

Calibration Certificate / Kalibrierschein

Issued by the calibration laboratory / *Erstellt durch das Kalibrierlaboratorium*

ProfEC Ventus GmbH



Member of / *Mitglied im*

Deutschen Kalibrierdienst

accredited to / *akkreditiert nach*
DIN EN ISO/IEC 17025:2018



Calibration Mark
Kalibrierzeichen

26228
D-K-
19142-01-00
09/2024

Object <i>Gegenstand</i>	Cup Anemometer
Manufacturer <i>Hersteller</i>	Adolf Thies GmbH & Co. KG D-37083 Göttingen Germany
Type <i>Typ</i>	4.3351.10.000
Serial Number <i>Fabrikat/Serien-Nr.</i>	09244802 / -
Customer <i>Auftraggeber</i>	SerFac Jeollanam-do Republic of Korea
Order No. <i>Auftragsnummer</i>	3153-2024
Numer of pages <i>Anzahl der Seiten</i>	6
Date of Calibration <i>Datum der Kalibrierung</i>	13.09.2024

This calibration certificate documents the metrological 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 metrologische 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.

This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates without signature are not valid.

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit.

Date
Datum Approval of the certificate of calibration by
Freigabe des Kalibrierscheins durch

14.10.2024



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Object	Cup Anemometer		
Kalibriergegenstand			
Calibration procedure	ISO / IEC 61400-50-1: 2022, Chapter 8		
Kalibrierverfahren			
Place of calibration	Wind Tunnel Center (MEASNET) at Carl von Ossietzky University, Oldenburg		
Ort der Kalibrierung			
Test Conditions	Wind tunnel area /	8000 cm ²	
Messbedingungen	Wind Tunnel Querschnittsfläche ¹		
	Anemometer frontal area /	274 cm ²	
	Anenometer Querschnittsfläche ²		
	Diameter of mounting pipe /	33.7 mm	
	Durchmesser des Montagerohrs ³		
	Blockage ratio of tested object /	0.034 [-]	
	Vorstauverhältnis des Prüflings ⁴		
	Software Version /	CAC Prog v2.1	
Auswertesoftware			
Ambient Conditions	Air temperature /	23.1 °C	± 0.2 K
Umgebungsbedingungen	Luft Temperatur		
	Air pressure /	1022.8 hPa	± 0.3 hPa
	Luftdruck		
	Relative air humidity /	52.8 %	± 1.7 %
	Relative Luftfeuchtigkeit		
Remarks	none		
Anmerkungen			
Revision	0		
Revision			

This calibration certificate has been generated electronically and signed manually.
Dieser Kalibrierschein wurde elektronisch erzeugt und manuell signiert.

¹Nozzle cross-section area of the tested object incl. mounting pipe / Querschnitt der Auslassdüse des Windkanals
²Projected cross-section area of the tested object incl. mounting pipe / Querschnittsfläche (Schattenwurf) des Prüflings inkl. Montagerohr
³Diameter of mounting pipe / Durchmesser des Montagerohrs
⁴Ratio² to¹ /Verhältnis von² zu¹



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Calibration Result ⁵

Kalibrierergebnis

File: 26228

Wind Speed Wind Tunnel Windgeschwindigkeit Windkanal	Measurement Sensor Messung Prüfling	Extended Uncertainty* ($k=2$) Erweiterte Messunsicherheit* ($k=2$)
m/s	Hz	m/s
3.911	80.433	0.10
5.833	122.000	0.10
7.779	164.767	0.10
9.757	207.733	0.10
11.725	250.967	0.10
13.740	294.700	0.10
15.672	337.700	0.10
14.704	316.167	0.10
12.738	273.167	0.10
10.750	229.833	0.10
8.769	186.633	0.10
6.796	142.967	0.10
4.861	101.233	0.10

Remark:

Vermerk:

*** The extended 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: 2022. The value of the measured value lies within the assigned range of values with a probability of 95%.**

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*Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor $k=2$ ergibt. Sie wurde gemäß EA-4/02 M: 2022 ermittelt. Der Wert der Messgröße liegt mit einer Wahrscheinlichkeit von 95% im zugeordneten Wertintervall. Die Deutsche Akkreditierungsstelle GmbH ist Unterzeichnerin der multilateralen Übereinkommen der European cooperation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.

⁵Calibration results only count for the tested circumstances, the tested sensor and environmental conditions during which calibration took place.



Annex

Detailed Calibration Results

DAkkS calibration no.	26228
Test object	Cup Anemometer
Manufacturer / Type	Adolf Thies GmbH & Co. KG / 4.3351.10.000
Body serial number ⁶	09244802
Cup serial number	-
Date of calibration	13.09.2024

