DEUTSCHE WINDGUARD

Deutsche WindGuard Wind Tunnel Services GmbH

IECRE and MEASNET approved test laboratory

accredited by the / *akkreditiert durch die*

Deutsche Akkreditierungsstelle GmbH

as calibration laboratory in the / *als Kalibrierlaboratorium im*

Deutschen Kalibrierdienst

DAkkS Deutsche Akkreditierungsstelle D-K-15140-01-00

1732243
D-K-15140-01-00
05/2017

Calibration certificate
Kalibrierschein

Calibration mark
Kalibrierzeichen

Object *Gegenstand*	1D Sonic Anemometer
Manufacturer *Hersteller*	METEK GmbH D-25337 Elmshorn
Type *Typ*	uSonic-1 Spinner 12 H
Serial number *Fabrikat/Serien-Nr.*	SN 3011715009 DN 0110036295, Path 1
Customer *Auftraggeber*	ROMO Wind A/S DK-8200 Aarhus N
Order No. *Auftragsnummer*	-
Project No. *Projektnummer*	VT170543
Number of pages *Anzahl der Seiten*	6
Date of Calibration *Datum der Kalibrierung*	22.05.2017

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.

Date *Datum*	Head of the calibration laboratory *Leiter des Kalibrierlaboratoriums*	Person in charge *Bearbeiter*
15.06.2017	Dipl. Phys. Dieter Westermann	Janick Suhr, M. Sc.

Calibration object
Kalibriergegenstand

1D Sonic 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	270 cm²
diameter of mounting pipe	27 mm
blockage ratio [1)]	0.027 [-]
software version	7.7

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

Ambient conditions
Umgebungsbedingungen

air temperature	23.5 °C ± 0.1 °C
air pressure	1019.2 hPa ± 0.3 hPa
relative air humidity	44.0 % ± 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

Path angle: 35.30°
Sensor output has been adjusted implementing calibration data of this certificate; Revision 1.0 (replaces certificate dated 22.05.2017)

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Calibration result
Kalibrierergebnis

Sensor speed	Sensor temperature	Tunnel Speed	Uncertainty (k=2)
m/s	deg	m/s	m/s
3.241	21.300	3.975	0.050
4.833	21.338	5.974	0.050
6.440	21.375	7.996	0.050
8.010	21.431	9.959	0.050
9.551	21.508	11.950	0.050
11.135	21.626	13.962	0.050
12.689	21.769	15.977	0.050
11.922	21.888	14.976	0.050
10.349	21.890	12.959	0.050
8.781	21.895	10.964	0.050
7.217	21.835	8.994	0.050
5.621	21.796	6.968	0.050
4.006	21.731	4.964	0.050

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Statistical analysis		
	Slope	1.26793 (m/s)/(m/s) ±0.00226 (m/s)/(m/s)
	Offset	-0.1530 m/s ±0.019 m/s
	Standard error (Y)	0.025 m/s
	Correlation coefficient	0.999983

