Deutsche WindGuard
Wind Tunnel Services GmbH, Varel

accredited by the / *akkreditiert durch die*

Deutsche Akkreditierungsstelle GmbH

as calibration laboratory in the / *als Kalibrierlaboratorium im*

Deutschen Kalibrierdienst

Deutsche Akkreditierungsstelle D-K-15140-01-00

Calibration certificate
Kalibrierschein

1620404

Calibration mark
Kalibrierzeichen

D-K-15140-01-00

02/2016

Object *Gegenstand*	Wind Vane
Manufacturer *Hersteller*	Thies Clima D-37083 Göttingen
Type *Typ*	4.3151.00.901
Serial number *Fabrikat/Serien-Nr.*	09150128
Customer *Auftraggeber*	Ammonit Measurement GmbH D-10997 Berlin
Order No. *Auftragsnummer*	L23835
Project No. *Projektnummer*	VT160176
Number of pages *Anzahl der Seiten*	6
Date of Calibration *Datum der Kalibrierung*	02.02.2016

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*
02.02.2016	Dipl. Phys. Dieter Westermann	Dipl.-Ing. (FH) Catharina Herold

Calibration object
Kalibriergegenstand

Wind Vane

Calibration procedure
Kalibrierverfahren

• Deutsche WindGuard Wind Tunnel Services: QM-KL-WRK-VA
Based on following standards:
• 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 16622: Meteorology - Sonic anemometers/thermometers
• ASTM 5366-96: Standard Test Method of Measuring the Dynamic Performance of Wind Vanes

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	200 cm²
diameter of mounting pipe	34 mm
blockage ratio [1)]	0.020 [-]
software version	7.64

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

Ambient conditions
Umgebungsbedingungen

air temperature	20.5 °C ± 0.1 °C
air pressure	1004.6 hPa ± 0.3 hPa
relative air humidity	49.1 % ± 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 (1/3)
Kalibrierergebnis (1/3)

Bin	Flow dir	Sensor out	Uncertainty	Flow speed
-	deg	deg	deg	m/s
1	5.02	5.69	0.8	8.198
2	10.00	10.60	0.8	8.197
3	15.01	15.79	0.8	8.196
4	20.00	20.62	0.8	8.199
5	25.00	25.65	0.8	8.194
6	29.99	30.74	0.8	8.199
7	34.84	35.62	0.8	8.199
8	39.97	40.50	0.8	8.197
9	44.95	45.64	0.8	8.195
10	49.97	50.81	0.8	8.196
11	54.59	55.45	0.8	8.200
12	59.97	60.80	0.8	8.196
13	64.96	65.76	0.8	8.195
14	69.96	70.78	0.8	8.194
15	74.98	75.82	0.8	8.195
16	79.94	80.75	0.8	8.194
17	84.96	85.67	0.8	8.196
18	89.99	90.66	0.8	8.196
19	94.96	95.67	0.8	8.201
20	99.95	100.48	0.8	8.197
21	104.98	105.49	0.8	8.200
22	110.00	110.65	0.8	8.194
23	114.98	115.73	0.8	8.195
24	119.95	120.72	0.8	8.196
25	125.03	125.92	0.8	8.197
26	130.01	130.97	0.8	8.195
27	134.98	135.78	0.8	8.197
28	139.99	140.73	0.8	8.196
29	145.03	145.88	0.8	8.201
30	150.05	150.65	0.8	8.193

Calibration result (2/3)
Kalibrierergebnis (2/3)

Bin	Flow dir	Sensor out	Uncertainty	Flow speed
-	deg	deg	deg	m/s
31	155.06	155.73	0.8	8.198
32	160.02	160.71	0.8	8.193
33	165.01	165.76	0.8	8.195
34	169.95	170.65	0.8	8.194
35	174.97	175.68	0.8	8.200
36	179.96	180.59	0.8	8.196
37	184.95	185.54	0.8	8.197
38	189.97	190.45	0.8	8.198
39	195.03	195.53	0.8	8.193
40	199.98	200.48	0.8	8.198
41	205.05	205.57	0.8	8.199
42	210.08	210.62	0.8	8.201
43	215.10	215.60	0.8	8.198
44	220.01	220.57	0.8	8.199
45	224.96	225.51	0.8	8.201
46	229.95	230.43	0.8	8.201
47	235.01	235.53	0.8	8.199
48	239.99	240.49	0.8	8.201
49	245.03	245.47	0.8	8.198
50	249.98	250.44	0.8	8.202
51	254.95	255.43	0.8	8.197
52	259.96	260.53	0.8	8.195
53	265.00	265.49	0.8	8.199
54	270.01	270.48	0.8	8.198
55	274.99	275.52	0.8	8.197
56	279.97	280.35	0.8	8.201
57	285.01	285.41	0.8	8.201
58	290.02	290.51	0.8	8.196
59	295.00	295.41	0.8	8.195
60	299.97	300.39	0.8	8.201
61	304.99	305.47	0.8	8.196
62	309.98	310.44	0.8	8.200

