Ultrasonic Anemometer 2D

Operating Instructions 4.3800.00.xxx

1. Range of Application

The **Ultrasonic Anemometer 2D** is designed to detect the horizontal components of wind speed and wind direction as well as the virtual temperature in two dimensions. Due to its very short measurement intervals, the instrument is ideal for the inertia-free measurement of gusts and peak values.
In certain weather situations the accuracy of the air temperature measurement (virtual-temperature) surpasses that one of the classic method where the temperature transmitter is used in a weather and thermal radiation shield.
The measured data are available as analogue signals and as a data telegram over a serial interface.
The sensors instrument as well as the instrument body are automatically heated so that the measuring results, in case of critical ambient temperatures, are not affected by ice, snow or rainfall.

2. Mode of Operation

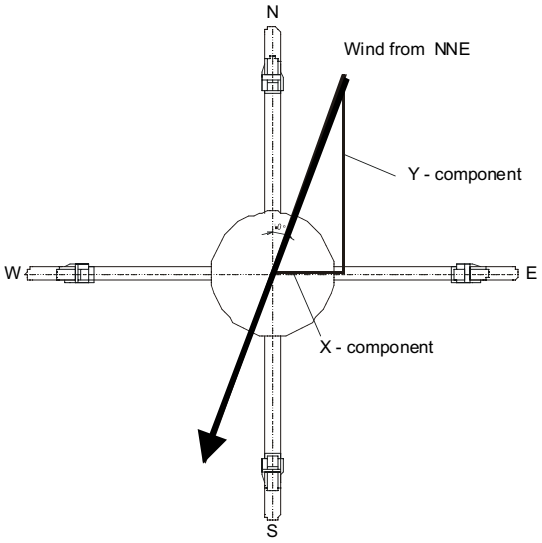
The **Ultrasonic Anemometer 2D** consists of 4 ultrasonic transformers, in pairs of 2 which are opposite each other at a distance of 200 mm.
The two measurement paths thus formed are vertical to each other.
The transformers act both as acoustic transmitters and acoustic receivers.
The respective measurement paths and their measurement direction are selected via the electronic control. When a measurement starts, a sequence of 8 individual measurements in all 4 directions of the measurement paths is carried out at maximum possible speed.
The measurement directions (acoustic 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 formed from the 8 individual measurements of the path directions and used for further calculations.
A measurement sequence takes approx. 20 msec at +20°C.

3. Measurement Principle

3.1 Wind speed and direction

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

A wind speed component in the direction of the propagation of the sound supports the speed of propagation, thus leading to an increase in the speed. A wind speed component opposite to the direction of propagation, on the contrary, leads to a reduction of the speed of propagation.
The speed of propagation resulting from the 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 is very dependent on the air temperature, the propagation time of the sound is measured on both of the measurement paths in both directions. In this way, the influence of the temperature-dependent speed of sound on the measurement result can be eliminated.



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

After the rectangular speed components have been measured, they are then transformed by the µ-processor of the anemometer into polar coordinates and output as sum and angle of wind speed.

3.2 Virtual Temperature

As previously mentioned, the speed of the propagation of sound depends in form of a square root law on the absolute air temperature, but is rather independent of air pressure, and only slightly dependent of humidity. Thus these physical properties of gases can be used to measure air temperature at constant chemical composition.
It is a measurement of gas temperature which is made without thermal coupling to a measurement sensor.

The advantages of this measured variable is, on the one hand, its inertia free reaction to the actual gas temperature, and, on the other hand, the avoidance of measurement errors such as those which occur when a solid state temperature sensor is heated up by radiation.

Due to the low dependency of the speed of propagation of the sound on the air humidity, the “Virtual Temperature” refers to dry air (0% humidity) under the same pressure conditions as that one actually measured.
The maximum deviation of the “Virtual Temperature” from the real air temperature is about –0.2K (15 % rel. hum.) up to +1K (100 % rel. air hum.) at a temperature of +25 °C (acc. to Harris 1971).

