

USER'S GUIDE



Vaisala Weather Transmitter WXT510



PUBLISHED BY

| | | |
|--------------------|---------------|------------------|
| Vaisala Oyj | Phone (int.): | +358 9 8949 1 |
| P.O. Box 26 | Fax: | +358 9 8949 2227 |
| FIN-00421 Helsinki | | |
| Finland | | |

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CHAPTER 1

GENERAL INFORMATION

This chapter provides general notes for the product.

About This Manual

This manual provides information for installing, operating, and maintaining Vaisala Weather Transmitter WXT510.

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 Weather Transmitter WXT510.
- Chapter 3, Functional Description: This chapter describes the measurement principles and heating function of Weather Transmitter WXT510.
- Chapter 4, Installation: This chapter provides you with information that is intended to help you install Weather Transmitter WXT510.
- Chapter 5, Wiring and Power Management: This chapter provides you with instructions on how to connect the power supply and the serial interfaces.

- Chapter 6, Communication Settings: This chapter contains the 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 Weather Transmitter WXT510 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 Weather Transmitter WXT510.

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[®], RAINCAP[®], HUMICAP[®], BAROCAP[®] and THERMOCAP[®] are registered trademarks of Vaisala. Microsoft[®], Windows[®], Windows NT[®], and Windows XP[®] 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 Weather Transmitter WXT510.

Weather Transmitter WXT510



Figure 1 Vaisala Weather Transmitter WXT510

Weather Transmitter WXT510 is a small and lightweight transmitter that offers six weather parameters in one compact package. WXT510 measures wind speed and direction, precipitation, atmospheric pressure, temperature and relative humidity.

WXT510 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 for the precipitation and wind sensors
- Windows[®] based Vaisala 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 Vaisala Configuration Tool is a user friendly parameter setting software for WXT510. With this software tool you can change the device and sensor settings easily in Windows[®] environment. See list of options and accessories in [Table 20 on page 127](#).

Heating Function

To improve the accuracy of measurements an optional heating for the wind and precipitation sensors is available. More about heating in section [Heating \(Optional\) on page 24](#).

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

WXT510 Transmitter Components

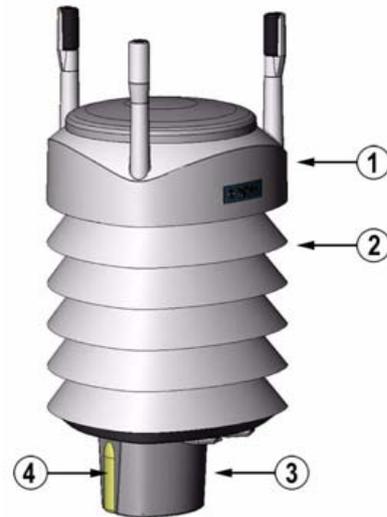


Figure 2 Main Components of Weather Transmitter WXT510

The following numbers refer to [Figure 2 on page 17](#):

- 1 = Top of the transmitter
- 2 = Radiation shield
- 3 = Bottom of the transmitter
- 4 = Screw cover

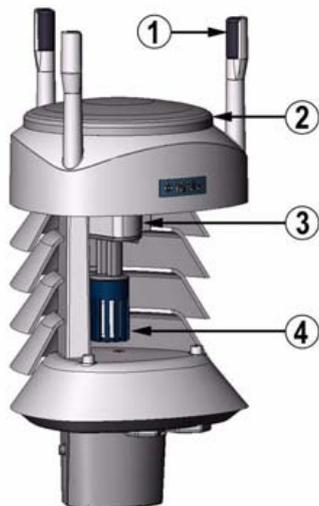


Figure 3 Cut Away View

The following numbers refer to [Figure 3 on page 18](#):

- 1 = Wind transducers (3 pcs)
- 2 = Precipitation sensor
- 3 = Pressure sensor inside the PTU module
- 4 = Humidity and temperature sensors inside the PTU module

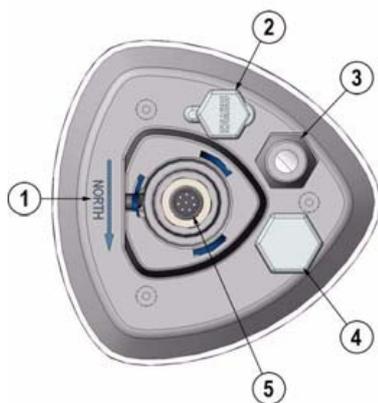


Figure 4 Bottom of Transmitter

The following numbers refer to [Figure 4 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 5 **Mounting Kit (Optional)**



Figure 6 **Service Cable (Optional)**

The following numbers refer to [Figure 6 on page 19](#):

- 1 = Battery connector
- 2 = D9-connector for PC serial port
- 3 = Connector for WXT510 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 transmitter bottom with hexagonal rubber plugs included in the delivery.

CHAPTER 3

FUNCTIONAL DESCRIPTION

This chapter describes the measurement principles and heating function of Weather Transmitter WXT510.

Wind Measurement Principle

WXT510 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 WXT510 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 all samples over the selected averaging time (1 ... 900 s). 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 145 for averaging method.

Precipitation Measurement Principle

WXT510 uses Vaisala RAINCAP[®] Sensor 2-technology in precipitation measurement.

The precipitation sensor comprises of a steel cover and a piezoelectrical sensor mounted on the bottom surface of the cover.

The precipitation sensor detects the impact of individual raindrops. The signals from the impact are proportional to the volume of the drops. Hence, the signal of each drop can be converted directly to accumulated rainfall. Advanced noise filtering technique is used to filter out signals originating from other sources than raindrops.

The measured parameters are accumulated rainfall, rain current and peak intensity, and the duration of a rain event. Detection of each individual drop enables computing of rain amount and intensity with high resolution. Precipitation current intensity internally updated every 10 seconds represents the intensity during the one minute period before requesting/automatic precipitation message sending (for fast reacting to a rain event, during the first minute of the rain event the intensity is calculated over the period rain has lasted in 10-second steps instead of fixed one minute). Precipitation peak intensity represents the maximum of the calculated current intensity values since last precipitation intensity reset.

The sensor is also capable of distinguishing hails from raindrops. The measured hail parameters are cumulative amount of hails, current and peak hail intensity and the duration of a hail shower.

The precipitation sensor operates in the following four modes:

- Precipitation Start/End mode:

Transmitter sends automatically a precipitation message 10 seconds after the recognition of the first drop. The messages are sent continuously as the precipitation proceeds and stopped when the precipitation ends.

- Tipping bucket mode:

This mode emulates tipping bucket type precipitation sensors. Transmitter sends automatically a precipitation message when the counter detects one unit increment (0.1 mm/0.01 in).

- Time mode:
Transmitter sends automatically a precipitation message in the update intervals defined by the user.
- Polled mode:
Transmitter sends a precipitation message whenever requested by the user.

More information about the precipitation sensor operation modes can be found in section [Precipitation Sensor on page 103](#).

PTU Measurement Principle

The PTU module contains separate sensors for pressure, temperature, and humidity measurement.

The measurement principle of the pressure, temperature, and humidity sensors is based on an advanced RC oscillator and two reference capacitors against which the capacitance of the sensors is continuously measured. The microprocessor of the transmitter performs compensation for the temperature dependency of the pressure and humidity sensors.

The PTU module includes

- capacitive silicon BAROCAP[®] sensor for pressure measurement,
- capacitive ceramic THERMOCAP[®] sensor for air temperature measurement, and
- capacitive thin film polymer HUMICAP[®]180 sensor for humidity measurement.

Heating (Optional)

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

Three fixed temperature limits, namely +4 °C, 0 °C, and -4 °C (+39 °F, +32 °F, +25 °F) control the heating power as follows:

$T_h > +4\text{ °C}$: heating is off,

$0\text{ °C} < T_h < +4\text{ °C}$: 50 % heating power,

$-4\text{ °C} < T_h < 0\text{ °C}$: 100 % heating power,

$T_h < -4\text{ °C}$: 50 % heating power.

When the heating function is disabled the heating is off in all conditions, see [Supervisor Message on page 108](#).

CHAPTER 4

INSTALLATION

This chapter provides you with information that is intended to help you install Weather Transmitter WXT510.

Unpacking Instructions

Weather Transmitter WXT510 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, re-aligning can be difficult or impossible.

Selecting Location

Finding a suitable site for Weather Transmitter WXT510 is important for getting representative ambient measurements. The site should represent the general area of interest.

Weather Transmitter WXT510 should 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 should be installed with the tip at least one meter above WXT510. The rod must be properly grounded, compliant with all applicable local safety regulations.

Assembling WXT510

1. Loosen the three fixing screws at the sensor bottom assembly.
2. Turn out the top of the transmitter.
3. Remove the vacuum bag protecting the PTU module. Connect the new PTU module. Make sure the module goes all the way in and is locked into its position with the small white latch (see section A in [Figure 7 on page 28](#)).
4. Avoid contacting the white filter cap with your hands while inserting the PTU module.
5. Replace the top and tighten the three fixing screws that fasten the top and the bottom. When turning the top back in, make sure that the flat cable does not get stuck or squeezed between the top and the funnel for the flat cable.

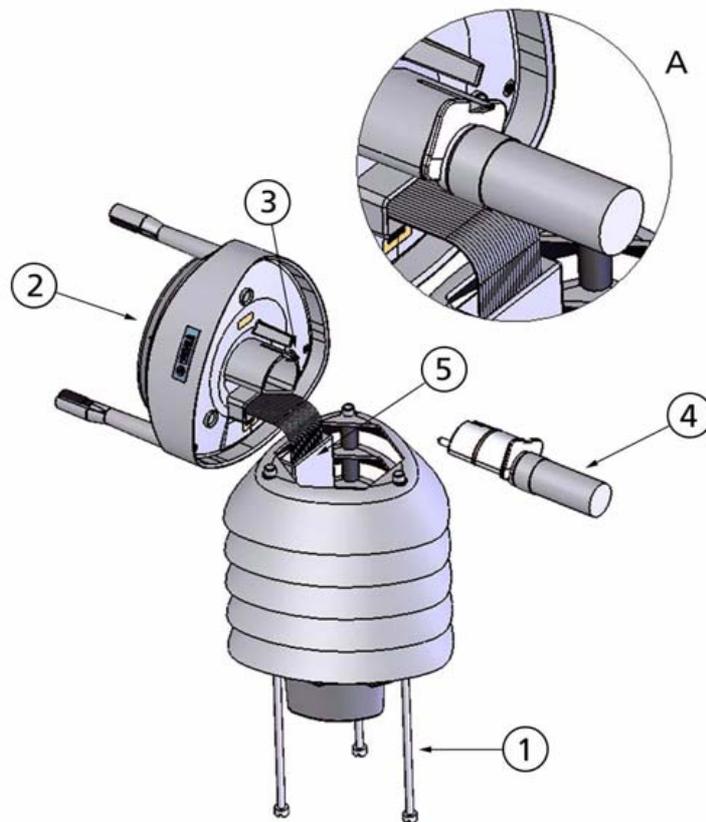


Figure 7 Assembling WXT510

Installation Procedure

At the measurement site, WXT510 needs to be mounted, aligned, and connected to the data logger and the power source.

