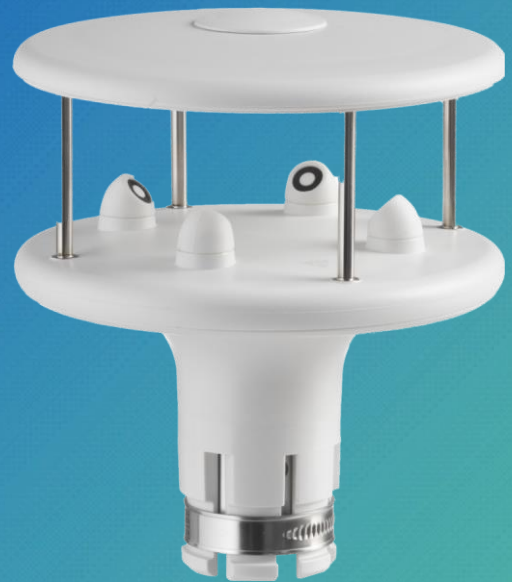


OPERATING MANUAL

HD53LS... series

Ultrasonic anemometers



EN
V1.5



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1 Introduction

HD53LS... is a series of 2-axis ultrasonic static anemometers for the measurement of:

- Wind speed and direction
- U-V Cartesian components of wind speed
- Wind Gust (**only HD53LS.S**)

The average of wind speed and direction over a period configurable up to 10 minutes is calculated.

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

The various models differ in the type of output and the presence or absence of the bird spikes:

Model	Output		Bird spikes
	RS485	Analog	
HD53LS[K].S	√		Option K
HD53LS[K].A		0/4...20 mA	
HD53LS[K].V		0...10 V	
HD53LS[K].V1		0...1 V	
HD53LS[K].V5		0...5 V	

HD53LS[K].S has Modbus-RTU standard protocol.

Models with analog output have two outputs: one for wind speed and one for wind direction.

All models are equipped with a magnetic compass.

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

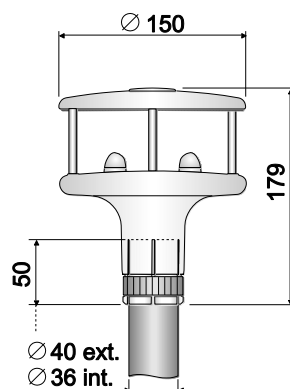
The low power consumption of the instrument allows installation in remote sites, with power supplied by photovoltaic panel and backup battery.

The instrument is factory-calibrated and does not require additional interventions of the user.

The absence of moving parts minimizes the instrument maintenance.

2 Technical specifications

Wind speed	
Used sensor	Ultrasounds
Measuring range	0...50 m/s
Resolution	0.01 m/s
Accuracy	± 0.2 m/s or $\pm 2\%$, the greatest (0...35 m/s), $\pm 3\%$ (> 35 m/s)
Wind direction	
Used sensor	Ultrasounds
Measuring range	0...359.9°
Resolution	0,1°
Accuracy	$\pm 2^\circ$ RMSE from 1.0 m/s
Compass	
Sensor	Magnetic
Measuring range	0...360°
Resolution	0.1°
Accuracy	$\pm 1^\circ$
General features	
Power Supply	10...30 Vdc (15...30 Vdc for version with 0...10 V analog output)
Power consumption	26 mA @ 12 Vdc
Analog output	2 analog outputs: one for wind speed and one for wind direction (only in HD53LS.A or HD53LS.V...). Analog output type can be 4...20 mA, 0...1 V, 0...5 V or 0...10 V depending on the model. Analog output refresh rate 1 Hz.
Digital output	RS485 Modbus-RTU (only in HD53LS.S)
Averaging interval	Configurable from 1 s to 10 min
Electrical connection	M23 connector
Operating temperature	-20...+55 °C
Survival speed	90 m/s
Protection degree	IP 66
Dimensions	H=179 mm, \varnothing =150 mm
Weight	640 g approx.
Case	ASA. Metal parts: AISI 316



