# USER'S GUIDE

# Vaisala WINDCAP® Ultrasonic Wind Sensor WMT50

M210736EN-A

PUBLISHED BY

Vaisala Oyj
P.O. Box 26
FIN-00421 Helsinki
Finland

Phone (int.): +358 9 8949 1
Fax: +358 9 8949 2227

Visit our Internet pages at http://www.vaisala.com/



The contents are subject to change without prior notice.

Please observe that this manual does not create any legally binding obligations for Vaisala towards the customer or end user. All legally binding commitments and agreements are included exclusively in the applicable supply contract or Conditions of Sale.

# Table of Contents

# List of Figures

# List of Tables

CHAPTER 1

# GENERAL INFORMATION

This chapter provides general notes for the product.

## About This Manual

This manual provides information for installing, operating, and maintaining the product.

## Contents of This Manual

This manual consists of the following chapters:

- Chapter 1, General Information: This chapter provides general notes for the product.
- Chapter 2, Product Overview: This chapter introduces the unique features and advantages of the Vaisala Ultrasonic Wind Sensor WMT50.
- Chapter 3, Functional Description: This chapter describes the measurement principles and heating function of Ultrasonic Wind Sensor WMT50.
- Chapter 4, Installation: This chapter provides you with information that is intended to help you install Ultrasonic Wind Sensor WMT50.
- Chapter 5, Wiring: This chapter provides you with instructions on how to connect the power supply and the serial interfaces.

- Chapter 6, Communication Settings: This chapter contains instructions for making the communication settings.
- Chapter 7, Getting the Data Messages: This chapter presents the general and data message commands.
- Chapter 8, Sensor and Data Message Settings: This chapter presents the sensor configuration and data message formatting commands for all communications protocols: ASCII, NMEA 0183 and SDI-12.
- Chapter 9, Maintenance: This chapter contains instructions for the basic maintenance of Ultrasonic Wind Sensor WMT50 and contact information for Vaisala Service Centers.
- Chapter 10, Troubleshooting: This chapter describes common problems, their probable causes and remedies, and includes contact information for technical support.
- Chapter 11, Technical Specifications: This chapter provides the technical data of Ultrasonic Wind Sensor WMT50.

## Feedback

Vaisala Customer Documentation Team welcomes your comments and suggestions on the quality and usefulness of this publication. If you find errors or have other suggestions for improvement, please indicate the chapter, section, and page number. You can send comments to us by e-mail: manuals@vaisala.com.

# Safety

## General Safety Considerations

Throughout the manual, important safety considerations are highlighted as follows:

| | |
|---|---|
| **WARNING** | Warning alerts you to a serious hazard. If you do not read and follow instructions very carefully at this point, there is a risk of injury or even death. |

| | |
|---|---|
| **CAUTION** | Caution warns you of a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost. |

| | |
|---|---|
| **NOTE** | Note highlights important information on using the product. |

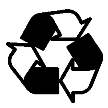
## ESD Protection

Electrostatic Discharge (ESD) can cause immediate or latent damage to electronic circuits. Vaisala products are adequately protected against ESD for their intended use. However, it is possible to damage the product by delivering electrostatic discharges when touching, removing, or inserting any objects inside the equipment housing.

To make sure you are not delivering high static voltages yourself:

- Handle ESD sensitive components on a properly grounded and protected ESD workbench. When this is not possible, ground yourself with a wrist strap and a resistive connection cord to the equipment chassis before touching the boards. When neither of the above is possible, at least touch a conductive part of the equipment chassis with your other hand before touching the boards.
- Always hold the boards by the edges and avoid touching the component contacts.

# Recycling

| | |
|---|---|
|  | Recycle all applicable material. |

| | |
|---|---|
|  | Dispose of batteries and the unit according to statutory regulations. Do not dispose of with regular household refuse. |

# Trademarks

WINDCAP® is a registered trademark of Vaisala. Microsoft®, Windows®, and Windows NT® are registered trademarks of Microsoft Corporation in the United States and/or other countries.

# License Agreement

All rights to any software are held by Vaisala or third parties. The customer is allowed to use the software only to the extent that is provided by the applicable supply contract or Software License Agreement.

# Warranty

Vaisala hereby represents and warrants all Products manufactured by Vaisala and sold hereunder to be free from defects in workmanship or material during a period of twelve (12) months from the date of delivery save for products for which a special warranty is given. If any Product proves however to be defective in workmanship or material within the period herein provided Vaisala undertakes to the exclusion of any other remedy to repair or at its own option replace the defective Product or part thereof free of charge and otherwise on the same conditions as for the original Product or part without extension to original warranty time. Defective parts replaced in accordance with this clause shall be placed at the disposal of Vaisala.

Vaisala also warrants the quality of all repair and service works performed by its employees to products sold by it. In case the repair or service works should appear inadequate or faulty and should this cause malfunction or nonfunction of the product to which the service was performed Vaisala shall at its free option either repair or have repaired or replace the product in question. The working hours used by employees of Vaisala for such repair or replacement shall be free of charge to the client. This service warranty shall be valid for a period of six (6) months from the date the service measures were completed.

This warranty is however subject to following conditions:

a)A substantiated written claim as to any alleged defects shall have been received by Vaisala within thirty (30) days after the defect or fault became known or occurred, and

b)The allegedly defective Product or part shall, should Vaisala so require, be sent to the works of Vaisala or to such other place as Vaisala may indicate in writing, freight and insurance prepaid and properly packed and labelled, unless Vaisala agrees to inspect and repair the Product or replace it on site.

This warranty does not however apply when the defect has been caused through

a)normal wear and tear or accident;

b)misuse or other unsuitable or unauthorized use of the Product or negligence or error in storing, maintaining or in handling the Product or any equipment thereof;

c)wrong installation or assembly or failure to service the Product or otherwise follow Vaisala's service instructions including any repairs or installation or assembly or service made by unauthorized personnel not approved by Vaisala or replacements with parts not manufactured or supplied by Vaisala;

d)modifications or changes of the Product as well as any adding to it without Vaisala's prior authorization;

e)other factors depending on the Customer or a third party.

Notwithstanding the aforesaid Vaisala's liability under this clause shall not apply to any defects arising out of materials, designs or instructions provided by the Customer.

This warranty is expressly in lieu of and excludes all other conditions, warranties and liabilities, express or implied, whether under law, statute or otherwise, including without limitation any implied warranties of merchantability or fitness for a particular purpose and all other obligations and liabilities of Vaisala or its representatives with respect to any defect or deficiency applicable to or resulting directly or indirectly from the Products supplied hereunder, which obligations and liabilities are hereby expressly cancelled and waived. Vaisala's liability shall under no circumstances exceed the invoice price of any Product for which a warranty claim is made, nor shall Vaisala in any circumstances be liable for lost profits or other consequential loss whether direct or indirect or for special damages.

CHAPTER 2
# PRODUCT OVERVIEW

This chapter introduces the unique features and advantages of the Vaisala Ultrasonic Wind Sensor WMT50.

## Introduction to Ultrasonic Wind Sensor WMT50

**Figure 1 Ultrasonic Wind Sensor WMT50**

Ultrasonic Wind Sensor WMT50 is a small and lightweight wind sensor that measures wind speed and direction.

WMT50 powers up with 5 ... 30 VDC and outputs serial data with a selectable communication protocol: SDI-12, ASCII automatic & polled and NMEA 0183 with query option. Four alternative serial interfaces are selectable: RS-232, RS-485, RS-422 and SDI-12.

The following options are available:

- Heating function
- Windows® based WXT/WMT Configuration Tool software and cable
- 8-pin M12 connector (also with 2 m/10 m cable)
- Mounting kit

# Optional Software for Easy Settings

Windows® based WXT/WMT Configuration Tool is a user friendly parameter setting software for WMT50. With this software tool you can change the device and sensor settings easily in Windows® environment. See list of options and accessories in Table 17 on page 101.

# Heating Function

To improve the accuracy of measurements an optional heating function is available. More about heating in section Heating (Optional) on page 23.

The heating function option must be chosen when placing the order.

# Ultrasonic Wind Sensor WMT50 Components

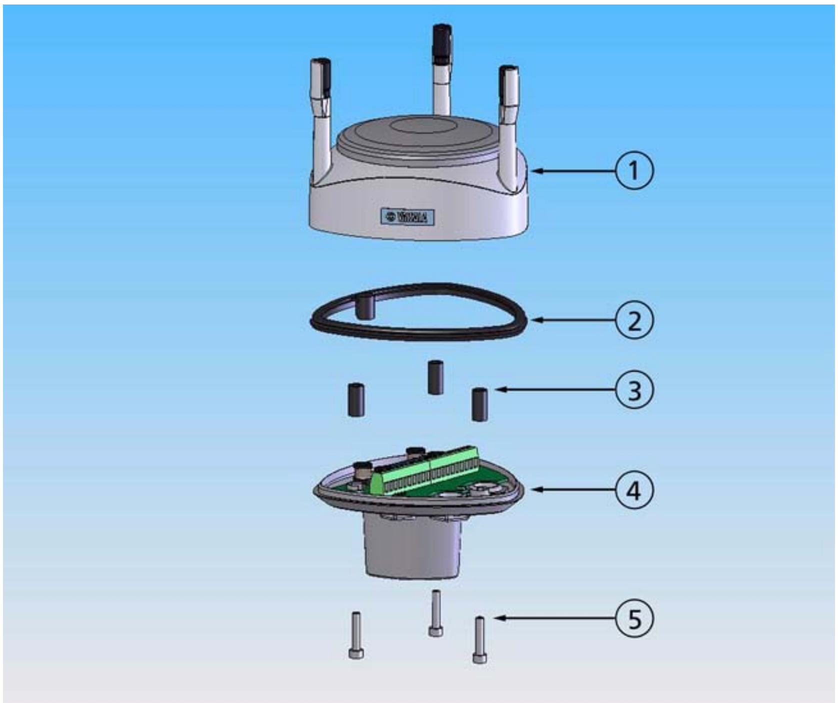



**Figure 2 WMT50 Components**

The following numbers refer to Figure 2 on page 17:

1 = Top assembly

2 = Silicon gasket

3 = Spacers

4 = Bottom assembly

5 = Allen screws

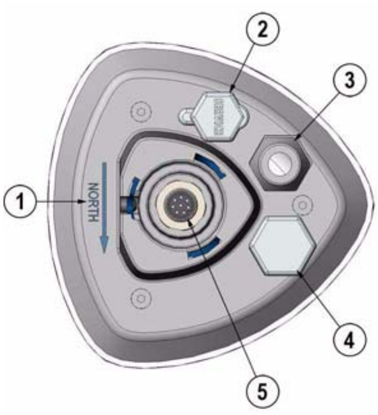



**Figure 3 Sensor Bottom Assembly**

The following numbers refer to Figure 3 on page 18:

1 = Alignment direction sign

2 = Service port

3 = Water tight cable gland (shown disassembled)

4 = Opening for cable gland (if unused, cover with hexagonal plug)

5 = 8-pin M12 connector for power/datacom cable (optional, cover with hexagonal plug if unused)

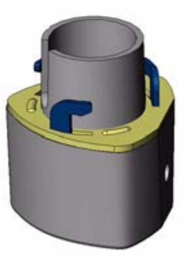


**Figure 4 Mounting Kit (Optional)**


**Figure 5 Service Cable (Optional)**

The following numbers refer to Figure 5 on page 19:

1 = Battery connector

2 = D9-connector for PC serial port

3 = Connector for WMT50 service port (press the white flap while disconnecting cable)

The service cable, while connected between the service port and PC, forces the service port to RS-232 / 19200, 8, N, 1.

| | |
|---|---|
| **CAUTION** | To prevent ingress of water, dust, and insects, cover the unused openings at the sensor bottom assembly with hexagonal rubber plugs included in the delivery. |

CHAPTER 3

# FUNCTIONAL DESCRIPTION

This chapter describes the measurement principles and heating function of Ultrasonic Wind Sensor WMT50.

## Wind Measurement Principle

The WMT50 uses Vaisala WINDCAP® sensor technology in wind measurement.

The wind sensor has an array of three equally spaced ultrasonic transducers on a horizontal plane. Wind speed and wind directions are determined by measuring the time it takes the ultrasound to travel from each transducer to the other two.

The wind sensor measures the transit time (in both directions) along the three paths established by the array of transducers. This transit time depends on the wind speed along the ultrasonic path. For zero wind speed, both the forward and reverse transit times are the same. With wind along the sound path, the up-wind direction transit time increases and the down-wind transit time decreases.

The wind speed is calculated from the measured transit times using the following formula:

$$V_w = 0.5 \times L \times (1/t_f - 1/t_r)$$

where:

| | | |
|---|---|---|
| $V_w$ | = | Wind speed |
| L | = | Distance between the two transducers |
| $t_f$ | = | Transit time in forward direction |
| $t_r$ | = | Transit time in reverse direction |

Measuring the six transit times allows $V_w$ to be computed for each of the three ultrasonic paths. The computed wind speeds are independent of altitude, temperature and humidity, which are cancelled out when the transit times are measured in both directions, although the individual transit times depend on these parameters.

Using $V_w$ values of two array paths is enough to compute wind speed and wind direction. A signal processing technique is used so that wind speed and wind direction are calculated from the two array paths of best quality.

The wind speed is represented as a scalar speed in selected units (m/s, kt, mph, km/h). The wind direction is expressed in degrees (°). The wind direction reported by WMT50 indicates the direction that the wind comes from. North is represented as 0°, east as 90°, south as 180°, and west as 270°.

The wind direction is not calculated when the wind speed drops below 0.05 m/s. In this case, the last calculated direction output remains until the wind speed increases again to the level of 0.05 m/s.

The average values of wind speed and direction are calculated as a scalar average of of all samples over the selected averaging time [1 ... 3600 s (= 60 min)]. The sample count depends on the selected sampling rate: 4 Hz (default), 2 Hz or 1 Hz. The minimum and maximum values of wind speed and direction represent the corresponding extremes during the selected averaging time. See also Appendix D, Wind Measurement Averaging Method, on page 117 for averaging method.

# Heating (Optional)

Heating elements located inside the wind transducers keep the wind sensors clean from snow and ice. A heating temperature sensor (Th) controls the heating.

Three fixed temperature limits, namely +3 °C, -2 °C, and -4 °C (+37 °F, +38 °F, +25 °F) control the heating power as follows:

Th > +3 °C: heating is off,

-2 °C < Th < +3 °C: 50 % heating power,

-4 °C < Th < -2 °C: 100 % heating power,

Th < -4 °C: 50 % heating power.

When the heating function is disabled the heating is off in all conditions, see Supervisor Message on page 86.

CHAPTER 4
# INSTALLATION

This chapter provides you with information that is intended to help you install Ultrasonic Wind Sensor WMT50.

## Unpacking Instructions

Ultrasonic Wind Sensor WMT50 comes in a custom shipping container. Be careful when removing the device from the container.

| | |
|---|---|
| **CAUTION** | Beware of damaging any of the wind transducers located at the top of the three antennas. Dropping the device can break or damage the transducers. If the antenna bends or twists the re-aligning can be difficult or impossible. |

## Selecting Location

Finding a suitable site for Ultrasonic Wind Sensor WMT50 is important for getting representative ambient measurements. The site should represent the general area of interest.

Ultrasonic Wind Sensor WMT50 needs to be installed in a location that is free from turbulence caused by nearby objects, such as trees or buildings.

| WARNING | To protect personnel (and the device), a lightning rod is recommended to be installed with the tip at least one meter above the WMT50. The rod must be properly grounded, compliant with all local applicable safety regulations. |
|---|---|

# Installation Procedure

At the measurement site, WMT50 needs to be mounted, aligned, and connected to the data logger and the power source.

## Mounting

Ultrasonic Wind Sensor WMT50 can be mounted either onto a vertical pole mast or onto a horizontal cross arm. When mounting WMT50 onto a pole mast, an optional mounting kit can be used to ease mounting. When using the optional mounting kit, alignment is needed only when mounted for the first time.

Each of the mounting options is further described in the following sections.

| NOTE | Ultrasonic Wind Sensor WMT50 must be installed to an upright, vertical position. |
|---|---|

### Mounting to Vertical Pole Mast

1. Remove the screw cover and insert the WMT50 to the pole mast.
2. Align the sensor in such a way that the arrow points to north.
3. Tighten the fixing screw (provided) and replace the screw cover.

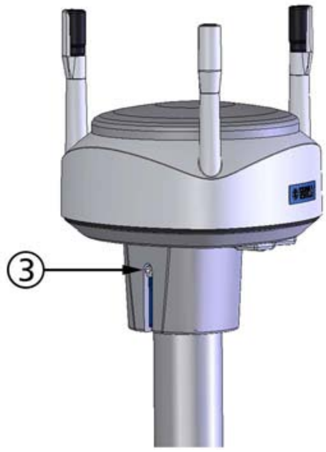



**Figure 6 Location of Fixing Screw**

## Mounting with Optional Mounting Kit

1. Insert the mounting kit adapter to the sensor bottom in the position shown in the picture.
2. Turn the kit inside the bottom firmly until you feel that the adapter snaps into the locked position.
3. Mount the adapter to the pole mast, do not tighten the fixing screw (provided).
4. Align the sensor in such a way that the arrow points to north.
5. Tighten the fixing screw to fix the adapter firmly to the pole mast.

