

HD52.3D...

ULTRASONIC ANEMOMETERS

ENGLISH

The quality level of our instruments is the result of the constant development of the product. This may produce some differences between the information written in this manual and the instrument you have purchased. We cannot completely exclude the possibility of errors in the manual, for which we apologize.

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1 INTRODUCTION

The instruments of the series HD52.3D... are 2-axes ultrasonic static anemometers for the measurement of:

- Wind speed and direction, U-V Cartesian components of wind speed,
- Relative Humidity and temperature (**optional**),
- Diffuse solar radiation (**optional**),
- Barometric pressure (**optional**).

The available measurement options combine in a single instrument the main quantities of meteorological interest, making the instrument like a compact and light meteorological station.

All models are equipped with a magnetic compass.

Wind speed and direction are determined by measuring the transit time of ultrasonic pulses between two pairs of ultrasonic transducers.

RS232, RS485, RS422 and SDI-12 serial interfaces are available with **NMEA**, **MODBUS-RTU** and **SDI-12** communication protocols.

All versions have two analog outputs, for wind speed and direction, which are factory-configurable within 4÷20 mA (standard), 0÷1 V, 0÷5 V or 0÷10 V (**to be specified when ordering**).

The **heater** option prevents the accumulation of snow and ice formation, allowing precise measurements in all environmental conditions.

Diameter 40 mm mast mounting. The electric connection is performed through a M23 19-pole connector situated on the bottom of the instrument.

The low power consumption of the instrument allows installation in remote sites, with power supplied by photovoltaic panel and backup battery.

The absence of moving parts minimizes the instrument maintenance.

1.1 AVAILABLE VERSIONS

The table below shows the measuring quantities available in the different models of the series:

TAB. 1.A – Available versions

Model	Wind speed	Wind direction	Relative humidity	Temperature	Solar radiation	Barometric pressure
HD52.3D	√	√				
HD52.3D4	√	√				√
HD52.3DP	√	√			√	
HD52.3DP4	√	√			√	√
HD52.3D17	√	√	√	√		
HD52.3D147	√	√	√	√		√
HD52.3DP17	√	√	√	√	√	
HD52.3DP147	√	√	√	√	√	√

All the above models are available with heating option (add **R** at the end of the code).

2 TECHNICAL SPECIFICATIONS

Wind speed

Used sensor	Ultrasounds
Measuring range	0...60 m/s
Resolution	0.01 m/s
Accuracy	± 0.2 m/s or ± 2%, the greatest (0...35 m/s), ± 3% (> 35 m/s)

Wind direction

Used sensor	Ultrasounds
Measuring range	0...359.9°
Resolution	0.1°
Accuracy	± 2° RMSE from 1.0 m/s

Compass

Used sensor	Magnetic
Measuring range	0...360°
Resolution	0.1°
Accuracy	± 1°

Air temperature *(needs option 17)*

Used sensor	Pt100
Measuring range	-40...+60 °C
Resolution	0.1 °C
Accuracy	± 0.15 °C ± 0.1% of measurement

Relative humidity *(needs option 17)*

Used sensor	Capacitive
Measuring range	0...100%RH
Resolution	0.1%
Accuracy (@ T = 15...35 °C)	± 1.5%RH (0...90%RH), ± 2%RH (remaining range)
Accuracy (@ T = -40...+60 °C)	± (1.5 + 1.5% of measurement) %RH

Barometric Pressure *(needs option 4)*

Used sensor	Piezoresistive
Measuring range	600...1100 hPa
Resolution	0.1 hPa
Accuracy	± 0.5 hPa @ 20 °C

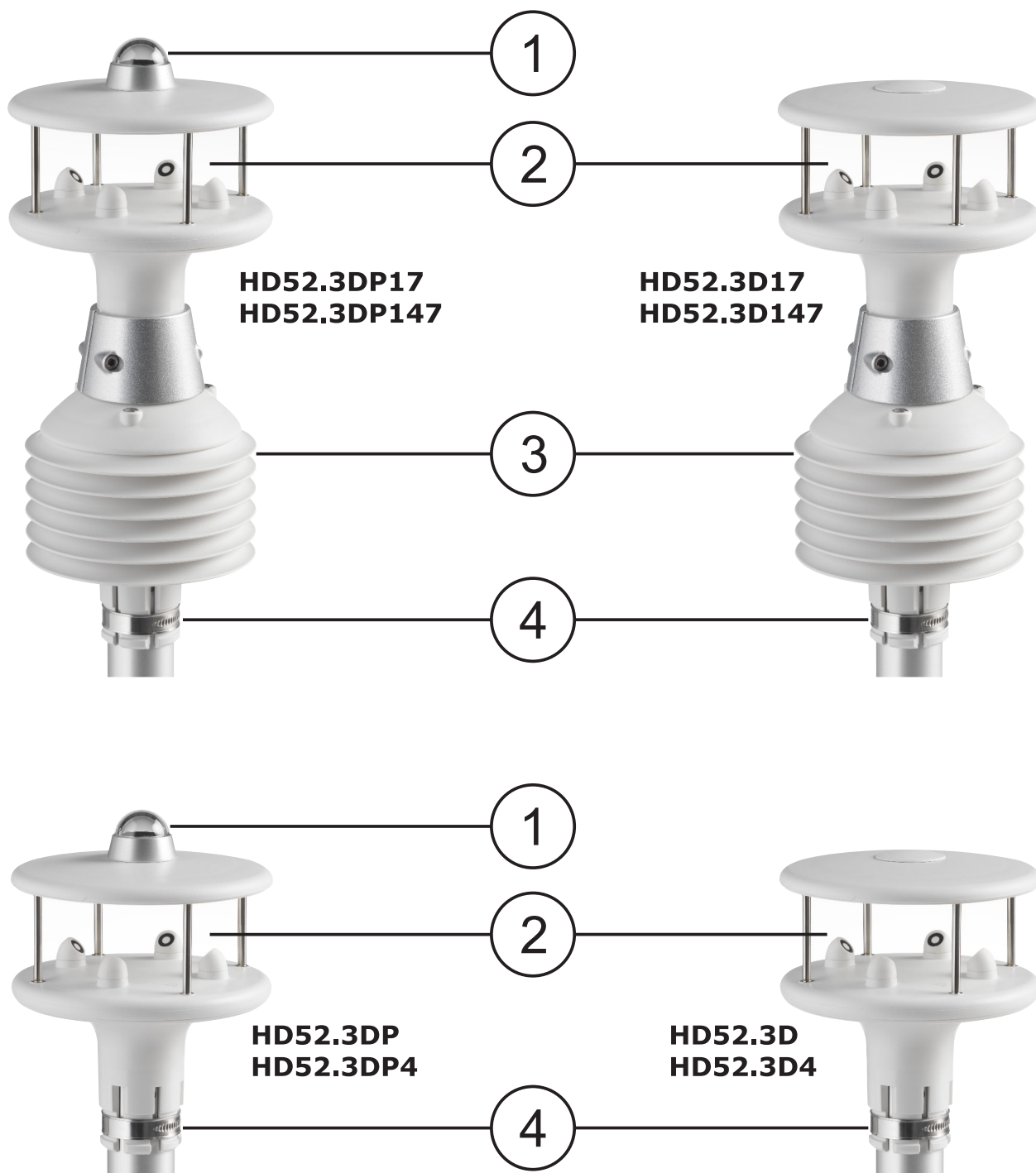
Solar radiation *(needs option P)*

Used sensor	Thermopile
Measuring range	0...2000 W/m ²
Resolution	1 W/m ²
Accuracy	2 nd Class Pyranometer

General features

Power Supply	10...30 Vdc
Power consumption	26 mA @ 12 Vdc without heater, 6 W with heater
Serial outputs	RS232, RS485 (¼ Unit Load), RS422 and SDI-12
Communication protocols	NMEA, MODBUS-RTU, SDI-12, proprietary RS232 and RS485
Analog outputs	2 analog outputs, for wind speed and direction. Output at choice among 4...20 mA (standard), 0...1V, 0...5V and 0...10V (option 0...10V needs 15...30 Vdc power supply)
Electrical connection	19-pole M23 male connector
Operating temperature	-40...+60 °C
Protection degree	IP 64
Dimensions	H=179 mm, Ø=150 mm (HD52.3D, HD52.3D4) H=200 mm, Ø=150 mm (HD52.3DP, HD52.3DP4) H=336 mm, Ø=150 mm (HD52.3D17, HD52.3D147) H=357 mm, Ø=150 mm (HD52.3DP17, HD52.3DP147)
Weight	About 1 kg (complete version HD52.3DP147)
Case	Plastic material: LURAN [®] S (ASA). Metal parts: AISI 316

3 DESCRIPTION



1. Pyranometer
2. Ultrasonic sensors for the measurement of wind speed and direction
3. Protective shield from solar radiation for relative humidity and temperature sensors
4. Fixing clamp to Ø 40 mm mast

Note: in the models measuring barometric pressure, the pressure sensor is inside the instrument.

4 MEASURING PRINCIPLE OF WIND SPEED AND DIRECTION

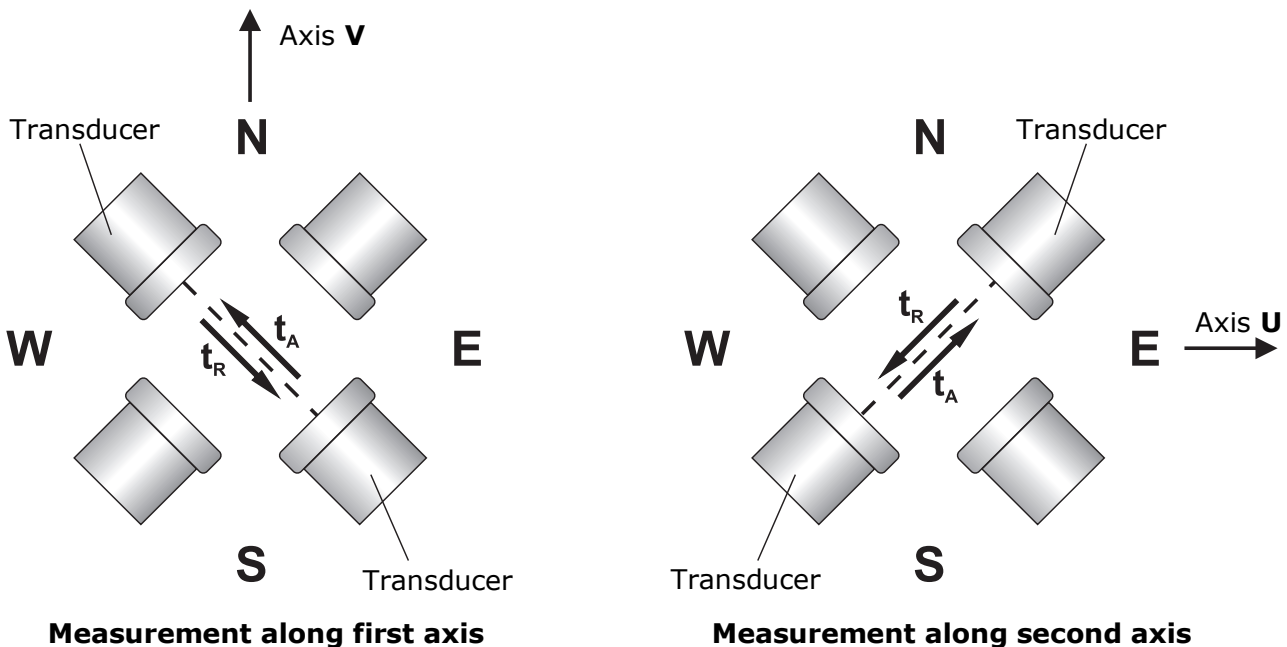
Wind speed and direction are determined by measuring the time taken by ultrasonic pulses to cover the distance from the transducer that generates the pulse to the receiving transducer.

The instrument uses 2 pairs of transducers oriented along two orthogonal axes. Detecting the wind speed along two axes allows to determine not only the intensity but also the wind direction.

The instrument measures the travel time of the ultrasonic pulse between the two transducers of the same pair in both directions. The travel times in the two opposed directions are defined as t_A (forward direction time) and t_R (reverse direction time).

If wind speed is zero, t_A and t_R values are the same. In the presence of wind, one of the two time values is greater than the other and the comparison between the two time values allows to determine the direction and the intensity of the wind.

Measuring the travel time in both directions allows to cancel the dependence of the transmission speed of ultrasounds in the air from the environmental conditions of temperature, humidity and barometric pressure.



The travel times of the ultrasonic pulses are given by:

$$t_A = \frac{D}{C + V_w} \quad t_R = \frac{D}{C - V_w}$$

Where:

D = Distance between the two transducers of the same pair

C = Sound speed

V_w = Component of wind speed along the measurement axis

Measuring the two travel times allows to determine the wind speed component:

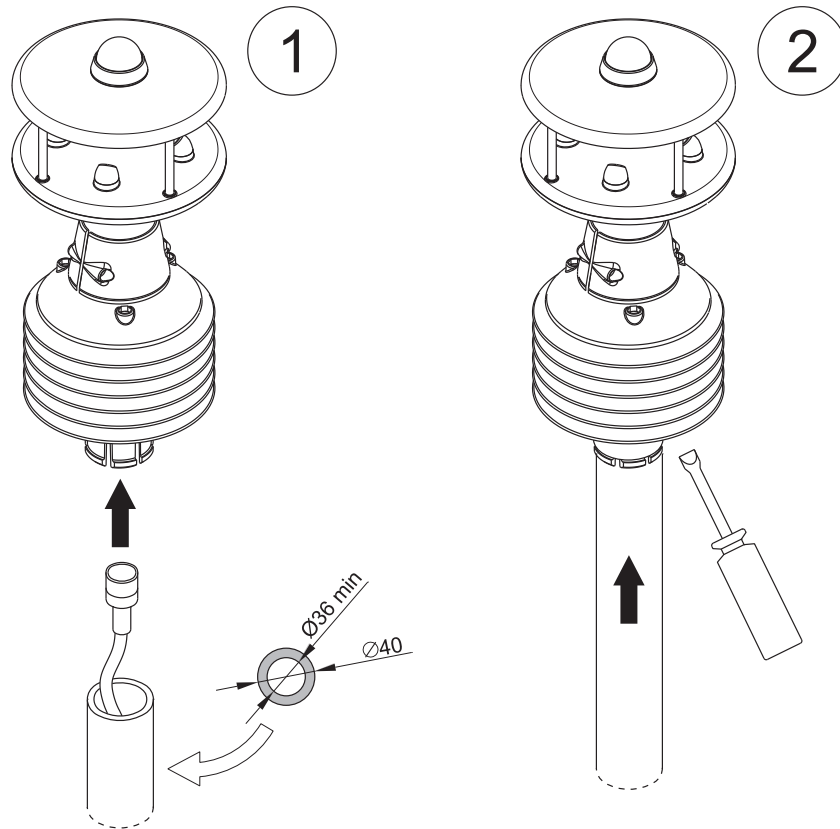
$$V_w = \frac{D}{2} \cdot \left(\frac{1}{t_A} - \frac{1}{t_R} \right)$$

Note: even if transducers are not aligned with U and V Cartesian axes, measurements given by the instrument refer in any case to standard axes.

