

## 15. Certificado de calibração:

Anemômetro 1 SN: 08182905



**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

1813471
D-K-
15140-01-00
08/2018

Calibration certificate  
Kalibrierschein

Calibration mark  
Kalibrierzeichen

<b>Object</b> <i>Gegenstand</i>	Cup Anemometer	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.
<b>Manufacturer</b> <i>Hersteller</i>	Thies Clima D-37083 Göttingen	<i>Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).</i>
<b>Type</b> <i>Typ</i>	4.3351.10.000	<i>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.</i>
<b>Serial number</b> <i>Fabrikat/Serien-Nr.</i>	08182905	<i>Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.</i>
<b>Customer</b> <i>Auftraggeber</i>	Thies Clima D-37083 Göttingen	
<b>Order No.</b> <i>Auftragsnummer</i>	AB1803894	
<b>Project No.</b> <i>Projektnummer</i>	VT180829	
<b>Number of pages</b> <i>Anzahl der Seiten</i>	4	
<b>Date of Calibration</b> <i>Datum der Kalibrierung</i>	27.08.2018	

This calibration certificate may not be reproduced other than in full except with the permission of both the German Accreditation Body and the issuing laboratory. Calibration certificates without signature are not valid. This calibration certificate has been generated electronically.

*Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Deutschen Akkreditierungsstelle als auch des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit. Dieser Kalibrierschein wurde elektronisch erzeugt.*

Date Datum	Head of the calibration laboratory Leiter des Kalibrierlaboratoriums	Person in charge Bearbeiter
27.08.2018		

Dipl. Phys. Dieter Westermann

Techniker Dirk Henninges

1813471
D-K-
15140-01-00
08/2018

Page 2 / 4  
Seite

<b>Calibration object</b> <i>Kalibriergegenstand</i>	Cup Anemometer	
<b>Calibration procedure</b> <i>Kalibrierverfahren</i>	IEC 61400-12-1:2017	
<b>Place of calibration</b> <i>Ort der Kalibrierung</i>	Wind tunnel of Deutsche WindGuard WindTunnel Services GmbH, Varel	
<b>Test conditions</b> <i>Messbedingungen</i>	wind tunnel area	10000 cm <sup>2</sup>
	anemometer frontal area	230 cm <sup>2</sup>
	diameter of mounting pipe	33.7 mm EN 10217
	blockage ratio <sup>1)</sup>	0.023 [-]
	software version	P_7.8.05
	<sup>1)</sup> Due to the special construction of the test section no blockage correction is necessary.	
<b>Ambient conditions</b> <i>Umgebungsbedingungen</i>	air temperature	25.6 °C ± 0.1 °C
	air pressure	1005.5 hPa ± 0.3 hPa
	relative air humidity	46.1 % ± 2.0 %
<b>Measurement uncertainty</b> <i>Messunsicherheit</i>	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 %, $k=2$ )	
<b>Additional remarks</b> <i>Zusätzliche Anmerkungen</i>	-	

Deutsche WindGuard  
Wind Tunnel Services GmbH, Varel

DEUTSCHE  
**WINDGUARD**

1813471
D-K-
15140-01-00
08/2018

**Calibration result**  
*Kalibriergebnis*

Reference Air velocity m/s	Reference Unc m/s	Test item Output Hz
3.928	0.05	80.533
5.847	0.05	122.031
7.850	0.05	165.332
9.880	0.05	209.128
11.877	0.05	254.081
13.815	0.05	295.027
15.798	0.05	337.720
14.776	0.05	316.070
12.882	0.05	274.037
10.871	0.05	229.966
8.850	0.05	186.434
6.901	0.05	144.735
4.888	0.05	100.554

<b>Statistical analysis</b>	Slope	0.04604 (m/s)/(Hz) $\pm 0.00009$ (m/s)/(Hz)
	Offset	0.2415 m/s $\pm 0.021$ m/s
	Standard error (Y)	0.021 m/s
	Correlation coefficient	0.999977

