Ultrasonic Anemometer 2D compact

Instruction for Use

4.3877.xx.xxx

from software version V1.0.8 Status: 01/2022

Dok. No. 021964/08/23

THE WORLD OF WEATHER DATA

Safety Instructions

- Before operating with or at the device/product, read through the operating instructions.
  This manual contains instructions which should be followed on mounting, start-up, and operation.
  A non-observance might cause:
  - failure of important functions
  - endangerment of persons by electrical or mechanical effect
  - damage to objects
- Mounting, electrical connection and wiring of the device/product must be carried out only by a qualified technician who is familiar with and observes the engineering regulations, provisions and standards applicable in each case.
- Repairs and maintenance may only be carried out by trained staff or **Adolf Thies GmbH & Co. KG**. Only components and spare parts supplied and/or recommended by **Adolf Thies GmbH & Co. KG** should be used for repairs.
- Electrical devices/products must be mounted and wired only in a voltage-free state.
- **Adolf Thies GmbH & Co KG** guarantees proper functioning of the device/products provided that no modifications have been made to the mechanics, electronics or software, and that the following points are observed:
- All information, warnings and instructions for use included in these operating instructions must be taken into account and observed as this is essential to ensure trouble-free operation and a safe condition of the measuring system / device / product.
- The device / product is designed for a specific application as described in these operating instructions.
- The device / product should be operated with the accessories and consumables supplied and/or recommended by **Adolf Thies GmbH & Co KG.**
- Recommendation: As it is possible that each measuring system / device / product may, under certain conditions, and in rare cases, may also output erroneous measuring values, it is recommended using redundant systems with plausibility checks for **security-relevant applications**.

Environment

- As a longstanding manufacturer of sensors Adolf Thies GmbH & Co KG is committed to the objectives of environmental protection and is therefore willing to take back all supplied products governed by the provisions of "*ElektroG*" (German Electrical and Electronic Equipment Act) and to perform environmentally compatible disposal and recycling. We are prepared to take back all Thies products concerned free of charge if returned to Thies by our customers carriage-paid.
- Make sure you retain packaging for storage or transport of products. Should packaging however no longer be required, please arrange for recycling as the packaging materials are designed to be recycled.

Documentation

-
- Although these operating instruction has been drawn up with due care, **Adolf Thies GmbH & Co KG** can accept no liability whatsoever for any technical and typographical errors or omissions in this document that might remain.
- We can accept no liability whatsoever for any losses arising from the information contained in this document.
- Subject to modification in terms of content.
- The device / product should not be passed on without the/these operating instructions.

Patent Protection

This instrument is patent-protected
Patent No.: EP 1 448 966 B1
Patent No.: US 7,149,151 B2

Operating Instructions

These operating instructions describe all possible applications and settings of the instrument.
The *Ultrasonic Anemometer 2D compact* is factory-set.

Shipment

1 x Ultrasonic Anemometer Compact
1 x Factory certification

Contents

Figure

Table

1 Models Available

Description	Article- No. *	Parameter	Output / Interface/ Equipment
US-Anemometer 2D Compact	4.3877.07.000	Wind velocity Wind direction Virtual temperature	- Ethernet - PROFINET / PROFIsafe - 8 pole plug connection - hard anodized housing
US-Anemometer 2D Compact	4.3877.27.000	Wind velocity Wind direction Virtual temperature Barometric air pressure	- Ethernet - PROFINET / PROFIsafe - 8 pole plug connection - hard anodized housing

*The complete article-no. results from the arranged equipment and configuration.

2 Application

The **Ultrasonic Anemometer 2D compact** is used to detect the horizontal components of **wind velocity** and **wind direction** in 2 dimensions in particular sturdy design. In addition, the **virtual temperature** is measured**.**

Optionally, the measurement of the "atmospheric air pressure (absolute)" is possible.

The instrument is especially suited for application in the fields of

- Industrial automation
- Regenerative power generation (wind power plants)
- Traffic engineering/ control system
- maritime and offshore applications

Due to the measuring principle the instrument is ideal for inertia-free measurement of gusts and peak values.

The measured values are output in digital form.

- Binary (PROFINET and PROFIsafe)
- ASCII (HTML JSON)

The digital interfaces operate in electrical isolation from supply and housing potential. Thus, there is no galvanic connection, which might result in a superposition of interference currents or voltages on the output signals.

Digital output: A PROFINET and PROFIsafe interface is available for communication. The PROFIsafe interface ensures transmission using various test procedures

The instrument is automatically heated if necessary with critical ambient temperatures. This also ensures functionality with snowfall and sleet and minimises the risk of malfunctions due to icing-up.

Thanks to the optional integrated ultrasonic converter heating the instrument is especially suited to cope with difficult icing conditions in high mountains and in other critical locations.

The instrument is equipped with a battery-buffered real-time-clock, so that the data telegrams are output with date- and time-stamp.

3 Mode of Operation

The **Ultrasonic Anemometer 2D compact** consists of 4 ultrasonic transformers, in pairs of two facing each other at a distance of 135mm. The two resulting measurement paths are vertical to each other. The transformers function both as acoustic transmitters and receivers.
The electronic control system is used to select the respective measurement path and its measuring direction. When a measurement starts, a sequence of 4 individual measurements is performed in all 4 directions of the measurement paths in a basis measuring cycle of one msec.
The measuring directions (sound propagation directions) rotate clockwise.
The mean values are worked out from the 4 individual measurements of the path directions and used to make further calculations.
The time required for a measuring sequence is exactly 8ms at the maximum measuring speed.

3.1 Measuring Principle: Wind Velocity and Direction

The speed of propagation of the sound in calm air is superposed by the velocity components of an airflow in the direction of the wind.

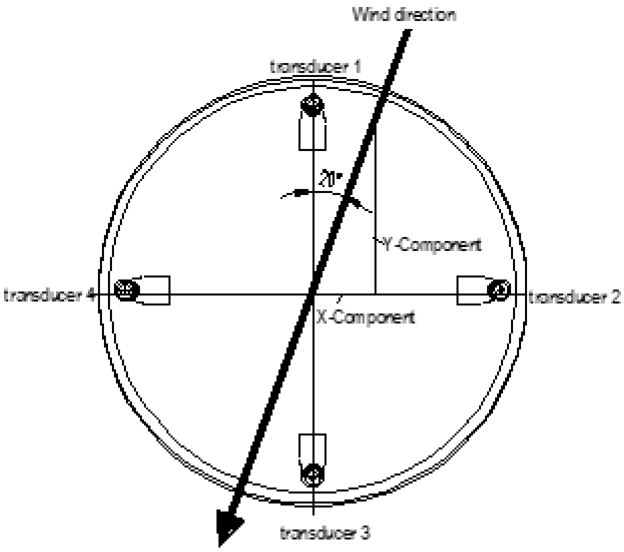
A wind velocity component in the propagation direction of the sound supports the speed of propagation; i.e. it increases it while a wind velocity component against the propagation direction reduces the speed of propagation.

The propagation speed resulting from superposition leads to different propagation times of the sound at different wind velocities and directions over a fixed measurement path.

As the speed of sound greatly depends on the temperature of the air, the propagation time of the sound is measured on each of the two measurement paths in **both** directions. This rules out the influence of temperature on the measurement result.

By combining the two measuring paths, which are at right angles to each other, the measurement results of the sum and the angle of the wind, velocity vector are obtained in the form of rectangular components.

