

Instruction for Use

021517/07/08

Wind Direction Transmitter „First Class“

- Device with digital output, RS 485
- Wind velocity signal acquisition

4.3150.x0.400



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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
 - Endangering of persons by electrical or mechanic effect
 - Damages at 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 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 under certain conditions, and in rare cases, may also output erroneous measuring values, it is recommended to use redundant systems with plausibility checks with **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, arrange for recycling as the packaging materials are designed to be recycled.



Documentation

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- Although this 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.

1 Models available

Order - No.	Wind direction Meas. range	Wind velocity Input [Hz]	Electrical Output	Supply	Heating
4.3150.00.400	0...360°	1082 Hz @ 50m/s	RS 485	3,3V...42V DC	with (24 V AC / DC)
4.3150.10.400	0...360°	1082 Hz @ 50m/s	RS 485	3,3V...42V DC	without

2 Application

The wind direction transmitter serves for the detection of the horizontal **wind direction** in the field of meteorology and the technology of environmental protection.

The measuring value is available as serial data telegram via an RS485 interface. The data telegram is able to operate, for ex., wind displays, weather displays, dataloggers, process control systems or to communicate with PC and software "Meteo-Online".

The wind direction transmitter can acquire wind velocity signals and can complete its serial data telegram by the parameter **wind velocity**.

Special characteristics:

- High level of measuring accuracy and resolution
- High damping ratio at a small delay distance
- Low starting threshold
- Low current consumption (3,3V – 15V @6,0mA)
- Option for connecting an anemometer „First Class 4.3351.x0.000“.
- Data telegram additionally with wind velocity
- Simple mounting and dismounting

For winter time use the wind direction transmitter (see chapter 1 models available) is optionally equipped with an electronically regulated heating, which guarantees the smooth-running of the ball bearing, and prevents ice forming in the space between the external rotation parts. Electrical supply of the wind transmitter heating is provided for ex.. by our power supply unit order-no. 9.3388.00.000.

3 Mode of Operation

Wind direction

The dynamic characteristics of the wind vane is achieved by the aluminum light-weight construction. The co-action of wind vane and balance weight results in a high damping ratio with small delay distance as excellent characteristic of the complete vane.

The axis of the wind vane is running in ball bearings and carries a diametrically magnetized magnet at the inner end. The angle position of the axis is scanned contact-free by a magnetic angle sensor (TMR-Sensor, Tunnel Magneto Resistance) through the position of the magnet field. As the sensor is operated in magnetic saturation, effects by external magnetic fields can almost be eliminated. The connected electronics calculates the angle position of the axis and provides the respective serial output signal.

Acquisition of Wind Velocity

Additionally to the wind direction acquisition the wind direction transmitter offers the option of supplying the wind velocity signal from the *Wind transmitter First Class 4.3351.x0.000*. The wind velocity signal is acquired and analyzed and is available in the output telegram along with the acquired wind direction.

General

An AC- or DC-voltage of 24 V is intended for the separate supply of the optional heating. In all probability, the heating guarantees a trouble-free function of the Wind Direction Transmitter First Class even under extreme meteorological icing-conditions..

The outer parts of the instrument are made of corrosion-resistant anodized aluminum, and stainless steel. Highly effective labyrinth gaskets and O-rings protect the sensitive parts inside the instrument against humidity and dust.

4 Recommendation Site Selection / Standard Installation

In general wind measurement instruments should be able to detect the wind conditions of a large area. In order to obtain comparable values when determining the surface wind, measurements should be taken at a height of 10 meters over an even area with no obstacles. An area with no obstacles means that the distance between the wind direction transmitter and an obstacle should be at least 10 times the height of the obstacle (s. VDI 3786 Part 2). If it is not possible to fulfill this condition then the wind direction transmitter should be set up a height where local obstacles do not influence the measured values to any significant extent (approx. 6-10 m above the obstacle). The wind direction transmitter should be set up in the center of flat roofs and not on the edge in order to avoid any preferential directions.

5 Installation

Attention:

Storing, mounting and operation under weather conditions is permissible only in vertical position, as otherwise water can get into the instrument.

Remark:

When using fastening adapters (angle, traverses, etc.) please take a possible effect on the measurements by turbulences into consideration.

Caution:

The device may only be supplied with a power supply of the "Class, 2, limited power".

5.1 Mounting of the Wind Vane

Attention:

Counterbalance and wind vane are perfectly matched by weight. Therefore: install only in this combination

Before the wind direction transmitter can be installed at a selected site, the wind vane and the balance weight must be mounted at the adaptors of the wind direction transmitter. The individual process steps are explained in the following list, and by the drawing (figure 1). Necessary tool: Philips screw driver.