3 Wind speed and direction measurement

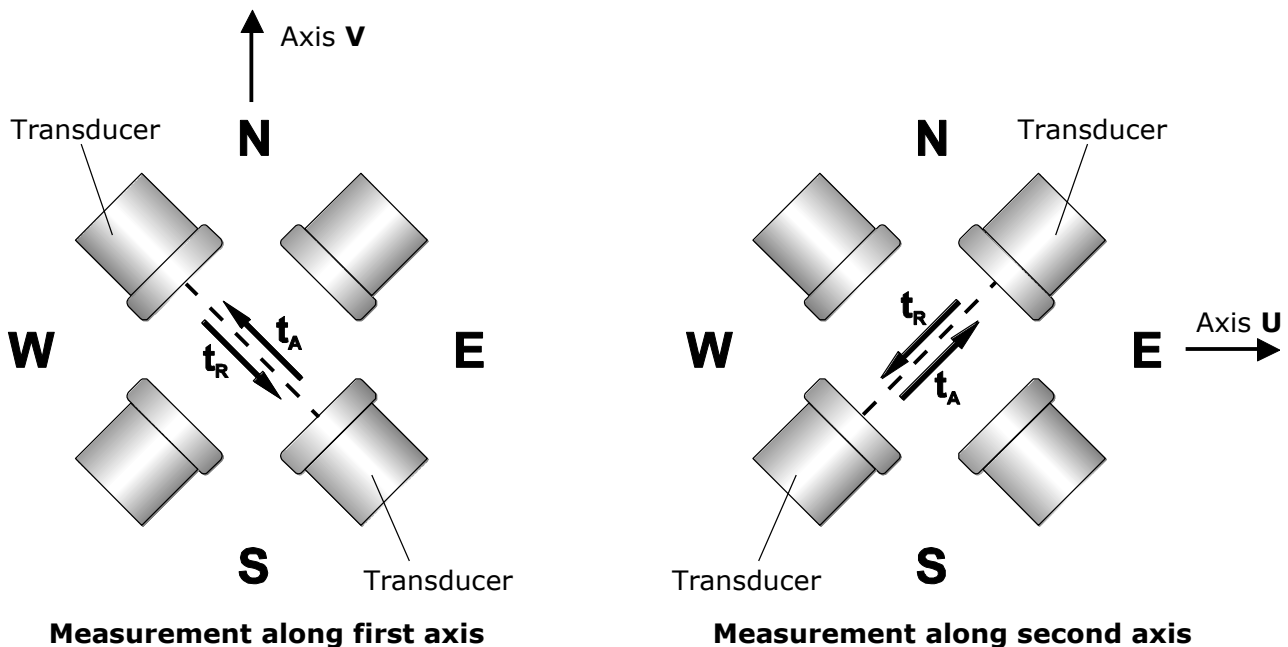
Wind speed and direction are determined by measuring the time taken by ultrasonic pulses to cover the distance from the transducer that generates the pulse to the receiving transducer.

The instrument uses 2 pairs of transducers oriented along two orthogonal axes. Detecting the wind speed along two axes allows determining 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

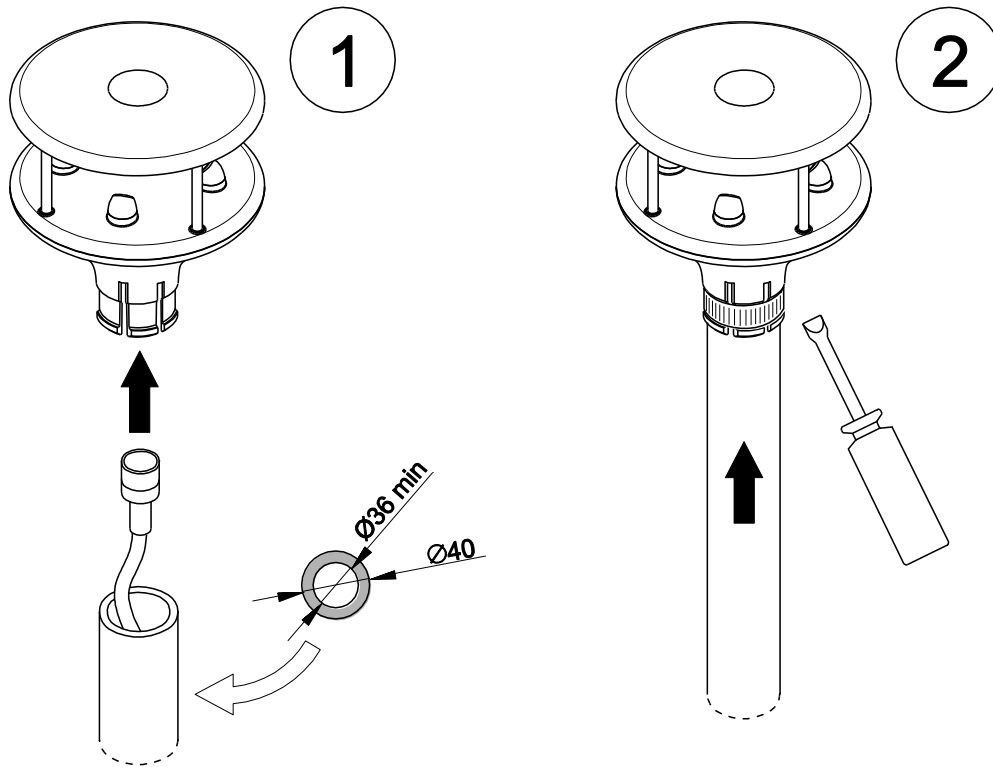
Measuring the two travel times allows determining the wind speed component:

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

4 Installation

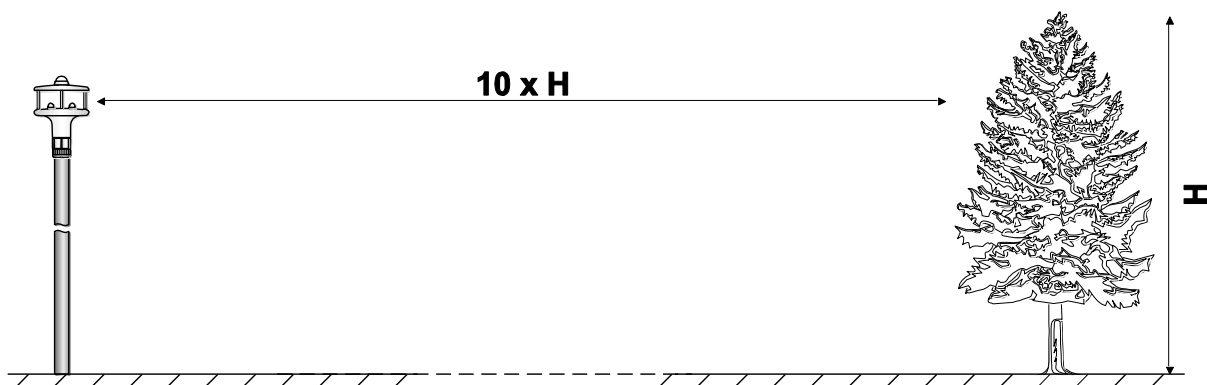
To install the instrument, pass the connection cable inside the support mast and connect the 19-pole M23 female connector of the cable to the 19-pole M23 male connector situated at the bottom of the instrument. Ensure connection stability by tightening the connector external nut.

Align the instrument to the desired direction (see par. 0), 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.

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.

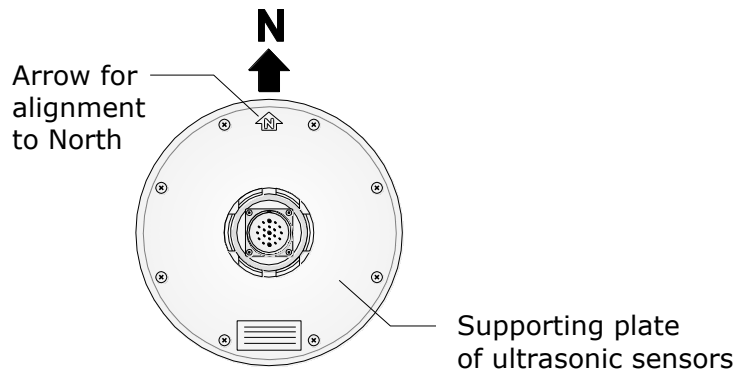
In case of mobile installations (for example on a boat), consider that the instrument measures the relative (apparent) wind speed with respect to the instrument. To determine the absolute (real) wind speed one should consider the movement velocity of the instrument.

In the model HD53LS.S, the RS485 Modbus-RTU mode will be active 10 seconds after power up.

4.1 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 obtaining accurate measurements even in case of mobile installations.

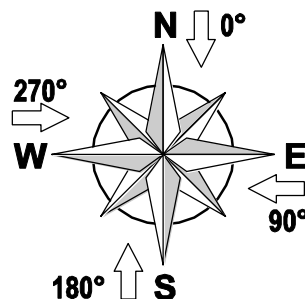
It is possible to disable the compass compensation of the wind speed and direction measurements. In this case it is necessary to align the instrument during installation. The arrows on the case will facilitate the alignment.



HD53LS.S only: for an accurate alignment, connect the instrument to a PC, then rotate the instrument on its vertical axis until the compass measures $0.0^\circ \pm 0.1^\circ$.

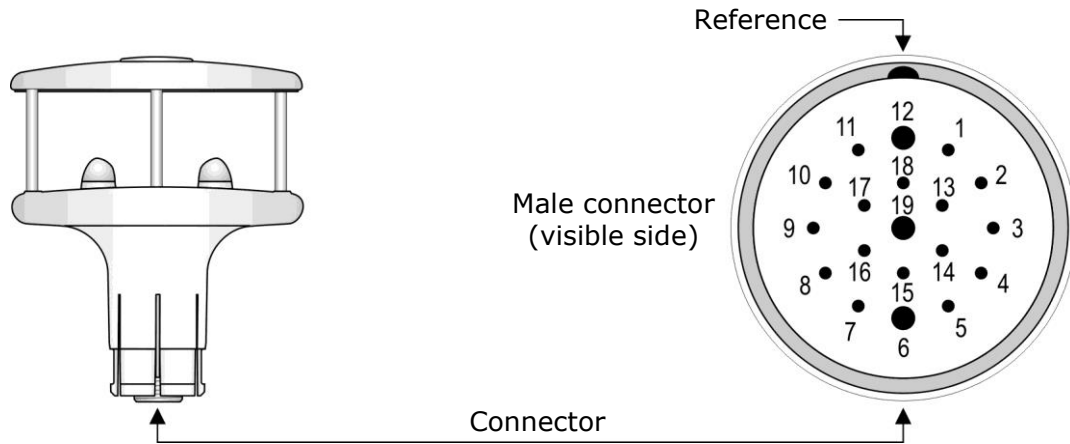
When evaluating the wind direction, one should consider that the geographic North differs from the magnetic North indicated by a magnetic compass. The difference, named **magnetic declination**, depends on the area where the instrument was installed (for example, about 15° in North-America and less than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