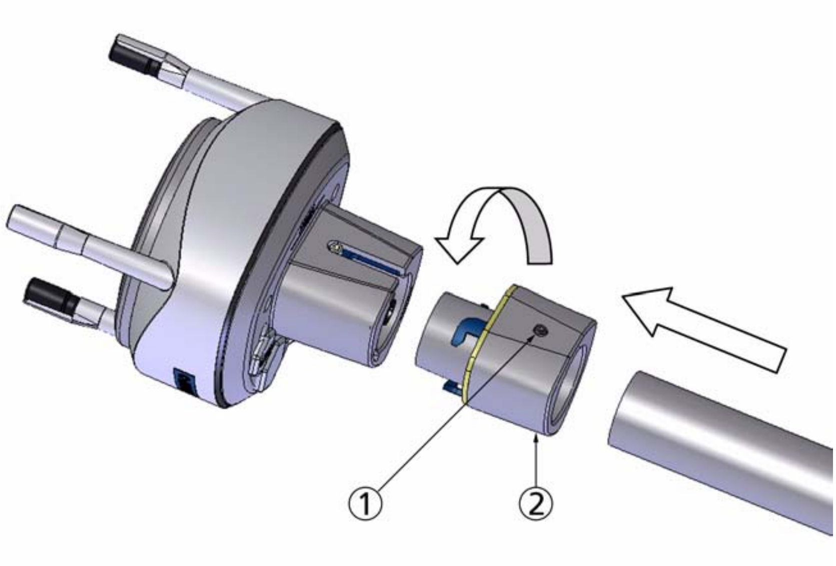



**Figure 7 Mounting WMT50 to Pole Mast Using Optional Mounting Kit**

The following numbers refer to Figure 7 on page 28:

1 = Fixing screw

2 = Mounting kit

| NOTE | When removing the WMT50 from the pole just turn the sensor so that it snaps out from the mounting kit. When replacing the device the alignment is not needed. |
|---|---|

## Mounting To Horizontal Cross Arm

1. Remove the screw cover.
2. Align the horizontal cross arm in south-north-direction, see Aligning WMT50 on page 29.In case the cross arm cannot be aligned, make the wind direction correction as instructed in section Wind Direction Correction on page 31.
3. Mount the sensor into the cross arm by using the fixing screw (M6 DIN933) and a nut, see Figure 7 on page 28 and Figure 8 on page 29.

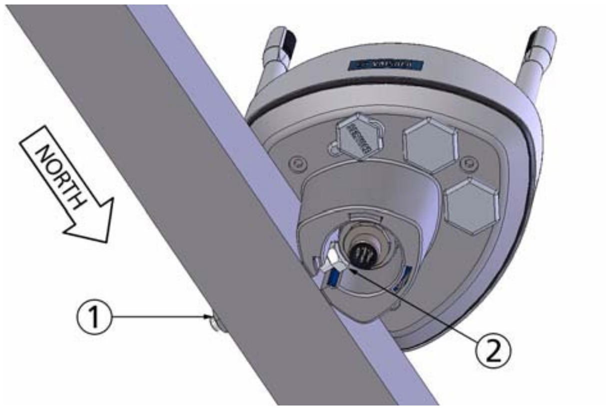



**Figure 8 Mounting WMT50 to Cross Arm**

The following numbers refer to Figure 8 on page 29:

1 = Nut

2 = Fixing screw (M6 DIN933)

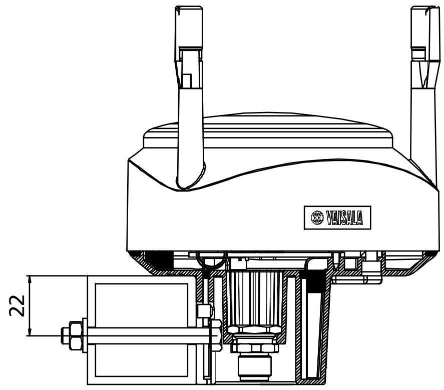



**Figure 9 Mounting Screw Location in Cross Arm**

# Aligning WMT50

To help the alignment, there is an arrow and the text "North" on the bottom of the sensor. WMT50 needs to be aligned in such a way that this arrow points to the north.

Wind direction can be referred either to true north, which uses the earth's geographic meridians, or to the magnetic north, which is read with a magnetic compass. The magnetic declination is the difference in degrees between the true north and magnetic north. The source for the magnetic declination needs to be current as the declination changes over time.

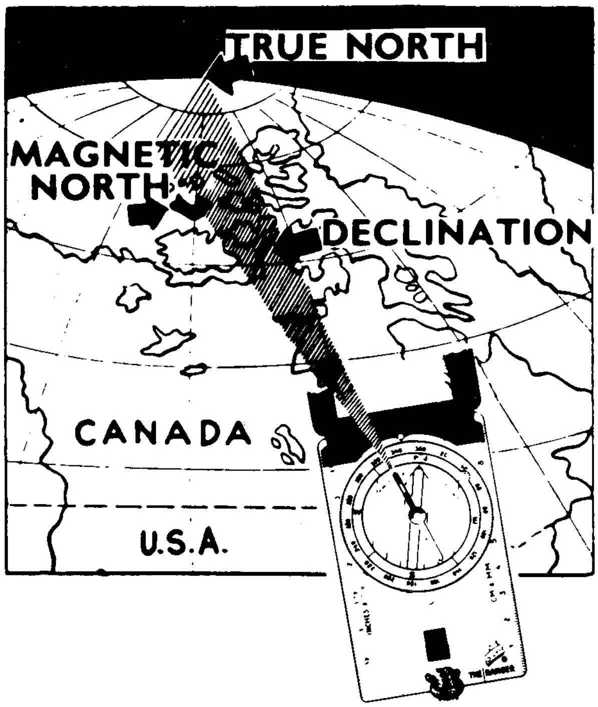



**Figure 10 Sketch of Magnetic Declination**

## Compass Alignment

To align Ultrasonic Wind Sensor WMT50, proceed as follows:

1. If the WMT50 is already mounted, loosen the fixing screw on the bottom of the sensor so that you can rotate the device.
2. Use a compass to determine that the transducer heads of WMT50 are exactly in line with the compass and that the arrow on the bottom of WMT50 points to the north.
3. Tighten the fixing screw on the bottom of the sensor when the bottom arrow is exactly aligned to north.

## Wind Direction Correction

Make a wind direction correction in case the WMT50 cannot be aligned in such a way that the arrow on the bottom points to the north. In this case, the deviation angle from the true north needs to be given to the WMT50.

1. Mount the sensor to a desired position, see section Mounting on page 26.
2. Define the deviation angle from the north-zero-alignment. Use the ± sign indication to express the direction from the north line (see example pictures).
3. Feed the deviation angle to the device by using the wind message formatting command aWU,D (direction correction), see section Checking the Settings on page 81.
4. From now on, the WMT50 transmits the wind direction data by using the changed zero-alignment.

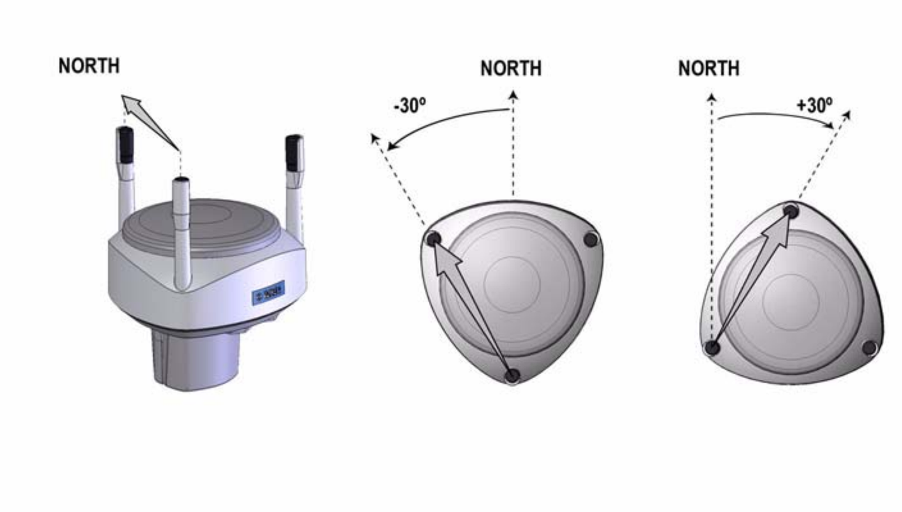



**Figure 11 Wind Direction Correction**

CHAPTER 5

# WIRING

This chapter provides you with instructions on how to connect the power supply and the serial interfaces.

The WMT50 can be accessed through four different serial interfaces: RS-232, RS-485, RS-422 and SDI-12. Each of them can be wired either through the internal screw terminal or the 8-pin M12 connector (optional). Only one serial interface can be used at a time.

| | |
|---|---|
| **CAUTION** | Cover the unused cable openings (in the sensor bottom assembly) with the hexagonal rubber plugs included in the accessories. |

## Power Supplies

### Operating Voltage

Operating voltage Vin+: 5 ... 30 VDC

Notice that for the average current consumption, see the graphs in Figure 12 on page 34. The minimum consumption graph is for SDI-12 standby mode.

The input power supply needs to be capable to deliver 60 mA (at 12 V) or 100 mA (at 6 V) instant current spikes with duration of 30 ms. These are drawn by the wind sensor (whenever enabled) at 4 Hz rate, which is the default value for wind sampling. Wind sampling at 2 Hz or 1 Hz rate is also available (see Chapter 8, Sensor and Data Message Settings, on page 81). The average current consumption will decrease almost in proportion to the sampling rate, since wind measurement is the most consuming operation in the system.

In most occasions the average consumption is less than 10 mA. Typically, the higher the voltage the lower the current, but with voltages above 18 V the current will gradually increase, adding to the usual consumption an extra 4 mA at 24 V (see the following graph).

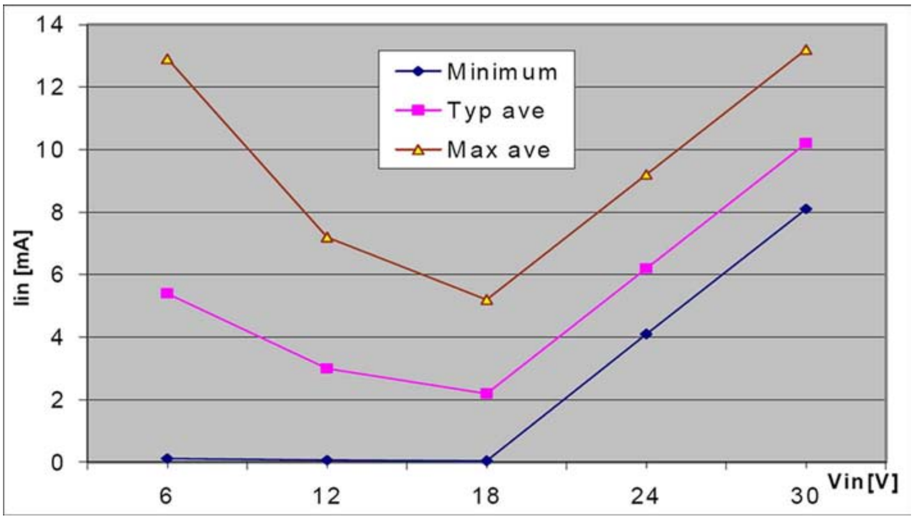



**Figure 12 Average Operational Current Consumption (with 4Hz Wind Sensor Sampling)**

# Heating Voltage

Heating voltage Vh+ (one of the following three alternatives):

- 5 ... 30 VDC;
- AC, max Vpeak-to-peak 84 V (= 30 VRMS); or
- Full-wave rectified AC, max Vpeak 42 V (= 30 VRMS).

The recommended DC voltage ranges are as follows:

- 12 VDC ± 20 % (max 1.1 A);
- 24 VDC ± 20 % (max 0.6 A).

At approx. 16 V heating voltage level the WMT50 automatically changes the heating element combination in order to consume equal power with 12 VDC and 24 VDC supplies. Input resistance (Rin) is radically increased with voltages above 16 V (see the following graph).

The recommended ranges for AC or full-wave rectified AC are:

- 68 Vp-p ± 20 % (max 0.6 A), for AC;
- 34 Vp ± 20 % (max 0.6 A), for f/w rectified AC.

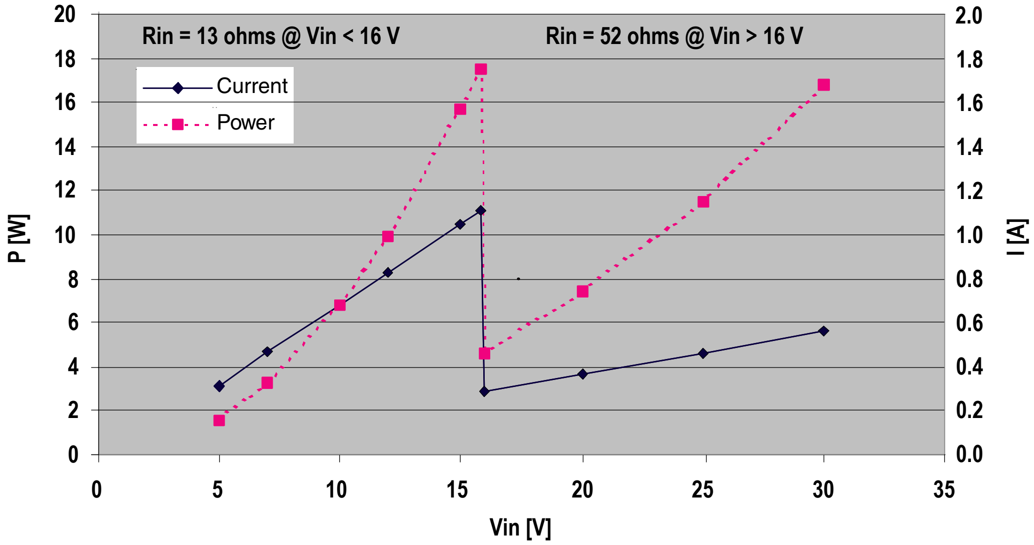



**Figure 13 Heating Current and Power Against Vh**

| | |
|---|---|
| **CAUTION** | To avoid exceeding the maximum ratings in any condition, the voltages must be checked with no load at the power supply output. |

| | |
|---|---|
| **WARNING** | Make sure that you connect only de-energized wires. |

# Wiring Using the Screw Terminals

1. Loosen the three long screws at the bottom of the WMT50.
2. Pull out the bottom part of the sensor.
3. Insert the power supply wires and signal wires through the cable gland(s) in the bottom of the sensor.
4. Connect the wires according to Table 1 on page 36.
5. Replace the bottom part and tighten the three screws.

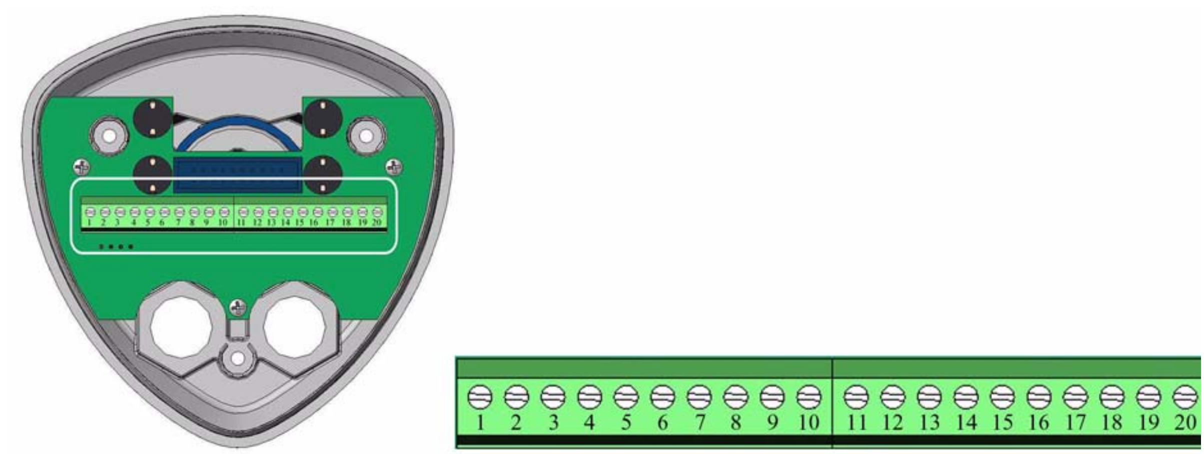



**Figure 14 Screw Terminal Block**

**Table 1 Screw Terminal Pin-outs for WMT50 Serial Interfaces and Power Supplies**

| Screw Terminal Pin | RS-232 | SDI-12 | RS-485 | RS-422 |
|---|---|---|---|---|
| 1 RX- | - | - | Data- | Data in (RX-) |
| 2 RX+ | - | - | Data+ | Data in (RX+) |
| 3 TX- | Data out (TxD) | Data in/out (Tx) | Data- | Data out (TX-) |
| 4 TX+ | - | - | Data+ | Data out (TX+) |
| 5 RXD | Data in (RxD) | Data in/out (Rx) | - | - |
| 6 SGND | GND for data | GND for data | - | - |
| 17 HTG- | GND for Vh+ | GND for Vh+ | GND for Vh+ | GND for Vh+ |
| 18 HTG+ | Vh+ (heating) | Vh+ (heating) | Vh+ (heating) | Vh+ (heating) |
| 19 VIN- | GND for Vin+ | GND for Vin+ | GND for Vin+ | GND for Vin+ |
| 20 VIN+ | Vin+ (operating) | Vin+ (operating) | Vin+ (operating) | Vin+ (operating) |

| NOTE | In the true SDI-12 mode the two Data in/out lines must be combined either in the screw terminal or outside the WMT50. |
|---|---|

| NOTE | Short-circuit jumpers are required between pins 1-3 and 2-4 for the RS-485 communication mode. For the RS-422 mode, the jumpers need to be removed. In the other modes the jumpers may stay or they can be removed. |
|---|---|

# Wiring Using the 8-pin M12 Connector (Optional)

## External Wiring

If the WMT50 is provided with an optional 8-pin M12 connector, the connector is located on the bottom of the sensor, see Figure 3 on page 18. The pins of the 8-pin M12 connector as seen from outside the sensor are illustrated in the following figure.