5 INSTALLATION

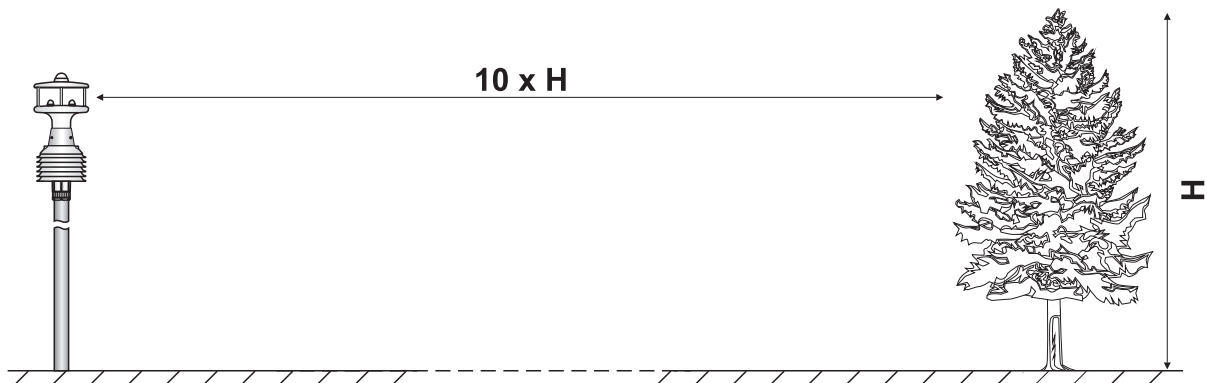
To install the instrument, pass the connection cable inside the support mast and connect the 19-pole M23 female connector of the cable to the 19-pole M23 male connector situated at the bottom of the instrument. Ensure connection stability by tightening the connector external nut.

Align the instrument to the desired direction (see par. 5.1 "Alignment"), then fix it on the support mast by tightening the cable tie at the bottom of the instrument.



The support mast, having 40 mm maximum outer diameter and 36 mm minimum inner diameter, should be positioned on a stable surface.

The instrument should be installed vertically and in an open area, far from obstructions located in the vicinity that might alter the natural air flow. Any close objects (such as buildings, trees, pylons, etc.) should be at a distance equal to at least ten times their height.



In the presence of close objects, it is advisable to place the instrument at a height of 10 m.

For open-space installations, the instrument can be installed using the 3 m tripod **HD2004.20**.

If the instrument is installed on a building, the height of the instrument should be at least 1.5 times the minimum value between the height of the building and the roof longest diagonal.

Mount the instrument far from magnetic materials and devices that generate magnetic fields (electric motors, electric power cables, electric transformers, radars, radio transmitters etc.) in order to prevent faulty indications from the magnetic compass.

In case of mobile installations (for example on a boat), take into account that the instrument measures the relative (apparent) wind speed with respect to the instrument. To determine the absolute (real) wind speed one should consider the movement velocity of the instrument.

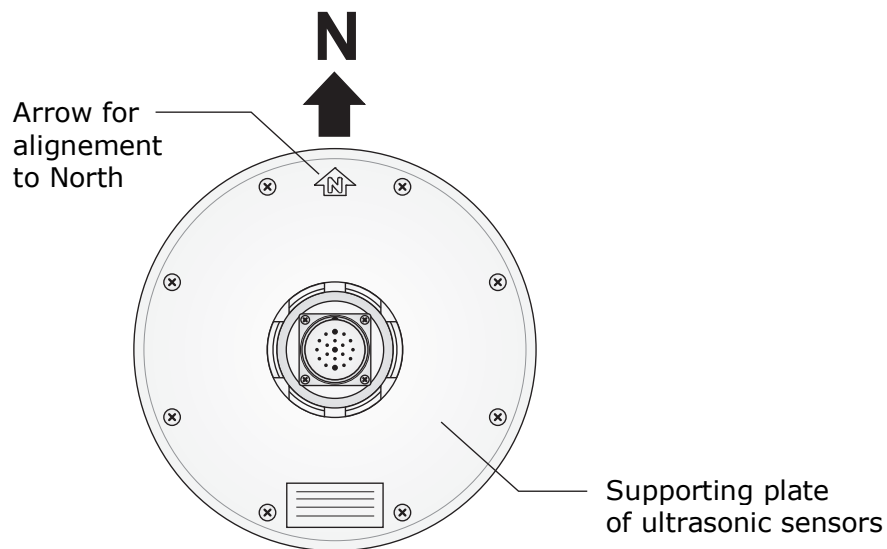
All instrument sensors are factory-calibrated and do not require additional interventions of the user.

Unless otherwise requested, with factory settings the instrument starts in configuration mode at power up and stands in waiting to receive the commands for the setting of the operating parameters through a RS232 serial connection. To know the available configuration parameters, the related factory settings, the commands to modify the parameters and to select the operating mode, see Chapter 6 "CONFIGURATION". If, however, the instrument is already set to operate in one of the available operating modes (SDI-12, NMEA, MODBUS-RTU, proprietary RS232, proprietary RS485), the set mode will be active 10 seconds after power up.

5.1 ALIGNMENT OF THE INSTRUMENT

The instrument is equipped with a magnetic compass, and wind speed and direction measurements are automatically compensated and referred to magnetic North, even if alignment to North is not performed. This allows to obtain accurate measurements even in case of mobile installations.

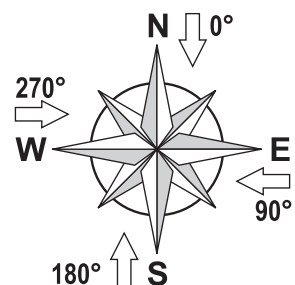
It is possible to disable the compass compensation of the wind speed and direction measurements. In this case it is necessary to align the instrument during installation. The arrows on the case will facilitate the alignment.



For an accurate alignment, connect the instrument to a PC (see following chapters for communication protocols), then rotate the instrument on its vertical axis until the compass measures $0.0^\circ \pm 0.1^\circ$.

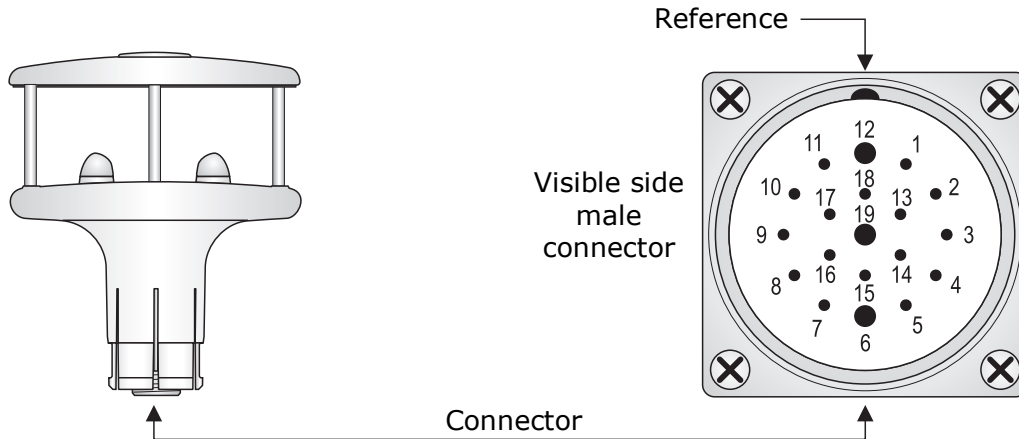
When evaluating the wind direction, one should take into account that the geographic North differs from the magnetic North indicated by the compass. The difference, named **magnetic declination**, depends on the area where the instrument was installed (for example, about 15° in North-America and less than 3° in Europe).

If wind speed and direction values are given in polar coordinates, 0° angle corresponds to a wind coming from North.



5.2 ELECTRICAL CONNECTIONS

All connections are performed through a 19-pole M23 male connector situated at the bottom of the instrument. The figure and the table below show numbers and function of the connector contacts:



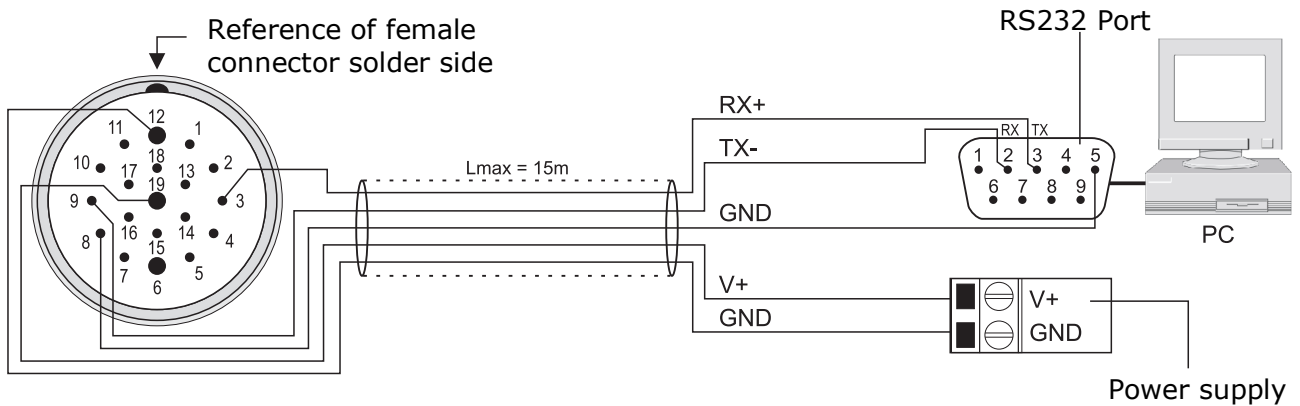
TAB. 5.A – Electrical connections

Pin number	Symbol	Description
1		Not connected
2	RX SDI	Data line for SDI-12 connection
3	RX +	Serial receive (input) positive
4	HEAT -	Heater power supply negative
5	HEAT +	Heater power supply positive
6	HEAT -	Heater power supply negative
7	HEAT +	Heater power supply positive
8	GND	Serial ground
9	TX -	Serial transmission (output) negative
10		Not connected
11		Not connected
12	GND	Instrument power supply negative
13	RX -	Serial receive (input) negative
14	OUT 1	Analog output 1 positive
15	GND	Analog ground
16	OUT 2	Analog output 2 positive
17	TX +	Serial transmission (output) positive
18	V +	Instrument power supply positive
19	V +	Instrument power supply positive

The instrument requires 10...30 Vdc power supply. Heating, if any, needs 12 Vdc power supply.

TX and RX signal connection depends on the chosen serial connection type. See next paragraphs for details on serial connections.

5.2.1 RS232 SERIAL CONNECTION

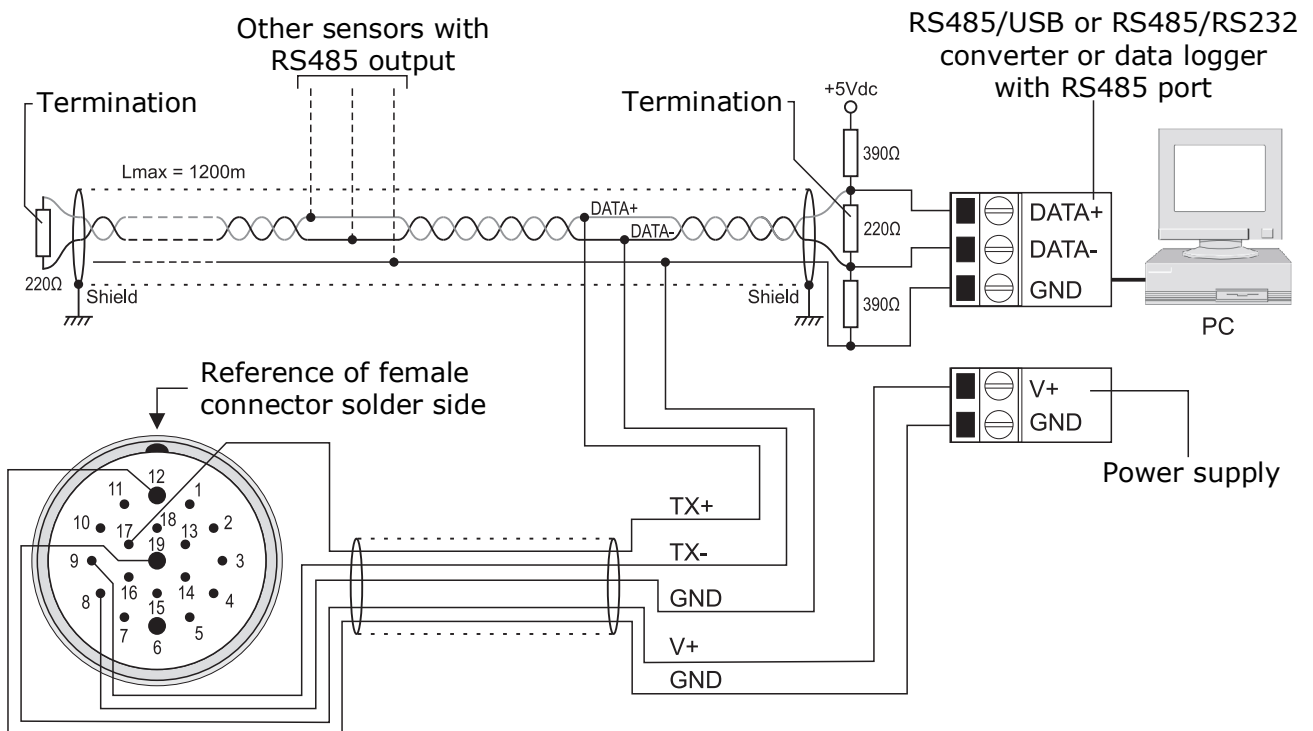


For RS232 connection, TX-, RX+ and serial GND signals (pin 9, 3 and 8 of M23 connector) are used, to be connected respectively to RX, TX and GND signals of RS232 port on PC (pin 2, 3 and 5 of 9-pole SubD connector). The length of RS232 cables should not exceed 15 m.