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



4.2 Electrical Connections

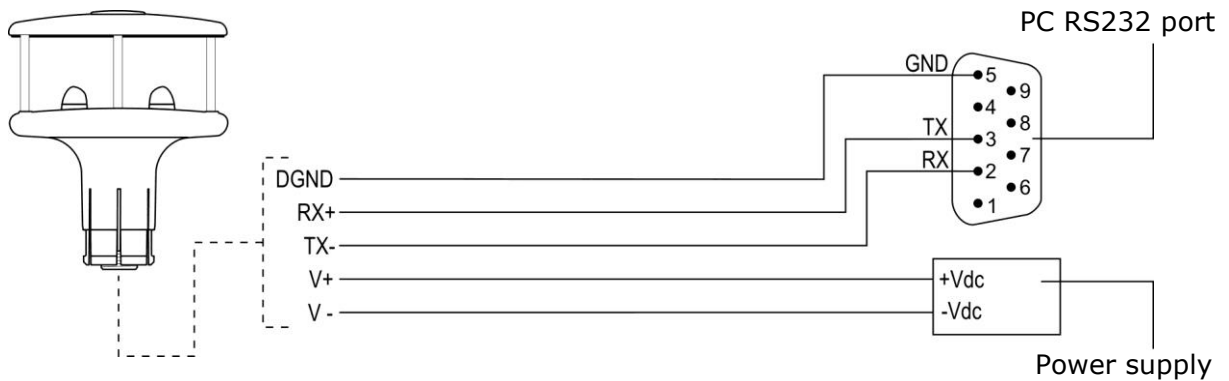
The instrument has 19-pole M23 male connector. Below are the numbering and function of the connector pins and the color correspondence with the wires of the optional **CP52.x** cable.



Connector pin number	CP52.x wire N°/color	Symbol	Description
1			Not connected
2	2 / Blue		Not connected
3	3 / Yellow	RX+	RX for RS232 connection
4			Not connected
5			Not connected
6	6 / Pink		Not connected
7	7 / Violet		Not connected
8	8 / Grey	DGND	Digital ground (*)
9	9 / White	TX-	DATA - for RS485 connection (only HD53LS.S) TX for RS232 connection
10			Not connected
11			Not connected
12	12 / Black	V-	Instrument power supply negative (*)
13	4 / Grey-Pink		Not connected
14	10 / Brown	AOUT1	Analog output 1 positive (HD53LS.A/V...)
15		AGND	Analog ground (HD53LS.A/V...) (*)
16	11 / Green	AOUT2	Analog output 2 positive (HD53LS.A/V...)
17	5 / Red-Blue	TX+	DATA + for RS485 connection (only HD53LS.S)
18		V+	Instrument power supply positive
19	1 / Red	V+	Instrument power supply positive
--	Black (thick wire)	SHIELD	Cable shield