Mounting

Weather Transmitter WXT510 can be mounted either onto a vertical pole mast or onto a horizontal cross arm. When mounting WXT510 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

Weather Transmitter WXT510 must be installed to an upright, vertical position.

Mounting to Vertical Pole Mast

1. Remove the screw cover and insert WXT510 to the pole mast.
2. Align the transmitter in such a way that the arrow points to north.
3. Tighten the fixing screw (provided) and replace the screw cover.

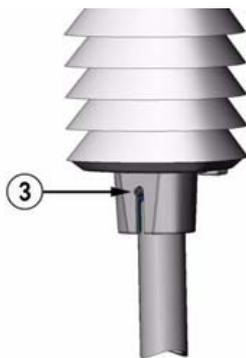


Figure 8 Location of Fixing Screw

Mounting with Mounting Kit (Optional)

1. Insert the mounting kit adapter to the transmitter 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 transmitter 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 9 **Mounting WXT510 to Pole Mast Using Optional Mounting Kit**

The following numbers refer to [Figure 9 on page 30](#):

- 1 = Mounting kit
- 2 = Fixing screw

NOTE

When removing WXT510 from the pole just turn the transmitter 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 WXT510 on page 32](#). In case the cross arm cannot be aligned, make the wind direction correction as instructed in section [Wind Direction Correction on page 34](#).
3. Mount the transmitter into the cross arm by using the fixing screw (M6 DIN933) and a nut, see [Figure 9 on page 30](#) and [Figure 10 on page 31](#).

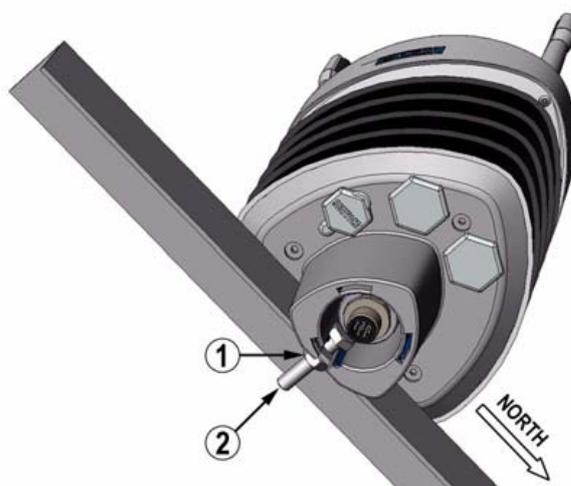


Figure 10 Mounting WXT510 to Cross Arm (L-Profile)

The following numbers refer to [Figure 10 on page 31](#):

- 1 = Nut
- 2 = Fixing screw (M6 DIN933)

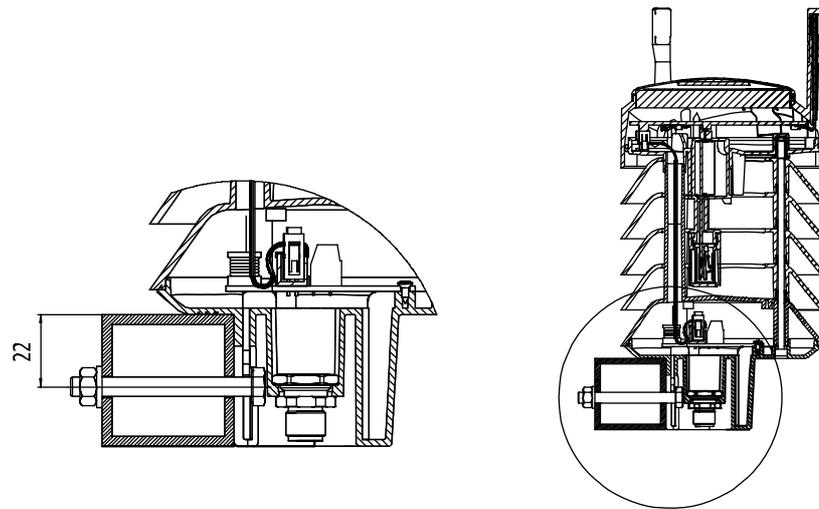


Figure 11 Mounting Screw Location in Cross Arm

Aligning WXT510

To help the alignment, there is an arrow and the text "North" on the bottom of the transmitter. WXT510 should 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 should be current as the declination changes over time.

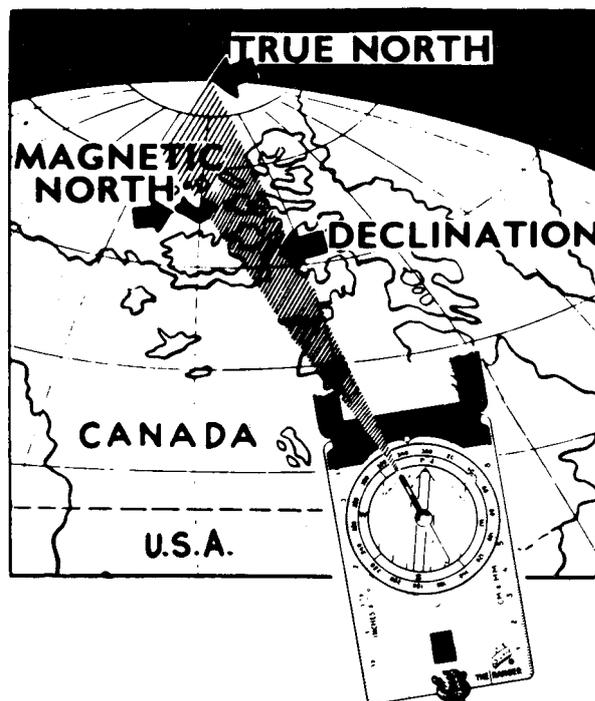


Figure 12 Sketch of Magnetic Declination

Compass Alignment

To align Weather Transmitter WXT510, proceed as follows:

1. If WXT510 is already mounted, loosen the fixing screw on the bottom of the transmitter so that you can rotate the device.
2. Use a compass to determine that the transducer heads of WXT510 are exactly in line with the compass and that the arrow on the bottom of WXT510 points to the north.
3. Tighten the fixing screw on the bottom of the transmitter when the bottom arrow is exactly aligned to north.

Wind Direction Correction

Make a wind direction correction in case WXT510 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 should be given to WXT510.

1. Mount the transmitter to a desired position, see section [Mounting on page 29](#).
2. Define the deviation angle from the north-zero-alignment. Use the \pm 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 93](#).
4. From now on, WXT510 transmits the wind direction data by using the changed zero-alignment.

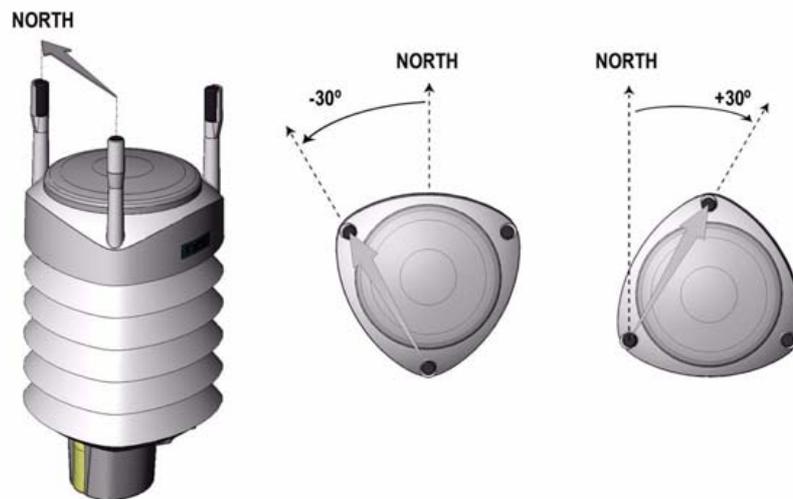


Figure 13 Wind Direction Correction

CHAPTER 5

WIRING AND POWER MANAGEMENT

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

WXT510 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 transmitter bottom) with the hexagonal rubber plugs included in the accessories.

Power Supplies

Operating voltage V_{in+} : 5 ... 30 VDC

Notice that for the average current consumption, see the graphs in [Figure 14 on page 36](#). The minimum consumption graph is for SDI-12 standby mode.

The input power supply shall 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 93](#)). 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 [Figure 14 on page 36](#)).

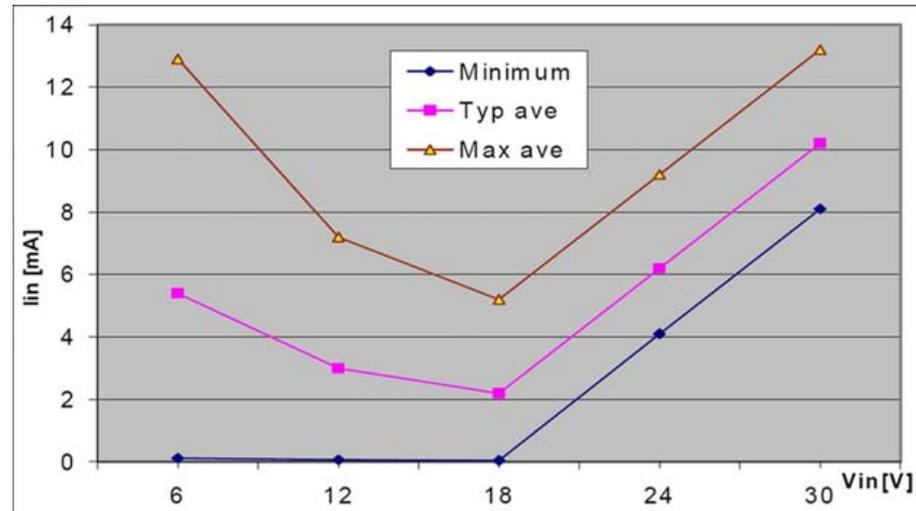


Figure 14 Average Operational Current Consumption (with 4Hz Wind Sensor Sampling)

Heating voltage V_{h+} (one of the following three alternatives):

- 5 ... 30 VDC;
- AC, max $V_{\text{peak-to-peak}}$ 84 V (= 30 V_{RMS}); or
- Full-wave rectified AC, max V_{peak} 42 V (= 30 V_{RMS}).

The recommended DC voltage ranges are as follows:

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

At approximately 16 V heating voltage level WXT510 automatically changes the heating element combination in order to consume equal power with 12 VDC and 24 VDC supplies. Input resistance (R_{in}) is radically increased with voltages above 16 V (see the following graph).

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

- 68 $V_{\text{p-p}}$ \pm 20 % (max 0.6 A), for AC;
- 34 V_{p} \pm 20 % (max 0.6 A), for f/w rectified AC.

