Ultrasonic Anemometer 2D

For upside down use

Instruction for Use

4.3825.32.500/503/506
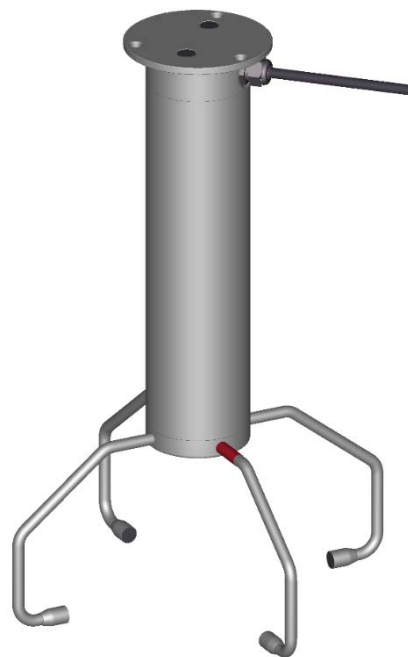4.3826.30.340

from software version V3.18

4.3826.30.340   4.3825.32.500/503/506

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

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- 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.

Contents

Table

Patent

Patent No.: EP 1 448 966 B1

Patent No.: US 7,149,151 B2

Shipment

1 x Ultrasonic Anemometer
1 x Short instructions for use (the complete instructions for use is available for download)
1 x Supplementary Sheet: Factory Setting
1 x Factory certification

The instructions for use are available for download under the following link:

https://www.thiesclima.com/db/dnl/4.382x.xx.xxx_US-Anemometer-2D_e.pdf

Operating Instructions

These operating instructions describe all possible applications and settings of the instrument. **The _Ultrasonic Anemometer 2D_ is factory-set**. Identification for the factory setting derives from the order No. and the respective "Factory Setting".

<div align="center">

Order number and Setting
see supplementary sheet
"Factory Setting"

</div>

With these detailed operating instructions and via the serial interface of the Ultrasonic Anemometer 2 D it is possible for the user to adapt the factory-settings to his own requirements.

1 Application

The **Ultrasonic Anemometer 2D** is used to detect the horizontal components of **wind velocity** and **wind direction** as well as the **virtual temperature** in 2 dimensions.

More than 35 different measurement values are available, such as:

- Orthogonal wind velocity vectors (X- and Y-path).
- Scalar wind velocity.
- Wind direction.
- Acoustic-virtual temperature [°C].
- Acoustic-virtual temperature of the orthogonal measurement path (X- and Y-path) [°C].
- Standard deviation of the vectorial wind velocity (X- and Y-path).
- Standard deviation of the scalar wind velocity.
- Standard deviation of the wind direction.
- Standard deviation of the acoustic-virtual temperature.
- Wind velocity of the gust acc. to WMO.
- Wind direction of the gust acc. to WMO.
- Measurement in Burst mode with trigger via plug PIN and recording of an analogue input value.
- More measuring values please refer to chapter 7.4.5.5 (measurement values and data formats available).

The instrument is especially suited for application in the fields of

- Meteorology.
- Climatology.
- Regenerative energy, wind power plants.
- Traffic engineering, aviation and navigation.
- Reconstruction of pollutant dispersal.
- Wind alarm devices, building construction and building safety.
- Indoor flow measurement.
- And in alpine field of application.
- As acoustic thermometer.

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

The level of accuracy achieved when measuring the air temperature (virtual temperature) surpasses that of classical methods, in which the temperature sensors are used with weather and radiation protection, following correction of the influence of damp occurring with certain weather situations.

Output of the measured values can be either digital and / or analogue.

Digital output: An RS485/422 is available for serial communication. It can be operated in full or half-mode. For the output of measured values there are a number of predefined telegrams or a user-defined telegram (e.g. WV, WD, virtual temp., standard deviation, status information, NMEA etc.).

Analogue outputs: Wind velocity and direction as well as acoustic-virtual temperature are output either as a current or voltage signal. Individual measuring range scaling of the analogue outputs for WV and WD are selectable.

The analogue outputs can be switched alternatively and individually as analogue voltage inputs (max. 3). These measuring values are output via the serial interface within a user-defined telegram.

The serial or analogue output of the data is either as an instantaneous value or as a gliding mean.

Heating

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

The Ultrasonic therefore is equipped with a sophisticated heating system. This system keeps all outer surfaces that might disturb the data acquision in case ice formation, efficiently on a temperature above +5°C.

The transducer carrying arms belong to the heated outer surfaces, as well as additionally the ultrasonic transducer itself and the housing – depending on the model.

Please take into consideration here, that the weakest link of the chain determines the complete functionality.
Instruments heating only a part of the construction, rarely show advantages compared with completely unheated instruments.

The Ultrasonic is able to acquire measuring data with high accuracy even in unheated state at temperatures down –40°C. There is no temperature-depending quality of the measuring data. The heating is necessary only for avoiding ice formation on the instrument construction and the associated blockage of the run time data acquisition.

The heating system avoids effectively an icing formation – depending on the model acc. to our in-house icing standard THIES STD 012002.

Mode of Operation:
The heating elements are activated via a 2-point controller by the acoustic-virtual temperature and a temperature sensor at an appropriate position inside the housing; they keep the temperature of the outer surfaces on approx. +5°C even at high wind velocities. This means that the full heating power is activated until the reference temperature is reached, and is repeatedly alternating switched on and off (2-point controller) by a hysteresis of approx. 2K.
The necessary integral heating power is depending on the thermal coupling to the surrounding air, and therefore on the wind velocity.

Thanks to additional **ultrasonic transformer heating systems** the model No.4.382x.**3x**.xxx particularly suitable for difficult conditions in high mountain areas or other critical measuring locations where icing is to be expected.

Thanks to additional ultrasonic transformer heating systems and additionally integrated housing heater the model No. 4.382x.**4x**.xxx, 4.3820.34.395 and 4.3820.34.398 are particularly suitable for extreme conditions in high mountain areas or other critical measuring locations where icing is to be expected.

1.1 Mode of operation

The **Ultrasonic Anemometer 2D** consists of 4 ultrasonic transformers, in pairs of two facing each other at a distance of 200mm. 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 at maximum speed.
The measuring directions (sound propagation directions) rotate clockwise, first from south to north, then from west to east, from north to south and finally from east to west.
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 approx. 2.5msec at +20°C at the maximum measuring speed.

2 Measuring principle

2.1 Wind velocity and direction

The speed of propagation of the sound in calm air is superposed by the velocity components of an air flow 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. These 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 digital-signal-processor of the anemometer and output as a sum and angle of wind velocity.
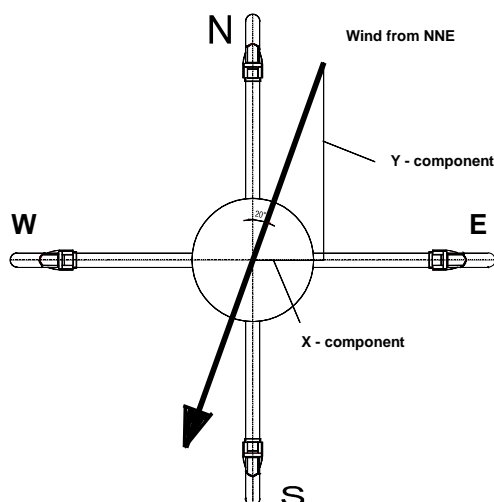
2.2 Acoustic virtual temperature

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.

The advantages of this measuring method are firstly its inertia-free reaction to the actual gas temperature, and secondly, the avoidance of measuring errors such as those that occur for example when a solid-state temperature sensor is heated by radiation or cooled through the evaporation of water on the sensor.

Many comparative tests between different weather and thermal radiation shield housings show the indirect effect of the above-mentioned sources of measurement errors on the temperature sensor. [1]
At sites with a high likelihood of icing-up ultrasonic anemometers are also used already as acoustic thermometers, as classical temperature sensors are no longer vented with weather and thermal radiation shield housings after icing-up. Due to the deteriorated thermal coupling to the outer world they response only extremely time-delayed, or due to the missing discharge of the own power dissipation the measured temperature is too high. [2]

2.2.1 Correction of the acoustic-virtual temperature from Influence of air humidity

Given the dependence, albeit low, of the sound propagation velocity on the air humidity level, the "acoustic virtual temperature" relates to dry air without any water vapour content.
The deviation of the measured "acoustic temperature" from the real air temperature shows linear dependence on the absolute humidity level of the air.
The amount of water vapour in the air proportionately increases the velocity of sound as H_2O molecules only have around half the mass of the other air molecules (O_2 and N_2).
The velocity of sound however only increases with the molar mass fraction of water vapour in the air to a disproportionately low degree.
The reason for this is the lower mean translatory velocity of the water vapour molecules in comparison with the other air molecules. With the more complex H_2O molecules greater degrees of freedom of motion are possible than with the more simple O_2 and N_2 molecules so that the total energy content (temperature) is divided between the possible degrees of freedom of translation and rotation as kinetic energy.

O_2 and N_2 molecules have 3 degrees of freedom of translation and 2 degrees of freedom of rotation, and H_2O molecules 3 degrees of freedom of translation and 3 degrees of freedom of rotation. The adiabatic exponent γ of each gas is determined by the total number of degrees of freedom according to the following interrelationship:

$$\gamma = 1 + \frac{2}{n}$$

The adiabatic exponents measured for dry air γ_d and water vapour γ_v are:

$$\gamma_d = 1.399463 \text{ and } \gamma_v = 1.331$$

The dependence of the acoustic virtual temperature Tv on the water vapour content of the air can be calculated using the following relationship:

$$Tv = Tt \bullet \left[1 + \left[\frac{\gamma_v}{\gamma_d} - \frac{M_v}{M_d} \right] \bullet \frac{e}{p - \left[1 - \frac{M_v}{M_d} \right] \bullet e} \right] \qquad [1]$$

where Tt is the acoustic virtual temperature of dry air and M_v the molar mass of water vapour, and M_d describes the molar mass of dry air. The ratios $\frac{M_v}{M_d}$ with the value 0.621978 and $\frac{\gamma_v}{\gamma_d}$ with the value 0.95108 can be included in the equation as fixed constants. [3]

The ratio $\frac{e}{p}$ describes the water vapour pressure divided by the air pressure, corrected by the effect of the water vapour pressure on the air pressure.

The vapour pressure e can be calculated according to the relationship $e = \frac{RH}{100} \bullet e_s$ where RH stands for relative humidity and e_s for saturation vapour pressure.

The saturation vapour pressure is a function of temperature and can be calculated according to the Magnus formula with coefficient according to Sonntag

$$e_s(T) = 6.112 hPa \bullet e^{\frac{17.62 \bullet T}{243.12 K + T}} \qquad [4]$$

with the temperature of interest where T must be specified in °C.

The following simplified expression with T as the temperature in Kelvin results for calculation of the acoustic virtual temperature measured with humid air:

$$Tv = Tt \bullet \left[1 + 0{,}329102 \bullet \frac{e}{p - [0{,}378022] \bullet e} \right]$$

The correcting effect of the water vapour pressure on the air pressure is relatively low, and is, for ex., approx. 2,8% with +40°C and 100% relative humidity.

The water vapour pressures to be expected in the nature are clearly below. The error with the simplification of the formalism can consequently almost be neglected.

Simplified formula:
$$Tv = Tt \bullet \left[1 + 0{,}329 \bullet \frac{e}{p} \right]$$

Example:

With an air temperature of +20°C, relative humidity of 100 % and an air pressure of 1000hPa an acoustic virtual temperature of 22.25°C is calculated from the sound velocity.
The acoustic virtual temperature is therefore 2.25°C above the actual air temperature and can be corrected accordingly using the above equation if the humidity level of the air is known, e.g. relative humidity and the air pressure.

Calibrated measurements performed in the climatic exposure test cabinet with different temperatures as parameters and relative humidity levels between 10% and 90% have shown that the factor in the above equation should be nearer 0.30.

$$Tv = Tt \bullet \left[1 + 0.30 \bullet \frac{e}{p} \right]$$

If required to improve accuracy of the calculated real air temperature, one or more iteration steps could be performed to determine the accurate saturation vapour pressure when using the measured relative humidity and the measured acoustic temperature as corrective variables as the real air temperature (corrected acoustic virtual-temperature) is necessary for the calculation of the saturation vapour pressure.

References:

[1] Lanzinger, Eckhard (Deutscher Wetterdienst), Langmack, Hans (Universität Hamburg): Measuring air temperature by using an ultrasonic anemometer.

[2] Musa, Mark (Meteo Swiss), Tammelin, Bengt (Finnish Meteorological Institute) et al.: Measurement of temperature with wind sensors during severe winter conditions.

[3] Aspiration-Psychrometer tables, Deutscher Wetterdienst, 7. edition.

[4] Coefficient of the Magnus formula acc. to Prof. Dr. Sonntag.

3 Preparation for operation

> ### Attention:
> *The working position of the anemometer is vertical (sensor arms "above").*
> *During installation, de-installation, transport or maintenance of the anemometer it must be ensured that no water gets into the shaft and connector or cable gland of the anemometer.*
> *When using a lightning rod takes care that it be installed in an angle of 45°to a measuring arm; otherwise there will be deviations in the measured values.*

> ### Caution
> *For all anemometers with specified maximum power up to and including 90VA:*
> *The device may only be supplied with a power supply of the "Class 2, limited power".*

3.1 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 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**.

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). 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 20V/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.

3.1.1   Handling of Packaging

The US anemometer is delivered in packing which protects the instrument against damages. For mounting, please remove the device from the packing. The sensor arm protection has to remain on the arms. The protection is to be removed only after mounting has been carried out (alignment, fixing etc.).

Packing and sensor arm protection are to be used for other transports of the instrument.

3.2 Installation of anemometer

The appropriate mounting is done by means of an anemometer flange.
For boring dimensions please refer to the dimension drawing (chapter 13).

- Working position: Flange: abowe, Sensor arm: below

3.3 Alignment to north

For exact determination of the wind direction the anemometer has to be installed aligned **to the north** (true north).

To align the anemometer, the **arm of the sonic transformer marked red must point to north** (true north). To do so, select a conspicuous feature of the landscape to the north or south with a compass and turn the mast or anemometer until the opposing arms are aligned in this direction.

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).
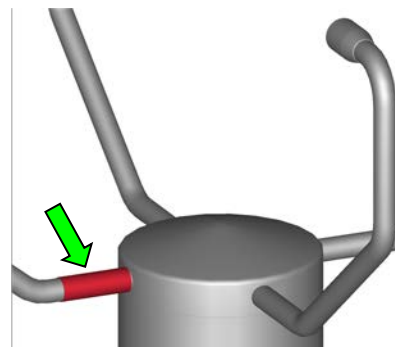
Attention:
If an additional **north marking "N"** is attached on the sensor head (see figure), it is overriding for the north alignment.
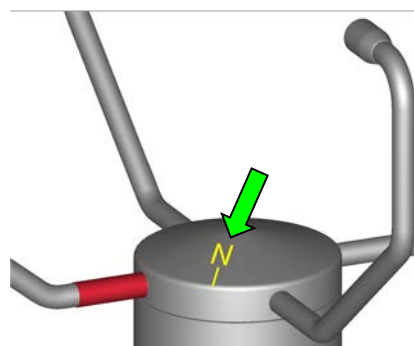
In the bottom of the anemometer stand there is a **north-drilling**.
The north- drilling serves for the use of a so-called north- ring with bolt. The north- ring is not included in delivery.
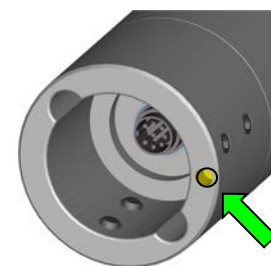
A North- ring ❶ is available as an optional feature to assist with alignment and for simple replacement of the ultrasonic anemometer without readjustment of north.

On initial installation this north- ring is mounted loose so it still rotates on the measuring mast. The north pin ❷ of the north-ring must show northward.

The direction bearing tube ❸ also supplied is inserted through the horizontal bores of the north- ring.

With this tube a conspicuous point in the landscape, building, tree or hill to the north can be selected, a bearing taken and the adapter fixed to the measuring mast with the screws.

The direction bearing tube is then removed and the ultrasonic anemometer mounted on the north pin of the north- ring and screwed in place.
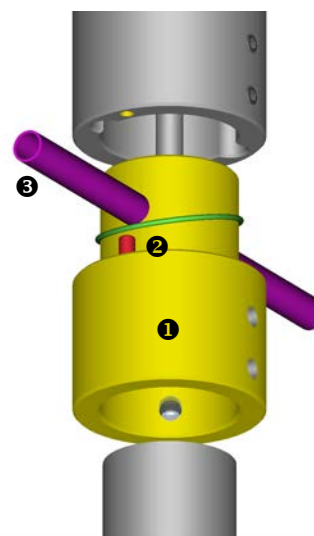
Installation of cover at **4.3826.30.340**	
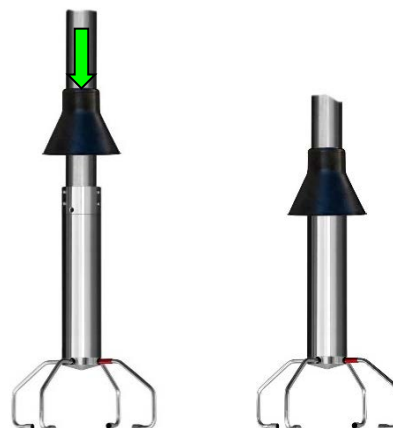
3.4 Cables, Cable preparation, Coupling socket Installation 4.3826.30.340

For pin assignment please refer to supplement „factory settings". Examples see chapter 3.4.2.

The cable must have the following properties:
8 cores; 0,5 to 0,75mm² core cross-section for supply; min. 0,14mm² core cross-section for data communications; 7- 8mm cable diameter, resistant to ultraviolet rays, overall shielding.

> ### Caution:
> **The cable to be connected must be at least the operating voltage class 01 correspond HAR (100V).**

> ### Remark:
> *Optionally, a completely converted connecting cable can be included in delivery for the ultrasonic-anemometer (see accessories).*

Coupling socket 507550 (Binder, Serial 423), EMC with cable clamp

1. Stringing parts on cable acc. to plan given above.
2. Stripping cable sheath 20mm
   cutting uncovered shield 15mm
   Stripping wire 5mm.

   Cable mounting 1:
   Putting shrink hose or insolating tape between wire and shield.

   Cable mounting 2:
   If cable diameter permits, put the shield backward on the cable sheath.
3. Soldering wire to the insert, positioning shield in cable clamp.
4. Screwing-on cable clamp.
5. Assembling remaining parts acc. to upper plan.
6. Tightening pull-relief of cable by screw-wrench (SW16 und 17).

Cable mounting 1
Viev X

Cable mounting 2
Viev X

Figure 1: Coupling socket installation
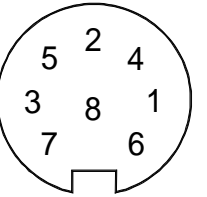
3.4.1 Connector Pin Assignment (Examples of Function) for devices: 4.3826.30.340

Remark:

- For exact allocation of function please refer to supplement "Factory Settings"
- The pins 1 – 6 (incl.) are galvanically isolated from the supply voltage and from housing.

Pin	Allocation	Function
• Serial Interface, full-duplex		
1	RXD-	Serial interface
2	TXD-	Serial interface
3	ADIO	Function not preset
4	RXD+	Serial interface
5	TXD+	Serial interface
6	AGND	Ground for analogue and serial
7	AC/DC	Supply, reverse-polarity protected
8	AC/DC	Supply reverse-polarity protected
⏚ Shield		Shield against electric fields

View of solder terminal of coupling socket

Pin	allocation	Function
• Serial Interface, half-duplex and analogue outputs		
1	WG	Analogue output wind velocity
2	TXD- / RXD-	Serial interface
3	ADIO	Function not preset
4	WR	Analogue output wind direction
5	TXD+ / RXD+	Serial interface
6	AGND	Ground for analogue and serial
7	AC/DC	Supply, reverse-polarity protected
8	AC/DC	Supply, reverse-polarity protected
⏚ Shield		Shield against electric fields

View of solder terminal of coupling socket

Pin	Allocation	Function
• Serial Interface, half-duplex and analogue inputs		
1	0-9,96V	Analogue input
2	TXD- / RXD-	Serial interface
3	0-9,96V	Analogue input
4	0-9,96V	Analogue input
5	TXD+ / RXD+	Serial interface
6	AGND	Ground for analogue and serial
7	AC/DC	Supply, reverse-polarity protected
8	AC/DC	Supply, reverse-polarity protected
⏚ Shield		Shield against electric fields

View of solder terminal of coupling socket

3.5 Electrical Installation for Ultrasonic Anemometer with Screwed Cable Gland 4.3825.32.500/503/506

The ultrasonic anemometer is equipped with a fix-connected cable by means of a screwed cable gland. The cable end is open. The core ends are marked by means of pin numbers on cable marking rings.

3.5.1 Cable Pin Assignment (Examples of function)

Remark:

For exact allocation of function please refer to supplement "Factory Settings"
The pins 1 – 6 (incl.) are galvanically isolated from the supply voltage and from housing.

	Cable assignment: Analogue outputs, serial interface halve-duplex		
Pin	**Colour Code**	**Assignment**	**Function**
1	white	WG	Analogue output wind velocity
2	green	TXD- / RXD-	Serial interface
3	black 1	ADIO	Heating control
4	brown	WR	Analogue output wind direction
5	yellow	TXD+ / RXD+	Serial interface
6	black 2	AGND	Ground for analogue output and serial interface
7	black 3	AC/DC	Supply, reverse-polarity protected
8	black 4	AC/DC	Supply, reverse-polarity protected
⏚	green / yellow	shield	

4 Maintenance

As the instrument does not have moving parts, i.e. is not subject to wear during operation, only minimal servicing is required. Given that the sensor surfaces are normally kept clean by rain, it will only be necessary to occasionally remove residues from the sensor surfaces in regions with very little rain. 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 shaft and connector or cable gland of the anemometer.*

5 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 are only caused by mechanical deformation of the transformer arms 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 0.17% in the measurement path length and thus a measuring error of 0.17% 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 6 K deviation of acoustic-virtual temperature.

In the event of a change in the measuring sections of the anemometer, e.g. due to external forces, with regard to squareness or section length and / or if the acoustic temperatures of the sections differ from each other by> 2 Kelvin, the manufacturer should be consulted about a new calibration.

> **Important:**
> *Mechanical deformation of the measuring arms results in errors in the measured values, which involve the output of error telegrams / error signals to the analog interfaces.*

6 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.**

7 Functional description

The functioning of the ULTRASONIC instrument is described below. Due to the limited number of plug connections some functions exclude the simultaneous operation with other functions. There are also restrictions regarding the functional definition of the cable connector. This is due to the double assignment of individual PINs.

7.1 Serial communication

The ULTRASONIC provides an RS485 / RS422 interface for serial communication. It can be operated either in full or half duplex mode and at different baud rates.
A standard terminal program, for ex., can be used for communication with the ULTRASONIC. With a Windows-based operating system Hyper Terminal is included in the scope of supply. It has to be installed subsequently if required.

The manufacturer, generally, is not aware of a possible use of the Ultrasonic Anemometer in a bus formation. Therefore, the instrument has a wave terminating resistor, which can be connected by the software, for half-duplex-operation. See command: BT (bus termination).

When starting the ULTRASONIC, the communications parameters are output to the serial interface. Output takes place at 9600.8N1. The baud rate, the duplex modus and the ID are output:

Example:
THIES ULTRASONIC
!00BR00005
!00DM00001

The ULTRASONIC starts with ID 0, with a baud rate of 9600.8N1 and full duplex mode.

7.1.1 Duplex mode

Duplex mode decides the type of physical connection of the serial interface. In full duplex mode the send and receive signals are each transmitted via separate pairs of cables. This means, it is possible to send and receive signals at the same time.

In half duplex mode transmission of the send and receive signals is via the same pair of cables in the time division (successively), see **Command DM**.

For a bus operation in the half-duplex-mode (RS485), where the ULTRASONIC, in general, is operated as "slave", it is necessary to switch the line-transmitter into the "high–impedance-state" during the intermission, so that the replies of the other bus parties are not suppressed.