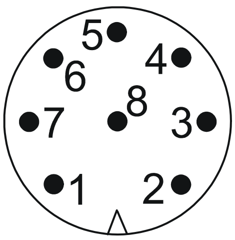



**Figure 15 Pins of 8-pin M12 Connector**

The pin connections for the 8-pin M12 connector and the wire colors of the respective M12 cable (optional, 2/10 m) are listed in Table 2 on page 38.

**Table 2 Pin-outs for WMT50 Serial Interfaces and Power Supplies**

| | | /----------------Default wiring----------------\ | | | RS-422 wiring |
|---|---|---|---|---|---|
| **Wire Color** | **M12 Pin#** | **RS-232** | **SDI-12** | **RS-485** | **RS-422** |
| Blue | 7 | Data out (TxD) | Data in/out (Tx) | Data- | Data in (RX-) |
| Gray | 5 | - | - | Data+ | Data in (RX+) |
| White | 1 | Data in (RxD) | Data in/out (Rx) | - | Data out (TX-) |
| Green | 3 | GND for data | GND for data | - | Data out (TX+) |
| Pink | 6 | GND for Vh+ | GND for Vh+ | GND for Vh+ | GND for Vh+ |
| Yellow | 4 | Vh+ (heating) | Vh+ (heating) | Vh+ (heating) | Vh+ (heating) |
| Red/Clear[1] | 8 | GND for Vin+ | GND for Vin+ | GND for Vin+ | GND for Vin+ |
| Brown | 2 | Vin+ (operating) | Vin+ (operating) | Vin+ (operating) | Vin+ (operating) |

1. Red in the internal wiring, clear in the cable (a non-insulated drain wire)

The signal names Data in (RxD) and Data out (TxD) in the table describe the direction of data flow as seen from the WMT50.

The terms "Default wiring" and "RS-422 wiring" refer to the two internal wiring options, see the diagrams on the next page.

# Internal Wiring

The 8-pin M12 connector is optional and hence may not be readily installed. For retrofitting, make the wiring between the connector and the screw terminal block according to one of the following pictures.

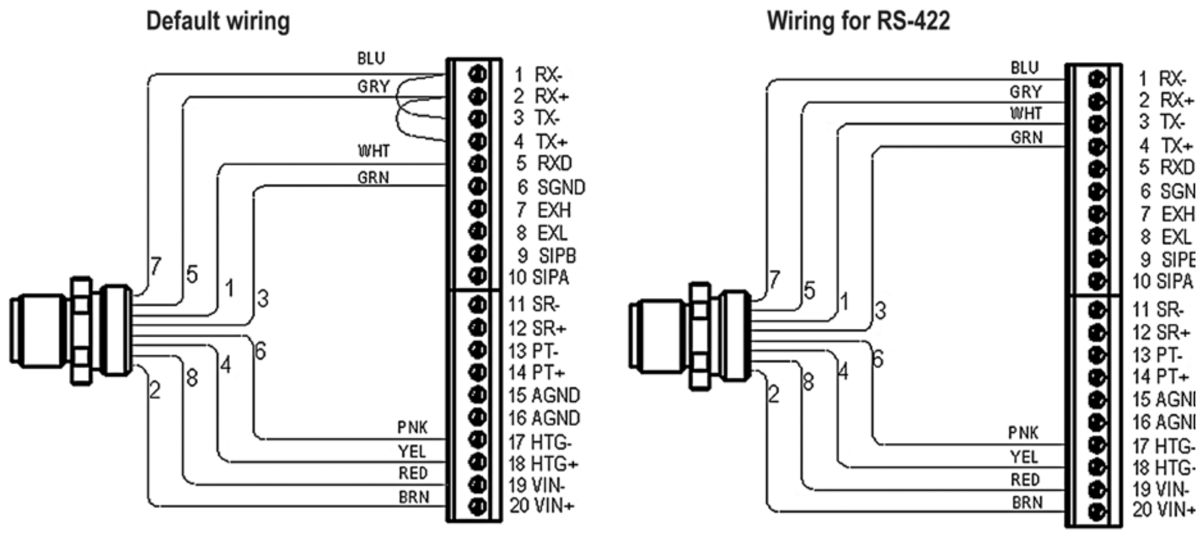



**Figure 16 Internal Wiring**

The telecommunication modes RS-232, SDI-12, and RS-485 can all be accomplished with Default wiring, whereas the 4-wire RS-422 requires a different internal wiring (see also Table 2 on page 38).

The RS-232 interface can be accessed with a standard PC ComPort, right through the M12 connector. Same applies to the SDI-12 interface, since the Rx and Tx lines are separate at the M12 connector.

| **NOTE** | The true SDI-12 line requires that the Rx and Tx wires are joined together (outside the WMT50). See the interface diagrams in the next section. |
|---|---|

Bidirectional use of the RS-485 and RS-422 interface requires a proper adapter module between the PC and the WMT50. For testing purposes, the inverted output of either interface (screw terminal pin #3 TX-) is directly readable with PC's Received Data line. In this case Signal Ground for PC ComPort is taken from screw terminal pin #6 SGND (for testing purposes pin #19 VIN- will also do).

For configuration work, the Service Port is most practical, since it has constant and convenient line parameters: RS232/19200, 8, N, 1. See Chapter 6, Communication Settings, on page 43 and Figure 3 on page 18.

# Data Communication Interfaces

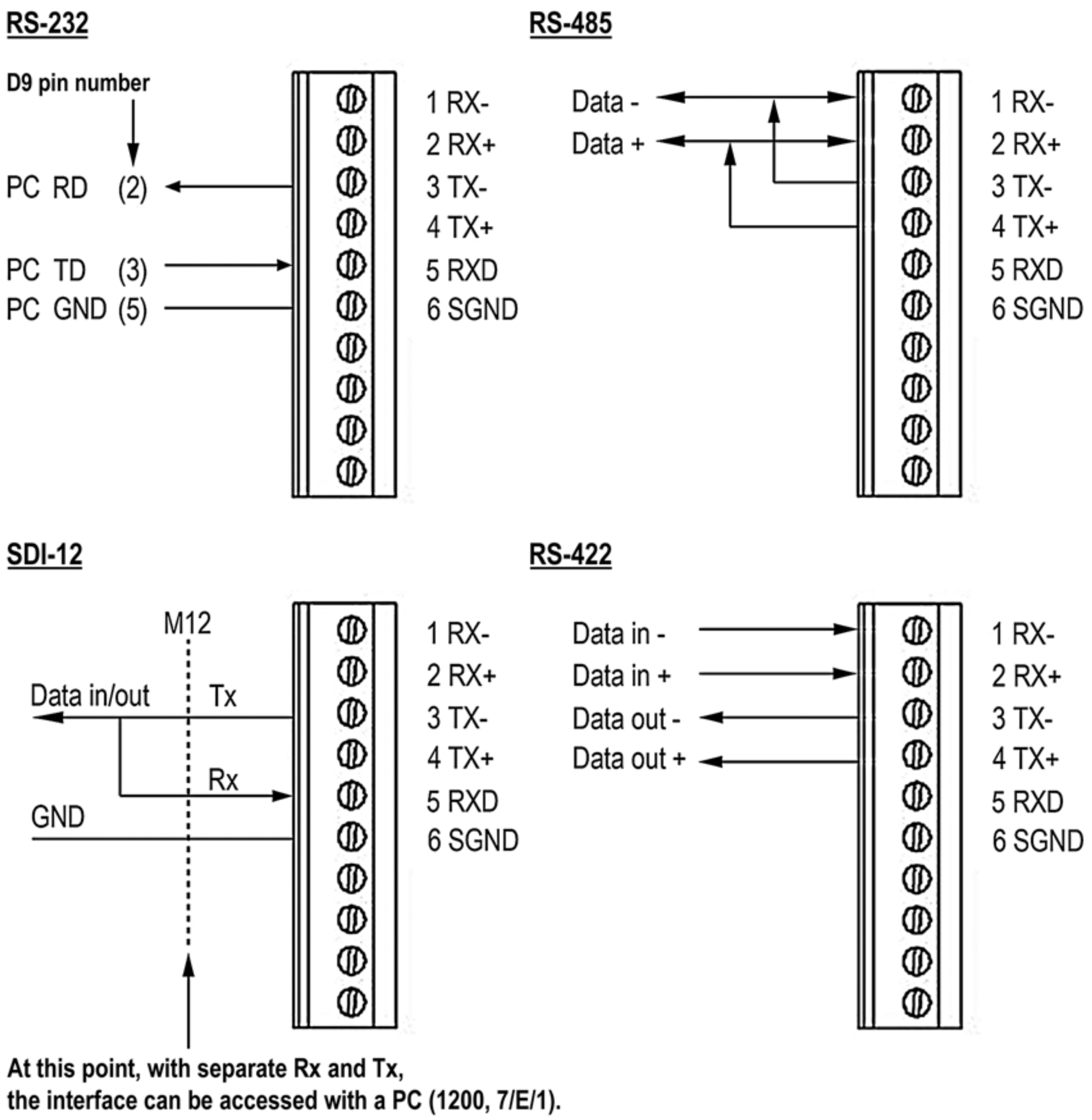



**Figure 17 Data Communication Interfaces**

With RS-485 and RS-422 interfaces, termination resistors need to be used at both ends of the line, if data rate is 9600 Bd or higher and distance is 600 m (2000 ft) or longer. Resistor range 100 ... 180 Ω is suitable for twisted pair lines. Resistors are connected across RX- to RX+ and across TX- to TX+ (with two-wire RS-485 only one resistor needed).

The termination resistors will remarkably increase power consumption during data transmission. If low power consumption is a must, a 0.1 μF capacitor needs to be connected in series with each termination resistor.

Note that the RS-485 interface can be used as well with four wires (as the RS-422). The basic difference between the RS-485 and RS-422 is actually their protocol. Namely, in the RS-422 mode the transmitter is held constantly enabled, while in the RS-485 mode it is enabled only during transmission (for allowing the host's transmission in the two-wire case).

The RS-232 output swings only between 0 ... +4.5 V. This is enough for modern PC inputs.The recommended maximum for RS-232 line length is 100 m (300 ft) with 1200 Bd data rate. Higher rates require shorter distance, for instance 30 m (100 ft) with 9600 Bd.

CHAPTER 6
# COMMUNICATION SETTINGS

This chapter contains instructions for making the communication settings.

## Communication Protocols

As soon as the WMT50 has been properly connected and powered the data transmission can be started. The communication protocols available in each of the serial interfaces are shown in the following table.

**Table 3 Available Serial Communication Protocols**

| Serial Interface | Communication Protocols Available |
|---|---|
| RS-232 | ASCII automatic and polled<br>NMEA 0183 v3.0 automatic and query<br>SDI-12 v1.3 and SDI-12 v1.3 continuous measurement |
| RS-485 | ASCII automatic and polled<br>NMEA 0183 v3.0 automatic and query<br>SDI-12 v1.3 and SDI-12 v1.3 continuous measurement |
| RS-422 | ASCII automatic and polled<br>NMEA 0183 v3.0 automatic and query<br>SDI-12 v1.3 and SDI-12 v1.3 continuous measurement |
| SDI-12 | SDI-12 v1.3 and SDI-12 v1.3 continuous measurement |

You have chosen the communication protocol (ASCII, NMEA 0183 or SDI-12) when placing the order. In case you want to check and/or change the protocol or other communication settings, see the following sections.

| | |
|---|---|
| **NOTE** | The RS-485 and RS-422 interfaces cannot be directly accessed with a standard PC terminal. They require a suitable converter. |

| | |
|---|---|
| **NOTE** | RS-232 and SDI-12 can be accessed with a standard PC terminal, presuming that, for SDI-12, the Data in/out lines have not been combined inside the WMT50. |

# Service Cable Connection

The service cable connection with fixed serial port settings is recommended for checking/changing the device settings. When making the changes, use the WXT/WMT Configuration Tool or a standard PC terminal program.

The service cable is included in the WXT/WMT Configuration Tool kit, see Table 17 on page 101. For a picture of the service cable, see Figure 5 on page 19.

When you connect the service cable between the service connector and PC serial port, the serial port settings are forced automatically to RS-232 / 19200, 8, N, 1. At the same time, the normal serial port (main port) at M12 and at screw terminals is disabled. The 9 V battery attached to a cable provides the power to the WMT50. Alternatively the normal power connection through M12 or screw terminals can be used (simultaneous use with 9 V battery is allowed).

1. Make a connection between the serial port of your PC and the service port connector on the bottom plate of the sensor (see Figure 3 on page 18) by using a service cable.
2. Power-up the WMT50 with a 9 V battery attached to the service cable or by using the screw terminals/M12 connector.
3. Open the WXT/WMT Configuration Tool/terminal program. Select the following default communication settings: 19200, 8, N, 1.
4. Make the desired changes. When working with a terminal program, see section Communication Setting Commands on page 46.

| NOTE | Changes in the serial interface/communication protocol/baud settings take place when disconnecting the service cable or when resetting the sensor.<br>If these settings are not changed during the service connection session, original main port settings (at M12 and screw terminals) are returned, as soon as the service cable is disconnected from either end. |
|---|---|

# Connection Through M12 Bottom Connector or Screw Terminals

Checking/changing the device settings can also be made through the M12 bottom connector or screw terminals. Then you have to know the communication settings of the device, have a suitable cable between the device and the host and, if needed, use a converter (for example, RS-485/422 to RS-232 if the host is a PC). The factory defaults settings are as follows:

**Table 4 Default Serial Communication Settings for M12/ Screw Terminal Connection**

| Serial Interface | Serial Settings |
|---|---|
| SDI-12 | 1200 baud, 7, E, 1 |
| RS-232, ASCII | 19200 baud, 8, N, 1 |
| RS-485, ASCII | 19200 baud, 8, N, 1 |
| RS-422 ASCII | 19200 baud, 8, N, 1 |
| RS-422 NMEA | 4800 baud, 8, N, 1 |

# Communication Setting Commands

| NOTE | Hereafter the commands to be typed are presented in normal text while the responses of the sensor are presented in *italic*. |
| --- | --- |

## Checking the Current Communication Settings (aXU)

With this command you can request the current communication settings of the WMT50.

Command format in ASCII and NMEA 0183: aXU<cr><lf>

Command format in SDI-12: aXXU!

where

| | | |
| --- | --- | --- |
| a | = | Device address, which may consist of the following characters: 0 (default) ... 9, A ... Z, a ... z. |
| XU | = | Device settings command in ASCII and NMEA 0183 |
| XXU | = | Device settings command in SDI-12 |
| <cr><lf> | = | Command terminator in ASCII and NMEA 0183 |
| ! | = | Command terminator in SDI-12 |

Example response in ASCII and NMEA 0183:

*aXU,A=a,M=[M],T=[T],C=[C],B=[B],D=[D],P=[P],S=[S],L=[L],*
*N=[N],V=[V]<cr><lf>*

Example response in SDI-12:

*aXXU,A=a,M=[M],T=[T],C=[C],B=[B],D=[D],P=[P],S=[S],*
*L=[L],N=[N],V=[V]<cr><lf>*

# Setting Fields

| | | |
|---|---|---|
| a | = | Device address |
| XU | = | Device settings command in ASCII and NMEA 0183 |
| XXU | = | Device settings command in SDI-12 |
| [A] | = | Address: 0 (default) ... 9, A ... Z, a ... z |
| [M] | = | Communication protocol<br>A = ASCII, automatic<br>a = ASCII, automatic with CRC<br>P = ASCII, polled<br>p = ASCII, polled, with CRC<br>N = NMEA 0183 v3.0, automatic<br>Q = NMEA 0183 v3.0, query (=polled)<br>S = SDI-12 v1.3<br>R = SDI-12 v1.3 continuous measurement |
| [T] | = | Test parameter (for testing use only) |
| [C] | = | Serial interface: 1 = SDI-12, 2 = RS-232, 3 = RS-485, 4 = RS-422 |
| [B] | = | Baud rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 |
| [D] | = | Data bits: 7/8 |
| [P] | = | Parity: O = Odd, E = Even, N = None |
| [S] | = | Stop bits: 1/2 |
| [L] | = | RS-485 line delay: 0 ... 10 000 ms<br>Defines the delay between the last character of the query and the first character of the response message from the WMT50. During the delay, the WMT50's transmitter is disabled. Effective in ASCII, polled and NMEA 0183 query protocols. Effective when RS-485 is selected (C=3). |
| [N] | = | Name of the device: WMT50 (read only) |
| [V] | = | Software version: for example, 1.00 (read only) |
| <cr><lf> | | Response terminator |

| NOTE | There are two different SDI-12 modes available for providing all the functionality of the SDI-12 v1.3 standard.<br>The lowest power consumption is achieved with the Native SDI-12 mode (aXU,M=S), as it makes measurements and outputs data only on request.<br>In the continuous SDI-12 mode (aXU,M=R) internal measurements are made at a user-configurable update interval, see Chapter 8, Sensor and Data Message Settings, on page 81. The data is outputted when requested. |
|---|---|

Example (ASCII and NMEA 0183, device address 0):

```
0XU<cr><lf>
0XU,A=0,M=P,T=0,C=2,B=19200,D=8,P=N,S=1,L=25,N=WMT50,
V=1.00<cr><lf>
```

Example (SDI-12, device address 0):

```
0XXU!0XXU,A=0,M=S,T=0,C=1,B=1200,D=7,P=E,S=1,L=25,
N=WMT50,V=1.00<cr><lf>
```

# Changing the Communication Settings

Make the desired setting with the following command. Select the correct value/letter for the setting fields, see Setting Fields on page 47. See also the examples.