After the rectangular velocity components have been measured, they are then converted to polar coordinates by the microprocessor of the anemometer and output as a sum and angle of wind velocity.



3.2 Measuring Principle: Acoustic Virtual Temperature

The thermodynamic interrelationship between the propagation velocity of sound and the absolute temperature of the air is defined by a root function. The sound velocity is also more or less independent of the air pressure and only depends on the absolute air humidity to a minor extent.
This physical interrelationship between sound velocity and temperature is ideal when measuring the air temperature as long as the chemical composition is known and constant. The levels of gases in the atmosphere are constant and with the exception of water vapour content vary at most by a few 100ppm (CO_2) even over lengthy periods.

Determination of gas temperature via its sound velocity is performed directly from measurement of its physical properties without the step of thermal coupling of this gas to a sensor, which would otherwise be necessary.

Remark:
Due to warming of the instrument by solar radiation or heating activity the measuring value can be considered only conditionally as real measuring value, particularly at low wind velocities.

3.3 Measuring Principle: Air Pressure (Optional)

The air pressure is measured via an MEMS sensor, basing on a piezo-resistive technology. The sensor is situated on the pc-board.

3.4 Heating

For many applications the continuous output of real measuring data of wind velocity and direction is an essential requirement to the measurement system even under meteorological extreme conditions such as icing situations.

The ultrasonic compact is, therefore, equipped with a sophisticated heating system which keeps a temperature of above +10°C on all outside surfaces, that might disturb the acquisition of run time data by ice formation.

Among the heated outside surfaces there are the base plate, sensor receiving sockets of the ultrasonic transducers, cover plate, and the ultrasonic transducer.

Please pay attention to the fact that the weakest link in the chain determines the complete functionality. Instruments, which heat only parts of the construction, hardly show advantages over completely unheated devices in icing situations.

The Ultrasonic Compact is capable to generate measuring data with high accuracy even in unheated condition with temperatures of up to below -40°C. There is no temperature dependency of the measuring data quality. The heating is necessary only for preventing icing formation at the instrument construction, so that possible disturbances of the run time acquisition can be avoided.

The heating system with a total maximum power of 250W avoids effectively icing according to the in-house icing standard THIES STD 012002.

Thus, icing is safely avoided, for example, at a temperature of -20°C up to a wind velocity of 10m/s.

Functionality:
Heating foils and transistors are activated by a temperature sensor at an appropriate position inside the housing via a two-level-controller, thus providing for a constant temperature at the outside surfaces of approx. +10°C. That means, that the total heating power is activated until the required temperature is reached, and is alternately switched on and off (two-level-control) with a hysteresis of approximately 1 Kelvin.
The necessary integral heating power depends on the thermal coupling to the surrounding air and thus to the wind velocity.

4 Preparation for Operation

Attention:

The working position of the anemometer is vertical (North arrow on the top).
During installation, de-installation, transport or maintenance of the anemometer it must be ensured that no water gets into the connector or cable gland of the anemometer. (IP68 is only fulfilled if the cable socket with connection cable is screwed on).
When using a lightning rod take care that it be installed in a angle of 45 ° to a measuring transducer; otherwise there will be deviations in the measured values.

4.1 Selection of Installation Site

As described above, the ultrasonic anemometer transmits sound packages required to measure the propagation speed. If these **sound packages** meet surfaces that reflect sound well, they are thrown back as an **echo** and can may result in **incorrect measurements** under unfavourable conditions.

It is therefore advisable to install the ultrasonic anemometer at a **minimum distance of 1 metre to objects in the measuring level**.

The choice of the installation location depends on the task position (e.g., data acquisition for weather services or for control purposes).

In general, wind meters should register wind conditions over a wide area. To obtain comparable values when measuring the ground wind, measurement should be performed at a height of 10 metres above even and undisrupted terrain. Undisrupted terrain means that the distance between the wind transmitter and the obstruction should be at least ten times the height of the obstruction (s. VDI 3786, sheet 2). If it is not possible to comply with this provision, the wind meter should be installed at a height at which measured values are influenced by obstructions located in the vicinity to the least possible extent (approx. 6 … 10m above the interference level). On flat roofs the anemometer should be installed in the middle of the roof and not at the edge to thus avoid any preferential directions.

The ultrasonic-anemometer has an electro-magnetic compatibility, which is far in excess of the required standard threshold value.

Within the complete frequency range, required by standard, electro-magnetic fields with 20 V/m (capacity of the test transmitter) could not affect the measuring value acquisition of the instrument.

In case you intend to install the instrument at transmitter masts or other sources of strong electro-magnetic radiation, where the local field strength is far above the standard threshold value, please contact the manufacturer.

4.2 Installation of Anemometer

Mechanical installation

Proper installation of the ULTRASONIC ANEMOMETER 2D compact is carried out using a tube socket Ø 50mmand at least 40mm in length. The inside diameter of the tube socket must be at least 25mm as the electrical connection of the ULTRASONIC is carried out at the bottom of the device.

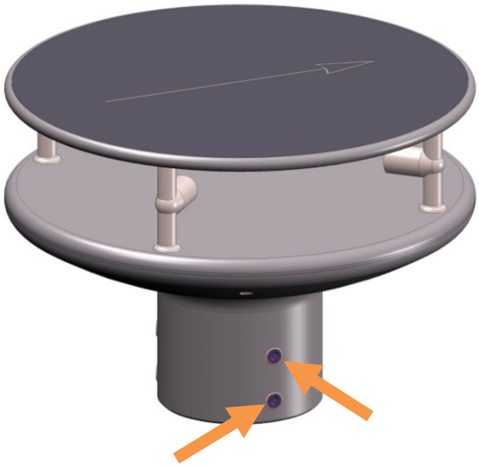
Tool:

Hexagon socket wrench Gr.4

Procedure:

1. Conduct and connect the cable/ plug connection of the ultrasonic anemometer through the boring of the mast, tube, bracket etc.
2. Put the ultrasonic anemometer onto the mast, tube etc.
3. The ultrasonic anemometer "Positioning". See chapter 4.3
4. Lock the ultrasonic anemometer afterwards at the mast by the four M8 hexagon socket screws.

Caution:.
The allen screws must be tightened to max. **7Nm**



4.3 Alignment to North / Positioning

North Alignment (Positioning) of the Anemometer at a Weather Station
For the accurate determination of the wind direction, the anemometer must be positioned to the north.

Procedure: 1. „Position" the ultrasonic anemometer by rotating on the mast tube until the **Orientation arrow** ❶ indicates to northern direction (geographical north). For this, please choose, in advance, a prominent point of the land scape in northern or southern direction by using a compass, und and rotate the mast or the anemometer until the Orientation arrow indicates to northern direction (geographical north). 2. Lock the ultrasonic anemometer afterwards at the mast by the four M8 hexagon socket screws. **Caution:**. The allen screws must be tightened to max. **7Nm** **Note:** When aligning the instrument to north using a compass, the magnetic variation (= deviation in direction of compass needle from true north) and local interfering magnetic fields (e.g. iron parts, electric cables). As additional positioning aid, or for a simple change without re-alignment you may use also the **position drilling**❷ in the base. Precondition, however, is a preparation by user at the mast.	 

Positioning of an Anemometer on a Wind Power Plant

For the exact determination of the wind direction the anemometer must be mounted in alignment with the generator hub.