Ambient conditions

Air temperature	23.1 °C
Air pressure	1022.8 hPa
Humidity	52.8 %

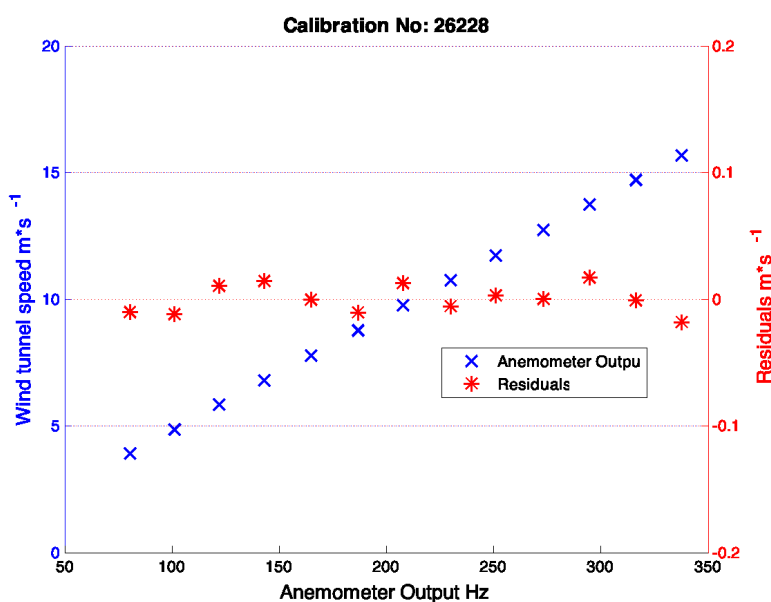


Linear regression analysis

Range of regression	4 m/s – 16 m/s
Slope	$0.04574 \text{ (m/s)/(Hz)} \pm 0.00004 \text{ (m/s)/(Hz)}$
Offset	$0.2421 \text{ m/s} \pm 0.0093 \text{ m/s}$
Standard error y	0.012 m/s
Correlation coefficient	0.999992 [-]

Remarks

none



ProfEC Ventus GmbH is a Calibration Laboratory accredited by the German Accreditation Body (Deutsche Akkreditierungsstelle, DAkkS), registration: D-K-19142-01-00

ProfEC Ventus GmbH is member of MEASNET (Measuring Network of Wind Energy Institutes) and participating in the anemometer and wind vane calibration expert working group of MEASNET.

⁶Body serial number OR device serial number if only one serial number is given for the test object



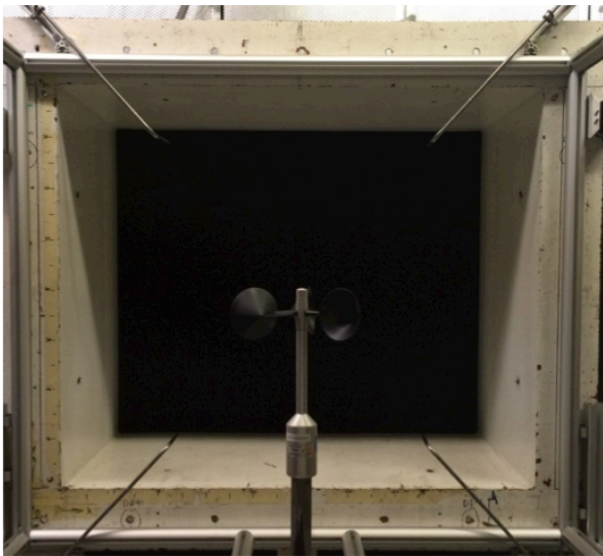
Annex

Instrumentation

Position	Sensor	Manufacturer	Type	Calibration
1	Pitot static and dynamic tube	Airflow	NPL 8 mm	09.04.15
2	Pitot static and dynamic tube	Airflow	NPL 8 mm	08.04.15
3	Pitot static and dynamic tube	Airflow	NPL 8 mm	02.04.15
4	Pitot static and dynamic tube	Airflow	NPL 8 mm	10.04.15
5	Differential Pressure	Setra	239	27.07.23
6	Differential Pressure	Setra	239	27.07.23
7	Differential Pressure	Setra	239	27.07.23
8	Differential Pressure	Setra	239	27.07.23
9	Barometer	Vaisala	PTB110	27.07.23
10	Thermometer	Galltec	KRC 1/5-ME	08.08.23
11	Humidity sensor	Galltec	KRC 1/5-ME	08.08.23
12	Wind tunnel control	ProfEC Ventus	CPU 44172	30.01.23

Table1: Description of the data acquisition system

Photo of the calibration set-up



Calibration set-up of the anemometer calibration in the wind tunnel at Carl von Ossietzky University, Oldenburg⁷. The anemometer shown may differ from the calibrated one. Remark: The proportion of the set- up is not true to scale due to imaging geometry.

Compliance with IEC and MEASNET calibration procedure

The calibration procedure in all aspects is in compliance with procedure ISO / IEC 61400-50-1:2022.

The calibration procedure in all aspects is in compliance with MEASNET Anemometer Calibration Procedure - Version 3: 2020

⁷ Carl-von.Ossietzky-Straße 11, 26129 Oldenburg



Annex

References

- [1] M. Hölzer, 2023 - Working Instruction: Measuring Velocity of Gases for Cup Anemometer Calibration
- [2] ISO / IEC 61400-50-1 Ed.1: 2022 - Wind measurement - Application of meteorological mast, nacelle and spinner mounted instruments
- [3] MEASNET Anemometer Calibration Procedure - Version 3: 2020
- [4] EA-4/02 M: 2022 Evaluation of the Uncertainty of Measurement In Calibration

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