It might be important with point-to-point-connections in the full-duplex-mode (RS422), depending on the disturb-ratio on the communication lines, that the line-transmitter remains active during the intermissions. So, a maximum differential input level leads to a maximum signal/noise ratio.

A half-duplex-mode can be selected via the command DM (duplex mode). With this mode, on principle, the line-transmitter is switched on only when sending. For the full-duplex-operation there are two modes: one for bus operation (RS485), where the line-transmitter is controlled as in half-duplex mode, and another one (RS422), where the line-transmitter remains active even in case of reception. See **command DM**.

For the ULTRASONIC there are restrictions on the parameter combination or function of the terminals depending on the transmission type selected. Due to the limited number of plug connector contacts multiple assignment of the connections are necessary. The following table shows the functional options for the modes full and half duplex.

Full duplex mode	Half duplex mode
Independent telegram output possible (see **Command TT**)	Independent telegram output possible from software version V3.10. Telegram output is active one minute after instrument start or resp. after setting the command.
Bus mode not possible (RS485, DM=1), No bus mode possible (RS422, DM=2)	Bus mode possible (RS485, DM=0).
No output of analogue values to PIN RXD- and RXD+	Output of analogue values possible.
No readin of ID from external PINs (see **Command XI**)	Readin of ID from external PINs possible (see **Command XI**).
Analogue inputs to PINs RXD- and RXD+ not possible. (see **Command *AA*, Command AB)**	Analogue inputs to PINs RXD- and RXD+ possible (see **Command *AA*, Command AB**).
Heating control via PIN ADIO possible	Heating control via PIN ADIO possible.

Table 1: Restrictions in full and half duplex mode

7.1.2 Response Delay

With the serial communication please take into consideration that the ULTRASONIC responds immediately to arriving telegrams. The response time of the instrument is in the lower range of milliseconds. Possibly, the delay between receiving signal and sending signal might be too short for some interface converters. It is possible that, within this time period, the interface converter has not yet switched over from the mode 'sending' to the mode 'receiving'. This might lead to absurd telegrams.

In order to avoid this effect, the ULTRASONIC has the parameter RD (response delay). With this parameter the response is additionally delayed, on receipt of a query or command, by the selected value in milliseconds.

The parameter depends on the order-number of the instruments.

7.1.3 General telegram structure

For serial communication the ULTRASONIC has a fixed telegram format, which also permits communication in bus mode. It has the following form:

NNBB<cr>   <cr> stands for Carriage return (Enter key)

for a data enquiry or

NNBBPPPPP<cr>   <cr> stands for Carriage return (Enter key)

for a parameter change.

The individual letters have the following meaning:

NN:	Two-position ID of the ULTRASONIC. It can be selected in the range from 00 to 99. The presetting is the ID '00': see also **Command ID** and **Command XI**
BB:	Two-position command. A complete list can be found in section Command list.
PPPPP:	If a new parameter is to be set, the parameter is changed with a 5-position value. The parameter is always right-justified; i.e. it thus has to be padded from the left with zeros.

Example:
Telegram No. 4 is to be interrogated. The relevant command is:

00TR4<cr>   <cr> stands for Carriage return (Enter key)

The prerequisite is that the ULTRASONIC ID has the value '0'.

Example:

With the command

00BR<cr>   <cr> stands for Carriage return (Enter key)

the selected data record for the baud rate is returned.

!00BR00005

Remark:

The receiving buffer of the ULTRASONIC can be cleared by sending a carriage return <CR>. If the ULTRASONIC possibly has invalid characters in the receiving buffer, this buffer can be processed by sending a carriage return. In this case, it is advisable to send a carriage return at the beginning of the telegram, for example:

<cr>00BR<cr>   <cr> stands for Carriage return (Enter key)

7.1.4   Return values of ULTRASONIC

After a valid command has been input, the ULTRASONIC sends acknowledgement, e.g. acceptance of the parameter or output of a data telegram.

For a standard command the response starts with a '!', followed by the ID and the parameter value.

If the input command is TR or TT, the ULTRASONIC transmits a data telegram as the response.

If the command cannot be processed for a certain reason, the instrument transmits a telegram with the error code 'CE' (Command Error). The meanings of the values for CE are summarised in '**Table 2**'.

Value output in CE telegram	Meaning
8	Incorrect access mode.
16	Parameter not in valid range.
4 or 32	Violation regarding parameters of other commands.

Table 2: Return values with incorrect interpretation of command

7.1.5 Access Mode

For configuration the ULTRASONIC has a set of commands, which determine behaviour in terms of the propagation time. The commands are broken down into three levels:

- Enquiry Mode.
- User mode.
- Configuration mode.

Enquiry mode:
This mode comprises commands, which do not influence the parameters of the ULTRASONIC. They include for example, output of the system status and interrogation of the data telegram with TR.

User mode:
This mode comprises commands, which affect the behaviour of the ULTRASONIC. These parameters can be changed by the user. The system behaviour of the instrument is adapted with these commands by alteration of parameters. This group of commands includes e.g. settings for data transmission and averaging.

Configuration mode
This mode comprises commands which were set when adjustment of the instrument was performed at the factory. They can be equated with calibration. These parameters must not be changed.

To distinguish between commands of the three groups when parameterising the ULTRASONIC the instrument is equipped with an access key KY. Inputting of the key accesses the individual levels. Access to commands at a higher level includes access to commands at a lower level.

Access key	Response from ULTRASONIC	Command level
00KY0	WRITE PROTECTED !00KY00000	Enquiry mode (preset).
00KY1	USER ACCESS !00KY00001	User mode.
00KYxxxxx	CONFIG ACCESS !00KYxxxxx	Configuration mode. Key must be asked from the manufacturer.

Table 3: Access key for different command levels

After the access key has been changed, the ULTRASONIC transmits a response, which contains not only the parameter input but also the access mode.

After parameters have been changed with the key '1' or 'xxxxx', the ULTRASONIC must be reset to the initial position with the command 00KY0.

In case, of power supply interruption the instrument is reset automatically to the query mode.

Example:
00KY1
USER ACCESS   Response from ULTRASONIC
!00KY00001   Response from ULTRASONIC
00AV5   Change in averaging time
00KY0
WRITE PROTECTEDResponse from ULTRASONIC
!00KY00000   Response from ULTRASONIC

7.1.6 Baud rate

The baud rate is used to select the transmission speed via the RS485. The parameter range is from 1200 baud to 921.6kBaud.

To prevent accidental reprogramming of the baud rate over 115.2kBaud, the baud rates above 115.2kBaud are accessed with the command BX.

Reprogramming of the baud rate with the command BR has an immediate effect on the ULTRASONIC. After the dispatch of a command, the user program used must be set to the corresponding baud rate.

When using a baud rate in the extended range (230400baud .. 921600baud) the ULTRASONIC includes an additional safety mechanism, which prevents unintentional adjustment of the baud rate. When the command BX is used, the ULTRASONIC immediately switches over its baud rate but does not store this change.

With each restart the ULTRASONIC starts with the old baud rate. To store the changes the baud rate of the PC must be set to the new speed, and the same command transmitted to the ULTRASONIC once again. After transmission the ULTRASONIC acknowledges the command with the output 'Baud rate saved'.

Example:
The baud rate is to be changed to 962100baud:

Command:	Response ULTRASONIC	Comment
00KY1	USER ACCESS	Permit access
	!00KY00001	
00BX103	For saving change baud rate and insert command again	
		Change baud rate of PC to 921600 here
00BX103	Baud rate saved	
	!00BX00103	

7.1.7 Instrument ID

The instrument ID specifies the address to which the ULTRASONIC is to respond during serial communication. The instrument ID lies in the range from '00' to '99'. The preset ID is '00'. Every telegram from the ULTRASONIC starts with the ID set. Under certain conditions this provides for bus mode: see Bus mode.

The ID is reprogrammed with the command 'ID'. The new ID of the ULTRASONIC is specified as the parameter. After the change has been made, the ULTRASONIC immediately responds to the new address.

Example:

00KY1	
USER ACCESS	Response from ULTRASONIC
!00KY00001	Response from ULTRASONIC
00ID04	ID changed to address 4
!04ID00004	ULTRASONIC confirms new ID
	The ULTRASONIC responds to the new ID '04' now, i.e. including after a restart
04AV	Interrogation of averaging time with new ID
!04AV00005	Return of averaging time

It is also possible to specify the ID on start-up via the external PINs WV/RXD-, WD/RXD+ and ADIO. For this purpose the parameters of the commands AA, AB, AC and XI must be set properly: see **Command AA**, **Command AB**, **Command AC**, **Command XI**.

7.1.8 Bus mode

The concept of ID-based communication allows the ULTRASONICs to be operated in a bus system. The prerequisites for this are:

- Half duplex mode.
- Different IDs of the individual bus users.
- Master-slave structure, i.e. there is a device in the bus (control, PC ...) that performs cyclic enquiry of the data of the individual ULTRASONICs and possibly parameterises the ULTRASONICs.

In bus mode, there are no restrictions on parameterisability and program upload. A station can also be provided with a new program in bus mode for a specific purpose. With an update a program update must be performed for every ULTRASONIC.

In bus mode it is recommended not using an ULTRASONIC with the ID '00' as this ID is reserved for devices that are integrated in the bus for the first time.

7.2 Analogue and digital I/O

In addition to output of the data via the serial RS485, the ULTRASONIC can also output the data using an analogue interface. These outputs can also be optionally switched as analogue inputs which read in an external voltage of 0.. 9.96V, perform digital conversion and output this via the user-specific telegram.
The ULTRASONIC is also equipped with the cable ADIO, which includes digital output functions in addition to the analogue input.

7.2.1 Analog inputs

The signals WV/RXD-, WD/RXD+ and ADIO of the connector can be switched as analogue inputs under certain conditions. WV/RXD- and WV/RXD+ are then only available as inputs when half duplex mode is selected and the ports have been set accordingly via the commands AA, AB and AC. See **Command AA**, **Command AB**, **Command AC**.
The function of the pin ADIO is independent of duplex mode and can be switched as an analogue input at any time.

The measured values read-in can be output with the user-specific telegram: see User-specific telegram. The input voltage range is 0…+10,0V, the sampling rate can be set in many ranges by the command AU (analogue Update rate). The minimum converting period is 2,5msec per channel. If, for ex., all three channel are configured as analogue inputs, the maximum sampling rate is 1/7,5ms = approx. 133Hz.
The parameter AU gives the sampling rate in ms. The time period of a sampling for all selected analogue channels is the value of AU multiplied by the number of channels.

The scanning rate can be changed through the command AU. The parameter gives the scanning interval in ms. The scanning rate for all analogue channels is the value of AU, multiplied by the number of channels.

The parameters AY,AZ; BY,BZ; CY,CZ are available for the scaled output of the analogue measuring values. By means of these parameters the measuring range (0..10,0V) can be converted into a linear output.

The Y-parameters always state the value corresponding to 0V, the Z-parameters state the value corresponding to 10,0V. As the command interpreter of the ULTRASONIC facilitates no negative numbers and no commas the scaling values must be converted before input.

The abbreviation **SKAW** means "scaled output value". This is the value which is output in the telegram after conversion of the measuring value.

The parameter value that has to be entered with AY, AZ; BY;CY, CZ is to be calculated as follows:

Parameter value = 30000+(SKAW*10)

Example:
A temperature sensor is to be connected to PIN ADIO. The sensor has the following characteristics:
0,0 V -> -40°C
+10,0V -> 80°C

The parameter CY describes the measuring value for 0V. It is to be calculated as follows:
Command value = 30000 +(-40*10) = 29600.
Through the command 00CY29600 the lower value is described.

The parameter CZ describes the measuring value for 10,0V. The output value for measuring value +10V shall be +80°C. The conversion is as follows:
Command value = 30000+(80*10) = 30800
Through the command 00CZ30800 the upper value is defined.

For the output of the data values the user-defined telegram is applied. If the measuring value of the ADIO-PIN shall be output with sign, two pre-dots, and one post-dot sign the definition
00UT@33,05,1,1@
must be added. See also **User-specific telegram**

For further information see
Command AA, Command AB, Command AC, Command AY, Command AZ, Command BY, Command BZ, Command CZ

7.2.2 Analogue outputs

As an additional option the analogue outputs WV/RXD- and WD/RXD+ offer the possibility of outputting the wind velocity and wind direction as analogue values both as a voltage and current value. It is also selectable if a constant offset of 20% of the upper range value is output with the current- or voltage output at measuring value 0. This realizes the interfaces 4..20mA. See the table for the possible combinations:

	Parameter SC=0	Parameter SC=1
Parameter AN=0	0..10V	2..10V
Parameter AN=1	0..20mA	4..20mA
Parameter AN=2	No output	No output

Parameter AA= 0; AB = 0

Table 4: Config. of analog outputs WV/RXD- and WD/RXD+ with parameters

AN and SC

From software version V3.10, the output of the velocity components V_{EW} (velocity east-west), and V_{NS} (velocity north-south) is possible, as well. Via the parameter AG is selected, if the analogue values WG, WR, and VT or V_{EW}, V_{NS}, VT are output.

Parameter AG	Analogue Output values
AG0	WG,WR und VT
AG1	V_{EW}, V_{NS}, VT

The analogue output of the wind velocity vectors is scaled in a way that the output at 0m/s wind velocity is positioned on its mean value, e.g. at 12mA when the output is set to 4…20mA. The scaling of the analogue outputs is selected by AR. With a value of AR65 an analogue output value of 20mA means a velocity of 65m/s.

The analogue output values and the wind vectors are allocated as follows:

Analogue output	Interpretation as wind vector
PIN 1 > mean value	Wind from East
PIN 1 < mean value	Wind from West
PIN 4 > mean value	Wind from North
PIN 4 < mean value	Wind from South

Table 6: Output of the analogue wind velocity vectors

7.2.3   Scaling of analog wind velocity

With the analog wind velocity the user has the option of specifying the velocity for the terminal value of the measuring range with the command AR. In the preset value the scaling is 0..60m/s: see **Command AR**.
The terminal scaling value is specified in m/s. For example the command 00AR30 scales the analog output range of 0..30m/s wind velocity. With a setting of 2..10V this results in the following:

WV =0m/s -> 2V and
WV=30m/s -> 10V

See also **Command AR**.

7.2.4   Scaling of analog wind direction

The ULTRASONIC offers additional formatting options for output of the analog wind direction. Firstly the wind direction can be corrected with a constant offset, and secondly the instrument allows the wind direction to be output via a range of 0..360°, 0..540° and 0..720°. The last two modes are used when compatibility of the indicating device is required.

7.2.5 Correction to north

The command NC is used to adjust the measured angle of the wind direction into positive direction by an angle offset. This entered value is added to the measured angle of the wind direction internally in the instrument. If the resulting value is greater than 360°, 360° is subtracted from the corrected angle value. The setting is then used when the ULTRASONIC with its north sensor could not directly be aligned to north, and this error angle must be corrected electronically afterwards
Also see here **Command NC**.

360°

The output value of the angle of 0..360° at the analog interface is the presetting. In this mode the value at the analog interface then always 'jumps' between Minimum and Maximum when the wind direction changes between 1° and 360°.
See also **Command AO**.

540°

With the setting 0..540° uncontrolled jumping is avoided with unsteadiness (0°). Here the unsteadiness is located at 540°. If the angle > 540°, a single jump to 180° takes place (540°-360° = 180).

Measured value output	Assigned wind direction
0°	West
90°	North
180°	East
270°	South
360°	West
450°	North
540°	East

Table 5: Assignment of wind direction with 0-540° angle range (as per VDI 3786 sheet 2)

When the calculated wind velocity is > 0,1m/s, the wind direct ion reset.
The wind direction 0° is reserved for the calm.
When the wind velocities are > 0,1m/s the exact wind direction north 0° is output respectively as 360° for differentiation to the calm.
Output value for this criterion is always the last-effective instantaneous value of the wind velocity.

720°

Another possible setting is scaling of 0..720°. As for 0..540° the unsteadiness is avoided at 360°. A jump to 360° only takes place when the limit of 360° (> 720°) is exceeded for the second time.
It should be noted that an output of 0..720° the value 0° means a southerly wind.
See also **Command AO**.

7.3 Data acquisition

The main function of the ULTRASONIC firmware is data acquisition and preparation. For data acquisition sound impulses are transmitted by the sensors in a clockwise direction and received by the sensor opposite. The propagation time measured is a measure of the velocity. A measuring cycle is complete when every sensor has performed transmit and receive once. The complete data record is then time-stamped and passed on to the next level. After the plausibility check the individual components are calculated and, depending on the setting, either output
(see **Instantaneous values**) or written to the averaging buffer (see **Averaging**) prepared and output.

7.3.1 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 are to be output, averaging must not be switched on. The parameter AV should be set to '0': see **Command AV**.

The OR parameter is used to adjust the output rate with independent output. With a value of '0' a telegram is output whenever a new measured value is determined. If the baud rate is set high enough and a short user-specific telegram is defined in this mode, the raw measured values of the ULTRASONIC can be output.

Note:

The user-specific telegram contains a data value 'measured value counter' (index 15), which is incremented with every new measured value. If the difference of the measured value counter between two output telegrams is one, every measured value is output. In the standard setting the acquisition of measured values takes place every 20ms.

To raise the acquisition of measured values to a maximum level (a new measured value approx. every 2.5ms), the following steps must be performed:

Switch off plausibility	00PC0
Set measuring delay to zero:	00MD0
Automatic measuring adjustment off:	00MA0

All measured values of the ULTRASONIC can now be output if the high baud rate is high enough. It is recommended creating a user-specific telegram and having it independently output by the ULTRASONIC (00TT6). The data field Time stamp (index 5 in user-defined telegram) shows the time of the measured value relative to system start-up in ms.

7.3.2 Averaging

Given the high data acquisition rate averaging is to be recommended in most cases. The averaging period is freely selectable from 600ms to 100 minutes within wide limits. See also '**Table 8**' and '**Command AV**'.

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 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). Output is performed in eight or 16 steps: see chapter 7.4.8 Status information.

The Ultrasonic 2D 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 undergoes 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.

For this purpose one of the four possible combinations is selected using the Command **AM** as for **Average Method**.

Command for selection of averaging procedure:

AM0 (Average Method) Vectorial averaging of velocity and direction.
AM1 Scalar averaging of velocity and direction.
AM2 Scalar averaging of velocity and vectorial averaging of direction.
AM3 Vectorial averaging of velocity and scalar averaging of direction.

7.3.3 Standard deviation

Calculation of the standard deviation is another feature offered by the ULTRASONIC. The standard deviation values are determined for the wind velocity, wind direction and virtual temperatures with an averaging time > 1 sec. Values are calculated according to the following formula:

$$Y = \sqrt{\frac{1}{n} \sum_{i=0}^{i<n} \left(\overline{M} - Xi \right)^2} \qquad \text{where} \quad \overline{M} = \frac{1}{n} \sum_{i=0}^{i<n} Xi$$

Standard deviation is switched on with the command "DE1". When using standard deviation the averaging memory used is limited to 2000 measured values. Otherwise there are no restrictions when using standard deviation.

Which calculated values are available when using standard deviation can be found under Available measured values and Data formats in the section User-specific telegram.

In the presetting calculation of the values for standard deviation is switched off. It must be switched on explicitly with the command 00DE1.

7.3.4 Measurement in Burst Mode

Another measuring method is measurement in burst mode. Here the ULTRASONIC performs measurement and stores the measured values in the internal data memory. If the internal data memory is full, or the required number of measuring values is achieved, the ULTRASONIC outputs the measured values via the serial interface. Burst mode can be used to register measured values at a high speed and to output them at a lower baud rate. In burst mode max. 40,000 measuring cycles can be stored. The memory depth can be selected with parameter BS, see **Command BS**.

Moreover, the burst mode offers the possibility of recording and outputting data, as well, before the trigger event. This function is determined by the parameter BP. BP indicates the time in ms when the data recording starts before the real trigger event.

Burst mode is activated with the command 00AC16 or 00AC17, see **Command AC**. Here the PIN 3 (ADIO) is used as the trigger signal to start measurement.

In the burst mode it is also possible to record the analogue data of the channel WG/RXD+ as well. For this, however, the instrument must be switched into halve duplex mode.

No data is output during measurement in burst mode. Once measurement has finished, the measured data is output in the output telegram selected, see **Command TB**.

On activating the burst mode the internal milliseconds counter is reset. After activation the burst mode must be started within 49 days in order to avoid a timer overflow. After termination of burst mode the trigger time is stated with the data output. During the data output a telegram „trigger" is displayed in place of the trigger signal. This output indicates the trigger time.

Parameterisation of burst mode

Before the start of burst mode system parameters can be adjusted for the acquisition of measured values:

- The number of measured values used is selected with the parameter BS.

- To achieve a maximum measuring speed the parameter MD can be switched to 0 and MA to 0, see **Command MA** and **Command MD**. This switches on the maximum measuring frequency.

- It may be sensible to switch off the plausibility filter with 00PC0,
  see **Command PC**.

Start burst mode

- Leave PIN3 (ADIO) open or connect to 5V potential.

- Select the required output telegram with command TB, see **Command TB**.

- Select the required buffer depth for measurement, see **Command BS**.

- Select the speed for acquisition of the measured values with MD and MA.

- Set the value for the pre-trigger by BP; for ex. the parameter PB100 records the data 100ms before the trigger event, as well.

- Poss. switch the plausibility check off with command PC.

- Activate burst mode with command 00AC17.

  The ULTRASONIC will output the text:

  Burst mode init.

  Starts when ADIO goes low.

- Measurement can now be started via the PIN 3 (ADIO). Once the measured value buffer is filled, the data will be output automatically. It is not possible to halt output.

Working with an additional analogue measured value

Burst mode is capable of registering an additional analogue measured value, storing and outputting it with the telegram. To output the analogue measured value it is necessary to create a user-defined telegram in which the analogue measured value is also output.

Only the measured value at PIN 4 can be acquired additionally as analogue value.

To include the analogue measured value from PIN 4 in the burst measurement, configure the system as follows:

- Switch the system to half duplex mode, see **Command DM**.
- Switch PIN 4 as the analog input with command AB1, see Command AB.
- Set the value for the pre-trigger by BP; for ex. the parameter PB00100 records the data 100ms before the trigger event, as well.
- Format the analog value with commands BY and BZ, see **Command BY**, **Command BZ**.
- Adjust the sampling speed of the input with command AU, see **Command AU**.
- Configure a user-specific telegram, see **User-specific telegram**.
- Configure burst mode as described above.

Examples of burst mode configuration:

Simple burst mode configuration

00KY1

00TB2   (VDT output telegram)

00BS100   (100 measurements in burst mode)

00AC16   (Activate burst mode)

Burst mode configuration with maximum measuring speed, without plausibility check and scientific output telegram:

00KY1

00TB12   (Data output after measurement: Scientific output telegram).

00BS100   (100 measurements in burst mode).

00BP100   Recording of data 100 ms before the trigger event.

00MD0   (No delay between measurements).

00MA0   (Switch-off of automatic measuring speed adjustment).

00PC0   (Switch-off of plausibility).

00AC16   (Activate burst mode).

Burst mode configuration with maximum measuring speed, with plausibility check, analog measured value and user-specific output telegram:

00KY1	
00DM0	(Switch to half duplex mode. ATTENTION!! Adapt wiring of RS485!!!)
00KY1	
00AB1	(Activate analogue input).
00TB6	(Data output after measurement: User-specific output telegram).
00UT@12,6,2@,@13,6,2@,@63,5,0@,@7,9,0@\0d	
	(Configuration of user-specific telegram with
	Wind speed, Wind direction, analogue measuring value, time stamp).
00US2	(Storage of user-specific telegram).
00AU1	(Update of analog inputs to maximum speed (max. 3ms)).
00BS100	(100 measurements in burst mode).
00BP100	Recording of data 100ms before the trigger event.
00MD0	(No delay between measurements).
00MA0	(Switch-off of automatic measuring speed adjustment).
00PC7	(Switch-on of plausibility).
00AC16	(Activate burst mode).

Ending burst mode:

- End burst mode with command 00AC0.
- Activate required output telegram with command TT.