Procedure (at generator hub north)**:**

1. „Position“ the ultrasonic anemometer by rotating on the mast tube, until the **orientation arrow** (in parallel to the generator axis) indicates towards the generator-hub.
2. Lock the ultrasonic anemometer afterwards through the four M6 hexagon socket screw at the mast.

   Caution:.
   The allen screws must be tightened to max. **7Nm**

Remark:
In order to avoid the discontinuity of the wind direction at the north leap (360 … 1°) the ultrasonic anemometer should be aligned oppositely to the generator hub by means of the reference arrow.

4.4 Electrical Installation for Ultrasonic Anemometer

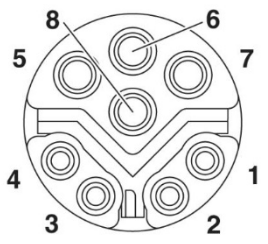
The ultrasonic anemometer is equipped with a plug for electrical connection. A Y-coded M-12 circular connector according to the DIN EN 61076-2-113 standard is used.

4.4.1 Cables, Cable preparation, Connector Installation

The sensor is connected via an 8-pin hybrid circular plug-in connection, which, in addition to Ethernet, also takes over the power supply. The plug is standardized and Y-coded according to the DIN EN 61076-2-113 standard. The differential impedance of the data transmission must be 100 ohms and correspond to CAT 5 (ISO/IEC 11801).

4.4.2 Connector Pin Assignment (Examples of Function)

Remark:
- The pins 1 – 4 (incl.) are galvanically isolated from the supply voltage and from housing.

Serial Interface, Half-duplex				View of solder terminal of coupling socket
Pin	**Allocation**	**Wire color**	**Function**	
1	TX+	Orange-White	Ethernet	
2	TX-	Orange	Ethernet	
3	RX+	Green-White	Ethernet	
4	RX-	Green	Ethernet	
5	48V DC nom.	Blue	(N) Power supply*	
6	48V DC nom.	White	(N) Power supply *	
7	48V DC nom.	Brown	(L) Power supply *	
8	48V DC nom.	Black	(L) Power supply *	
⏚	Schirm			© Bildquelle: PHOENIX CONTACT GmbH & Co. KG

* Polarity interchangeable in pairs

5 Maintenance

As the instrument does not have moving parts, i.e. is not subject to wear during operation, only minimal servicing is required. The instrument is subject to natural pollution, the level of pollution depends on the location. If necessary the instrument and the sensor surfaces can be cleaned from soil cleaning can be carried out as required using non-aggressive cleaning agents in water and a soft cloth during routine checks.

Attention:
During storage, installation, de-installation, transport or maintenance of the anemometer it must be ensured that no water gets into the instrument stand and plug of the anemometer.

6 Calibration

The ultrasonic anemometer does not contain any adjustable components such as electrical or mechanical trimming elements. All components and materials used show invariant behaviour in terms of time. This means that no regular calibration is required due to ageing. Errors in measured values can only be caused by coarse mechanical deformation of the instrument and associated changes in measurement path lengths.

The acoustic-virtual temperature can be used to check the effective-acoustic measurement path length. A change of approx. 0.3% in the measurement path length and thus a measuring error of approx. 0.3% for the wind velocity corresponds to a deviation in the virtual temperature of 1K at 20°C; there is a measuring error of approx. 1% for the wind velocity with a deviation of acoustic-virtual temperature of approx. 3.4K.

If the measuring sections of the anemometer are changed, you should consult the manufacturer about a new calibration if the difference in the acoustic temperatures of the individual sections is > 2 Kelvin when there is no wind. The acoustic temperature of the individual sections is output with website of the device.

> ***Important:***
> ***Mechanical damages with deformation of the instrument might lead to measuring value errors.***

7 Warranty

Damage caused by improper handling or external influences, e.g. lightning, do not fall under the warranty provisions. The warranty entitlement expires if the instrument is opened.

> ***Important:***
> ***The ultrasonic anemometer must be returned in the original packaging as the warranty entitlement otherwise expires with mechanical damage, e.g. deformation of measuring arms.***

8 Functional Description

The device functions of the ULTRASONIC are described below.

8.1 PROFINET / PROFIsafe

Zum Austausch der Sensordaten und die Parametrierung des Geräts steht die PROFINET und PROFIsafe Schnittstelle zur Verfügung.

8.1.1 GSDML-file

The Generic Station Description Markup Language file describes the PROFINET and PROFIsafe interface and facilitates the integration of the sensor into the controller. The file can be obtained from Adolf Thies GmbH and imported into the programming environment of the controller.

8.1.2 Parametrierung

The sensor is parameterized using a "record data list" in the Telegram submodule with index 1. Table 1 lists the data points for parameterization:

Name	Datentyp	Byte Offset	Min	Max	Unit
Averaging Mode	Unsigned 16 Bit	0	0	3	
Averaging Time	Unsigned 16 Bit	2	0	1200	100ms
Error Timeout	Unsigned 16 Bit	4	10	60	Seconds
Heating start temperature	Unsigned 16 Bit	8	2	15	Celsius
Heating start voltage	Unsigned 16 Bit	10	5	48	Volt
Heating Function	Unsigned 16 Bit	12	0	1	
Measurement Delay	Unsigned 16 Bit	14	20	15000	ms
North Correction	Unsigned 16 Bit	16	0	359	Degree
Velocity Deviation	Unsigned 16 Bit	18	3	10	m/s

Table 1: Submodul Telegram Record Data List

The graphical user interface of the programming environment, the programmable logic controller, can be used for parameterization.

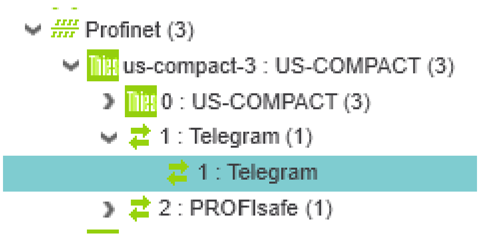


Figure 1 : Selection submodule telegram

The settings for the parameters are in the "Telegram" submodule, see 8.1.3 Telegram submodule.

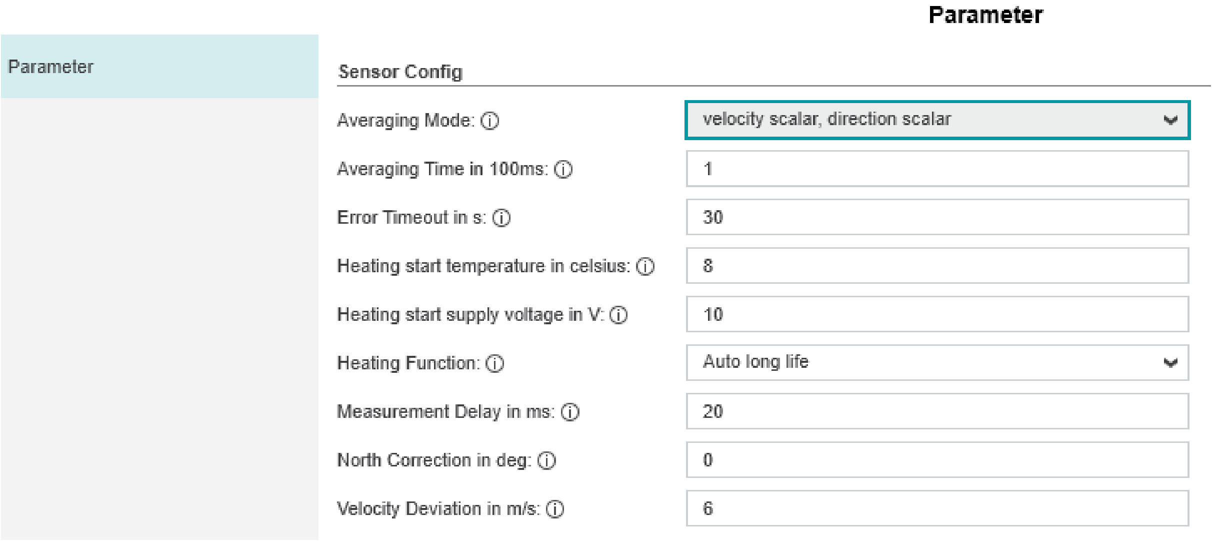


Figure 2: Parameter Submodul Telegram im PLCnext Engineer

Figure 2 shows the parameterization via the PLCnext Engineer programming environment.