- **Wind vane:**
 - Remove the screw M3 from the thin adaptor.
 - Put the wind vane onto the thin adaptor. (The longer part of the wind vane deflector must indicate upward).
 - Put the screw M3 through the hole of the wind vane from below into the adaptor, and screw tight.
- **Balance weight:**
 - Remove the screw M3 from the thicker adaptor.
 - Put the balance weight onto the thicker adaptor.
 - Put the screw M3 through the hole of the balance weight from below into the adaptor, and screw tight.

Remark:

As the screws are covered with locking varnish they are rough-running with the fastening. The self-locking screws shall possibly be used only once. Two spare screws are included.

The screw head must be immersed completely in the counter-bore of balance weight and wind vane!

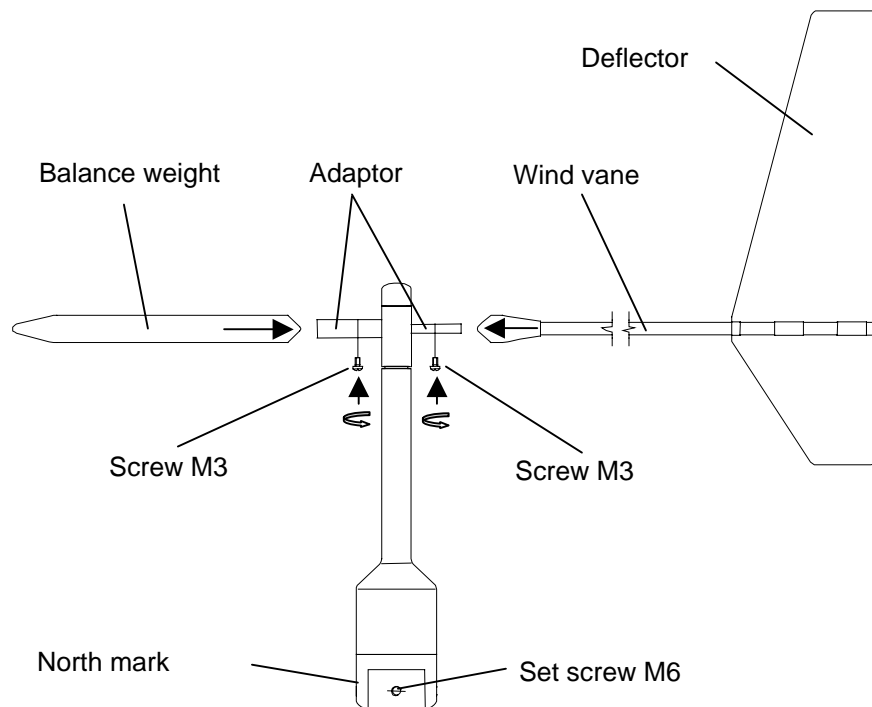


Figure 1: Mounting of the wind vane

5.2 Electrical Mounting

5.2.1 Cable

Solder a shielded cable with diameter 7-8 mm and a core cross-section of 0,5...0,75 mm² to the enclosed coupling socket.

- The number of necessary wires is given in the connection diagram (chapter 7).

5.2.1.1 Cable Recommendation

No. of wires/ diameter / type / cable diameter		
CABLE	8x0,5mm ² LIYCY	BLACK, UV- resistant, Ø 7,6 mm

5.2.2 Cable Shield

The connection of the cable shield between sensor and data acquisition device should be selected in way, that in case of over-voltages no equalizing currents will flow that might destroy the electronic components.

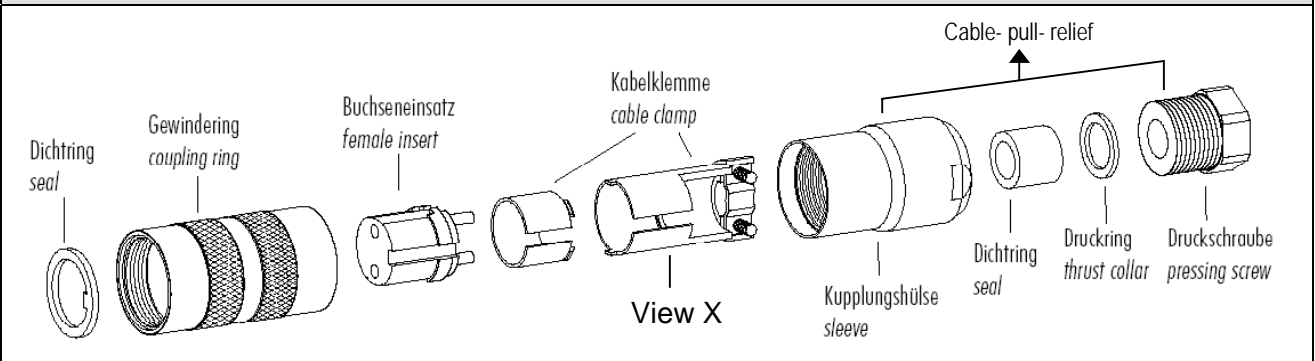
The connection of the cable shield should depend on the selected isolated, or respectively, non-isolated mounting of the sensors.