With RS232 connection, NMEA, MODBUS-RTU and proprietary RS232 protocols can be used.

If the PC is not equipped with RS232 serial ports, the **RS52** adapting cable (with built-in USB/RS232 converter) can be inserted between the PC and the instrument (see paragraph 5.2.7).

5.2.2 RS485 SERIAL CONNECTION



Thanks to RS485 connection, multiple instruments can be connected to a multi-point network. Instruments are connected in sequence through a twisted-pair shielded cable for signals and a third wire for ground.

Line terminations should be placed at the two ends of the network. To polarize the line during non-transmission periods, resistors connected between signal lines and power supply are used. Polarization resistors are placed in one point only of the line, in proximity of the PC or data logger. The cable shield should be connected to both ends of the line.

The maximum number of devices that can be connected to the RS485 line (Bus) depends on the load characteristics of the devices to be connected. The RS485 standard requires that the total

load does not exceed 32 unit loads. The load of an HD52.3D... anemometer is equal to ¼ of unit load. If the total load is greater than 32 unit loads, divide the network into segments and add a signal repeater between a segment and the successive one. Line termination should be applied at both ends of each segment.

The maximum length of the cable depends on the transmission speed and the cable characteristics. Typically, the maximum length is 1200 m. The data line should be kept separated from any power lines in order to prevent interference with the transmitted signal.

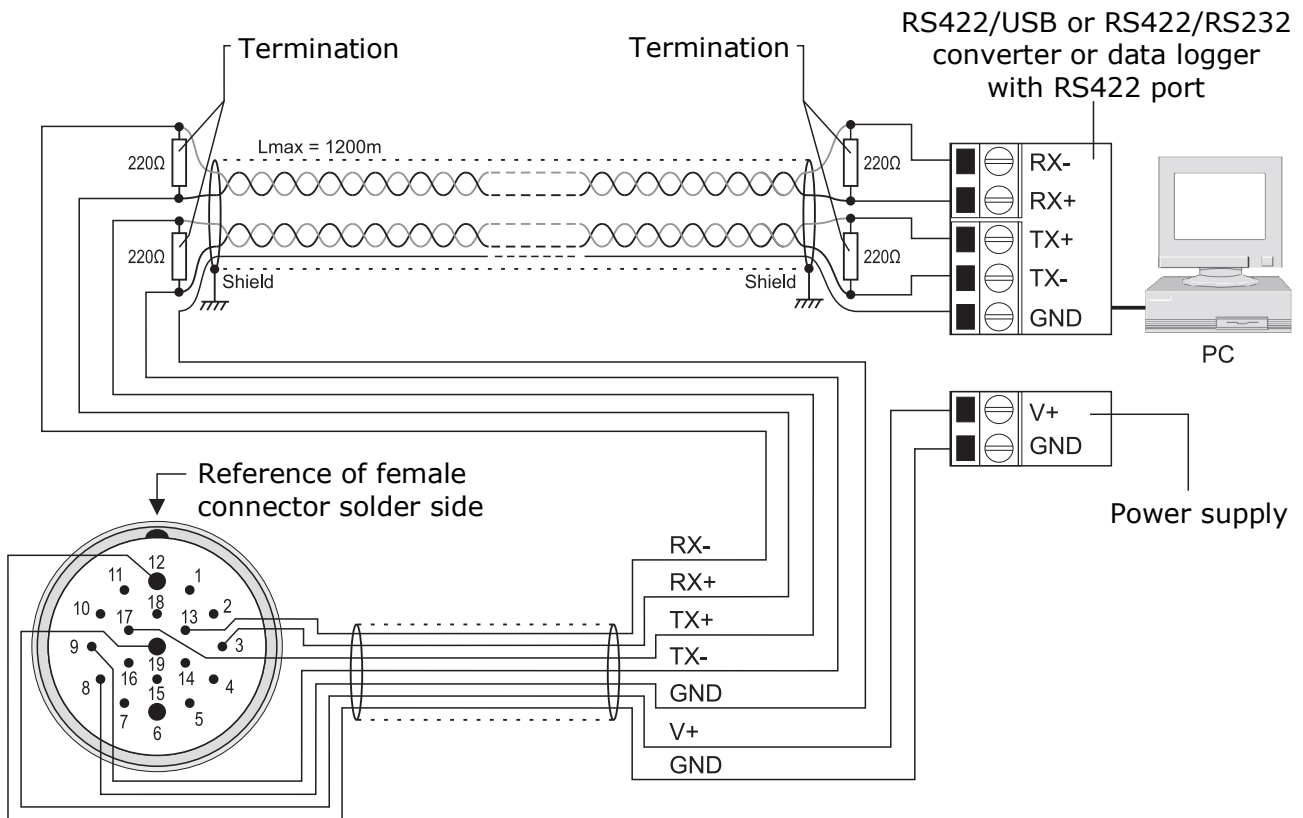
Each instrument on the network is univocally identified by an address. **Multiple transmitters with the same address should not be placed on the network.**

If the instrument is connected to a data logger, the possibility to connect multiple sensors to the network depends on the data logger capacity to manage multiple sensors.

NMEA, MODBUS-RTU and proprietary RS485 protocols can be used with RS485 connection.

Before connecting the instrument to the network, configure address and Baud Rate (see chapter 6 "CONFIGURATION").

5.2.3 RS422 SERIAL CONNECTION



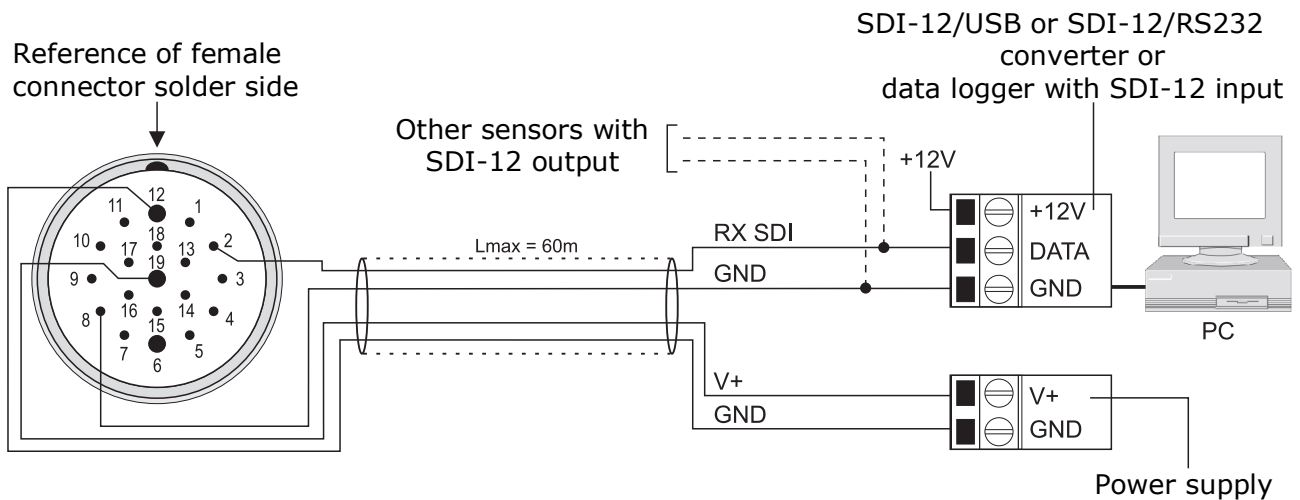
RS422 standard is used for point-to-point connection on long distances. The instrument is connected to a PC/data logger through a shielded cable with two twisted pairs for signals and an additional wire for ground. The extremities of the connections should end with line terminators.

The maximum length of the cable depends on the transmission speed and the cable characteristics. Typically, the maximum length is 1200 m. The data lines should be kept separated from any power lines in order to prevent interference with the transmitted signal.

NMEA, MODBUS-RTU and proprietary RS485 protocols can be used with RS422 connection.

Before connecting the instrument to the network, configure address and Baud Rate (see chapter 6 "CONFIGURATION").

5.2.4 SDI-12 SERIAL CONNECTION



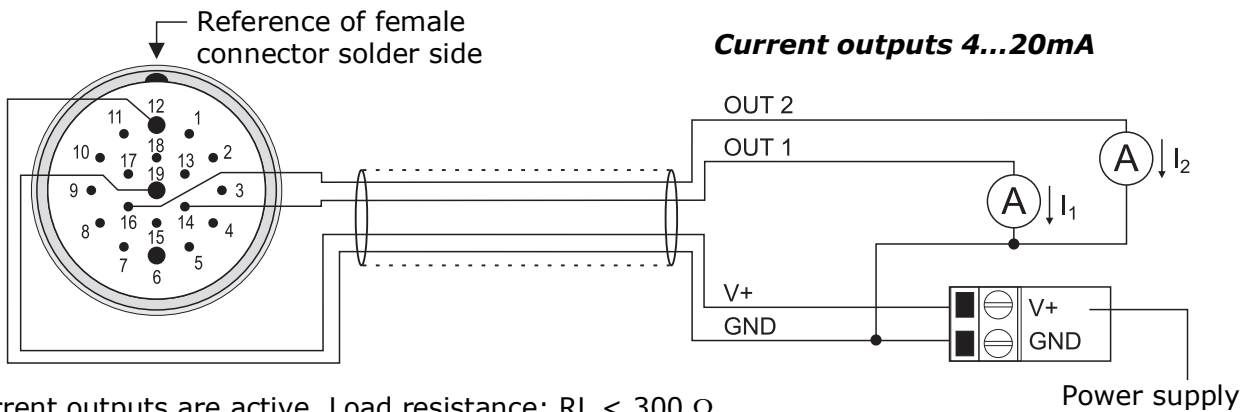
SDI-12 standard has three connection wires: power supply +12V, data line and ground.

Up to 10 sensors can be connected in parallel, each of them identified by its own address. Communication between sensors and PC/datalogger is performed at 1200 baud. Connection cables should not exceed 60 m.

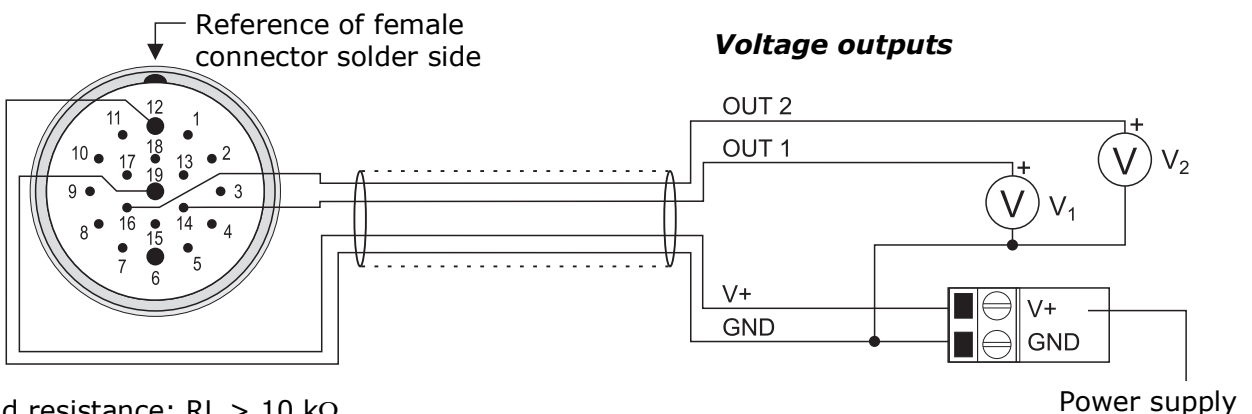
The instrument should be configured to operate in SDI-12 mode. Set the address (see chapter 6 "CONFIGURATION") before connecting the instrument to the network.

5.2.5 ANALOG OUTPUTS CONNECTION

Connect the outputs according to one of the two schemes below, depending on the output type, current (standard) or voltage (on request), available in the instrument. **OUT 1** and **OUT 2** are associated to wind speed and direction respectively. To change the type of speed and direction measurements associated to the outputs, see chapter 6 "CONFIGURATION".



Current outputs are active. Load resistance: $R_L < 300 \Omega$.

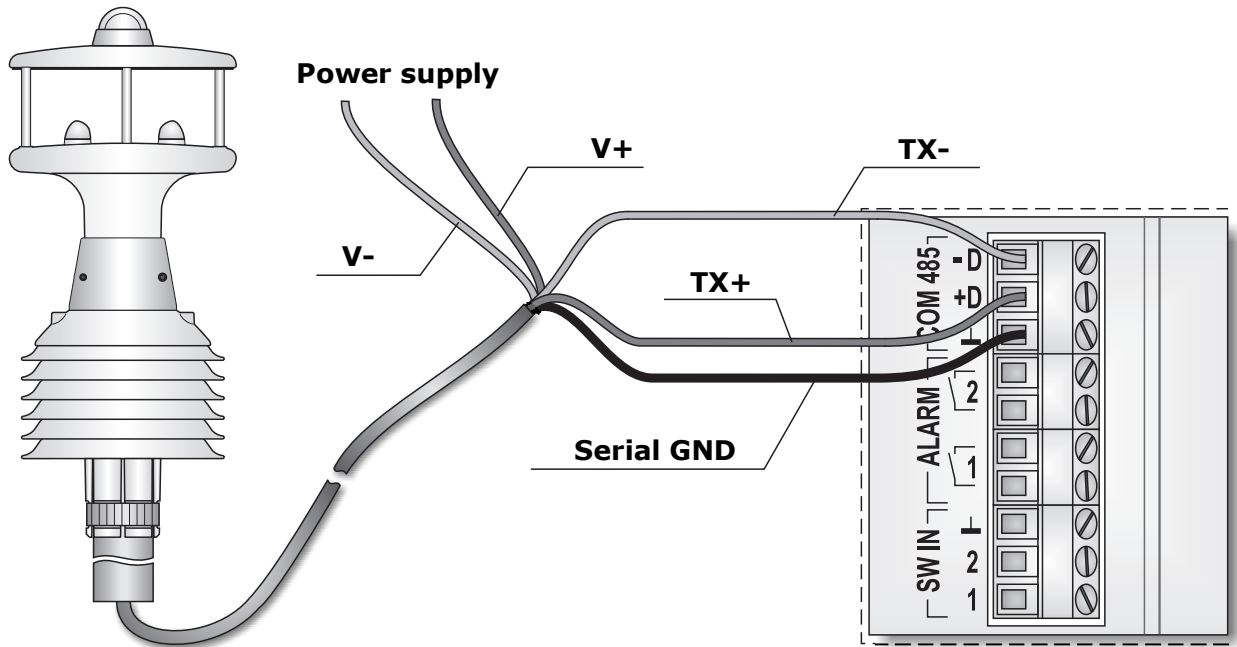


Load resistance: $R_L > 10 \text{ k}\Omega$.