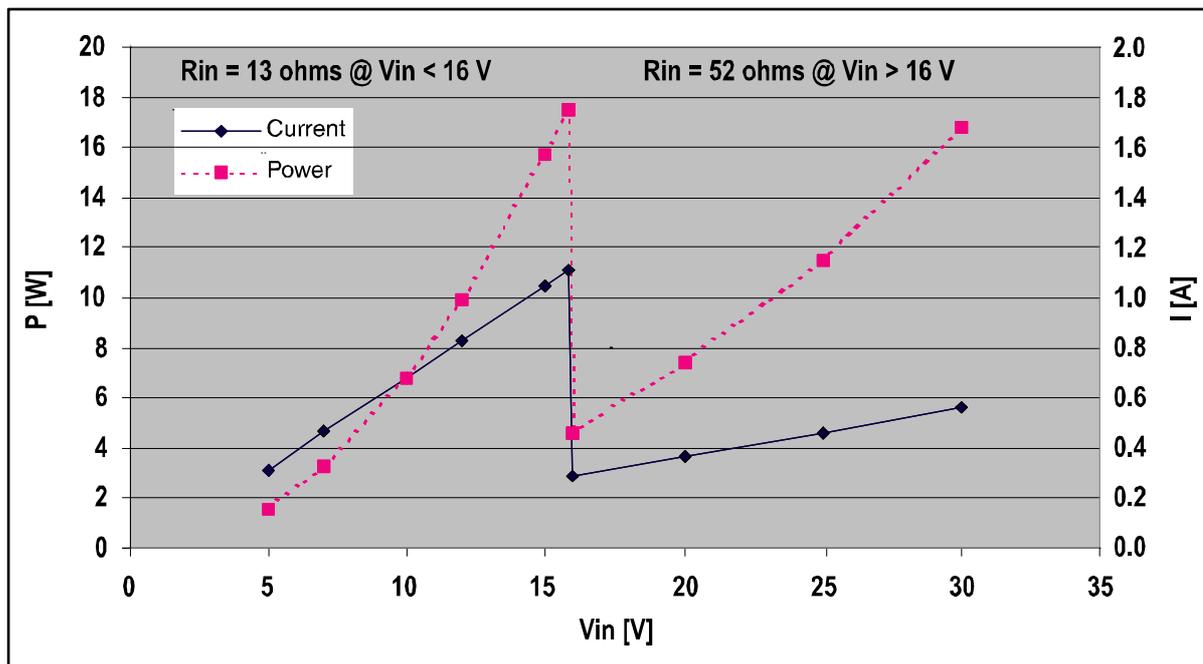


Figure 15 Heating Current and Power vs Vh

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 WXT510.
2. Pull out the bottom part of the transmitter.
3. Insert the power supply wires and signal wires through the cable gland(s) in the bottom of the transmitter.
4. Connect the wires according to [Table 1 on page 38](#).
5. Replace the bottom part and tighten the three screws.

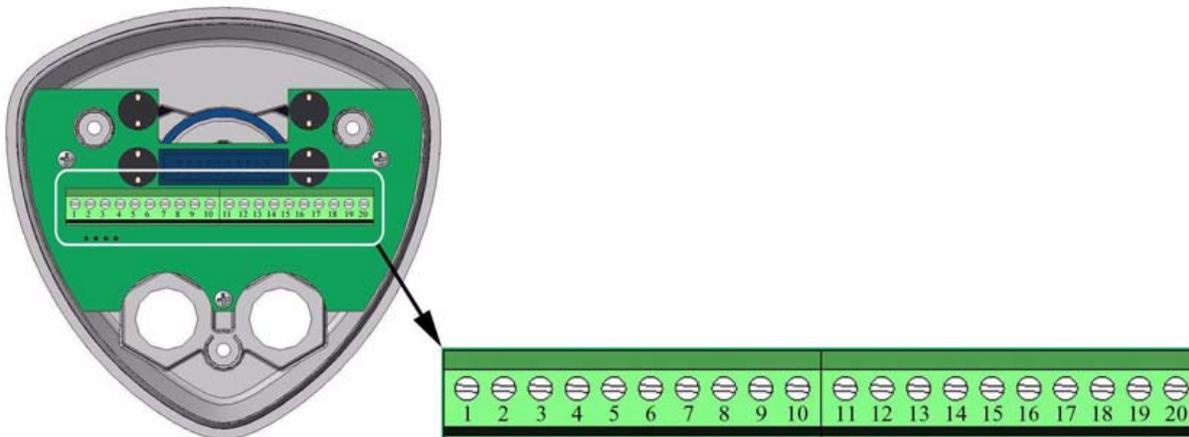


Figure 16 Screw Terminal Block

Table 1 Screw Terminal Pin-outs for WXT510 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 WXT510.

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 should 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 WXT510 is provided with the optional 8-pin M12 connector, the connector is located on the bottom of the transmitter, see [Figure 4 on page 18](#). The pins of the 8-pin M12 connector as seen from outside the transmitter are illustrated in the following figure.

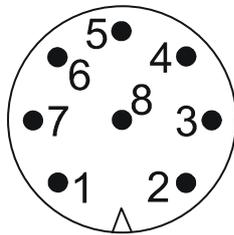


Figure 17 8-Pin M12 Connector Pins

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 the table below.

Table 2 Pin-outs for WXT510 Serial Interfaces and Power Supplies

| Wire Color | M12 Pin# | /----- Default wiring -----\ | | | RS-422 wiring |
|------------------------|----------|------------------------------|------------------|------------------|------------------|
| | | 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 WXT510.

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.

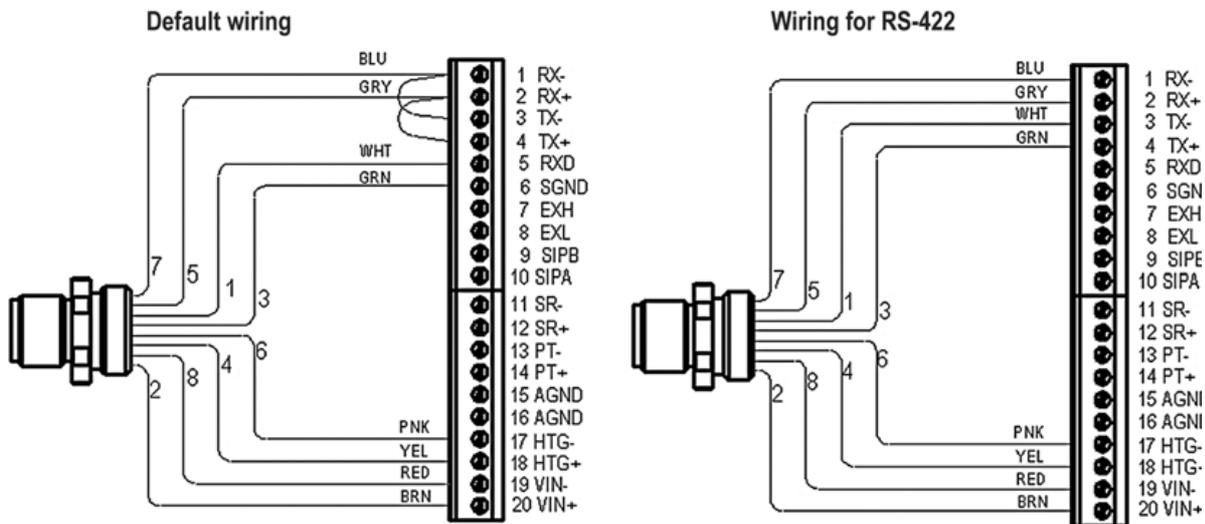


Figure 18 Internal Wiring

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 39](#)).

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 WXT510). 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 WXT510. 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 45](#) and [Figure 4 on page 18](#)).

Data Communication Interfaces

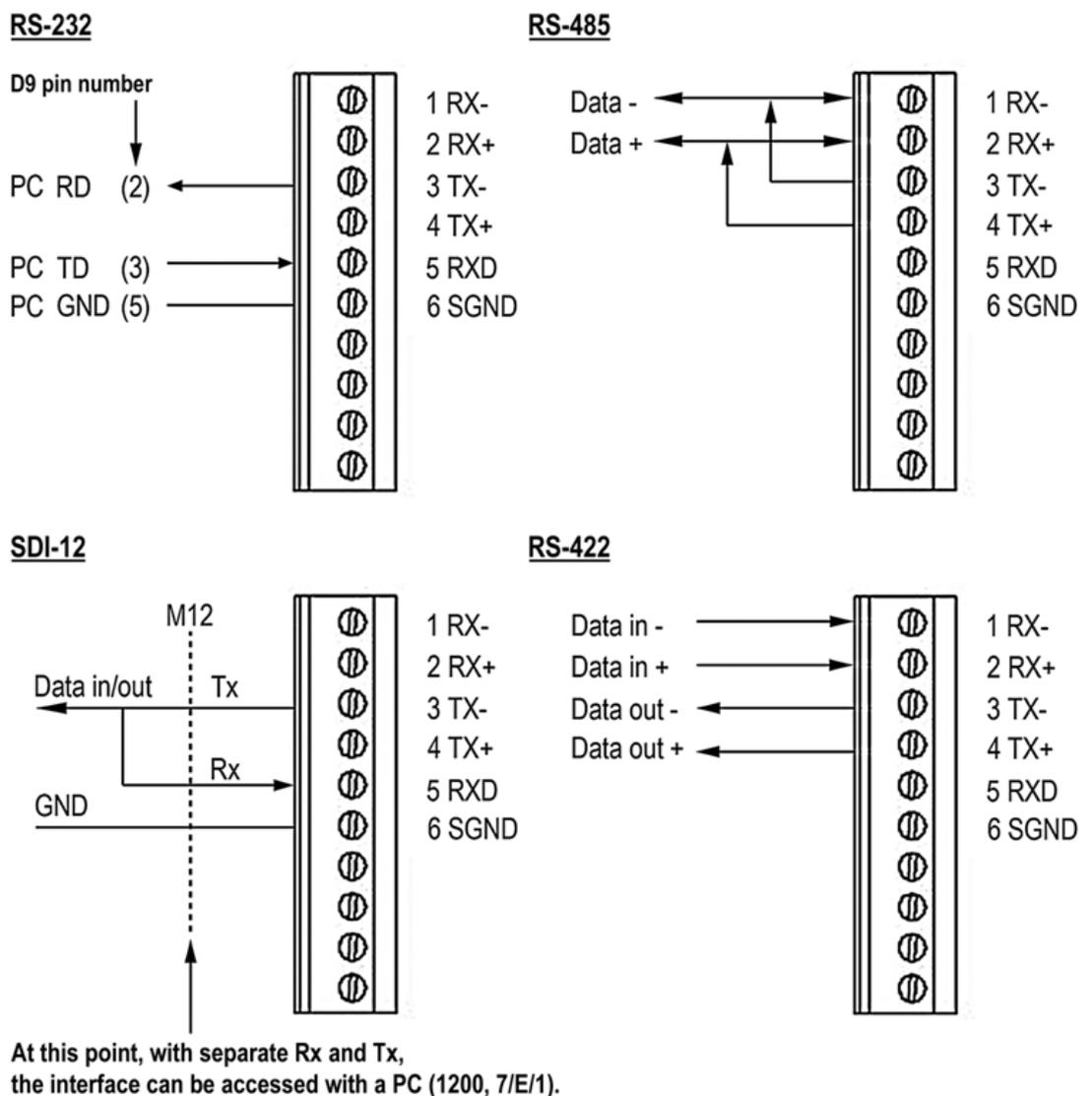


Figure 19 Data Communication Interfaces

With RS-485 and RS-422 interfaces, termination resistors should 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 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 μ F capacitor should 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.