Remarks

The calibrated sensor complies with the demanded linearity of MEASNET

Graphical representation of the result
Grafische Darstellung des Ergebnisses

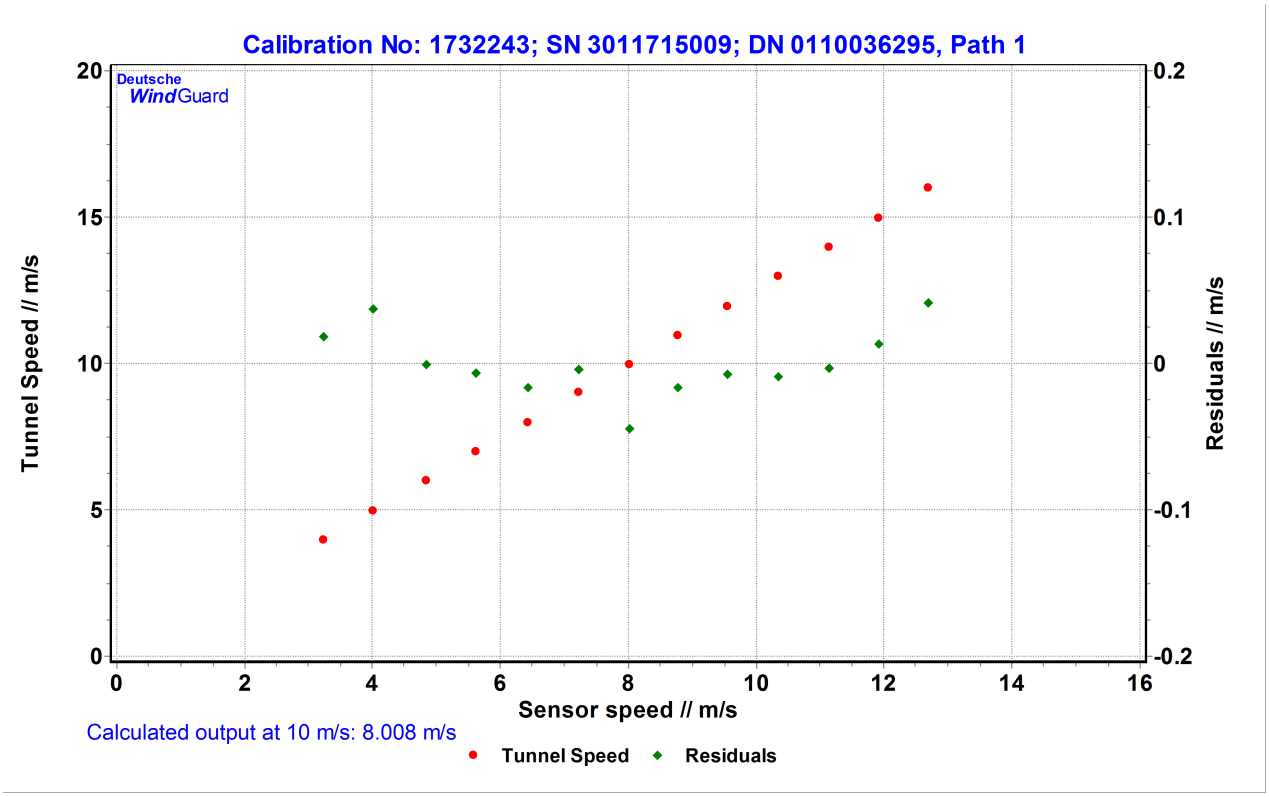

Photo of the measurement setup
Foto des Messaufbaus

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

Sensor config during calibration (1/2)
Sensorkonfiguration während der Kalibrierung (1/2)

?SPN > ?4D
?SPN 170522105827 UTC+0000 variables:
AD=0
AV=600
AZ=0.0
BC=91
BR=57600
CD=0
D1=0.00000
D2=0.00000
D3=0.00000
DT=0
E1=1.00000
E2=1.00000
E3=1.00000
EC=1
F1=0.00000
F2=0.00000
F3=0.00000
FR=2
G1=1.0000000
G2=1.0000000
G3=1.0000000
H1=0.00000
H2=0.00000
H3=0.00000
HT=2
I1=1.00000
I2=1.00000
I3=1.00000
J1=1.00000
J2=1.00000
J3=1.00000
K0=1.15340
K1=1.00000
K2=1.00000
L1=09.05.17 14:12:34
L2=09.05.17 14:12:34
L3=09.05.17 14:12:34
LC=09.05.17 14:12:34
LS=01.01.70 00:00:00
N0="09.05.17 Delivery Parameter Set"
N1="09.05.17 Delivery Parameter Set"
N2="09.05.17 Delivery Parameter Set"
N3="09.05.17 Delivery Parameter Set"
O1=2459
O2=2473
O3=2463
O4=2460
O5=2529
O6=2541
OM=2
P1=1658
P2=1659
P3=1659
SF=10000
T1=2231
T2=2231
T3=2231
TA=5.0
TC=2231
TI=22.05.17 10:58:27
TS=0
TZ=+00
Y1=3.00
Y2=45.00

Sensor config during calibration (2/2)
Sensorkonfiguration während der Kalibrierung (2/2)

YA=0

YC=0

YI=0

YS=1

YW=0

Z1=20.0

Z2=22.5

Z3=22.5

Z4=22.5

Z5=22.5

Z6=25.0

VN=9.43RX

VD=170503091327

DN=0110036295

SN=1321706017

HR=10

BV=3.671□15