5.2.6 CONNECTION TO THE RS485 PORT OF HD32MT.1 DATA LOGGER

The instruments of the series HD52.3D... can be directly connected to the RS485 communication port of Delta OHM HD32MT.1 data logger.

Connection is performed as follows:



TX+ signal of the anemometer should be connected to **+D** input of data logger.

TX- signal of the anemometer should be connected to **-D** input of data logger.

The serial ground is to be connected to the terminal indicated by the symbol ⏏, corresponding to the isolated ground of RS485 circuit.

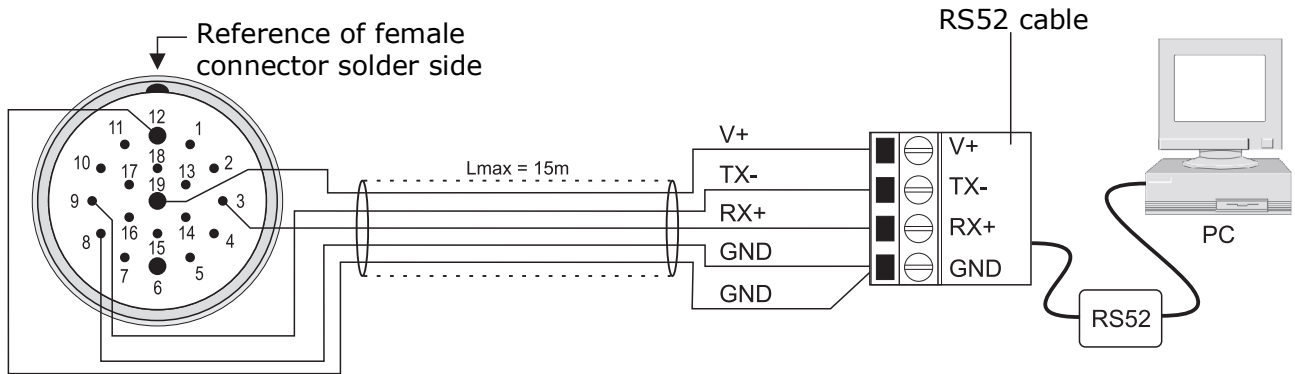
Note: if the connection cable is too long, it is advisable to add surge protection devices on RS485 TX+ and TX- data lines.

For a correct system operation, anemometers should be configured in advance with the following settings:

1. The anemometer should send the measured quantities following the order programmed in the data logger.
2. The air speed measuring unit set in the anemometer should correspond to the value programmed in the data logger.
3. Measuring average period equal to 1 second.
4. Communication protocol = proprietary RS485.
5. The RS485 Address must match the one programmed into the data logger.
6. Baud Rate = 115200

5.2.7 CONNECTION OF RS52 CABLE

If the PC is not equipped with RS232 serial ports, but with USB ports only, the **RS52** adapting cable (with built-in USB/RS232 converter) should be interposed between the PC and the instrument.



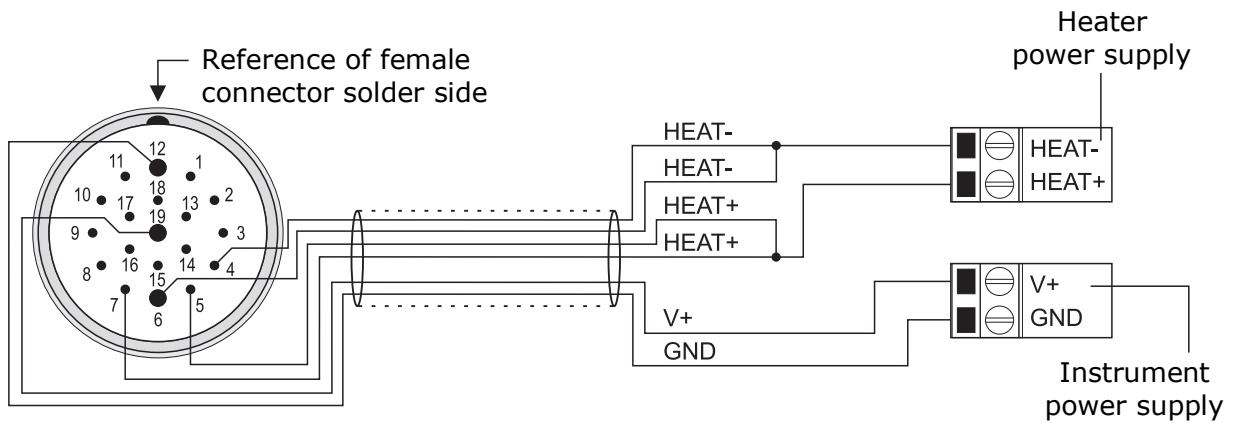
To use the **RS52** cable, the drivers included in the CD-ROM supplied with the instrument should be installed in the PC (see the guide to USB drivers installation in the *Documentation* section of the CD-ROM).

The instrument is powered directly from the USB port of the PC.

5.2.8 CONNECTION OF HEATING SYSTEM

Models with heat option (**R** option) have an integrated device that heats sonic transducers in order to prevent ice forming and ensure correct operation even in the presence of snow.

The heater power supply is separated from the instrument's main power supply.



Heating needs 12Vdc power supply and 6W power. The heat circuit is switched on below +4 °C. After switching on, the heating is switched off when the temperature exceeds +8 °C.

5.2.9 CONNECTION OF CP52.X CABLE

The table below shows numbers and function of the optional 12-pole CP52.x cable wires:

TAB. 5.B – Connection of CP52.x cable

CP52.x cable (12 poles) wire number	Connector pin number	Symbol	Description
1	19	V +	Instrument power supply positive
2	2	RX SDI	Data line for SDI-12 connection
3	3	RX +	Serial receive (input) positive
4	13	RX -	Serial receive (input) negative
5	17	TX +	Serial transmission (output) positive
6	6	HEAT -	Heater power supply negative
7	7	HEAT +	Heater power supply positive
8	8	GND	Serial ground
9	9	TX -	Serial transmission (output) negative
10	14	OUT 1	Analog output 1 positive
11	16	OUT 2	Analog output 2 positive
12	12	GND	Instrument power supply negative

ATTENTION:

The CP52.x cable wire number **does not** always coincide with the M23 connector pin number.

6 CONFIGURATION

Configuration mode allows to read the instrument's general info (firmware version, calibration date, serial number), to set the operation mode, to read and set the instrument operation parameters.

To configure the instrument, a RS232 serial connection to a PC should be performed (see paragraph 5.2.1). If your PC is not equipped with RS232 serial ports, the **RS52** adapting cable can be placed between the PC and the instrument (see paragraph 5.2.7).

Communication parameters should be set in the PC as follows:

- Baud rate: 115200
- Data Bits: 8
- Parity: None
- Stop Bit: 2

The instrument configuration can be realized with the aid of the **HD52.3D-S** application software (see the instructions of the software) or by sending serial commands via standard communication programs.

The configuration procedure by sending serial commands slightly differs depending on whether the instrument is set in configuration mode (factory setting, unless otherwise requested), or whether it is set in one of the available operation modes (SDI-12, NMEA, MODBUS-RTU, proprietary RS232, proprietary RS485).

➤ **INSTRUMENT SET IN CONFIGURATION MODE** (factory setting)

If the instrument is set in configuration mode, at power-up it remains waiting to receive the configuration serial commands described in the following tables. To configure and make the instrument operational, the following should be performed:

- Send command for operation mode selection (see table *Operation Mode* described at paragraph 6.1 "Serial Commands").
- Send commands to set the parameters of the selected operation mode (see tables described at paragraph 6.1 "Serial Commands").
- Send commands to set operational general parameters (parameters independent from operation mode)
- Turn the instrument off and on. The selected operation mode will become active after 10 seconds from restart.

Note: configuration commands can be sent in any order, it is not necessary to respect the indicated sequence.

➤ **INSTRUMENT SET IN ONE OF THE AVAILABLE OPERATION MODES**

If the instrument is set in one of the available operation modes, when started up it remains waiting for a serial command for 10 seconds. For instrument configuration, the following should be performed:

- Send the following command to the instrument before 10 seconds have elapsed:

@<CR>

with <CR> = ASCII character *Carriage Return*.

If the instrument doesn't receive the over mentioned command after 10 seconds from start up, the operation mode set in the instrument is immediately activated.

- Send commands to change the desired parameters (see tables described at paragraph 6.1 "Serial Commands").
- Turn the instrument off and on. The selected operation mode will become active after 10 seconds from restart with the new parameter values.

6.1 SERIAL COMMANDS

The tables below describe the serial commands that allow to read the current instrument configuration and change the operation parameters.

Measuring units:

Command	Reply	Description
CGUVn	&	Sets measuring unit of wind speed: <ul style="list-style-type: none"> ▪ m/s if n=1 ▪ cm/s if n=2 ▪ km/h if n=3 ▪ knot if n=4 ▪ mph if n=5 <i>Default</i> : m/s (n=1)
RGUV	n	Reads the wind speed measuring unit set in the instrument
CGUTn	&	Sets temperature measuring unit: <ul style="list-style-type: none"> ▪ °C if n=1 ▪ °F if n=2 <i>Default</i> : °C (n=1)
RGUT	n	Reads the temperature measuring unit set in the instrument
CGUPn	&	Sets pressure measuring unit: <ul style="list-style-type: none"> ▪ mbar if n=1 [Note:1 mbar=1 hPa] ▪ mmHg if n=2 ▪ inchHg if n=3 ▪ mmH₂O if n=4 ▪ inchH₂O if n=5 ▪ atm if n=6 <i>Default</i> : mbar (n=1)
RGUP	n	Reads the pressure measuring unit set in the instrument

Operation Mode:

Command	Reply	Description
CUMn	&	Sets instrument in mode: <ul style="list-style-type: none"> ▪ Configuration if n=0 ▪ proprietary RS485 if n=1 ▪ proprietary RS232 if n=2 ▪ SDI-12 if n=3 ▪ NMEA if n=4 ▪ MODBUS-RTU if n=5 <i>Default</i> : Configuration (n=0) (see Note 1)
RUM	&n	Reads mode set in the instrument

Note 1: after sending the command for the selection of the operation mode, the instrument remains in configuration mode. The selected configuration mode will become active at the following restart of the instrument.

Parameters for proprietary RS232 and RS485 modes:

Command	Reply	Description
CU1Ac	&	Sets the address for proprietary RS485 mode to c value The address is an alphanumeric character ranging within 0...9, a...z, A...Z <i>Default</i> : 0
RU1A	& c	Reads the address for proprietary RS485 mode set in the instrument
CU1Bn	&	Sets Baud Rate for proprietary RS485 mode to: <ul style="list-style-type: none"> ▪ 9600 if n=3 ▪ 19200 if n=4 ▪ 38400 if n=5 ▪ 57600 if n=6 ▪ 115200 if n=7 <i>Default</i> : 115200 (n=7)
RU1B	& n	Reads Baud Rate setting for proprietary RS485 mode
CU2Bn	&	Sets Baud Rate for proprietary RS232 mode to: <ul style="list-style-type: none"> ▪ 9600 if n=3 ▪ 19200 if n=4 ▪ 38400 if n=5 ▪ 57600 if n=6 <i>Default</i> : 57600 (n=6)
RU2B	& n	Reads Baud Rate setting for proprietary RS232 mode
CU1Dcccccccccc	&	Sets measurements order in the string sent in proprietary RS232 and RS485 modes In the sequence ccccccccc (max. 11 characters) each character identifies a measurement according to the following correspondence: <ul style="list-style-type: none"> 0 ⇒ Barometric Pressure 1 ⇒ Temperature (sensor Pt100) 2 ⇒ Relative Humidity 3 ⇒ Pyranometer 6 ⇒ Wind speed (coordinates U,V) 7 ⇒ Wind speed (intensity) 8 ⇒ Wind Direction (Azimuth) T ⇒ Sonic Temperature C ⇒ Compass E ⇒ Errors <i>Default</i> : 78 (see Note 2)
RU1D	& ccccccccc	Reads measurements order in the string sent in proprietary RS232 and RS485 modes

Command	Reply	Description
CU2Rnnnn	&	Sets transmission interval of string with measurements in proprietary RS232 mode to nnnn seconds The interval should range within 1 and 3600 seconds <i>Default</i> : 1 second
RU2R	& nnnn	Reads transmission interval of string with measurements in proprietary RS232 mode

NOTE 2 : MEASUREMENTS ORDER

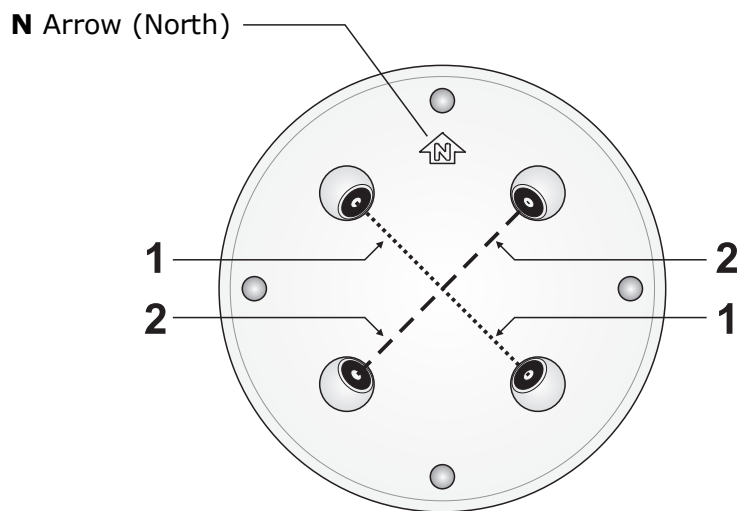
In the measurement string sent by the instrument (constantly in proprietary RS232 mode, on request in proprietary RS485 mode), measurements can be set in arbitrary order: one should simply indicate the desired order in the sequence of characters "cccccccccc" sent by the command C1UD. The sequence of characters "cccccccccc" can have a variable length up to a maximum of 11 characters.

Example: if the sequence of characters is set to 78012, wind speed, wind direction, barometric pressure, temperature and relative humidity measurements will appear from left to right in the data string sent by the instrument.