NOTE

When WXT510 is used on an RS-485 bus with other polled devices, the error messaging feature shall always be disabled. This is done by the following command: **0SU,S=N<crLf>**.

Power Management

The power consumption of the WXT510 varies a lot, depending on the selected operating mode or protocol, the data interface type, the sensor configuration, and the measurement and reporting intervals. Lowest consumption is achieved with the Native SDI-12 mode, typically less than **1 mW in standby** (0.07 mA @ 12 V), while with ASCII RS-232 or Continuous SDI-12 modes it is 2 ... 3 times higher. Any sensor measurement, while being activated, adds its own extra consumption to the standby power.

Some hints for economic power management are given below. The current consumption values are all defined for **12 V** supply. For 6 V supply, multiply the values by 1.9. For 18 V or higher supply voltages, multiply the values by 0.7 and add 1.5 mA for each 1 V increase above 18 V (see [Figure 14 on page 36](#)).

- **Wind measurement** is absolutely the most consuming operation in the system. So, it all depends on how the wind is to be reported. If long time averages are needed, the wind must be constantly measured - then it makes no big difference, which requesting period or mode is used. Fully continuous wind measurement with 4 Hz sampling rate adds **2 ... 5 mA** to the standby current (depending on the wind and some other climatic conditions). But for instance 10 second average requested every 2 minutes consumes 12 times less. And 1 Hz sampling rate makes it further decrease to one fourth.
- **PTU measurement** adds approximately **0.75 mA** to the standby consumption. Each single measurement of PTU takes 5 seconds (including the warm-up period). This can be used for estimating the average consumption of PTU.
- **Continuous precipitation** adds some **0.07 mA** to the standby consumption. A single, isolated raindrop causes an additional 0.04 mA to the standby consumption, this condition lasting about 10 seconds (continued, if more raindrops are detected within the 10-second period).
- **ASCII RS-232 Standby consumption** with baud rates 4800 and higher is typically **0.19 mA**. With a low baud rate selection (1200 or 2400 Bd) this is reduced by 28% to less than **0.14 mA**. The jumper wires across TX+/RX+ and TX-/RX- add an extra 0.01 - 0.02 mA (they are necessary only in 2-wire RS-485 mode).
- **ASCII RS-232 Polling mode and Automatic mode** have equal consumption. Thus Automatic mode is a little more economic, since interpreting the poll takes more processing time than starting the Automatic message. However, care should be taken when selecting Precipitation Autosend mode, where the submodes M=R and M=C may cause extra consumption in rainy conditions, as triggered to send messages by the rain incidents.
- **ASCII RS-232 Data transmission** adds **1 ... 2 mA** to the standby consumption during the message sending time. Also it should be noted that the host device's input (data logger or PC) may constantly draw some current from the TX line.
- **RS-485 and RS-422 Data interfaces** consume about the same as RS-232. But with long data cables the consumption during data transmission may be a lot higher, especially when termination resistors are used. On the other hand, the RS-485 driver is in high impedance state when not transmitting - thus in idle state no current can be drawn by the host input.
- **NMEA modes** consume about the same as ASCII modes.

- **SDI-12 Native mode** (M=S, C=1) has the lowest standby consumption, about **0.07 mA**. Note that it can also be used with RS-232 terminals (PC or equivalent), see the SDI-12 connection diagram in [Figure 19 on page 41](#). In this case the commands must be in SDI-12 format, but no special line break signals are required. The SDI-12 mode is for polling only.
- **SDI-12 Continuous mode** (M=R) consumes about the same as the ASCII RS-232 mode.

NOTE

If Heating function is enabled, SDI-12 Native mode consumes the same as ASCII RS-232 mode.

When heating is on (or temperature is such it should be on), some **0.15 mA** extra current is drawn from the operational power supply.

NOTE

While in Service mode and/or while supplied through the Service port the WXT510 consumes **0.5 ... 1 mA** more than in normal mode, supplied through the Main port (M12 connector or screw terminals). When supplied through the Service port the minimum voltage level for reliable operation is 6V. This can also be seen in the supply voltage reading of the Supervisor message - the Vs value is 1V lower than the actual input voltage.

CHAPTER 6

COMMUNICATION SETTINGS

This chapter contains the instructions for making the communication settings.

Communication Protocols

As soon as WXT510 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 NMEA 0183 v3.0 automatic and query SDI-12 v1.3 and SDI-12 v1.3 continuous measurement |
| RS-485 | ASCII automatic and polled NMEA 0183 v3.0 automatic and query SDI-12 v1.3 and SDI-12 v1.3 continuous measurement |
| RS-422 | ASCII automatic and polled NMEA 0183 v3.0 automatic and query 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 WXT510.

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 Vaisala Configuration Tool or a standard PC terminal program.

The service cable is included in the Vaisala Configuration Tool kit, see [Table 20 on page 127](#). For a picture of the service cable, see [Figure 6 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 at M12 and at screw terminals is disabled. The battery (9 V) attached to a cable provides the power to WXT510. 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 transmitter (see [Figure 4 on page 18](#)) by using the service cable.
2. Power-up WXT510 with a 9 V battery attached to the service cable or by using the screw terminals/M12 connector.
3. Open the Vaisala 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 48](#).

NOTE

Changes in the serial interface/communication protocol/ baud settings take place when disconnecting the service cable or when resetting the sensor.

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 Terminal

Checking/changing the device settings can also be made through the M12 bottom connector or screw terminal. Then you have to have 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 transmitter are presented in *italic*.

Checking the Current Communication Settings (aXU)

With this command you can request the current communication settings of WXT510.

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],I=[I],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],I=[I],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: A = ASCII, automatic a = ASCII, automatic with CRC P = ASCII, polled p = ASCII, polled, with CRC N = NMEA 0183 v3.0, automatic Q = NMEA 0183 v3.0, query (= polled) S = SDI-12 v1.3 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 |
| [I] | = | Automatic repeat interval for Composite data message:1 ... 3600 s, 0 = no automatic repeat |
| [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 ... 10000 ms
 Defines the delay between the last character of the query and the first character of the response message from WXT510. During the delay, the WXT510'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: WXT510 (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.

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.

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 93](#). The data is outputted on request.

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

0XU<cr><lf>

0XU,A=0,M=P,T=0,C=2,I=0,B=19200,D=8,P=N,S=1,L=25,
 N=WXT510,V=1.00<cr><lf>

Example (SDI-12, device address 0):

0XXU!0XXU,A=0,M=S,T=0,C=1,I=0,B=1200,D=7,P=E,S=1,L=25,
 N=WXT510,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 49](#). See also the examples.

Command format in ASCII and NMEA 0183:

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

where

- A, M, C, I, = The communication setting fields, see [Setting Fields on page 49](#).
- B, D, P, S, L
- 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:

Each serial interface requires its specific wiring and/or jumper settings described in [Chapter 5, Wiring and Power Management, on page 35](#).

Change first the serial interface field C and then the communication protocol field M.

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 transmitter to validate the changes of communication parameters by disconnecting the service cable or using the **Reset (aXZ)** command, see [Reset \(aXZ\) on page 53](#).

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,I=0,B=19200,D=8,P=N,S=1,L=25,  
N=WXT510,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,I=0,B=19200,D=8,P=N,S=1,L=25,N=WXT510,  
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,I=0,B=9600,D=8,P=N,S=1,L=25,  
N=WXT510,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 93](#).

NOTE

Type commands in CAPITAL letters.

General Commands

In case the error messaging is disabled (see [Supervisor Message on page 108](#)), WXT510 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 the examples.

Example (ASCII):

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

Example (SDI-12):

```
0XZ!0<cr><lf> (=device address)
```

Example (NMEA 0183):

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

Precipitation Counter Reset (aXZRU)

This command is used to reset the rain and hail accumulation and duration parameters Rc, Rd, Hc, and Hd.

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

Command format in SDI-12: **aXZRU!**

where

- a = Device address
- XZRU = Precipitation counter reset command
- <cr><lf> = Command terminator in ASCII and NMEA 0183
- ! = Command terminator in SDI-12

Example (ASCII):

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

```
0TX,Rain reset<cr><lf>
```

Example (SDI-12):

```
0XZRU!0<cr><lf> (= device address)
```

Example (NMEA 0183):

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

```
$WITXT,01,01,10,Rain reset*26<cr><lf>
```

Precipitation Intensity Reset (aXZRI)

This command is used to reset the rain and hail intensity parameters Ri, Rp, Hi and Hp.

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

Command format in SDI-12: **aXZRI!**

where

- a = Device address
- XZRI = Precipitation intensity reset command
- <cr><lf> = Command terminator in ASCII and NMEA 0183
- ! = Command terminator in SDI-12

NOTE

The precipitation counter and precipitation intensity parameters are reset also when the supply voltage is disconnected, the command **aXZ** is issued, precipitation counter reset mode is changed or when the precipitation/surface hits units are changed.

Example (ASCII):

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

OTX,Inty reset<cr><lf>

Example (SDI-12):

0XZRI!0<cr><lf> (= device address)

Example (NMEA 0183):

0XZRI<cr><lf>

*\$WITXT,01,01,11,Inty reset*39<cr><lf>*

Measurement Reset (aXZM)

This command is used to interrupt all ongoing measurements of the transmitter 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>

OTX,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

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 93](#).

Table 5 Abbreviations and Units

| Abbreviation | 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 |
| Pa | Air pressure | hPa, Pa, bar, mmHg, inHg | #, H, P, B, M, I |
| Ta | Air temperature | °C, °F | #, C, F |
| Tp | Internal temperature | °C, °F | #, C, F |
| Ua | Relative humidity | %RH | #, P |
| Rc | Rain accumulation | mm, in | #, M, I |
| Rd | Rain duration | s | #, S |
| Ri | Rain intensity | mm/h, in/h | #, M, I |
| Rp | Rain peak intensity | mm/h, in/h | #, M, I |
| Hc | Hail accumulation | hits/cm ² , hits/in ² , hits | #, M, I, H |
| Hd | Hail duration | s | #, S |
| Hi | Hail intensity | hits/cm ² h, hits/in ² h, hits/h | #, M, I, H |
| Hp | Hail peak intensity | hits/cm ² h, hits/in ² h, hits/h | #, M, I, H |
| 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 transmitter is connected to the bus, see [Appendix A, Networking, on page 131](#). If you need to change the device address, see [Changing the Communication Settings on page 51](#).

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 93](#).

Pressure, Temperature and Humidity Data Message (aR2)

With this command you can request a pressure, temperature and humidity data message.