Restrictions in burst mode

Measurement in burst mode is subject to the following restrictions:

- No standard deviations and covariance's are calculated in burst mode.

- The mean value buffer is deleted after burst mode.

- Burst mode does not function in bus mode.

- When using the analog input, the first two analog measured values may contain incorrect values depending on the setting. Such behaviour is due to technical reasons and cannot be prevented.

- In the period of the pre-trigger the recorded analogue values are invalid.

7.3.5 Gust Acquisition

With preset averaging the ULTRASONIC acquires mean values of wind velocity and wind direction. It is expedient, with some application, to output the maximum wind velocity within the mean value period and the respective wind direction..

From software version V1.42 this function is supported. The maximum wind velocity in the mean value buffer is acquired through the command GU ('gust'). The length of gust is set in 100ms increments through the parameter of the command GU. It ranges from 100m to 3sec. The parameter value 0 deactivates the gust measurement.

Example

00GU10   Activates the gust acquisition. The length of gust I 1 second.

00GU0   Deactivates the gust measurement.

The measurement values of the gust can be output only by means of the user-specific telegram. See chapter **User-specific telegram**.

Example:

00AV3   One minute averaging.

00GU030   Length of gust is 3 seconds (WMO-recommendation for gust length).

00UT\02@08,04,01@ @09,03@ @12,05,01,01@ @39,04,01@ @40,03@ @27,02,02@*@36,01,27,02,02@\0D\03

                User-specific protocol. Query through TR6 or TT6.

                VDT-telegram plus gust.

                (STX) WV WD VT WV_gust WD_gust status*check sum(CR)(ETX)

00US00002   Storing of the user-specific telegram.

00TT6   Automatic output of the data telegram.

The measurement values of the gusts have the following characteristic:

- The preset time for the gust must be less than the preset averaging period.
  See **Command AV**.

- If the period of the mean values is less than or even the period of gust, zero is output for the wind velocity and wind direction of the gust.

- In case, the wind velocity of the gust is < 0,1m/s, 0 is output for the wind direction.

- If the calculated wind direction is 0, it is set to 360.

7.4 Serial data output

The transmission of data via the RS485 interface is known as serial data output. Two modes are available for data transmission:

- Independent transmission of data.
- Transmission of data via interrogation telegram.

Independent transmission of the data is selected using the command 00TTXX, with XX standing for the relevant telegram number. In this case the ULTRASONIC transmits its data cyclically in the repeat rate selected with the parameter OR.

7.4.1 Data enquiry

The command TR is used for data enquiry via the ULTRASONIC. The command has no access protection. After processing the command the instrument sends back the appropriate response telegram. The time between the last character in the request telegram and the first character in the data telegram is < 0.5ms.
The user-defined telegram and the telegrams, as for the definitions described under 7.4.3 'Fixed telegram formats', are available as data telegrams.

7.4.2 Independent telegram output

Independent telegram output is selected using the command TT. After a valid telegram type has been input, the ULTRASONIC independently transmits the data telegram selected. The transmission interval is set in ms using the command OR. The telegram is transmitted every 100ms as standard. If the baud rate selected does not allow the output cycle to be observed (the time for data transmission is greater than the interval time), it is possible that telegram output cannot be carried out.

> #### Remark:
> *An independent telegram output is possible in full-duplex mode, and from software version V3.10 also in half-duplex mode.*

7.4.3 Fixed telegram formats

A number of predefined telegrams are available to for the independent output of telegrams (commands TT) and data request (Command TR). The detailed structure is described in 'Appendix 1 Predefined data telegrams'. A reference list of telegram formats can be found in '**Table 6**':

Telegram name	Telegram number	Telegram structure
VD	1	(STX)gg.g ddd*cc(CR)(ETX)
VDT	2	(STX)gg.g ddd ttt.t ss*cc(CR)(ETX)
V4DT	3	(STX)ggg.g ddd ttt.t v ss*cc(CR)(ETX)
NMEA V 2.0	4	$WIMWV,ddd.d,R,ggg.g,v,A*xx(CR)(LF)
Standard deviation	5	(STX)gg.g hhh.h ddd eee ttt.t uuu.u ss*cc(CR)(ETX)
User-specific	6	The user-specific telegram is output (see chapter 7.4.5)
Vx, Vy	7	(STX)aaa.a;bbb.b;ttt.t;ss;cc(CR)(ETX)
VD- Variant 1	8	(STX)gg.g ddd*cc(CRLF)(ETX)
VDT- Variant1	9	!iivvvdddttttwf
VDT- Variant2	11	See appendix (chapter 10)
Scientific telegram	12	See appendix (chapter 10)
VDT- Variant3	13	See appendix (chapter 10)
NMEA V 2.0 (Output of WIMWV and WIMTA)	14	$WIMWV,xxx.x,R,xxx.x,N,A*xx(CR)(LF) $WIMTA,xxx.x,C,*xx(CR)(LF)

Table 6: List of predefined data telegrams

Declaration:

v: Wind velocity (see **Command OS).**
h: Standard deviation of wind velocity.
d: Wind direction.
e: Standard deviation of wind direction.
t: Temperature.
u: Standard deviation of temperature.
s: Status byte.
c: Check sum Type 1 (EXOR link).
v: Identifier for scaling of wind velocity (K, N, M, S = km/h, Knots, m/s, mph).
a: Wind velocity in X-direction (east -> west).
b: Wind velocity in Y-direction (north -> south).
w: Status byte Variant 1.
f: Check sum Type 2.
i: Instrument ID.

7.4.4 Generation of check sum

Depending on the output telegram two different check sums are generated; type 1 resp. type 2.

7.4.4.1 Type 1

The check sum is the result of the byte wise EXOR link of the bytes output in the telegram.
The EXOR link encompasses all bytes between the telegram start character "STX", or "$" with the NMEA telegram and the byte "* " as the identifying character for the start of the check sum.
The bytes "STX" or "$" and "* " are thus not taken into account for calculation of the check sum!

7.4.4.2 Type 2

The check sum is the result of the byte wise EXOR link of the bytes output in the telegram without the '!' character at the beginning of the telegram.
With the resulting check byte, high- and low-nibbles are linked, added by the value 48 and are output as a single ASCII-value.

7.4.5   User-specific telegram

The ULTRASONIC offers the user the option of specifying his own telegrams. A formatted text can be used to output the internal measured and status values of the ULTRASONIC. Over 30 different values are available for output.
The user-defined telegram with the telegram number 6 is output. For example, the input of 00TR6 prompts the ULTRASONIC to output the user-defined telegram.
The commands UA, UT, UR and US are available to define the user-defined telegram. See here also: **Command UA**, **Command UR**, **Command US**, **Command UT**. These commands can be used to create a new telegram, extend an existing telegram, delete telegram information and lastly, to store the telegram definition in the EEPROM.
The measured values are selected and the format specified in the formatted text. '**Table 7**' shows a list of the available data.
The formatted text also includes the option of outputting a fixed character string. The definition

00UAHello World\0d<cr>   <cr> stands for Carriage return (Enter key)

Generates the telegram output

Hello World

7.4.5.1 Generation of a new, user-specific telegram

The command UT is used to overwrite an existing telegram in full. For example with the command:

00UTWind velocity: @8,6,2@m/s\0d<cr>   <cr> stands for Carriage return (Enter key)

the output

Wind velocity: 001.64m/s

is returned with the telegram output. (The prerequisite is of course that the current wind velocity is 1.64m/s).

7.4.5.2 Attachment of definitions

The command UA can be used to attach new definitions at the end. Here it must be borne in mind that the attachment of definitions may require more memory than telegram definition using the command UT.

Internally the ULTRASONIC is equipped with over 30 definition blocks. Each of these blocks can accommodate the definition of one data value or 5 fixed characters. It must be borne in mind that once a block has been defined, it cannot be extended.

The user-specific telegram can receive up to 28 definitions. One definition can include 1 to 5 characters, i.e. even a single semicolon covers a definition.

Example:
The definition

00UAHELLO<cr>   <cr> stands for Carriage return (Enter key)

Generates a new block which contains the character string HELLO.

The definitions
UAH<cr>   <cr> stands for Carriage return (Enter key)
UAE<cr>   <cr> stands for Carriage return (Enter key)
UAL<cr>   <cr> stands for Carriage return (Enter key)
UAL<cr>   <cr> stands for Carriage return (Enter key)
UAO<cr>   <cr> stands for Carriage return (Enter key)

Occupy 5 blocks, in which only one character each is seized. The output leads to the same result in both cases, but considerably more memory is used in the second version.

A new block is generally always started with a definition of a measured value. Definition of a measured value is always framed with the character '@' . A new block is also occupied after the definition of a measured value. If this is taken into consideration on inputting, the same effective memory occupancy can be achieved using the command UA as with the command UT.

The method using the least amount of memory is to input the complete telegram using the command UT.

7.4.5.3   Deletion of definitions

The deletion of definitions always relates to the last blocks in the definitions list,
see **Attachment of definitions**.
The command UR2 can be used to delete the last two definition blocks, for example. It should be noted that a definition, input using UA or UT, could be divided up internally into several blocks. It is therefore recommended proceeding step by step when deleting definitions and checking the effect in telegram 6.

7.4.5.4   Storage of definitions

After the user-defined telegram has been input, it can be stored using the command 00US2. Storage is necessary to ensure that the ULTRASONIC loads the defined telegram on the next restart.

7.4.5.5   Available measured values and data formats

The measured values (shown by a number) and the output format of the measured value are defined in the user-specific telegram within the formatting characters '@' Here every measured value is an object of a data type. Data types are for example TEXT, NUMBER or WHOLE_NUMBER. The wind velocity is for example the data type NUMBER: see **Table 7.**

Example:

The wind velocity is to be output in the user-specific telegram. From the table given below it can be seen that the wind velocity has the index 8. The formatting string thus starts with
00UT@8

It can also be seen from the table that the WV is the data type NUMBER. If the wind velocity is to be output without a sign using a total of 6 characters (including comma) and 2 places after the comma, the complete formatting string is as follows:

00UT@8,6,2@

If a line feed is to also be added to the end of the output, the ASCII character 13 (0Dh) must be attached.

00UT@8,6,2@\0d<cr>   <cr> stands for Carriage return (Enter key)

Measured value number	Description	Data type
0	Reserved.	
1	Path measured value south -> north (counter value). With averaging this is the mean value of all measured values.	WHOLE_NUMBER
2	Path measured value west -> east (counter value). With averaging this is the mean value of all measured values.	WHOLE_NUMBER
3	Path measured value north -> south (counter value). With averaging this is the mean value of all measured values.	WHOLE_NUMBER
4	Path measured value east -> west (counter value). With averaging this is the mean value of all measured values.	WHOLE_NUMBER
5	Time stamp of last measured data record (value in ms, relative to system start-up).	WHOLE_NUMBER
6	Wind velocity in X-direction (Positive means wind from easterly direction).	NUMBER
7	Wind velocity in Y-direction (Positive means wind from northerly direction).	NUMBER
8	Wind velocity .	NUMBER
9	Wind direction.	NUMBER
10	Normalised wind velocity X-direction.	NUMBER
11	Normalised wind velocity Y-direction.	NUMBER
12	Virtual temperature [°C].	NUMBER
13	Virtual temperature of X-path [°C] This value is not contained in the averaging buffer. The last measured value in the averaging interval is output. If the last measurement fails to generate a valid value, -273,15 displayed.	NUMBER
14	Virtual temperature of Y-path [°C] This value is not contained in the averaging buffer. The last measured value in the averaging interval is output. If the last measurement fails to generate a valid value, -273,15 displayed.	NUMBER
15	Reserved.	
16	Standard deviation of wind velocity in X-direction.	NUMBER
17	Standard deviation of wind velocity in Y-direction.	NUMBER
18	Standard deviation of wind velocity.	NUMBER
19	Standard deviation of wind direction.	NUMBER
20	Standard deviation of normalised wind velocity in X-direction.	NUMBER
21	Standard deviation of normalised wind velocity in Y-direction.	NUMBER
22	Standard deviation of virtual temperature.	NUMBER
23	Reserved.	
24	Reserved.	
25	Reserved.	
26	Status information (4BYTE).	WHOLE_NUMBER

Measured value number	Description	Data type
27	THIES status (2Byte).	WHOLE_NUMBER
28	Reserved.	
29	Storage interval (specifies the time interval in which the data are written to the averaging memory).	WHOLE_NUMBER
30	Quantity of data in the mean value buffer.	WHOLE_NUMBER
31	Read-in analogue measured value from pin 1.	NUMBER (since V1.38)
32	Read-in analogue measured value from pin 4.	NUMBER (since V1.38)
33	Read-in analogue measured value from pin 3.	NUMBER (since V1.38)
34	Reserved.	
35	Reserved.	
36	Exclusive OR proof total of data flow 8 (type 1).	PRÜF_SUMME
37	ULTRASONIC ID.	WHOLE_NUMBER
38	Status for telegram 9, see chapter 7.4.6.4.	Whole NUMBER
39	Wind velocity of the gust (see command GU).	NUMBER
40	Wind direction of the gust (see command GU).	NUMBER
41	Reserved.	
42	Internal supply voltage measured.	NUMBER
43	Internal temperature of housing.	NUMBER

Table 7: Measured values and data types for user-specific telegram

7.4.5.6 Data formats

As already described under Available measured values and data formats, every data value is derived from a specific type. To indicate this the types each have their own formatting definition. The formatting string is specified after the measured value number on inputting, with the formatting string and measured value number being separated here by a comma.

Example:
The command

00UTHello World @12,8,2,1@\0d<cr>   <cr> stands for Carriage return (Enter key)

Defines output of the text 'Hello World', followed by the virtual temperature (formatted: 8 characters in total,   2 characters after the comma, with sign) and one line feed.

7.4.5.6.1   Output of fixed texts

The ULTRASONIC is equipped with an internal data format TEXT that is the simplest and at the same time most universal data format. It is used to output fixed text within the telegram output. This data format requires no further formatting characters. For example, the command

00UTHello World\0d<cr>
defines the output telegram

Hello World

Within this data type all ASCII characters are available via the key character '\' . It must nevertheless be borne in mind that the ASCII code is specified with 2 characters in the hexadecimal format. The input

00UT\41

thus generates an A in the output. The key character \ was introduced in order to include a control character like STX, ETX, CR in a telegram. The input

00UA\0d

attaches a line feed to the telegram.

A constant text can be positioned anywhere in the telegram definition (it should of course not interrupt the formatting of another data type). For example, the following definition is conceivable:

00UTWV = @8,6,2@ WD = @9,3@\0d<cr>   <cr> stands for Carriage return (Enter key)

The following output string is conceivable:

WV = 000.06 WD = 210

7.4.5.6.2   Data format WHOLE_NUMBER

A whole number is a number, which is output without commas. However, it can include a sign   or /and be in hexadecimal format.

Format:
@'Measured value','Number of characters','Format'@

where

Measured value: see **Table 7**
Number of characters: Number of characters output including any sign
Format: format of number shown.
            0:    Without sign and decimal.
            1:    With sign and decimal.
            2:    Without sign and hexadecimal.
            3:    With sign and hexadecimal.

The number of characters and the 'Format' do not have to be specified; in this case they are padded with the values '3' (Number of characters) and '0' (Format).

Example 1:
00ut@29@\0d<cr>   <cr> stands for Carriage return (Enter key)

Outputs the storage interval with three places without a sign. (Only with averaging switched on is display not equal to zero)

Example 2:
00ut@29,3,2@h\0d<cr>   <cr> stands for Carriage return (Enter key)

Outputs the storage interval with three places without a sign as a hexadecimal value. (Only with averaging switched on is display not equal to zero)

7.4.5.6.3 Data format NUMBER

A floating point number is known as a number. It is formatted as for the WHOLE_NUMBER with the addition that a decimal place can be included.

Format:
@'Measured value','Number of characters',' Decimal places','Format'@

with

Measured value: See **Table 7.**
Number of characters: Number of characters output including decimal points And any sign.
Decimal places: Number of places after decimal points.
Format: Format of number shown.
    0: Without sign and decimal.
    1: With sign and decimal.
    2: Without sign and hexadecimal.
    3: With sign and hexadecimal.

The number of characters, decimal places and the 'Format' do not have to be specified; in this case they are padded with the values '3' (Number of characters) '0' (Decimal places) and '0' (Format) .

Example 1:
00ut@9@\0d<cr>   <cr> stands for Carriage return (Enter key)

Outputs the wind direction with three places before the decimal point?, no places after the decimal point? and in decimal format.

Example 2:
00UT@12,8,2,1@\0d<cr>   <cr> stands for Carriage return (Enter key)

Outputs the virtual temperature with a total of 8 characters, 2 places after the decimal point? and plus sign.

7.4.5.6.4 Data format PRÜF_SUMME (Check sum)

The data format PRÜF_SUMME supports calculation of a check sum on the basis of a byte wise exclusive OR link. The CHECK SUM has the following format:

@36,'First','Last', 'Number of characters','Format'@

where

36: Measured value identifier for EXOR check sum
First: Number of character at which generation of the check sum starts. This character is included in the calculation (counting method starts with 0)
Last: Number of character at which generation of the check sum ends. This character is not included in the calculation
Number of characters: Number of characters output including any sign

Format: Format of number shown.
                0:    Without sign and decimal.
                1:    With sign and decimal.
                2:    Without sign and hexadecimal.
                3:    With sign and hexadecimal.

Example 1:
With a constant text 'AABBCC' the check sum is to be generated using the characters BB. The output is hexadecimal with 2 characters:

00UTAABBCC XOR=@36,2,4,2,2@h\0d<cr>   <cr> stands for Carriage return (Enter key)

The output is

AABBCC XOR=00h

The XOR link of two identical characters is always 0.

Example 2:
The proof total is to be generated using the character 'B' via a constant text 'AABBCC'. The output is hexadecimal with 2 characters:

00UTAABBCC XOR=@36,2,3,2,2@h\0d<cr>   <cr> stands for Carriage return (Enter key)

The output is

AABBCC XOR=42h

The value for the check sum is 42h. The ASCII value of 42h is 'B', which is the character to be checked itself.

7.4.5.7 Examples for user-defined Telegrams

7.4.5.7.1 Output of the Wind Velocity and Wind Direction

Delivered are the wind velocity, wind direction, and virtual-temperature. The measurement value numbers (s.tab.7) are 8, 9 und 12 .

The wind velocity is output with two pre-decimal places and one decimal place, the wind direction with three digits. The output of the temperature occurs with signs, two decimal places and one decimal place. The separator between the telegrams is ; . The data output ends with CRLF. The associated telegram definition is as follows:

00UT@8,4,1,0@;@9,3,0,0@;@12,5,1,1,@\\0d\\0a<cr>

00US2<cr>

Remark: <cr> stands for entering the sign „Carriage return", or resp. pressing the „Enter key".

7.4.5.7.2 Division of the Telegram Configuration into several Telegrams

On programming the user-specific telegrams the text for a telegram definition must not be longer than 128 characters. For being able, anyhow, to enter longer telegram definitions, the definition must be divided into several blocks. The first block is programmed by the command UT, all others are attached by UA. The example from 7.4.5.7.1 can also be programmed as follows.

00UT@8,4,1,0@;@9,3,0,0@<cr>

00UA;@12,5,1,1,@\\0d\\0a<cr>

00US2<cr>

Also possible is, for example, the following alternative:

00UT@8,4,1,0@;@9,3,0,0@<cr>

00UA;@12,5,1,1,@ <cr>

00UA\\0d\\0a<cr>

Important is that the command sequences between two @ are always included in one telegram definition.

Remark: <cr> stands for entering the sign „Carriage return", or resp. pressing the „Enter key".

7.4.6   Status information

In the ULTRASONIC two different status bytes are available:

- Extended status information.
- THIES status.

The THIES status is derived from the extended status information. The structure of the status values is described below.

7.4.6.1 Extended status information

The extended status is structured bitwise. The individual bits in the status value have the following meanings:

Bit number	Function	Description	
Bit 0	General malfunction	Averaging time < 10sec	An error is output when no new measured value can be determined during a period of 10sec.
		Averaging time >= 10sec	An error is output when, based on a one-second measuring rate, less than 50% of values are contained. Example: With an averaging time of 10 seconds 5 measured values must be contained in the averaging buffer.
Bit 1	Heating criterion	Is one when the criterion for switch-on of the heating is satisfied.	
Bit 2	Heating on	Is one when heating is switched on.	
Bit 3	Reserved	Is always zero.	
Bit 4	Static malfunction	Is set when a static malfunction has occurred, e.g. lasting violation of VT, no measured values. (> 1min)	
Bit 5 .. bit 7	Reserved	Is always zero.	
Bit 8 Bit 9 Bit 10 Bit 11	Used averaging memory	Specifies the averaging memory occupied. Bit 1 to bit 3 indicate the filling level of the averaging buffer in binary format. 0: Buffer $0< x \leq 1/16$ 1: Buffer $1/8 < x \leq 1/8$ filled 2: Buffer $1/8 < x \leq 3/16$ filled 3: Buffer $3/16 < x \leq 1/4$ filled 4: Buffer $1/4< x \leq 5/16$ filled 5: Buffer $5/16 < x \leq 3/8$ filled 6: Buffer $3/8 < x \leq 7/16$ filled 7: Buffer $7/16 < x \leq 1/2$ filled 8: Buffer $1/2 < x \leq 9/16$ filled 9: Buffer $9/16 < x \leq 5/8$ filled 10: Buffer $5/8 < x \leq 11/16$ filled 11: Buffer $11/16 < x \leq 3/4$ filled 12: Buffer $3/4 < x \leq 13/16$ filled 13: Buffer $13/16 < x \leq 7/8$ filled 14: Buffer $7/8 < x \leq 15/16$ filled 15: Buffer $15/16 < x \leq 1$ filled	
Bit 12	Reserved		
Bit 13	Flag restart	Is reset to zero in the first output-telegram after restart.	
Bit 14..bit15	Reserved	Is always zero.	
Bit 16..bit31	Reserved	Is always zero.	

7.4.6.2 THIES status

The THIES status is structured bitwise. The individual bits in the status value have the following meanings:

Bit number	Function	Description	
Bit 0	General malfunction	Averaging time < 10sec	An error is output when no new measured value can be determined during a period of 10sec.
		Averaging time >= 10sec	An error is output when, based on a one-second measuring rate, less than 50% of values are contained in the averaging buffer. Example: With an averaging time of 10 seconds at least 5 measured values must be contained in the averaging buffer.
Bit 1 Bit 2 Bit 3	Used averaging memory	Specifies the averaging memory occupied. Bit 1 to bit 3 indicate the filling level of the averaging buffer in binary format. 0: Buffer $0 < x \leq 1/8$ 1: Buffer $1/8 < x \leq 1/4$ filled 2: Buffer $1/4 < x \leq 3/8$ filled 3: Buffer $3/8 < x \leq \frac{1}{2}$ filled 4: Buffer $\frac{1}{2} < x \leq 5/8$ filled 5: Buffer $5/8 < x \leq 3/4$ filled 6: Buffer $3/4 < x \leq 7/8$ filled 7: Buffer $7/8 < x \leq 1$ filled	
Bit 4	Reserved	Is always zero.	
Bit 5	Static malfunction	Is set when a static malfunction has occurred, e.g. lasting violation of VT, no measured values. (> 1min)	
Bit 6	Heating criterion	Is one when the criterion for switch-on of the heating is satisfied.	
Bit 7	Heating on	Is one when heating is switched on.	

7.4.6.3 Status Information in the Bayern Hessen Format

For the Bayern Hessen command interpreter a separate operating status and error status are generated with the following construction:

Bayern Hessen Operating Status:

Bit-Number	Function	Description
Bit 0		Always zero.
Bit 1 Bit 2 Bit 3	Used Averaging memory	Specifies the averaging memory occupied. Bit 1 to bit 3 indicate the filling level of the averaging buffer in binary format. 0: Buffer $0 < x \leq 1/8$ 1: Buffer $1/8 < x \leq 1/4$ filled 2: Buffer $1/4 < x \leq 3/8$ filled 3: Buffer $3/8 < x \leq 1/2$ filled 4: Buffer $1/2 < x \leq 5/8$ filled 5: Buffer $5/8 < x \leq 3/4$ filled 6: Buffer $3/4 < x \leq 7/8$ filled 7: Buffer $7/8 < x \leq 1$ filled
Bit 4	Reserved	Is always zero.
Bit 5	Heating criterion	Is one when the criterion for switch-on of the heating is satisfied.
Bit 6	H Heating on	Is one when heating is switched on.
Bit 7	Reserved	Is always zero.