Command format in ASCII and NMEA 0183:

aXU,A=x,M=x,C=x,B=x,D=x,P=x,S=x,L=x<cr><lf>

Command format in SDI-12:

aXXU,A=x,M=x,C=x,B=x,D=x,P=x,S=x,L=x!

where

| | | |
|---|---|---|
| A, M, C, B, D, P, S,L | = | The communication setting fields, see Setting Fields on page 47. |
| x | = | Input value for the setting |
| <cr><lf> | = | Command terminator in ASCII and NMEA 0183 |
| ! | = | Command terminator in SDI-12 |

| NOTE | When changing the serial interface and communication protocol, note the following:<br>Each serial interface requires its specific wiring and/or jumper settings described in Chapter 5, Wiring, on page 33.<br>Change first the serial interface field C and then the communication protocol field M.<br>Changing the serial interface to SDI-12 (C=1) will automatically change the baud settings to 1200, 7, E, 1 and the communication protocol to SDI-12 (M=S). |
|---|---|

| NOTE | Reset the sensor to validate the changes of communication parameters by disconnecting the service cable or using the Reset (aXZ) command, see Reset (aXZ) on page 51. |
|---|---|

Example (ASCII and NMEA 0183, device address 0):

Changing the device address from 0 to 1:

```
0XU,A=1<cr><lf>
1XU,A=1<cr><lf>
```

Checking the changed settings:

```
1XU<cr><lf>
1XU,A=1,M=P,T=1,C=2,B=19200,D=8,P=N,S=1,L=25,N=WMT50,
V=1.00<cr><lf>
```

Example (ASCII, device address 0):

Changing RS-232 serial interface with ASCII, polled communication protocol and baud settings 19200, 8, N, 1 to RS-485 serial interface with ASCII, automatic protocol and baud settings 9600, 8, N, 1.

Checking the actual settings:

```
0XU<cr><lf>
0XU,A=0,M=P,C=2,B=19200,D=8,P=N,S=1,L=25,N=WMT50,
V=1.00<cr><lf>
```

| NOTE | You can change several parameters in the same command as long as the command length does not exceed 32 characters (including command terminator characters ! or <cr><lf>). You do not have to type those setting fields that are not to be changed. |
|---|---|

Changing several settings with one command:

```
0XU,M=A,C=3,B=9600<cr><lf>
0XU,M=A,C=3,B=9600<cr><lf>
```

Checking the changed settings:

```
0XU<cr><lf>
0XU,A=0,M=A,
T=1,C=3,B=9600,D=8,P=N,S=1,L=25,N=WMT50,V=1.00<cr><lf>
```

CHAPTER 7

# GETTING THE DATA MESSAGES

This chapter presents the general and data message commands.

Each communication protocol has its own section for data message commands.

For changing the message parameters, units and other settings, see Chapter 8, Sensor and Data Message Settings, on page 81.

| | |
|---|---|
| **NOTE** | Type commands in CAPITAL letters. |

## General Commands

In case the error messaging is disabled (see Supervisor Message on page 86), the WMT50 does not return any response message with the general commands given in ASCII and NMEA-formats.

### Reset (aXZ)

This command is used to perform software reset on the device.

Command format in ASCII and NMEA 0183: aXZ<cr><lf>

Command format in SDI-12: aXZ!

where

a = Device address

XZ = Reset command

<cr><lf> = Command terminator in ASCII and NMEA 0183

! = Command terminator in SDI-12

The response depends on the communication protocol, see examples.

Example (ASCII):

```
0XZ<cr><lf>
0TX,Start-up<cr><lf>
```

Example (SDI-12):

`0XZ!0` (=device address)

Example (NMEA 0183):

```
0XZ<cr><lf>
$WITXT,01,01,07,Start-up*29
```

# Measurement Reset (aXZM)

This command is used to interrupt all ongoing measurements of the sensor and start them from the beginning.

Command format in ASCII and NMEA 0183: aXZM<cr><lf>

Command format in SDI-12: aXZM!

where

a = Device address

XZM = Measurement break command

<cr><lf> = Command terminator in ASCII and NMEA 0183

! = Command terminator in SDI-12

Example (ASCII):

```
0XZM<cr><lf>
0TX,Measurement reset<cr><lf>
```

Example (SDI-12):

`0XZM!0` (= device address)

Example (NMEA 0183):

```
0XZM<cr><lf>
$WITXT,01,01,09,Measurement reset*50<cr><lf>
```

# ASCII Protocol, Polled (without CRC)

This section presents the data commands and data message formats for the ASCII communication protocols.

## Abbreviations and Units

For changing the units, see Chapter 8, Sensor and Data Message Settings, on page 81.

**Table 5 Abbreviations and Units**

| Abbr. | Name | Unit | Status[1] |
|---|---|---|---|
| Sn | Wind speed minimum | m/s, km/h, mph, knots | #,M, K, S, N |
| Sm | Wind speed average | m/s, km/h, mph, knots | #,M, K, S, N |
| Sx | Wind speed maximum | m/s, km/h, mph, knots | #,M, K, S, N |
| Dn | Wind direction minimum | deg | #, D |
| Dm | Wind direction average | deg | #, D |
| Dx | Wind direction maximum | deg | #, D |
| Th | Heating temperature | °C, °F | #, C, F |
| Vh | Heating voltage | V | #, N, V, W, F[2] |
| Vs | Supply voltage | V | V |
| Vr | 3.5 V ref. voltage | V | V |

1. The letters in the status field indicate the Unit, the # character indicates invalid data.
2. For heating # = heating option is not available (has not been ordered). N = heating option is available but have been disabled by user or the heating temperature is over the high control limit. V = heating is on at 50% duty cycle and the heating temperature is between the high and middle control limits. W = heating is on at 100% duty cycle and the heating temperature is between the low and middle control limits. F = heating is on at 50% duty cycle and the heating temperature is below the low control limit.

# Device Address (?)

This command is used to query the address of the device on the bus.

Command format: ?<cr><lf>

where

| | | |
|---|---|---|
| ? | = | Device address query command |
| <cr><lf> | = | Command terminator |

The response:

```
b<cr><lf>
```

where

| | | |
|---|---|---|
| b | = | Device address (default = 0) |
| <cr><lf> | = | Response terminator. |

Example:

```
?<cr><lf>
0<cr><lf>
```

If more than one sensor is connected to the bus, see Appendix A, Networking, on page 105. If you need to change the device address, see Changing the Communication Settings on page 48.

# Acknowledge Active Command (a)

This command is used to ensure that a device is responding to a data recorder or another device. It asks a device to acknowledge its presence on the bus.

Command format: a<cr><lf>

where

| | | |
|---|---|---|
| a | = | Device address |
| <cr><lf> | = | Command terminator |

The response:

*a<cr><lf>*

where

| | | |
|---|---|---|
| a | = | Device address |
| <cr><lf> | = | Response terminator |

Example:

```
0<cr><lf>
0<cr><lf>
```

# Wind Data Message (aR1)

With this command you can request the wind data message.

Command format: aR1<cr><lf>

where

| | | |
|---|---|---|
| a | = | Device address |
| R1 | = | Wind message query command |
| <cr><lf> | = | Command terminator |

Example of the response (the parameter set is configurable):

```
0R1,Dn=236D,Dm=283D,Dx=031D,Sn=0.0M,Sm=1.0M,Sx=2.2M
<cr><lf>
```

where

| | | |
|---|---|---|
| a | = | Device address |
| R1 | = | Wind message query command |
| Dn | = | Wind direction minimum (D = degrees) |
| Dm | = | Wind direction average (D = degrees) |
| Dx | = | Wind direction maximum (D = degrees) |
| Sn | = | Wind speed minimum (M = m/s) |
| Sm | = | Wind speed average (M = m/s) |
| Sx | = | Wind speed maximum (M = m/s) |
| <cr><lf> | = | Response terminator |

To change the parameters and units in the response message and to make other sensor settings, see section Wind Sensor on page 81.

# Supervisor Data Message (aR5)

With this command you can request a supervisor data message containing self-check parameters of the heating system and power supply voltage.

Command format: aR5<cr><lf>

where

| | | |
|---|---|---|
| a | = | Device address |
| R5 | = | Supervisor message query command |
| <cr><lf> | = | Command terminator |

Example of the response (the parameter set is configurable):

*0R5,Th=25.9C,Vh=12.0N,Vs=15.2V,Vr=3.475V<cr><lf>*

where

| | | |
|---|---|---|
| a | = | Device address |
| R5 | = | Supervisor message query command |
| Th | = | Heating temperature (C = °C) |
| Vh | = | Heating voltage (N = heating is off) |
| Vs | = | Supply voltage (V = V) |
| Vr | = | 3.5 V reference voltage (V = V) |
| <cr><lf> | = | Response terminator |

To change the parameters and units in the response message and to make other settings, see section Supervisor Message on page 86.

# Combined Data Message (aR)

With this command you can request both individual messages aR1 and aR5 with just one command.

Command format: aR<cr><lf>

where

| | | |
|---|---|---|
| a | = | Device address (default = 0) |
| R | = | Combined message query command |
| <cr><lf> | = | Command terminator |

Example of the response:

```
0R1,Dm=027D,Sm=0.1M<cr><lf>
0R5,Th=76.1F,Vh=11.5N,Vs=11.5V,Vr=3.510V<cr><lf>
```

# Composite Data Message Query (aR0)

This command is used to request a combined data message with user configurable set of wind and supervisor data.

Command format: aR0<cr><lf>

where

| | | |
|---|---|---|
| a | = | Device address |
| R0 | = | Composite message query command |
| <cr><lf> | = | Command terminator |

Example of the response (the parameters included can be chosen from the full parameter set of the commands aR1 and aR5):

```
0R0,Dx=005D,Sx=2.8M,Th=23.6C<cr><lf>
```

For selecting the parameter set in the response message, see Chapter 8, Sensor and Data Message Settings, on page 81.

# ASCII Protocol, Polled (with CRC)

Use the same data query commands as in the previous sections but type the first letter of the command in lower case and add a correct three-character CRC before the command terminator. The response contains also a CRC. For more information about the CRC-computation see Appendix C, CRC-16 Computation, on page 115.

Requesting a wind data message with a CRC:

Command format: ar1xxx<cr><lf>

where

| | | |
|---|---|---|
| a | = | Device address |
| r1 | = | Wind message query command |
| xxx | = | Three-character CRC for ar1 command |
| <cr><lf> | = | Command terminator |

Example of the response (the parameter set is configurable):

*0r1,Dn=236D,Dm=283D,Dx=031D,Sn=0.0M,Sm=1.0M,Sx=2.2MLFj*
*<cr><lf>*

where the three characters before <cr><lf> are the CRC for the response.

**NOTE** The correct CRC for each command can be requested by typing the command with an arbitrary three-character CRC.

Example of asking the CRC for the wind data message query 0r1 (the device address is 0):

Command format: 0r1yyy<cr><lf>

where

| | | |
|---|---|---|
| 0 | = | Device address |
| r1 | = | Wind message query command |
| yyy | = | Arbitrary three-character CRC |
| <cr><lf> | = | Command terminator |

Response:

```
0tX,Use chksum GoeIU~<cr><lf>
```

where

| | | |
|---|---|---|
| 0 | = | Device address |
| tX,Use chksum | = | Text prompt |
| Goe | = | Correct three-character CRC for the 0r1 command |
| IU~ | = | Three-character CRC for the response message |
| <cr><lf> | = | Response terminator |

Example of the other data query commands with CRC (when the device address is 0):

| | | |
|---|---|---|
| Supervisor query | = | 0r5Kcd<cr><lf> |
| Combined message query | = | 0rBVT<cr><lf> |
| Composite message query | = | 0r0Kld<cr><lf> |

In every case the response contains a three-character CRC before the <cr><lf>.

For selecting the parameters to be included in the response messages, changing the units and making other configurations of the measured parameters, see Chapter 8, Sensor and Data Message Settings, on page 81.

# ASCII Protocol, Automatic

When ASCII automatic protocol is selected, the sensor sends data messages at user configurable update intervals. The message structure is the same as with data query commands aR1 and aR5. You can choose an individual update interval for each sensor, see Chapter 8, Sensor and Data Message Settings, on page 81, sections Changing the Settings.

Example:

```
0R1,Dm=027D,Sm=0.1M<cr><lf>
0R5,Th=76.1F,Vh=11.5N,Vs=11.5V,Vr=3.510V<cr><lf>
```

Example (with CRC):

```
0r1,Sn=0.1M,Sm=0.1M,Sx=0.1MGOG<cr><lf>
0r5,Th=25.0C,Vh=10.6#,Vs=10.8V,Vr=3.369VO]T<cr><lf>
```

| NOTE | You can stop the automatic output by changing the communication protocol to polled mode (aXU,M=P).<br><br>Composite message aR0 can not be obtained by automatic sending.<br><br>Polling commands aR1 and aR5 can be used also in ASCII automatic protocol for requesting data. |
|---|---|

# SDI-12 Protocol

There are two different modes available for providing all the functionality of the SDI-12 v1.3 standard.

The lowest power consumption is achieved with the Native SDI-12 mode (aXU,M=S), as it makes measurements and outputs data only when requested. In this mode all the commands presented in this chapter are available except those for the Continuous measurement.

In the Continuous mode (aXU,M=R) measurements are made at user-configurable update intervals, see Chapter 8, Sensor and Data Message Settings, on page 81. The data is outputted on request. In this mode all the commands presented in this chapter are available.

For changing the message parameters, units and other settings, see Chapter 8, Sensor and Data Message Settings, on page 81.

In the Native SDI-12 mode (aXU,M=S) the WMT50 is in idle state most of the time (power consumption < 1 mW). More power is consumed only during the measurements and data transmit requested by the host device. Especially, the wind measurement typically consumes 60 mW average power (with 4 Hz sampling rate), throughout the averaging period. In the Continuous mode (aXU=M,R) the power consumption is determined by the internal update intervals of the sensors and wind averaging time. These have certain limits, so very long measurement intervals can not be achieved with this mode. Also the power consumption between the measurements is about three times that of the Native mode.

# Address Query Command (?)

This command is used to query the address of the device on the bus.

If more than one sensor is connected to the bus, they will all respond, causing a bus collision.

Command format: ?!

where

| | | |
|---|---|---|
| ? | = | Address query command |
| ! | = | Command terminator |

The response:

*a<cr><lf>*

where

| | | |
|---|---|---|
| a | = | Device address (default = 0) |
| <cr><lf> | = | Response terminator |

Example (device address 0):

`?!`*0<cr><lf>*

# Acknowledge Active Command (a)

This command is used to ensure that a device is responding to a data recorder or another SDI-12 device. It asks a device to acknowledge its presence on the SDI-12 bus.

Command format: a!

where

| | | |
|---|---|---|
| a | = | Device address |
| ! | = | Command terminator |

The response:

*a<cr><lf>*

where

| | | |
|---|---|---|
| a | = | Device address |
| <cr><lf> | = | Response terminator |

Example:

`0!`*0<cr><lf>*

# Change Address Command (aAb)

This command changes the device address. After the command has been issued and responded to, the sensor is not required to respond to another command for one second time in order to ensure writing the new address to the non-volatile memory.

Command format: aAb!

where

| | | |
|---|---|---|
| a | = | Device address |
| A | = | Change address command |
| b | = | Address to change to |
| ! | = | Command terminator |

The response:

*b<cr><lf>*

where

| | | |
|---|---|---|
| b | = | Device address = the new address (or the original address, if the device is unable to change it) |
| <cr><lf> | = | Response terminator |

Example (changing address from 0 to 3):

`0A3!`*3<cr><lf>*

# Send Identification Command (aI)

This command is used to query the device for the SDI-12 compatibility level, model number, and firmware version and serial number.

Command format: aI!

where

| | | |
|---|---|---|
| a | = | Device address |
| I | = | Send identification command |
| ! | = | Command terminator |

The response:

*a13ccccccccmmmmmmvvvxxxxxxxx<cr><lf>*

where

| | | |
|---|---|---|
| a | = | Device address |
| 13 | = | The SDI-12 version number, indicating SDI-12 version compatibility; for example, version 1.3 is encoded as 13 |
| cccccccc | = | 8-character vendor identification Vaisala_ |
| mmmmmm | = | 6 characters specifying the sensor model number |
| vvv | = | 3 characters specifying the firmware version |
| xxxxxxxx | = | 8-character serial number |
| <cr><lf> | = | Response terminator |

Example:

`0I!`*`013VAISALA_WMT50103Y2630000<cr><lf>`*

# Start Measurement Command (aM)

This command asks the device to make a measurement. The measured data are not sent automatically and need to be requested with a separate Send data command aD.

The host device is not allowed to send any commands to other devices on the bus until the measurement is completed. When several devices are connected to the same bus and simultaneous measurements from the different devices are needed, Start concurrent measurement (aC) or start concurrent measurement with CRC (aCC) need to be used, see the next sections.

See Examples of aM, aC and aD Commands on page 68.