Command format: **aR2<cr><lf>**

where

a = Device address
R2 = Pressure, temperature and humidity message query command
<cr><lf> = Command terminator

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

0R2,Ta=23.6C,Ua=14.2P,Pa=1026.6H<cr><lf>

where

a = Device address
R2 = Pressure, temperature and humidity query command
Ta = Air temperature (C = °C)
Ua = Relative humidity (P = % RH)
Pa = Air pressure (H = hPa)
<cr><lf> = Response terminator

To change the parameters and units in the response message and to make other sensor settings, see section [Pressure, Temperature, and Humidity Sensors on page 99](#).

Precipitation Data Message (aR3)

With this command you can request the precipitation data message.

Command format: **aR3**<cr><lf>

where

a = Device address
R3 = Precipitation message query command
<cr><lf> = Command terminator

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

*OR3,Rc=0.0M,Rd=0s,Ri=0.0M,Hc=0.0M,Hd=0s,Hi=0.0M,Rp=0.0M,
Hp=0.0M<cr><lf>*

where

a = Device address
R3 = Precipitation message query command
Rc = Rain accumulation (M = mm)
Rd = Rain duration (s = s)
Ri = Rain intensity (M = mm/h)
Hc = Hail accumulation (M = hits/cm²)
Hd = Hail duration (s = s)
Hi = Hail intensity (M = hits/cm²h)
Rp = Rain peak intensity (M = mm/h)
Hp = Hail peak intensity (M = hits/cm²h)
<cr><lf> = Response terminator

To change the parameters or the units in the response message and to make other precipitation sensor settings, see section [Precipitation Sensor on page 103](#).

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 108](#).

Combined Data Message (aR)

With this command you can request all individual messages **aR1**, **aR2**, **aR3** 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>

0R2,Ta=74.6F,Ua=14.7P,Pa=1012.9H<cr><lf>

*0R3,Rc=0.10M,Rd=2380s,Ri=0.0M,Hc=0.0M,Hd=0s,
 Hi=0.0M<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, pressure, temperature, humidity, precipitation and supervisor data.

Command format: **aR0<cr><lf>**

where

a = Device address
 R0 = Composite data 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, aR2, aR3 and aR5):

*0R0,Dx=005D,Sx=2.8M,Ta=23.0C,Ua=30.0P,Pa=1028.2H,
 Hd=0.00M,Rd=10s,Th=23.6C<cr><lf>*

For selecting the parameter set in the response message, see [Chapter 8, Sensor and Data Message Settings, on page 93](#).

Polling 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 143](#).

Requesting a wind data message with a CRC:

Command format: **0r1xxx<cr><lf>**

where

0 = 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 ar1:

Command format: **ar1yyy<cr><lf>**

where

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

Response:

```
atX,Use chksum GoeIU~<cr><lf>
```

where

| | | |
|----------|---|--------------------------------------------------------|
| 0 | = | Device address |
| tX,Use | = | Text prompt |
| chksum | | |
| Goe | = | Correct three-character CRC for the ar1 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):

| | | |
|--------------------------------------------------|---|----------------|
| Pressure, humidity and temperature message query | = | 0r2Gje<cr><lf> |
| Precipitation query | = | 0r3Kid<cr><lf> |
| Supervisor query | = | 0r5Kcd<cr><lf> |
| Combined message query | = | 0rBVT<cr><lf> |
| Composite data 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 93](#).

Automatic Mode

When automatic ASCII protocol is selected the transmitter sends data messages at user configurable update intervals. The message structure is same as with data query commands **aR1**, **aR2**, **aR3** and **aR5**. You can choose an individual update interval for each sensor, see [Chapter 8, Sensor and Data Message Settings, on page 93](#), sections Changing the Settings.

Example:

0R1,Dm=027D,Sm=0.1M<cr><lf>

0R2,Ta=74.6F,Ua=14.7P,Pa=1012.9H<cr><lf>

*0R3,Rc=0.10M,Rd=2380s,Ri=0.0M,Hc=0.0M,Hd=0s,
Hi=0.0M<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>

0r2,Ta=22.7C,Ua=55.5P,Pa=1004.7H@Fn<cr><lf>

0r3,Rc=0.00M,Rd=0s,Ri=0.0Mllm<cr><lf>

0r5,Th=25.0C,Vh=10.6#,Vs=10.8V,Vr=3.369VOJT<cr><lf>

NOTE

Stop the automatic output by changing the communication protocol to polled mode (**aXU,M=P**).

Polling commands **aR1**, **aR2**, **aR3**, and **aR5** can be used also in ASCII automatic protocol for requesting data.

Automatic Composite Data Message

When automatic composite data messaging is selected, the transmitter sends composite data messages at user configurable intervals. The message structure is the same as with the composite data query command **aR0** and contains a user configurable set of wind, pressure, temperature, humidity, precipitation and supervisor data.

Example (the parameters included can be chosen from the full parameter set of the commands aR1, aR2, aR3 and aR5):

*0R0,Dx=005D,Sx=2.8M,Ta=23.0C,Ua=30.0P,Pa=1028.2H,
Hd=0.00M,Rd=10s,Th=23.6C<cr><lf>*

For selecting the parameter set in the response message, see [Chapter 8, Sensor and Data Message Settings, on page 93](#).

Automatic composite data messaging is a concurrent, not an alternate mode to either the polled or automatic modes.

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 93](#). 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 93](#).

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:

```
a13ccccccmmmmmmvvvxxxxxxxx<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
ccccccc = 8-character vendor identification Vaisala_
mmmmm = 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_WXT510103Y2630000<cr><lf>
```

Start Measurement Command (aM)

This command asks the device to make a measurement. The measured data are not sent automatically and should 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** should be used, see the next sections.

See [Examples of aM, aC and aD Commands on page 75](#).

Command format: **aMx!**

where

| | | |
|---|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a | = | Device address |
| M | = | Start measurement command |
| x | = | The desired sensor to make the measurement 1 = Wind 2 = Temperature, humidity, pressure 3 = Precipitation 5 = Supervisor If x is left out, the query refers to the combined data message used for requesting data from several sensors with just one command. See Examples of aM, aC and aD Commands on page 75 . |
| ! | = | Command terminator |

The response is sent in two parts:

The response part one:

attn<cr><lf>

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

a<cr><lf>

where

| | | |
|----------|---|-----------------------------------------------------------------------|
| a | = | Device address |
| ttn | = | 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 93](#).

NOTE

When the measurement takes less than one second, the response part two is not sent. In WXT510 this is the case in the precipitation measurement aM3.

NOTE

The maximum number of parameters that can be measured with aM and aMC commands is nine (9). If more parameters are to be measured, Start concurrent measurement commands aC and aCC should 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 as 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** should 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 nine (9) measurement parameters are requested from a single device.

The measured data is not sent automatically and it should be requested with separate Send data command **aD**. See [Examples of aM, aC and aD Commands on page 75](#).

Command format: **aCx!**

where

a = Device address

C = Start concurrent measurement command

| | | |
|---|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x | = | The desired measurement 1 = Wind 2 = Temperature, humidity and pressure 3 = Precipitation 5 = Supervisor If x is left out, the query refers to combined data message in which the user can request data from several sensors with just one command. See the examples below. |
| ! | = | Command terminator |

The response:

attnn<cr><lf>

where

| | | |
|----------|---|------------------------------------------------------------------------|
| a | = | Device address |
| t | = | The measurement completing time in seconds |
| n | = | 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 93](#).

Start Concurrent Measurement with CRC (aCC)

Command format: **aCCx!**

This command has the same function as **aC** 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** should 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 75](#).

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 commands until all the data is 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 should 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 75](#).
- ! = 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, precipitation and supervisor data messages are as presented in the parameter selection setting field, see [Chapter 8, Sensor and Data Message Settings, on page 93](#). The parameter order of the temperature, humidity and pressure data messages are as follows: air temperature, internal temperature, relative humidity and air pressure. For all sensors check also the bit tables in the parameter selection fields to see the activated parameters.

The device address is 0 in all examples.

Example 1:

Start a wind measurement and request the data (all six 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 concurrent pressure, humidity and temperature measurement and request the data:

```
0C2!000503<cr><lf> (measurement ready in 5 seconds and 3  
parameters available, for aC command device address not sent as a sign  
of a completed measurement)
```

```
0D0!0+23.6+29.5+1009.5<cr><lf>
```

Example 3:

Start a precipitation measurement and request the data:

0M3!00006<cr><lf> (6 parameters available immediately, thus the device address is not sent)

0D0!0+0.15+20+0.0+0.0+0+0.0<cr><lf>

Example 4:

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>

Example 5:

Start a composite measurement and request the data. The configuration of the parameter set is such that nine (9) parameters are available. Thus start measurement command **aM** can be used. Due to the 35-character limit in response message, **aD0** returns only six parameters. The remaining parameters are retrieved with **aD1**.

0M!00059<cr><lf> (measurement ready in 5 seconds and 9 parameters available)

0<cr><lf> (measurement completed)

0D0!0+340+0.1+23.7+27.9+1009.3+0.15<cr><lf>

0D1!0+0.0+0+0.0<cr><lf>

Example 6:

Start a composite measurement and request the data. The configuration of the parameter set is such that 20 parameters are available. Thus Start concurrent measurement command **aC** shall be used. Due to the 75-character limit in response message, **aD0** returns only 14 parameters. The remaining parameters are retrieved with **aD1**.

0C!000520<cr><lf> (measurement ready in 5 seconds and 20 parameters available)

0<cr><lf> (measurement completed)

0D0!0+069+079+084+0.1+0.6+1.1+21.1+21.7+32.0+1000.3+0.02
+20+0.0+0.0<cr><lf>

0D1!0+0+0.0+1.3+0.0+0+77.1<cr><lf>

Continuous Measurement (aR)

The device can be configured so that all 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 update intervals, see [Chapter 8, Sensor and Data Message Settings, on page 93](#)).

NOTE

For using Continuous measurement commands for all WXT510 parameters (wind, PTU, precipitation, and supervisor) the respective protocol must be selected (**aXU,M=R**).

The **M=S** selection requires use of **aM**, **aMC**, **aC**, **aCC** + **aD** commands, only the precipitation data can be retrieved continuously (using **aR3** command).

Command format: **aRx!**

where

- | | | |
|---|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a | = | Device address |
| R | = | Start continuous measurement command: |
| x | = | The desired sensor to make the measurement: 1 = Wind 2 = Temperature, humidity, pressure 3 = Precipitation 5 = Supervisor If x is left out, the query refers to the combined data message used for requesting data from several sensors with just one command. |
| ! | = | Command terminator |

The response:

$a + \langle \text{data fields} \rangle \langle \text{cr} \rangle \langle \text{lf} \rangle$

where

a = Device address

$\langle \text{data fields} \rangle$ = 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.