Bayern Hessen Error Status:

Bit-Number	Function	Description	
Bit 0	General malfunction	Averaging time < 10sec	An error is output when no new measured value can be determined during a period of 10sec.
		Averaging time >= 10sec	An error is output when, based on a one-second measuring rate, less than 50% of values are contained in the averaging buffer. Example: With an averaging time of 10 seconds at least 5 measured values must be contained in the averaging buffer.
Bit 1	Static malfunction	Is set when a static malfunction has occurred, e.g. lasting violation of VT, no measured values. (> 1min).	
Bit 2..7	Reserved	Always zero.	

7.4.6.4 Status information in telegram 9

Telegram 9 has a separate status information, consisting of one byte.

Bit-Number	Function	Description		
Bit 0	Data error	Data valid (0) / invalid (1)		
Bit 1	Temperature difference X and Y	Bit 2	Bit 1	Temperature difference
Bit 2		0	0	0,0K..3,1K
		0	1	3,2K..6,3K
		1	0	6,4K..7,9K
		1	1	>7,9K
Bit 31	Buffer fill level	Bit 4	Bit 3	Buffer fill level
Bit 4		0	0	100% ≥ x > 80%
		0	1	80% ≥ x > 66%
		1	0	66% ≥ x > 33%
		1	1	< 33%
Bit 5	reserved	Is always zero.		
Bit 6	Reserved	Is always one.		
Bit 7	Heating on	Is one when heating is switched on.		

7.5 Behavior 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 analog 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 this case the error bits are set in the status byte and the analog outputs are set to a defined value. If a special error telegram is defined with a serial telegram, this is output.

7.5.1 In the event of error:

Error may occur under the following circumstances:

Averaging time < 10sec (Parameter AV)	An error is output when no new measured value can be determined during a period of 10sec.
Averaging time >= 10sec (Parameter AV)	An error is output when, based on a one-second measuring rate, less than 50% of values are contained in the averaging buffer. Example: With an averaging time of 10seconds at least 5 measured values must be contained in the averaging buffer.

7.5.2 Behaviour of analog outputs

If the analog 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 **Command EI**.

7.5.3 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.

7.6 Heating control

(The description does not include the function of the housing-heating)

To prevent the instrument from freezing, and to avoid consequential error measurements, the ULTRASONIC is equipped with built-in heating for the sensor arms. In standard mode the heating is controlled by the system status.
In addition, there is a PT1000 temperature sensor in the ULTRASONIC instrument base. The values of this sensor are used as plausible information for heating control. For further information see the **Command HT**. The control of the heating by the software can be configured in 6 modes. The individual control conditions for the heating are given under **Command HT**.

For the switch-on criterion the following requirements must be met:
1. Continuous failure of the measuring value acquisition of at least 10s.
2. The supply voltage must be higher than the set threshold (see HC).

Function Test by a Technician:

The technician disturbs the measurement value acquisition for ex. by blocking a sensor by hand.

For HT1 applies:
The heating switches on after approx. 10s.

For HT3 / HT4 and HT5 applies:
The arm heating is activated after 10 s when the inside temperature of housing is < 25 °C (< 15 °C with HT5). After a re-start by „Reboot at Fail" (see command RF for the time period until re-start) the heating switches immediately on with continuous error, regardless of the inside temperature of housing, provided that the supply voltage is above parameter HC.The restart is triggered by permanently blocking one of the measured distances by hand. The time for blocking is stated by parameter RF.
The technician realizes the restart from the fact that the ultrasonic transformers do not "tick" anymore for approx. 4sec.
The heating starts approx. 3s after the restart, and remains active as long as the disturbance lasts.
In case the disturbance lasts longer than the „Reboot at Fail" time (parameter RF), the sensor restarts. The heating starts again approx. 3s after the restart. The process keeps repeating itself until the disturbance has been resolved. In case that there is no disturbance of the measured distance for a longer period than the pre-set „Reboot at Fail" time, the heating control of the sensor switches again into standard mode.

Important: **When the set temperature of the arms reaches approx. 30°C, the arm heating switches off automatically, in order to avoid an overheating of the sensors. The PTC heating is not active in this test mode.**

The heating modes 2 and 6 are provided only for the test mode or resp. for the factory calibration! (see also command HT)

HT0:

Heating remains permanently switched off.

HT1:

Heating software-controlled by virtual-temperature. (Softstart)

Activate measuring arms:
Virtual-temperature < parameter HL [Kelvin], or faulty measuring value acquisition.

De-activate measuring arms:
After 10 seconds, and virtual-temperature > parameter HH [Kelvin], and activating criterion not satisfied.

Activating Ultrasonic transducer heating:
Virtual-temperature < parameter HL [Kelvin], or faulty measuring value acquisition.

De-activating Ultrasonic transducer heating:
When the virtual-temperature > parameter HL [Kelvin] a**nd** the switch-on criterion is no longer met, the ultrasonic transducer heating remains active for an hour, and then shuts down.

HT2:

Softstart by ramp function (125s), afterward the heating remains active permanently.

HT 3:

Heating software controlled (Softstart)

Switch on heating of transducer arms:
Virtual temperature < 2°C or PT1000 temperature < 5°C, or disturbed data acquisition and PT1000 temperature < 25 °C.

Switch off heating of transducer arms:
Virtual-temperature > 7°C and PT1000 temperature > 8°C, and switch-on criterion not met.

Switch on transducer heating:
Virtual temperature < 2°C or PT1000 temperature < 5°C, or disturbed data acquisition and PT1000 temperature < 10°C.

Switch off transducer heating:
When virtual-temperature > 2°C **and** PT1000 temperature > 5°C **and** the switch-on criterion is no longer met at PT1000 temperature <10°C, the ultrasonic transducer heating remains active for an hour, and then shuts down.

HT 4:

Heating software controlled (Softstart)

Switch on heating of transducer arms:
Virtual-temperature < 2°C or PT1000 temperature < 5°C, or switch-on criterion and PT1000 temperature < 25°C.

Switch off heating of transducer arms:
Virtual-temperature > 7°C and PT1000 temperature > 8°C and switch-on criterion not met.

Switch on transducer heating:
Virtual temperature < -25°C or PT1000 temperature < -20°C, or switch-on criterion and PT1000 temperature < 5°C.

Switch off transducer heating:
When virtual-temperature > -20°C **and** PT1000 temperature > -15°C **and** the switch-on criterion is no longer met at PT1000 temperature <5°C, the ultrasonic transducer heating remains active for an hour, and then shuts down.

Note:

The function of the HT4 heating mode can be adversely affected if the device is installed on a heated pipe.

HT 5 (for operation with housing heating):

Heating software controlled for operation with housing heating (Softstart).

Switch on heating of transducer arms:
Virtual-temperature < 2°C or PT1000 temperature < 5°C, or switch-on criterion and PT1000 temperature < 15°C.

Switch off heating of transducer arms:
Virtual temperature > 7°C and PT1000 temperature > 15°C and switch-on criterion not met.

Switch on transducer heating:
Virtual-temperature < -25°C or PT1000 temperature < -20°C, or switch-on criterion and PT1000 temperature < 15°C.

Switch off transducer heating:
When virtual-temperature > -20°C **and** PT1000 temperature > -5°C **and** the switch-on criterion is no longer met at PT1000 temperature <15°C, the ultrasonic transducer heating remains active for an hour, and then shuts down.

HT 6:

The heating is immediately switched on permanently but not clocked (as HT 2, w/o softstart).

The heating is switched on only in case that the supply voltage is above the value, which is stated by parameter "HC", in addition to the above-mentioned criterions. The parameter HC determines the threshold of the supply voltage when the heating is activated.

The supply voltage can be inquired by the „command PW". Additionally it can be output in the user-specific telegram. If the available hardware does not support the control of the supply voltage, a message „Heating ctrl not supported" is output on entering the command (ID) PW.

The measurement of the operating voltage is carried out after alignment via a low pass by means of an analogue-digital-converter. Due to the very high complexity it was dispensed with a real effective value measurement. Thus the measuring values are measured exactly by „Command PW2 with DC-supply, however, with AC-supply they are between effective- and peak value, that means they are measured too high.

For setting the automatic threshold between supply in heated standard operation and unheated back-up operation the following procedure is recommended:

1. On supply of instrument for standard operation the measuring value of parameter „PW" should be read-out preferably with active heating (Consideration of voltage drop at supply and cable with active heating under full-load, see **Command HT**.

2. Reading-out of value on supply of instrument in back-up-operation with inactive heating.

3. Setting of automatic threshold on mean value between the measured values by „command HC", see **Command HC**.

Model with additional Ultrasonic Converter Heating (4.382x.3x.xxx)

For locations with a particular risk of icing a model is recommended with electric heated ultrasonic converters. Thanks to this additional heating measurement operation is possible even under difficult conditions of icing.

Model with additional Ultrasonic Converter Heating and Housing Heater (4.382x.4x.xxx)

For locations with an extreme risk of icing a model is recommended with electric heated ultrasonic converters and housing heater. Thanks to this additional heating measurement operation is possible even under very difficult conditions of icing.

With certain models the activation of case heating (housing heating) can be suppressed by software.

7.7 Instruments with Housing Heating (4.382x.4x.xxx)

Instruments with housing heating will be heated by an inside mounted foil.
This heating is controlled by an own module to a casing temperature of +8°C.

The housing heating is controlled independently by default via its own internal temperature sensor. It is also possible to deactivate the housing heating via the external ADIO PIN. See **command AC**. The values AC9 and AC20 can be used for additional control.

With certain models the activation of case heating (housing heating) can be suppressed by software.

7.8 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: see also **Command SS**.

7.9 Enquiry about software version

The command SV is used to enquire about the software version. For further information see **Command SV**.

7.10 Operating Hours Counter

The instrument provides an operating hours counter, which can be queried via the parameter OH (operating hour). The counter returns the operating hours in "hours", see also **Command OH**.

The operating hours counter overflows after 11,4 years and restarts with 0.

7.11 Storing of System Events

The instrument has an internal circular buffer, that stores important system information. The parameter SM (system event mask) determines, which events are to be stored in the system event memory. The following events are available:

1. System start (valence 1).

2. Closing up in configuration mode (valence 2).

3. Description of internal registers PR and PT (valance 4).

4. No valid data over a longer period (valence 8).

5. Averaging buffer fill level < 2 increments (basis is the value from the extended status) (valence 16).

6. Temperature difference from X- to Y-distance >3Kelvin (at WV < 2 m/s) (valence 32).

7. Temperature difference from X- to Y distance > 5Kelvin (at WV < 2 m/s) (valence 64).

8. Temperature difference from X- to Y-distance -<7Kelvin (at WV < 2 m/s) (valence 128).

9. System voltage falls below voltage of parameter HC, see heating control (automatically switched on, when1, 2 and 3 are activated).

10. System voltage exceeds voltage of parameter HC, see heating control (automatically switched on when1, 2 and 3 are activated).

If, for ex., the events 'system start' and 'description of internal registers PR and PT' shall be stored, the value for SM is to be set to 5, see also **Command SM**.

The values are stored in the memory along with the operating hours counter. The output is effected in clear text.

By the query 00SE the system outputs the stored information. The output starts with the Text

'System events:'

'SM5'   //output of the current parameter SM

and ends with the output

'End'.

Between both output the status signals are output in chronological order.

Description of the Status Signal

To 1) System start

Signal is generated with every restart.

To 2) Closing up in configuration mode

If the system is set into the configuration mode by the command 00KY1, this is stored.

To 3) Description of internal registers PR and PT

I for 15 seconds no valid value has been measured the internal registers PR and PT are newly recorded.

To 4) No valid data over a longer period

If no valid measuring value has been acquired over a period, which is selectable by the parameter RF, the system make a restart. Before restart, the ULTRASONIC sends a respective signal to the buffer.

To 5) Averaging buffer fill level

If the fill level of the averaging buffer in the extended status is < 2 increments, a signal is sent. A new signal is sent in case the fill level is > 2 increments in the meantime. This signal might occur in case of extreme precipitation events.

To 6,7,8) Temperature difference from X- to Y-distance > n Kelvin (when WV < 2m/s)

If the measurement value of the virtual temperature is >2K,5K,7K at a wind velocity of < 2m/s and a valid measurement, this is recorded in the buffer. Reasons for this might be deformed sensor arms,

Initiating defects of the sensors respectively temporary disturbance in the measurement distance.

If these errors occur several times in quick succession, only the first signal is recorded, or in case the new value means an increase over the previous one.

Example:

The signal "temperature difference >5Kelvin" is recorded. Every other signal of "temperature difference >5Kelvin" respectively "temperature difference >3Kelvin" is ignored. A signal "temperature difference >7Kelvin", however, is recorded.

To 9, 10): Supply voltage falls below/exceeds value of parameter HC

Effective from software version V3.09 the supply voltage is monitored for control of heating. If the voltage falls below the value of parameter HC the heating is de-activated. If the voltage exceeds this value the heating control is activated. The falling below/exceeding is each recorded.

7.12 Bayern Hessen mode

The standard version of the ULTRASONIC contains a command interpreter for Bayern Hessen telegrams. For further information refer to own documentation.
The command interpreter for the Bayern Hessen variant is switched on using the command 00CI00001: see also **Command CI**.

For coding the operating status and error status refer to **Status Information in the Bayern Hessen Format**.

In the Bayern Hessen command interpreter also all commands of the ULTRASONIC are available. They are embedded in the command <CTR B>ST0....<CTRL C>. Thus, for example, the user access is activated by the command <CTR B>ST000KY1<CTRL C> and by <CTR B>ST000AM1<CTRL C> the averaging time is changed.

Moreover, in the Bayern Hessen mode different combinations of measuring instrument addresses are available, see **Command BH**.

7.13 Forcing a restart

The command RS can be used to force a restart of the ULTRASONIC. The commands

00KY1 <cr>
00RS1 <cr>

will restart the ULTRASONIC after approx. 3 sec: see also **Command RS**.

7.14 Energy-saving mode

The ULTRASONIC does not itself have an energy-saving mode. However, it can be configured so that it only has to be supplied with power for a limited period. The following parameters can be used for optimisation:

Switch on fast boot:

> On startup using the parameter 00FB1 and FB2 prevents the ULTRASONIC from first starting the bootloader and waiting for a program update. See also **Command FB**
> A value of SM >0 delays the boot procedure for approx. 200 ms. See **Command SM**.

Signal when averaging buffer is full:

> The connector pin ADIO can be switched so that the PIN is set to +%V when the averaging buffer of the ULTRASONIC has reached a content level > 7/8. Here the shortest adjustable averaging time is 600ms: see also **Command AC**, **Command AV**.
> The signal can be used to disconnect the ULTRASONIC from the voltage supply.

Switch off heating:

> With the command 00HT0 the heating of the ULTRASONIC is switched off completely: see **Command HT**.

7.15 Bootloader

Whenever the ULTRASONIC is restarted, the instrument first starts a bootloader. The function of the program is to start program upload. For this a specific program containing the new firmware must be started at a connected PC. After identification program upload then starts automatically. If the bootloader does not know its remote station, the ULTRASONIC firmware starts. The bootloader can be bypassed if the parameter "Fast Boot" FB is set to 00FB1 or FB2.

The instrument is internally equipped with two different bootloaders:

- THIES-specific bootloader (bus-compatible).
- X-modem CRC bootloader (256byte per frame).

The bootloaders are selected through the commands FB0 (THIES-bootloader) respectively FB3 (X-modem bootloader).

The bootloader is started after each system start.

00FB00001 or FB00002

is set.

7.15.1 X-Modem Boot loader

For the uploading of new firmware via the serial interface the protocol XMODEM CRC is used with a reference length of 128byte per package Necessary are a PC and a terminal program with a respective possibility of setting. Tested and released is the boot loader with Windows-hyper terminal and ZOC (V4.11).

> ### Note:
> **For the X-Modem Upload, the Fastboot parameter must be set to 3 (00FB00003).**

Operation:

The boot loader starts always with 96000baud, 8 data bits, no parity, and a stop bit (9600,8,N,1) On starting the instrument the following data are output: version, used ID, and the set duplex mode of the ULTRASONIC. For re-starting the instrument without cutting-off the supply please use the reset-command „<id>RS1".

> *XModem Loader CRC*
>
> *Version 3.04*
>
> *Insert 00UP00001 to start bootloader*

In order to continue to parameterize the boot loader, please enter the command <id>UP1 together with the ID, here: 00UP1. Alternatively, the command<id>UP2 can be transmitted directly in order to start the transfer immediately. For entering the command the user has approx. 10 minutes. If no valid command or <id>UP0 is entered within this time period the ULTRASONIC firmware starts. When entering <id>UP1 the ULTRASONIC turns into the boot loader mode where further details can be stated. The following output appears:

> *Use <id>BR000XX to set baudrate*
>
> *Use <id>ID000XX to set ID*
>
> *Use <id>DM0000X to set duplex mode*
>
> *Use <id>UP00000 to cancel uploads*
>
> *Use <id>UP00002 to start upload*

- The command codes have to be entered always in capital letters (in „normal" operation also lower case letters are accepted).
- The baud rate can be changed through BR. All baud rates, containing 8 data bits, are valid. For further parameter see chap. **Command BR**.
- The instrument address can be set by ID. Valid valued are here within the range 0 <= ID <= 99.
- The duplex mode is changed by DM. <id>DM1 is full duplex, <id>DM0 is halve duplex.
- The program transfer is started by the command <id>UP2.
- By <id>UP0 the transfer program is terminated and the ultrasonic-firmware is started.

Remark: All parameters which are changed here, are valid only for the time period of the boot loader. They do not change the values in the global parameter memory.

After entering of the command <id>UP2 the ULTRASONIC starts the data transfer, by sending cyclically the sigh "C". The user has now approx. 30 sec. for starting the transfer program of the

terminal. When the transfer program is started the data transfer initiates with secured CRC-check sum. Erroneous and disappeared data packages are resent automatically, so that the received data are error-free.

Only when the binary data are completely available on the ULTRASONIC, the new program is written into the program memory. After successful transmission the new program starts automatically.

If the transmission is stopped, the ULTRASONIC starts automatically the firmware available after a respective timeout (20s).

7.16 Fast boot

See Energy-saving mode.

7.17 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. rain). A complete data record is now made every 4ms using all 4 sensors so that the ULTRASONIC generates 250 measured values per second.
For plausibility check selection see also **Command MD**, **Command PC**.

7.18 Online help

For a short description of commands the ULTRASONIC contains an Online help which provides information about individual commands. The Help text for the command is returned by inputting the command and a '?'.

If the command

00?? ?<cr>   <cr> stands for Carriage return (Enter key)

is input, the ULTRASONIC will list all commands with the relevant help.

Example:

Help with setting the baud rate is to be called up: see **Command BR**.
With the command

00BR?<cr>   <cr> stands for Carriage return (Enter key)

The ULTRASONIC provides the following response:
BR: Set / get baud rate

0 -> reserved	10 -> 1200 7E1
1 -> reserved	11 -> 1200 7E1
2 -> 1200 8N1	12 -> 4800 7E1
3 -> 2400 8N1	13 -> 9600 7E1
4 -> 4800 8N1	14 -> 19200 7E1
5 -> 9600 8N1*	15 -> 38400 7E1
6 -> 19200 8N1	16 -> 57600 7E1
7 -> 38400 8N1	17 ->115200 7E1
8 -> 57600 8N1	
9 ->115200 8N1	

8 Configuration of ultrasonic anemometer by customer

The Ultrasonic Anemometer 2D is factory-set prior to delivery to the customer.
Setting is described in the supplementary sheet *"Factory Setting"*.

It is possible for the customer to alter the factory setting of the Ultrasonic Anemometer 2D or to adapt it to new requirements. Here it should be borne in mind that with a change in settings, the order number allocated at the factory can then no longer help with identification.

The Anemometer 2D can be configured via its serial data interface using commands.
see section:

   - *Access mode.*
   - *Command list.*

Any standard terminal program such as "Procomm", "Telix" or a Windows terminal program (e.g. Hyper Terminal) can be used for this purpose.

Recommendation:

After performing configuration please amend the supplementary sheet "Factory Setting" and also send in to the manufacturer in the event of maintenance or repair.

8.1 Storing of Parameter Data Set

The ULTRASONIC is able to store internally three complete parameter data sets. By the commands SP and RP complete parameter sets are stored respectively read-out from the memory and applied. Parameter sets are stored, for ex. In case that tests with different instruments settings (for ex. different user-defined telegrams) shall be carried out. When a configuration with user-defined telegram has been made, this can be stored and another configuration can be effected. This can be stored, too. By downloading the respective configuration the user can now select from the stored configurations.

By the command 00SP1 for ex. all parameters are stored into the buffer '1'. By command 00RP1 all parameters are read and applied by the system. After back-reading the data from the buffer by command RP a system start is carried out automatically, see also **Command RP, Command SP.**

The buffer with the index '0' contains all values of the delivery, and cannot be overwritten.

8.2 Establishing of Delivery Condition

The parameter data set on delivery is stored in the parameter data set '0'. By calling 00RP0 the instrument is set into the condition of delivery. After reading a system start is carried out automatically.

8.3 Administration of User Information

The instrument provides a data buffer of 32 texts with 32 signs each, where any text can be stored. By the command UD this buffer is administered. The format of entry is

>   00Udn,xxxx

with

>   n: index 1..32

>   xxxx: text with a maximum length of 32 signs

Storing of user information:

The command

>   00UD1, THIES ULTRASONIC

Stores the text 'THIES ULTRASONIC' at data position one. The query

>   00UD1

provides the result

>   01: THIES ULTRASONIC.

During the query the data set number is always included in the output in order to allow a selective changing.

The query

      00UD

           Returns all user-specific texts, for ex.

           01: THIES ULTRASONIC

           03: mounted at Göttingen

Deletion of Definitions

Data sets must be deleted individually. For this, the data set number followed by a comma, is necessary. The input of

      00UD3,

deletes the text at position 3.

9 List of Commands

	Command	Description
Command AA	<id>AA<para5>	Functions for PIN WG/RXD-(analogue channel A).
Command AB	<id>AB<para5>	Functions for PIN WR/RXD+ (analogue channel B).
Command AC	<id>AC<para5>	Functions for the PIN ADIO (analogue channel C).
Command AG	<id>AG<para5>	Setting of the analogue output group (WG,Wr,VT or V_{EW},V_{NS},VT).
Command AM	<id>AM<para5>	Setting the method of communication (average mode).
Command AN	<id>AN<para5>	Analogue output mode (analogue output).
Command AO	<id>AO<para5>	Scaling of the analogue wind direction output (angle output).
Command AR	<id>AR<para5>	Scaling of the analogue wind speed output (analogue range).
Command AS	<id>AS<para5>	Set the analogue outputs to a fixed value.
Command AT	<id>AT<para5>	Checks the analogue in-/outputs.
Command AV	<id>AV<para5>	Communication period (averaging time).
Command AU	<id>AU<para5>	Update of the analogue inputs (analogue update rate).
Command AY	<id>AY<para5>	Scaling of the minimum value for analogue input PIN WG/RXD-.
Command AZ	<id>AZ<para5>	Scaling of the maximum value for analogue input PIN WG/RXD-.
Command BH	<id>BH<para5>	Select measuring instrument address of Bavaria Hesse.
Command BL	<id>BL<para5>	Returns the version of the boot loader (boot loader version).
Command BP	<id>BP<para5>	Time for pretrigger in burst mode (burst pretrigger).
Command BS	<id>BS<para5>	Buffer range in burst mode (burst store).
Command BR	<id>BR<para5>	Selecting the baud rate (baud rate).
Command BT	<id>BT<para5>	bus terminating resistor (bus termination).
Command BX	<id>BX<para5>	Selecting the baud rate (baud rate extension).
Command BY	<id>BY<para5>	Scaling of the minimum value for analogue input PIN WG/RXD+ .
Command BZ	<id>BZ<para5>	Scaling of the maximum value for analogue input PIN WG/RXD+ .
Command CA	<id>CA<para5>	Adjustment value for analog outputs in 0.1 per mil (inclination).
Command CB	<id>CB<para5>	Adjustment value for analog outputs (offset correction).
Command CI	<id>CI<para5>	Select the command interpreter (command Interpreter) .
Command CY	<id>CY<para5>	Scaling of the minimum value for analogue input PIN ADIO.
Command CZ	<id>CZ<para5>	Scaling des maximum value for analogue input PIN ADIO .
Command DA	<id>DA<para5>	Data request of the command interpreter of Bavaria Hesse
Command DE	<id>DE<para5>	Standard deviation.
Command DF	<id>DF<para5>	Set initial values (default values).
Command DM	<id>DM<para5>	Duplex mode of the serial interface (Duplex mode).
Command DV	<id>DV<para5>	Instrument version, date- time information of firmware.
Command DX	<id>DX<para5>	Effective acoustic measurement path length of the X-path (nominally 20000).
Command DY	<id>DY<para5>	Effective acoustic measurement path length of the Y-path (nominally 20000).
Command EI	<id>EI<para5>	Analogue value max. /min. in case of error (error inversion).
Command FB	<id>FB<para5>	Instrument re-start with/ w/o option for firmware update (Fast Boot).
Command GU	<id>GU<para5>	Maximum value of WV and resp. WD in the averaging time, gust.
Command HC	<id>HC<para5>	Threshold of the supply voltage for switch-on suppression of heating (heating control).
Command HL	<id>HL<para5>	Lower threshold temperature for turning heating into Kelvin.
Command HH	<id>HH<para5>	Upper threshold temperature for turning heating into Kelvin.
Command HT	<id>HT<para5>	Heating control.