Measuring sensors in a weather and thermal radiation shield show values which are, on the one hand, too high, due to sun irradiation, and on the other hand too low, due to evaporation cooling with rain and wind.

The measuring errors of those thermometers in practice can be up to ± 2°K.

The 2D-Anemometer achieves a measuring accuracy of ± 1 °K over the entire temperature range from –40°C to + 70°C, thus offering a very precise determination of the air temperature without the disadvantages caused by the use in a weather and thermal radiation shield.

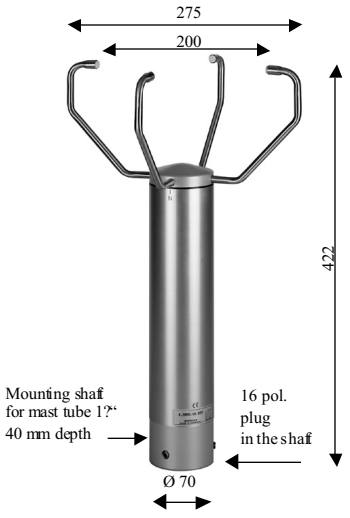
4. Technical Data

Wind Speed		Meas. range	0...60 m/s
		Accuracy	± 0.1 m/s , at the range 0 ... 5 m/s resp. ± 2 % rms from meas. value , at > 5 m/s
		Resolution	0.1 m/s
Wind Direction		Meas. range	0...360°
		Accuracy	± 1.0°
		Resolution	1°
Virtual Temperature		Meas. range	- 40 .... + 70 °C
		Accuracy	± 1 K
		Resolution	0.1 K
Data output	**digital**	Interface	RS 232 ; RS 485 / 422
		Baud rate	1200, 2400, 4800, 9600, 19200 adjustable
		Output	Instantaneous values Gliding mean values 1sec.; 10sec.; 1min.; 2min.; 10min.
		Output rate	10 per second
		Status identification	heater, transmission break-downs
	analogue	Electr. Output	0 ... 20 mA / 0 ... 10 V or 4 ... 20 mA / 2 ... 10 V Load at current output max. 180 Ω
		Output	Instantaneous values Gliding mean values 1sec.; 10sec.; 1min.; 2min.; 10min.
		Output rate	1 per 100 msec. up to1 per 25 sec. , adjustable
		Resolution	12 bit
General		Internal meas. rate	400 measurements per sec. , at 25 °C
		Temp. range	- 40 ... + 70 °C
		Operating voltage	electronic, 12 ... 24 V AC/DC ; max. 3 VA heater , 24 V AC/DC , max. 70 VA
		Protection	IP 65
		Icing	acc. to MIL STD 810 E
		EMV	EN 55022 5/95 class B; EN50082-2 2/96
		Mounting	to a mast tube 1 _ ", for ex. DIN 2441
		Type of connection	16 pole plug connection in the shaft
		Model	Stainless steel for housing and sensor arms
		Weight	approx. 2.5 kg

5. Plug Connection Assignment

Pin-No.	Function		Remark
1 (A)	Analogue output current WV		0 / 4 – 20 mA
2 (B)	Analogue output current WD		0 / 4 – 20 mA
3 (C)	Analogue Ground		AGND
4 (D)	Analogue output voltage WV		0 / 2 – 10 V
5 (E)	Analogue output voltage WD		0 / 2 – 10 V
6 (F)	TXD RS232	RS485 (RS 422) TX+	serial interface
7 (G)	RXD	RX+	serial interface
8 (H)	GND	GND	serial interface
9 (I)		RX-	serial interface
10 (K)		TX-	serial interface
11 (L)	Power electr. 12 ... 24V AC/DC		
12 (M)	Power electr. 12 ... 24V AC/DC		
13 (N)	Power heater 24 V AC/DC		bridged with PIN 14
14 (O)	Power heater 24 V AC/DC		bridged with PIN 13
15 (P)	Power heater 24 V AC/DC		bridged with PIN 16
16 (R)	Power heater 24 V AC/DC		bridged with PIN 15

Scale Drawing



5.1 Remarks concerning Power Supply of Instrument:

The connecting cables for the heating (13 u. 14; 15 u. 16) must be bridged on the supply side in order to guarantee the complete heating power!
The supply of the electronics is effected additionally via diodes uncoupled through the heating connections 13,14, and 15, 16.
If the heating voltage exceeds the supply voltage the heating voltage takes on the supply of the electronics.