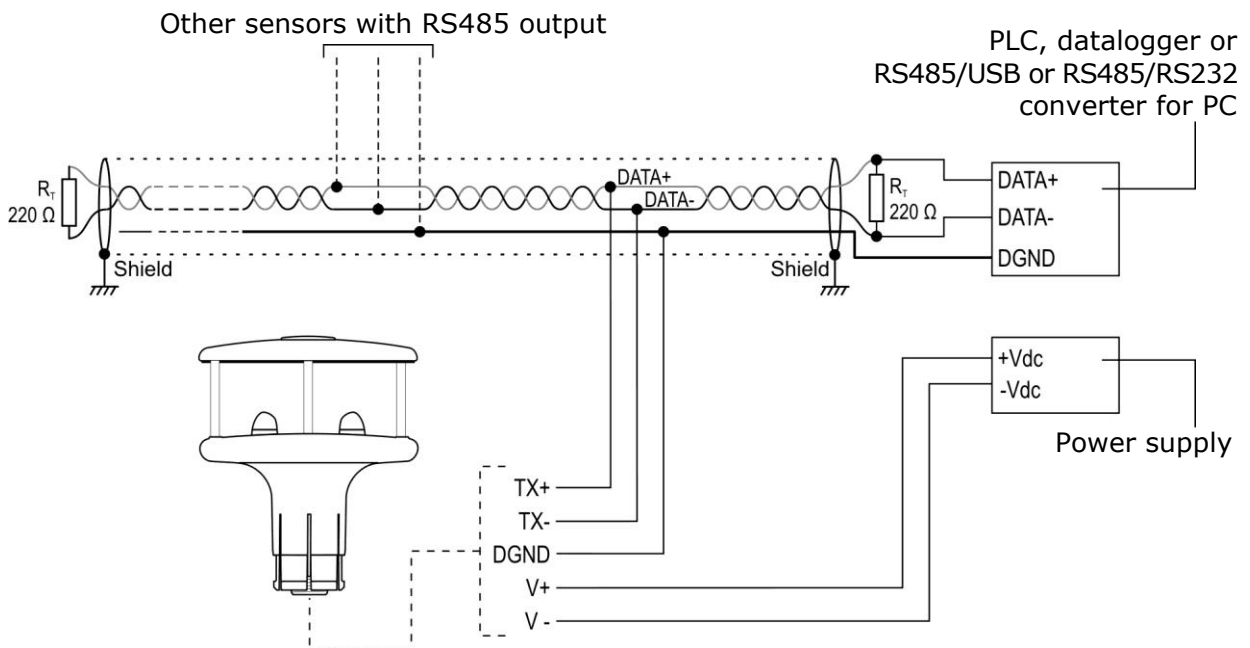
(*) V-, DGND and AGND are internally shorted.

4.2.1 RS232 connection



The maximum length of the RS232 connection is typically 15 m.

4.2.2 RS485 connection (only HD53LS.S)

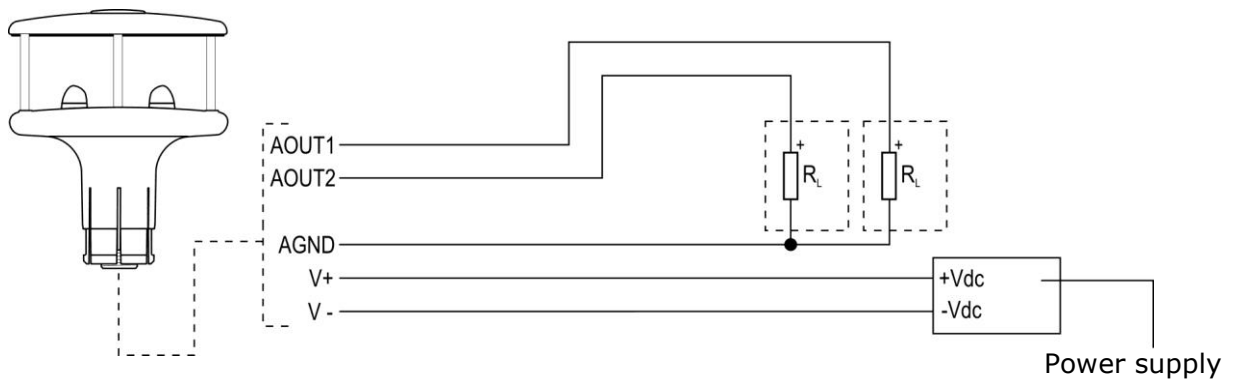


Multiple sensors can be connected in sequence through a twisted-pair shielded cable for signals and a third wire for ground.

The maximum RS485 bus length depends on baud rate and cable characteristics. Typically, using a specific RS485 cable, the maximum length is 1200 m.

Before connecting the anemometer to the network, set the address and the communication parameters, if different from the factory preset (see configuration chapter).

4.2.3 Analog outputs Connection (HD53LS.A and HD53LS.V...)



If the CP52.x cable is used, in which AGND is not available, V- can be used as analog ground (AGND and V- are internally shorted).

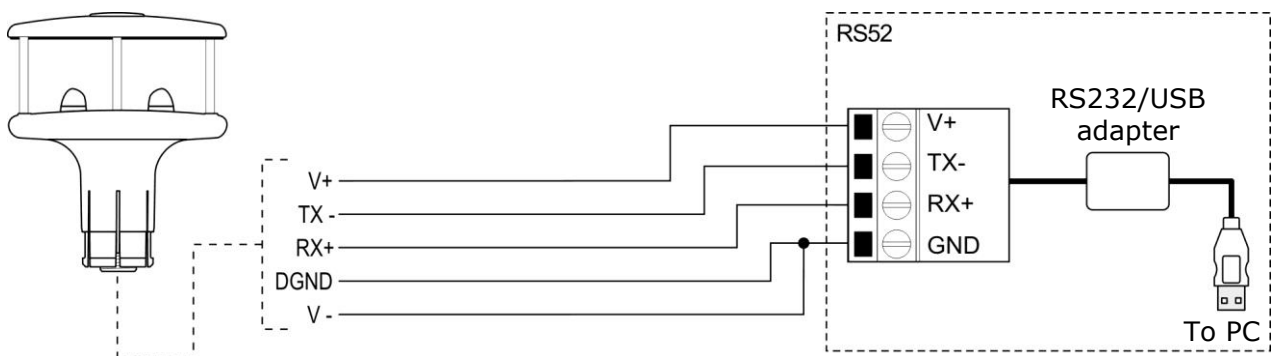
The anemometer power supply and the load resistance vary according to the type of analog output:

Analog output	Power supply required	Load resistance
0...20 mA	12...30 Vdc	≤ 300 Ω
4...20 mA	12...30 Vdc	≤ 300 Ω
0...1 V	12...30 Vdc	≥ 10 kΩ
0...5 V	12...30 Vdc	≥ 10 kΩ
0...10 V	15...30 Vdc	≥ 10 kΩ

For associating the outputs with the various available parameters, see configuration chapter.

4.2.4 RS52 cable connection

The **RS52** optional cable, equipped with RS232/USB converter, allows connecting the instrument RS232 output to a PC USB port.



To use the RS52 cable, the USB drivers included in the HD52.3D-S software package should be installed in the PC.

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

5 Configuration

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

To configure the instrument, a RS232 serial connection to a PC should be performed (see paragraph 0). 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 4.2.4).

The instrument configuration can be done:

- With the aid of **HD52.3D-S** application software (see the software online help), downloadable from the website.
- By sending serial commands via a standard communication program, setting the following parameters in the program: 115200 (baud rate), 8N2, flow control none.

HD53LS.S:

The serial output of the HD53LS.S model is preset to operate in Modbus-RTU mode; in order to enter configuration mode after connecting the instrument to the PC via RS232 it is necessary to send **within 10 seconds from power on** (if the instrument is already powered, power cycle the instrument) the serial command @ (if a standard communication program is used) or the request of connection with the HD52.3D-S software, if the application software is used.

To reset the serial output of the HD53LS.S model to Modbus-RTU mode after the configuration has been carried out, power cycle the instrument: the Modbus-RTU protocol will become active after 10 seconds from restart.

HD53LS.A and HD53LS.V...:

The serial output of the HD53LS.A and HD53LS.V... models is always in configuration mode.

5.1 Serial Commands

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

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)

General parameters:

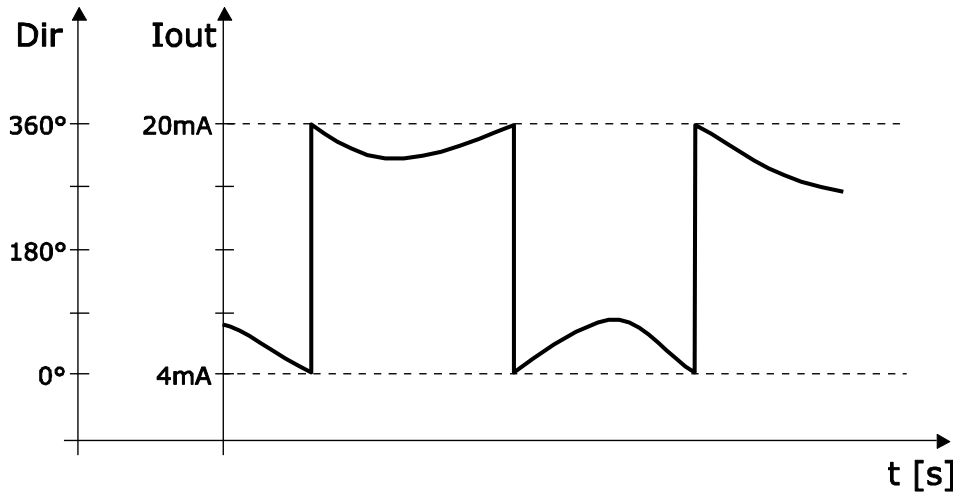
Command	Reply	Description
CGUVn	&	Sets measuring unit of wind speed: <ul style="list-style-type: none"> ▪ m/s if n=1 ▪ cm/s if n=2 ▪ km/h if n=3 ▪ knot if n=4 ▪ mph if n=5 <i>Default</i> : m/s (n=1)
RGUV	n	Reads the wind speed measuring unit set in the instrument
CWCnnnn	&	Sets wind speed threshold to 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 1)
RWC	& nnnn	Reads the wind speed threshold value set in the instrument (in hundredths of m/s)
CWaLnnn	&	Sets time interval for the calculation of average speed and average direction to nnn value Value should range within 1 and 600 s. If the value is greater than 10 s, it must be an integer multiple of 10. <i>Default</i> : 1 s
RWaL	& nnn	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 2). ▪ If n=1: vector mean. The average of the coordinates along each measurement axis is 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	&	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 1 : WIND SPEED THRESHOLD VALUE