	Command	Description
Command ID	<id>ID<para5>	Instrument ID.
Command IT	<id>ID<para5>	Internal temperature of housing.
Command KY	<id>KY<para5>	Access mode (key).
Command MA	<id>MA>>para5>	Automatic adjustment of the measuring value acquisition (measurement automation).
Command MD	<id>MD>>para5>	Interval of the meas. value acquisition of the measurement delay.
Command NC	<id>NC<para5>	North Correction.
Command OD	<id>OD<para5>	Emulation of an ULTRASONIC 1D (one dimension).
Command OH	<id>OH<para5>	Query of the operatingl hours counter (operational hours).
Command OR	<id>OR<para5>	Telegram output interval (output ratio).
Command OS	<id>OS<para5>	Scaling of wind speed output (output scale).
Command PC	<id>PC<para5>	Plausibility check.
Command PR	<id>PR<para5>	Period receive time.
Command PT	<id>PT<para5>	Period Transmit Time .
Command PW	<id>PW<para5>	Output of measured supply voltage (power).
Command RC	<id>RC<para5>	Slew rate calibration of the A/D converter.
Command RD	<id>RD<para5>	Response delay on telegram query (Response delay).
Command RF	<id>RF<para5>	Restart in case of invalid measuring values (restart at fail).
Command RP	<id>RP<para5>	Read Parameter data set (read parameters).
Command RS	<id>RS<para5>	Re-start ULTRASONIC (reset).
Command SC	<id>SC<para5>	Starting value of the characteristic of the analogue outputs, 4..20 mA (start current).
Command SE	<id>SE<para5>	Output of the stored system information (system events).
Command SH	<id>SH<para5>	Serial number high word.
Command SL	<id>SL<para5>	Serial number low word.
Command SM	<id>SM<para5>	System event mask.
Command SP	<id>SP<para5>	Store parameter data set (Store Parameters).
Command SS	<id>SS<para5>	System status.
Command SV	<id>SV<para5>	Software version.
Command TB	<id>TB<para5>	Specifies data telegram outputting data after burst measurement.
Command TC	<id>TC<para5>	Correction of cross wind component of VT (Temperature correction).
Command TD	<id>TD<para5>	Change of direction of rotation for upside down installation.
Command TF	<id>TF<para5>	Transformer for generating acoustic signals.
Command TE	<id>TE<para5>	Sensor delay EAST sensor.
Command TN	<id>TN<para5>	Sensor delay NORTH sensor.
Command TR	<id>TR<para5>	Telegram request (transmit request).
Command TT	<id>TT<para5>	Autonomous telegram output (transmit telegram).
Command TS	<id>TS<para5>	Sensor delay SOUTH sensor.
Command TW	<id>TW<para5>	Sensor delay WEST sensor.
Command UA	<id>UA<para5>	Definition of user-specific telegram (User Added telegram).
Command UD	<id>UD<para5>	User-defined character (User data).
Command UR	<id>UR<para5>	Remove in the user-defined telegram (remove user telegram).
Command US	<id>US<para5>	Save user-specific telegram definition (user telegram save).
Command UT	<id>UT<para5>	Telegram acc. to user's specification (user telegram).
Command VC	<id>VC<para5>	Constant velocity correction (velocity correction).
Command VT	<id>VT<para5>	Angle-dependent velocity correction (Velocity table).
Command XI	<id>XI<para5>	External ID.

10 Command and description

Command AA

T <id>AA<para5>	Functions for PIN 1
Access:	User mode
Description:	Sets the mode for PIN 1. Values for this parameter can only be changed when the ULTRASONIC runs in half duplex mode (see **Command DM**). For the signal line PIN1 the following functions can be specified:

Parameter description:

- **0:** Analog input signal is not used. Full duplex mode is possible (see **Command DM**).
- **1:** PIN 1 is used as analog input. The analog voltage value at PIN 1 is read in cyclically by the system and digital conversion performed. The analog output value for WV is switched off (see **Command AN**).
  With a maximum input voltage of 10.0V the digital value output is 65536 (16bit) with a resolution of 152ppm.
  The prerequisite for this mode is half duplex mode (see **Command DM**).
- **2:** Self test of analog wind velocity output
  In this state the analog output signal of the wind velocity is read back via the analog input signal. The prerequisite is that the analog wind velocity output is switched as a voltage output.
  (see **Command AN**)
  PIN1 must not be connected externally. The analog values are output by the ULTRASONIC, and are re-imported. The analog voltage value at WV/RXD- undergoes digital conversion cyclically and is read in by the system.
  The digital value read-in can be output via the user-defined telegram (*see* **User-specific telegram***).*
  The prerequisite for this mode is half duplex mode (see **Command DM**).
- **3:** Analog output of wind velocity in azimuth. Is output when AN != 2, see **Command AN**.
- **4:** Input used as SONIC ID (Bit 0). If the mode is selected in which the ULTRASONIC is to receive its ID via the external lines, this PIN <u>must</u> be configured as follows: 00AA00004. (see also **Command XI**)

When using AA, AB and AC the parameter AN must not be switched to two!!! See also Command AN.

Range of values:	0..4
Initial value:	0

Command AB

T <id>AB<para5>   Functions for PIN 4
Access: User mode
Description: Sets the mode for PIN 4. The values for this parameter can only be changed when the ULTRASONIC runs in half duplex mode (see **Command DM**). For the signal line PIN4 the following functions can be specified:

Parameter description:

0:	Signal is not used. Full duplex mode is possible (see **Command DM**)
1:	PIN 4 is used as analog input. The analog voltage value at PIN 4 is read in cyclically by the system and digital conversion performed. The analog output value for WD is switched off (see **Command AN**).
	The prerequisite for this mode is half duplex mode (see **Command DM**). With a maximum input voltage of 10.0V the digital value output is 65536 (16bit) with a resolution of 152ppm.
2:	Self test of analog wind direction output.
	In this state the analog output signal of the wind direction is read back via the analog input signal. The prerequisite is that the analog wind direction output is switched as a voltage output (see **Command AN**). PIN 4 must not be connected externally. The analog values are output by the ULTRASONIC, and are re-imported.
	The digital value read-in can be output via the user-defined telegram (see **User-specific telegram**).
	The prerequisite for this mode is half duplex mode (see **Command DM**).
3:	Analog output of wind direction in azimuth. Is output when AN != 2, see **Command AN**
4:	Input used as SONIC ID (Bit 1). If the mode is selected in which the ULTRASONIC is to receive its ID via the external lines, this PIN <u>must</u> be configured as follows: 00AB00004. (see also **Command XI**)

When using AA, AB and AC the parameter AN must not be switched to two!!! See also Command AN.

Range of values: 0..4
Initial value: 0

Command AC

T <id>AC<para5>	Functions for PIN 3 (ADIO)
Access:	User mode
Description:	Sets the mode for PIN 3 (ADIO). It can either be switched as an analog input, digital input or digital output. The functions of the PIN 3 (ADIO) are independent of the duplex mode selected.

Parameter description:

0: Signal is not used.

1: PIN is used as analog input. The analog voltage value is read in cyclically by the system. Input resistance 200kΩ.
With a maximum input voltage of 10.0V the digital value output is 65535 with a resolution of 16 bit or approx.15ppm.

2: Reserved

3: Analogue output of acoustic virtual temperature. Is output when AN != 2, see **Command AN**. The analogue output is firmly scaled in the range from – 40°C to + 80°C.

4: Input used as SONIC ID (Bit2). If the mode is selected in which the ULTRASONIC is to receive its ID via the external lines, this PIN must be configured as follows: 00AC00004. (see also **Command XI**). Input resistance 200kΩ.

5: PIN is switched as digital output. The output is set to +5V when the averaging buffer is filled to over 80% for the first time after startup. This function can be used when the ULTRASONIC is to be operated so that it is to be disconnected from the voltage supply after complete measurement, see also **7.14**.

6: PIN 3 (ADIO) is switched as digital output. The output is set to 0V.

7: PIN 3 (ADIO) is switched as digital output. The output is set to +5V.

8: The PIN 3 (ADIO) is used for heating control. A level of <2V switches the heating off, and a level of > 2V activates parameterised heating control, see **7.6.** Input resistance 200kΩ.

9: The PIN 3 (ADIO) is used for heating control. A level of < 3V switches the heating off, and a level of > 2V activates parameterised heating control, see Command HT. Input resistance 200kΩ. In diesem Fall wird der ADIO-PIN als Eingang verwendet. Bei Geräten mit und ohne Schaftheizung wird mit dem Pegel das Einschalten der Arm – PTC - und der Schaftheizung gesteuert. Ist der Pegel 0V steuert sich bei Geräten mit Schaftheizung die Schaftheizung über einen eingebauten Temperatursensor selbstständig.

10: As for 8) with additional 10k pull-up resistor at PIN 3 (ADIO)
11: As for 9) with additional 10k pull-down resistor at PIN 3 (ADIO)
12: As for 8) with additional 10k pull-down resistor at PIN 3 (ADIO)
13: As for 9) with additional 10k pull-up resistor at PIN 3 (ADIO)

14: Triggers a single measurement on rising edge, when PIN 3 (ADIO) is set to +5V. This mode can be used for synchronous measurement acquisition. Required pulse length > 1µsec. Input resistance 10kΩ pull down.

15: Starts the continuous measurement on rising edge, when PIN 3 (ADIO) is set to +5V. Required pulse length. > 1µsec. The current measurement can be stopped again by command input AC15. Input resistance10kΩ pull down.

16: Starts measurement in burst mode when PIN 3 (ADIO) is set to 5V. Required pulse length > 1µsec. If PIN 3 (ADIO) is open, no measurement is started. (Internal pull-down resistor switched on) If PIN 3 (ADIO)is fixed to +5V, burst mode is started automatically when previous measurement ends. Input resistance 10kΩ pull down.

17: Starts measurement in burst mode when PIN 3 (ADIO)is switched to AGND. If PIN 3 (ADIO) is open, no measurement is started. (Internal pull-up resistor switched on) If PIN 3 (ADIO)is fixed to AGND, burst mode is started automatically when previous measurement ends. Input resistance 10kΩ pull up.

18: For wind directions <170° ADIO-pin outputs 5V, for
wind directions >= 170° 0V

19: PIN 3 (ADIO) output the internal status of heating. A level of 0V means:
heating off, level of 5V means: heating on.

20: PIN 3 (ADIO) output the internal status of heating. A level of 0V means: heating on, level of 5V means: heating off. Parameter is used when instrument is equipped with housing heater. With AC20 the ADIO-PIN is switched as an output. No external signal may be applied to the ADIO PIN. For devices with shaft heating, the shaft heating is deactivated with the output signal if the output level is 5V. If the level is 0V, the shaft heating controls itself via a built-in temperature sensor.

Range of values: 0...20
Initial value: 0

Command AG

T <id>AG<para5>	Determines the group for the analogue outputs (Analogue group).
Access:	User mode.
Description:	This command is used to determine the group for the analogue outputs. The following groups are available: WV,WD,VT, and V_{EW},$V_{NS, VT.}$ With V_{EW},V_{NS}. VT the velocity vectors of the North-South- and East-West distance are output. If the wind velocity is 0m/s the analogue output value is set exactly to half of the used output signal, e.g. to 12mA with a scaling from 4..20mA.

Parameter description:

0: output of the components WG,Wr,VT.
1: output of the components VEW,VNS,VT aus.

Command AM

T <id>AM<para5>	Selection of averaging method (Average Mode)
Access:	User mode
Description:	This command can be used to select the type of averaging method. Averaging can be either vectorial or scalar: see also **Averaging**.
Parameter description:	

0:	vectorially averaged velocity and vectorially averaged angle
1:	scalarly averaged velocity and scalarly averaged angle
2:	scalarly averaged velocity and vectorially averaged angle
3:	vectorially averaged velocity and scalarly averaged angle

Range of values	0…3
Initial value:	0

Command AN

T <id>AN<para5>	Analog output mode (Analog output)
Access	User mode
Description:	Sets the mode for output of the analog wind direction (WD) and wind velocity (WV). This command can be used to switch between the current output and voltage output. Any change in the value always relates to both outputs (WD and WV) simultaneously. The output value range can be selected with the **Command SC**. It is either 0..20mA (0..10V) or 4..20mA (2..10V): see **Command SC**. The command can only be changed when the mode half duplex is selected: see **Command DM**.
Parameter description:	

0:	Voltage output
1:	Current output
2:	Analog outputs are not used. Internal calculation and output of the analog values is switched off completely when AN=2 is set and with AA=AB=AC=0.

Range of values	0...2
Initial value:	0

Command AO

T <id>AO<para5>	Scaling of analog wind direction output (Angle Output)
Access:	User mode
Description:	With analog output of the wind direction scaling can be selected in which the angle is output. To preserve compatibility with existing systems it is sometimes necessary to select an extended angle range. The ranges 0..360°, 0..540° and 0..720° are supported here. See also **Command AN**, **Command DM**, **Command SC**.
Parameter description:	

0:	Output of angle in range 0..360° (0° is north)
1:	Output of angle in range 0..540° (0° is west)
2:	Output of angle in range 0..720° (0° is south);

Range of values	0...2
Initial value:	0

Command AR

<id>AR<para5>	Scaling of analog wind velocity output (Analog Range)
Access:	User mode
Description:	Specifies the range used for scaling of the analog wind velocity output. The standard ULTRASONIC scales the wind velocity as follows: 0..10V (2..10V) corresponds to 0..60m/s It may however also be sensible to scale the wind velocity of 0..30m/s: 0..10V (2..10V) corresponds to 0..30m/s The end of the measuring range is specified with this parameter. Specification is made in m/s.
Parameter description:	

	0..100: Specifies of the end of the measuring range of the wind velocity (WV). If the command AR00045 is input for example, 10V or 20mA corresponds to a wind velocity of 45m/s.
Range of values	1…100
Initial value:	60

Command AS

<id>AS<para5>	Sets the analogue outputs to a fixed value
Access:	User mode
Description:	Sets the analogue outputs to a fixed value. The value is stated in increments for the internal AD transformer. Value ‚0' for AS deactivates the function. Function is used for instrument adjustment.
Value range:	0...65535
Initial value:	0

Command AT

<id>AT<para5>	Checks the analogue in-/outputs.
Access:	User mode
Description:	Connects different voltages to the outputs and read them in again. Operates only in half-duplex mode. The analogue in-/outputs must not be connected.
Value range:	0...65535
Initial value:	0

Command AU

\<id>AU\<para5>	Update rate of analogue inputs/outputs (Analogue Update)
Access:	User mode
Description:	This command is used to specify the time interval in which the selected analogue inputs are sampled and the outputs are written. The parameter defines the interval between two complete update intervals in ms.

A conversion time of approx. 2.5ms is required per channel

In the configuration each of the three PINs PIN 1, PIN 4 and PIN 3 (ADIO) can be defined individually as an analog output. The time for an update-interval is the sum of the A/D-conversions of the individual measurement channels, i.e. with 3 channels thus 7,5msec.

When using analog data output (see **Command AN**) the channels PIN 1, PIN 4 are used simultaneously and require a conversion time of approx. 5ms.
Example:
PIN 3 (ADIO) is switched as an analog input.
The sampling interval is 50ms (with AU00050). The ULTRASONIC finishes conversion after approx. 3ms if no other analog channel is switched on.
If the sampling interval is set shorter than the update-interval takes, the actual duration of the update-interval dominates, and the value set for the sampling interval has no effect.
If the parameter AU is set to 0, the analogue inputs/outputs are not sampled resp. updated.

Range of values:	1...256
Initial value:	50

Command AV

\<id>AV\<para5>	Averaging period	(Average)
Access:	User mode	
Description:	This command can be used to specify the period over which the ULTRASONIC averages its measured values. Given the high measuring speed of up to 4ms for the generation of a measured value, the use of averaging is sensible in most cases.	

Parameter description:

Parameter for AV	Selected averaging time
0	Parameter OR specifies the averaging interval in ms
1	Averaging over 1s
2	Averaging over 10s
3	Averaging over 60s
4	Averaging over 120s
5	Averaging over 10min
6..60000	Averaging over n* 100ms, e.g. 00AV25 means averaging over 2.5s

Table 8: Adjustment of averaging periods with parameter AV

The averaging memory is designed as a sliding memory. With every measurement the measured value is provided with a time stamp. The mean value buffer is only so large as data over the averaging period is contained in the memory.

On startup the data of the averaging memory are instantly valid. Averaging is performed immediately using the measured values available as the quality of the measured values is not achieved until a certain content level of the mean value buffer.

If an averaging period of AV0 is selected, the averaging period is calculated from the selected output interval OR (see Command OR).

Range of values   0...60000
Initial value: 10

Command AY

<id>AY<para5>	Scales the output value of the minimum value of the analogue input PIN WG/RXD- (analogue channel A)
Access:	User mode
Description:	The measuring values of the analogue inputs can be output in scaled form. By means of the command AY the output value is stated for 0V input voltage. The value for the parameter AY is calculated as follows: Parameter value = 30000+(reference value*10). See also **Analog inputs** and **Command AZ**.

Command AZ

<id>AZ<para5>	Scales the output value of the minimum value of the analogue input PIN WG/RXD-(analogue channel A)
Access:	User mode
Description:	The measuring values of the analogue inputs can be output in scaled form. By means of the command AZ the output value is stated for 9,96V input voltage. The value for the parameter AZ is calculated as follows: Parameter value = 30000+(reference value*10) See also **Analog inputs** and **Command AY**.

Command BH

<id>BH<para5>	Selects the Bayern Hessen measuring instrument addresses (Bayern-Hessen instrument address)
Access:	User mode
Description:	The ULTRASONIC contains several command interpreters. The THIES command interpreter is active in standard mode. **Command CI** can be used to change the command interpreter. If the Bayer - Hessen interpreter is selected, the measured values for wind direction, wind velocity and virtual temperature are interrogated under different measuring instrument addresses. The command BH specifies which measuring instrument addresses are active. The following combinations are available for selection:

Parameter description:

Parameter value	Measuring instrument address		
	WV	WD	VT
0	011	001	022
1	400	410	420
2	202	201	211
3	011	001	021
4	081	082	083
5	001	002	003
6	008	009	010

Table 9: Measuring instrument addresses in Bayern Hessen command interpreter

See also **Command CI**, Bayern Hessen mode.

Command BL

<id>BL<para5>	Returns the software version of the bootloader
Access:	Query mode
Description:	On query of the parameter the software version of the bootloader is returned.. For interpretation the output version must be divided by 100. An output value 00BL00300 represents the version V3.00. Number ‚3' means the main version, 00 is the build–label.

Command BP

<id>BP<para5>	Determine the pretrigger in the burst mode.
Access	User mode
Description:	States the time (ms) of the data recording in the burst mode before the real trigger event.
Value range:	0..65535
Initial value:	100ms

Command BR

<id>BR<para5>	Select baud rate (Baud Rate)
Access:	User mode
Description:	The ULTRASONIC communication can be used with different baud rates. The adjustment range is from 1200baud to 921Kbaud. The baud rate can be selected with the commands BR and BX. With the command BR the baud rate is specified in the range from 1200baud to 115200baud. The command BX specifies the baud rate from 230400baud to 921600baud. The following baud rates are defined for BR:

Parameter description:

	1200	2400	4800	9600	19200	38400	57600	115.2K
8N1	2	3	4	5 *	6	7	8	9
7E1	10	11	12	13	14	15	16	17
7O1	18	19	20	21	22	23	24	25
8N2	26	27	28	29	30	31	32	33
7E2	34	35	36	37	38	39	40	41
7O2	42	43	44	45	46	47	48	49

Table 10: List of baud rates with telegram BR

When interrogating the baud rate using the command BR, the ULTRASONIC gives back the last programmed baud rate selected either using the command BR or BX.

Range of values 2..49
Initial value: 5

Command BS

<id>BS<para5>	Sets buffer size in burst mode
Access:	User mode
Description:	When burst mode is activated, this parameter can be used to select the buffer size. The maximum buffer size is 40,000 complete measuring cycles. Burst mode is activated with command 00AC16 or 00AC17, see **Command AC**.
Range of values:	1..40000
Initial value:	1000

Command BT

<id>BT<para5>	Set bus terminating resistor (Bus Termination)
Access:	User mode
Description:	Connects a 100R resistance between the lines TXD+ und TXD- in case BT01 is set. With BT0 the resistance is switched off.
Value range:	0...1
Initial value:	0

Command BX

<id>BX<para5>	Select baud rate (Baud Rate extension)	
Access:	User mode	
Description:	The ULTRASONIC communication can be operated with different baud rates. The adjustment range is from 1200baud to 921Kbaud. The baud rate can be selected with the commands BR and BX. With the command BR the baud rate is specified in the range from 1200baud to 115200baud. The command BX specifies the baud rate from 230400baud to 921600baud. The following baud rates are defined for BX:	

Parameter description:

101:	230400 baud	8,N,1
102:	460800 baud	8,N,1
103	921600 baud	8,N,1

<div align="center">

Table 11: List of baud rates with telegram BX

</div>

Programming of the extended baud rate includes a safety mechanism which does not allow a baud rate to be selected with the command BX when communication cannot be established at this baud rate. With most PCs the maximum baud rate of the integrated RS485 is set at 115200baud. It is not possible to select a higher baud rate. If the ULTRASONIC has a baud rate >115200Kbaud, communication with the instrument might not be possible. To work with such baud rates a standard PC requires a special extension card.

To set the ULTRASONIC to an extended baud rate the procedure given below must be followed:

Output situation:

Communication with the ULTRASONIC is available (e.g. 9600baud)

Change baud rate:

The user selects a new baud rate, e.g. 230400baud.

The ULTRASONIC changes its baud rate, but does not yet store the parameter.

The user sets his PC to the new baud rate.

He repeats the input to change the baud rate (same command as above)

This is the signal to the ULTRASONIC that communication functions at the new baud rate, and it stores the parameter internally.

If the user is unable to set the new baud rate, the ULTRASONIC must be restarted. It will then automatically set the last valid baud rate (here 9600baud).

Example:	
00KY1<cr>	Opens access key
00BX103<cr>	ULTRASONIC baud rate changed to 921600baud 'Set baud rate at PC to 921600baud'
00BX103<cr>	Repeat command for baud rate. The ULTRASONIC stores the baud rate. This baud rate is loaded with every restart.

When interrogating the baud rate using the command BX, the ULTRASONIC gives back the last programmed baud rate selected either using the command BR or BX.

Range of values	101..103
Initial value:	As the initial value for the baud rate the command BR is responsible.