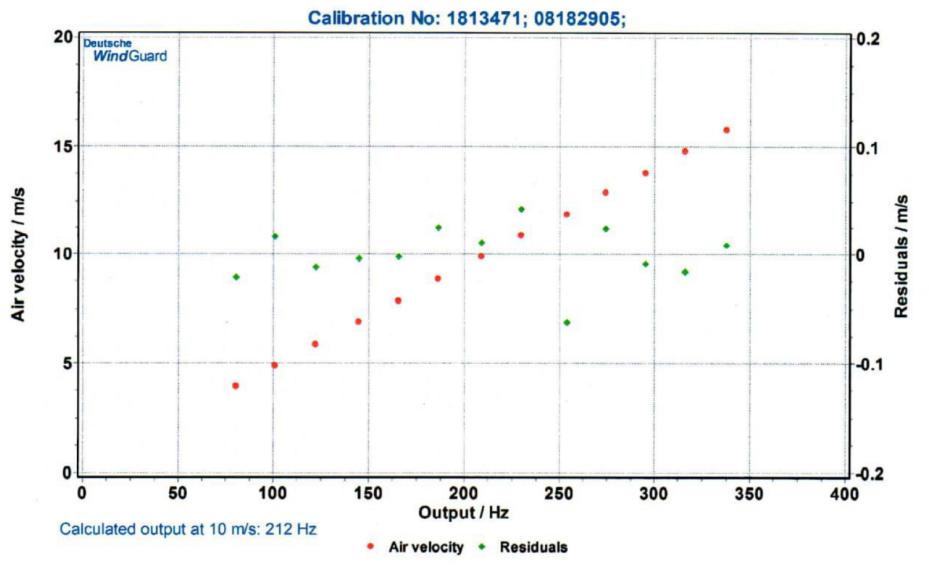
**Remarks** The calibrated sensor complies with the demanded linearity of MEASNET



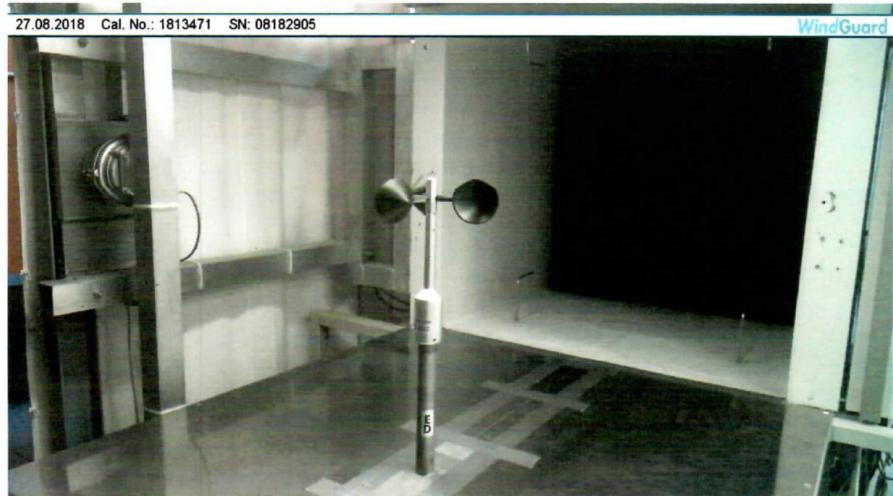
1813471  
D-K-  
15140-01-00  
08/2018

Page 4 / 4  
Seite

**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.

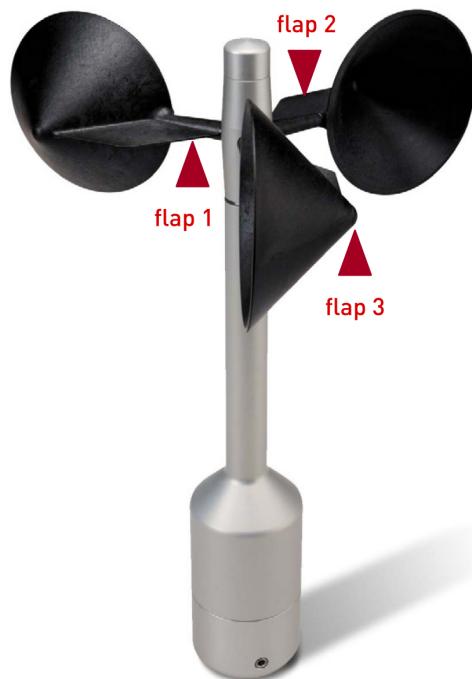
Deutsche WindGuard  
Wind Tunnel Services GmbH, Varel

DEUTSCHE  
**WINDGUARD**

## Thies Anemometer First Class Advanced

P6101 / P6101H

Accredited according to: IEC 61400-12-1 (2005-12), CLASS A 0.9, B 3.0 & S 0.5  
MEASNET, ISO 17713-1, CLASSCUP



### Classification:

IEC 61400-12-1 (2005-12)	
Class A	Classification Index A 0.9
Class B	Classification Index B 3.0

### Linearity (MEASNET):

$r > 0.999\ 99$  (4...20 m/s)

### Optically Scanned Cup Anemometer

The new Thies First Class Advanced anemometer gives outstanding performance. It is the only anemometer on the market that complies with all the requirements of IEC 61400-12-1 (2005-12), Class S 0.5.

Its performance ratings have even improved on the previous Thies First Class anemometer, which was rated the best of its kind according to the CLASSCUP / ACCUWIND Study, [Risø-R-1563-EN, Table 4-4].