Command format: aMx!

where

| | | |
|---|---|---|
| a | = | Device address |
| M | = | Start measurement command |
| x | = | The desired measurement<br>1 = Wind<br>5 = Supervisor<br>If x is left out, the query refers to the composite message for a mixture of parameters from several data groups. See Examples of aM, aC and aD Commands on page 68. |
| ! | = | Command terminator |

The response is sent in two parts:

The response part 1:

```
atttn<cr><lf>
```

The response part 2 (indicates the data is ready to be requested):

```
a<cr><lf>
```

where

| | | |
|---|---|---|
| a | = | Device address |
| ttt | = | The measurement completing time (in seconds) |
| n | = | The number of the measured parameters available (maximum number is 9) |
| <cr><lf> | = | Response terminator |

| | |
|---|---|
| **NOTE** | For changing the message parameters, units and other settings, see Chapter 8, Sensor and Data Message Settings, on page 81. |

| | |
|---|---|
| **NOTE** | When the measurement takes less than one second, the response part 2 is not sent. |

| | |
|---|---|
| **NOTE** | The maximum number of parameters that can be measured with aM and aMC commands is 9. If more parameters are to be measured, Start concurrent measurement commands aC and aCC need to be used (for which the maximum number of parameters to be measured is 20), see the following sections. |

# Start Measurement Command with CRC (aMC)

Command format: aMCx!

This command has the same function than the aM but a three-character CRC is added to the response data strings before <cr><lf>. In order to request the measured data, Send data command aD needs to be used, see the following sections.

# Start Concurrent Measurement (aC)

This command is used when there are several devices on the same bus and simultaneous measurements are needed from the devices, or if more than 9 measurement parameters are requested from a single device.

The measured data are not sent automatically and it needs to be requested with separate send data command aD. See Examples of aM, aC and aD Commands on page 68.

Command format: aCx!

where

| | | |
|---|---|---|
| a | = | Device address |
| C | = | Start concurrent measurement command |
| x | = | The desired measurement<br>1 = Wind<br>5 = Supervisor<br>If x is left out, the query refers to the composite message for a mixture of parameters from several data groups. See Examples of aM, aC and aD Commands on page 68. |
| ! | = | Command terminator |

The response:

```
atttnn<cr><lf>
```

where

| | | |
|---|---|---|
| a | = | Device address |
| ttt | = | The measurement compliting time (in seconds) |
| nn | = | The number of the measured parameters available (maximum number is 20) |
| <cr><lf> | = | Response terminator |

| | |
|---|---|
| **NOTE** | For changing the message parameters, units and other settings, see Chapter 8, Sensor and Data Message Settings, on page 81. |

# Start Concurrent Measurement with CRC (aCC)

Command format: aCCx!

This command has the same function than aC but a three-character CRC is added to the response data strings before <cr><lf>.

In order to request the measured data, the Send data command aD needs to be used, see the following sections.

# Send Data Command (aD)

This command is used to request the measured data from the device. See Examples of aM, aC and aD Commands on page 68.

| | |
|---|---|
| **NOTE** | Start measurement command tells the number of parameters available. However, the number of the parameters that can be included in a single message depends on the number of characters in the data fields. If all the parameters are not retrieved in a single response message, repeat the Send data command until all the data are obtained. |

Command format: aDx!

where

| | | |
|---|---|---|
| a | = | Device address |
| D | = | Send data command |
| x | = | The order of consecutive send data commands. Always, the first Send data command needs to be addressed with x=0. If all the parameters are not retrieved, the next Send data command is sent with x=1 and so on. The maximum value for x is 9. See Examples of aM, aC and aD Commands on page 68. |
| ! | = | Command terminator |

The response:

```
a+<data fields><cr><lf>
```

where

| | | |
|---|---|---|
| a | = | Device address |
| <data fields> | = | The measured parameters in selected units, separated with '+' marks (or - marks in case of negative parameter values). |
| <cr><lf> | = | Response terminator |

| | |
|---|---|
| **NOTE** | aD0 command can also be used to break the measurement in progress started with commands aM, aMC, aC or aCC. |

| | |
|---|---|
| **NOTE** | In SDI-12 v1.3 Continuous measurement mode (aXU,M=R) the sensor makes measurements at configurable update intervals. The aD command following the aM, aMC, aC or aCC command always returns the latest updated data. Thus in aXU,M=R mode issuing consecutive aD commands may result in different data strings if the value(s) happen to be updated between the commands. |

# Examples of aM, aC and aD Commands

| | |
|---|---|
| **NOTE** | The parameter order in the wind and supervisor data messages are as presented in the parameter selection setting field, see Chapter 8, Sensor and Data Message Settings, on page 81. |

The device address is 0 in all examples.

Example 1:

Start a wind measurement and request the data (all 6 wind parameters are enabled in the message):

`0M1!`*`00036<cr><lf>`* (measurement ready in 3 seconds and 6 parameters available)
*`0<cr><lf>`* (measurement completed)
`0D0!`*`0+339+018+030+0.1+0.1+0.1<cr><lf>`*

Example 2:

Start a supervisor measurement with CRC and request the data:

`0MC5!`*`00014<cr><lf>`* (measurement ready in one second and 4 parameters available)
*`0<cr><lf>`* (measurement completed)
`0D0!`*`0+34.3+10.5+10.7+3.366DpD<cr><lf>`*

# Continuous Measurement (aR)

The device can be configured so that the parameters can be requested instantly with the command aR instead of the two phase request procedure of commands aM, aMC, aC, aCC + aD. In this case the obtained parameter values are those from the latest internal updating (for setting of updating intervals, see Chapter 8, Sensor and Data Message Settings, on page 81).

| | |
|---|---|
| **NOTE** | For using Continuous measurement commands for wind and supervisor parameters the respective protocol must be selected (aXU,M=R).<br>The M=S selection requires use of aM, aMC, aC, aCC + aD commands. |

Command format: aRx!

where

| | | |
|---|---|---|
| a | = | Device address |
| R | = | Start continuous measurement command: |
| x | = | The desired measurement<br>1 = Wind<br>5 = Supervisor.<br>If x is left out, the query refers to the composite message for a mixture of parameters from several data groups. |
| ! | = | Command terminator |

The response:

```
a+<data fields><cr><lf>
```

where

| | | |
|---|---|---|
| a | = | Device address |
| <data fields> | = | The measured parameters in selected units, separated with '+' marks (or '-' marks in case of negative parameter values). The maximum number of parameters to be measured with one request is 15. |
| <cr><lf> | = | Response terminator |

Examples (device address 0):

```
0R1!0+323+331+351+0.0+0.4+3.0<cr><lf>
0R5!0+20.3+12.0+12.2+3.530<cr><lf>
0R!0+178+288+001+15.5+27.4+38.5+20.3+12.0+12.2+3.530<cr>
<lf>
```

## Continuous Measurement with CRC (aRC)

Command format: aRCx!

Has the same function as the Continuous measurement command aR but a three-character CRC is added to the response data strings before <cr><lf>.

Example (device address 0):

```
0RC1!0+323+331+351+0.0+0.4+3.0INy<cr><lf>
```

## Start Verification Command (aV)

This command is used to query self diagnostic data from the device. However, the command is not implemented in the WMT50. The self-diagnostic data can be requested with aM5 command.

# NMEA 0183 V3.0 Protocol

This section presents the data query commands and data message formats for the NMEA 0183 v3.0 Query and automatic protocols.

For changing the message parameters, units and other settings, see Chapter 8, Sensor and Data Message Settings, on page 81.

A two-character checksum (CRC) field is transmitted in all data request sentences. For definition of the CRC, see Appendix C, CRC-16 Computation, on page 115.

# Device Address (?)

This command is used to query the address of the device on the bus.

Command format: ?<cr><lf>

where

| | | |
|---|---|---|
| ? | = | Device address query command |
| <cr><lf> | = | Command terminator |

The response:

*b<cr><lf>*

where

| | | |
|---|---|---|
| b | = | Device address (default = 0) |
| <cr><lf> | = | Response terminator. |

Example:

```
?<cr><lf>
0<cr><lf>
```

If more than one sensor is connected to the bus, see Appendix A, Networking, on page 105. If you need to change the device address, see Changing the Communication Settings on page 48.

# Acknowledge Active Command (a)

This command is used to ensure that a device is responding to a data recorder or another device. It asks a sensor to acknowledge its presence on the bus.

Command format: a<cr><lf>

where

| | | |
|---|---|---|
| a | = | Device address |
| <cr><lf> | = | Command terminator |

The response:

```
a<cr><lf>
```

where

| | | |
|---|---|---|
| a | = | Device address |
| <cr><lf> | = | Response terminator |

Example:

```
0<cr><lf>
0<cr><lf>
```

# MWV Wind Speed and Direction Query

The wind speed and direction data with are requested with the MWV query command. For using the MWV query the NMEA wind formatter parameter in the wind sensor settings needs to be set to W (see section Wind Sensor on page 81). With the MWV query only wind speed and direction average values can be requested. For obtaining min and max data for speed and direction, see section XDR Transducer Measurement Query on page 74.

Command format: $--WIQ,MWV*hh<cr><lf>

where

| | | |
|---|---|---|
| $ | = | Start of the message |
| -- | = | Device identifier of the requester |
| WI | = | Device type identifier (WI = weather instrument) |
| Q | = | Defines the message as Query |
| MWV | = | Wind speed and direction query command |
| * | = | Checksum delimiter |
| hh | = | Two-character checksum for the query command. |
| <cr><lf> | = | Command terminator |

The response format:

```
$WIMWV,x.x,R,y.y,M,A*hh<cr><lf>
```

where

| | | |
|---|---|---|
| $ | = | Start of the message |
| WI | = | Talker identifier (WI = weather instrument) |
| MWV | = | Wind speed and direction response identifier |
| x.x | = | Wind direction value[1] |
| R | = | Wind direction unit (R = relative) |
| y.y | = | Wind speed value |
| M | = | Wind speed unit (m/s) |
| A | = | Data status: A = valid, V = Invalid |
| * | = | Checksum delimiter |
| hh | = | Two-character checksum for the response |
| <cr><lf> | = | Response terminator |

1. Wind direction is given in relation to the device's north-south axis. An offset value to the measured direction can be set, see section Wind Sensor on page 76.

The checksum to be added to the query depends on the device identifier characters. The correct checksum can be requested by typing any three characters after the $--WIQ,MWV command.

Example:

The WMT50 responds to the command $--WIQ,MWVxxx<cr><lf> (xxx = arbitrary characters) as follows:

```
$WITXT,01,01,08,Use chksum 2F*72<cr><lf>
```

telling that 2F is the correct checksum for the $--WIQ,MWV command.

Example of the MWV Query:

```
$--WIQ,MWV*2F<crlf>
$WIMWV,282,R,0.1,M,A*37<cr><lf>
```

(Wind angle 282 degrees, Wind speed 0.1 m/s)

# XDR Transducer Measurement Query

The XDR query command normally returns the data of all the sensors other than wind. For including the wind data to the NMEA wind formatter parameter response, the wind sensor settings needs to be set to T (see section Wind Sensor on page 81).

Command format: $--WIQ,XDR*hh<cr><lf>

where

| | | |
|---|---|---|
| $ | = | Start of the message |
| -- | = | Device identifier of the requester |
| WI | = | Device type identifier (WI = weather instrument) |
| Q | = | Defines the message as Query |
| XDR | = | Transducer measurement command |
| * | = | Checksum delimiter |
| hh | = | Two-character checksum for the query command. |
| <cr><lf> | = | Command terminator |

The response includes the parameters activated in the data messages (see Chapter 8, Sensor and Data Message Settings, on page 81).

| NOTE | The parameter order in the output is as shown in the parameter selection setting field, see Chapter 8, sections Setting the Fields. |
|---|---|

The response format:

```
$WIXDR,a1,x.x1,u1,c--c1, ...  ... ..an,x.xn,un,c--
cn*hh<cr><lf>
```

where

| | | |
|---|---|---|
| $ | = | Start of the message |
| WI | = | Device type identifier (WI = weather instrument) |
| XDR | = | Transducer measurement response identifier |
| a1[1] | = | Transducer type for the first transducer, see the following transducer table. |

| | | |
|---|---|---|
| x.x1 | = | Measurement data from the first transducer |
| u1 | = | Units of the first transducer measurement, see the following transducer table. |
| c--c1 | = | First transducer identification (id). The WMT50's address aXU,A is added as a base number to the transducer id. For changing the address, see Checking the Current Communication Settings (aXU) on page 46 (command aXU,A= [0 ... 9/A ... Z/a ... z]1 |
| ... | | |
| an | = | Transducer type for the transducer n, see the following transducer table. |
| x.xn | = | Measurement data from the transducer n |
| un | = | Units of the transducer n measurement, see the following transducer table. |
| c--cn | = | transducer n id. The WMT50's address aXU,A is added as a base number to the Transducer #ID. The address is changeable, see command aXU,A= [0 ... 9/A ... Z/a ... z]1 |
| * | = | Checksum delimiter |
| hh | = | Two-character checksum for the response |
| <cr><lf> | = | Response terminator |

1. NMEA-format transmits only numbers as transducer ids. If the WMT50 address is a letter character, it is converted to a number as follows: A = 10, B = 11, ... a = 36, b = 37, etc.

The checksum to be typed in the query depends on the device identifier characters and can be asked from the WMT50, see example below.

Example:

The WMT50 responds to the command $--WIQ,XDRxxx<cr><lf> (xxx = arbitrary characters) as follows:

```
$WITXT,01,01,08,Use chksum 2D*72<cr><lf>
```

indicating that 2D is the correct checksum for the $--WIQ,XDR command.

If there are several distinct measurements of the same parameter (according to the transducer table below), they are assigned with different transducer ids. For example, minimum, average and maximum wind speed are measurements of the same parameter (wind speed) so if all three are configured to be shown in the XDR message, they get transducer ids A, A+1 and A+2, respectively, where A is the WMT50 address aXU,A. The same applies for the wind direction.

For example, for a WMT50 with device address 0 the transducer ids of all the measurement parameters are as follows:

**Table 6 Transducer IDs of the Measurement Parameters**

| Measurement | Transducer ID |
|---|---|
| Wind direction min | 0 |
| Wind direction average | 1 |
| Wind direction max | 2 |
| Wind speed min | 0 |
| Wind speed average | 1 |
| Wind speed max | 2 |
| Heating temperature | 2 |
| Supply voltage | 0 |
| Heating voltage | 1 |
| 3.5 V reference voltage | 2 |

Example of the XDR Query (all parameters of each sensor enabled and NMEA wind formatter set to T):

```
$--WIQ,XDR*2D<cr><lf>
```

Example of the response when all the parameters of each sensor are enabled (NMEA wind formatter set to T):

Wind sensor data

```
$WIXDR,A,302,D,0,A,320,D,1,A,330,D,2,S,0.1,M,0,S,0.2,M,
1,S,0.2,M,2*57<cr><lf>
```

Supervisor data

```
$WIXDR,C,25.5,C,2,U,10.6,N,0,U,10.9,V,1,U,3.360,V,
2*71<cr><lf>
```

The structure of the wind sensor response message:

where

| | | |
|---|---|---|
| $ | = | Start of the message |
| WI | = | Device type (WI = weather instrument) |
| XDR | = | Transducer measurement response identifier |
| A | = | Transducer id 0 type (wind direction), see the following Transducer table |
| 302 | = | Transducer id 0 data (min wind direction) |
| D | = | Transducer id 0 units (degrees, min wind direction) |
| 0 | = | Transducer id for min wind direction |
| A | = | Transducer id 1 type (wind direction) |
| 320 | = | Transducer id 1 data (average wind direction) |
| D | = | Transducer id 1 units (degrees, average wind direction) |
| 1 | = | Transducer id for average wind direction |
| A | = | Transducer id 2 type (wind direction) |
| 330 | = | Transducer id 2 data (max wind direction) |
| D | = | Transducer id 2 units (degrees, max wind direction) |
| 2 | = | Transducer id for max wind direction |
| S | = | Transducer id 0 type (wind speed) |
| 0.1 | = | Transducer id 0 data (min wind speed) |
| M | = | Transducer id 0 units (m/s, min wind speed) |
| 0 | = | Transducer id for min wind speed |
| S | = | Transducer id 1 type (wind speed) |
| 0.2 | = | Transducer id 1 data (average wind speed) |
| M | = | Transducer id 1 units (m/s, average wind speed) |
| 1 | = | Transducer id for average wind speed |
| S | = | Transducer id 2 type (wind speed) |
| 0.2 | = | Transducer id 2 data (max wind speed) |
| M | = | Transducer id 2 units (m/s, max wind speed) |
| 2 | = | Transducer id for max wind speed |
| * | | Checksum delimiter |
| 57 | = | Two-character checksum for the response |
| <cr><lf> | = | Response terminator |

The structure of the supervisor response message:

where

| | | |
|---|---|---|
| $ | = | Start of the message |
| WI | = | Device type (WI = weather instrument) |
| XDR | = | Transducer measurement response identifier |
| C | = | Transducer id 2 type (temperature), see the following Transducer table |
| 25.5 | = | Transducer id 2 data (Heating temperature) |
| C | = | Transducer id 2 units (C, Heating temperature) |
| 2 | = | Transducer id for Heating temperature |
| U | = | Transducer id 0 type (voltage) |
| 10.6 | = | Transducer id 0 data (Heating voltage) |
| N | = | Transducer id 0 units (N = heating disabled or heating temperature too high1, Heating voltage) |
| 0 | = | Transducer id for Heating voltage |
| U | = | Transducer id 1 type (Supply voltage) |
| 10.9 | = | Transducer id 1 data (voltage) |
| V | = | Transducer id 1 units (V, Supply voltage) |
| 1 | = | Transducer id for Supply voltage |
| U | = | Transducer id 2 type (voltage) |
| 3.360 | = | Transducer id 2 data (3.5V reference voltage) |
| V | = | Transducer id 2 units (V, 3.5V reference voltage) |
| 2 | = | Transducer id for 3.5V reference voltage |
| * | | Checksum delimiter |
| 71 | = | Two-character CRC for the response. |
| <cr><lf> | = | Response terminator |

1 See section Supervisor Message on page 86 for definitions of the Heating voltage field.

**Table 7 Transducer Table**

| Transducer | Type | Units Field | Comments |
|---|---|---|---|
| Temperature | C | C = Celsius<br>F = Fahrenheit | |
| Angular displacement (wind direction) | A | D = degrees | |
| Wind speed | S | K = km/h, M = m/s, N = knots | S = mph, non-standardized[1] |
| Voltage | U | V = volts (also 50 % duty cycle for heating) | N = not in use, F = 50% duty cycle for heating, W = full power for heating |

1. Not specified in the NMEA 0183 Standard.

# TXT Text Transmission

These short text messages and their interpretation are shown in Table 11 on page 96.