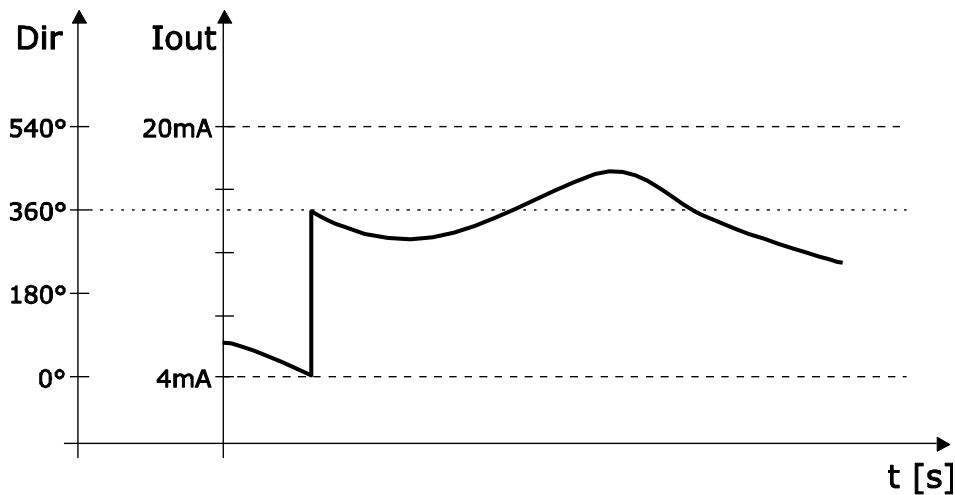
If the wind speed is very low, the determination of the direction can result inaccurate. The instrument allows setting the threshold value of speed below which the direction value is frozen on the last acquired value.

NOTE 2 : WIND DIRECTION EXTENDED CHARACTERISTIC

With 0÷359° 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° range instead of 0÷359°. The wide output fluctuation occurs the first time that the wind direction goes from 0 to 359°; 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° 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 (HD53LS.A and HD53LS.V...):

Command	Reply	Description										
CAFxnn	&	<p>Sets offset and direction of the analog output x (x=1 or 2) to:</p> <ul style="list-style-type: none"> ▪ Standard if nn=00 [ex. 4...20 mA, 0...1 V, 0...5 V, 0...10 V] ▪ Without offset if nn=01 [ex. 0...20 mA] ▪ With offset if nn=02 [ex. 0.2...1 V, 1...5 V, 2...10 V] ▪ Inverted if nn=04 [ex. 20...4 mA, 1...0 V, 5...0 V, 10...0 V] ▪ Inverted without offset if nn=05 [ex. 20...0 mA] ▪ Inverted with offset if nn=06 [ex. 1...0.2 V, 5...1 V, 10...2 V] <p><i>Default</i> : Standard (nn=00)</p>										
RAFx	& nn	<p>Reads offset and direction setting of the analog output x (x=1 or 2)</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 3): 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 4): 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> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">▪ 5 m/s if n=0</td> <td style="width: 50%;">▪ 30 m/s if n=5</td> </tr> <tr> <td>▪ 10 m/s if n=1</td> <td>▪ 35 m/s if n=6</td> </tr> <tr> <td>▪ 15 m/s if n=2</td> <td>▪ 40 m/s if n=7</td> </tr> <tr> <td>▪ 20 m/s if n=3</td> <td>▪ 45 m/s if n=8</td> </tr> <tr> <td>▪ 25 m/s if n=4</td> <td>▪ 50 m/s if n=9</td> </tr> </table> <p><i>Default</i> : 50 m/s (n=9)</p>	▪ 5 m/s if n=0	▪ 30 m/s if n=5	▪ 10 m/s if n=1	▪ 35 m/s if n=6	▪ 15 m/s if n=2	▪ 40 m/s if n=7	▪ 20 m/s if n=3	▪ 45 m/s if n=8	▪ 25 m/s if n=4	▪ 50 m/s if n=9
▪ 5 m/s if n=0	▪ 30 m/s if n=5											
▪ 10 m/s if n=1	▪ 35 m/s if n=6											
▪ 15 m/s if n=2	▪ 40 m/s if n=7											
▪ 20 m/s if n=3	▪ 45 m/s if n=8											
▪ 25 m/s if n=4	▪ 50 m/s if n=9											
RAH	& n	<p>Reads the value corresponding to the wind speed analog output full scale</p>										

NOTE 3 : 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 50 m/s, the speed range associated to the analog outputs is -50...+50 m/s.

NOTE 4 : 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.

