DEUTSCHE WINDGUARD

IECRE and MEASNET approved test laboratory

Calibration Certificate / *Kalibrierschein*

issued by the calibration laboratory / *erstellt durch das Kalibrierlaboratorium*

Deutsche WindGuard
Wind Tunnel Services GmbH

Member of / *Mitglied im*

Deutschen Kalibrierdienst

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

Calibration certificate *Kalibrierschein*	Calibration mark *Kalibrierzeichen*	2110000 D-K-15140-01-00 01/2021

Object *Gegenstand*	Cup Anemometer
Manufacturer *Hersteller*	Example Manufacturer Example Manufacturer Address
Type *Typ*	Example Anemometer
Serial number *Fabrikat/Serien-Nr.*	Example Serial Number
Customer *Auftraggeber*	Example Customer Example Customer Address
Order No. *Auftragsnummer*	Example Ordercode
Project No. *Projektnummer*	VTXXXXXX
Number of pages *Anzahl der Seiten*	5
Date of Calibration *Datum der Kalibrierung*	01.01.2021

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 presented results relate only to the calibrated object. 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. Die dargestellten Ergebnisse beziehen sich nur auf den kalibrierten Gegenstand. 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*
01.01.2021	Dipl. Phys. Dieter Westermann	Alina Roß, M. Sc.

Calibration object *Kalibriergegenstand*	Cup Anemometer	
Calibration procedure *Kalibrierverfahren*	IEC 61400-12-1:2017	
Place of calibration *Ort der Kalibrierung*	Wind tunnel 1 of Deutsche WindGuard Wind Tunnel Services GmbH, Varel	
Test conditions *Messbedingungen*	wind tunnel area	10000 cm²
	DUT frontal area	230 cm²
	diameter of mounting pipe	33.7 mm
	blockage ratio [1)]	0.023 [-]
	software version	1.0
Ambient conditions *Umgebungsbedingungen*	air temperature	(24.4 ± 0.4) °C – (25.5 ± 0.4) °C
	air pressure	(1010.8 ± 0.4) hPa – (1011.6 ± 0.4) hPa
	relative air humidity	(52.7 ± 5.0) % – (54.7 ± 5.0) %

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

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 EA-4/02 M: 2013. 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 (Expanded uncertainty 0.2 %, k=2)