Command BY

\<id>BY\<para5> WG/RXD+	Scales the output value of the minimum value of the analogue input PIN
	(analogue channel B)
Access:	User mode
Description:	The measuring values of the analogue inputs can be output in scaled form. By means of the command BY the output value is stated for 0V input voltage. The value for the parameter BY is calculated as follows:
	Parameter value = 30000+(reference value*10)
	See also **Analog inputs** and **Command BZ**.

Command BZ

\<id>BZ\<para5>	Scales the minimum value of the analogue input PIN WG/RXD+(analogue channel B)
Access:	User mode
Description:	The measuring values of the analogue inputs can be output in scaled form. By means of the command BZ the output value is stated for 9,96V input voltage. The value for the parameter BZ is calculated as follows:
	Parameter value = 30000+(reference value*10)
	See also **Analog inputs** and **Command BY**.

Command CA

\<id>CA\<para5>	Calibration value for analogue current/ voltage outputs (slope).
Access:	Configuration mode
Description:	The initial value of 60000 corresponds to the non-calibrated inclination 1,0000. The difference to the initial value changes the slew rate by 0,1 per mil ($1*10^{-4}$), per increment. The calibration value is below the initial value of 600000, as the internal boost is charged by 1% too high for balancing the accuracy of the reference and the part variance.
Range of values:	5900..61000
Initial value:	Device-dependent

Command CB

<id>CB<para5>	Calibration value for the analogue current/voltage outputs (offset correction)
Access:	Configuration mode
Description:	The initial value of 1000 represents an offset correction of 0.

The difference value to the initial value adds (value >1000) or subtracts an offset (value <1000) as a multiple of an increment of the 16 bit LSB-value (approx. 15ppm of FS) as offset to the respective output value.

Value range:	800..1200
Initial value:	Device-dependent

Command CI

<id>CI<para5>	Selects the command interpreter (Command Interpreter)
Access:	Configuration mode
Description:	The ULTRASONIC contains several command interpreters. The THIES command interpreter is active in standard mode. The **Command CI** can be used to change the command interpreter. The command interpreter decides the format of the commands input. "THIES" is selected as the standard command interpreter. It awaits commands in the form:

XXBBnnnnn<CR>   Telegram to change a parameter

XXBB<CR>   Interrogation telegram

Where
XX   -> two-position ID (initial value is 00: see **Command CI**)
BB   -> two-character command identifier
nnnnn   -> 5-character parameter
<CR>   -> Carriage return as delimiter

When changing a parameter it should be ensured that the appropriate access key is selected: see **Command KY**.

Parameter description:

	0: Standard Thies command interpreter
	1: Bayern Hessen command interpreter
Range of values	0..1
Initial value:	0

Command CY

<id>CY<para5>	Scales the minimum value of the analogue input PIN ADIO (analogue channel C)
Access:	User mode
Description:	The measuring values of the analogue inputs can be output in scaled form. By means of the command CY the output value is stated for 0V input voltage. The value for the parameter CY is calculated as follows:

Parameter value = 30000+(reference value*10)
See also **Analog inputs** and **Command CZ**.

Command CZ

<id>CZ<para5>	Scales the output value of the minimum value of the analogue input PIN ADIO (analogue channel C)
Access:	User mode
Description:	The measuring values of the analogue inputs can be output in scaled form. By means of the command CZ the output value is stated for 9,96V input voltage. The value for the parameter CZ is calculated as follows: Parameter value = 30000+(reference value*10) See also **Analog inputs** and **Command CY**.

Command DA

<id>DA<para5>	Data request in Bayern Hessen command interpreter
Access:	Enquiry mode
Description:	Requests data in Bayern Hessen format. The command DA complies with the Bayern Hessen specification. It can be used either with or without the measuring instrument address.
Range of values	Depending on measuring instrument addresses selected: see **Command BH**.
Initial value:	No initial value

Command DE

<id>DE<para5>	Standard deviation (Deviation)
Access:	User mode
Description:	Switches calculation of standard deviation on or off. The ULTRASONIC includes an option for calculation of the standard deviation. When calculation is switched on, the standard deviation for the wind direction, velocity and temperature is determined. As calculation of the standard deviation is very time-consuming depending on the averaging period, it can be switched on / off separately. Standard deviation is not active when instantaneous values are output.
Parameter description:	

0:     standard deviation off
1:     standard deviation on

Some standard deviation values are output in telegram 5. All further values are available in the user-defined telegram: see fixed telegram formats and User-specific telegram.

If calculation of the standard deviation is set, the number of the data records in the mean value buffer is limited to 2000 as all data records of the buffer have to be processed for each new measured value.

Range of values	0..1
Initial value:	0

Command DF

<id>DF<para5>	Set initial values (Default values)
Access:	Configuration mode
Description:	Sets all parameters to their initial value.
	After this command all parameters of the ULTRASONIC are written to their initial value.
	1. ATTENTION: The values in the EEPROM are not overwritten. After a restart the ULTRASONIC reads out the 'old' parameters from the EEPROM.
	2. Sets all parameters in EEPROM to the initialisation value.
	ATTENTION: EEPROM-parameter are overwritten by the initialisation values.
Range of values:	0..2
Initial value:	No initial value

Command DM

<id>DM<para5>	Duplex mode
Access:	User mode
Description:	Duplex mode decides the type of physical connection of the serial interface. In full duplex mode the send and receive signals are each transmitted via separate pairs of cables. This means it is possible to send and receive signals as required. In half duplex mode transmission of the send or receive signals is via the same pair of cables:
	Depending on the setting there are restrictions on the function of the connector PINs of the ULTRASONIC, see **Command AA, Command AB**, **Command AC**, **Command TT Serial data output**, 7.1.1.
	From software version V.3.10 the independent telegram output can be activated also in half duplex operation. Here, the telegram output is active only after one minute, so that in the meantime, other commands can be transmitted to the instrument. In case of a re-start of the instrument in half-duplex mode and with independent telegram output the telegram output is active only one minute after instrument start. In case of active telegram output in half-duplex mode, it might be not possible to communicate with the instrument. In order to transmit commands to the instrument it has to be restarted. As within the first minute not data are transmitted it is possible to send commands to the instrument.
	It is only possible to switch from half duplex to full duplex mode with the following prerequisites:
	• The PINs WG/RXD- and WR/RXD+ must not be selected as analogue inputs/ analogue outputs see **Command AA, Command AB**.

Parameter description:

0:	Half duplex mode (RS485, transmission drivers are switched off if no data sent).
1:	Full duplex mode (RS485 transmission drivers are switched off if no data sent).
2:	Full duplex mode (RS422 transmission drivers are not switched off during intermissions).

Range of values:	0..2
Initial value:	2

Command DV

<id>DV<para5>	Read instrument information
Access:	Only query
Description:	Outputs the instrument version and date-/time information of the firmware.
Value range:	none
Initial value:	none

Command DX

<id>EI<para5>	Effective acoustic length of the X- measurement path (Distance-X-path)
Access	Configuration mode
Description:	Effective acoustic distance between the ultrasonic converters West and East. This parameter is set on factory-adjustment and must not be changed.
Range of values	18000…21000
Initial value:	20000

Command DY

<id>EI<para5>	Effective acoustic length of the Y- measurement path (Distance-Y-path)
Access	Configuration mode
Description:	Effective acoustic distance between the ultrasonic converters North and South. This parameter is set on factory-adjustment and must not be changed.
Range of values	18000…21000
Initial value:	20000

Command EI

<id>EI<para5>	Analog value in case of error (Error Inversion)
Access:	User key
Description:	Specifies whether 0 or maximum value is output at the analog outputs in the case of error. If the ULTRASONIC establishes a static error during a measurement, it will output an error under certain conditions. This output is designed to prevent the user from interpreting incorrect measured values. If the analog signals of wind direction and wind velocity are used for evaluation, the ULTRASONIC switches the outputs to the maximum or minimum output value in the case of error. This parameter is used to specify whether the minimum or maximum value is output in the case of error.

Parameter description:

0:	Analog outputs are set to maximum in the case of error
1:	Analog outputs are set to 0 in the case of error
2:	Analog output of the wind speed is set to 0 in case of error
	Analog output of the wind direction is set to maximum in case of error
3:	Analog output of the wind speed is set to maximum in case of error
	Analog output of the wind direction is set to 0 in case of error
4:	Analog outputs are set to 2mA or resp. 1V in case of error
	The parameter SC must then be set to 1!

The output in case of error with parameters 0…3 is independent of parameter SC, see Command SC.

Range of values	0..4
Initial value:	0

Command FB

\<id\>FB\<para5\>	Fast Boot
Access:	User mode
Description:	The ULTRASONIC is equipped with a boot loader that is called up automatically on startup of the instrument. The function of the boot loader is to load a new program into the memory of the ULTRASONIC. For this purpose the boot loader transmits a specific character string via the RS485 and waits for an appropriate response. If the instrument receives a valid response, the program update starts. The command FB can be used to order the ULTRASONIC to bypass the boot loader on the next startup. In this case no attempt is made to initiate an update via the RS485. This means, that the ULTRASONIC starts its main program more quickly. Startup behaviour is influenced with the parameter FB.

0:	Fast boot switched off. After a restart the THIES-boot loader starts first, the main program afterwards.
1:	Fast boot switched on. On system startup the first data telegram is available after 200ms (averaging switched off).
2:	The boot loader suppresses output of the start parameters with 9600baud (from boot loader- version V1.43)
3:	Fast boot switched off. After a restart the X-modem boot loader starts first, the main program afterwards.

In case of a preferably fast system start the parameter SM is set to '0'. See also command SM and Storing of system events.

Value range:	0..3
Initial value:	0

Command GU

\<id\>GU\<para5\>	Maximum value in the averaging buffer (gust acquisition)
Access:	User mode
Description:	When using mean value buffers, with this parameter the maximum wind velocity and the respective wind direction (gust) can be acquired in the mean value buffer. The value of the command GU indicates the time length of the gust in 100ms-increments. The gust acquisition is deactivated through GU0. For this, see also section **7.3.5 Gust Acquisition**.
Parameter description:	

0:	gust acquisition deactivated.
>0:	Gust acquisition activated. The length of the gust must be less than the preset averaging period.

Example:	
	AV3
	GU30
	The instrument acquires the maximum gust in the gliding mean value buffer (here 1 minute). The gust value is the mean value from 3 seconds. All values in the averaging buffer are checked gradually. The acquisition of the gust is carried out after each measurement.
Value range:	0..30
Initial value:	0

Command HC

\<id\>HC\<para5\>	Voltage threshold for the Arm- and Transducer- heating suppression (Heating Control)
Access:	User mode
Description:	With this parameter the minimum supply voltage, when the heating control is activated, is stated in volt. If the supply voltage falls below this value, the heating is de-activated respectively switched off. Effective from firmware V3.09 and the hardware-revision V08-08 the parameter is supported. By means of the command (ID) PW it might be determined if the available instrument supports this option. If (ID) PW returns a numerical value, the heating control is supported. If the heating control is not supported, the instrument responses with the output: „System power ctrl not supported".
Value range:	5..48
Initial value:	10

Command HL

\<id\>HL\<para5\>	Lower threshold temperature for switching the Arm- and Transducer- heating (Heating low)
Access:	User mode
Description:	This parameter is used to indicate the lower threshold temperature for the heating control for HT00001. If the acoustic virtual-temperature falls below this value the heating is switched on. Input is performed in Kelvin.

  0 °C -> 273Kelvin; 2°C -> 275Kelvin

  Value range: 220K..320K

Initial value:	275

Command HH

\<id\>HH\<para5\>	Upper threshold temperature for switching the Arm- and Transducer- heating (Heating hight)
Access:	User mode
Description:	This parameter is used to indicate the upper threshold temperature for the heating control for HT00001. If the acoustic virtual temperature exceeds this value the temperature criterion for activating the heating is not satisfied. In case all other criterions for de-activating the heating are satisfied, the heating is switched off. Input is performed in Kelvin. 0°C -> 273Kelvin; 7°C -> 280Kelvin
Value range:	220K..320K
Initial value:	280

Command HT

<id>HT<para5>	Heating control (Heating) Arm- and Transducer- heating.
Access:	User mode
Description:	To prevent freezing-up the ULTRASONIC is equipped with an effective heating system that heats the sensor arms and the ultrasonic converters, if necessary. The command HT can be used to influence the heating function. The heating is switched on clocked, in order to avoid a response of the electric overload protection in the external power supply unit of the instrument on activation of the heating. After 125 seconds the arm heating is completely active. With instruments with transducer heating this is activated in intervals.
	After 125 seconds the arm heating is completely active. In instruments with additional ultrasonic-converters-heating it has also clocked activation.

Parameter description:

0:	Heating permanently off.
1:	Heating software-controlled by virtual-temperature.
2:	Heating permanently on.
3:	Heating software-controlled by virtual-temperature and housing temperature. Arm heating and ultrasonic-transducer-heating are controlled separately according to the virtual temperature, the temperature of the casing and in case of measurement perturbations.
4:	Heating software-controlled by virtual-temperature and housing temperature. Arm heating and ultrasonic-transducer-heating are controlled separately according to the virtual temperature and the temperature of the casing with one hour follow-up time of ultrasonic-transducer heating.
5:	For devices with heated housing: Heating software-controlled by virtual-temperature and housing temperature. Arm heating and ultrasonic-transducer-heating are controlled separately according to the virtual temperature and the temperature of the casing with one hour follow-up time of ultrasonic-transducer heating.
6:	The heating is immediately switched on permanently but not clocked.

Remark:

Detailled description ref to „heating control" chapter 7.6.

	The temperature criterion for control of the heating is always derived from the last valid measured value and not from the current mean value. In continuous operation the heating system is protected by temperature monitoring. If the temperature of the sensors exceeds approx. 70°C, the heating automatically switches off. If a threshold value is not attained, it switches back on. See also Command HC
Range of values	0…6
Initial value:	Depending on instrument

Command ID

<id>ID<para5>	ULTRASONIC ID
Access:	User mode
Description:	This command is used to specify the ID of the ULTRASONIC when the parameter XI is set to 0: see **Command XI**. The ID is used in every telegram of the ULTRASONIC when the command interpreter 'THIES' is selected: see **Command CI**. After the ID has been changed, the ULTRASONIC immediately responds to the new identifier.
	The ID 99 is an extended ID. The ULTRASONIC always responds to commands with the ID 99 (with the correct baud rate). The ID 99 must not be used in bus mode.

Example:

00KY1	Open with user key
00ID23	Change ID from 0 to 23
!23ID00023	ULTRASONIC acknowledges change
23DM	Interrogation of duplex mode with new ID
!23DM00000	Response from ULTRASONIC
23ID0	Change ID from 23 to 0
!00ID00000	ULTRASONIC acknowledges change

Range of values	0..99
Initial value:	0

Command IT

<id>IT<para5>	Internal temperature of housing
Access:	Query mode
Description:	Returns the internal temperature of housing in 0.1°C. The resolution of the temperature is approx. 0.1°C. A value of 256 means 25,6 °C. The internal temperature of housing is used for heating control. The time constant for adjusting the internal temperature of housing to the external temperature is approx. 20 min.
	The internal temperature of housing can be used with instruments from delivery date October 2009, and from software version V3.10..

Command KY

<id>KY<para5>	Access mode (Key)
Access:	Enquiry mode
Description:	To change the parameters of the ULTRASONIC access authorisations are necessary for most commands. This prevents any accidental change in parameters. Access takes place on three levels:

- Enquiry mode
- User mode
- Configuration mode

Parameter description:

	0:	Enquiry mode
		Parameters which have no access restrictions are those not stored in the EEPROM, e.g. cyclic telegram enquiry or output of system status.
	1:	User mode (USER ACCESS)
		The user key protects parameters which influence the behaviour of the ULTRASONIC, e.g. averaging period and baud rate. The user can change these parameters but he must realise that a change of the parameter will alter the behaviour of the ULTRASONIC. Before every change it is recommended using the command SS to output and save the current configuration.
	xxxxx:	Configuration mode (CONFIG ACCESS)
		Parameters protected with this key should not be changed. They are partly set on adjustment of the instrument at the factory. If these parameters are misadjusted, full malfunction may result. For the sake of completeness these parameters are included in this documentation although they should not be changed.

After a restart the system is always switched to the enquiry mode. If a command is entered incorrectly or an invalid command input, the ULTRASONIC immediately sets the access mode to the enquiry mode.

Range of values	0;1; xxxxx
Initial value	0

Command MA

<id>MA>>para5>	Automatic adjustment of measured value acquisition (Measurement Automation)
Access:	User mode
Description:	Specifies whether the measuring interval MA is automatically changed when an incorrect measurement is identified: see **Command MD**.
Parameter description:	

	0:	An incorrect measured value identified during the plausibility check has no influence on the interval for the acquisition of measured values.
	>0:	An incorrect measured value identified during the plausibility check causes the measuring interval to be set to the selected value and measurement performed with this frequency in the case of error. In case of error the parameter MA, divided by 10, replaces the selected measured value interval, which was set by parameter MD. If MD and MA (multiplied by 10) have the same value, the measuring speed does not change in the case of error. The measuring interval is reset when 4 consecutive data records contain no error. The value for MA is stated on 0.1ms, that means a value MA equates 1.3ms

Range of values	0..100
Initial value	13

Command MD

<id>MD>>para5>	Measuring interval (Measurement Delay)
Access:	User mode
Description:	Specifies the time in ms waited between two ultrasonic pulses. The ULTRASONIC is designed so that it cyclically measures the path run times of the individual paths. The parameter MD specifies how long the period between two ultrasonic pulses is. In standard mode this time is 5ms, so that every 20ms a complete data record is made from all sensors. If the ULTRASONIC identifies an incorrect measurement, the value MD can be set to 0, i.e. the send pulses directly follow each other: see **Command MA.** If for example a sensor is blocked, the change from MD to MA is identified by the higher repetition frequency of the pulses given off by the ULTRASONIC.
Range of values	0..1000
Initial value:	5

Command NC

<id>NC<para5>	Correction to north (North Correction)
Access:	User mode
Description:	With North correction a constant angle is also added to the measured angle. This value is used to correct a known angle error. If the ULTRASONIC is for example not aligned directly to north but to north-east, the wind direction will always show 45° too little. In this case a north correction of 45 must be selected. North correction affects the values in the data telegrams as well as the analog output values.
Range of values	0...360 in 1° steps
Initial value:	0

Command OD

<id>OD<para5>	Emulation of ULTRASONIC 1D (One Dimension)
Access:	User key
Description:	This parameter is used to specify whether the ULTRASONIC is to behave as a 1D-variant. If the parameter = 1, only the velocity component in a north/south direction is used to determine the velocity. The parameter takes the setting NC into account. When using OD00001 it is recommended setting north correction to NC00045 and mounting the ULTRASONIC at a 45° angle to the main wind direction.
	The angle output with the 1D variant is 0 (no wind), 1°, and 181°.
Range of values	0: Standard two dimensional
	1: 1D emulation
Initial value:	0

Command OH

<id>ZB<para5>	Operating hours counter (Operational Hours)
Access:	Query mode
Description:	The operation hours counter states the actually accumulated operating hours of the instrument as 5-digit-number. Hence, a maximum of 99999 hours of operating time can be counted without carryover. This corresponds to a period of approx. 11,4 years.
	The counter reading remains, of course, in case of power failure or de-installation of the instrument.
Initial value:	0

Command OR

<id>OR<para5>	Telegram output interval (Output Rate)
Access:	User mode
Description:	With independent telegram output this parameter is used to specify the time interval in which telegrams are output via the serial interface. Specification is made in milliseconds. If the output speed is higher than the data can be transmitted, the available output is discarded. If the output is faster than acquisition of the measured values, the measured values available are output again.
	If the averaging period is 0ms (see Command AV), the averaging period is automatically adapted to the output interval regardless of whether independent telegram output is selected. See also **Independent telegram output, Command TT**, **Command DM**.

Parameter description:

0:	A telegram is always output when the internal acquisition of measured values has calculated a new data record.
1..60000	Gives the output interval in milliseconds.
Range of values	0..60000 [ms]
Initial value:	100

Command OS

<id>OS<para5>	Scaling of wind velocity output (Output Scale)
Access:	User mode
Description:	This command is used to specify in which unit of measurement the wind velocity is output in the serial telegram. Different units of measurement are available for this purpose.

Parameter description:

Parameter	Unit of measurement	Conversion factor related to m/s
0	m/s	1
1	km/h	1m/s => 3.6 km/h
2	miles/h	1m/s => 2.237 miles/h
3	knots	1m/s => 1.94 kn

Table 12: Conversion factors between different wind velocities

Range of values	0..3
Initial value:	0

Command PC

<id>PC<para5>	Plausibility test (Plausibility check)
Access:	User mode
Description:	Switches the plausibility checks on/off. Every measured value is checked when Plausibility is switched on. It is checked whether the measured value is plausible and whether it fits into the sequence of measured values acquired. If this is the case, it is released for further processing.
	If this is not the case, the measured value is discarded. In the standard configuration this has the following effects:

- The heating is switched on: see **Command HT**

- The measured value acquisition interval is set to 0: see **Command MD**

Range of values	0..7
Initial value:	7

Command PR

<id>PR<para5>	Periodic receive time (Receive Time)
Access:	Configuration mode
Description:	This value sets the receive time period in the serial register in the analog section of the ULTRASONIC. This value must not be changed under any circumstances. It is factory-set.
Range of values	13..99
Initial value:	Device-dependent
Unit:	100ns

Command PT

<id>PT<para5>	Periodic Time transmitter (Period Transmit Time)
Access:	Configuration mode
Description:	The value sets the transmit time period in the serial register in the analog section of the ULTRASONIC. This value must not be changed under any circumstances. It is factory-set.
Range of values	13..99
Initial value:	Device-dependent
Unit:	100ns

Command PW

<id>PW<para5>	System voltage (Power)
Access:	User mode
Description:	Returns the measured supply voltage in Volt.
	Effective from software version V3.09 and hardware 08-08 the parameter is supported. If the available instrument does not support the measurement of the supply voltage, the text „System power ctrl not supported" is output on inquiry.

Command RC

<id>RC<para5>	Correction factor for analog input values (Reference Correction)
Access:	Configuration mode
Description:	The command specifies a correction factor in 10ppm for the measured values of the analog inputs. The value is factory-adjusted and must not be changed.
Range of values:	0…1000
Initial value:	Device-dependent

Command RD

<id>RD<para5>	Response delay
Access:	User mode
Description:	The command delays the response, after a command via the serial interface, by the mentioned time in ms.
Range of values:	0...1000
Initial value:	5
Unit:	ms

Command RF

<id>RF<para5>	Restart with invalid measuring values (Restart at fail)
Access:	User mode
Description:	By this command it is determined after which period the ULTRASONIC carries out a restart, in case no valid data have been measured. A parameter value of 0 inactivates the function.
	A restart is triggered only in case no valid measuring value has been acquired within the stated time interval.
Value range:	0; 10...1000
Initial value:	60
Unit:	Seconds

Command RP

<id>RP<para5>	Read parameter data set
Access	User mode
Description	With this command a pre-stored data set can be loaded; see also **Command SP**. After loading a restart is carried out automatically. The data set with the index '0' contains the parameters on delivery and cannot be overwritten. The data sets '1' and '2' are available for use.
Value range	0..2

Command RS

<id>RS<para5>	Restart ULTRASONIC (Reset)
Access:	User mode
Description:	With transmission of this command the ULTRASONIC watchdog is no longer operated. This results in a cold start after approx. 2sec. The ULTRASONIC performs a complete restart.

Parameter description:

	1:	The ULTRASONIC performs a cold start. It behaves as after connection of the supply voltage.
Range of values	1	
Initial value:	No initial value	

Command SC

<id>SC<para5>	Minimum value of analog outputs (Start Current)
Access:	User mode
Description:	When using analog outputs the minimum value to be output can be selected. This does not influence the terminal value of the outputs. The minimum value is 0% or 20% of the terminal value. Depending on the parameter AN the selected minimum value is converted to a current or voltage value. This provides for current and voltage outputs with 0..20mA, 4..20mA, 0..10V, and 2..10V: see **Command AN** See also: **Command AA**, **Command AB**

Parameter description:

	0:	Minimum value 0% of maximum value
	1:	Minimum value 20% of maximum value

Together with the parameter AN the analog outputs can be configured as follows:

	Parameter SC=0	Parameter SC=1
Parameter AN=0	0..10V	2..10V
Parameter AN=1	0..20mA	4..20mA

Parameter AA= 0; AB = 0

Table 13: Configuration of analog outputs WV/RXD- and WD/RXD+ with parameters AN and SC

Range of values	0..1
Initial value:	0

Command SE

\<id>SE\<para5>	Output of the stored system information (system event)
Access:	Query mode
Description	Returns the stored system information. There are 178 entries available, before the eldest entries of the circular buffer are overwritten. Events are stored which have been activated by the command SM. See **Command SM**.