8.1.2.1 Averaging Mode

Setting the averaging method (Average method)

Description: This parameter is used to set the type of averaging method. The averaging can be carried out either vectorially or scalarly, please see **chapter 8.3.1.**

Parameter description:

0: vector average velocity and vector average angle
1: scalar average velocity and scalar average angle
2: scalar average velocity and vector average angle
3: vector average velocity and scalar average angle

Values: 0 ... 3
Initial value: 1

8.1.2.2 Averaging Time

Averaging period

Description: This parameter is used to define the period over which the ULTRASONIC averages its measured values. Due to the high measuring speed of up to 100Hz for generating a complete set of measured values, the use of an averaging makes sense in most cases.

Parameter description:

Parameter für AV	Set averaging time
0	no averaging
1	Averaging over 100ms
10 ... 1200	Averaging over 1 ... 120.0s

Table 2: Setting the averaging periods with parameter

The average memory is designed as a floating memory. When starting, the data in the averaging memory are valid immediately. It is immediately averaged over the existing measured values.

Values range: 0 ... 1200
Initial value: 10

8.1.2.3 Error Timeout

Time in s until the generic error bit is set (error timeout).

Description: Determines after which time the error bits measurement fails internal and measurement fails external are set.
Special case: With output rates (OR) < 100ms, the error time base is reduced by the ratio OR/100.

Values range: 10 ... 60
Initial value: 30

8.1.2.4 Heating Start Temperature

Heating start temperature (heating start temperature)

Description:	Indicates the temperature in degrees Celsius above which the heating is switched on.
Values range:	2 ... 15
Initial value:	8

8.1.2.5 Heating Start Voltage

Heating Start Voltage

Description:	If the supply voltage drops below the set value, the supply voltage is deactivated. If the supply voltage rises 2V above the set value, it is activated again. For example, if a value of 10V is set, the heating is deactivated below 10V. If the supply voltage then rises above 12V, it is reactivated.
Values range:	5 ... 48
Initial value:	10

8.1.2.6 Heating Function

Heating Function

Description: The behavior of the heating can be influenced with the parameter Heating Function.

Off:
The heating is deactivated under all circumstances.
Automatic mode with detection of an icing situation:
The housing heating is controlled depending on the parameters Heating Start Voltage and Heating Start Temperature. However, the transducer heating is only activated when icing of the ultrasonic transducer is detected. Because icing situations are relatively rare, this reduces the thermal stress on the converters and their aging.

Automatic mode:
With the housing heater will be also the converter heater controlled depending on the parameters Heating Start Voltage and Heating Start Temperature. The increased thermal stress can accelerate the aging of US converters.

Values range:	0 off 1 automatic mode with protection of the ultrasonic transducer
Initial value:	1

8.1.2.7 Measurement Delay

Messintervall (Measurement Delay)

Description:	Indicates the time in 1ms increments from the beginning of one measurement cycle (4 TOF) to the beginning of the next and thus determines the repetition rate of the wind and acoustic temperature measurement. The parameter MD must always be set longer than the measurement time specified by the parameter AD from the sum of 4 individual TOF measurements. The MD parameter is automatically adjusted for longer times as the AD parameter is increased, but not automatically for shorter times. In standard operation, the repetition rate is 20ms, so that a complete data set is recorded by all sensors every 20ms.
Values range:	20 ... 15000
Initial value:	20

8.1.2.8 North Correction

North Correction

Description:	With the north correction, a constant angle is added to the measured angle. The value is used to correct a known misalignment. For example, if the ULTRASONIC is not aligned directly to the north, but rather to the north-west, the wind direction always shows 45° too little. In this case, a north correction of 45 must be set. The north correction affects both the wind directions in the data telegrams and the vectorial output values.
Values range:	0 … 359 in 1° steps
Initial value:	0

8.1.2.9 Velocity Deviation

Velocity Deviation as meter per seconds

Description:	With the Velocity Deviation parameter, the plausibility threshold of the wind speed scatter from measurement to measurement is set. Values range: 3 … 10
Initial value:	6

8.1.3 Submodul Telegram

The "Telegram" submodule only contains input values. The table describes the data points. The "Status Word" data point is described in more detail under point 8.1.17 Status Word.

Name	Data type	Description	Unit	Scaling	Min	Max
wind direction	Integer32	wind direction	grad	10	0	3600
wind speed	Integer32	wind speed	m/s	10	0	750
wind speed vector y	Integer32	wind speed vector y	m/s	10	-750	750
wind speed vector x	Integer32	wind speed vector x	m/s	10	-750	750
heater current	Integer32	heater current	Ampere	10	0	100
supply voltage	Integer32	supply voltage	Volt	10	0	800
acoustical temperature	Integer32	acoustical temperature	°C	10	-400	850
housing temperature	Integer32	housing temperature	°C	10	-400	850
air pressure	Integer32	air pressure	hPA	100	26000	126000
data quality	Integer16	data quality	%	1	0	100
live counter	Integer32	live counter	ms	1	0	2147483647
predictive maintenance indicator	Unsigned32	predictive maintenance indicator	‰	1	0	1000
status word	Unsigned16	status word				

Table 3: Description of input data submodule telegram

8.1.4 Submodul PROFIsafe

The "Telegram" submodule only contains input values. Table 4 describes the data points. The "Status Word" data point is described in more detail under point 8.1.17 Status Word.

Name	Datentyp	Description	Unit	Scaling	Min	Max
status word low byte	Unsigned8	status word low byte				
status word high byte	Unsigned8	status word high byte				
data quality	Integer16	data quality	%	1	0	100
live counter	Integer32	live counter	ms	1	0	2147483647
wind direction	Integer32	wind direction	grad	10	0	3600
wind speed	Integer32	wind speed	m/s	10	0	750
wind speed vector y	Integer32	wind speed vector y	m/s	10	-750	750
wind speed vector x	Integer32	wind speed vector x	m/s	10	-750	750
air pressure	Integer32	air pressure	hPA	100	26000	126000

Table 4: Description of input data submodule PROFIsafe

8.1.5 Wind direction

The "wind direction" data point outputs the measured wind direction and is output in degrees with one decimal place.

8.1.6 Wind speed

The "wind speed" data point outputs the measured wind speed and the wind speed is output in meters per second with one decimal place.

8.1.7 Wind speed vector Y

The data point "wind speed vector Y" outputs the proportion of the measured wind speed in a north-south direction. The wind speed is given in meters per second with one decimal place.