5.2.2.1 Connecting Recommendation for the Cable Shield

	Sensor Carrier	Sensor	Shielding / Ground	Lightning Protection
1.	Metallic measurement mast, grounded	Isolated mounting at the measuring mast (e.g. by non-metallic brackets, holder etc. or by metallic brackets, holder etc. with isolated plastic adaptors)	Apply the cable shield between sensor and data acquisition device (e.g. datalogger) both-sided. Ground data acquisition device.	Mount metallic lightning protection rod on the mast. Alternatively: Install separate lightning protection rod beside the measurement mast.
2.	Metallic measurement mast, grounded	Non-isolated mounting at the measurement mast (e.g. by metallic brackets, holders etc.)	Apply cable shield between sensor and data acquisition device (e.g. datalogger) only one-sided at the acquisition device.. Ground data acquisition device.	Mount metallic lightning protection rod on the mast in isolated condition , and ground lightning protection rod.. Alternatively: Install separate lightning protection rod beside the measurement mast.
3.	Metallic measurement mast, not grounded (mounted in isolated condition, e.g. on the attic)	Non-isolated mounting at the measurement mast. (e.g. by metallic brackets, holders etc.)	Apply the cable shield between sensor and data acquisition device (e.g. datalogger) both-sided. Ground data acquisition device.	Mount metallic lightning protection rod on the mast in isolated condition , and ground lightning protection rod.. Alternatively: Install separate lightning protection rod beside the measurement mast.
4.	Non-metallic measuring mast (=isolated)	Mounting at the measurement mast. (e.g. by metallic brackets, holders etc.)	Apply the cable shield between sensor and data acquisition device (e.g. datalogger) both-sided. Ground data acquisition device.	Mount metallic lightning protection rod on the mast, and ground lightning protection rod... Alternatively: Install separate lightning protection rod beside the measurement mast..

5.2.3 Plug and Cable Mounting

Coupling socket, Type: Binder, Serial 423, EMC with cable clamp



Cable connection: **with** cable shield

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

Cable mounting 1

Putting shrink hose or insulating tape between wire and shield.

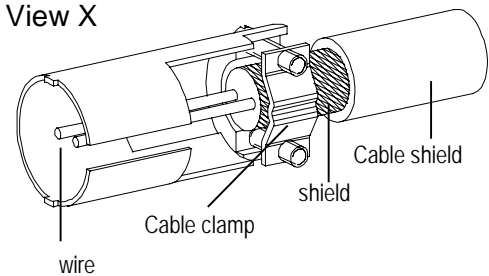
Cable mounting 2

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).

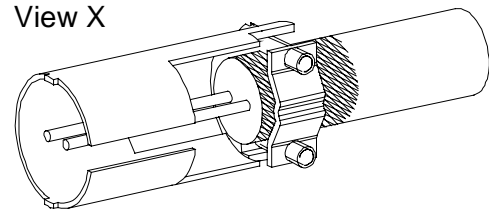
Cable mounting 1

View X



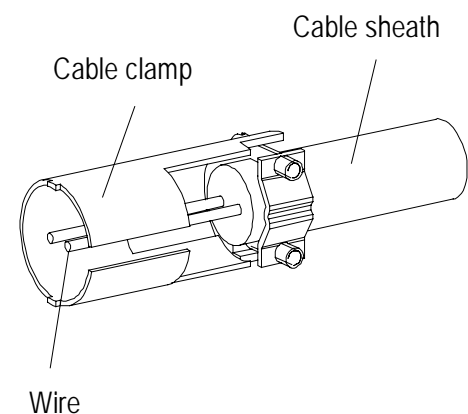
Cable mounting 2

View X



Cable connection: **without** cable shield

1. Stringing parts on cable acc. to plan given above.
2. Stripping cable sheath 20 mm
3. Cutting uncovered shield 20 mm
4. Stripping wire 5mm.
5. Soldering wire to the insert
6. Positioning shield in cable clamp.
7. Screwing-on cable clamp.
8. Assembling remaining parts acc. to upper plan.
9. Tightening pull-relief of cable by screw-wrench (SW16 und 17).



5.3 Mechanical Mounting

Mount the transmitter onto a pipe socket of R 1" (Ø 33,5 mm) and a length of 25 mm. The pipe socket must have an internal diameter of at least 25 mm as the wind direction transmitter must be connected electrically with a plug from below. After electrical connection the wind direction transmitter is put onto the pipe socket, and is fixed by means of 2 threaded pins (female hexagon 3 mm) at the base of the transmitter.