If information on error conditions is requested (E character), three numbers with the following meaning will appear in the data string sent by the instrument:

1. *First number* = error code identifying the transducers and the type of error.

The number is composed by two digits. The first digit indicates the path (that is the transducers pair) that presents the error, according to the numeration indicated in the figure:



Digit 7 indicates an error in the compass. Digit 0 indicates that no errors are present in the ultrasonic transducers or in the compass.

The second digit of the error code indicates the type of error: **0** = no errors; **1** = transducer broken, electric interruption, path obstruction; **Other** = codes reserved to technical service.

2. *Second number* = state of activation of the ultrasonic transducers heating.
0 = heating turned off, **1** = heating turned on
3. *Third number* = number of invalid measurements.

Example: if **21 0 2** appears in correspondence to the error condition in the data string sent by the instrument, it means that an error occurred (broken transducer or path obstruction) in the path number 2, that the heating is turned off and that two measurements have been rejected due to the error occurrence.

Parameters for NMEA mode:

Command	Reply	Description
CU4Bn	&	Sets Baud Rate for NMEA mode to: <ul style="list-style-type: none"> ▪ 2400 if n=1 ▪ 4800 if n=2 ▪ 9600 if n=3 ▪ 19200 if n=4 ▪ 38400 if n=5 ▪ 57600 if n=6 ▪ 115200 if n=7 <i>Default</i> : 4800 (n=2)
RU4B	& n	Reads Baud Rate setting for NMEA mode
CU4In	&	Sets interface for NMEA mode to: <ul style="list-style-type: none"> ▪ RS232 if n=0 ▪ RS485 if n=1 ▪ RS422 if n=2 <i>Default</i> : RS485 (n=1)
RU4I	& n	Reads interface setting for NMEA mode
CU4Mn	&	Sets parity and stop bits for NMEA mode to: <ul style="list-style-type: none"> ▪ 8N1 if n=0 [No parity, 1 stop bit] ▪ 8N2 if n=1 [No parity, 2 stop bits] ▪ 8E1 if n=2 [Even parity, 1 stop bit] ▪ 8E2 if n=3 [Even parity, 2 stop bits] ▪ 8O1 if n=4 [Odd parity, 1 stop bit] ▪ 8O2 if n=5 [Odd parity, 2 stop bits] The number of data bits is fixed to 8 <i>Default</i> : 8N1 (n=0)
RU4M	& n	Reads current setting of parity and stop bits for NMEA mode
CU4Rnnn	&	Sets transmission interval of string with measurements in NMEA mode to nnn seconds The interval should range within 1 and 255 seconds <i>Default</i> : 1 second
RU4R	& nnn	Reads setting of transmission interval of string with measurements in NMEA mode

Parameters for MODBUS-RTU mode:

Command	Reply	Description
CU5Annn	&	Sets MODBUS address to nnn The address should range within 1 and 247 <i>Default</i> : 1
RU5A	& nnn	Reads MODBUS address set in the instrument
CU5Bn	&	Sets the Baud Rate for MODBUS mode to: <ul style="list-style-type: none"> ▪ 9600 if n=3 ▪ 19200 if n=4 <i>Default</i> : 19200 (n=4)
RU5B	& n	Reads Baud Rate setting for MODBUS mode
CU5In	&	Sets interface for MODBUS mode to: <ul style="list-style-type: none"> ▪ RS232 if n=0 ▪ RS485 if n=1 ▪ RS422 if n=2 <i>Default</i> : RS485 (n=1) Note: with RS232 option you can connect to PC or datalogger 1 instrument only; option useful to do tests without RS232/RS485 conversion.
RU5I	& n	Reads interface setting for MODBUS mode
CU5Mn	&	Sets parity and stop bits for MODBUS mode to: <ul style="list-style-type: none"> ▪ 8N1 if n=0 [No parity, 1 stop bit] ▪ 8N2 if n=1 [No parity, 2 stop bits] ▪ 8E1 if n=2 [Even parity, 1 stop bit] ▪ 8E2 if n=3 [Even parity, 2 stop bits] ▪ 8O1 if n=4 [Odd parity, 1 stop bit] ▪ 8O2 if n=5 [Odd parity, 2 stop bits] The number of bits is fixed to 8 <i>Default</i> : 8E1 (n=2)
RU5M	& n	Reads current setting of parity and stop bits for MODBUS mode
CU5Wn	&	Sets waiting time after transmission in MODBUS mode to: <ul style="list-style-type: none"> ▪ Immediate reception if n=0 (violates protocol) ▪ Waiting 3.5 characters if n=1 (respects protocol) <i>Default</i> : Waiting 3.5 characters (n=1)
RU5W	& n	Reads current setting of waiting time after transmission in MODBUS mode

Parameters for SDI-12 mode:

Command	Reply	Description
CU3Ac	&	Sets the SDI-12 address to c value The address is an alphanumeric character ranging within 0...9, a...z, A...Z. <i>Default</i> : 0
RU3A	& c	Reads the SDI-12 address set in the instrument

General parameters:

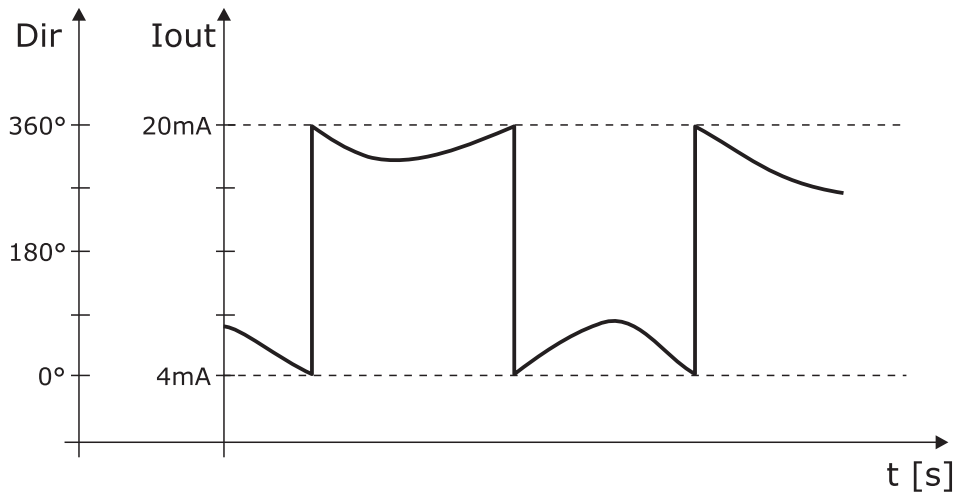
Command	Reply	Description
CGHn	&	Enables/disables heating: <ul style="list-style-type: none"> ▪ Disables if n=0 ▪ Enables if n=1 <i>Default</i> : Enabled (n=1)
RGH	n	Reads heating enabling state set in the instrument
CWCnnnn	&	Sets wind speed threshold to nnnn value (in hundredths of m/s) Value should range within 0 and 100 hundredths of m/s (= 0...1 m/s) <i>Default</i> : 20 (= 0.2 m/s) (see Note 3)
RWC	& nnnn	Reads the wind speed threshold value set in the instrument (in hundredths of m/s)
CWALn	&	Sets time interval for the calculation of average speed and average direction to n value Value should range within 1 and 9 s <i>Default</i> : 9 seconds
RWAL	& n	Reads the time interval for the calculation of average speed and average direction set in the instrument
CWAMn	&	Sets the method for the calculation of average speed and average direction: <ul style="list-style-type: none"> ▪ If n=0: scalar mean. The average intensity is calculated as average of intensities without consideration of direction. The average direction is calculated as average of directions, and expressed according to the extended characteristic (see Note 4). ▪ If n=1: vector mean. The mean values along the U-axis and along the V-axis are calculated. The average intensity and the average direction are those determined by the two average coordinates. <i>Default</i> : vector mean (n=1)
RWAM	& n	Reads the method for the calculation of the average speed and average direction set in the instrument
CCn <i>note: command available from firmware version 2.06</i>	&	Enables/disables the compass compensation of wind speed and direction: <ul style="list-style-type: none"> ▪ Disables if n=N ▪ Enables if n=Y <i>Default</i> : Enabled (n=Y)

NOTE 3 : WIND SPEED THRESHOLD VALUE

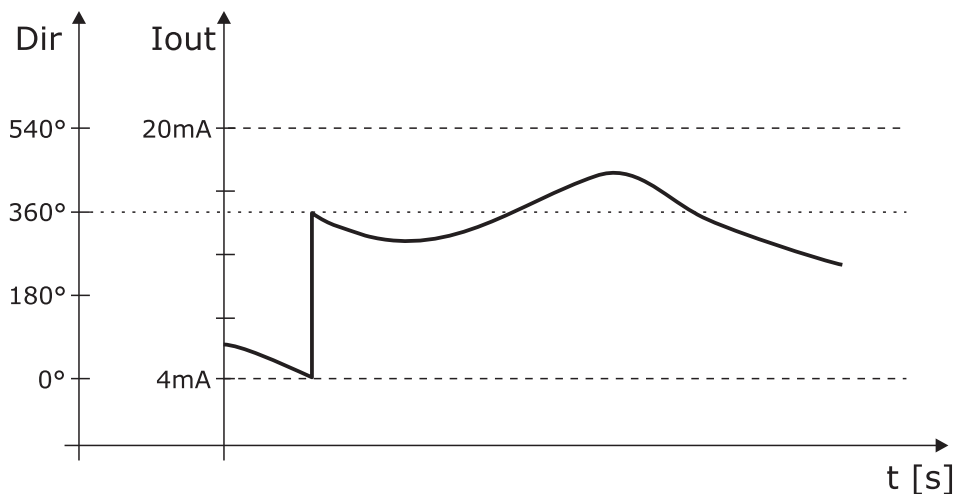
If the wind speed is very low, the determination of the direction can result inaccurate. The instrument allows to set the threshold value of speed below which the direction value is frozen on the last acquired value.

NOTE 4 : WIND DIRECTION EXTENDED CHARACTERISTIC

With 0÷359.9° wind direction measuring range, the analog output continues to oscillate between maximum and minimum scale if the direction continues to slightly fluctuate around 0°:



This effect can be reduced through the extended ("wrap-around") characteristic of wind direction. In this mode, the wind direction is considered as corresponding to 0÷539.9° range instead of 0÷359.9°. The wide output fluctuation occurs the first time that the wind direction goes from 0 to 359.9°; if later the "physical" direction goes back to 0°, the analog output will always remain around 360°. Using the extended characteristic, the behavior of the above graph changes into the following:



If 539.9° value is exceeded in extended mode, the output goes to the value corresponding to 180°.

The table below shows the correspondence between the value of the analog output and the direction of the wind in the two modes.

Wind direction	4...20mA output		0...1V output		0...5V output		0...10V output	
	standard	extended	standard	extended	standard	extended	standard	extended
0°	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00
180°	12.00	9.33	0.50	0.33	2.50	1.67	5.00	3.33
360°	20.00	14.67	1.00	0.67	5.00	3.33	10.00	6.67
540°	--	20.00	--	1.00	--	5.00	--	10.00

Analog outputs:

Command	Reply	Description
CAF1nn	&	<p>Sets offset and direction of the analog outputs to:</p> <ul style="list-style-type: none"> ▪ Standard if nn=00 [ex. 4...20mA, 0...1V, 0...5V, 0...10V] ▪ Without offset if nn=01 [ex. 0...20mA] ▪ With offset if nn=02 [ex. 0.2...1V, 1...5V, 2...10V] ▪ Inverted if nn=04 [ex. 20...4mA, 1...0V, 5...0V, 10...0V] ▪ Inverted without offset if nn=05 [ex. 20...0mA] ▪ Inverted with offset if nn=06 [ex. 1...0.2V, 5...1V, 10...2V] <p><i>Default</i> : Standard (nn=00)</p>
RAF1	& nn	<p>Reads offset and direction setting of analog outputs</p>
CAMn	&	<p>Association of the analog outputs:</p> <ul style="list-style-type: none"> ▪ If n= 0: Output 1 = Mean wind speed Output 2 = Mean wind direction ▪ If n= 1 (see Note 5): Output 1 = Instant wind speed component along V-axis Output 2 = Instant wind speed component along U-axis ▪ If n= 2 (Tunnel mode, see Note 6): Output 1 = Instant wind speed component along the direction indicated by the arrow on the instrument case Output 2 = Instant wind direction referred to the direction indicated by the arrow on the instrument case <p><i>Default</i> : n=0</p>
RAM	& n	<p>Reads the association of analog outputs</p>
CAHn	&	<p>Associates full scale of wind speed analog output to:</p> <ul style="list-style-type: none"> ▪ 5 m/s if n=0 ▪ 10 m/s if n=1 ▪ 15 m/s if n=2 ▪ 20 m/s if n=3 ▪ 25 m/s if n=4 ▪ 30 m/s if n=5 ▪ 35 m/s if n=6 ▪ 40 m/s if n=7 ▪ 45 m/s if n=8 ▪ 50 m/s if n=9 ▪ 55 m/s if n=10 ▪ 60 m/s if n=11 <p><i>Default</i> : 60 m/s (n=11)</p>
RAH	& n	<p>Reads the value corresponding to the wind speed analog output full scale</p>

NOTA 5 : U,V COMPONENTS

By selecting the U and V components, the speed value associated to the initial scale of the two analog outputs is equal to the opposite of the speed value associated to the full scale of the outputs.

For example, if the speed full scale value is set to 60 m/s, the speed range associated to the analog outputs is -60...+60 m/s.

NOTA 6 : TUNNEL MODE

In tunnel mode the wind direction measurement is not compensated by the magnetic compass, but the measurement is referred to the direction indicated by the arrow on the instrument case.

The output 2 is set to full scale value if the wind blows in the direction of the arrow, and to initial scale value if the wind blows in the opposite direction.

The initial scale of output 1 is associated to the speed value opposite to that associated to the output full scale.

The arrow on the instrument case should be aligned with the direction of the tunnel.

Instrument information

Command	Reply	Description
G1	&Vnn.nn yyyy/mm/dd	Version and date of firmware
RGD	&yyyy/mm/dd hh.mm.ss	Date and time of calibration
RGS	&nnnnnnnn	Serial number of instrument
RGI	&ccc...ccc	User code
CGIccc...ccc	&	Sets user code to ccc...ccc (max. 34 characters)

7 PROPRIETARY RS232 MODE

In proprietary RS232 mode, the instrument sends automatically the acquired measurements at regular intervals. The interval is factory-set to 1 second and is configurable from 1 to 3600 seconds. To change the interval, you should enter in configuration mode and send the command **CU2Rnnnn**, where nnnn indicates the interval value in seconds (see chapter 6 "CONFIGURATION" for details regarding the setting of operation parameters).

