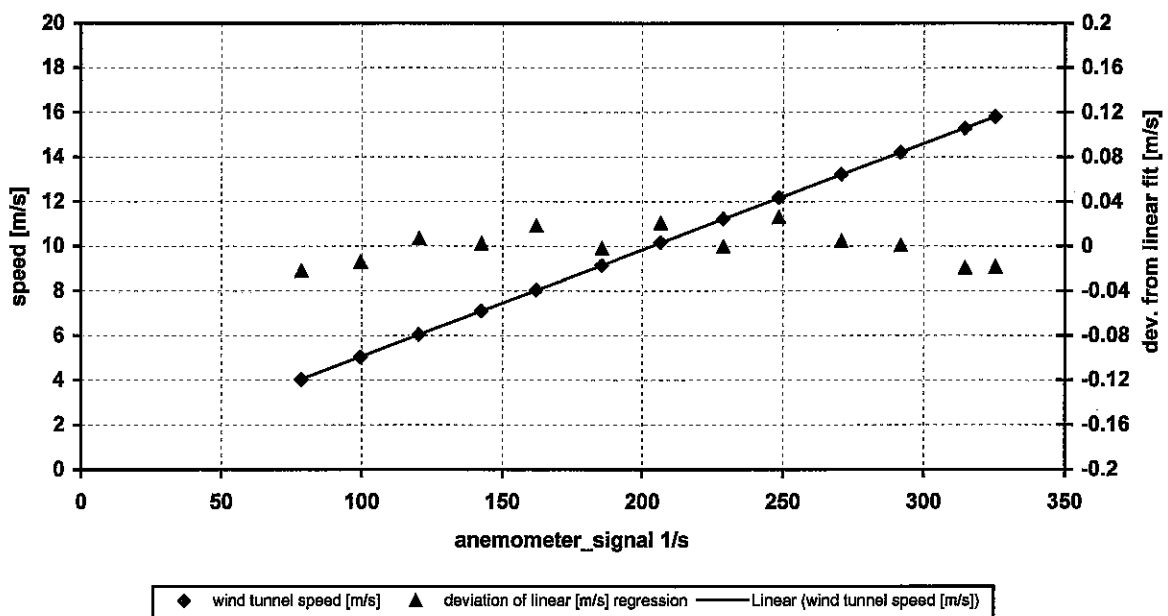


linear regression analysis

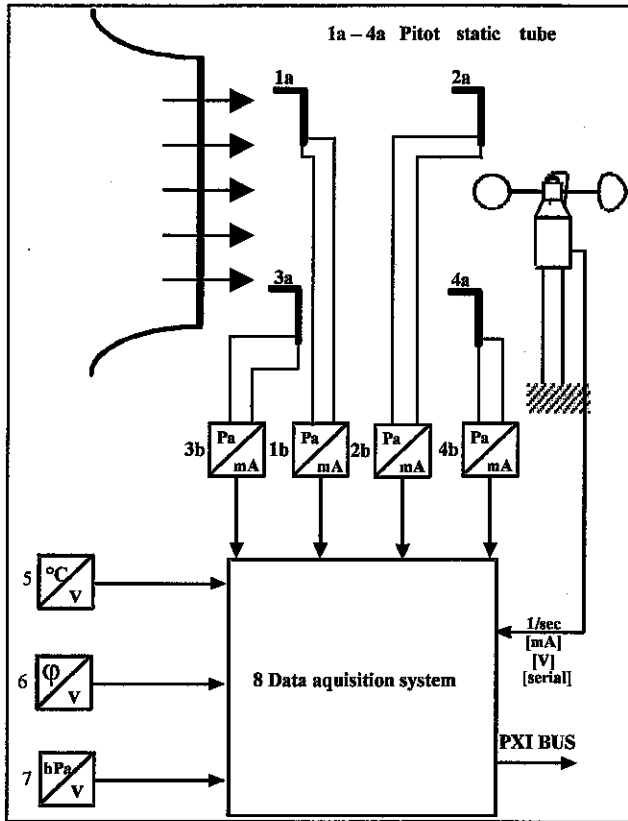
slope 0.04772 m ± 0.00006 m
 offset 0.301 m/s ± 0.013 m/s
 correlation coefficient 0.999992
 standard error (v) 0.016 m/s
 COV(A,B) -670.450E-9