Attention:

Due to the coupling of heating- and supply voltage both voltages must be configured in galvanic isolation on the supply side (for ex. two separate secondary windings); in case of non-observance the instrument would be in danger of damage!

6. Interface Description

6.1 Telegram forms

6.1.1 Telegram VD **(STX)xx.x xxx*xx(CR)(ETX)**

Z. NR.	FUNCTION
1	STX (HEX 02)
2	10^1 Wind speed
3	10^0 Wind speed
4	"." Decimal point
5	10^{-1} Wind speed
6	space (HEX 20)
7	10^2 Wind direction
8	10^1 Wind direction
9	10^0 Wind direction
10	* (HEX 2A) Check sum identification
11	High Byte check sum in HEX
12	Low Byte check sum in HEX
13	CR (HEX 0D) Carriage return
14	ETX (HEX 03)

6.1.2 Telegram VDT (STX)xx.x xxx xxx.x x*xx(CR)(ETX)

Z. NR.	FUNCTION
1	STX (HEX 02)
2	10^1 Wind speed
3	10^0 Wind speed
4	"." (HEX 2E) Decimal point
5	10^{-1} Wind speed
6	Space (HEX 20)
7	10^2 Wind direction
8	10^1 Wind direction
9	10^0 Wind direction
10	Space (HEX 20)
11	+ or - sign
12	10^1 Temperature
13	10^0 Temperature
14	"." (HEX 2E) Decimal point
15	10^{-1} Temperature
16	Space (HEX 20)
17	High Byte status byte
18	Low Byte status byte
19	* (HEX 2A) Check sum ident.
20	High Byte Check sum in HEX
21	Low Byte Check sum in HEX
22	CR (HEX 0D) Carriage return
23	ETX (HEX 03)

6.1.3 Telegram V4DT (STX)xxx.x xxx xxx.x x xx*xx(CR)(ETX)

Z. NR.	FUNKCTION
1	STX (HEX 02)
2	10^2 Wind speed
3	10^1 Wind speed
4	10^0 Wind speed
5	. (HEX 2E) Decimal point
6	10^{-1} Wind speed
7	Spare (HEX 20)
8	10^2 Wind direction
9	10^1 Wind direction
10	10^0 Wind direction
11	Space (HEX 20)
12	+ or - Sign
13	10^1 Temperature
14	10^0 Temperature
15	. (HEX 2E) Decimal point
16	10^{-1} Temperature
17	Space (HEX 20)
18	K, N, M, S = km/h, Knots, m/s, mph
19	Space (HEX 20)
20	High Byte Status byte
21	Low Byte Status byte
22	* (HEX 2A) Check sum marking
23	High Byte Check sum in HEX
24	Low Byte Check sum in HEX
25	CR (HEX 0D) Carriage return
26	ETX (HEX 03)

6.1.4 Telegram NMEA V 2.0 $WIMWV,xxx.x,R,xxx.x,N,A*xx(CR)(LF)

Z. NR.	FUNCTION
1	$ (HEX 24) Dollar
2	W (HEX 57)
3	I (HEX 49)
4	M (HEX 4D)
5	W (HEX 57)
6	V (HEX 56)
7	, (HEX 2C) Comma
8	10^2 Wind direction
9	10^1 Wind direction
10	10^0 Wind direction
11	. (HEX 2E) decimal point
12	10^{-1} Wind direction
13	, (HEX 2C) Comma
14	R (HEX 52)
15	, (HEX 2C) Comma
16	10^2 Wind speed
17	10^1 Wind speed
18	10^0 Wind speed
19	. (HEX 2E) Decimal point
20	10^{-1} Wind speed
21	, (HEX 2C) Comma
22	K, N, M, S = km/h, Knots, m/s, mph
23	, (HEX 2C) Comma
24	A, V A = valid, V = non valid
25	* (HEX 2A) Check sum marking
26	High Byte Check sum in HEX
27	Low Byte Check sum in HEX
28	CR (HEX 0D) Carriage Return
29	LF (HEX 0A) Line Feed