To use this mode, you must connect to a RS232 serial port. Communication parameters should be set in your PC as follows:

- Baud rate: 9600 to 57600 (same as the setting in the instrument)
- Data bits: 8
- Parity: None
- Stop bits: 2

The instrument sends measurements in the following format:

<M1><M2>....<Mn><CR><LF>

with <M1><M2>....<Mn> = values of the first, second,...., nth measurement

<CR> = ASCII character *Carriage Return*

<LF> = ASCII character *Line Feed*

Fields <M1><M2>....<Mn> consist of 8 characters each. Measurement values are justified right; spaces can be added to the left margin of the values to obtain the 8 character length requested by the fields.

The sequence of the measurement values <M1><M2>....<Mn> is configurable (see chapter 6 "CONFIGURATION").

EXAMPLE

Supposing that the instrument measures the following values (the measuring unit is not considered, being not output by the instrument): M1=2.23, M2=-28.34, M3=0.34, M4=28.30, M5=359.3, M6=-1.3, the data string sent by the instrument takes the form:

2.23 -28.34 0.34 28.30 359.3 -1.3<CR><LF>

8 PROPRIETARY RS485 MODE

In proprietary RS485 mode, the instrument sends the acquired measurements only if requested by the PC.

To use this mode, you must connect to a RS485 or RS422 serial port. Communication parameters should be set in the PC or data logger as follows:

- Baud rate: 9600 to 115200 (same as the setting in the instrument)
- Data bits: 8
- Parity: None
- Stop bits: 2

The instrument is requested to send measurements by generating a *Break Signal*^(*) on the serial line for at least 2 ms, and then sending the following command, consisting of 4 ASCII characters:

M<Address><x><x>

with <Address> = address of the instrument measurements are requested to
<x> = any ASCII character

EXAMPLE

To ask the instrument with address 2 to send the acquired measurements, do the following:

- 1) **Break Signal** for at least 2 ms;
- 2) Send command: **M2aa**.

The instrument answers with the following string:

IIIIIM<Address>I&<M1><M2>...<Mn><SP>&AAAM<Address><CS><CR>

with <Address> = address of the instrument sending measurements
<M1><M2>...<Mn> = values of the first, second, ..., nth measurement
<SP> = space
<CS> = checksum (hex value of the 8-bit checksum of all the preceding characters)
<CR> = ASCII character *Carriage Return*

Fields <M1><M2>...<Mn> consist of 8 characters each. Measurement values are justified right; spaces can be added to the left margin of the values to obtain the 8 character length requested by the fields. The sequence of the measurement values <M1><M2>...<Mn> is configurable (see chapter 6 "CONFIGURATION").

EXAMPLE

Supposing that the instrument with address 2 measures the following values (the measuring unit is not considered, being not output by the instrument): M1=2.23, M2=-28.34, M3=0.34, M4=28.30, M5=359.3, M6=-1.3, the instrument reply takes the following form:

IIIIIM2I& 2.23 -28.34 0.34 28.30 359.3 -1.3 &AAAM28C<CR>

A minimum time interval should elapse between two commands, depending on the Baud Rate setting:

Baud Rate	Minimum interval between two commands
9600	200 ms
19200	100 ms
38400	70 ms
57600	40 ms
115200	25 ms

(*) Break Signal means interruption of the serial communication for a given time interval. It is used to inform the devices connected to the network that a command is going to be sent. The function that generates the Break Signal is usually available in the programming languages or in the serial communication programs.

9 NMEA MODE

NMEA protocol, mainly used in the nautical field and in satellite-based navigation systems, specifies that only one of the devices connected can send data, while the others can only act as recipients.

In NMEA mode, the instrument sends automatically the acquired measurements at regular intervals. The interval is factory-set to 1 second and can be configured within 1 and 255 seconds. To change the interval you should access the configuration mode and send **CU4Rnnn** command, where nnn indicates the interval value in seconds (see chapter 6 "CONFIGURATION" for details regarding the setting of operation parameters).

This mode is available with RS232, RS485 and RS422 serial connections. Communication parameters should be set in the PC or data logger as follows:

- Baud rate: same as the setting in the instrument (default = 4800)
- Data bits: 8
- Parity: same as the setting in the instrument (default = None)
- Stop bits: same as the setting in the instrument (default = 1)

The instrument is compatible with NMEA 0183 V4.00 protocol.

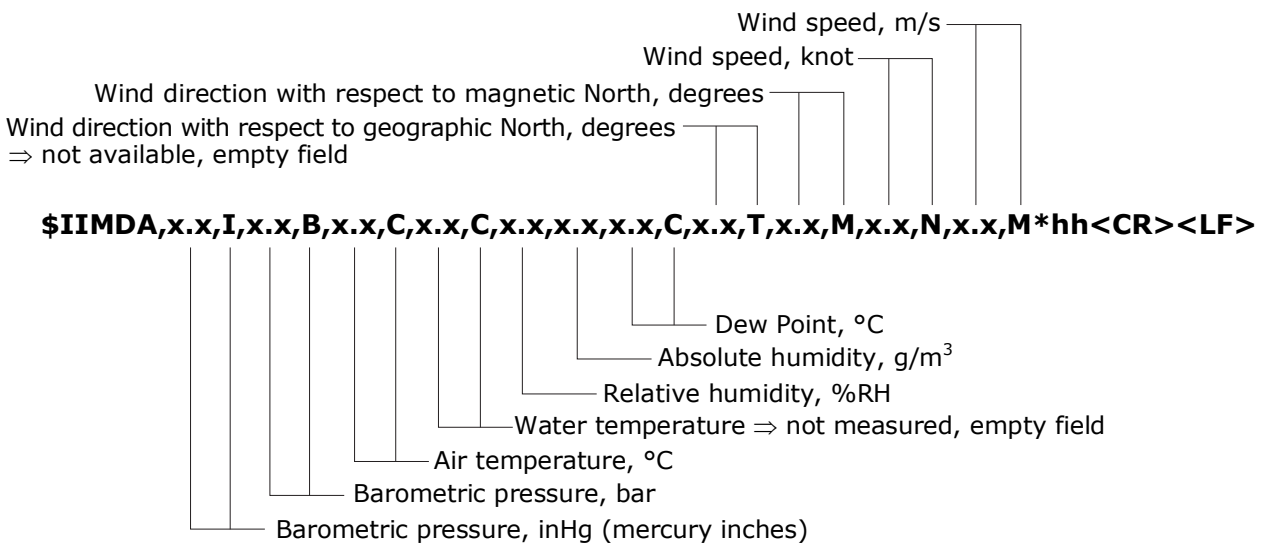
The protocol establishes that data are sent in the following format:

\$<Prefix>,<Data>*<hh><CR><LF>

- with <Prefix> = field consisting in 5 alphanumeric characters: the first two indicate the type of transmitting device, the other three indicate the type of transmitted data
- <Data> = values measured by the instrument, separated by commas
- <hh> = checksum, consisting in two hexadecimal characters
- <CR> = character ASCII *Carriage Return*
- <LF> = character ASCII *Line Feed*

The checksum is calculated by performing the exclusive OR of all characters ranging within \$ and * symbols. The 4 most significant bits and the 4 less significant bits of the result are converted in hexadecimal. The hexadecimal value corresponding to the most significant bits is transmitted as the first.

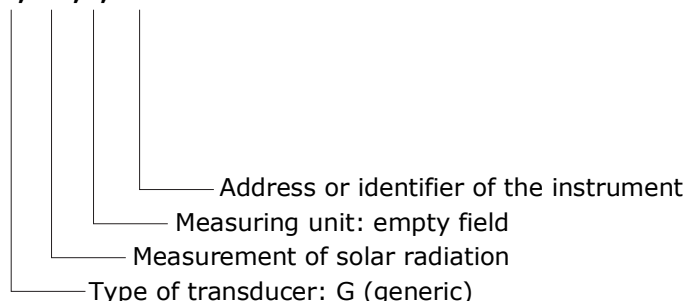
The instrument regularly sends a string in the following general format requested by the protocol:



If the instrument model is not equipped to measure some of the quantities indicated in the general format, the relevant fields will be empty and multiple consecutive commas will appear to indicate the missing fields.

The previous string doesn't include the measurement of solar radiation. Models equipped with a pyranometer provide to send the measurement with a second string continuously alternating to the former:

\$IIXDR,a,x.x,a,c--c*hh<CR><LF>



EXAMPLE

Suppose that there are the following environmental conditions:

- Wind speed = 5.60 m/s (=10.88 knot)
- Wind direction with respect to magnetic North = 38.7°
- Barometric pressure = 1014.9 hPa (= 30.0 inHg)
- Relative humidity = 64.2 %
- Air temperature = 26.8 °C
- Solar radiation = 846 W/m²

Based on the above values, the following can be calculated:

- Absolute humidity = 16.4 g/m³
- Dew Point = 19.5 °C

The strings sent by the instrument in three different cases are indicated below:

- Case 1 - instrument measuring only wind speed and direction:

\$IIMDA,,I,,B,,C,,C,,,,C,,T,38.7,M,10.88,N,5.60,M*26<CR><LF>

- Case 2 - instrument measuring wind speed and direction, temperature, relative humidity and barometric pressure:

\$IIMDA,30.0,I,1.0149,B,26.8,C,,C,64.2,16.4,19.5,C,,T,38.7,M,10.88,N,5.60,M*2A<CR><LF>

- Case 3 - instrument measuring wind speed and direction, solar radiation, temperature, relative humidity and barometric pressure:

\$IIMDA,30.0,I,1.0149,B,26.8,C,,C,64.2,16.4,19.5,C,,T,38.7,M,10.88,N,5.60,M*2A<CR><LF>

alternated to:

\$IIXDR,G,846,,01*32<CR><LF>

For additional information regarding the protocol, visit the site "www.nmea.org".

10 MODBUS-RTU MODE

In MODBUS-RTU mode, the instrument sends the acquired measurements only if specifically requested by the PC.

The mode is available with RS232, RS485 and RS422 serial connections.

Note: with the RS232 connection, only one instrument can be connected to the PC; the option is useful to perform tests in MODBUS mode in the case a RS232/RS485 converter is not available.

Communication parameters should be set in the PC or data logger as follows:

- Baud rate: same as the setting in the instrument (default = 19200)
- Data bits: 8
- Parity: same as the setting in the instrument (default = even)
- Stop bits: same as the setting in the instrument (default = 1)

The protocol is a "**Master-Slave**" type. Only one "Master" device is on the network, typically a PC, the other units are all of "Slave" type. The "Master" unit can send commands and requests of data to the "Slave" devices on the network. A "Slave" device communicates only with the "Master" unit answering to a request of the latter. Direct communication among "Slave" devices is not allowed, nor a "Slave" unit can send on line data if not requested.

Commands sent by the PC to the instrument consist of four fields:

<Address><Function><Data><CRC>

with <Address> = address of the instrument the command is sent to (1 byte)
<Function> = type of operation to be performed by the instrument (1 byte)
<Data> = data communicated by the PC to the instrument (0 to 252 bytes)
<CRC> = cyclic redundancy check of data for data correctness (2 bytes)

The address should range within 1 and 247 (in the case of multi-point RS485 serial connection, see paragraph 5.2.2 on page 10 for the maximum number of connectable instruments).

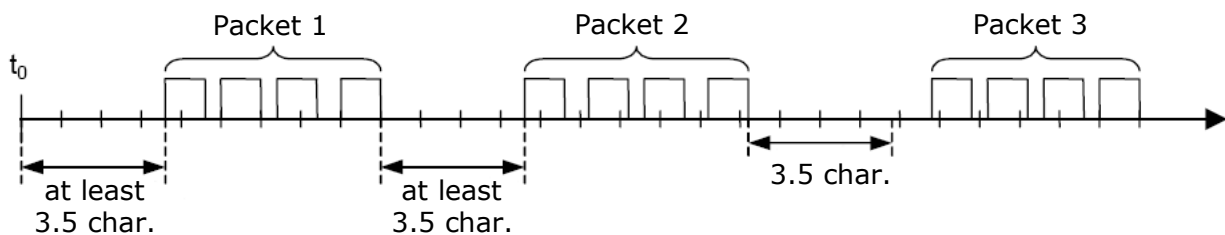
Each byte (8 bits) consists of two 4-bit hexadecimal characters.

Each byte is preceded by a start bit and followed by a parity bit and a stop bit, for a total of 11 bits. If parity is not used, the byte should be followed by two stop bits.

The byte is transmitted starting from the less significant bit (LSB).

All bytes forming the command are transmitted consecutively without interruption, starting from the address byte. The last byte to be transmitted is the most significant byte of the control code (CRC). If a pause longer than 1.5 characters elapses between two consecutive bytes, the command will be considered as not correct and will be discarded by the recipient.

An interval of at least 3.5 characters should elapse between a command and the following:



After a pause on line longer than 3.5 characters, the connected devices will consider the command transmission as concluded. The first character received after the pause will be considered as the new command.

The instrument sends the requested data after elaboration of the received command. The reply structure is identical to the message sent by the "Master" unit:

<Address><Function><Data><CRC>

with <Address> = address of the answering instrument (1 byte)
 <Function> =type of operation the instrument has performed (1 byte)
 <Data> = data communicated by the instrument to the PC (0 to 252 bytes)
 <CRC> = cyclic redundancy check for data correctness (2 bytes)

When the address field takes the value "0", it means that the command is sent to all the devices on the network. In this case the devices perform the command, if this is compatible with their functionalities, but don't send any reply to the PC, to prevent transmission conflicts.

In order to prevent transmission conflicts among the instruments, the PC should wait for the reply from the questioned instrument before sending a new command.

If the instrument doesn't receive correctly the command (time intervals between characters or check codes were not respected), it doesn't send any reply to the PC. If the PC doesn't receive a reply within a given time interval (time-out), it will consider the command reception from the recipient as not successful and can try again to transmit or generate an error signal.

The functions that can be requested from the PC to the instrument, together with the corresponding codes to be entered in the command field *Function*, are indicated in the table below:

TAB. 10.A – Modbus functions

Function code	Function
04h	Measurement reading
07h	Error condition reading
2Bh	Instrument general information reading

MEASUREMENT READING (function **04h**)

Function code 04h allows to read the values measured by the instrument.

The data field of the request shows the address of the input register containing the first quantity to be read and the number of consecutive quantities to be read.