Suitable as carrier are masts, tubes, traverses, brackets, adaptors, adaptors made of POM for isolated mounting, which comply with the mounting dimensions of the wind transmitter and fulfill the static requirements.

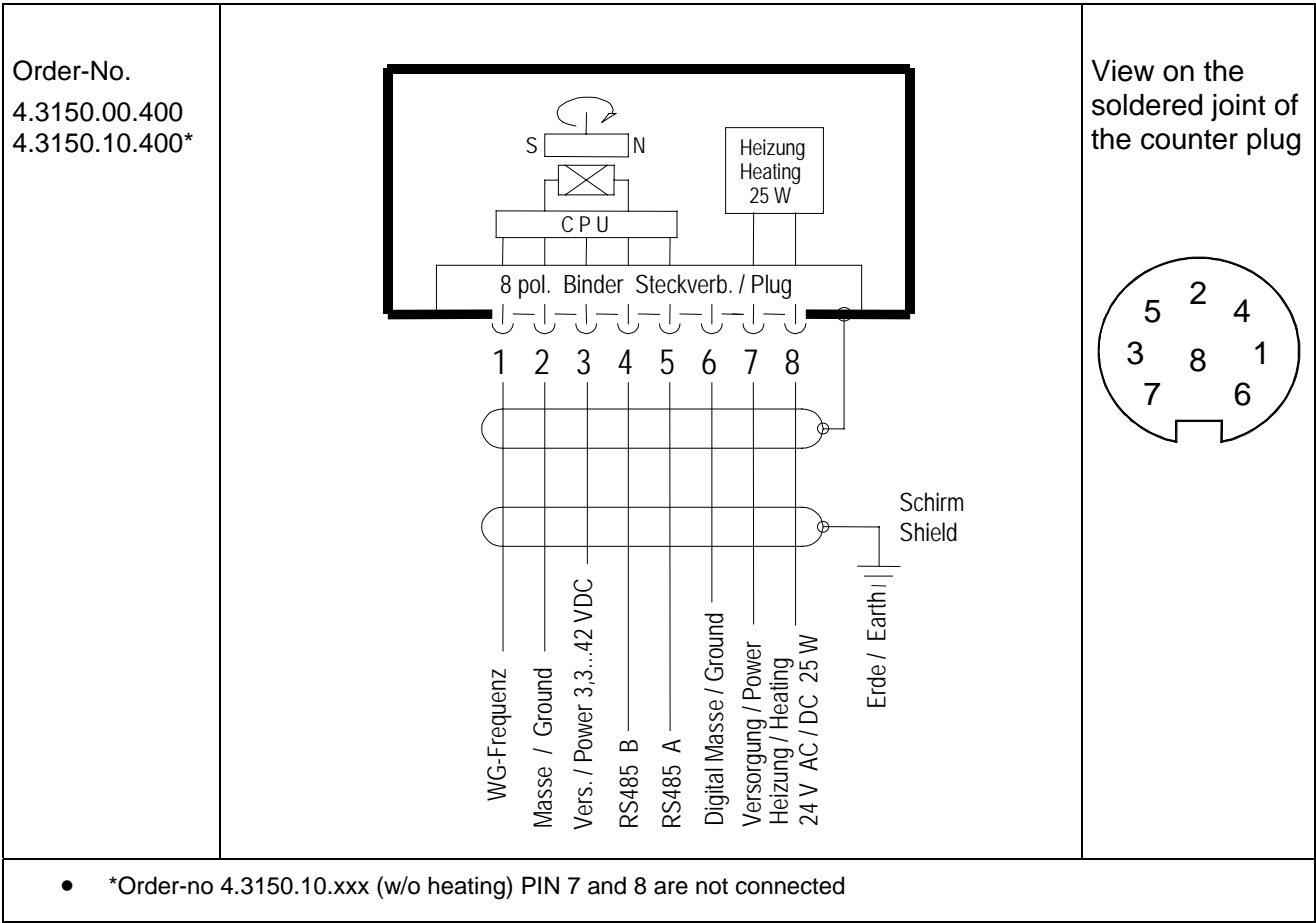
5.4 North Alignment

Remark:

When the wind direction transmitter is in operation, the north marking (line mark) at the base of the transmitter must indicate to the geographical north.