8.1.8 Windspeed Vector X

The data point "wind speed vector X" outputs the proportion of the measured wind speed in east-west direction. The wind speed is given in meters per second, with one decimal place.

8.1.9 Heater current

Outputs the heating current in amperes with one decimal place. The current is determined as an RMS value over 100ms.

8.1.10 Supply Voltage

Outputs the supply voltage with one decimal place. The voltage is determined as an RMS value over 100ms.

8.1.11 Accoustical Temperature

The acoustic temperature is measured using the transit times over the measurement sections and is output in degrees Celsius with one decimal place.

8.1.12 Housing Temperature

Outputs the housing temperature measured on the device with one decimal place. The measured value is internally the reference value for the device heating.

8.1.13 Air Pressure

Returns the air pressure in hectopascals with one decimal place. The air pressure is output in absolute terms, there is no compensation for sea level.

8.1.14 Data Quality

Indicates the number of valid values in the mean buffer as a percentage. 100% means that the buffer is completely filled with valid values.

8.1.15 Live Counter

Outputs an internal counter that is incremented every 1 ms. The start value is 0 and when the value 2147483647 is reached, the counter is reset to 0.

8.1.16 Predictive Maintenance Indicator

The status of the ultrasonic converters is output via the predictive maintenance indicator. The value range is between 0 and 1000. New converters have a value of 1000. If the converter degenerates, the value drops. The value is determined over a period of 24 hours.

8.1.17 Status Word

The status word is used in the Telegram submodule. Table 4 describes the individual data points of the status word.

Name	Bit	Description
general warning	0	General warning
general error	1	General error
exceeding max wind speed	2	Exceeding the maximum Wind Speed (Wind Speed will be capped at 750)
operational Temperature!	3	Exceeding the maximum operating temperature
measurement fails internal	4	Measurement fails internal
measurement fails external	5	Measurement fails external
heater malfunction	6	Heater error
power supply failure	7	Power supply failure
status run up	8	The sensor has completed the start-up process
status operation	9	The sensor has assumed the operation status and is ready for operation
status heater active	10	Heating active
status transducer heater active	11	Converter heating active

Table 5: Description status word

8.1.18 Status Byte Low

The status byte low is used in the PROFIsafe submodule. Table 6 describes the individual data points.

Name	Bit	Description
general warning	0	General warning
general error	1	General error
exceeding max wind speed	2	Exceeding the maximum Wind Speed (Wind Speed will be capped at 750)
operational Temperature!	3	Exceeding the maximum operating temperature
measurement fails internal	4	Measurement fails internal
measurement fails external	5	Measurement fails external
heater malfunction	6	Heater error
power supply failure	7	Power supply failure

Table 6: Description Status byte low

8.1.19 Status Byte High

The status byte high is used in the PROFIsafe submodule. Table 7 describes the individual data points.

Name	Bit	Description
status run up	0	The sensor has completed the start-up process
status operation	1	The sensor has assumed the operation status and is ready for operation
status heater active	2	Heating aktiv
status transducer heater active	3	Transducer heater active

Table 7: Description State High

8.1.20 F_Dest_Add

The sensor is delivered from the factory with the destination address 392. The address can be changed later via the web interface, under the PROFINET tab.

8.1.21 F_Src_Add

The sensor is delivered from the factory with the source address 1024. The address can be changed later via the web interface, under the PROFINET tab.

8.1.22 F_iPar_Crc

The iParameter CRC is calculated in the sensor from the parameters written by the controller and compared with the F_Dest_Add. If the CRC does not match, bit 4 "FV_activated" is set in the status byte. The calculation of the iParameter CRC is described in point 8.2.3 iParameter CRC.

8.1.23 F_SIL

Only the value NoSIL can be selected for the F_SIL parameter. The device **does not** meet a safety integrity level.

8.2 Web interface

A web interface is available in addition to the PROFINET interface. The web interface can be accessed by entering the IP address in the web browser. Current measured values can be read out via the interface, the time can be set, a firmware update can be carried out and the iParameter CRC can be calculated. Figure 3 shows the start page of the sensor.

Home Settings PROFINET Info

Datapoint	Value	Datapoint	Value	Datapoint	Value
Wind speed	0.7 m/s	Wind Direction	288.2 °	Acoustical Temperature	25.8 °C
Housing Temperature	25.0 °C	Air Pressure	985.24 hPa	Supply Voltage	0.3 V
Heater Current Top	0.5 A	Heater Current Bottom	0.4 A	Transducer heating current	0.4 A
Heater Shift	55.1	Data Quality	100.0 %	Counter	218 s
Internal Temperature	67.9 °C	Wind speed y	0.2 m/s	Wind speed x	-0.7 m/s
Acoustical Temperature 13	26.0 °C	Acoustical Temperature 24	25.9 °C	Device Time	2021.7.14 6:45:22
Time of flight 31	393164 ns	Time of flight 42	388614 ns		
Time of flight 13	387064 ns	Time of flight 24	391392 ns		

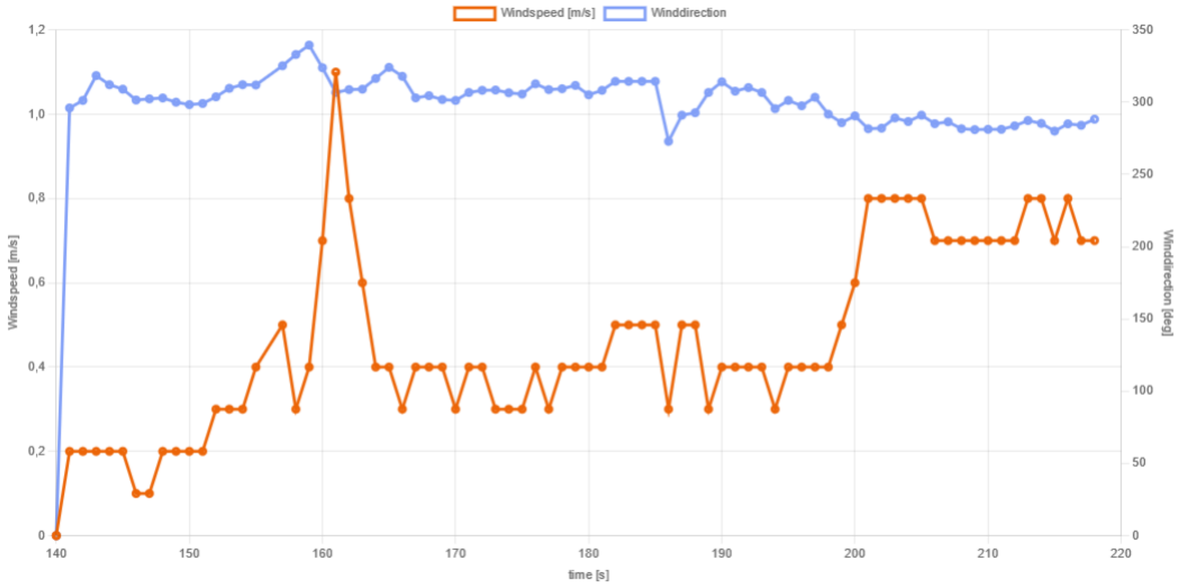


Figure 3: Web interface

8.2.1 Setting the time

The time can be set via the "Settings" tab. Two different times can be set. Once the UTC and the local time provided by the operating system. There is no automatic changeover between winter and summer time on the device. The time is set using the "Set UTC Time" and "Set Local Timer" buttons and is applied directly.