Since registers are numbered starting from 1 in the protocol, but data is addressed starting from 0, the register address is equal to the register number decreased by 1.

The instrument answers with the value of the measured quantities. It is not allowed to read quantities that are not measured by that particular model.

The fields *Function* and *Data* of command and reply take consequently the following form:

Command

	Value	Length	Description
<i>Function:</i>	04h	1 byte	Command of measurement reading
<i>Data:</i>	0000h to FFFFh	2 byte	Address of first quantity
	0001h to 007Dh	2 byte	Number of quantities to be read (N)

Reply

	Value	Length	Description
<i>Function:</i>	04h	1 byte	Measurement reading command
<i>Data:</i>	2 x N	1 byte	Number of values bytes
		2 x N byte	Values of measurements

The value of a measurement is memorized in a 16-bit register and therefore it always needs a 2-byte length. The most significant byte precedes the less significant one.

The table below lists the available quantities with the corresponding register number:

TAB. 10.B - Input Registers

Register number	Quantity	Format	From FW version	Note
0001	Wind speed (x100)	unsigned 16 bits	1.00	(1)
0002	Wind direction in degrees (x10)	unsigned 16 bits	1.00	
0003	Sonic temperature measured by the first transducers pair (x10)	16 bits	1.00	(1)
0004	Sonic temperature measured by the second transducers pair (x10)	16 bits	1.00	(1)
0005	Average of the two sonic temperatures measured by the two transducers pairs (x10)	16 bits	1.00	(1)
0006	Temperature measured by Pt100 sensor (x10)	16 bits	1.00	(1)
0007	Relative humidity in %RH (x10)	unsigned 16 bits	1.00	
0008	Barometric pressure (x1000 if the unit of measurement is atm, x10 in the other cases)	unsigned 16 bits	1.00	(1)
0009	Compass angle in degrees (x10)	unsigned 16 bits	1.00	
0010	Solar radiation in W/m ²	unsigned 16 bits	1.00	
0011	Mean wind speed (x100)	unsigned 16 bits	1.00	(1)
0012	Mean wind direction in degrees (x10)	unsigned 16 bits	1.00	
0013	Absolute humidity in g/m ³ (x100)	unsigned 16 bits	1.00	
0014	Dew point temperature (x10)	16 bits	1.00	(1)
0015	Wind direction in degrees (x10) with extended feature (see page 23)	unsigned 16 bits	1.00	
0016	Wind speed (x100) along V-axis	unsigned 16 bits	2.00	
0017	Wind speed (x100) along U-axis	unsigned 16 bits	2.00	
0018	Status register bit0=1 ⇒ speed measurement error bit1=1 ⇒ compass measurement error bit2=1 ⇒ temperature meas. error bit3=1 ⇒ humidity measurement error bit4=1 ⇒ pressure measurement error bit5=1 ⇒ solar rad. measurement error	unsigned 16 bits	2.00	
0019	Wind speed unit of measurement 0 ⇒ m/s 3 ⇒ knot 1 ⇒ cm/s 4 ⇒ mph 2 ⇒ km/h	unsigned 16 bits	2.00	
0020	Temperature unit of measurement 0 ⇒ °C 1 ⇒ °F	unsigned 16 bits	2.00	
0021	Atm. pressure unit of measurement 0 ⇒ mbar (=hPa) 3 ⇒ mmH ₂ O 1 ⇒ mmHg 4 ⇒ inchH ₂ O 2 ⇒ inchHg 5 ⇒ atm	unsigned 16 bits	2.00	

(1) For quantities with configurable measurement unit, the measurement value is expressed in the unit set in the instrument.

If the request involves the reading of at least one parameter not listed in the table, the instrument replies with the following error message.

Reply

	Value	Length	Description
<i>Function:</i>	84h	1 byte	Measurement reading error
<i>Data:</i>	02h	1 byte	Request of an inexistent parameter

EXAMPLE

Suppose you want to read the wind direction measurement of an instrument whose current measurement is 65.8°.

From the input register table we obtain that the wind direction value is memorized in the register number 0002. To read the quantity value, we need to enter the following in the request:

- address (= number - 1) of the register with the first parameter (0001 = 0001h)
- number of parameters to be read (1 = 0001h)

Therefore the command takes the form below:

Command

	Value	Length	Description
<i>Function:</i>	04h	1 byte	Measurement reading command
<i>Data:</i>	00h	2 bytes	Address of first quantity (MSB)
	01h		Address of first quantity (LSB)
	00h	2 bytes	Number of quantities to be read (MSB)
	01h		Number of quantities to be read (LSB)

The instrument will reply with the measured value: $65.8^\circ \times 10 = 658 = 0292h$

Reply

	Value	Length	Description
<i>Function:</i>	04h	1 byte	Measurement reading command
<i>Data:</i>	02h	1 byte	Number of values bytes
	02h	2 bytes	Measured Value (MSB)
	92h		Measured Value (LSB)

INSTRUMENT ERROR CONDITIONS (function **07h**)

The function code 07h allows to read the 8-bit register containing information about error conditions of the instrument.

Each register bit corresponds to an error condition:

- *Bit 0*: Error of wind speed measurement;
- *Bit 1*: Error of compass measurement;
- *Bit 2*: Error of temperature measurement;
- *Bit 3*: Error of relative humidity measurement;
- *Bit 4*: Error of barometric pressure measurement;
- *Bit 5*: Error of solar radiation measurement;
- *Bit 6*: Not assigned;
- *Bit 7*: Not assigned.

There is an error condition if the corresponding bit value is 1.

The command for an error register reading is:

Command

	Value	Length	Description
<i>Function:</i>	07h	1 byte	Error register reading command
<i>Data:</i>		0 byte	<i>Data</i> field is empty

The instrument reply takes the following form:

Reply

	Value	Length	Description
<i>Function:</i>	07h	1 byte	Error register reading command
<i>Data:</i>	00h to FFh	1 byte	Register value

READING OF INSTRUMENT GENERAL INFORMATION (function **2Bh**)

Function code 2Bh allows to read the basic general information of the instrument, consisting of:

- Manufacturer;
- Instrument model;
- Firmware version.

The command takes the following form:

Command

	Value	Length	Description
<i>Function:</i>	2Bh	1 byte	Information reading command
<i>Data:</i>	0Eh	1 byte	Fixed value (MEI type- Modbus Encapsulated Interface)
	01h	1 byte	Fixed value (Type of basic identification)
	00h	1 byte	Fixed value (First field of information)

The instrument answers as follows:

Reply

	Value	Length	Description
<i>Function:</i>	2Bh	1 byte	Command of information reading
<i>Data:</i>	0Eh	1 byte	Fixed value (MEI - Modbus Encapsulated Interface type)
	01h	1 byte	Fixed value (Type of identification - basic)
	01h	1 byte	Fixed value (Conformity level – basic – fields not individually accessible)
	00h	1 byte	Fixed value (No other fields are available)
	00h	1 byte	Fixed value (ID next object)
	03h	1 byte	Fixed value (Number of fields)
	00h	1 byte	Fixed value (ID first field)
	Length1	1 byte	First field length
	Value 1	(Length1) byte	First field value (Manufacturer)
	01h	1 byte	Fixed value (ID second field)
	Length 2	1 byte	Second field length
	Value 2	(Length2) byte	second field value (Model)
	02h	1 byte	Fixed value (ID third field)
	Length 3	1 byte	Third field length
	Value 3	(Length3) byte	Third field value (Firmware version)

ERROR REPLIES

Correctly addressed commands, that got also through CRC control, can nevertheless generate error conditions, for example if one tries to read an inexistent parameter or if the instrument is asked to perform a function which is not compatible with its model.

A reply containing an error code is generated in all cases in which the instrument cannot fulfill, for whatever reason, the requested operation. The value entered in the field *Function* corresponds to the received function code, but with the most significant bit (MSB) set to 1, so as to signal to the "Master" unit both the error condition and the function that caused the error.

Reply

	Value	Length	Description
<i>Function:</i>	Requested function code with MSB=1	1 byte	Error in performing the requested function
<i>Data:</i>	from 01h to 02h	1 byte	Error code

The table below shows the error codes:

TAB. 10.C - Error codes

Error code	Error	From FW version	Note
0001	Invalid function. The instrument doesn't manage the requested function.	1.00	
0002	Invalid address. At least one of the registers specified in the command is inexistent.	1.00	

For additional information regarding the protocol, visit the site "www.modbus.org".

11 SDI-12 MODE

In SDI-12 mode, the instrument sends the acquired measurements only if specifically requested by the PC.

To use this mode, an SDI-12 serial connection should be performed. Communication parameters should be set in the PC or data logger as follows:

- Baud rate: 1200
- Data bits: 7
- Parity: Even
- Stop bit: 1

Communication with the instrument is performed by generating a *Break Signal* (*) on the serial line for at least 12 ms, and then by sending a command in the following format:

<Address><Command>!

with <Address> = address of the instrument the command is sent to.
<Command> = type of operation requested to the instrument.

The instrument reply is as follows:

<Address><Data><CR><LF>

with <Address> = address of the replying instrument
<Data> = information sent by the instrument
<CR> = ASCII character *Carriage Return*
<LF> = ASCII character *Line Feed*

Typically, the PC or data logger requests the data measured by the instrument following the sequence below:

1. Generation of *Break Signal* for at least 12 ms.
2. The PC/datalogger sends a command to the instrument asking to perform measurements.
3. Reply of the instrument (within 15 ms) to communicate the number of measurements to be sent and the time needed to make them available.
4. If measurements are immediately available, the PC/datalogger sends a command to the instrument asking to send measurements. If measurements aren't immediately available, the PC/datalogger waits for the instrument to communicate the availability of measurements, before sending the command of request.
5. The instrument sends the acquired measurements to the PC/datalogger.

The instrument is compatible with V1.3 version of the protocol.

The table below shows the available SDI-12 commands. To comply with the SDI-12 standard, the instrument address is indicated in the table with the letter a.

(*)**Break Signal** means interruption of the serial communication for a given time interval. It is used to inform the devices connected to the network that a command is going to be sent. The function that generates the Break Signal is usually available in the programming languages or in the serial communication programs.

SDI-12 COMMANDS

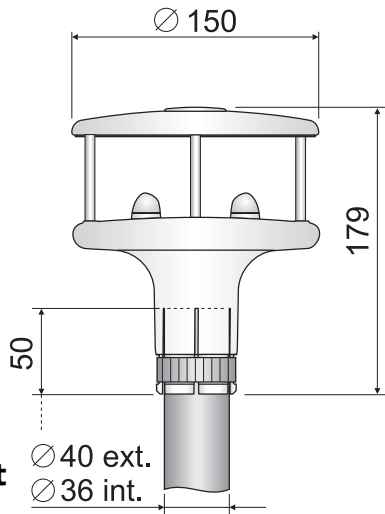
Command	Instrument reply	Description
a!	a<CR><LF>	Checks for the presence of the instrument.
aI!	allccccccmmmmmmvxx...x<CR><LF> where: a = address of the instrument (1 character) ll = compatible SDI-12 version (2 characters) ccccccc = manufacturer (8 characters) mmmmmm = instrument model (6 characters) vvv = firmware version (3 characters) x...x = instrument version (up to 13 characters) . . . ⇒ Example of reply: 113DeltaOhmHD523D103P147R with: 1 = address of the instrument 13 = compatible SDI-12 version 1.3 DeltaOhm = name of manufacturer HD523D = model of HD52.3D series 103 = firmware version 1.0.3 P147R = instrument version HD52.3DP147R	Request for instrument information.
aAb! where: b = new address	b<CR><LF> Note: if character b is not an acceptable address, the instrument answers with a in the place of b.	Change of instrument address.
?!	a<CR><LF>	Request for instrument address in case this is unknown. If more than a sensor is connected to the bus, a conflict will occur.
aM!	attn<CR><LF> where: a = address of the instrument (1 character) ttt = number of seconds needed by the instrument to make measurements available (3 characters) n = number of detected quantities (1 character) Note: ttt is always equal to 000 because the measuring process is continuous. Measurements can be directly requested (command aD0!) without sending this command before.	Request to perform the measurement.

Command	Instrument reply	Description
aD0! ⋮ aD9!	<p>a<Measurements><CR><LF> ⋮ a<Measurements><CR><LF></p> <p>where: a = address of the instrument (1 character) <Measurements> = sequence of measured values</p> <p>Commands aD1!, aD2!, etc. are sent only if all the expected values are not received with command aD0!.</p> <p style="text-align: center;">• • •</p> <p>⇒ Sequence of measurements in the most complete model: <WS><WD><T><RH><AH><DP><P><R><C></p> <p>with: <WS> = wind speed <WD> = wind direction in degrees <T> = temperature (sensor Pt100) <RH> = relative humidity in %RH <AH> = absolute humidity in g/m³ <DP> = dew point temperature <P> = barometric pressure <R> = solar radiation in W/m² <C> = compass angle in degrees</p> <p>Notes: The positive values are always preceded by a + sign to identify the beginning of the measurement value. As to the quantities with configurable measuring unit (wind speed, temperature and barometric pressure), the measurement value is expressed in the unit set in the instrument. <DP> measurement has the same format as temperature. If a quantity measurement is in error condition, all the digits of the sent value will consist in a series of 9. The fields corresponding to quantities not measured by that particular model are always present. A value consisting in a series of 9 is sent.</p>	Request for measured values.

For additional information regarding the protocol, visit the site "www.sdi-12.org".

12 DIMENSIONS

The figures below indicate the dimensions of the instrument in mm.



Mast

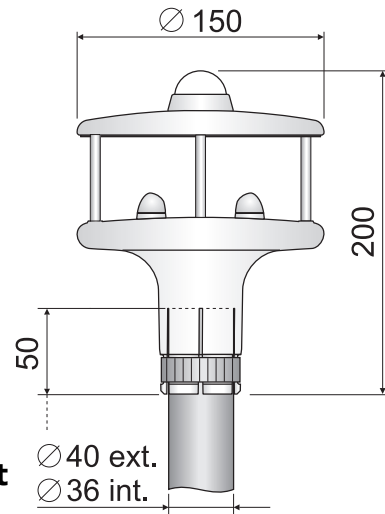
∅ 40 ext.
∅ 36 int.

HD 52.3D

Wind speed and direction.