remarks -

DEWI Calibration No. 2000_09



2. Instrumentation



Description of the data acquisition system

2b Pressure Transducer

Type: ASHCROFT XLdp
Year: 1993
Calibration: recalibration DEWI

3b Pressure Transducer

Type: Setra 239
Year: 2003
Calibration: recalibration DEWI

4b Pressure Transducer

Type: Setra 239
Year: 2001
Calibration: recalibration DEWI

5 Thermometer

Type: Galtec KRC 2/5
Serial no. 48448
Calibration: 4706/2009/02

6 Humidity Sensor

Type: Galtec KRC 2/5
Serial no. 48448
Calibration: 4706/2009/02

7 Barometer

Type: Vaisala PTB 100A
Serial no. U5030013
Calibration: 05066/2009/02

8 Data acquisition system

Type: NI 1042
Year: 2003
Calibration: checked with calibrated current, voltage and frequency standard

1a – 4a Pitot tube

Type: Airflow (ISO 3966)
Year: 2005
Calibration: No; ISO 3966 [1]

1b Pressure Transducer

Type: ASHCROFT XLdp
Year: 1993
Calibration: recalibration DEWI

Reference Pressure transducer

Type: Ashcroft XLDP 2
Year: 2004
Calibration: A14742 /2009/03

Wind Tunnel:

University of Oldenburg

Remark: Ambient pressure standard is calibrated by DKD in 01/2008
Combined temperature and humidity standard is calibrated by the German 'Eichamt' in 4/2000
The multimeter is calibrated by 'DKD' in 07/2008
The frequency counter is calibrated by the German 'DKD' in 09/2007

3 Deviation to MEASNET Procedure

- The time to get stable flow conditions between two speed settings is approx. 30 seconds (it has been proven for this tunnel that 30 seconds are sufficient enough to establish a stable flow).
- The expanded uncertainty from page 3 shows only values ≥ 0.10 m/s due to the *best measurement capability* of 0.10 m/s as defined by the DKD accreditation.

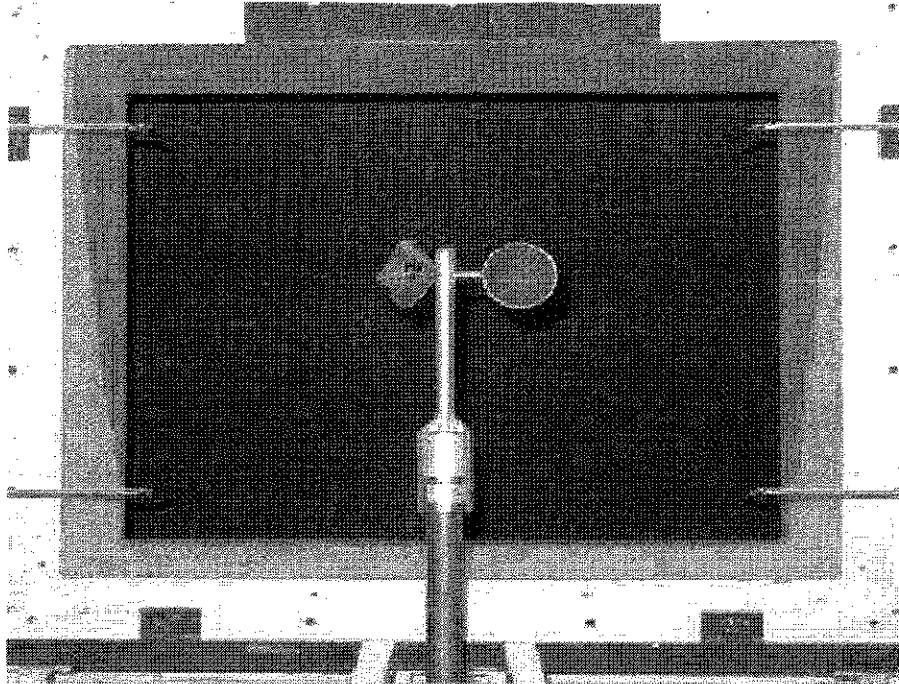


Photo showing the anemometer and the mounting system in the wind tunnel.
The anemometer shown in the photo is not the actual calibrated one but it is identical with the calibrated anemometer.
Remark: The photo does not show the real proportions, it is distorted by the lens of the camera.

4 References

- [1] MEASNET
Cup Anemometer Calibration Procedure
September 1997
- [2] ISO 3966 1977
Measurement of fluid flow in closed conduits.
- [3] H.Klug, P.Busche, K.Nolopp 2005
DEWI QMH-AKL Rev.05