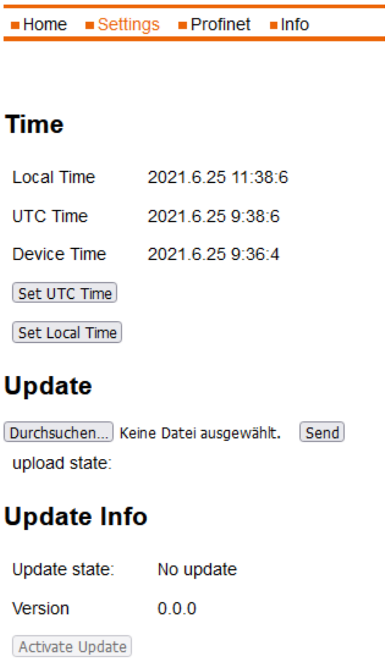


Figure 4: Web interface Settings

8.2.2 Firmware Update

The firmware can also be updated via the web interface. The update file is selected with the "Browse" button and transferred to the device with the "Send" button. The current status is displayed after "upload state". It says "uploading..." while the update is being sent. If the transfer is successful, "success" is displayed. In the event of a faulty transmission, "error". If the transfer was successful, the status of the update file (OK, faulty file...) and the version are displayed under "Update Info". An update can only be carried out with a more recent version. The new update can be activated using the "Activate Update" button and the device restarts with the new version. To check the version, the current software version can be read out in the "Info" tab.

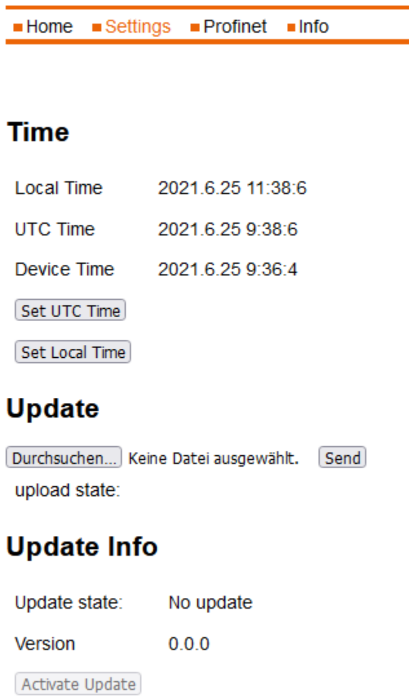
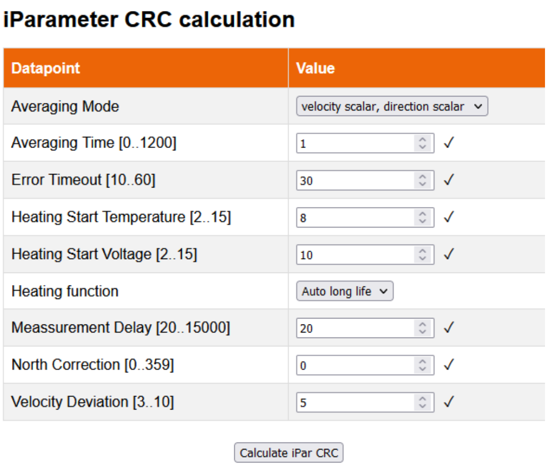


Figure 5: Web interface Update

8.2.3 iParameter CRC

The parameters set in section 8.1.2 Parameterization are checked with a 32-bit CRC. The calculation can be done via the "PROFINET" tab. The same settings must be made in the input mask as in the programming environment. Behind the input fields, a cross or a tick indicates whether the input was valid or not. The actual calculation is started with the "Calculate iPar CRC" button and then displayed. The calculated CRC can now be copied into the programming environment in the PROFIsafe submodule. If the expected CRC does not match the calculated CRC on the device, the device sends a diagnosis message "0x4B Inconsistent iParameters (iParCRC error)". The message can be read from the alarm list of the controller.



iParameter CRC calculation

Datapoint	Value
Averaging Mode	velocity scalar, direction scalar
Averaging Time [0..1200]	1 ✓
Error Timeout [10..60]	30 ✓
Heating Start Temperature [2..15]	8 ✓
Heating Start Voltage [2..15]	10 ✓
Heating function	Auto long life
Meassurement Delay [20..15000]	20 ✓
North Correction [0..359]	0 ✓
Velocity Deviation [3..10]	5 ✓

Calculate iPar CRC

Figure 6: Calculation of iParameter CRC

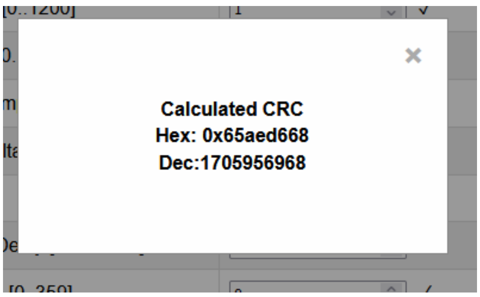


Figure 7: Display of the calculated CRC

8.3 Instantaneous Values and Output of Raw Measured Values

The output of instantaneous values is generally a special case. Due to the high acquisition speed for the measured values averaging of the data is sensible in most cases. If instantaneous Values range: are to be output, averaging must not be switched on. The parameter AV should be set to '0': see 8.1.2 Parameterization.

8.3.1 Averaging

Given the high data acquisition rate averaging is to be recommended in most cases. The averaging period is freely selectable from 100ms to 120 seconds within wide limits. See 8.1.2 Parameterization.

It is a basic rule that only valid values are written to the averaging puffer. The size of the buffer is not determined by the number of data records but by the difference in the time stamp between the first and last data record. As a result any missing measured values range: do not influence the averaging result. The content level of the averaging buffer is shown in the status value of the ULTRASONIC. It is the ratio between the memory actually occupied and the maximum required memory (calculated value).

The Ultrasonic 2D compact incorporates two different practical procedures for averaging:

- One **procedure for generating vectorial mean values** and
- one **procedure for generating scalar mean values**.

These different procedures can be selected for averaging wind velocity as well as wind direction depending on the actual application.
Vectorial averaging involves the wind direction for averaging of the wind velocity, and wind velocity for averaging of the wind direction.
Both averaged variables, wind velocity and wind direction, thus each undergo evaluation with the other measured variable.
This averaging procedure is very suitable e.g. for measuring and evaluating the propagation of pollutants.
Scalar averaging averages both variables, wind velocity and wind direction, independently of each other.
This averaging procedure leads to comparable results with mechanical wind velocity and wind

direction pickups.
The scalar averaging procedure is suitable e.g. for location analysis for wind turbines where only the wind vector variable relevant for the generation of energy is of interest and not its direction.
The vectorial and scalar procedure can be used within one output telegram independently of the wind velocity and wind direction see 8.1.2 Parameterization.

8.4 Behaviour of Instrument under extreme Conditions of Measurement Value Acquisition

The ULTRASONIC is equipped with a highly effective internal fault detection and correction system. This allows it to detect incorrect measured values using the history and to correct them where possible. It cannot however be ruled out that the ULTRASONIC will get into a situation in which the acquisition of new data is impossible. In this case the error bits are set in the status values and a defined value possibly output at the analogue outputs.

It is a basic rule that the measured values output are always valid and can be interpreted by the target system (unless a specific error telegram is output in the in the case of error). In the case of error might happen that the data become 'too old', i.e. they are not updated over a certain time and freeze. In the event of an error, it can happen that the data becomes 'too old', i.e. it is not updated for a certain time and freezes. In this case, the error bits are set in the status byte.