Additional remarks
Zusätzliche Anmerkungen

-

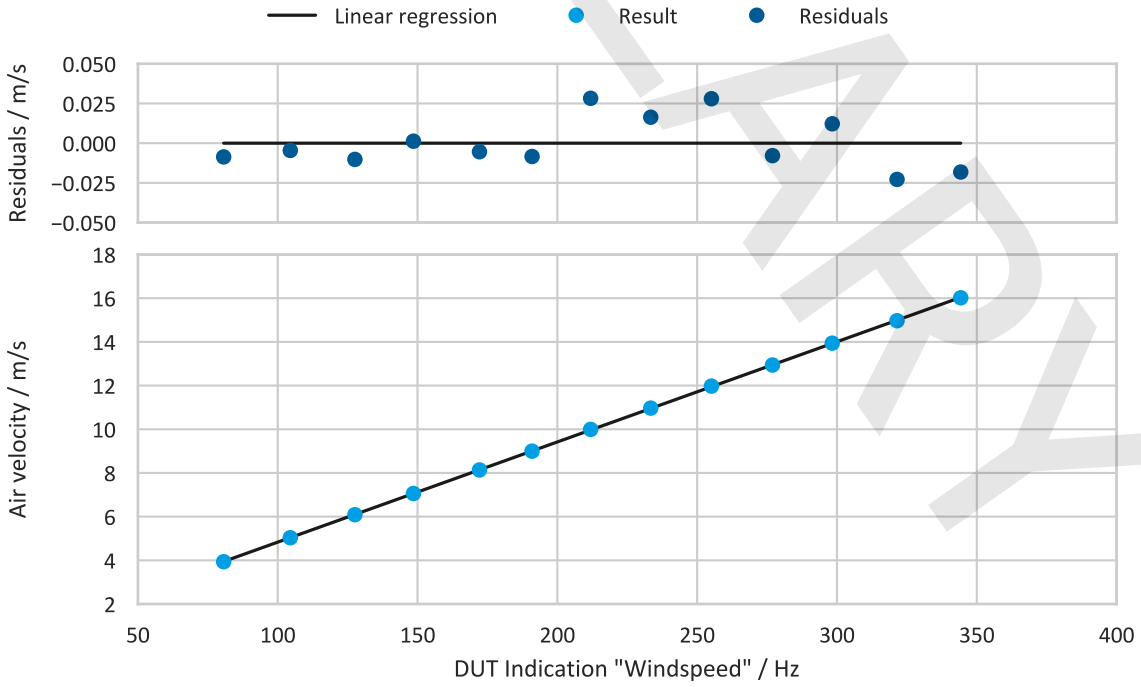
Revision
Revision

0

Calibration result
Kalibrierergebnis

Index	Air velocity		DUT Indication "Windspeed"		DUT Indication (regression conversion)		Deviation	
-	m/s		Hz		m/s		m/s	
i	v_{Ref}	$U(v_{Ref})$	v_{DUT}	$U(v_{DUT})$	v'_{DUT}	$U(v'_{DUT})$	Δv	$U(\Delta v)$
1	3.936	0.050	80.67	0.20	3.945	0.009	-0.009	0.051
2	6.088	0.050	127.60	0.30	6.098	0.014	-0.010	0.052
3	8.136	0.050	172.15	0.41	8.142	0.019	-0.005	0.053
4	9.994	0.050	211.91	0.49	9.965	0.022	0.028	0.055
5	11.975	0.060	255.10	0.52	11.947	0.024	0.028	0.064
6	13.941	0.070	298.31	0.54	13.929	0.025	0.012	0.074
7	16.019	0.080	344.26	0.76	16.037	0.035	-0.018	0.087
8	14.969	0.075	321.48	0.62	14.992	0.028	-0.023	0.080
9	12.941	0.065	276.94	0.56	12.949	0.026	-0.008	0.070
10	10.968	0.055	233.40	0.50	10.951	0.023	0.016	0.059
11	8.996	0.050	190.96	0.40	9.004	0.018	-0.008	0.053
12	7.060	0.050	148.54	0.38	7.059	0.017	0.001	0.053
13	5.033	0.050	104.49	0.23	5.038	0.010	-0.005	0.051

Graphical representation of the result
Grafische Darstellung des Ergebnisses



Statistical analysis	Slope *m*	(0.04587 ± 0.00006) Hz/(m/s)
	Offset *b*	(0.24453 ± 0.01331) m/s
	Standard error (Y) / RSD	0.01708 m/s
	Correlation coefficient *R*	0.999991

Remarks

The calibrated sensor complies with the demanded linearity of MEASNET

Calibration result remarks
Erläuterungen zum Kalibrierergebnis

Air velocity
v_{Ref}

The reference air velocity. The uncertainty is given as the expanded uncertainty with a coverage factor of k=2.

DUT Indication "Windspeed"
v_{DUT}

The indication of the device under test. The expanded uncertainty is given with a coverage factor of k=2. The short-term stability (repeatability) and the resolution are taken into account.

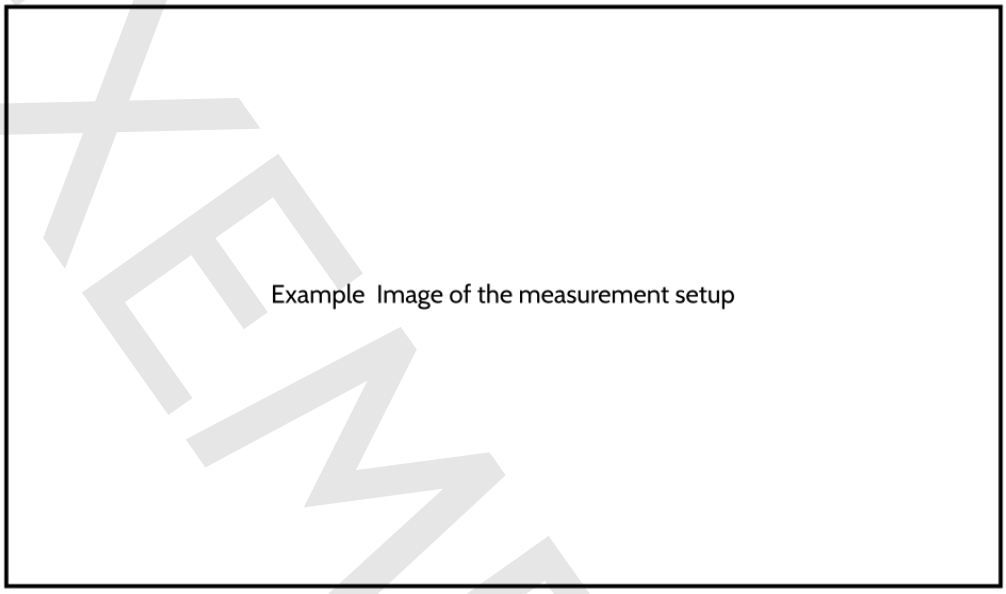
DUT Indication (regression conversion)
v'_{DUT}

The DUT Indication converted with the following equation: $v_{DUT} \cdot m + b$. No uncertainties are considered for this conversion.

Deviation
Δv

The difference between the reference air velocity and the DUT indication $v_{Ref} - v'_{DUT}$. This is equal to the residuals. **The given uncertainty *U(Δv)* is the combined expanded uncertainty with a coverage factor of k=2.**

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.

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