Command SH

\<id>SH\<para5>	Serial number (High Word) (Serial number High word)
Access:	Configuration mode
Description:	During factory adjustment of the ULTRASONIC every ULTRASONIC is given a serial number. This serial number allows the ULTRASONIC to be clearly identified. Storage of the serial number is divided up into high and low bytes. The serial number must not be changed.
Range of values	0..65535

Command SL

\<id>SH\<para5>	Serial number (Low Word) (Serial number Low word)
Access:	Configuration mode
Description:	During factory adjustment of the ULTRASONIC every ULTRASONIC is given a serial number. This serial number allows the ULTRASONIC to be clearly identified. Storage of the serial number is divided up into high and low bytes. The serial number must not be changed.
Range of values	0..65535

Command SM

\<id>SM\<para5>	Mask for storing of system information (System event Mask)
Access	User mode
Description	Gives the mask for writing system information into the system memory. If the respective valance is set in the mask, the related events are written into the system event memory. The following events can be selected:

1: System start
2: Closing up in configuration mode
4: Description of internal registers PR and PT
8: No valid data over a longer period
16: Averaging buffer fill level < 2 increments (basis is the value from the extended status)
32: Temperature difference from X- to Y-distance >3Kelvin (at WV < 2m/s)
64: Temperature difference from X- to Y distance > 5Kelvin (at WV < 2m/s)
128: Temperature difference from X- to Y-distance -<7Kelvin (at WV < 2m/s)

When the parameter is set to '0' the system memory is switched off.
The mask value is the sum of the system information which has to be stored.
The value '5' for ex., stored the events ' system start' and 'Description of internal registers PR and PT'.
A value of SM > 0 delays the boot procedure for approx. 200ms. This should be taken into consideration when using 'Fastboot', see **Storing of System Events**.

Value range	0..255
Initial value	0

Command SP

<id>SP<para5>	Store parameter data set
Access	User mode

Description   A data set can be stored by this command. All parameters are stored internally and can be reloaded by RP, see **Command RP**. The data set with index '0' contains the parameters on delivery and cannot be overwritten.

The data sets '1' and '2' are available for use.

Value range   0..2

Command SS

<id>SS<para5>	System status (System Status)
Access:	Enquiry mode
Description:	Outputs the selected parameters of all commands. All parameters stored in the EEPROM are output here.
	Before parameters of the ULTRASONIC are changed, this command should be used to generate and save a list of the selected parameters, e.g. by copying parameters to a text file.

Parameter description:

No parameter is necessary when using the command SS. Callup with selected instrument - ID 00 is as follows:
00SS<cr>   with <cr> Carriage return (Enter key)

Range of values	No value range
Initial value:	No initial value

Command SV

<id>SV<para5>	Software version (Software Version)
Access:	Enquiry mode
Description:	This command reads out the current software version and gives it back. For interpretation the version output must be divided by 100. The output value 00SV00123 represents version V1.23.
	'1' means the main version, 23 is the build label. The build label is changed when available functions have been changed. The version changes when new functions have been added.

Command TB

<id>TB<para5>	Telegram in burst mode
Access:	Interrogation mode
Description:	The command TB is used to select the telegram which outputs the data after a burst measurement ends. All data telegrams are permissible. See also **Command TR**.
Range of values:	1..13
Initial value:	2

Command TC

\<id>TC\<para5>	Temperature correction (Temperature correction)
Access:	Configuration mode
Description:	When measuring the acoustic virtual temperature the orthogonal wind component to the measured section lengthens the acoustic path, and thus results in a too lowly calculated acoustic virtual temperature. The orthogonal wind artificially lengthens the propagation time of the ultrasound, ultimately resulting in corruption of an acoustic virtual temperature. Parameter TC is used to take account of the crosswind component and to correct the acoustic virtual temperature.

Parameter description:

	0:	correction deactivated
	1:	correction activated
Range of value:	0...1	
Initial value:	1	

Command TD

\<id>TC\<para5>	Change of direction for upside down installation
Access:	Configuration mode
Description:	With the command TD, the directions east <-> west are swapped, thereby correcting the direction of rotation for upside down installation.

Parameter description:

	0:	normal assembly
	1:	overhead assembly
Range of value:	0...1	
Initial value:	0	

Command TE

\<id>TE\<para5>	Propagation time delay east sensor (Sensor delay EAST sensor)
Access:	Configuration mode
Description:	Instrument-dependent delay time of sensor. This parameter is set on factory adjustment and must not be changed.
Range of values	0..FFFh
Initial value:	0

Command TF

\<id>TF\<para5>	Transformer for generating acoustic signals (Transformer)
Access:	configuration mode
Description:	Indicates the type of the used transformer for generating the analogue signals.
Value range:	0..1h
Initial value:	instrument-dependent

Command TN

\<id>TN\<para5>	Propagation time delay north sensor (Sensor delay NORTH sensor)
Access:	Configuration mode
Description:	Instrument-dependent delay time of sensor. This parameter is set on factory adjustment and must not be changed.
Range of values	0..FFFh
Initial value:	0

Command TR

<id>TR<para5>	Telegram request (Transmit request)
Access:	Enquiry mode
Description:	The command TR is used to specifically request a telegram from the ULTRASONIC. After interpretation the ULTRASONIC sends back the requested telegram. The instrument specifies a series of predefined telegrams, as well as option for the user to configure his own telegram: see Fixed telegram formats, User-specific telegram.
	In half duplex mode the command TR is the sole option for requesting measured values via the RS485 interface.
	The response time of the ULTRASONIC with a telegram request is defined as follows:
	The time interval after receipt of the last character until transmission of the first character of the response telegram is also < 1ms with standard deviation switched on (measured at RXD+ and TXD+ of RS485).

Parameter description:

1:	VD telegram (wind velocity, wind direction)
2:	VDT telegram (wind velocity, wind direction, virtual temperature)
3:	V4DT telegram (wind velocity, wind direction, virtual temperature)
4:	NMEA V2.0
5:	VDT with standard deviation values
6:	User-defined telegram
7:	Velocity components Vx and Vy
8:	VD Telegram Variant 1
9:	VDT Telegram Variant 1
10..13:	reserved
12:	Scientific diagnostic telegram
14:	NMEA V2.0
16:	User-defined telegram with error codes

Range of values	1..16
Initial value:	No initial value

Command TS

<id>TS<para5>	Sensor Time delay SOUTH Sensor
Access:	Configuration mode
Description:	Instrument-dependent time delay of the sensor. This parameter is factory-set and must not be changed.
Value range:	0...4096
Initial value:	0

Command TT

<id>TT<para5>	Autonomous telegram output (Telegram Transmission)
Access:	User mode
Description:	Determines the number of the telegram, which the ULTRASONIC sends cyclic-autonomously. The telegrams available are the same as specified under **Command TR**, **Command OR** determines the time interval for transmitting the telegrams.
	Value range 0...16
Initial value:	0

Command TW

<id>TW<para5>	Propagation time delay west sensor (Sensor delay WEST sensor)
Access:	Configuration key
Description:	Instrument-dependent delay time of sensor. This parameter is set on factory adjustment and must not be changed.
Range of values	0…4096
Initial value:	0

Command UA

<id>UA<para5>	Addition of characters to user-defined telegram (Add User telegram item)
Access:	Enquiry mode
Description:	In the user-specific telegram this command can be used to add a new definition to the end of the telegram: see, User-specific telegram, **Command US**. The data generated can be interrogated using the command TR6 or TT6: see also **Command TR**, **Command TT**.
Range of values	Character string
Initial value:	No initial value

Command UD

<id>UD,<para5>	User-defined text (User data)
Access	User mode
Description	The instrument provides a data buffer of 32 texts with 32 signs each, where any text can be stored. By the command UD this buffer is administered. The format of entry is
	00Udn,xxxx
	with
	n: index 1..32
	xxxx: text with a maximum length of 32 signs
	query:
	00UD
	returns all user-specific texts, for ex.
	01: THIES ULTRASONIC
	03: LOCATION WASSERKUPPE
	00UDn with 0<n<33
	returns the text with index 'n'
	See also Administration of User Information
Range of values	character string
Initial value	no initial value

Command UR

<id>UR<para5>	Deletion of one or more definitions at the end of the user-defined telegram (Remove User telegram item)
Access:	Enquiry mode
Description:	This command can be used to delete one or more definitions from the end of the user-defined telegram. The ULTRASONIC internally splits the character strings given to it into separate definitions. For example, the output of a variable is always an independent definition.
	This command can be used to delete definitions step by step: see also User-specific telegram, **Command US**.
	The data generated can be interrogated using the command TR6 or TT6: see also **Command TR**, **Command TT**.
Parameter description:	

	0..30	Number of definitions to be deleted at the end of the user-specific telegram.
Range of values	0..30	
Initial value:	No initial value	

Command US

<id>US<para5>	Save user-specific telegram definition (User telegram Save)
Access:	User mode
Description:	This command can be used to store the current definition of the user-specific telegram in the EEPROM. All changes made with the commands UA, UR and UT are not permanently saved. The command US is used to store definitions in the EEPROM.
	The data generated can be interrogated using the command TR6 or TT6: see also **Command TR**, **Command TT**.
Parameter description:	

	2:	Saves the telegram definition in the internal EEPROM.
Range of values	2	
Initial value:	No initial value	

Command UT

<id>UT<para5>	User-specific telegram (User Telegram)
Access:	Enquiry mode
Description:	This command can be used to create a new definition of the user-specific telegram. Any existing definition is overwritten: see also User-specific telegram, **Command US**.
	The data generated can be interrogated using the command TR6 or TT6: see also **Command TR**, **Command TT**.
Range of values	Character string
Initial value:	No initial value

Command VC

<id>VC<para5>	Constant velocity correction (Velocity Correction)
Access:	Configuration mode
Description:	Specifies the factor used to correct the velocity. Specification is made "per mil". This factor must not be changed.

Range of values	0..2000
Initial value:	1055

Command VT

<id>VT<para5>	Angle-dependent velocity correction (Velocity Table)
Access:	Configuration mode
Description:	Switches the calculation on/off which corrects the wind velocity as a function of wind direction.

Parameter description:

0:	Switches correction off
1:	Switches correction on (standard converter)
2:	Switches correction on (encapsulated converter)

Range of values	0..2
Initial value:	2

Command XI

<id>XI<para5>	External ID (External ID)
Access:	User mode
Description:	When set, the instrument ID is determined via the external lines WV/RXD- (BIT 0) , WD/RXD+ (BIT 1) and ADIO (BIT 2). Here the channels must be configured accordingly. See **Command AA, Command AB**, **Command AC**.
	On start-up the ULTRASONIC reads in the ID and stores it in the EEPROM. Reprogramming of the ID is output via the RS485 as a command sequence on start-up.
	If the parameter is set to 0, the ULTRASONIC reads its ID out from the internal EEPROM.
	The individual inputs are LOW-active, that means with a level of 0V the respective ID-bit is set to one. An open input equals a high-level, which means that the respective ID-bit has the valence of 0.

Parameter description:

0:	ULTRASONIC reads ID from internal EEPROM
1:	ULTRASONIC reads ID from external lines

Range of values	0..1
Initial value:	0

11 Appendix 1 Predefined data telegrams

11.1 Telegram 1 VD

Wind speed and wind direction

Command: TR1   Command: TT1

Telegram construction: (STX)xx.x xxx*xx(CR)(ETX)				Telegram output in case of error			
No.	Character	Function	Value	No.	Character	Function	Value
1	STX	Start of Text	02h	1	STX	Start of Text	02h
2	nn.n	Wind velocity		2	„FF.F"	Wind velocity	
6		Blank character	20h	6		Blank character	20h
7	nnn	Wind direction		7	„FFF"	Wind direction	
10	*	Check sum identifier	2Ah	10	*	Check sum identifier	2Ah
11	nn	Check sum hexadecimal (2..9)		11	nn	Check sum hexadecimal (2..9)	
13	CR	Carriage Return	0Dh	13	CR	Carriage Return	0Dh
14	ETX	End of Text	03h	14	ETX	End of Text	03h

11.2 Telegram 2 VDT

Wind speed, wind direction, acoustic-virtual temperature

Command: TR2   command: TT2

Telegram construction:: (STX)xx.x xxx xxx.x xx*xx(CR)(ETX)				Telegram output in case of error			
No.	Character	Function	Value	No.	Character	Function	Value
1	STX	Start of Text	02h	1	STX	Start of Text	02h
2	nn.n	Wind velocity		2	FF.F	Wind velocity	
6		Blank character	20h	6		Blank character	20h
7	nnn	Wind direction		7	FFF	Wind direction	
10		Blank character	20h	10		Blank character	20h
11	±nn.n	Temperature		11	±FF.F	Temperature	
16		Blank character	20h	16		Blank character	20h
17	nn	Status value hexadecimal		17	nn	Status value hexadecimal	
19	*	Check sum identifier	2Ah	19	*	Check sum identifier	2Ah
20	nn	Check sum hexadecimal (2..18)		20	nn	Check sum hexadecimal (2..18)	
22	CR	Carriage return	0Dh	22	CR	Carriage return	0Dh
23	ETX	End of Text	03h	23	ETX	End of Text	03h

11.3 Telegram 3   V4DT

Wind speed, wind direction, acoustic-virtual temperature

Command TR3   Command: TT3

Telegram construction: (STX)xxx.x xxx xxx.x x xx*xx(CR)(ETX)				Telegram output in case of error			
No.	Character	Function	Value	No.	Character	Function	Value
1	STX	Start of Text	02h	1	STX	Start of Text	02h
2	nnn.n	Wind velocity		2	FFF.F	Wind velocity	
7		Blank character	20h	7		Blank character	20h
8	nnn	Wind direction		8	FFF	Wind direction	
11		Blank character	20h	11		Blank character	20h
12	±nn.n	Temperature		12	±FF.F	Temperature	
17		Blank character	20h	17		Blank character	20h
18	n	K, N, M, S = km/h, Knots, m/s, mph		18	n	K, N, M, S = km/h, Knots, m/s, mph	
19		Blank character	20h	19		Blank character	20h
20	nn	Status value hexadecimal		20	nn	Status value hexadecimal	
22	*	Check sum identifier	2Ah	22	*	Check sum identifier	2Ah
23	nn	Check sum hexadecimal (2..18)		23	nn	Check sum hexadecimal (2..18)	
25	CR	Carriage return	0Dh	25	CR	Carriage return	0Dh
26	ETX	End of Text	03h	26	ETX	End of Text	03h

11.4 Telegram 4   NMEA

NMEA V 2.0

Command: TR4   Command TT4

Telegram construction: $WIMWV,xxx.x,R,xxx.x,N,A*xx(CR)(LF)				Telegram output in case of error			
No.	Character	Function	Value	No.	Character	Function	Value
1	$	Dollar	24h	1	$	Dollar	24h
2	W		57h	2	W		57h
3	I		49h	3	I		49h
4	M		4Dh	4	M		4Dh
5	W		57h	5	W		57h
6	V		56h	6	V		56h
7	,	Comma	2Ch	7	,	Comma	2Ch
8-12	nnn.n	Wind direction		8	,	Comma	2Ch
13	,	Comma	2Ch	9	R		52h
14	R		52h	10	,	Comma	2Ch
15	,	Comma	2Ch	11	,	Comma	2Ch
16-20	nnn.n	Wind velocity		12		K, N, M, S = km/h, Knots, m/s, mp	
21	,	Comma	2Ch	13	,	Comma	2Ch

Telegram construction: $WIMWV,xxx.x,R,xxx.x,N,A*xx(CR)(LF)				Telegram output in case of error			
22		K, N, M, S = km/h, Knots, m/s, mp		14	V	V = invalid	
23	,	Comma	2Ch	15	*	Check sum identifier	2Ah
24	A, V	A = valid, V = invalid		16	nn	Check sum hexadecimal (2..14 inclusive)	
25	*	Check sum identifier		18	CR	Carrige return	0Dh
26-27	nn	Check sum hexadecimal (2..24 inclusive)		19	LF	Line Feed	0Ah
28	CR	Carriage return	0Dh				
29	LF	Line Feed	0Ah				

11.5 Telegram 5   VDT, Standard deviation

Standard deviation

When using the standard deviation the VDT telegram is extended by the standard deviation of the wind speed and wind direction.

Command: TR5   Command: TT05

Telegram construction: (STX)xx.x xx.x xxx xxx xxx.x xxx.x xx*xx(CR)(ETX)				Telegram output in case of error The telegram format corresponds to the data telegram with respective status value.
No.	Character	Function	Value	
1	STX	Start of Text	02h	
2	nn.n	Wind velocity		
6		Blank character	20h	
7	nn.n	Wind velocity (Standard deviation)		
11		Blank character	20h	
12	nnn	Wind direction		
15		Blank character	20h	
16	nnn	Wind direction (Standard deviation)		
19		Blank character	20h	
20	±nn.n	Temperature		
25		Blank character	20h	
26	±nn.n	Temperature (Standard deviation)		
31		Blank character	20h	
32	nn	Status value hexadecimal		
34	*	Check sum identifier	2Ah	
35	nn	Check sum hexadecimal (1..33)		
37	CR	Carriage return	0Dh	
38	ETX	End of Text	03h	

11.6 Telegram 7   Vx, Vy, VT

Velocity components Vx und Vy

Command: TR7   Command: TT07

No.	Character	Function	Value	No.	Character	Function	Value
Telegram construction: (STX)xxx.x;xxx.x;xxx.x;xx;xx(CR)(ETX)				Telegram output in case of error			
1	STX	Start of Text	02h	1	STX	Start of Text	02h
2	±nn.n	Wind velocity X		2	±FFF.F	Wind velocity	
7	;	Semicolon		7	;	Semicolon	
8	±nn.n	Wind velocity Y		8	±nn.n	Wind velocity Y	
13	;	Semicolon		13	;	Semicolon	
14	±nn.n	Temperature		14	±FF.F	Temperature	
19	;	Semicolon		19	;	Semicolon	
20	nn	Status value hexadecimal		20	nn	Status value hexadecimal	
22	;	Semicolon		22	;	Semicolon	
23	nn	Check sum hexadecimal (1..22)		23	nn	Check sum hexadecimal (1..22)	
25	CR	Carriage return	0Dh	25	CR	Carriage return	0Dh
26	ETX	End of Text	03h	26	ETX	End of Text	03h

11.7 Telegram 8   VD Variant 1

Wind speed and Wind direction Variant 1

Command: TR8   Command: TT8

No.	Character	Function	Value	No.	Character	Function	Value
Telegram construction: (STX)xx.x.xxx*(CRLF)(ETX)				Telegram output in case of error			
1	STX	Start of Text	02h	1	STX	Start of Text	02h
2	nn.n	Wind velocity X		2	FF.F	Wind velocity X	
6		Blank character	20h	6		Blank character	20h
7	nnn	Wind direction		7	FFF	Wind direction	
10	*	Check sum identifier	2Ah	10	*	Check sum identifier	2Ah
11	nn	Check sum hexadecimal (2..9)		11	nn	Check sum hexadecimal (2..9)	
13	CR	Carriage Return	0Dh	13	CR	Carriage Return	0Dh
14	LF	Line Feed	0Ah	14	LF	Line Feed	0Ah
15	ETX	End of Text	03h	15	ETX	End of Text	03h

11.8 Telegram 9   VDT Variant 1

Wind speed, Wind direction, acoustic-virtual temperature, status and check sum (type 2)

Command: TR9   Command: TT9

No.	Character	Character repertoire	Function
Telegram construction: **!iivvvdddttttwfR**
No.	Character	Character repertoire	Function
1	!		Response character
2	i	0 ••• 9	Instrument ID
3	i	0 ••• 9	Instrument ID
4	v	0 ••• 9	Wind velocity * 10^{1} m/s
5	v	0 ••• 9	Wind velocity * 10^{0} m/s
6	v	0 ••• 9	Wind velocity * 10^{-1} m/s
7	d	0 ••• 9	Wind direction * 10^{2} Grad
8	d	0 ••• 9	Wind direction * 10^{1} Grad
9	d	0 ••• 9	Wind direction * 10^{0} Grad
10	t	+ ••• −	Sign
11	t	0 ••• 9	Temperature * 10^{1} °C
12	t	0 ••• 9	Temperature * 10^{0} °C
13	t	0 ••• 9	Temperature * 10^{-1} °C
14	w	ASCII	Status byte, see 7.4.6.4
15	f	ASCII	Check sum (type2) 1

11.9 Telegram 11   VDT Variant 2

Wind velocity, wind direction, and acoustic-virtual temperature

Command: TR11   Command: TT11

No.	Character	Function	Value	No.	Character	Function	Value
	**Telegram construction:** **(STX)xx;xx.x;xxx;xxx.x;xxxx*xx(CR)(LF)(ETX)**		**Telegram output in case of error**
No.	Character	Function	Value	No.	Character	Function	Value
1	STX	Start of Text	02h	1	STX	Start of Text	02h
2	nn	ID		2	FF	ID	
4	;	Semicolon		4	;	Semicolon	
5	nn.n	Wind velocity		5	FF.F	Wind velocity	
9	;	Semicolon		9	;	Semicolon	
10	nnn	Wind direction		10	FFF	Wind direction	
13	;	Semicolon		13	;	Semicolon	
14	±nn.n	Temperature		14	±FF.F	Temperature	
19	;	Semicolon		19	;	Semicolon	
20	nnnn	Status value (extended status)		20	nnnn	Status value (extended status)	
24	*	Star		24	*	Star	
25	nn	Check sum hexadecimal (2..23)		25	nn	Check sum hexadecimal (2..23)	
27	CR	Carriage Return	0Dh	27	CR	Carriage Return	0Dh
28	LF	Line Feed	0Ah	28	LF	Line Feed	0Ah
29	ETX	End of Text	03h	29	ETX	End of Text	03h

11.10 Telegram 12   Scientific Telegram

Scientific Diagnostic Telegram

Command: TR12   Command: TT12

Telegram construction: **WG;WR;VT;V13;V24;T13;T24; C31; C42; C13; C24;N1;N2;N3;N4;TS;TC**	
WG	Wind speed (7,2;)
WR	Wind direction (6,2;)
VT	Virtual temperature (6,2;)
V13	Speed of distance 13 (7,2;)
V24	Speed of distance 24 (7,2;)
T13	Virtual temperature of distance 13 (7,2;) (last measured value in averaging interval; -273,15 in case of no valid value)
T24	Virtual temperature of distance 24 (7,2;) (last measured value in averaging interval; -273,15 in case of no valid value)
C31	Measuring value run-time Converter 3 in direction Converter 1 (south- north direction) (5;)
C42	Measuring value run-time Converter 4 in direction Converter 2 (west- east direction) (5;)
C13	Measuring value run-time Converter 1 in direction Converter 3 (north- south direction) (5;)
C24	Measuring value run-time Converter 2 in direction Converter 4 (east- west direction) (5;)
N1	Internal counter (5;)
N2	Time interval, where the values are written into the main average memory (5;)
N3	Number of values in the main average memory (5;)
N4	THIES Status (2h;)
TS	Telegram status, see **Extended status information** (hexadecimal display) (4h;)
TC	Internal tick count in ms of the processor (9;\r\n)

Signification (7,2;)   (x;y)

X=> Number of digits in the telegram

Y=> Number of decimal places

for ex. (7;2;)

  0000.00;

11.11 Telegram 13 VDT Variant 3

Wind velocity, wind direction, and acoustic-virtual temperature
Command: TR13 Command: TT13

