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

Calibration mark
Kalibrierzeichen

1620403
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.*	09150127
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	20.3 °C ± 0.1 °C
air pressure	1004.0 hPa ± 0.3 hPa
relative air humidity	49.2 % ± 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	4.97	4.79	0.8	8.103
2	9.97	9.76	0.8	8.106
3	14.96	14.75	0.8	8.107
4	19.99	19.78	0.8	8.103
5	24.98	24.80	0.8	8.101
6	30.01	29.87	0.8	8.103
7	34.97	34.91	0.8	8.107
8	39.92	40.01	0.8	8.104
9	44.94	45.08	0.8	8.111
10	49.97	50.27	0.8	8.106
11	55.08	55.14	0.8	8.104
12	60.03	60.09	0.8	8.107
13	64.65	64.75	0.8	8.102
14	70.04	70.17	0.8	8.106
15	75.05	75.22	0.8	8.101
16	80.08	80.22	0.8	8.102
17	85.02	84.99	0.8	8.102
18	90.08	90.00	0.8	8.103
19	95.03	94.81	0.8	8.103
20	100.06	99.75	0.8	8.104
21	105.08	104.68	0.8	8.110
22	110.07	109.68	0.8	8.104
23	115.07	114.74	0.8	8.108
24	119.94	119.66	0.8	8.104
25	124.90	124.65	0.8	8.109
26	129.93	129.70	0.8	8.105
27	134.90	134.69	0.8	8.105
28	139.95	139.69	0.8	8.105
29	144.91	144.62	0.8	8.105
30	149.92	149.77	0.8	8.107

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

Bin	Flow dir	Sensor out	Uncertainty	Flow speed
-	deg	deg	deg	m/s
31	154.91	154.90	0.8	8.106
32	159.96	160.06	0.8	8.105
33	165.01	165.09	0.8	8.103
34	170.02	170.15	0.8	8.105
35	174.95	175.14	0.8	8.105
36	180.00	180.13	0.8	8.105
37	185.03	185.08	0.8	8.106
38	190.00	190.09	0.8	8.104
39	194.99	194.98	0.8	8.106
40	200.02	200.03	0.8	8.104
41	204.97	205.02	0.8	8.104
42	209.99	210.05	0.8	8.101
43	215.00	215.26	0.8	8.104
44	220.01	220.32	0.8	8.103
45	225.00	225.27	0.8	8.108
46	229.96	230.27	0.8	8.105
47	234.97	235.37	0.8	8.105
48	240.00	240.45	0.8	8.105
49	244.92	245.44	0.8	8.111
50	249.95	250.55	0.8	8.102
51	255.01	255.56	0.8	8.107
52	260.04	260.50	0.8	8.107
53	264.97	265.39	0.8	8.105
54	269.98	270.29	0.8	8.108
55	274.97	275.18	0.8	8.106
56	279.95	280.13	0.8	8.107
57	284.98	285.11	0.8	8.107
58	290.02	290.14	0.8	8.106
59	295.07	295.23	0.8	8.103
60	300.06	300.22	0.8	8.105
61	305.11	305.27	0.8	8.107
62	310.12	310.41	0.8	8.105

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

Bin	Flow dir	Sensor out	Uncertainty	Flow speed
-	deg	deg	deg	m/s
63	315.13	315.29	0.8	8.109
64	320.10	320.25	0.8	8.110
65	325.07	325.31	0.8	8.104
66	330.09	330.35	0.8	8.105
67	334.98	335.26	0.8	8.106
68	339.97	340.16	0.8	8.107
69	344.97	345.15	0.8	8.104
70	350.02	350.07	0.8	8.103
71	355.00	354.93	0.8	8.103

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Linear regression analysis

Slope	1.00128 deg/deg
Offset	-0.1573 deg

Graphical representation of the result
Grafische Darstellung des Ergebnisses

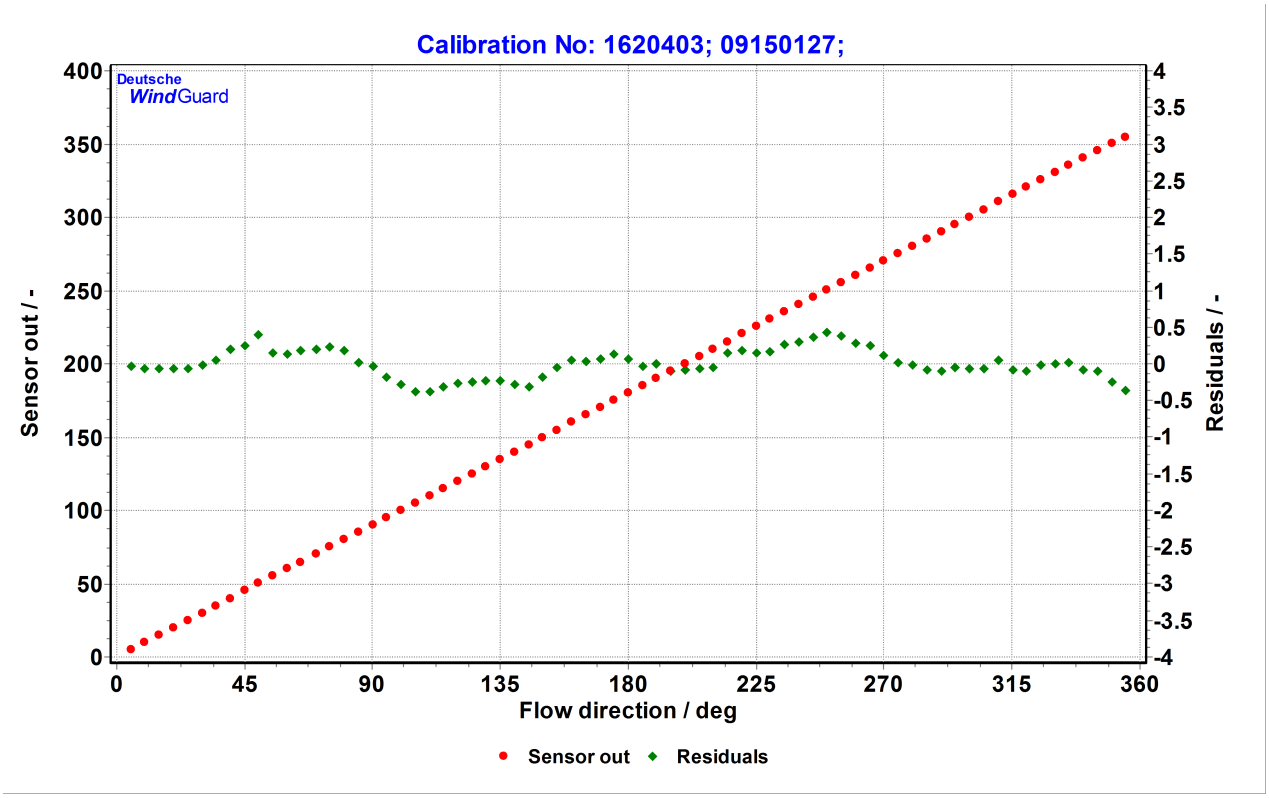

Photo of the measurement setup
Foto des Messaufbaus

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