8.5 Behaviour in Case of Error

An error case occurs in the following circumstances:

Averaging time(AV) < 30s, see “ET“ Command Error Timeout	An error is output in case that for a time period of > 30s (s. “ET“) no new measuring value has been detected.
Averaging time >= 30s pre-set error Timeout, see command ET	An error is output in case that the averaging buffer does include no more valid values.

8.5.1 Behaviour of Analogue Outputs

If the analogue outputs are active, they are switched to the minimum or maximum value in the case of error. The parameter EI determines which of the two values is output: see **8.15 Status Word.**

8.5.2 Behaviour of Telegram Output

In the case of error the relevant error telegram is output. In parallel the error information is shown in the status byte: see **Fixed telegram formats**.

8.6 Output of all System Parameters

Most parameters of the ULTRASONIC are stored internally in an EEPROM. The command SS can be used to output all stored parameters.
Before amending parameters it is recommended making a backup copy of existing settings and storing them in a text file.

8.7 Enquiry about Software Version

The software version can be read out via PROFINET or via the webpage.

8.8 Plausibility

To identify incorrectly measured values the ULTRASONIC offers an internal plausibility check, which assesses measured values using the history. Incorrect measured values can be caused for example by heavy rainfall or foreign bodies in the measurement path.
If an incorrect measured value is identified, the ULTRASONIC sets its acquisition of measured values to the maximum speed. In this mode it is more likely to obtain a valid measured value in fault conditions (e.g. horizontal rain). A complete data record is now made every 12ms using all 4 sensors so that the ULTRASONIC generates approx. 80 measured values per second.

9 Technical Data

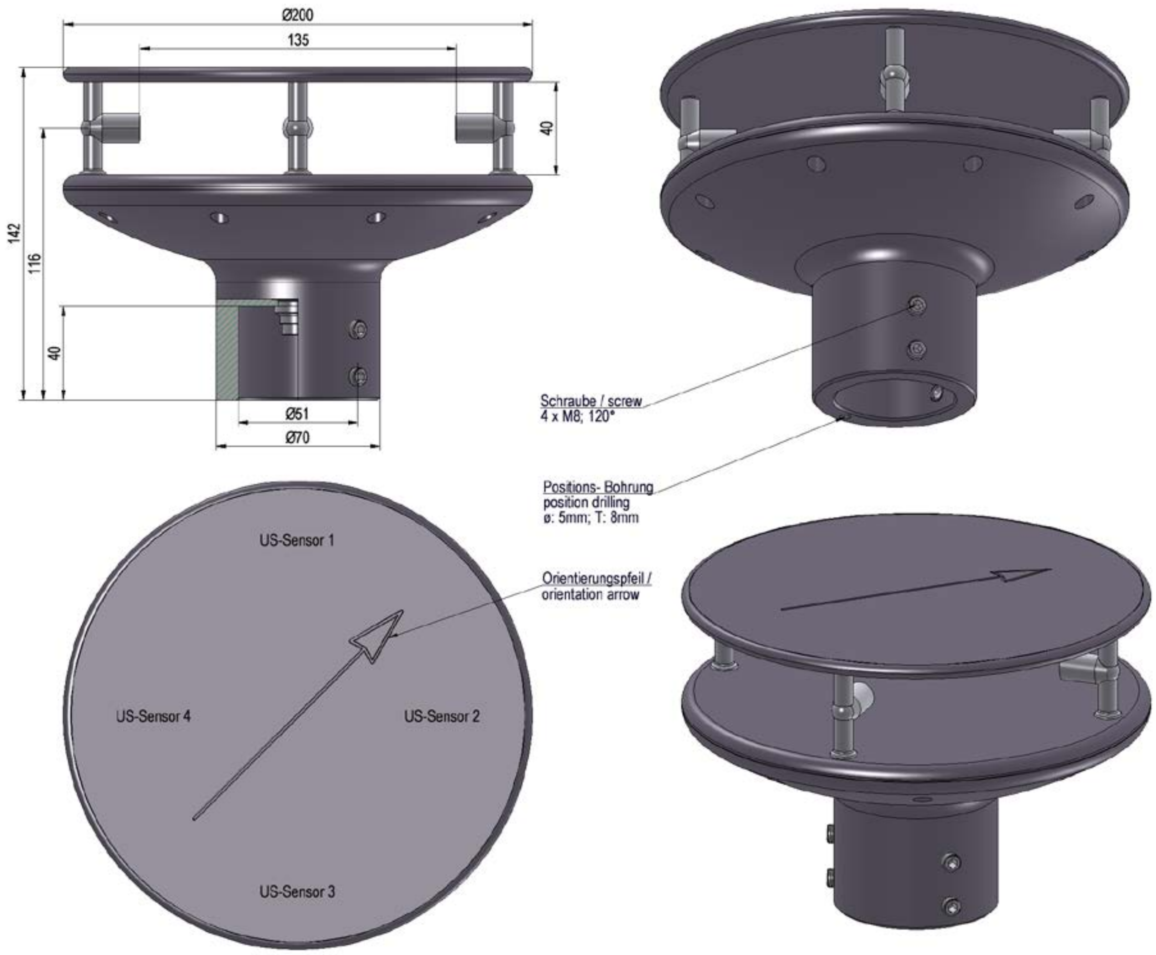
Wind velocity	Measuring range	0.01 ... 75m/s Scaling of analogue output freely selectable	
	Accuracy	≤5m/s:	±0.2m/s (rms, mean over 360°)
		5 … 60m/s:	±2% of meas. value (rms- mean over 360 °)
		60 … 75m/s:	±3% of meas. value (rms- mean over 360 °)
	Resolution	0.1m/s:	
		0.01m/s:	
Wind direction	Measuring range	0 ... 360°	
	Accuracy	± 2.0° at WV >1m/s	
	Resolution	1°:	
		0.1°:	
Virtual temperature	Measuring range	-50 ... +70 °C	
	Accuracy	±2.0K	
	Resolution	0.1K (in the telegrams 2 and 7	
Air pressure	Measuring range	300 ...1100hPa	
	Accuracy	± 0.25hPa @ 700 ... 1050hPa and +25 ...+40 °C ± 2.0hPa @ 300 ... 1100hPa, -40...+60 °C and activated heating	
	Resolution	0.1hPa	
	Long-term stability	< ± 1hPa per year	
Data output digital	Interface	PROFINET V2.42 CLASS B, PROFIsafe V2.6.1, Webinterface	
	Data rate	10-Mbit/s, 100-Mbit/s	
	Conformance Class	B	
	Netload Class	III	
General	Internal measuring rate	Up to 1000 runtime-measurements per seconds, up to 250 complete measurement sequences/second inclusive calculations.	
	Firmware update	Firmware update via Ethernet.	