No.	Character	Function	Value	No.	Character	Function	Value
	**Telegram construction:** **(STX)xx;xx.x;xx.x;xxx;xxx.x;xxx.x;xxx.x;xxxxx;** **xxxx*xx(CR)(LF)(ETX)**			**Telegram output in case of error**		
1	STX	Start of Text	02h	1	STX	Start of Text	02h
2	nn	ID		2	FF	ID	
4	;	Semicolon		4	;	Semicolon	
5	nn.n	Wind velocity (vectorial)		5	99.9	Wind velocity (vectorial)	
9	;	Semicolon		9	;	Semicolon	
10	nn.n	Wind velocity (scalar)		10	99.9	Wind velocity (scalar)	
14	;	Semicolon		14	;	Semicolon	
15	nnn	Wind direction (vectorial)		15	999	Wind direction (vectorial)	
18	;	Semicolon		18	;	Semicolon	
19	±nn.n	Temperature		19	±99.9	Temperature	
24	;	Semicolon		24	;	Semicolon	
25	±nn.n	Wind velocity Vx		25	±99.9	Wind velocity Vx	
30	;	Semicolon		30	;	Semicolon	
31	±nn.n	Wind velocity Vy		31	±99.9	Wind velocity Vy	
36	;	Semicolon		36	;	Semicolon	
37	nnnnn	Number of mean values		37	99999	Number of mean values	
42	;	Semicolon		42	;	Semicolon	
43	nnnn	Status value (extended status)		43	9999	Status value (extended status)	
47	*	Star		47	*	Star	
48	nn	Check sum hexadecimal (2..46 inclusive)		28	nn	Check sum hexadecimal (2..46 inclusive)	
50	CR	Carriage Return	0Dh	50	CR	Carriage Return	0Dh
51	LF	Line Feed	0Ah	51	LF	Line Feed	0Ah
52	ETX	End of Text	03h	52	ETX	End of Text	03h

11.12 Telegram 14   NMEA

NMEA 0183 Version 2.0 (Output WIMWV and WIMTA)

Command: TR14   Command: TT14

Telegram construction: $WIMWV,xxx.x,R,xxx.x,N,A*xx(CR)(LF)				Telegram output in error case			
No.	Charact.	Function	Value	No.	Charact.	Function	Value
1	$	Dollar	24h	1	$	Dollar	24h
2	W		57h	2	W		57h
3	I		49h	3	I		49h
4	M		4Dh	4	M		4Dh
5	W		57h	5	W		57h
6	V		56h	6	V		56h
7	,	comma	2Ch	7	,	comma	2Ch
8-12	nnn.n	Wind direction		8	,	comma	2Ch
13	,	comma	2Ch	9	R		52h
14	R		52h	10	,	comma	2Ch
15	,	comma	2Ch	11	,	comma	2Ch
16-20	nnn.n	Wind velocity		12		K, N, M, S = km/h, Knots, m/s, mp	
21	,	comma	2Ch	13	,	comma	2Ch
22		K, N, M, S = km/h, Knots, m/s, mp		14	V	V = invalid	
23	,	comma	2Ch	15	*	Check sum detection	2Ah
24	A, V	A = valid, V = invalid		16	nn	Check sum hexadecimal (2..14 including)	
25	*	Check sum detection		18	CR	Carriage return	0Dh
26-27	nn	Check sum hexadecimal (2..24 including)		19	LF	Line Feed	0Ah
28	CR	Carriage return	0Dh				
29	LF	Line Feed	0Ah				

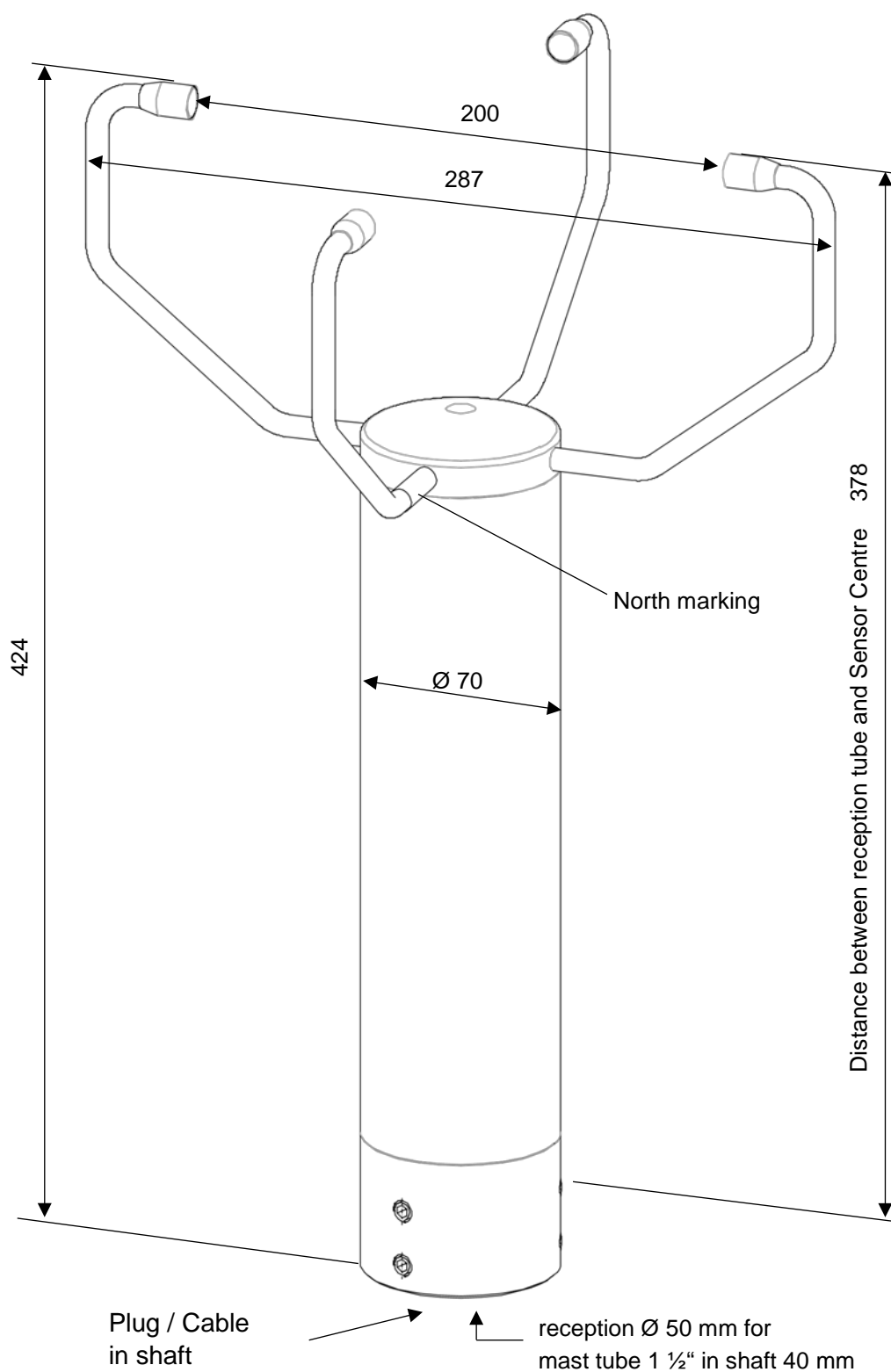| Telegram construction: $WIMTA,xxx.x,C,*xx(CR)(LF)				Telegram output in error case			
No.	Charact.	Function	Value	No.	Charact.	Function	Value
1	$	Dollar	24h	1	$	Dollar	24h
2	W		57h	2	W		57h
3	I		49h	3	I		49h
4	M		4Dh	4	M		4Dh
5	T		54h	5	T		54h
6	A		41h	6	A		41h
7	,	comma	2Ch	7	,	comma	2Ch
8-12	nnn.n	Acoustic virtual temperature		8-12	999.9	999.9	
13	,	comma	2Ch	13	,	comma	2Ch
14	C		43h	14	C		43h
15	*	Check sum detection		15	*	Check sum detection	2Ah
16-17	nn	Check sum hexadecimal (2..14 including)		16	nn	Check sum hexadecimal (2..14 including)	
18	CR	Carriage return	0Dh	18	CR	Carriage return	0Dh
19	LF	Line Feed	0Ah	19	LF	Line Feed	0Ah

12 Technical data

Wind velocity	Measuring range	0.01 ... 85m/s (Starting threshold: 0,01m/s) Scaling of analog output freely selectable.	
	Accuracy	<= 5m/s:	±0,1m/s (rms, mean over 360°)
		>5m/s:	±2% of meas. value (rms, mean over 360°)
	Resolution	0.1m/s:	In the telegrams: No. 1 to 5, 7 to 9, 11 to 13
		0.01m/s:	in the user-defined telegrams: (Nr. 6)
Wind direction	Measuring range	0 ... 360° (0 ... 540 °, 0 ... 720 ° for analogue output, adjustable)	
	Accuracy	± 1.0°	
	Resolution	1°:	In the telegrams: No. 1 to 5, 7 to 9, 11 to 13
		<1°:	in the user-defined telegrams: (No. 6)
Virtual temperature	Measuring range	-50 .... + 70°C	
	Accuracy	±0.5K to 35m/s	
	Resolution	0.1K (in the telegrams No. 1 to 5, 07 to 9, 11 to 013)	
Data output digital	Interface	RS 485 / RS 422	
	Baud rate	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600 adjustable	
	Output	Instantaneous values, wind velocity / direction and acoustic-virtual temp. Sliding mean values 0.5sec..100min freely selectable Standard deviation for wind velocity /direction and acoustic-virtual temp. Predefined data telegrams or user-defined data telegram.	

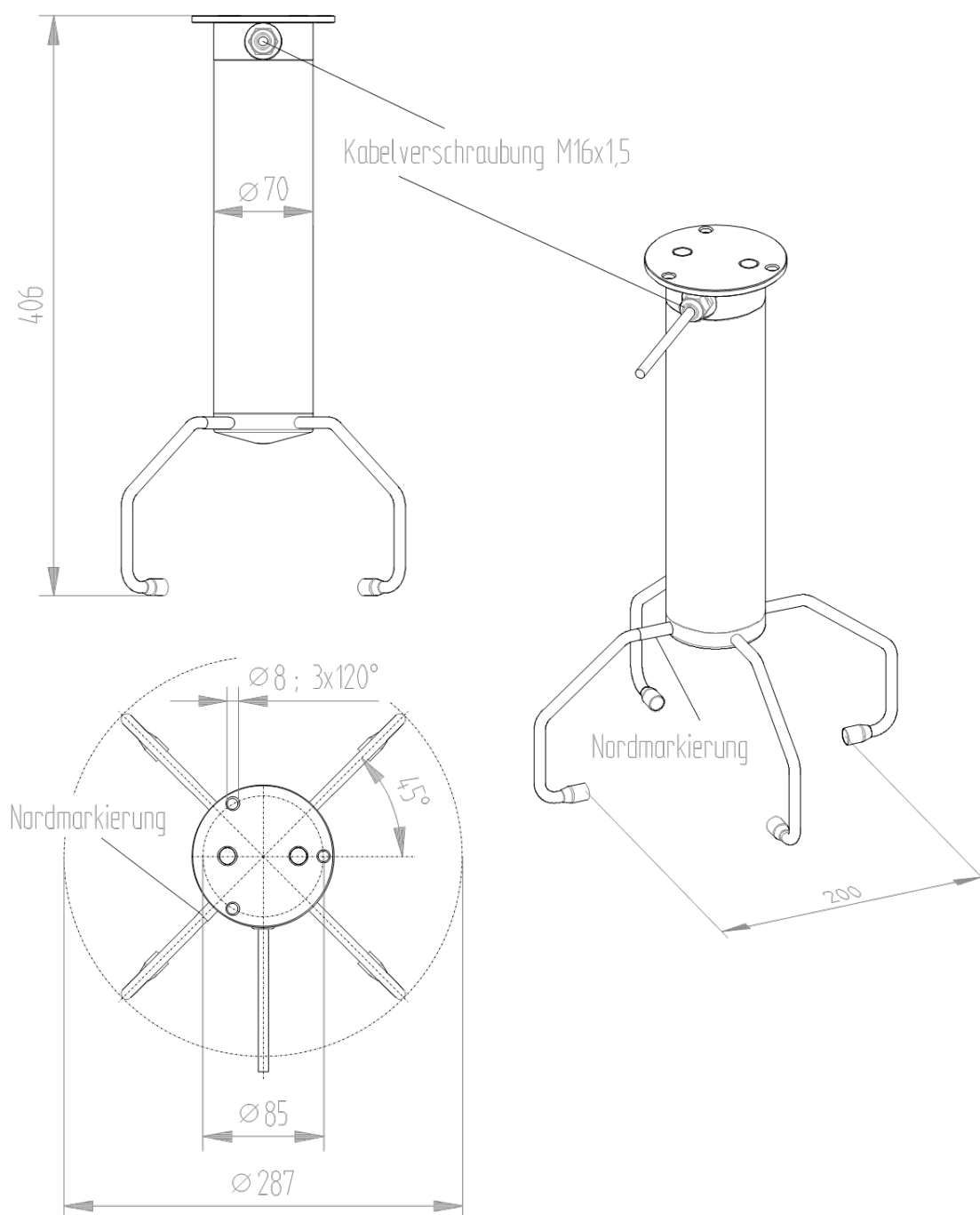|	Output rate	1 per 1msec to 1 per 60 seconds adjustable in msec steps
	Status identification	Heating, failure of measurement path , ΔT path temperatures
Data output analogue	Electr. output	0 ...+20mA / 0 ... +10V or 4 ... +20mA / 2 ... +10V Wind velocity, wind direction and virt. temperature
		Burden on current output maximum 500Ω
		Burden on voltage output minimum 4000Ω
	Output	Instantaneous values Sliding mean values 0.5sec..100min freely selectable
	Output rate	Updating rate 7.5 up to 256msec adjustable
	Resolution	16bit
Analogue inputs	Number	Up to three analog inputs possible (3 x standard, 2 x add. configurable after consulting manufacturer)
	Resolution	16bit
	Sampling rate	0.1 ... 100Hz per channel
	Input range	0 to + 10,0V
	Data processing	Output of measured values in user-specific telegram
	Accuracy	$\pm$1,0% of meas. value in the range –40 ... +70°C
	Linearity integral Effective noise free bits	INL: typ. < 6 LSB Typ. 14bit* *with DC-supply for avoiding dynamic crosstalk in the connecting line
General	Internal measuring rate	Up to 400 measurements per second at +20 °C
	Bus mode	Bus mode with up to 99 instruments possible
	Program update	Program update possible in bus mode
Ambient condition	Temperature	Operating temperature –50 ... + 80°C heated –30 ... + 80°C unheated Storing –50 ... + 80°C Measuring operation possible with heating down to -75°C
	Rel. humidity	0 … 100% r.h.
Operating voltage	Supply electronics - w/o heating operation	U: 8 ...78VDC or 12 ...55VAC, 45 …65Hz P: typ. 1.5VA , max. 2.5VA
(with 4.382x.0x.xxx)	Supply: electronics + heating - with heating operation of US-arms	U: 24VAC/DC ±15%, 45 … 65Hz P: typ. 80VA , max. 90 VA @ 24V
(with 4.382x.3x.xxx)	Supply: electronics + heating - with heating operation of US-arms and US-converter	U: 24VAC/DC ±15%, 45 … 65Hz P: typ. 85VA , max. 90 VA @ 24V
(with 4.382x.4x.xxx)	Supply: electronics + heating - with heating operation of US-arms US-converter and housing	U: 48 VAC/DC ±15%, 45 … 65Hz P: typ. 280VA , max. 310VA @ 48V
(with 4.3820.34.317)	Supply: electronics + heating	U: 2 x 24VAC/DC ±15 %, 45 … 65Hz P: typ. 85VA , max. 90VA @ 24V separated in 1 x max. 10VA and 1x max. 80VA

	- with heating operation of US-arms and US-converter	
(with 4.382x.34.398)	Supply: electronics + heating - with heating operation of US-arms US-converter and housing	U: 2 x 24VAC/DC ±15%, 45 … 65Hz P: typ. 240VA @ 24V
Icing resistance	- w/o transducer heating	acc. to THIES STD 012001
Icing resistance	- with transducer heating	acc. to THIES STD 012002
	Housing material	Stainless steel (V4A)
	Installation type	Mast tube Ø 50mm (see dimension drawing)
	Connection type	8-pole plug connection in shaft or with connected cable
	Protection	IP 67 (in case of conventional mounting and screwed and converted coupling socket (if necessary), see chapter „Preparation for operation")
	Weight	2.5kg

13 Dimension Drawing

4.3826.30.340

North marking

200

287

Ø 70

424

Distance between reception tube and Sensor Centre   378

Plug / Cable
in shaft

reception Ø 50 mm for
mast tube 1 ½" in shaft 40 mm

4.3825.32.500/503/506

Kabelverschraubung M16x1,5

∅70

406

∅8 : 3x120°

45°

Nordmarkierung

∅85

∅287

Nordmarkierung

200

14 Accessories (available as optional features)

Connecting cable, complete	507751	15m cable with socket outlet on transmitter side. The other end of the cable is equipped with core identification rings.
PC-Program Meteo-Online	9.1700.98.000	For graphical display of measured values on a PC.
Interface converter	9.1702.xx.000	For RS 422 signal conversion in RS 232.
Lightning rod	4.3100.99.150	As lightning protection.
Device to refuse birds Pin US 2 D Protective cap	 508396 212352	A protective pin, which is to be screwed onto the arm carrier of the ultrasonic anemometer, shall prevent bigger birds from sitting on the instrument.
Device to refuse birds	507245	In order to prevent small birds from sitting on the Ultrasonic-Anemometer, which might interfere the measurement of the measuring path. The device consists of a metal band with clamps.
North- ring	508696	Serves as mounting and adjustment aid.

15 More Information / Documents as download

Further information can be found in the short instructions for use. These document and also the instruction for use are available for download under the following links.

Short instruction for use

https://www.thiesclima.com/db/dnl/4.382x.3x.xxx_US-Anemometer-2D_e_kurz.pdf

Instruction for use

https://www.thiesclima.com/db/dnl/4.382x.3x.xxx_US-Anemometer-2D_e.pdf

16 EC-Declaration of Conformity

Manufacturer: Adolf Thies GmbH & Co. KG

Hauptstraße 76

37083 Göttingen, Germany

http://www.thiesclima.com

Product: US 2D

Doc. Nr. 606-44763_CE

Article Overview:

4.3820.00.050	4.3820.00.240	4.3820.00.251	4.3820.00.260	4.3820.00.300	4.3820.00.330	4.3820.00.340	4.3820.00.347	4.3820.00.348	4.3820.00.349
4.3820.00.350	4.3820.00.360	4.3820.00.398	4.3820.00.399	4.3820.00.430	4.3820.00.440	4.3820.00.640	4.3820.00.740	4.3820.01.300	4.3820.01.309
4.3820.01.310	4.3820.01.312	4.3820.01.400	4.3820.01.940	4.3820.02.300	4.3820.02.302	4.3820.02.306	4.3820.02.310	4.3820.02.320	4.3820.02.321
4.3820.02.322	4.3820.02.323	4.3820.02.500	4.3820.03.000	4.3820.03.300	4.3820.03.301	4.3820.05.390	4.3820.30.000	4.3820.30.001	4.3820.30.051
4.3820.30.059	4.3820.30.060	4.3820.30.131	4.3820.30.260	4.3820.30.261	4.3820.30.300	4.3820.30.340	4.3820.30.340E	4.3820.30.347	4.3820.30.349
4.3820.30.350	4.3820.30.351	4.3820.30.398	4.3820.30.401	4.3820.30.440	4.3820.30.740	4.3820.31.300	4.3820.31.310	4.3820.31.311	4.3820.31.401
4.3820.31.410	4.3820.32.029	4.3820.32.300	4.3820.32.301	4.3820.32.308	4.3820.32.309	4.3820.32.310	4.3820.32.320	4.3820.32.500	4.3820.33.000
4.3820.34.315	4.3820.34.318	4.3820.34.319	4.3820.34.398	4.3820.34.399	4.3820.35.390	4.3820.36.390	4.3820.37.340	4.3820.40.260	4.3820.40.300
4.3820.40.340	4.3820.40.351	4.3820.40.360	4.3820.41.301	4.3820.41.310	4.3820.42.300	4.3820.43.005	4.3820.43.305	4.3820.46.390	4.3820.90.340
4.3820.98.000	4.3821.00.000	4.3821.01.000	4.3821.01.100	4.3821.01.319	4.3821.31.000	4.3821.31.318	4.3821.31.319	4.3821.41.000	4.3822.40.340
4.3824.31.318	4.3824.34.319	4.3824.44.319	4.3825.32.500	4.3826.30.340					

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.
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).
2018/1139/EU	04.07.2018	Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency.

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

DIN EN 50625-1	2014-09	Collection, logistics & Treatment requirements for WEEE. General treatment requirements.
DIN EN 60945	2003-07	Maritime navigation and radiocommunication equipment and systems. General requirements. Methods of testing and required test results
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 61000-6-2	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 61010-1	2020-03	Safety requirements for electrical equipment for measurement, control, and laboratory use. 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.

17 UK-CA Declaration of Conformity

Manufacturer: Adolf Thies GmbH & Co. KG

Hauptstraße 76

37083 Göttingen, Germany

http://www.thiesclima.com

Product: US 2D   **Doc. Nr. 606-44763_CA**

Article Overview:

4.3820.00.050	4.3820.00.240	4.3820.00.251	4.3820.00.260	4.3820.00.300	4.3820.00.330	4.3820.00.340	4.3820.00.347	4.3820.00.348	4.3820.00.349	
4.3820.00.350	4.3820.00.360	4.3820.00.398	4.3820.00.399	4.3820.00.430	4.3820.00.440	4.3820.00.640	4.3820.00.740	4.3820.01.300	4.3820.01.309	
4.3820.01.310	4.3820.01.312	4.3820.01.400	4.3820.01.940	4.3820.02.300	4.3820.02.302	4.3820.02.306	4.3820.02.310	4.3820.02.320	4.3820.02.321	
4.3820.02.322	4.3820.02.323	4.3820.02.500	4.3820.03.000	4.3820.03.300	4.3820.03.301	4.3820.05.390	4.3820.30.000	4.3820.30.001	4.3820.30.051	
4.3820.30.059	4.3820.30.060	4.3820.30.131	4.3820.30.260	4.3820.30.261	4.3820.30.300	4.3820.30.340	4.3820.30.340E	4.3820.30.347	4.3820.30.349	
4.3820.30.350	4.3820.30.351	4.3820.30.398	4.3820.30.401	4.3820.30.440	4.3820.30.740	4.3820.31.300	4.3820.31.310	4.3820.31.311	4.3820.31.401	
4.3820.31.410	4.3820.32.029	4.3820.32.300	4.3820.32.301	4.3820.32.308	4.3820.32.309	4.3820.32.310	4.3820.32.320	4.3820.32.500	4.3820.33.000	
4.3820.34.315	4.3820.34.318	4.3820.34.319	4.3820.34.398	4.3820.34.399	4.3820.35.390	4.3820.36.390	4.3820.37.340	4.3820.40.260	4.3820.40.300	
4.3820.40.340	4.3820.40.351	4.3820.40.360	4.3820.41.301	4.3820.41.310	4.3820.42.300	4.3820.43.005	4.3820.43.305	4.3820.46.390	4.3820.90.340	
4.3820.98.000	4.3821.00.000	4.3821.01.000	4.3821.01.100	4.3821.01.319	4.3821.31.000	4.3821.31.318	4.3821.31.319	4.3821.41.000	4.3822.40.340	
4.3824.31.318	4.3824.34.319	4.3824.44.319	4.3825.32.500	4.3826.30.340						

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

1091	08.12.2016	The Electromagnetic Compatibility 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)
2018/1139/EU	04.07.2018	Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency.

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

BS EN 50625-1	31.03.2014	Collection, logistics & Treatment requirements for WEEE. General treatment requirements
BS EN 60945	15.04.2003	Maritime navigation and radiocommunication equipment and systems. General requirements. Methods of testing and required test results
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 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 61010-1+A1	31.03.2017	Safety requirements for electrical equipment for measurement, control, and laboratory use. 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 certifies 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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