$\langle \text{cr} \rangle \langle \text{lf} \rangle$ = Response terminator

Examples (device address 0):

$0R1!0+323+331+351+0.0+0.4+3.0 \langle \text{cr} \rangle \langle \text{lf} \rangle$

$0R3!0+0.15+20+0.0+0.0+0+0.0+0.0+0.0 \langle \text{cr} \rangle \langle \text{lf} \rangle$

$0R!0+178+288+001+15.5+27.4+38.5+23.9+35.0+1002.1+0.00+0+0.0+23.8 \langle \text{cr} \rangle \langle \text{lf} \rangle$

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 $\langle \text{cr} \rangle \langle \text{lf} \rangle$.

Example (device address 0):

$0RC3!0+0.04+10+14.8+0.0+0+0.0INy$

Start Verification Command (aV)

This command is used to query self diagnostic data from the device. However, the command is not implemented in WXT510. 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 93](#).

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 143](#).

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 transmitter is connected to the bus, see [Appendix A, Networking, on page 131](#). If you need to change the device address, see [Changing the Communication Settings on page 51](#).

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

Request the wind speed and direction data with a MWV query command. For using MWV query the NMEA Wind formatter parameter in the wind sensor settings shall be set to W (see section [Wind Sensor on page 93](#)). With 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 82](#).

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 devices north-south axis. An offset value to the measured direction can be set, see section Chapter 8, section Wind Sensor.

The checksum to be typed in the query depends on the device identifier characters. The correct checksum can be asked from WXT510 by typing any three characters after the **\$--WIQ,MWV** command.

Example:

Typing the command `$--WIQ,MWVxxx<cr><lf>` (xxx arbitrary characters) WXT510 responds

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

which tells that *2F is the correct checksum for the `$--WIQ,MWV` command.

Example of the MWV Query:

```
$--WIQ,MWV*2F<cr><lf>
```

```
$WIMWV,282,R,0.1,M,A*37<cr><lf>
```

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

XDR Transducer Measurement Query

XDR query command outputs the data of all other sensors except wind. When requesting also wind data with the XDR command the NMEA Wind formatter parameter in the wind sensor settings shall be set to T (see section [Wind Sensor on page 93](#)).

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 93](#)).

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 |
| a ¹ | = | Transducer type for the first transducer, see the following transducer table. |
| x.x ¹ | = | Measurement data from the first transducer |
| u ¹ | = | Units of the first transducer measurement, see the following transducer table. |
| c--c ¹ | = | First transducer identification (id). WXT510'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 48 (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. WXT510'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 WXT510 address is given as a letter, it will be shown as a number (0 ... 9, 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 WXT510, see example below.

Example:

Typing the command **\$--WIQ,XDRxxx<cr><lf>** (xxx arbitrary characters) WXT510 responds

*\$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 WXT510 address **aXU,A**. The same applies for the wind direction. Temperature, internal temperature and heating temperature have the same unit, thus they are assigned with transducer ids A, A+1 and A+2, respectively. Accumulation, duration and intensity for rainfall and hails are measurements of the same parameters so they get transducer ids A for rainfall and A+1 for hails. Rain and hail peak intensities are assigned with transducer ids A+2 and A+3, respectively.

For example, for a WXT510 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 |
| Pressure | 0 |
| Air temperature | 0 |

Table 6 Transducer IDs of the Measurement Parameters (Continued)

| Measurement | Transducer ID |
|-------------------------|---------------|
| Internal temperature | 1 |
| Relative humidity | 0 |
| Rain accumulation | 0 |
| Rain duration | 0 |
| Rain current intensity | 0 |
| Hail accumulation | 1 |
| Hail duration | 1 |
| Hail current intensity | 1 |
| Rain peak intensity | 2 |
| Hail peak intensity | 3 |
| 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>
```

P, T, and RH data

```
$WIXDR,C,23.3,C,0,C,24.0,C,1,H,50.1,P,0,P,1009.5,H,0*75<cr><lf>
```

Precipitation data

```
$WIXDR,V,0.02,M,0,Z,30,s,0,R,2.7,M,0,V,0.0,M,1,Z,0,s,1,R,0.0,M,1,R,6.3,M,2,R,0.0,M,3*51<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 pressure, temperature and humidity sensor response message:

where

\$ = Start of the message
WI = Device type (WI = weather instrument)
XDR = Transducer measurement response identifier
C = Transducer id 0 type (Temperature), see the following Transducer table
23.3 = Transducer id 0 data (Temperature)
C = Transducer id 0 units (C, Temperature)
0 = Transducer id for Temperature
C = Transducer id 1 type (temperature)
23.3 = Transducer id 1 data (Tp internal temperature)
C = Transducer id 1 units (C, Tp internal temperature)
1 = Transducer id for Tp internal temperature
H = Transducer id 0 type (Humidity)
50.1 = Transducer id 0 data (Humidity)
P = Transducer id 0 units (% , Humidity)
0 = Transducer id for Humidity
P = Transducer id 0 type (Pressure)
1009.1 = Transducer id 0 data (Pressure)
H = Transducer id 0 units (hPa, Pressure)
0 = Transducer id for Pressure
* = Checksum delimiter
75 = Two-character checksum for the response
<cr><lf> = Response terminator

The structure of the precipitation sensor response message:

where

\$ = Start of the message

| | | |
|------|---|---------------------------------------------------------------------------------|
| WI | = | Device type (WI = weather instrument) |
| XDR | = | Transducer measurement response identifier |
| V | = | Transducer id 0 type (Accumulated rainfall), see the following Transducer table |
| 0.02 | = | Transducer id 0 data (Accumulated rainfall) |
| I | = | Transducer id 0 units (mm, Accumulated rainfall) |
| 0 | = | Transducer id for Accumulated rainfall |
| Z | = | Transducer id 0 type (Rain duration) |
| 30 | = | Transducer id 0 data (Rain duration) |
| s | = | Transducer id 0 units (s, Rain duration) |
| 0 | = | Transducer id for Rain duration |
| R | = | Transducer id 0 type (Rain intensity) |
| 2.7 | = | Transducer id 0 data (Rain intensity) |
| M | = | Transducer id 0 units (mm/h, Rain intensity) |
| 0 | = | Transducer id for Rain intensity |
| V | = | Transducer id 1 type (Hail accumulation) |
| 0.0 | = | Transducer id 1 data (Hail accumulation) |
| M | = | Transducer id 1 units (hits/cm ² , Hail accumulation) |
| 1 | = | Transducer id for Hail accumulation |
| Z | = | Transducer id 1 type (Hail duration) |
| 0 | = | Transducer id 1 data (Hail duration) |
| s | = | Transducer id 1 units (s, Hail duration) |
| 1 | = | Transducer id for Hail duration |
| R | = | Transducer id 1 type (Hail intensity) |
| 0.0 | = | Transducer id 1 data (Hail intensity) |
| M | = | Transducer id 1 units (hits/cm ² h, Hail intensity) |
| 1 | = | Transducer id for Hail intensity |
| R | = | Transducer id 1 type (Rain peak intensity) |
| 6.3 | = | Transducer id 1 data (Rain peak intensity) |
| M | = | Transducer id 1 units (mm/h, Rain peak intensity) |
| 2 | = | Transducer id for Rain peak intensity |
| R | = | Transducer id 1 type (Hail peak intensity) |
| 0.0 | = | Transducer id 1 data (Hail peak intensity) |

| | | |
|----------|---|--------------------------------------------------------------------|
| M | = | Transducer id 1 units (hits/cm ² , Hail peak intensity) |
| 3 | = | Transducer id for Hail peak intensity |
| * | | Checksum delimiter |
| 51 | = | 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) |
| M | = | Transducer id 0 units (N = heating disabled or heating temperature too high ¹ , 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 Chapter 8, section Supervisor Message, Setting Fields for definitions of the Heating voltage field.

Table 7 Transducer Table

| Transducer | Type | Units Field | Comments |
|---------------------------------------|------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Temperature | C | C = Celsius 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 |
| Pressure | P | B = bars, P = Pascal | H = hPa, I = inHg, M = mmHg |
| Humidity | H | P = Percent | |
| Accumulated precipitation | V | M = mm, I = in, H = hits | non-standardized ¹ |
| Time (duration) | Z | S = seconds | non-standardized ¹ |
| Intensity (flow rate) | R | M = mm/h, I = in/h, H = hits/h for rainfall M = hits/cm ² h, I = hits/in ² h, H = hits/h for hails | 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 10 on page 120](#).

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<cr><lf>* (wind data request when all the wind parameters were disabled from the wind message).

*\$WITXT,01,01,03,Unknown cmd error*1F* (unknown command OXO!<cr><lf>).

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

Automatic Mode

When NMEA 0183 v3.0 automatic protocol is selected, the transmitter 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**, **aR2**, **aR3**, **aR5**, **aR**, **aR0** and their CRC-versions **ar1**, **ar2**, **ar3**, **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 93](#).

Automatic Composite Data Message

When automatic composite data messaging is selected, the transmitter sends composite data messages at user configurable intervals. The message structure is the same as with the composite data query command **aR0** and contains a user configurable set of wind, pressure, temperature, humidity, precipitation and supervisor data.

Example (the parameters included can be chosen from the full parameter set of the commands aR1, aR2, aR3 and aR5):

*OR0,Dx=005D,Sx=2.8M,Ta=23.0C,Ua=30.0P,Pa=1028.2H,
Hd=0.00M,Rd=10s,Th=23.6C<cr><lf>*

For selecting the parameter set in the response message, see [Chapter 8, Sensor and Data Message Settings](#), on page 93.

Automatic composite data messaging is a concurrent, not an alternate mode to either the polled or automatic modes.

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 Vaisala Configuration Tool software. With this software tool you can change the device and sensor settings easily in Windows® environment. See [Table 20 on page 127](#).

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:

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

[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 34](#).

- [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
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 four 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 95](#). 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, = The wind sensor setting fields, see [Setting Fields on page 95](#).

D, N, F

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 shall be a whole multiple of the update interval and at maximum 12 times greater. Example: If I = 5 s, $A_{\max} = 60$ 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 data 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.

Pressure, Temperature, and Humidity Sensors

Checking the Settings

With this command you can check the current pressure, temperature and humidity sensor settings.

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

Command format in SDI-12: **aXTU!**

where

| | | |
|----------|---|-----------------------------------------------------------------------------------|
| a | = | Device address |
| TU | = | Pressure, temperature and humidity sensor settings command in ASCII and NMEA 0183 |
| XTU | = | Pressure, temperature and humidity 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:

aTU,R=[R],I=[I],P=[P],H=[H]<cr><lf>

The response in SDI-12:

aXTU,R=[R],I=[I],P=[P],H=[H]<cr><lf>

where **[R][I][P][H]** are the setting fields, see the following section.