HD 52.3D4

Wind speed, wind direction and barometric pressure



Mast

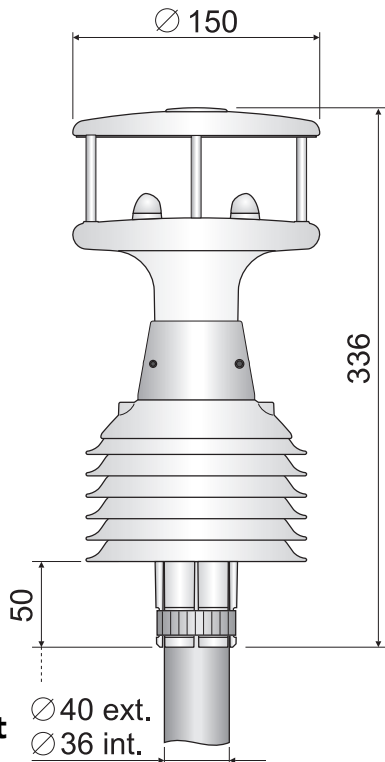
∅ 40 ext.
∅ 36 int.

HD 52.3DP

Wind speed, wind direction and solar radiation.

HD 52.3DP4

Wind speed, wind direction, solar radiation and barometric pressure.



Mast

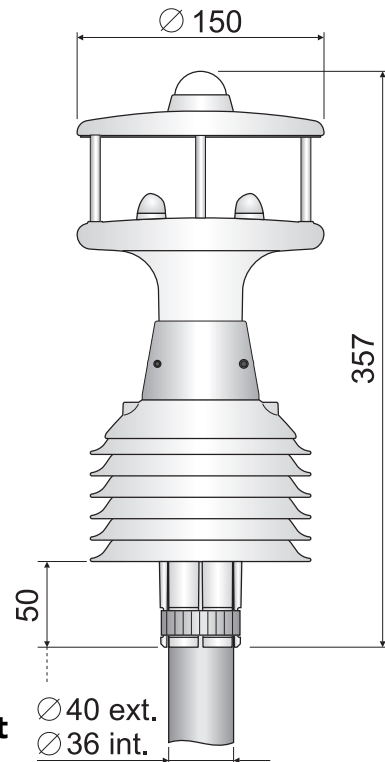
∅ 40 ext.
∅ 36 int.

HD 52.3D17

Wind speed, wind direction, temperature and relative humidity.

HD 52.3D147

Wind speed, wind direction, temperature, relative humidity and barometric pressure.



Mast

∅ 40 ext.
∅ 36 int.

HD 52.3DP17

Wind speed, wind direction, solar radiation, temperature and relative humidity

HD 52.3DP147

Wind speed, wind direction, solar radiation, temperature, relative humidity and barometric pressure

13 INSTRUMENT STORAGE

Instrument storage conditions:

- Temperature: -40...+65 °C.
- Humidity: less than 90 %RH no condensation.
- In storing, avoid locations where:
 - There is a high humidity level.
 - The instrument is exposed to direct sunlight.
 - The instrument is exposed to a high temperature source.
 - There are high vibration levels.
 - There is presence of vapor, salt and/or corrosive gas.

14 SAFETY INSTRUCTIONS

General safety instructions

This instrument has been manufactured and tested in accordance with EN61010-1 safety directives for electronic measuring instruments and has left the factory in perfect safety technical conditions.

The instrument proper operation and operating safety can be ensured only if all standard safety measures as well as the specific measures described in this manual are followed.

The instrument proper operation and operating safety can be ensured only in the climatic conditions specified in this manual.

Do not use the instrument in places where there are:

- Rapid ambient temperature variations that may cause condensation.
- Corrosive or flammable gases.
- Direct vibrations or shocks to the instrument.
- High-intensity electromagnetic fields, static electricity.

If the instrument is moved from a cold place to a hot one, or vice versa, condensation formation can cause an instrument malfunction. In this case, you will have to wait for the instrument temperature to reach ambient temperature before turning the instrument on.

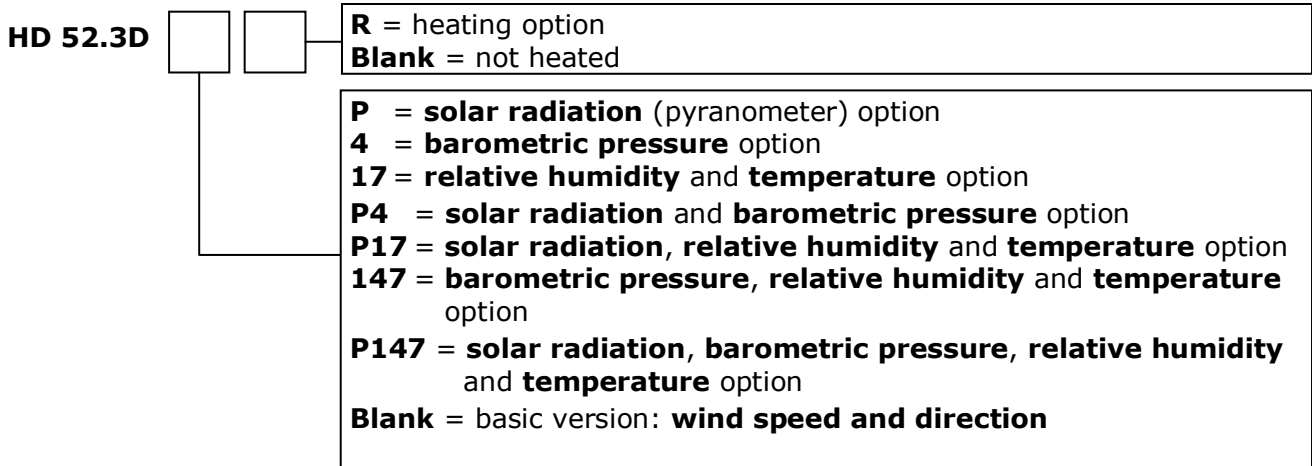
User obligations

The instrument operator shall follow the directives and regulations below that refer to the treatment of dangerous materials:

- EEC directives on workplace safety
- National low regulations on workplace safety
- Accident prevention regulations

15 ORDER CODES

HD52.3D... 2-axes ultrasonic static anemometer for the measurement of wind speed and direction, U-V Cartesian components of wind speed, relative humidity and temperature (**optional**), diffuse solar radiation (**optional**) and barometric pressure (**optional**). Equipped with compass. RS232, RS485, RS422 and SDI-12 serial outputs, **NMEA**, **MODBUS-RTU** and **SDI-12** communication protocols. Two analog outputs, for wind speed and direction, factory-configurable within 4÷20 mA (**standard**), 0÷1 V, 0÷5 V or 0÷10 V (**to be specified when ordering**). **Heater option** available. Power supply: 10...30 Vdc (15...30 Vdc in case of 0÷10 V analog outputs). Installation on mast Ø 40 mm external and Ø 36 mm internal. Input with 19-pole M23 male connector and 19-pole M23 female free connector. Supplied with: **HD52.3D-S** software for instrument configuration and monitor, operating manual. **On request, 5 m, 10 m, 15 m or 20 m cable with connector on one end and open wires on the other.**



Analog outputs for wind speed and direction: 4...20 mA **standard**; on request 0...1 V, 0...5 V or 0...10 V (**0...10 V option needs 15...30 Vdc power supply**).

ACCESSORIES

- HD52.3D-S** Further copy of CD-ROM with HD52.3D-S software for PC connection, instrument configuration and monitor. For Windows® operating systems.
- RS52** Serial connection cable with built-in USB/RS232 converter. USB connector for the PC and screw terminals on the instrument side.
- HD2004.20** Kit with anodized aluminum tripod for the installation of anemometers on a flat base. Height 3 m.
- HD2004.22** Kit for fixing 1200 x 530 x 34 mm solar panel to Ø 40÷50 mm mast. AISI 304 stainless steel.
- HD2004.30** 80 W single crystal solar panel. Dimensions 1200 x 530 x 34 mm. Model MD 5000080 – CS EVOLUTION.
- CP52.5** 12-pole connecting cable with 19-pole M23 female free connector on one end, open wires on the other. Length 5 m.
- CP52.10** 12-pole connecting cable with 19-pole M23 female free connector on one end, open wires on the other. Length 10 m.

- CP52.15** 12-pole connecting cable with 19-pole M23 female free connector on one end, open wires on the other. Length 15 m.
- CP52.20** 12-pole connecting cable with 19-pole M23 female free connector on one end, open wires on the other. Length 20 m.
- CP52.C** Additional 19-pole M23 female free connector.
- HD32.35** Outdoor housing complete with acquisition system for weather stations. **Material: AISI 304 stainless steel.** Screen to protect the housing from solar radiation. Powder-coated white. Double locking one of which is a key. Dimensions 450 x 300 x 210 mm. Degree of protection IP66. Supplied with accessories for attachment to the pole diameter 36 ÷ 52 mm. **Provided for 100 ÷ 240Vac mains power supply**, includes: HD32MT.1 datalogger, AC/DC power supply unit with integrated battery charger, 12V rechargeable backup battery, surge protectors, disconnectors, terminal block for power supply distribution and connectors for connecting the external sensors. **Wired and tested.**
- HD32.35FP** Outdoor housing complete with acquisition system for weather stations. **Material: AISI 304 stainless steel.** Screen to protect the housing from solar radiation. Powder-coated white. Double locking one of which is a key. Dimensions 450 x 300 x 210 mm. Degree of protection IP66. Supplied with accessories for attachment to the pole diameter 36 ÷ 52 mm. **Provided for power supply from solar panel**, includes: HD32MT.1 datalogger, solar charge controller, terminal block for power supply distribution and connectors for connecting the external sensors. **Wired and tested.**
- HD32.36** Outdoor housing complete with acquisition system for weather stations. **Material: Polyester with fiberglass-reinforced hot-pressed.** Screen to protect the housing from solar radiation, powder-coated anodized aluminum. White. Key lock. Dimensions 415 x 310 x 170 mm. Degree of protection IP66. Supplied with accessories for attachment to the stainless steel pole diameter 36 ÷ 52 mm. **Provided for 100 ÷ 240Vac mains power supply**, includes: HD32MT.1 datalogger, AC/DC power supply unit with integrated battery charger, 12V rechargeable backup battery, surge protectors, disconnectors, terminal block for power supply distribution and connectors for connecting the external sensors. **Wired and tested.**
- HD32.36FP** Outdoor housing complete with acquisition system for weather stations. **Material: Polyester with fiberglass-reinforced hot-pressed.** Screen to protect the housing from solar radiation, powder-coated anodized aluminum. White. Key lock. Dimensions 415 x 310 x 170 mm. Degree of protection IP66. Supplied with accessories for attachment to the stainless steel pole diameter 36 ÷ 52 mm. **Provided for power supply from solar panel**, includes: HD32MT.1 datalogger, solar charge controller, terminal block for power supply distribution and connectors for connecting the external sensors. **Wired and tested.**

DELTA OHM metrology laboratories LAT N° 124 are accredited by ACCREDIA for Temperature, Humidity, Pressure, Photometry / Radiometry, Acoustics and Air Velocity. They can supply calibration certificates for the accredited quantities.

CERTIFICATO DI CONFORMITÀ DEL COSTRUTTORE

MANUFACTURER'S CERTIFICATE OF CONFORMITY

rilasciato da

issued by

DELTA OHM SRL STRUMENTI DI MISURA

DATA
DATE

2011/06/07

Si certifica che gli strumenti sotto riportati hanno superato positivamente tutti i test di produzione e sono conformi alle specifiche, valide alla data del test, riportate nella documentazione tecnica.

We certify that below mentioned instruments have been tested and passed all production tests, confirming compliance with the manufacturer's published specification at the date of the test.

La riferibilità delle misure ai campioni internazionali e nazionali è garantita da una catena di riferibilità che ha origine dalla taratura dei campioni di prima linea dei laboratori accreditati di Delta OHM presso l'Istituto Primario Nazionale di Ricerca Metrologica.

The traceability of measures assigned to international and national reference samples is guaranteed by a reference chain which source is the calibration of Delta OHM accredited laboratories reference samples at the Primary National Metrological Research Institute.

Tipo Prodotto: Anemometro a ultrasuoni

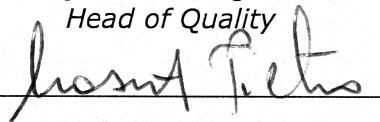
Product Type: Ultrasonic Anemometer

Nome Prodotto: HD52.3D

Product Name:

Responsabile Qualità

Head of Quality



DELTA OHM SRL
35030 Caselle di Selvazzano (PD) Italy
Via Marconi, 5

Tel. +39.0498977150 r.a. - Telefax +39.049635596
Cod. Fisc./P.Iva IT03363960281 - N.Mecc. PD044279
R.E.A. 306030 - ISC. Reg. Soc. 68037/1998

WARRANTY



TERMS OF WARRANTY

All DELTA OHM instruments are subject to accurate testing, and are guaranteed for 24 months from the date of purchase. DELTA OHM will repair or replace free of charge the parts that, within the warranty period, shall be deemed non efficient according to its own judgement. Complete replacement is excluded and no damage claims are accepted. The DELTA OHM guarantee only covers instrument repair. The guarantee is void in case of incidental breakage during transport, negligence, misuse, connection to a different voltage than that required for the appliance by the operator. Finally, a product repaired or tampered by unauthorized third parties is excluded from the guarantee. The instrument shall be returned FREE OF SHIPMENT CHARGES to your dealer. The jurisdiction of Padua applies in any dispute.



The electrical and electronic equipment marked with this symbol cannot be disposed of in public landfills. According to the UE Directive 2002/96/EC, the European users of electrical and electronic equipment can return it to the dealer or manufacturer upon purchase of a new one. The illegal disposal of electrical and electronic equipment is punished with an administrative fine.

This guarantee must be sent together with the instrument to our service centre.

IMPORTANT: Guarantee is valid only if coupon has been correctly filled in all details.

Instrument code **HD52.3D**

Serial Number _____

RENEWALS

Date _____

Date _____

Inspector _____

Inspector _____

Date _____

Date _____

Inspector _____

Inspector _____

Date _____

Date _____

Inspector _____

Inspector _____



CE CONFORMITY

The product complies with 2004/108/CE (EMC) and 2006/95/CE (low voltage) directives, and meets the requirements of the following technical standards:

Safety	EN61010-1
Electrostatic discharge immunity test	EN61000-4-2 Level 3
Radiated, radio-frequency, electromagnetic field immunity	EN61000-4-3 Level 3
Electrical fast transient/burst immunity	EN61000-4-4 Level 3
Immunity to conducted disturbances, induced by RF fields	EN61000-4-6
Voltage dips, short interruptions and voltage variations immunity	EN61000-4-11
Radio disturbance characteristics (conducted and radiated emissions)	EN55022:2007 class B