7. List of control commands

The Anemometer 2D can be controlled via its serial data interface using the commands in the following list.
Any standard terminal program such as “procomm“ , “telix“ or a *Windows* terminal program (e.g. “*Hyper Terminal”*) can be used.
All adjustments are stored in a E_ROM so that the adjusted parameters cannot get lost after switching off or failure of power supply.

7.1 List of commands

Command	Function	Remark
<ID> AV 00000	**Instantaneous value**	Output of the instantaneous values
<ID> AV 00001	**Mean value over 1 second**	Output of the gliding mean value over 1 second
<ID> AV 00002	**Mean value over 10 seconds**	Output of the gliding mean value over 10 seconds
<ID> AV 00003	**Mean value over 1 minute**	Output of the gliding mean value over 1 minute
<ID> AV 00004	**Mean value over 2 minutes**	Output of the gliding mean value over 2 minutes
<ID> AV 00005	**Mean value over 10 minutes**	Output of the gliding mean value over 10 minutes
<ID> BR 00002	**1200 Baud N 8 1**	Data rate 1200 Baud, 8 Data bits, No Parity, 1 Stop bit
<ID> BR 00010	**1200 Baud E 7 1**	Data rate 1200 Baud, 7 Data bits, Parity Equal, 1 Stop bit
<ID> BR 00003	**2400 Baud N 8 1**	Data rate 2400 Baud, 8 Data bits, No Parity, 1 Stop bit
<ID> BR 00011	**2400 Baud E 7 1**	Data rate 2400 Baud, 7 Data bits, Parity Equal, 1 Stop bit
<ID> BR 00004	**4800 Baud N 8 1**	Data rate 4800 Baud, 8 Data bits, No Parity, 1 Stop bit
<ID> BR 00012	**4800 Baud E 7 1**	Data rate 4800 Baud, 7 Data bits, Parity Equal, 1 Stop bit
<ID> BR 00005	**9600 Baud N 8 1**	Data rate 9600 Baud, 8 Data bits, No Parity, 1 Stop bit
<ID> BR 00013	**9600 Baud E 7 1**	Data rate 9600 Baud, 7 Data bits, Parity Equal, 1 Stop bit
<ID> BR 00006	**19200 Baud N 8 1**	Data rate 19200 Baud, 8 Data bits, No Parity, 1 Stop bit
<ID> BR 00014	**19200 Baud E 7 1**	Data rate 19200 Baud, 7 Data bits, Parity Equal, 1 Stop bit
<ID> EC 00000	**Command-echo switched off**	Echo operation of recognised commands switched off
<ID> EC 00001	**Command-echo switched on**	Echo operation of recognised commands switched on
<ID> ES 00000	**Sign-echo switched off**	Echo operation of transmitted characters switched off
<ID> ES 00001	**Sign-echo switched on**	Echo operation of transmitted characters switched on
<ID> KY 00000	**Key, no access**	Software-key, access to EEPROM closed
<ID> KY 00001	**Key, open access**	Software- key, access to EEPROM open
<ID> LT 00000	**Interface selection**	Interface standard RS 485 (RS 422)
<ID> LT 00001	**Interface-selecting**	Interface standard RS 232
<ID> NC 00xxx	**North correction in 0.1°**	Input of north correction, value range 00000 up to 003600
<ID> OR 00xxx	**Output rate online (spontaneous)**	Output rate xxx times 100ms, value range 00001 up to 00255
<ID> OS 00000	**Wind speed in m/s**	Scale of Wind speed in meter per sec.
<ID> OS 00001	**Wind speed in Km/h**	Scaling of Wind speed in kilo meter per hour
<ID> OS 00002	**Wind speed in mph**	Scaling of Wind speed in miles per hour
<ID> OS 00003	**Wind speed in Knots**	Scaling of Wind speed in knots (nautically)
<ID> SC 00000	**Starting value 0mA**	Analogue output current 0 - 20mA / 0 – 10 V
<ID> SC 00001	**Starting value 4mA**	Analogue output current 4 - 20mA / 2 – 10 V
<ID> TR 00000	**no Telegram on request**	
<ID> TR 00001	**Telegram VD on request**	single output of the telegram form, see 6.1.1
<ID> TR 00002	**Telegram VDT on request**	single output of the telegram form, see 6.1.2
<ID> TR 00003	**Telegram NMEA on request**	single output of the telegram form, see 6.1.3
<ID> TT 00000	**No telegram output**	
<ID> TT 00001	**Telegram VW**	Online output of telegram form, see 6.1.1
<ID> TT 00002	**Telegram VDT**	Online output of telegram form, see 6.1.2
<ID> TT 00003	**Telegram V4DT**	Online output of telegram form, to 6.1.3
<ID> TT 00004	**Telegram NMEA V 2.0**	Online output of telegram form, to 6.1.4