The text transmission response format:

```
$WITXT,xx,xx,xx,c--c*hh<cr><lf>
```

where

| | | |
|---|---|---|
| $ | = | Start of the message |
| WI | = | Talker identifier (WI = weather instrument) |
| TXT | = | Text transmission identifier. |
| xx | = | Total number of messages, 01 to 99 |
| xx | = | Message number. |
| xx | = | Text identifier (see text message table) |
| c---c | = | Text message (see text message table) |
| * | | Checksum delimiter |
| hh | = | Two-character checksum for the query command. |
| <cr><lf> | = | Response terminator |

Examples:

`$WItXT,01,01,01,Unable to measure error*6D<crlf>` (wind data request when all the wind parameters were disabled from the wind message)

`$WITXT,01,01,03,Unknown cmd error*1F` (unknown command 0XO!<cr><lf>)

`$WITXT,01,01,08,Use chksum 2F*72` (wrong checksum used in MWV query command)

# NMEA 0183 v3.0, Automatic

When NMEA 0183 v3.0 automatic protocol is selected, the sensor sends data messages at user configurable update intervals. The message format is the same as in the MWV and XDR data queries. The NMEA wind formatter parameter in the wind sensor settings determines whether the wind messages are sent in MWV or XDR format.

You can use ASCII data query commands aR1, aR5, aR, aR0 and their CRC-versions ar1, ar5, ar and ar0 also in NMEA 0183 protocol. The responses to these commands will be in standard NMEA 0183 format. For formatting the messages, see Chapter 8, Sensor and Data Message Settings, on page 81.

CHAPTER 8

# SENSOR AND DATA MESSAGE SETTINGS

This chapter presents the sensor configuration and data message formatting commands for all communications protocols: ASCII, NMEA 0183 and SDI-12.

Sensor and data message settings can also be done by using the WXT/WMT Configuration Tool software.With this software tool you can change the device and sensor settings easily in Windows® environment. See Table 17 on page 101.

## Wind Sensor

### Checking the Settings

With the following command you can check the current wind sensor settings.

Command format in ASCII and NMEA 0183: aWU<cr><lf>

Command format in SDI-12: aXWU!

where

| | | |
|---|---|---|
| a | = | Device address |
| WU | = | Wind sensor settings command in ASCII and NMEA 0183 |
| XWU | = | Wind sensor settings command in SDI-12 |
| <cr><lf> | = | Command terminator in ASCII and NMEA 0183 |
| ! | = | Command terminator in SDI-12 |

The response in ASCII and NMEA 0183:

```
aWU,R=[R],I=[I],A=[A],U=[U],D=[D],N=[N],F=[F]<cr><lf>
```

The response in SDI-12:

```
aXWU,R=[R],I=[I],A=[A],U=[U],D=[D],N=[N],F=[F]<cr><lf>
```

where [R][I][A][U][D][N] are the setting fields, see the following sections.

Example (ASCII and NMEA 0183, device address 0):

```
0WU<cr><lf>
0WU,R=01001000&00100100,I=60,A=10,U=N,D=-90,N=W,
F=4<cr><lf>
```

Example (SDI-12, device address 0):

```
0XWU!0XWU,R=11111100&01001000,I=10,A=3,U=M,D=0,N=W,
F=4<cr><lf>
```

# Setting Fields

[R] = Parameter selection: This field consists of 16 bits defining the precipitation parameters included in the data messages. The bit value 0 disables and the bit value 1 enables the parameter.

The parameter order is shown in the following table:

<table>
<tr><td rowspan="9">The bits 1-8 determine the parameters in the data message obtained with the following commands:<br>-ASCII: aR1 and ar1<br>-NMEA 0183: $--WIQ,XDR*hh<br>-SDI-12: aM1, aMC1, aC1, and aCC1<br>-SDI-12 continuous: aR1 and aRC1</td><td>1st bit (most left)</td><td>Dn Direction minimum</td></tr>
<tr><td>2nd bit</td><td>Dm Direction average</td></tr>
<tr><td>3rd bit</td><td>Dx Direction maximum</td></tr>
<tr><td>4th bit</td><td>Sn Speed minimum</td></tr>
<tr><td>5th bit</td><td>Sm Speed average</td></tr>
<tr><td>6th bit</td><td>Sx Speed maximum</td></tr>
<tr><td>7th bit</td><td>spare</td></tr>
<tr><td>8th bit</td><td>spare</td></tr>
<tr><td>&</td><td>delimiter</td></tr>
<tr><td rowspan="8">The bits 9-16 determine the wind parameters in the composite data message obtained with the following commands:<br>-ASCII: aR0, ar0<br>-NMEA 0183: aR0, ar0<br>-SDI-12: aM, aMC, aC, and aCC<br>-SDI-12 continuous: aR and aRC</td><td>9th bit</td><td>Dn Wind direction minimum</td></tr>
<tr><td>10th bit</td><td>Dm Wind direction average</td></tr>
<tr><td>11th bit</td><td>Dx Wind direction maximum</td></tr>
<tr><td>12th bit</td><td>Sn Speed minimum</td></tr>
<tr><td>13th bit</td><td>Sm Speed average</td></tr>
<tr><td>14th bit</td><td>Sx Speed maximum</td></tr>
<tr><td>15th bit</td><td>spare</td></tr>
<tr><td>16th bit (most right)</td><td>spare</td></tr>
</table>

[I] = Update interval: 1 ... 3600 seconds

[A] = Averaging time: 1 ... 3600 seconds
Defines the period over which the wind speed and direction averaging is calculated. See also Appendix D for averaging method.

[U] = Speed unit: M = m/s, K = km/h, S = mph, N = knots

[D] = Direction correction: -180 ... 180°, see Wind Direction Correction on page 31.

[N] = NMEA wind formatter: T = XDR (Transducer syntax), W = MWV (Wind speed and angle)
Determines whether the wind message in NMEA 0183 (automatic) is sent in XDR or MWV format.

| | | |
|---|---|---|
| [F] | = | Sampling rate: 1, 2, or 4 Hz<br>Defines how often the wind measurement is performed. By selecting lower sampling rate the power consumption of the device diminishes (the representativeness of the measurement decreases as well if short averaging time is used with low sampling rate). |
| <cr><lf> | = | Response terminator |

| NOTE | When using MWV wind messages in NMEA 0183, one of the R field's bits 1-6 must be 1. |
|---|---|

| NOTE | If you want representing values for wind speed and direction min and max values, use long enough averaging time in relation to sampling rate (at least 4 samples during the averaging time). |
|---|---|

# Changing the Settings

You can change the following settings:

- parameters included in the wind data message,
- update interval,
- averaging time,
- speed unit,
- direction correction, and
- NMEA wind formatter.

Make the desired setting with the following command. Select the correct value/letter for the setting fields, see Setting Fields on page 83. See the examples.

Command format in ASCII and NMEA 0183:

aWU,R=x,I=x,A=x,U=x,D=x,N=x,F=x<cr><lf>

Command format in SDI-12:

aXWU, R=x,I=x,A=x,U=x,D=x,N=x,F=x!

where

| | | |
|---|---|---|
| R, I, A, U, D, N, F | = | The wind sensor setting fields, see Setting Fields on page 83. |
| x | = | Value for the setting |
| <cr><lf> | = | Command terminator in ASCII and NMEA 0183 |
| ! | = | Command terminator in SDI-12 |

**NOTE** If averaging time [A] is greater than update interval [I], it needs to be a whole multiple of the update interval and at maximum 12 times greater. Example: If I = 5 s, Amax = 60 s.

Examples (ASCII and NMEA 0183, device address 0):

You need 20 seconds averaging time for wind speed and direction data to be available both in wind data message and composite message in every 60 seconds. Wind speed in knots and wind direction correction +10°.

Changing the measurement interval to 60 seconds:

```
0WU,I=60<cr><lf>
0WU,I=60<cr><lf>
```

**NOTE** Several parameters can be changed with the same command as long as the command length does not exceed 32 characters, see below.

Changing the averaging time to 20 seconds, the wind speed units to knots, and making the direction correction:

```
0WU,A=20,U=N,D=10<cr><lf>
0WU,A=20,U=N,D=10<cr><lf>
```

Changing the wind parameter selection:

```
0WU,R=0100100001001000<cr><lf>
0WU,R=01001000&00100100<cr><lf>
```

| NOTE | Character '&' is not allowed in the command. |
|---|---|

The response after the change:

```
0R1<cr><lf>
0R1,Dm=268D,Sm=1.8N<cr><lf>
```

Example (SDI-12, device address 0):

Changing the measurement interval to 10 seconds:

```
0XWU,I=10!0<cr><lf>
```

In SDI-12 mode a separate enquiry (0XWU!) must be given to check the data content.

# Supervisor Message

## Checking the Settings

With this command you can check the current supervisor settings.

Command format in ASCII and NMEA 0183: aSU<cr><lf>

Command format in SDI-12: aXSU!

where

| | | |
|---|---|---|
| a | = | Device address |
| SU | = | Supervisor settings command in ASCII and NMEA 0183 |
| XSU | = | Supervisor settings command in SDI-12 |
| <cr><lf> | = | Command terminator in ASCII and NMEA 0183 |
| ! | = | Command terminator in SDI-12 |

The response in ASCII and NMEA 0183:

```
aSU,R=[R],I=[I],S=[S],H=[Y]<cr><lf>
```

The response in SDI-12:

```
aXSU,R=[R],I=[I],S=[S],H=[Y]<cr><lf>
```

# Setting Fields

[R] = Parameter selection: This field consists of 16 bits defining the supervisor parameters included in the data messages. The bit value 0 disables and the bit value 1 enables the parameter.

| | | |
|---|---|---|
| The bits 1-8 determine the parameters included in the message obtained with the following commands:<br>-ASCII: aR5 and ar5<br>-NMEA 0183: $--WIQ,XDR*hh<br>-SDI-12: aM5, aMC5, aC5, and aCC5<br>-SDI-12 continuous: aR5 and aRC5 | 1st bit (most left) | Th Heating temperature |
| | 2nd bit | Vh Heating voltage |
| | 3rd bit | Vs Supply voltage |
| | 4th bit | Vr 3.5 V reference voltage |
| | 5th bit | spare |
| | 6th bit | spare |
| | 7th bit | spare |
| | 8th bit | spare |
| | & | delimiter |
| The bits 9-16 determine the supervisor parameters included in the composite data message obtained with the following commands:<br>-ASCII: aR0 and ar0<br>-NMEA 0183: aR0, ar0<br>-SDI-12: aM, aMC, aC, and aCC<br>-SDI-12 continuous: aR and aRC | 9th bit | Th Heating temperature |
| | 10th bit | Vh Heating voltage |
| | 11th bit | Vs Supply voltage |
| | 12th bit | Vr 3.5 V reference voltage |
| | 13th bit | spare |
| | 14th bit | spare |
| | 15th bit | spare |
| | 16th bit (most right) | spare |

[I] = Update interval: 1 ... 3600 seconds. When the heating is enabled the update interval is forced to 15 seconds.

[S] = Error messaging: Y = enabled, N = disabled

[H] = Heating control enable: Y = enabled, N = disabled
Heating enabled: The control between full and half heating power is on as described in Heating (Optional) on page 23. Heating disabled: Heating is off in all conditions.

<cr><lf> = Response terminator

Example (ASCII and NMEA 0183, device address 0):

```
0SU<cr><lf>
0SU,R=11110000&11000000,I=15,S=Y,H=Y<cr><lf>
```

Example (SDI-12, device address 0):

```
0XSU!0XSU,R=11110000&11000000,I=15,S=Y,H=Y<cr><lf>
```

# Changing the Settings

You can change the following settings:

- parameters included in the supervisor data message,
- update interval,
- error messaging on/off, and
- heating control.

Make the desired setting with the following command. Select the correct value/letter for the setting fields, see Setting Fields on page 87. See the examples.

Command format in ASCII and NMEA 0183:

aSU,R=x,I=x,S=x,H=x<cr><lf>

Command format in SDI-12;

aXSU,R=x,I=x,S=x,H=x!

where

| | | |
|---|---|---|
| R, I, S, H | = | The supervisor setting fields, see Setting Fields on page 87. |
| x | = | Value for the setting |
| <cr><lf> | = | Command terminator in ASCII and NMEA 0183 |
| ! | = | Command terminator in SDI-12 |

Example (ASCII and NMEA 0183, device address 0):

Disabling the heating and error messaging:

```
0SU,S=N,H=N<cr><lf>
0SU,S=N,H=N<cr><lf>
```

Example (SDI-12, device address 0):

Changing the update interval to 10 seconds:

```
0XSU,I=10!0<cr><lf>
```

In SDI-12 mode a separate enquiry (0XSU!) must be given to check the data content.

# Composite Message

The parameters to be included in the composite message aR0 can be defined in the parameter selection fields of each parameter (aWU,R, and aSU,R). See parameter tables of wind sensor and supervisor message in the previous sections. See the following examples.

| **NOTE** | When changing the bits 9-16 of the parameter selection of the wind sensor or the supervisor message, the command can be shortened by replacing the bits 1-8 with a single '&' character, see the examples. |
|---|---|

Example (ASCII and NMEA 0183, device address 0):

Change the maximum wind direction (Dx) and speed (Sx) to average wind direction (Dm) and average wind speed (Sm):

```
0RU,R=&01001000<cr><lf>
0RU,R=11110000&01001000<cr><lf>
```

Remove the heating voltage (Vh) and temperature (Th) data from the composite message:

```
0SU,R=&00000000<cr><lf>
0SU,R=11110000&00000000<cr><lf>
```

CHAPTER 9
# MAINTENANCE

This chapter contains instructions for the basic maintenance of Ultrasonic Wind Sensor WMT50 and contact information for Vaisala Service Centers.

## Cleaning

To ensure the accuracy of measurement results, Ultrasonic Wind Sensor WMT50 needs to be cleaned when it gets contaminated. Leaves and other such particles need to be removed from the wind transducers and the sensor is recommended to be cleaned carefully with a soft, lint-free cloth moistened with mild detergent.

| | |
|---|---|
| **CAUTION** | Be extremely careful when cleaning the wind transducers. The transducers must not be rubbed nor twisted. |

# Factory Calibration and Repair Service

Send the device to Vaisala Instruments Service Centre for calibration and adjustment, see contact information below.

# Vaisala Service Centers

**NORTH AMERICAN SERVICE CENTER**
**Vaisala Inc.,** 10-D Gill Street, Woburn, MA 01801-1068, USA.
Phone: +1 781 933 4500, Fax: +1 781 933 8029
E-mail: us-customersupport@vaisala.com

**EUROPEAN SERVICE CENTER**
**Vaisala Instruments Service,** Vanha Nurmijärventie 21 FIN-01670 Vantaa, FINLAND.
Phone: +358 9 8949 2658, Fax: +358 9 8949 2295
E-mail: instruments.service@vaisala.com

**TOKYO SERVICE CENTER**
**Vaisala KK,** 42 Kagurazaka 6-Chome, Shinjuku-Ku, Tokyo 162-0825, JAPAN.
Phone: +81 3 3266 9617, Fax: +81 3 3266 9655
E-mail: aftersales.asia@vaisala.com

**BEIJING SERVICE CENTER**
**Vaisala China Ltd.,** Floor 2 EAS Building, No. 21 Xiao Yun Road, Dongsanhuan Beilu, Chaoyang District, Beijing, P.R. CHINA 100027.
Phone: +86 10 8526 1199, Fax: +86 10 8526 1155
E-mail: china.service@vaisala.com

**www.vaisala.com**

# Parts List for Consumables

**Table 8 Available Spare Parts**

| Spare Part | Order Code |
|---|---|
| 215194 | WXT/WMT Configuration Tool (software and service cable) |
| 215191 | 2-meter cable with 8-pin M12 female connector |
| 215193 | 10-meter cable with 8-pin M12 female connector |
| 217020 | 40-meter cable, open ends |
| 215190 | Bushing accessory kit |
| WXT510BOTTOMSP | WXT510 Bottom assembly (with M12 connector) |
| 212792 | Mounting Kit |

# CHAPTER 10
# TROUBLESHOOTING

This chapter describes common problems, their probable causes and remedies, and includes contact information for technical support.