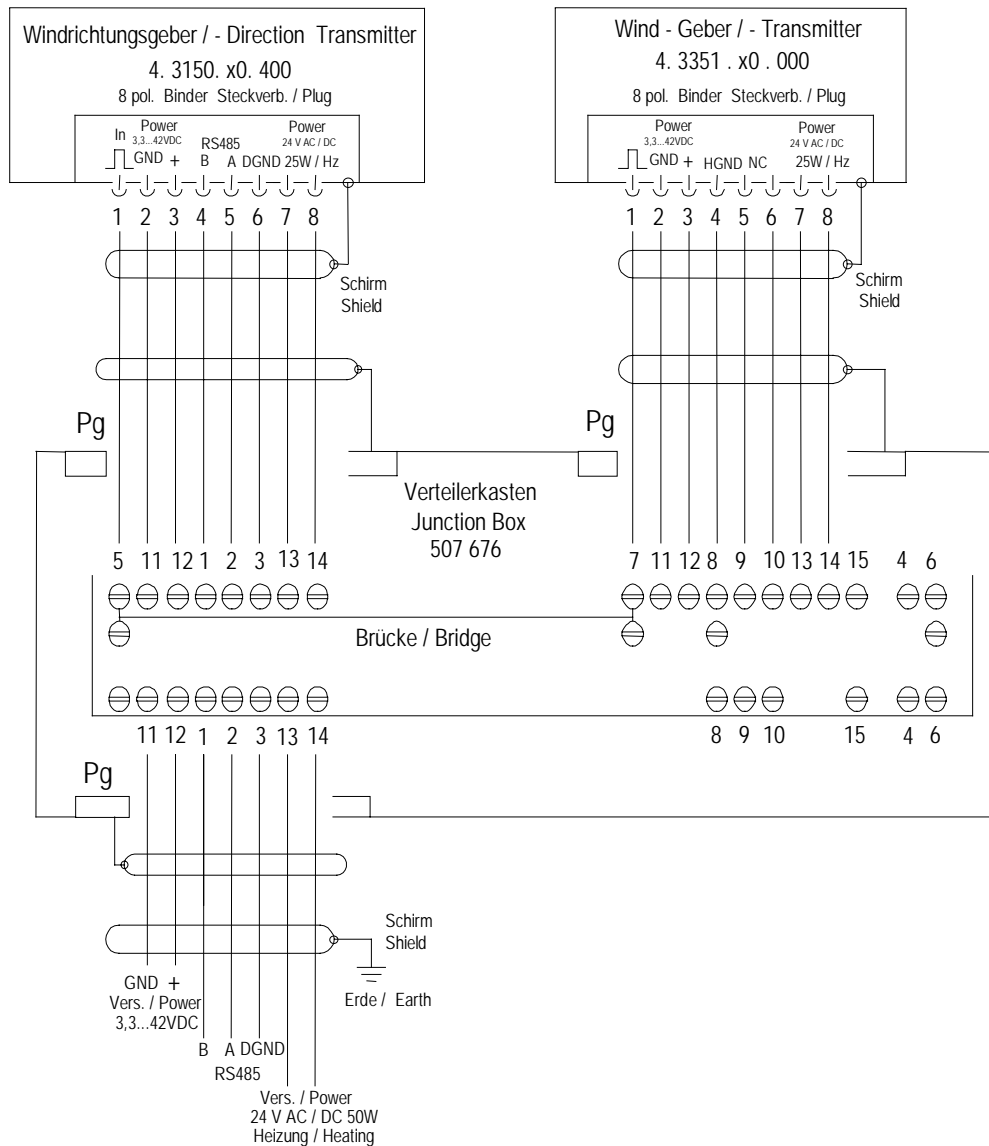
6 Connecting Diagram

Connection diagram acc. to chapter 5.2.2.1 no. 1, 3 and 4:



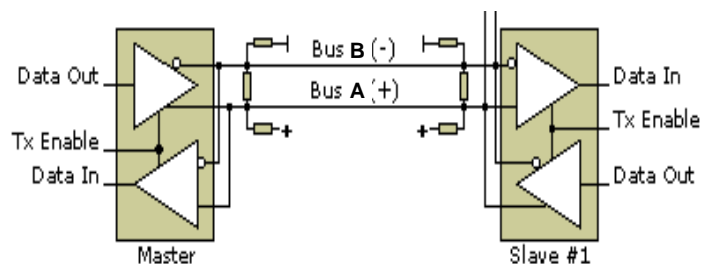
Pin	Name	Function
1	WV-frequency	Input wind velocity
2	GND	Supply ground
3	+Vcc	Supply 3.3 V ... 42 V DC
4	Serial B	RS 485 (B), serial- synchron Clock
5	Serial A	RS 485 (A), serial- synchron Clock
6	DGND	Digital ground / ground wind velocity
7	HZG	Heating supply:
8		Voltage: 24 V AC/DC Power: 25 W
*Order-no 4.3150.10.xxx (w/o heating) PIN 7 and 8 are not connected		

6.1 Example Connection Diagram



7 Serial Interface (RS485)

The wind direction transmitter has an RS485 interface, which is operated in half-duplex mode. For a respective termination (terminating resistance) of the connecting cable must be provided externally (no termination in the wind direction transmitter).