Remark:
Due to the compatibility the telegrams VD and VDT supply the wind speed in 3 digits form
In order to avoid that the measuring range is exceeded the telegrams deliver the wind speed exclusively in the unit of m/s (meters per second)!

Please find your ID (ident-number) in the works certificate included in the delivery.

For the input of commands and parameters please open first the access to the EEPROM by entering the command (ID) KY00001.
After all inputs have been made the access to the EEPROM should be locked again through the command (ID) KY00000 in order to avoid unauthorised changes of the system parameters.
The command is input by entering the instrument identification number (ID) followed by two letters which specify the actual command followed by a 5-digit code number resp. value.
The characters are entered **without a space** and are **activated with Return**.
Entering the command without the 5-digit code number is interpreted as a query of the command status and leads to the output of the current command status.
Correcting the command word during input when an error has occurred is **not allowed** and the command will not be accepted.
All letters must be **capitalised**, otherwise they will not be accepted.

Example: Correcting an angle of displacement while setting up the anemometer by entering a corrective angle:
Instrument ID is accepted as 12. The necessary angular correction is 47°. The angle stored in the system up to that time was 15°. Attention: Input and representation in units of 1°.
The correction angle is added clockwise to the measured wind direction angle.

Input: 12NC System response: !12NC00015
Input: 12NC00047 System response: !12NC00047

The system verifies the accepted input and displays the set value.

Attention: After the supply voltage of the instrument has been switched on or switched off the locking is automatically activated.

For **bus operation** in RS485 interface mode the permanent output of the measuring data must be stopped through the command **(ID)TT00000**. In addition, the echo operation for commands, and characters (ID)EC00000 and (IC)ES00000 must be switched off in order to avoid a bus conflict.
A single data telegram can then be called in through the command **(ID)TR0000(x)** in a telegram form described under item 6.1.
The „X“ in the command string means the selected telegram form (1, 2 or 3).
The ID-number selects the required instrument.

7.3 Pre-setting of Instruments (Models for Delivery)

Order-No.	Output parameter	Connecting to:	
4.3800.00.000	RS232 , 0-20 mA / 0 - 10 V , WDT, 9600 N 8 1	Basic Setting	
4.3800.00.040	RS232 , 0-20 mA / 0 - 10 V , WDT, 1200 E 7 1	LED Display	4.32xx.xx.1xx
4.3800.00.041	RS232 , 4-20 mA / 2 - 10 V , VDT, 1200 E 7 1	LED Display	4.32xx.xx.1xx
4.3800.00.140	RS422 , 0-20 mA / 0 - 10 V , VDT, 1200 E 7 1	LED Display	4.32xx.xx.2xx
4.3800.00.141	RS422 , 4-20 mA / 2 - 10 V , VDT, 1200 E 7 1	LED Display	4.32xx.xx.2xx
4.3800.00.241	RS232 , 4-20 mA / 2 - 10 V , VDT, 9600 N 8 1	Online Wind	9.1700.97.010
4.3800.00.340	RS422 , 0-20 mA / 0 - 10 V , VDT, 9600 N 8 1	Online Wind	9.1700.97.010
4.3800.00.341	RS422 , 4-20 mA / 2 - 10 V , VDT, 9600 N 8 1	Online Wind	9.1700.97.010
4.3800.00.440	RS232 , 0-20 mA / 0- 10 V, TDL14, 1200 N 8 1	TDL 14	
4.3800.00.540	RS422 , 0-20 mA / 0- 10V , NMEA 2.0, 4800 N 8 1	Nacos	