**Table 9 Data Validation**

| Problem | Interpretation | Action |
|---|---|---|
| Wind measurement failure. Both the speed and direction units are replaced by a # sign or the data values are irrelevant. | Blockage (trash, leaves, branches, bird nests) between the wind transducers.<br>Check that the wind transducers are not damaged.<br>Incorrect <cr><lf> settings in the terminal program. | Remove the blockage.<br>Note! The direction unit is # for the wind speeds less than 0.05 m/s.<br><br>In ASCII and NMEA protocols both <cr> and <lf> are required after each command. Check that your terminal program sends both when pressing enter. |

### Table 10 Communication Problems

| Problem | Interpretation | Action |
|---|---|---|
| No response to any commands. | Wrong wiring or operation voltage not connected.<br>Baud rate/start bits/parity/stop bit settings do not match between the device and the host. | Check the wiring and operation voltage, see Chapter 5, Wiring, on page 33.<br>Connect the service cable, use the communication settings 19200,8 N,1. Check the serial port settings of the device with Configuration Tool or with terminal program. Use command aXU! (SDI-12) or aXU<cr><lf> (ASCII/NMEA). Change the values if needed. A software/ hardware reset is needed to validate the changes.<br>When you have no service cable, try typing address query commands ?! and ?<cr><lf> with different serial settings in terminal program. When the communication parameters match, the device responds with its address. The settings can now be changed using aXU! (SDI-12) or aXU<cr><lf> (ASCII/ NMEA) commands. A software/ hardware reset is needed to validate the changes. |
| | Incorrect <cr><lf> settings in the terminal program. | In ASCII and NMEA protocols both <cr> and <lf> are required after each command. Check that your terminal program sends both when pressing enter. |
| Connection works but data messages not available. | Wrong device address in a SDI-12 command or a mistyped SDI-12 command (in SDI-12 a mistyped command is in no way responded).<br>A command mistyped in ASCII/ NMEA mode while error messaging/text messages is disabled (aSU,S=N). | Request the device address with ?! command and then retype the command now with the correct address. Check the data query commands from Chapter 7, Getting the Data Messages, on page 51.<br>Enable the error messaging using the WXT/WMT Configuration Tool or any terminal by setting aSU,S=Y, then try the command again. |

**Table 10 Communication Problems (Continued)**

| Problem | Interpretation | Action |
|---|---|---|
| Data messages are not in expected format. | The communication protocol may not be the one you want. | Check the communication protocol of the device by using the WXT/WMT Configuration Tool or any terminal with command aXU,M! (SDI-12) aXU,M<cr><lf> (ASCII/NMEA) and change it if needed. See Chapter 6, Communication Settings, on page 43. |
| Some parameters are missing from the data messages. | The formatting of the data messages is not what you expect. | Format the data messages of the concern by using the WXT/WMT Configuration Tool or any terminal program. See Chapter 8, Sensor and Data Message Settings, on page 81. |
| An error message as a response to a command. | See section Error Messaging/ Text Messages on page 95. | See section Error Messaging/ Text Messages on page 95. |

# Self-Diagnostics

## Error Messaging/Text Messages

WMT50 sends a text message when certain type of errors occur. This function works in all communication modes except in the SDI-12 mode. You may disable error messaging by using the supervisor message aSU, S=N, see Changing the Settings on page 88.

Examples:

`0R1!`*`0TX,Unable to measure error<cr><lf>`* (request of wind data while all the wind parameters were disabled from the wind message)
`1XU!`*`0TX,Sync/address error<cr><lf>`* (Wrong device address. Ask the correct address with ? or ?! command.)
`0XP!`*`0TX,Unknown cmd error<cr><lf>`*
`0xUabc!`*`0TX,Use chksum CCb<cr><lf>`* (wrong checksum applied to the 0xU command)

### Table 11 Error Messaging/Text Messages Table

| Text message identifier (in NMEA 0183 v3.0 protocol only) | Text Message | Interpretation and action |
|---|---|---|
| 01 | Unable to measure error | The requested parameters are not activated in the message, see Chapter 8, Sensor and Data Message Settings, on page 81, and check the parameter selection fields. |
| 02 | Sync/address error | The device address in the beginning of the command is invalid. Ask the device address with the ?! (SDI-12) or ?<cr><lf> (ASCII and NMEA) command and retype the command with the correct address. |
| 03 | Unknown cmd error | The command is not supported, use the correct command format, see Chapter 7, Getting the Data Messages, on page 51. |
| 04 | Profile reset | Checksum error in configuration settings during power-up. Factory settings used instead. |
| 05 | Factory reset | Checksum error in calibration settings during power-up. Factory settings used instead. |
| 06 | Version reset | New software version in use. |
| 07 | Start-up | Software reset. Program starts from the beginning. |
| 08 | Use chksum xxx | Given checksum not correct for the command. Use the proposed checksum. |
| 09 | Measurement reset | The ongoing measurement of all the sensors interrupted and started from the beginning. |

See also Chapter 10, Troubleshooting, on page 93. In case of constant error, please contact Vaisala Service Center, see Vaisala Service Centers on page 92.

# Wind Sensor Heating Control

The supervisor message aSU (see Supervisor Message on page 86) shows you continuously monitored information about wind sensor heating (heating temperature Th and heating voltage Vh).

The heating temperature should stay above 0 °C when the heating is on (except in extremely cold conditions where the heating power is not sufficient). The heating voltage Vh should correspond to the heating voltage supplied. If there is a remarkable deviation, check the wiring. Note that wire gauge needs to be large enough to avoid remarkable voltage drop in the cable.

| | |
|---|---|
| **NOTE** | In case AC or full-wave rectified (f/w) AC is used for the heating, the Vh measurement behaves as follows:<br>While heating is off, Vh indicates the positive peak value (Vp) of the heating voltage waveform.<br>While heating is on, Vh indicates:<br>- 0.35 x Vp in case of AC voltage<br>- 0.70 x Vp in case of f/w rectified AC voltage |

# Operating Voltage Control

The supervisor message aSU (see Supervisor Message on page 86) shows you continuously monitored supply voltage level (Vs). In case of deviations between the supplied voltage and monitored voltage, check the wiring and the power supply.

# Technical Support

For technical questions, contact the Vaisala technical support:

E-mail helpdesk@vaisala.com

Fax +358 9 8949 2790

# CHAPTER 11
# TECHNICAL SPECIFICATIONS

This chapter provides the technical data of Ultrasonic Wind Sensor WMT50.

## Specifications

**Table 12 Performance**

| Property | Description/Value |
|---|---|
| Wind speed | |
| range | 0 ... 60 m/s |
| response time | 0.25 s |
| available variables | average, maximum, and minimum |
| accuracy | ±0.3 m/s or ±3 % whichever is greater for the measurement range of 0 ... 35 m/s<br>±5 % for the measurement range of 35 ... 60 m/s |
| output resolution | 0.1 m/s (km/h, mph, knots) |
| units available | m/s, km/h, mph, knots |
| Wind direction | |
| azimuth | 0 ... 360° |
| response time | 0.25 s |
| available variables | average, maximum, and minimum |
| accuracy | ±3.0° |
| output resolution | 1° |
| Measurement frame | |
| averaging time | 1 ... 3600 s (= 60 min), at 1 s steps, on the basis of samples taken at 4, 2 or 1 Hz rate (configurable) |
| update interval | 1 ... 3600 s (= 60 min), at 1 s steps |

### Table 13 Inputs and Outputs

| Property | Description/Value |
|---|---|
| Operation voltage | 5 ... 30 VDC[1] |
| Average power consumption<br>minimum<br>typical<br><br>maximum | <br>0.07 mA @ 12 VDC (SDI-12)<br>3 mA @ 12 VDC (with default measuring interval)<br>13 mA @ 30 VDC (constant measurement with shortest measuring interval) |
| Heating voltage<br>recommended ranges<br><br><br><br>absolute max<br><br> | Options: DC, AC, full-wave rectified AC<br>12 VDC ± 20 %, 1.1 A max<br>24 VDC ± 20 %, 0.6 A max<br>68 Vp-p ± 20 % (AC), 0.6 Arms max<br>34 Vp ± 20 % (f/w rect. AC), 0.6 Arms max<br>30 VDC<br>84 Vp-p (AC)<br>42 Vp (f/w rect. AC) |
| Serial data interfaces | SDI-12, RS-232, RS-485, RS-422 |
| Communication protocols | SDI-12 v1.3, ASCII automatic & polled, NMEA 0183 v3.0 with query option |

1. Below 5.3 V the measurement performance for high wind speeds may be degraded.

### Table 14 Operating Conditions

| Property | Description/Value |
|---|---|
| Housing protection class | IP65 |
| Temperature<br>operation<br>storage | <br>-52 ... +60 °C (-60 ... +140 °F)<br>-60 ... +70 °C (-76 ... +158 °F) |
| Relative humidity | 0 ... 100 %RH |
| Pressure | 600 ... 1100 hPa |
| Wind | 0 ... 60 m/s |
| Electromagnetic compatibility | EN61326: 1997 + Am 1:1998 + Am2:2001 Electrical equipment for measurement, control and laboratory use - EMC requirements; Generic environment |

### Table 15 Materials

| Property | Description/Value |
|---|---|
| Housing | Polycarbonate + 10 % glass fibre |
| Weight<br>WMT50<br>with mounting adapter | <br>510 g<br>595 g |

### Table 16 General

| Property | Description/Value |
|---|---|
| Self-diagnostic | Separate supervisor message, unit/status fields to validate measurement stability |
| Start-up | Automatic, <5 seconds from power on to the first valid output |

### Table 17 Options and Accessories

| Order code | Description |
|---|---|
| 215194 | WXT/WMT Configuration Tool (software and service cable) |
| 215191 | 2-meter cable with 8-pin M12 female connector |
| 215193 | 10-meter cable with 8-pin M12 female connector |
| 217020 | 40-meter cable, open ends |
| 215190 | Bushing accessory kit |
| WXT510BOTTOMSP | WXT510 Bottom assembly (with M12 connector) |
| 212792 | Mounting Kit |

# Dimensions

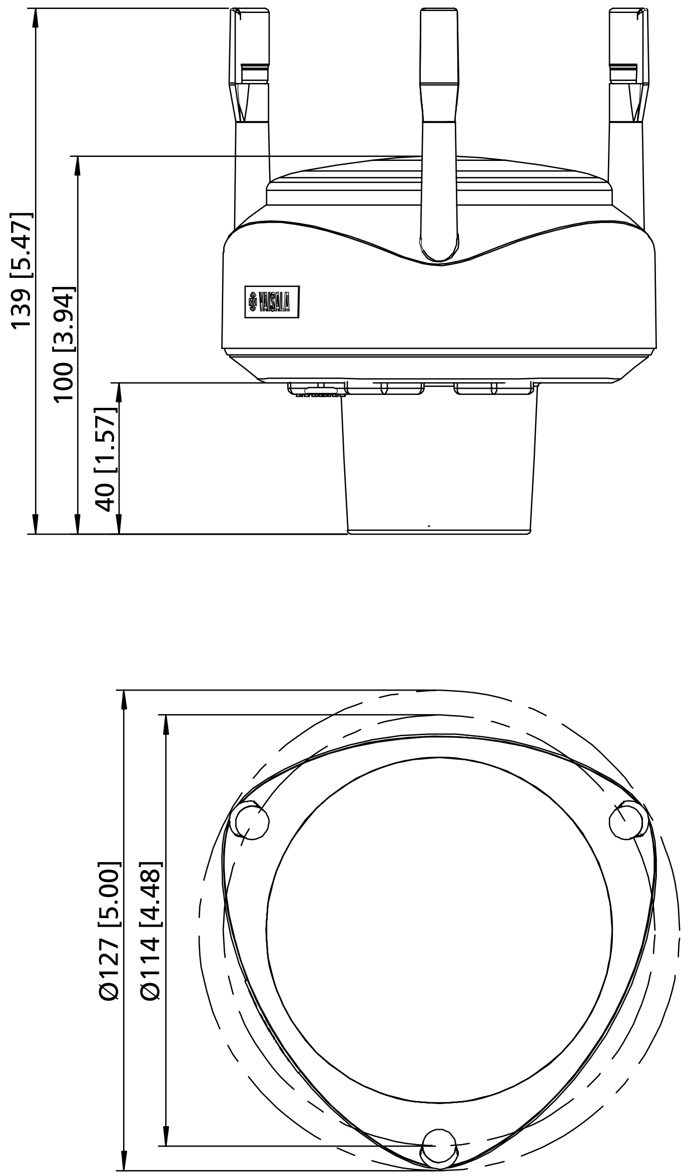



**Figure 18 WMT50 Dimensions in mm [inches]**

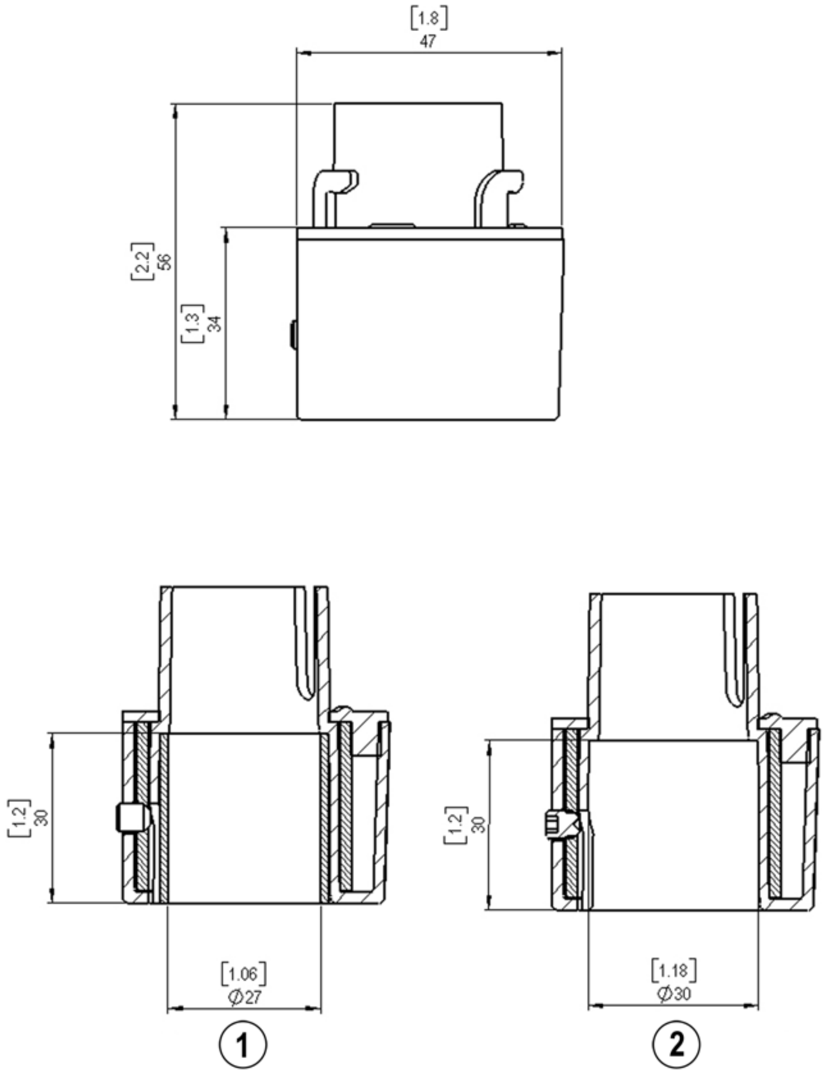



**Figure 19 Mounting Kit Dimensions in mm [inches]**

The following numbers refer to Figure 19 on page 92:

1 = Mounting kit with adapter sleeve for ø26.7 mm mast tube

2 = Mounting kit without adapter sleeve for ø30 mm mast tube

# APPENDIX A
# NETWORKING

## Connecting Several WMT50s on the Same Bus

Connecting several WMT50s on the same bus is possible in two ways:

1. Using SDI-12 serial interface and communication protocol
2. Using RS-485 serial interface and one of the following communication protocols: ASCII or NMEA 0183 v3.0

## SDI-12 Serial Interface

### Wiring

1. Make the SDI-12 wiring in the WMT50 as described in Chapter 5, Wiring, on page 33. Remember to combine the two "Data in/ out"wires of each WMT50 either in the internal screw terminal or outside the sensor.
2. In the data logger end, combine the "GND for data" wires of each WMT50 to the logger "GND for data" wire. Connect the "Data in/ out" wires of each WMT50 to the logger "Data" wire.

## Communication Protocol

Set the communication protocol SDI-12 v 1.3 (aXU,C=1,M=S) or SDI-12 v1.3 continuous (aXU,C=1,M=R).

The WMT50s on the bus need to be assigned with different addresses (for example: aXU,A=0,1,2, ... ). Thereafter the WMT50s on the bus do not respond to the commands not assigned to them nor to the data messages sent by the other WMT50s.

Example (a bus with three WMT50s):

WMT50 #1 communication settings:
0XXU,A=0,M=S,C=1,B=1200,D=7,P=E,S=1, L=25

WMT50 #2 communication settings:
1XXU,A=1,M=S,C=1,B=1200,D=7,P=E,S=1, L=25

WMT50 #3 communication settings:
2XXU,A=2,M=S,C=1,B=1200,D=7,P=E,S=1, L=25

If simultaneous measurements of the different units are needed, Start concurrent measurement commands aC or aCC need to be used for all devices. If the measurements are to be performed consecutively for only one unit at time, in addition to these also Start measurement commands aM and aMC can be used. Start continuous measurement commands aR1, aR5, aR, aRC1, aRC5 and aRC available only in SDI-12 continuous protocol (aXU,M=R) can be used eiher for simultaneous measurements of the units or consecutive measurements for one unit at a time. See also SDI-12 Protocol on page 60.

# RS-485 Serial Interface

## Wiring

1. Make the RS-485 wiring of the WMT50 as described in Chapter 5, Wiring, on page 33.
2. In the data logger end, combine the "Data+"wires of each WMT50 to the logger "Data +" wire. Connect the "Data-" wires of each WMT50 to the logger "Data -" wire.