Principle circuit diagram

8 Placing into operation

The wind direction transmitter is to be connected to a voltage source and a RS485 interface, as given in the connection diagram. With the connection of the supply voltage, and after a delay of 5 sec, the output of serial data starts automatically with the following setting:

Setting of interface:

Baud rate	9600 baud
Data bits	8 bit
Parity bit	no
Stop bit	1

9 Serial Communication

For communication purpose the wind transmitter has a command interpreter. By means of this interpreter the behavior of the instrument can be changed. Thus, for example, the baud rate the instrument ID, and the starting behavior can be adapted to the own requirements. On principle, the command has the following construction:

AABB<CR> or AABBBCCCC<CR>

with:

AA: Wind transmitter – ID. Is always two-digit and in the range 00... 98

ID-works setting: 00

BB: the command, see list of commands

CCCC: A five-digit value for setting a new parameter value.

<CR>: Means here carriage-return (enter-button). This sign terminates the entering of commands.

A check of the command syntax is carried out in the wind transmitter. The correct reception of a command is acknowledged with „echo telegram“ for ex.:

00BR00005<CR> transmitting command

!00BR00005<CR> echo telegram

If a command is transmitted to the instrument without parameter value, it serves for querying the value currently set. For example, by means of the command
00BR<CR>

the current baud rate is queried. The reply telegram, for ex., appears as follows:

!00BR00005<CR> **00005** = 9600baud (see table of baud rates)

In order to avoid an unmeant parameter adjustment some commands (see list of commands) are secured by a so-called “key”. This “key” must be transmitted before the actual modification command.

Example: modification of baud rate

00KY00001<CR> Key-secured command released

00BR00006<CR> baud rate set to 19200

Attention:

The key-secured commands are released until the supply voltage is activated, or the command 00KY00000<CR> is transmitted.

10 List of Commands

For the wind direction transmitter the following commands are available

	Command	Description	Key
Command KY	<id>KY<param>	KEY-Number (Access authorization)	No
Command TR	<id>TR<param>	Telegram on request	No
Command BR	<id>BR<param>	Setting the baud rate	Yes
Command TT	<id>TT<param>	Automatic Telegram output (ATG) ON/OFF	Yes
Command OR	<id>OR<param>	Setting output interval for ATG	Yes
	<id>ID<param>	Setting wind transmitter ID	Yes

11 Commands and Description

Command KY

<id>KY<param> Release (cancel) KEY secured command

<id>KY Query of the current KEY- parameter

Command echo !xxKYxxxxx

Description: The next command, for ex. command BR for changing the baud rate, is released by the KEY- command and the parameter 00001

 The KEY command along with Parameter 00000, or switching-on the supply voltage resets the release.

Parameter description:

Parameter	Description
00000	Access authorization canceled
00001	Access authorization released

Command TR

<id>TR<param> Telegram on request

<id>TR Query is not relevant (!xxTR00000)

Command echo no Echo

Description: The TR command with parameter 0003 starts a measurement and the transmission of the current measuring values,.

Response telegram (<STX>xx.x xxx.x*HL<CR><ETX>)

Parameter description:

Parameter	Description
00003	Request for current measuring value (on request)

Command BR

<id>BR<param> Setting the baud rate

<id>BR Query of the current BR-Parameter

Command echo !xxBRxxxxx

Description: By the BR command and with parameter 0000x the requested baud rate is set.

Parameter description:

Parameter	Description
00002	1200 baud (8n1)
00003	2400 baud (8n1)
00004	4800 baud (8n1)
00005	9600 baud (8n1)
00006	19200 baud (8n1)
00007	38400 baud (8n1)
00008	57600 baud (8n1)

Command TT

<id>TT<param> Automatic Telegram output (ATG) ON/OFF

<id>TT Query of the current TT-Parameter

Command echo !xxTTxxxxx

Description: By the command TT and the parameter 0000x the automatic telegram output is switched on or off resp.

Parameter description:

Parameter	Description
00000	Automatic telegram output OFF
00003	Automatic telegram 3 ON

Command OR

<id>OR<param> Set output interval for ATG.

<id>OR Query of the current OR-parameter

Command echo !xxORxxxxx

Description: By the command OR and the parameter xxxxx the output interval is set for the telegram output. The parameter is specified in ms. The interval range is 100ms ... 60000ms.

Parameter description:

Parameter	Description
XXXXX	Interval 100ms 60000 ms

Command ID

<id>DI<param> Set wind transmitter ID

<id>ID Query of the current ID-parameter

Command echo !xxIDxxxxx

Description: By the ID-command and the parameter 000xx the
Wind transmitter ID is set. The ID-setting range is 0..98. The ID guarantees the operation of several wind transmitters in one bus system.