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

0TU<cr><lf>

0TU,R=11010000&11010000,I=60,P=H,T=C<cr><lf>

Example (SDI-12, device address 0):

0XTU!0XTU,R=11010000&11010000,I=60,P=H,T=C<cr><lf>

Setting Fields

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

| | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------------------|
| <p>The bits 1-8 determine the parameters included in the message obtained with the following commands: -ASCII: aR2 and ar2 -NMEA 0183: \$--WlQ,XDR*hh -SDI-12: aM2, aMC2, aC, and aCC2 -SDI-12 continuous: aR2 and aRC2</p> <p>The bits 9-16 determine the PTU parameters included in the composite data message obtained with the following commands: -ASCII: aR0 and ar0 -NMEA 0183: aR0, ar0 -SDI-12: aM, aMC, aC, and aCC -SDI-12 continuous: aR and aRC</p> | 1st bit (most left) | Pa Air pressure |
| | 2nd bit | Ta Air temperature |
| | 3rd bit | Tp Internal temperature ¹ |
| | 4th bit | Ua Air humidity |
| | 5th bit | spare |
| | 6th bit | spare |
| | 7th bit | spare |
| | 8th bit | spare |
| | & | delimiter |
| | 9th bit | Pa Air pressure |
| | 10th bit | Ta Air temperature |
| | 11th bit | Tp Internal temperature ¹ |
| | 12th bit | Ua Air humidity |
| | 13th bit | spare |
| | 14th bit | spare |
| | 15th bit | spare |
| 16th bit | spare | |

1. Tp temperature value is used in pressure calculation, it does not express the air temperature.

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

[P] = Pressure unit: H = hPa, P = Pascal, B = bar, M = mmHg, I = inHg

[T] = Temperature unit: C = Celsius, F = Fahrenheit

<cr><lf> = Response terminator

Changing the Settings

You can change the following settings:

- parameters included in the data message,
- update interval,
- pressure unit, and
- temperature unit.

Make the desired setting with the following command. Select the correct value/letter for the setting fields, see [Setting Fields on page 100](#). See the examples.

Command format in ASCII and NMEA 0183:

aTU,R=x,I=x,P=x,T=x<cr><lf>

Command format in SDI-12:

aXTU,R=x,I=x,P=x,T=x!

where

R, I, P, T = The pressure, temperature and humidity sensor setting fields, see [Setting Fields on page 100](#).

x Value for the setting

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

! = Command terminator in SDI-12

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

You need the temperature and humidity data to be available in every 30 seconds

Changing the parameter selection:

0TU,R=0101000001010000<cr><lf>

0TU,R=01010000&01010000<cr><lf>

NOTE

Character '&' is not allowed in the command.

Changing the update interval:

0TU,I=30<cr><lf>

0TU,I=30<cr><lf>

The response after the change:

0R2<cr><lf>

0R2,Ta=23.9C,Ua=26.7P<cr><lf>

Example (SDI-12, device address 0):

Changing the temperature unit to Fahrenheit:

0XTU,U=F!0<cr><lf>

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

Precipitation Sensor

Checking the Settings

With this command you can check the current precipitation sensor settings.

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

Command format in SDI-12: **aXRU!**

where

| | | |
|----------|---|--------------------------------------------------------------|
| a | = | Device address |
| RU | = | Precipitation sensor settings command in ASCII and NMEA 0183 |
| XRU | = | Precipitation 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:

aRU,R=[R],I=[I],U=[U],S=[S],M=[M],Z=[Z]<cr><lf>

The response in SDI-12:

aXRU,R=[R],I=[I],U=[U],S=[S],M=[M],Z=[Z]<cr><lf>

where **[R][I][U][S][M][Z]** are the setting fields, see the following section.

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

0RU<cr><lf>

0RU,R=11111100&10000000,I=60,U=M,S=M,M=R,Z=M<cr><lf>

Example (SDI-12, device address 0):

0RU!0RU,R=11111100&10000000,I=60,U=M,S=M,M=R,Z=M<cr><lf>

0RU!0RU,R=11111100&10000000,I=60,U=M,S=M,M=R,Z=M<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:

| | | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------|
| <p>The bits 1-8 determine the parameters included in the messages obtained with the following commands: -ASCII: aR3 and ar3 -NMEA 0183: \$--WlQ,XDR*hh -SDI-12: aM3, aMC3, aC3, aCC3 -SDI-12 continuous: aR3 and ar3</p> <p>The bits 9-16 determine the precipitation parameters included in the composite data messages obtained with the following commands: -ASCII: aR0 and ar0 -NMEA 0183: aR0, ar0 -SDI-12: aM, aMC, aC, aCC -SDI-12 continuous: aR and aRC</p> | 1st bit (most left) | Rc Rain amount |
| | 2nd bit | Rd Rain duration |
| | 3rd bit | Ri Rain intensity |
| | 4th bit | Hc Hail amount |
| | 5th bit | Hd Hail duration |
| | 6th bit | Hi Hail intensity |
| | 7th bit | spare |
| | 8th bit | spare |
| | & | delimiter |
| | 9th bit | Rc Rain amount |
| | 10th bit | Rd Rain duration |
| | 11th bit | Ri Rain intensity |
| | 12th bit | Hc Hail amount |
| | 13th bit | Hd Hail duration |
| | 14th bit | Hi Hail intensity |
| | 15th bit | spare |
| 16th bit (most right) | spare | |

[I] = Update interval: 1 ... 3600 seconds. This interval is valid only if the **[M]** field is = T

[U] = Precipitation units:
M = metric (accumulated rainfall in mm, Rain duration in s, Rain intensity in mm/h)
I = imperial (the corresponding parameters in units in, s, in/h)

- [S]** = Units for surface hits:
M = metric (accumulated hailfall in hits/cm², Hail event duration in s, Hail intensity in hits/cm²h)
I = imperial (the corresponding parameters in units hits/in², s, hits/in²h), H = hits (hits, s, hits/h)
Changing the unit resets the precipitation counter.
- [M]** = Autosend mode: R = precipitation on/off, C = tipping bucket, T = time based
R = precipitation on/off: The transmitter sends a precipitation message 10 seconds after the first recognition of precipitation. Rain duration Rd increases in 10 s steps. Precipitation has ended when Ri = 0. This mode is used for indication of the start and the end of the precipitation.
C = tipping bucket: The transmitter sends a precipitation message at each unit increment (0.1 mm/0.01 in). This simulates conventional tipping bucket method.
T = time based: Transmitter sends a precipitation message in the intervals defined in the **[I]** field. However, in polled protocols the autosend mode tipping bucket should not be used as in it the resolution of the output is decreased (quantized to tipping bucket tips).
- [Z]** = Counter reset: M = manual, A = automatic, Y = immediate
Sets both rain/hail accumulation count and duration of the rain/hail event to zero.
M = manual reset mode: The counter is reset with aXZRU command only, see [Precipitation Counter Reset \(aXZRU\) on page 54](#).
A = automatic reset mode: The counts are reset after each precipitation message whether in automatic mode or when polled.
Y = immediate reset: The counts are reset immediately after receiving the command.
- <cr><lf>** = Response terminator

NOTE

The autosend mode parameter is significant only in ASCII automatic (+CRC) and NMEA 0183 automatic protocols.

NOTE

Changing the counter reset mode or precipitation/surface hits units also resets precipitation counter and intensity parameters.

The accumulation counter resets automatically when the accumulation value exceeds 655.35 mm (or 65.535 inch).

When using the automatic reset mode and precipitation update interval/polling interval less than one minute, the internal averaging time of the intensity becomes less than one minute (it will be the time since last precipitation counted in 10 s steps).

Changing the Settings

You can change the following settings:

- parameters included in the precipitation data message,
- update interval in the time based autosend mode,
- precipitation units,
- hail units,
- autosend mode, and
- counter reset.

Make the desired setting with the following command. Select the correct value/letter for the setting fields, see [Setting Fields on page 104](#). See the examples.

Command format in ASCII and NMEA 0183:

aRU,R=x,I=x,U=x,S=x,M=x,Z=x<cr><lf>

Command format in SDI-12:

aXRU,R=x,I=x,U=x,S=x,M=x,Z=x!

where

- R, I, U, S, M, Z = The precipitation sensor setting fields, see [Setting Fields on page 104](#).
x = Input value for the setting
<cr><lf> = Command terminator in ASCII and NMEA 0183
! = Command terminator in SDI-12

Examples (ASCII and NMEA 0183):

Changing the precipitation units to imperial:

```
0RU,U=I<cr><lf>
```

```
0RU,U=I<cr><lf>
```

Changing the autosend mode to the tipping bucket mode:

```
0RU,M=C<cr><lf>
```

```
0RU,M=C<cr><lf>
```

Making the Rain amount Rc and Rain intensity Ri available both in the precipitation message and composite data message:

```
0RU,R=1010000010100000<cr><lf>
```

```
0RU,R=10100000&10100000<cr><lf>
```

The response after the change:

```
0R3<cr><lf>
```

```
0R3,Rc=0.00M,Ri=0.00M<cr><lf>
```

Example (SDI-12, device address 0):

Changing the counter reset mode (resets the precipitation counters):

```
0XRU,Z=M!0<cr><lf>
```

In SDI-12 mode a separate enquiry (0XRU!) 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.

| | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------------|
| <p>The bits 1-8 determine the parameters included in the message obtained with the following commands: -ASCII: aR5 and ar5 -NMEA 0183: \$--WIQ,XDR*hh -SDI-12: aM5, aMC5, aC5, and aCC5 -SDI-12 continuous: aR5 and aRC5</p> <p>The bits 9-16 determine the supervisor parameters included in the composite data message obtained with the following commands: -ASCII: aR0 and ar0 -NMEA 0183: aR0, ar0 -SDI-12: aM, aMC, aC, and aCC -SDI-12 continuous: aR and aRC</p> | 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 |
| | 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 24](#).
 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 109](#). 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 109](#).

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 Data Message

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

NOTE

When changing the bits 9-16 of the parameter selection of any sensor, 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):

How to format a composite data message with average wind direction, average wind speed, temperature, humidity and pressure data when the original composite data message contains following data: maximum wind direction, maximum wind speed, temperature, humidity, pressure, accumulated rainfall, supply voltage and heating voltage:

```
0R0<cr><lf>
```

```
0R0,Dx=009D,Sx=0.2M,Ta=23.3C,Ua=37.5P,Pa=996.8H,  
Rc=0.000I,Vs=12.0V,Vh=0.0N<cr><lf>
```

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 data message:

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

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

Remove the accumulated rainfall (Rc) from the composite data message:

```
0RU,R=&00000000<cr><lf>
```

```
0RU,R=11111100&00000000<cr><lf>
```

The final composite data message query and response in ASCII:

```
0R0<cr><lf>
```

```
0R0,Dm=009D,Sm=0.2M,Ta=23.3C,Ua=37.5P,  
Pa=996.8H<cr><lf>
```

CHAPTER 9

MAINTENANCE

This chapter contains instructions for the basic maintenance of Weather Transmitter WXT510 and contact information for Vaisala Service Centers.

Cleaning

To ensure the accuracy of measurement results, Weather Transmitter WXT510 should be cleaned when it gets contaminated. Leaves and other such particles should be removed from the precipitation sensor and the transmitter should be cleaned carefully with a soft, lint-free cloth moistened with mild detergent.

CAUTION

Be extremely careful when cleaning the wind sensors. The sensors should not be rubbed nor twisted.