# Communication Protocol

Set the communication protocol to ASCII polled (with or without CRC) or NMEA query. When using NMEA query, the wind message should be set to XDR (aWU,N=T).

| | |
|---|---|
| **NOTE** | No matter which communication protocol is chosen, ASCII polled or NMEA query, the error messaging parameter of the supervisor message must be deactivated with aSU,S=N for each WMT50 on the bus in order to prevent the units pesponding to the commands not assigned to them. |

# ASCII, Polled

Example (a bus with three WMT50s):

WMT50 #1 communication settings:
0XU,A=0,M=P,C=3,I=0,B=19200,D=8,P=N,S=1,L=25

WMT50 #2 communication settings:
1XU,A=1,M=P,C=3,I=0,B=19200,D=8,P=N,S=1,L=25

WMT50 #3 communication settings:
2XU,A=2,M=P,C=3,I=0,B=19200,D=8,P=N,S=1,L=25

Example (Composite message queries to the sensors 1 and 3 are assigned as follows):

0R0<crlf>

1R0<crlf>

2R0<crlf>

# NMEA 0183 v3.0, Query

The NMEA 0183 query messages do not contain device address information. Individual query commands can thus not be directed to different sensors. Instead, a specific Time Slot method can be used for receiving data from several sensors on the bus, just with a single query command.

To generate different time slots, each WMT50 is given an individual delay for its query response, by using the RS-485 line delay parameter aXU,L. This parameter defines the time (in milliseconds) between the last character of the query and the first character of the response from the WMT50.

Example (a bus with three WMT50s):

WMT50 #1 communication settings:
0XU,A=0,M=Q,C=3,I=0,B=4800,D=8,P=N,S=1,L=25

WMT50 #2 communication settings:
0XU,A=0,M=Q,C=3,I=0,B=4800,D=8,P=N,S=1,L=1000

WMT50 #3 communication settings:
0XU,A=0,M=Q,C=3,I=0,B=4800,D=8,P=N,S=1,L=2000

Now, when the XDR-query command $--WIQ,XDR*2D<crlf> is sent, the WMT50 #1 responds after 25 ms, the WMT50 #2 after 1000 ms and the WMT50 #3 responds after 2000 ms. The sufficient delays depend on the maximum number of characters in the response messages and the baud rate. Note that all the sensors are assigned with the same address. Hence the data logger, after sending the query, needs to sort out the response messages on the basis of the individual response times.

To gain even more addressability transducer ID information provided in the XDR response message can also be used. If the WMT50 address is set to 0 (aXU,A=0), the response to the XDR-query $--WIQ,XDR*2D<crlf> will be like:

For the transducer IDs, see NMEA 0183 V3.0 Protocol on page 70.

```
$WIXDR,A,316,D,0,A,326,D,1,A,330,D,2,S,0.1,M,0,S,0.1,M,
1,S,0.1,M,2*57<crlf>
$WIXDR,C,25.8,C,2,U,10.7,N,0,U,10.9,V,1,U,3.360,V,2*7D
<crlf>
```

The maximum transducer ID is three when the WMT50 address is 0. Hence, assigning address 4 for the second and address 8 for the third WMT50 on the bus the following responses to the XDR-query $--WIQ,XDR*2D<crlf> will be obtained from these sensors(same message parameter configuration):

The second sensor (address 4):

```
$WIXDR,A,330,D,4,A,331,D,5,A,333,D,6,S,0.1,M,4,S,0.1,M,
5,S,0.2,M,6*55<crlf>
$WIXDR,C,25.8,C,6,U,10.6,N,4,U,10.9,V,5,U,3.362,V,
6*78<crlf>
```

The third sensor (address 8):

```
$WIXDR,A,341,D,8,A,347,D,9,A,357,D,10,S,0.1,M,8,S,0.2,M,
9,S,0.2,M,10*53<crlf>
$WIXDR,C,25.8,C,10,U,10.6,N,8,U,10.9,V,9,U,3.360,V,
10*7C<crlf>
```

Now the response messages of all three sensors can be recognized and parsed by the data logger.

| NOTE | WMT50 address may consist of letter characters but the transducer IDs in the NMEA XDR messages can only be numbers. The addresses given in letters will show in the transducer IDs in the following way: WMT50 address = A => transducer ID = 10, B => 11, a => 36, b => 37 etc. |
|---|---|

# NMEA 0183 v3.0 Query with ASCII Query Commands

You can use ASCII query commands aR1, aR5, aR, aR0 and their CRC-versions ar1, ar5, ar and ar0 also in NMEA 0183 protocol. The responses to these commands will be in standard NMEA 0183 format. The sensors need to be assigned with different addresses (for example: aXU,A=0,1,2, ... ). The RS-485 line delays are not needed.

Example, a bus with three WMT50s. Data requests with combined data message query commands; the same message parameter configuration as in the previous example:

WMT50 #1 communication settings:
0XU,A=0,M=Q,C=3,I=0,B=4800,D=8,P=N,S=1,L=25

WMT50 #2 communication settings:
0XU,A=1,M=Q,C=3,I=0,B=4800,D=8,P=N,S=1,L=25

WMT50 #3 communication settings:
0XU,A=2,M=Q,C=3,I=0,B=4800,D=8,P=N,S=1,L=25

The query for WMT50 #1 and the response:

```
0R<cr><lf>
$WIXDR,A,316,D,0,A,326,D,1,A,330,D,2,S,0.1,M,0,S,0.1,M,
1,S,0.1,M,2*57<crlf>
$WIXDR,C,25.8,C,2,U,10.7,N,0,U,10.9,V,1,U,3.360,V,2*7D
<crlf>
```

The query for WMT50 #2 and the response:

```
1R<cr><lf>
$WIXDR,A,330,D,1,A,331,D,2,A,333,D,3,S,0.1,M,1,S,0.1,M,
2,S,0.2,M,3*55<crlf>
$WIXDR,C,25.8,C,3,U,10.6,N,1,U,10.9,V,1,U,3.362,V,2*78
<crlf>
```

The query for WMT50 #3 and the response:

```
2R<cr><lf>
$WIXDR,A,341,D,2,A,347,D,3,A,357,D,4,S,0.1,M,2,S,0.2,M,
3,S,0.2,M,4*53<crlf>
$WIXDR,C,25.8,C,4,U,10.6,N,2,U,10.9,V,2,U,3.360,V,3*7C
<crlf>
```

If needed, for making the transducer IDs distinguishable, device addresses 0, 4, 8 can be used as described in the previous section.

APPENDIX B
# SDI-12 PROTOCOL

SDI-12 is a standard for interfacing data recorders with microprocessor-based sensors. The name stands for serial/digital interface at 1200 baud. More information of the complete SDI-12 standard text is available from the SDI-12 web-site in the following address: www.sdi-12.org.

## SDI-12 Electrical Interface

The SDI-12 electrical interface uses the SDI-12 bus to transmit serial data between SDI-12 data recorders and sensors. The SDI-12 bus is the cable that connects multiple SDI-12 devices. This is a cable with three conductors:

- Serial data line
- Ground line
- 12-volt line

The SDI-12 bus can have at least 10 sensors connected to it. The bus topology is a parallel connection, where each of the three wires of different sensors are connected in parallel.

## SDI-12 Communications Protocol

SDI-12 data recorders and sensors communicate by an exchange of ASCII characters on the data line. The data recorder sends a break to wake up the sensors on the data line. A break is continuous spacing on the data line for at least 12 milliseconds. The data recorder then sends a command. The sensor, in turn, returns the appropriate response. Each command is for a specific sensor. The first character of each command is a unique sensor address that specifies with which sensor the recorder wants to communicate. Other sensors on the SDI-12 bus ignore the command and return to low-power standby mode. When a data recorder tells a sensor to start its measurement procedure, the recorder does not communicate with any other sensor until the data collection from the first sensor is complete.

A typical recorder/sensor measurement sequence proceeds in the following order:

1. The data recorder wakes all sensors on the SDI-12 bus with a break.
2. The recorder transmits a command to a specific, addressed sensor, instructing it to make a measurement.
3. The addressed sensor responds within 15.0 milliseconds returning the maximum time until the measurement data will be ready and the number of data values it will return.
4. If the measurement is immediately available, the recorder transmits a command to the sensor instructing it to return the measurement(s). If the measurement is not ready, the data recorder waits for the sensor to send a request to the recorder, which indicates that the data is ready. The recorder then transmits a command to get the data.
5. The sensor responds, returning one or more measurements.

# SDI-12 Timing

Figure on page shows a timing diagram for a SDI-12 command and its response. The tolerance for all SDI-12 timing is ±0.40 milliseconds. The only exception to this is the time between the stop bit of one character and the start bit of the next character. The maximum time for this is 1.66 milliseconds, with no tolerance.

- A data recorder transmits a break by setting the data line to spacing for at least 12 milliseconds.
- The sensor will not recognize a break condition for a continuous spacing time of less than 6.5 milliseconds. The sensor will always recognize a break when the line is continuously spacing for more than 12 milliseconds.

- When receiving a break, a sensor must detect 8.33 milliseconds of marking on the data line before it looks for an address.
- A sensor must wake up from a low-power standby mode and be capable of detecting a start bit from a valid command within 100 milliseconds after detecting a break.
- -After a data recorder transmits the last character of a command, it must relinquish control of the data line within 7.5 milliseconds.

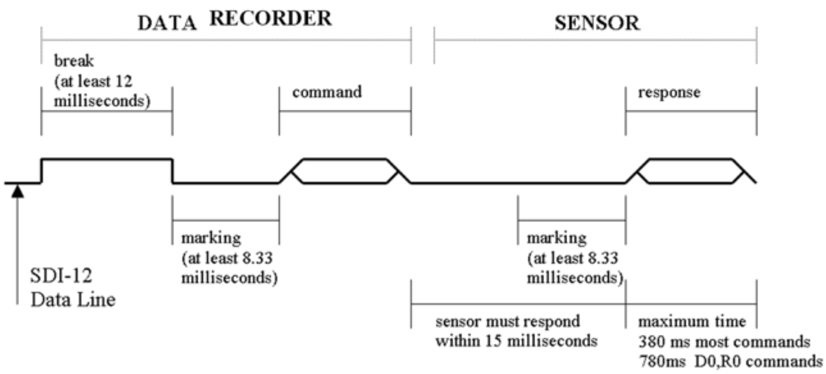



**Figure 20 Timing Diagram**

- After receiving the break and the command, the addressed sensor sets the data line to marking at 8.33 milliseconds and then sends the response (tolerance: -0.40 milliseconds.) The start bit of the first response byte must start within 15 milliseconds after the stop bit of the last byte of the command (tolerance: +0.40 milliseconds).
- After a sensor transmits the last character of a response, it must relinquish control of the data line within 7.5 milliseconds (tolerance: +0.40 milliseconds.)
- No more than 1.66 milliseconds of marking are allowed between the end of the stop bit and the start bit (for example between characters) on any characters in the command or the response (no tolerance.) This permits a response to an M command to be sent within a 380-millisecond window.

- Sensors must return to a low-power standby mode after receiving an invalid address or after detecting a marking state on the data line for 100 milliseconds (tolerance: +0.40 milliseconds).
- When a recorder addresses a different sensor, or if the data line has been in the marking state for more than 87 milliseconds, the next command must be preceded by a break.

| | |
|---|---|
| **NOTE** | The low-power standby mode, in addition to being a low-power consumption state, is a protocol state and a break is required to leave that state. |

# APPENDIX C
# CRC-16 COMPUTATION

The computation of the CRC is performed on the data response before parity is added. All operations are assumed to be on 16 bit unsigned integers. The least significant bit is on the right. Numbers preceded by 0x are in hexadecimal. All shifts shift in a zero. The algorithm is:

```
Initialize the CRC to zero. For each character beginning
with the address, up to but not including the carriage
return (<cr>), do as follows:

{Set the CRC equal to the exclusive OR of the character
and itself
for count =1 to 8
{
if the least significant bit of the CRC is one
{
right shift the CRC one bit
set CRC equal to the exclusive OR of 0xA001 and itself
}
else
{
right shift the CRC one bit
}
}
}
```

# Encoding the CRC as ASCII Characters

The 16 bit CRC is encoded to three ASCII characters by using the following algorithm:

1st character = 0x40 OR (CRC shifted right 12 bits)

2nd character = 0x40 OR ((CRC shifted right 6 bits) AND 0x3F)

3rd character = 0x40 OR (CRC AND 0x3F)

The three ASCII characters are placed between the data and <cr><lf>. Parity is applied to all three characters, if selected for the character frame.

The CRC computation code is added to the end of the response, if the first letter of the command is sent by using lower case.

# NMEA 0183 v3.0 Checksum Computation

The checksum is the last field in the NMEA sentence and follows the checksum delimiter character "*". It is the 8-bit exclusive OR of all characters in the sentence, including "," and "^" delimiters, between but not including the "$" or "!" and the "*" delimiters. The hexadecimal value of the most significant and least significant four bits of the result is converted to two ASCII characters (0-9,A-F) for transmission. The most significant character is transmitted first.

APPENDIX D

# WIND MEASUREMENT AVERAGING METHOD

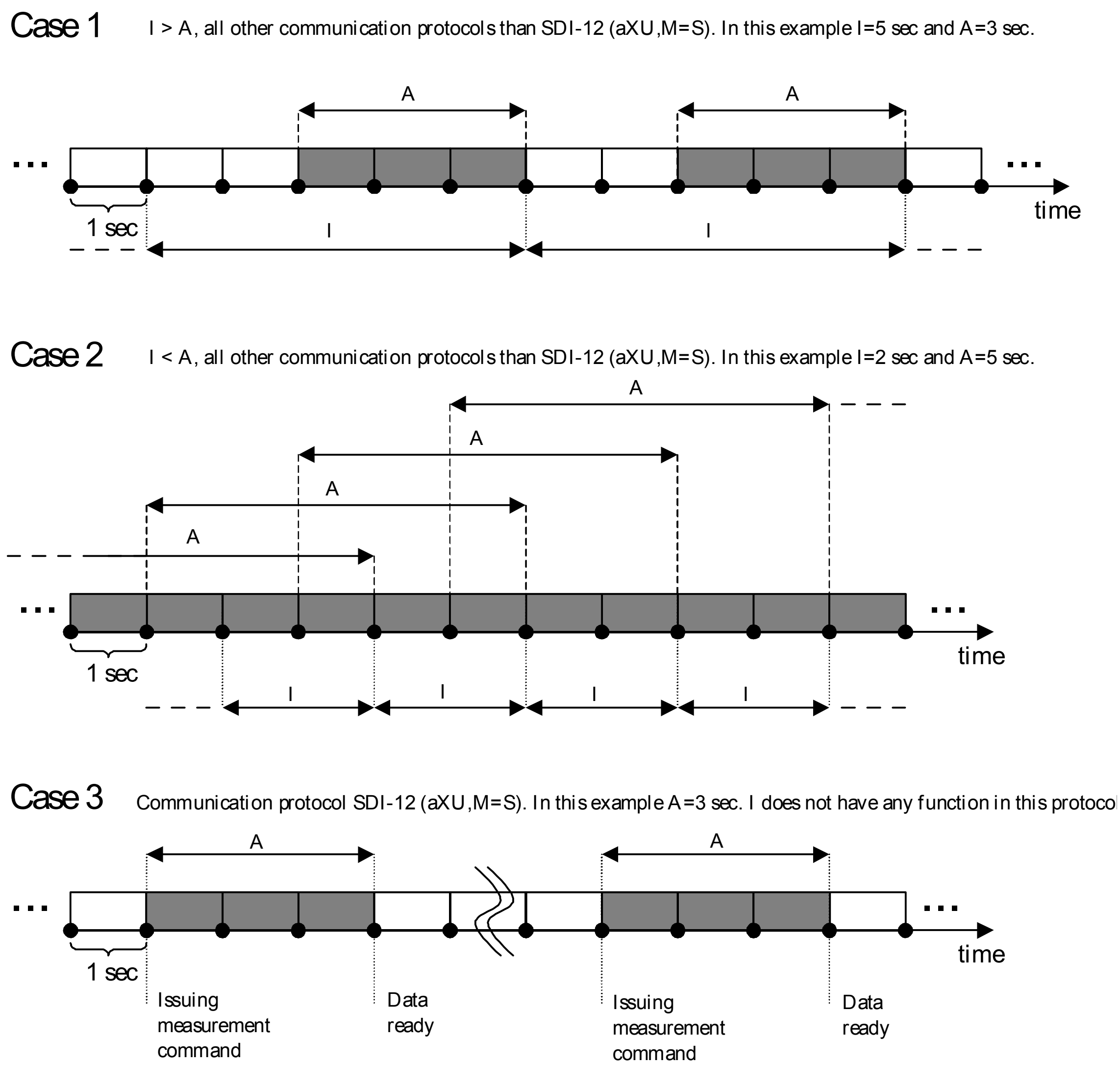



**Figure 21 Wind Measurement Averaging Method**

The three cases in Figure 21 on page 117 represent the wind measurement averaging for different selections of communication protocol, wind measurement update interval (I) and averaging time (A). Scalar averaging is used for both wind speed and direction. For direction, zero degree crossing, when present, is taken correctly into account in averaging.

| | |
|---|---|
| **NOTE** | Grey boxes indicate that the measurement is in progress during the corresponding second.<br>Update (= internal calculation) is always made in the end of the update interval.<br>In the auto sending protocols (ASCII automatic (+ CRC) and NMEA automatic) outputting the data messages is synchronized to take place immediately after the update.<br>In ASCII polled (+ CRC), NMEA query and SDI-12 continuous measurement protocols trying to request data before the update interval is completed will result in getting the data from the previous completed update interval.<br>Wind measurement sampling rate (4, 2, or 1 Hz) does not have any effect on the averaging scheme. It determines from how many samples the one second values seen in the figures are calculated. |

www.vaisala.com