Parameter description:

Parameter	Description
000XX	Wind transmitter ID 0.... 98

12 Data Telegram

Telegram construction

<STX>xx.x xxx.x***HL**<CR><ETX> z.B. <STX>12.3 345.6*14<CR><ETX>

Characters	Description
1	STX (HEX 02)
2	10 ¹ wind velocity
3	10 ⁰ wind velocity
4	(HEX 2E) decimal point
5	10 ⁻¹ wind velocity
6	space (HEX 20)
7	10 ² wind direction
8	10 ¹ wind direction
9	10 ⁰ wind direction
10	(HEX 2E) decimal point
11	10 ⁻¹ wind direction
12	(HEX 2E) '*'
13	H = high nibble check sum
14	L = low nibble check sum
15	CR (HEX 0D) Carriage Return
16	ETX (HEX 03)

The parameters in the data telegram are output with leading zeros.
(for ex. 01.4 008.7)

On state of delivery the data output is set as follows.

Data output	automatic
Output	100ms

The check sum is formed by the XOR-function from the characters between <STX> and „*“ (starting with Hex00). Afterwards, the 8-bit-check sum is divided into two ASCII-characters (high and low nibble) with a value range of 0...F (Hex).

13 Maintenance

If properly installed, the instrument requires no maintenance. Heavy pollution can lead to blockage of the slot between the rotating and the stable parts of the transmitter. Thus it is advisable to remove the accumulated dirt from the instrument .

Cleaning

For the cleaning of the device should use a damp cloth without chemical cleaning agents are used.

Certain symptoms of wear and tear can appear on the ball bearings after years of use. These symptoms are expressed in a lowered sensitivity of response, standstill or run-noises of the ball bearings. In case that such disturbances might occur we recommend to return the instrument - in original package – to the factory for maintenance work.

Remark:

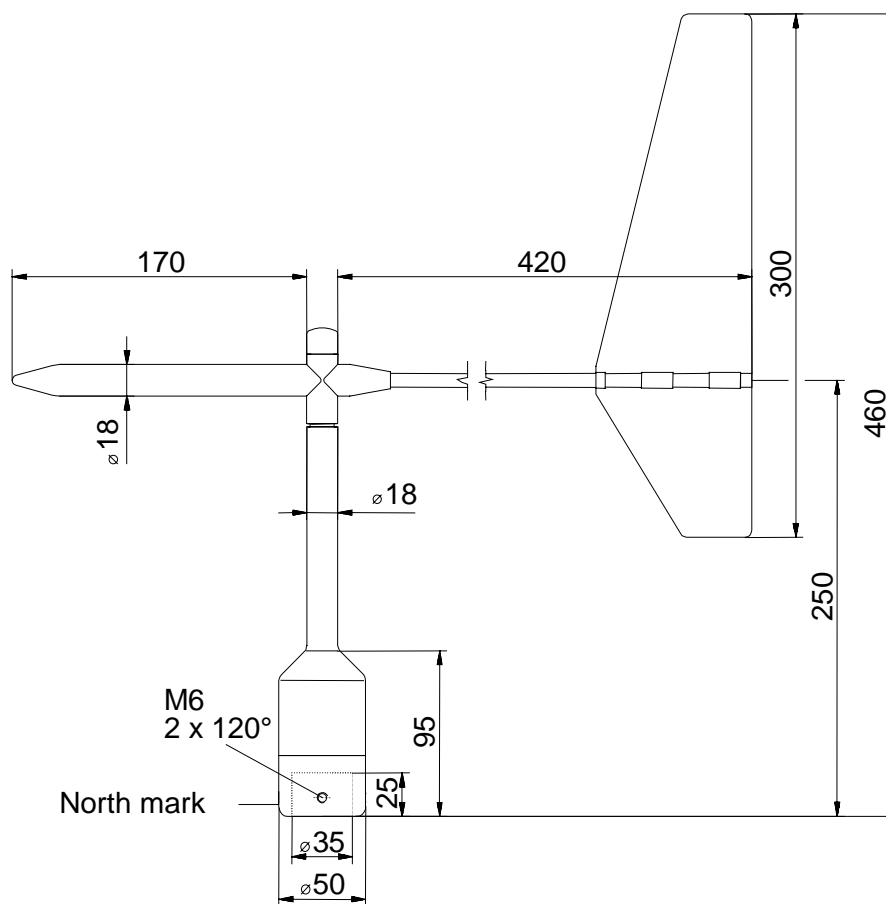
For transport of instrument please use original packing.