This anemometer gives optimal dynamic performance with the following characteristics:

- ▶ High accuracy
- ▶ Minimal deviation from cosine line
- ▶ Excellent behaviour to turbulences
- ▶ Minimum overspeeding
- ▶ Small distance constant
- ▶ Low start up value
- ▶ Low power consumption
- ▶ Digital output

Measurement of power curves and site assessment reports are the main tasks for this instrument. The patented design is the result of long testing in the wind tunnel.

The sensor is designed for measuring the horizontal component of wind velocity in the fields of meteorology, climate measuring technology, site assessment, and the measurement of capacity characteristics of wind power systems (power curves).

For winter operation this instrument is equipped with electronically regulated heating to guarantee smooth running of the ball bearings and prevent the shaft and slot from ice build up.

### Comparison of Performance of Anemometers

Cup Anemometer	Class A	Class B	
NRG max 40	2.4	7.7	Information as stated according to CLASSCUP & ACCUWIND Study (Table 4-4 horizontal wsp definition Risø R-1563-EN)
Risø P2546	1.9	8.0	
Vaisala WAA151	1.7	11.1	
Vector L100	1.8	4.5	
Thies First Class	1.5	2.9	
<b>Thies First Class Advanced</b>	<b>0.9</b>	<b>3.0</b>	<b>IEC 61400-12-1 (2005-12) according to Deutsche WindGuard</b>

© Copyright Ammonit 2012

## Specification

<b>Characteristics</b>	
Physical functionality	Optically scanned cup anemometer
Delivered signal	Frequency output (pulse)
<b>Accuracy</b>	
Accuracy	0.3...50 m/s 1% of meas. value or < 0.2 m/s
Linearity	Correlation factor r between frequency and wind speed $y = 0.0462 * f + 0.21$ typical $r > 0.99999$ (4...20 m/s)
Starting velocity	< 0.3 m/s
Resolution	0.05 m wind run
Distance constant	< 3 m (acc. to ASTM D 5096 - 96) 3 m acc. to ISO 17713-1
Turbulent flow	Deviation $\Delta v$ turbulent compared with stationary horizontal flow -0.5 % < $\Delta v$ < +2 % Frequency < 2 Hz
Inclined flow - mean deviation from cosinus line	< 0.1 % (in range of ±20°) < 1 % (in the range up to 30% turbulence intensity)
Wind load	Approx. 100 N @ 75 m/s
<b>Operating range</b>	
Measuring range	0.3...75 m/s
Survival speed	80 m/s (mind. 30 min)
Permissible ambient conditions	-50...+80 °C, all occurring situations of relative humidity
<b>Electrical data</b>	
Output signal	Form rectangle, 1082 Hz @ 50 m/s, supply voltage max. 15 V
Electrical supply for optoelec. scanning	Voltage: 3.3...42 VDC (galvanic isolation from housing) Current: 0.3 mA @ 3.3 V (w/o external load) < 0.5 mA @ 5 V (w/o external load)
Electrical supply for heating*	Voltage: 24 V AC/DC (galvanic isolation from housing) Idling Voltage: max. 30 V AC, max. 42 VDC Power Consumption: 25 W
<b>General</b>	
Connection	8-pole plug-connection for shielded cable in the shaft
Mounting	on mast tube R1"
Dimensions	290 x 240 mm
Fixing boring	35 x 25 mm
Weight	approx. 0.5 kg
Finishes - housing	Anodised Aluminium
Finishes - cup star	Carbon-fibre-reinforced plastic
Protection	IP 55 (DIN 40050)
Patented	EP 1398637
EMC	EN 61000-6-2:2001 (immunity) EN 55022:2001, Class B (interfering transmission)
Manufacturer	Thies 4.3351.10.000 (without heating) / 4.3351.00.000 (with heating)

\* applies only for S11100H (P6101H)

## Thies Anemometer First Class Advanced

P6101 / P6101H

### Characteristics curve / Calibration

Wind speed Y is determined by the linear function of the frequency output f:

$$Y = a * f + b$$

Y = corrected values (m/s)

a = slope (m)

f = raw data (1/s)

b = Offset (m/s)

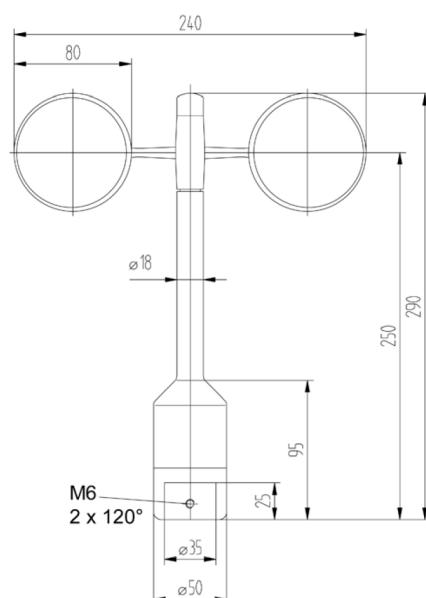
Manufacturers instructions:

Slope = 0.046 m

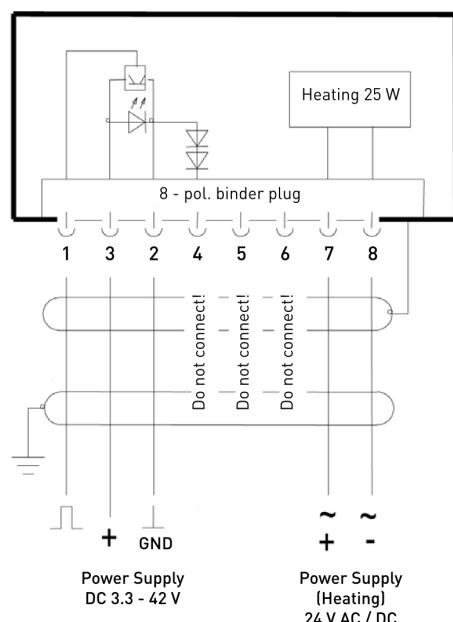
Offset = 0.21 m/s

For wind assessment campaigns it is required to perform an individual MEASNET calibration of each anemometer in a wind tunnel test to achieve an optimum accuracy and precision. After calibration please use the values for slope and offset according to the calibration protocol.

### Dimensional Drawing



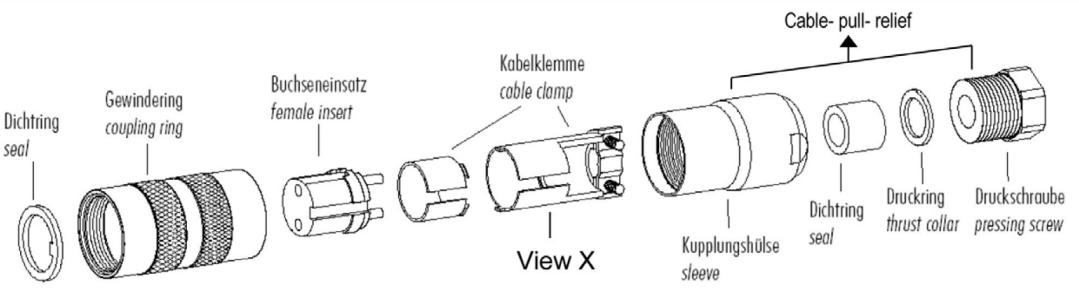
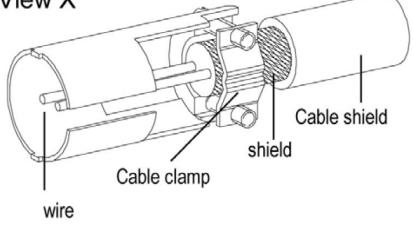
### Cable Connection



wire colors	Connection Anemometer	Connection Data Logger (32)		
		"Wind" 12-pin.	"Meteo" 7-pin.	"Xtend" 8-pin.
1 - Pulse	green	A, B or C	6	5, 6
2 - Ground	brown	M	-	-
3 - Supply	white	H	-	-
7 - heating 1	yellow, grey			
8 - heating 2	pink, blue			
4	Do not connect Ammonit data loggers!			
5 / 6	Do not connect!			

Cable type without heating: LiY (C) Y 3 x 0.25 mm<sup>2</sup>  
 Cable type with heating cores: LiY (C) Y 7 x 0.25 mm<sup>2</sup>

Connect the shield logger-sided to Ground (GND)

Coupling socket 507550 (Binder, Serial 423), EMC with cable clamp	
 <p>Dichtring seal Gewindering coupling ring Buchseneinsatz female insert Kabelklemme cable clamp View X Kupplungshülse sleeve Dichtring seal Druckring thrust collar Druckschraube pressing screw</p>	<p>Cable-pull-relief</p>
<ol style="list-style-type: none"> <li>Stringing parts on cable acc. to plan given above.</li> <li>Stripping cable sheath 20 mm Cutting uncovered shield 15 mm Stripping wire 5mm.</li> </ol> <p><i>Cable mounting 1</i> Putting shrink hose or insulating tape between wire and shield.</p> <p><i>Cable mounting 2</i> If cable diameter permits, put the shield backward on the cable sheath.</p> <ol style="list-style-type: none"> <li>Soldering wire to the insert, positioning shield in cable clamp.</li> <li>Screwing-on cable clamp.</li> <li>Assembling remaining parts acc. to upper plan.</li> <li>Tightening pull-relief of cable by screw-wrench (SW16 und 17).</li> </ol>	<p><i>Cable mounting 1</i> View X</p>  <p>Cable shield shield Cable clamp wire</p> <p><i>Cable mounting 2</i> View X</p> 