	Temperature range	Operating temperature - 50 ... + 80 °C heated - 30 ... + 80 °C unheated Storing - 50 ... + 80 °C Measuring operation possible with heating up to -75°C at temperatures > - 60°C a lower MTBF is to be expected.
	safety integrity level	Not certified
Operating voltage	Supply w/o heating	U: 17V... 48V DC ±10% P: typ. 4,5W, max. 6W SELV or PLEV
Operating voltage	Supply with heating	U: 48V DC ±10% P: max. 300 W SELV or PLEV
	Protection	IP 68 - applies with proper installation, see section 4. Preparation for operation
Icing resistance	W/o US converter heating	Acc. to THIES STD 012001
Icing resistance	With US converter heating	Acc. to THIES STD 012002
Icing resistance	With US converter heating	Acc. to MIL-STD-810G, METHOD 521.3, 2008/10 Configuration: Initial value
Housing		Aluminium, seawater-resistant Surface: hard-anodized with basic colouring Coat thickness: 40 … 60µm
	Installation type	e.g. Mast tube Ø 50mm (see dimension drawing)
	Connection type	8-pole plug connection in shaft
	Weight	approx. 2kg

Note on the operating voltage:

An AC supply of 15 ... 34V AC is possible, but in this case the heating output < 250VA and icing resistance according to the Thies standard are not guaranteed.

10 Dimension Drawing



11 Accessories (available as optional features)

Lightning rod	**4.3100.99.150**	As lightning protection.
North ring	**508696**	Serves as mounting and alignment aid.

12 EC-Declaration of Conformity

Manufacturer: Adolf Thies GmbH & Co. KG
Hauptstraße 76
37083 Göttingen, Germany
http://www.thiesclima.com

Product: Ultrasonic Anemometer 2D compact

Doc. Nr. 2010-44659_CE

Article Overview:

4.3877.27.000 4.3877.07.000

The indicated products correspond to the essential requirement of the following European Directives and Regulations:

2014/30/EU	26.02.2014	DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.
2014/35/EU	26.02.2014	DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.
2017/2102/EU	15.11.2017	DIRECTIVE (EU) 2017/2102 of the European Parliament and of the Council of November 15, 2017 amending Directive 2011/65 / EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
2012/19/EU	13.08.2012	DIRECTIVE 2012/19/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012 on waste electrical and electronic equipment (WEEE).

The indicated products comply with the regulations of the directives. This is proved by the compliance with the following standards:

DIN EN 55011+A1:2017	2018-05	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement (CISPR 11:2015, modified + A1:2017); German version EN 55011:2016 + A1:2017
DIN EN 61000-4-2	2009-12	Electromagnetic Compatibility (EMC) - Part 4-2: Testing and measuring procedures - Testing of immunity to static electricity discharge
DIN EN 61000-4-3	2011-04	Electromagnetic compatibility (EMC) - Part 4-3: Test and measurement procedures - Testing of immunity to high-frequency electromagnetic fields
DIN EN 61000-4-4	2013-04	Electromagnetic compatibility (EMC) - Part 4-4: Test and measurement methods - Testing of immunity to fast transient electrical disturbances / burst
DIN EN 61000-4-5	2019-03	Electromagnetic compatibility (EMC) - Part 4-5: Test and measurement procedures - Testing of immunity to surge voltages
DIN EN 61000-4-6	2014-08	Electromagnetic compatibility (EMC) - Part 4-6: Test and measurement methods - Immunity to conducted disturbances, induced by high-frequency fields
DIN EN 61000-4-8	2010-11	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test (IEC 61000-4-8:2009); German version EN 61000-4-8:2010
DIN EN 61000-4-9	2017-05	Electromagnetic compatibility (EMC) - Part 4-9: Testing and measurement techniques - Impulse magnetic field immunity test
DIN EN 61000-4-10	2018-01	Electromagnetic compatibility (EMC) - Part 4-10: Testing and measurement techniques - Damped oscillatory magnetic field immunity test (IEC 61000-4-10:2016); German version EN 61000-4-10:2017
DIN EN 61000-6-1	2019-11	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity standard for residential, commercial and light-industrial environments (IEC 61000-6-1:2016)
DIN EN 61000-6-2	2019-11	Electromagnetic compatibility Immunity for industrial environment
DIN EN 61000-6-3:2007 + A1:2011	2011-09	Electromagnetic compatibility (EMC). Generic standards. Emission standard for residential, commercial and light-industrial environments
DIN EN 61000-6-4	2020-09	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments (IEC 61000-6-4:2018)
DIN EN 61010-1	2020-03	Safety requirements for electrical equipment for measurement, control, and laboratory use. General requirements
DIN EN 61326-1	2013-07	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements
DIN EN 63000	2019-05	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.

Legally binding signature: Legally binding signature:

General Manager - Dr. Christoph Peper Development Manager - ppa. Jörg Petereit

This declaration certificates the compliance with the mentioned directives, however does not include any warranty of characteristics.

Please pay attention to the security advises of the provided instructions for use.

13 UK-CA-Declaration of Conformity

Manufacturer:	Adolf Thies GmbH & Co. KG Hauptstraße 76 37083 Göttingen, Germany http://www.thiesclima.com
Product:	Ultrasonic Anemometer 2D compact

Doc. Nr. 2010-44659_CA

Article Overview:

4.3877.27.000 4.3877.07.000

The indicated products correspond to the essential requirement of the following Directives and Regulations:

1091	08.12.2016	The Electromagnetic Compatibility Regulations 2016
1101	08.12.2016	The Electrical Equipment (Safety) Regulations 2016
RoHS Regulations 2012	01.01.2021	The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
3113	01.01.2021	Regulations: waste electrical and electronic equipment (WEEE)

The indicated products comply with the regulations of the directives. This is proved by the compliance with the following standards:

BS EN 55011+A2:2016	31.05.2016	Industrial, scientific and medical equipment. Radio-frequency disturbance characteristics. Limits and methods of measurement
BS EN 61000-4-2	31.05.2009	Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrostatic discharge immunity test
BS EN IEC 61000-4-3	04.11.2020	Electromagnetic compatibility (EMC). Testing and measurement techniques. Radiated, radio-frequency, electromagnetic field immunity test
BS EN 61000-4-4	30.11.2012	Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrical fast transient/burst immunity test
BS EN 61000-4-5+A1	30.09.2014	Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test
BS EN 61000-4-6	28.02.2014	Electromagnetic compatibility (EMC). Testing and measurement techniques. Immunity to conducted disturbances, induced by radio-frequency fields
BS EN 61000-4-8	30.04.2014	Electromagnetic compatibility (EMC). Testing and measurement techniques. Power frequency magnetic field immunity test
BS EN 61000-4-9	31.10.2016	Electromagnetic compatibility (EMC). Testing and measurement techniques. Impulse magnetic field immunity test
BS EN 61000-4-10	31.03.2017	Electromagnetic compatibility (EMC). Testing and measurement techniques. Damped oscillatory magnetic field immunity test
BS EN 61000-6-1	28.02.2007	Electromagnetic compatibility (EMC) - Generic standards - Immunity for residential, commercial and light-industrial environments
BS EN IEC 61000-6-2	25.02.2019	Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments
BS EN IEC 61000-6-3	30.03.2021	Electromagnetic compatibility (EMC). Generic standards. Emission standard for equipment in residential environments
BS EN IEC 61000-6-4	30.09.2019	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments
BS EN 61010-1+A1	31.03.2017	Safety requirements for electrical equipment for measurement, control, and laboratory use. General requirements
BS EN IEC 61326-1	07.06.2021	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements
BS EN IEC 63000	10.12.2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Legally binding signature:	Legally binding signature:
General Manager - Dr. Christoph Peper	Development Manager - ppa. Jörg Petereit

This declaration certificates the compliance with the mentioned directives, however does not include any warranty of characteristics.

Please pay attention to the security advises of the provided instructions for use.

Please contact us for your system requirements.
We advise you gladly.

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