Calibration result (3/3)
Kalibrierergebnis (3/3)

Bin	Flow dir	Sensor out	Uncertainty	Flow speed
-	deg	deg	deg	m/s
63	315.01	315.55	0.8	8.195
64	320.06	320.54	0.8	8.196
65	325.06	325.55	0.8	8.199
66	330.04	330.60	0.8	8.199
67	334.98	335.60	0.8	8.197
68	340.04	340.64	0.8	8.198
69	345.02	345.63	0.8	8.197
70	350.01	350.71	0.8	8.198
71	355.04	355.74	0.8	8.196

File: 1620404

Linear regression analysis

Slope	0.99916 deg/deg
Offset	0.7734 deg

Graphical representation of the result
Grafische Darstellung des Ergebnisses

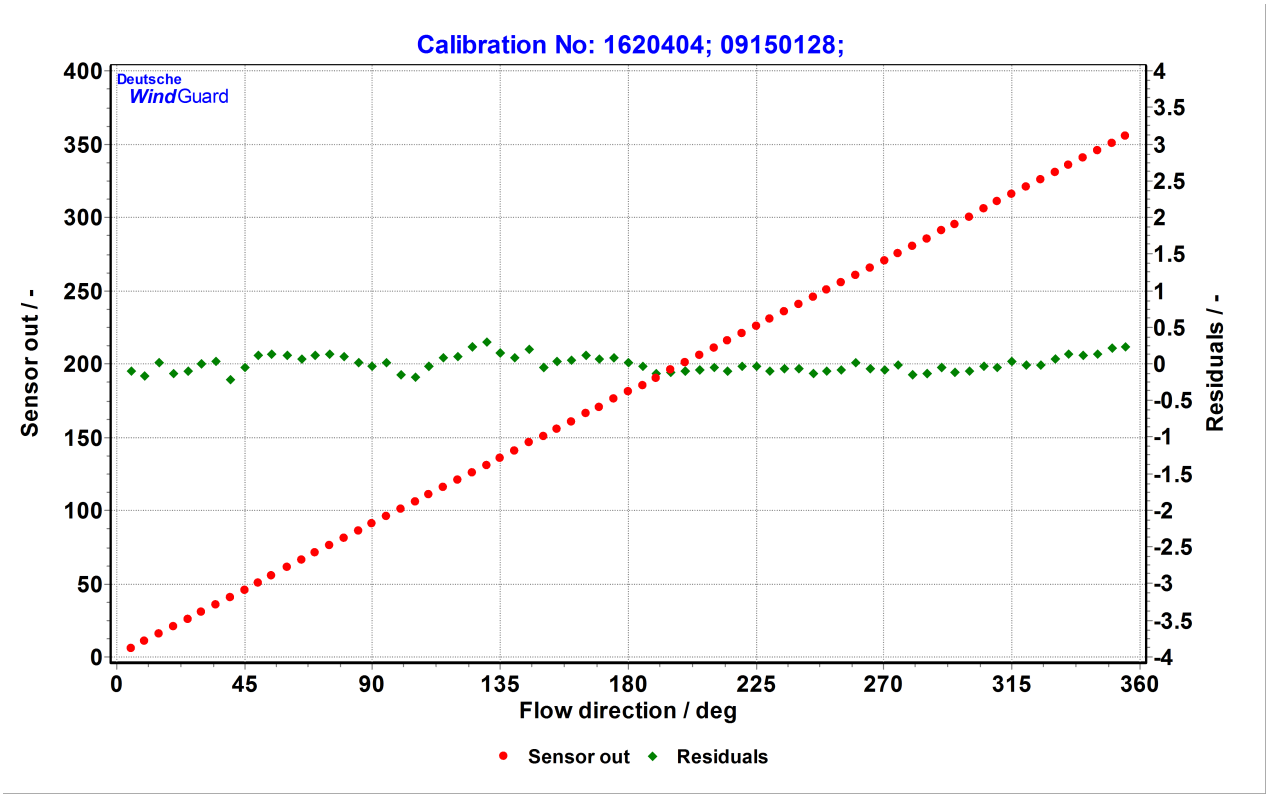

Photo of the measurement setup
Foto des Messaufbaus

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