14 Technical Data

Characteristic	Description
Measuring range	0 ... 360 °
Measuring Accuracy	1°
Resolution of measuring value	0,01° @ 12 Bit serial data stream
Output telegram	<STX>xx.x xxx.x*HL<CR><ETX> z.B. 15.3(m/s) 347.1(°)
Measuring time	approx. 10ms / WD-measurement
Survival speed	85 m/s up to 0.5 h
Electric input of wind velocity	0....1082Hz @ 0...50m/s U _{PP_max} = 0...15V, U _{PP_min} = 0...3V
Permissible ambient conditions for operation	-50 ... +80°C all occurring situations of rel. humidity incl. dew moistening
Electrical output	RS 485: 1200; 2400; 4800; 9600; 19200; 38400; 57600 Baud 8 Bit no parity 1Stopbit
Starting threshold	< 0.5 m/s at 10° amplitude (acc. to ASTM D 5366-96) < 0.2 m/s at 90° amplitude (acc. to VDI 3786 Part 2)
Delay distance	< 1 m (acc. to ASTM D 5366-6)
Damping ratio	D > 0.25 (acc. to ASTM D 5366-96)
Quality factor	K > 1 $K = \frac{4 \cdot D \cdot \omega_0}{\rho \cdot u}$ D damping ratio, ω ₀ angular frequency of undamped oscillation, ρ air density u wind speed.
Heating	Surface temperature of housing neck > 0 °C at 20 m/s up to -10 °C air temperature, at 10 m/s up to -20 °C using the Thies icing standard 012002 on the housing neck heating regulated with temperature sensor
Power supply	V _{cc} : 3.3 V ... 42 V DC I _{cc} : ca. 6 mA

Electrical supply for heating	Voltage: 24 V AC/DC, 54...65Hz (galvanically isolated from housing) Power: 25 W
Connection	8-pole plug connection for shielded cable in the shaft (see connecting diagram)
Mounting	Mounting on mast 1" (DIN EN 10255; 1" = Ø 33.4 mm), Remark: mounting on mast 1½ " is possible with separate adapter (option).
Dimensions	See dimensional drawing
Weight	ca. 0.7 kg
Protection	IP 55 (DIN 40050)

15 Dimensional drawing



16 Accessories

Traverse 0,6 m For mounting the wind speed and wind direction transmitter jointly onto a mast	4.3174.00.000	Horizontal sensor distance: 0,6 m Vertical sensor distance: 0,2 m Mast receptacle: 48 - 50 mm Material: Aluminum, anodized Dimensions: tube Ø 34x4mm, 668 mm long, 756 mm high
Hanger –FIRST CLASS- 1m For the lateral mounting of a wind speed and wind direction transmitter onto a mast tube..	4.3184.01.000	Sensor distance to mast: 1 m Mast clamp: 40 – 80 mm Tube diameter: 34 mm Material: Aluminum
Lightning rod For mounting the a/m traverse or hanger.	4.3100.98.000	Dimension: Ø 12 mm, 500 mm long, 1050 mm high Material: Aluminum
Wind – Junction box Serves for the connection of several measuring value transmitters. Minimizes the number of cable cores.	507 676	Dimension: 125 x 80x 57 mm Material: Aluminium
Adaptor For isolated mounting of each wind transmitter and wind direction transmitter on the traverse (4.3174.0.000).	509077	Dimension: A:Ø 34 mm, outside 25 mm high B:Ø 35 mm, inside 45 mm high Material: POM

Please contact us for other accessories such as cables, power supply units, masts, as well as for additional mast- or system-constructions.

Example: Wind transmitter with traverse and lightning rod.



17 EC-Declaration of Conformity

Document-No.: 001584

Month: 06 Year: 08

Manufacturer: **ADOLF THIES GmbH & Co. KG**

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Description of Product: **Wind Direction Transmitter FIRST CLASS**

Article No.	4.3150.00.000	4.3150.00.001	4.3150.00.012	4.3150.00.110
	4.3150.00.140	4.3150.00.141	4.3150.00.161	4.3150.00.212
	4.3150.00.400	4.3150.10.000	4.3150.10.001	4.3150.10.110
	4.3150.10.140	4.3150.10.141	4.3150.10.161	4.3150.10.212
	4.3150.10.400			

specified technical data in the document: **021413/08/06; 021479/12/06; 021513/10/06; 021516/12/06
021534/06/07**

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

2004/108/EC	DIRECTIVE 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
2006/95/EC	DIRECTIVE 2006/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits
552/2004/EC	Regulation (EC) No 552/2004 of the European Parliament and the Council of 10 March 2004 on the interoperability of the European Air Traffic Management network (the interoperability Regulation)

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

Reference number	Specification
IEC 61000-6-2: 2005	Electromagnetic compatibility Immunity for industrial environment
IEC 61000-6-3: 2006	Electromagnetic compatibility Emission standard for residential, commercial and light industrial environments
IEC 61010-1: 2001	Safety requirements for electrical equipment for measurement, control and laboratory use. Part 1: General requirements

Place: Göttingen

Date: 25.06.2008

Legally binding signature:

issuer:

.....
Wolfgang Behrens, General Manager

.....
Joachim Beinhorn, Development Manager

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.



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