8. Preparation for Use

8.1 Selecting the Site

As already described above the ultrasonic anemometer transmits sonic bursts which are necessary for the measurement of the propagation speed. If these sonic bursts hit a well sonic-reflecting surface they are reflected as echo and might cause error measurements – under unfavourable conditions.

It is, therefore, advisable to install the US-anemometer with a minimum distance of 1 meter to objects in the measurement area.

In general wind measurement instruments should be able to detect the wind conditions over a wide area. In order to obtain comparative values when determining the surface wind, measurements should be taken at a height of 10 meters above a plane, unobstructed area. An unobstructed area is one where the distance between the wind transmitter and any obstacle is at least 10 times greater than the height of the obstacle. (s. VDI (German Engineers Association) 3786). If this requirement cannot be fulfilled, then the wind measurement instrument should be set up at a height where the measured values are not influenced by any local obstacles (approx. 6-10 m above the level of the obstacle). The anemometer should be set up in the center of flat roofs, not at the edge in order to avoid possible preferred directions.

8.2 Mounting the wind transmitter

The wind transmitter can be mounted to a pipe piece of R 1 _" (Ø 48.3 mm) which is 50 mm long. The internal diameter of the pipe must be at least 40 mm as the wind transmitter is connected electrically from below with a plug. Solder a flexible control line LiYCY with the corresponding number of cores to the enclosed plug. After the wind transmitter has been connected, set it onto the pipe piece respectively the mast piece and align to North with the north sensor marking (red ring at the sensor). To do this, take a bearing via the ultasonic transducer of the North/South path onto an object to the North, for example a building or a special geographic feature. Use the four screws with hexagonal recessed holes (SW 4 mm) to attach the instrument to the shaft.

9. Accessories

Connecting cable, compl. , Order No. **506702** (15 m cable with connecting plug)

Software Online Wind, Order-No. **9.1700.97.010**

Power Supply Unit, Order-No**. 9.3388.00.000** for the electrical power supply of the transmitter and the heater**.**

In areas with considerable thunder and lightning activity it is recommendable to mount **Lightning Rod,** Order-No. **4.3100.99.000.** This may lead to deviations in the measured values.

10. Maintenance

As the instrument has no moving parts i.e. operates without wear or tear, only minimal maintenance is required. As the sensor surface is permanently washed up by the falling rain it is only occasionally necessary to clean the surface with non-aggressive cleansing agent and soft cloth. These cleansing activities can be carried out – as far as necessary – on occasion of the routine checks.

11. Calibration

The ultrasonic anemometer does not contain any adjustable components such as electrical or mechanical trimming elements. All of the components and materials are invariant in time. Thus, regular calibration because of ageing is not required. Only a mechanical deformation of the transformer arms and the resulting changes in the length of the measurement paths lead to errors in the measured values.
The virtual temperature can be used to check the length of the measurement path. A change in the measurement path length of 0.17% and consequently a measurement error of 0.17% of the wind speed corresponds to a 1 K deviation of the virtual temperature at 20 °C, thus at 6 K deviation, the measurement error of wind speed is approx. 1%.
If the measuring distance of the anemometer is damaged please contact the producer for a re-calibration of the instrument.

12. Guarantee

Damages resulting from improper handling or caused by external influences, e.g. lightning, are excluded from the guarantee. The guarantee expires if the instrument is opened.

Attention :
A return of the instruments must be effected in the original packing as otherwise the guarantee expires in case of mechanical damages e.g. by deformation of the measuring arms.

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