Parameters for Modbus-RTU mode (only HD53LS.S):

Command	Reply	Description
CU5Annn	&	Sets Modbus address to nnn The address should range within 1 and 247 <i>Default</i> : 1
RU5A	& nnn	Reads the Modbus address setting
CU5Bn	&	Sets the Baud Rate for Modbus 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> : 19200 (n=4)
RU5B	& n	Reads Baud Rate 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 the 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 the setting of waiting time after transmission in Modbus mode

6 Modbus-RTU mode (only HD53LS.S)

In Modbus-RTU mode, the instrument sends the acquired measurements only if specifically requested by the PC, PLC or data logger.

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)

Below is the list of registers.

Input Registers

Address	Description	Format
0	Instantaneous wind speed (x100)	unsigned 16 bits
1	Instantaneous wind direction in degrees (x10)	unsigned 16 bits
8	Compass angle in degrees (x10)	Unsigned 16 bits
10	Average wind speed (x100)	unsigned 16 bits
11	Average wind direction in degrees (x10)	unsigned 16 bits
14	Wind direction in degrees (x10) with extended feature (see page 13)	unsigned 16 bits
15	Wind speed (x100) along V-axis	unsigned 16 bits
16	Wind speed (x100) along U-axis	unsigned 16 bits
17	Status register: bit0=1 ⇒ Speed measurement error	unsigned 16 bits
18	Wind speed unit of measurement 0 ⇒ m/s, 1 ⇒ cm/s, 2 ⇒ km/h, 3 ⇒ knot, 4 ⇒ mph	unsigned 16 bits
21	Wind Gust intensity (x100)	unsigned 16 bits
22	Wind Gust direction in degrees (x10)	unsigned 16 bits

Note: the wind speed measurement value is expressed in the unit set in the instrument.

The Wind Gust measurement is determined by continuously calculating the wind speed averages in a time interval equal to 3 seconds and detecting the maximum value of the calculated averages over the time elapsed between the current reading command and the previous reading command (the Wind Gust measurement is reset after each reading command).

7 Maintenance

Wind speed sensors does not generally require maintenance.

In case abnormal measures are detected, verify the cleanliness of the ultrasonic sensors. For cleaning, use a moistened soft cloth. The sensors should be wiped gently: **do not brush or twist the sensors.**

8 Instrument storage

Instrument storage conditions:

- Temperature: -40...+70 °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.

9 Safety instructions

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

Do not use the instrument in places where there are:

- Corrosive or flammable gases.
- Direct vibrations or shocks to the instrument.
- High-intensity electromagnetic fields, static electricity.

User obligations

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

- EU directives on workplace safety.
- National law regulations on workplace safety.
- Accident prevention regulations.

10 Accessories ordering codes

- CP52...** Connecting cable with 19-pole M23 female free connector on one end, open wires on the other. Available lengths: 5 m (CP52.5) and 10 m (CP52.10).
- RS52** Serial connection cable with built-in USB/RS232 converter. USB connector for the PC and screw terminals on the instrument side.
- CP52.C** Additional 19-pole M23 female free connector.

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WARRANTY

The manufacturer is required to respond to the "factory warranty" only in those cases provided by Legislative Decree 6 September 2005 - n. 206. Each instrument is sold after rigorous inspections; if any manufacturing defect is found, it is necessary to contact the distributor where the instrument was purchased from. During the warranty period (24 months from the date of invoice) any manufacturing defects found will be repaired free of charge. Misuse, wear, neglect, lack or inefficient maintenance as well as theft and damage during transport are excluded. Warranty does not apply if changes, tampering or unauthorized repairs are made on the product. Solutions, probes, electrodes and microphones are not guaranteed as the improper use, even for a few minutes, may cause irreparable damages.

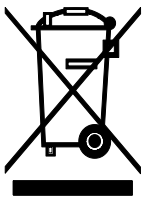
The manufacturer repairs the products that show defects of construction in accordance with the terms and conditions of warranty included in the manual of the product. For any dispute, the competent court is the Court of Padua. The Italian law and the "Convention on Contracts for the International Sales of Goods" apply.

TECHNICAL INFORMATION

The quality level of our instruments is the result of the continuous product development. This may lead to differences between the information reported in the manual and the instrument you have purchased.

We reserve the right to change technical specifications and dimensions to fit the product requirements without prior notice.

DISPOSAL INFORMATION



Electrical and electronic equipment marked with specific symbol in compliance with 2012/19/EU Directive must be disposed of separately from household waste. European users can hand them over to the dealer or to the manufacturer when purchasing a new electrical and electronic equipment, or to a WEEE collection point designated by local authorities. Illegal disposal is punished by law.

Disposing of electrical and electronic equipment separately from normal waste helps to preserve natural resources and allows materials to be recycled in an environmentally friendly way without risks to human health.



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