Replacing the PTU Module

1. Turn the power off. Loosen the three fixing screws at the sensor bottom assembly.
2. Turn out the top of the transmitter.
3. Release the small white latch (see section A in [Figure 20 on page 114](#)) and remove the PTU module. Remove the vacuum bag protecting the PTU module. Connect the new PTU module.

4. Avoid contacting the white filter cap with your hands while inserting the PTU module.
5. Replace the top and tighten the three fixing screws that fasten the top and the bottom. When turning the top back in, make sure that the flat cable does not get stuck or squeezed between the top and the funnel for the flat cable.

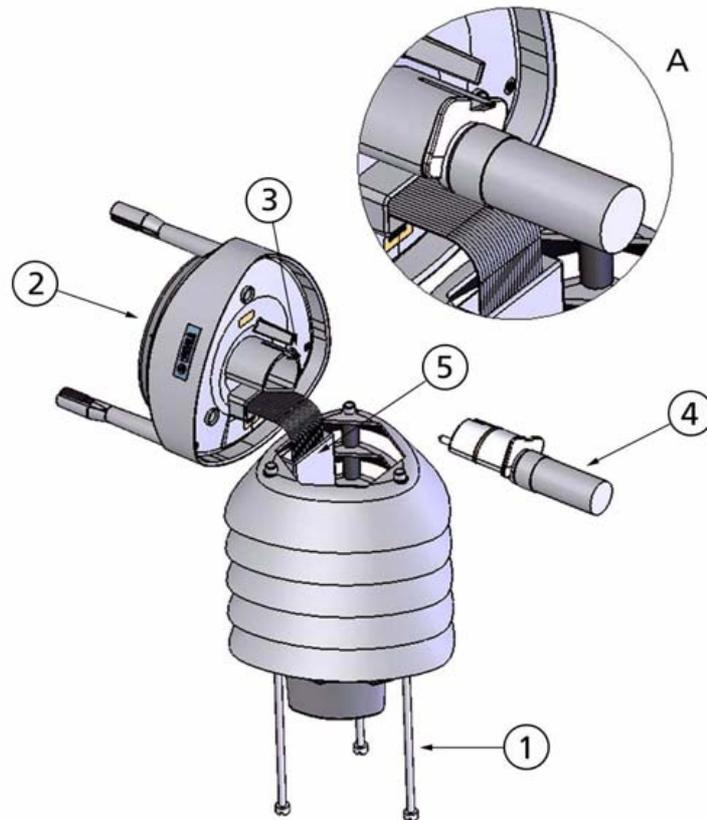


Figure 20 Replacing the PTU Module

Factory Calibration and Repair Service

Send the device to Vaisala Instruments Service Centers 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

CHAPTER 10

TROUBLESHOOTING

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

Table 8 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. Check that the wind transducers are not damaged. Incorrect <cr><lf> settings in the terminal program. | Remove the blockage. Note! The direction unit is # for the wind speeds less than 0.05 m/s. In ASCII and NMEA protocols both <cr> and <lf> are required after each command. Check that your terminal program sends both when pressing enter. |
| Pressure, humidity or temperature measurement failure. The unit is replaced by a # sign or the data values are irrelevant. | The PTU module may not be properly connected. There may be water in the PTU module. | Ensure the proper connection of the PTU module. Remove and dry the module. |

Table 9 Communication Problems

| Problem | Interpretation | Action |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No response to any commands. | <p>Wrong wiring or operation voltage not connected. Baud rate/start bits/parity/stop bit settings do not match between the device and the host.</p> <p>Incorrect <cr><lf> settings in the terminal program.</p> | <p>Check the wiring and operation voltage, see Chapter 5, Wiring and Power Management, on page 35. 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. 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.</p> <p>In ASCII and NMEA protocols both <cr> and <lf> are required after each command. Check that your terminal program sends both when pressing enter.</p> |
| Connection works but data messages not available. | <p>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). A command mistyped in ASCII/NMEA mode while error messaging/text messages is disabled (aSU,S=N).</p> | <p>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 53. Enable the error messaging using the Vaisala Configuration Tool or any terminal by setting aSU,S=Y, then try the command again.</p> |

Table 9 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 Vaisala 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 45 . |
| 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 Vaisala Configuration Tool or any terminal program. See Chapter 8, Sensor and Data Message Settings, on page 93 . |
| An error message as a response to a command. | See section Error Messaging/Text Messages on page 119 . | See section Error Messaging/Text Messages on page 119 . |
| WXT510 keeps sending the message "TX Sync/address error". | The polling address and WXT510 address do not match. The WXT510 is on an RS-485 bus with other polled devices and Error Messages are enabled. | Set correct address either for the WXT510 or to the polling request. Disable the Error Messages with the command aSU,S=N <crlf> . |

Self-Diagnostics

Error Messaging/Text Messages

WXT510 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 110](#).

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 10 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 93 , 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 53 . |
| 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. |
| 10 | Rain reset | The precipitation sensor counter reset. |
| 11 | Inty reset | Precipitation sensor intensity counter reset. |

See also [Chapter 10, Troubleshooting, on page 117](#). In case of constant error, please contact Vaisala Service Center, see [Vaisala Service Centers on page 115](#).

Rain and Wind Sensor Heating Control

The supervisor message **aSU** (see [Supervisor Message on page 108](#)) shows you continuously monitored information about rain and wind sensor heating (heating temperature T_h and heating voltage V_h).

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 V_h should correspond to the heating voltage supplied. If there is a remarkable deviation, check the wiring. Note that wire gauge should 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 V_h measurement behaves as follows:

While heating is off, V_h indicates the positive peak value (V_p) of the heating voltage waveform.

While heating is on, V_h indicates:

- $0.35 \times V_p$ in case of AC voltage

- $0.70 \times V_p$ in case of f/w rectified AC voltage

Operating Voltage Control

The supervisor message **aSU** (see [Supervisor Message on page 108](#)) shows you continuously monitored supply voltage level (V_s). 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 Weather Transmitter WXT510.

Performance

Table 11 Barometric Pressure

| Property | Description/Value |
|-------------------|--------------------------------------------|
| Range | 600 ... 1100 hPa |
| Accuracy | ±0.5 hPa at 0 ... 30 °C (+32 ... +86 °F) |
| Output resolution | ±1 hPa at -52 ... +60 °C (-60 ... +140 °F) |
| Units available | hPa, Pa, bar, mmHg, inHg |

Table 12 Air Temperature

| Property | Description/Value |
|------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Range | -52 ... +60 °C (-60 ... +140 °F) |
| Accuracy (for sensor element) at +20 °C (+68 °F) For accuracy over temperature range, see the following graph | ±0.3 °C |
| Output resolution | 0.1 °C (0.1 °F) |
| Units available | °C, °F |

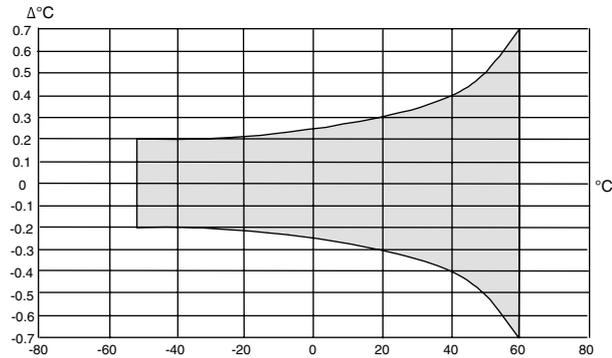


Figure 21 Accuracy Over Temperature Range

Table 13 Relative Humidity

| Property | Description/Value |
|------------------------|----------------------------------------------------|
| Range | 0 ... 100 %RH |
| Accuracy | ±3 %RH at 0 ... 90 %RH ±5 %RH at 90 ... 100 %RH |
| Output resolution | 0.1 %RH |
| PTU Measuring interval | 1 ... 3600 s (= 60 min), at one second steps |

Table 14 Wind

| 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 ±5 % for the measurement range of 36 ... 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° |

Table 14 Wind (Continued)

| Property | Description/Value |
|--------------------------|----------------------------------------------------------------------------------------------------------|
| 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 15 Precipitation

| Property | Description/Value |
|---------------------------------------|---------------------------------------------------------------|
| Rainfall | cumulative accumulation after the latest auto or manual reset |
| collecting area | 60 cm ² |
| output resolution | 0.01 mm (0.001 in) |
| field accuracy for daily accumulation | better than 5 % ¹ , weather dependent |
| units available | mm, in |
| Rain duration | counting each 10-second increment whenever droplet detected |
| output resolution | 10 s |
| Rain intensity | running one minute average in 10-second steps |
| range | 0 ... 200 mm/h (broader range with reduced accuracy) |
| units available | mm/h, in/h |
| Hail | cumulative amount of hits against collecting surface |
| output resolution | 0.1 hits/cm ² , 1 hits/in ² , 1 hit |
| units available | hits/cm ² , hits/in ² , hits |
| Hail duration | counting each 10-second increment whenever hailstone detected |
| output resolution | 10 s |
| Hail intensity | one-minute running average in 10-second steps |
| output resolution | 0.1 hits/cm ² h, 1 hits/in ² h, 1 hit/h |
| units available | hits/cm ² h, hits/in ² h, hits/h |

1. Due to the nature of the phenomenon, deviations caused by spatial variations may exist in precipitation readings, especially in short time scale. The accuracy specification does not include possible wind induced error.

Inputs and Outputs

Table 16 Inputs and Outputs

| Property | Description/Value |
|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Operation voltage | 5 ... 30 VDC ¹ |
| Average power consumption minimum typical maximum | 0.07 mA @ 12 VDC (SDI-12) 3 mA @ 12 VDC (with default measuring intervals) 13 mA @ 30 VDC (constant measurement of all parameters) |
| Heating voltage recommended ranges absolute max | Options: DC, AC, full-wave rectified AC 12 VDC ± 20 %, 1.1 A max 24 VDC ± 20 %, 0.6 A max 68 V _{p-p} ± 20 % (AC), 0.6 A _{rms} max 34 V _p ± 20 % (f/w rect. AC), 0.6 A _{rms} max 30 VDC 84 V _{p-p} (AC) 42 V _p (f/w rect. AC) |
| Digital outputs | 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.

Operating Conditions

Table 17 Operating Conditions

| Property | Description/Value |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Housing protection class | IP55 |
| Temperature operation storage | -52 ... +60 °C (-60 ... +140 °F) -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 |

Materials

Table 18 Materials

| Property | Description/Value |
|-----------------------------------------|----------------------------------|
| Radiation shield, top, and bottom parts | Polycarbonate + 20 % glass fibre |
| Precipitation sensor plate | Stainless steel (AISI 316) |
| Weight | 650 g (1.43 lbs.) |

General

Table 19 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 |

Options and Accessories

Table 20 Options and Accessories

| Order code | Description |
|----------------|---------------------------------------------------------|
| 215194 | Vaisala 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 plate (with M12 connector) |
| 212792 | Mounting kit |
| WXT510PTUSP | WXT510 PTU module |
| 214692 | WXT510 Radiation shield (5 pcs) |
| WSP150 | Surge Protector |

Dimensions

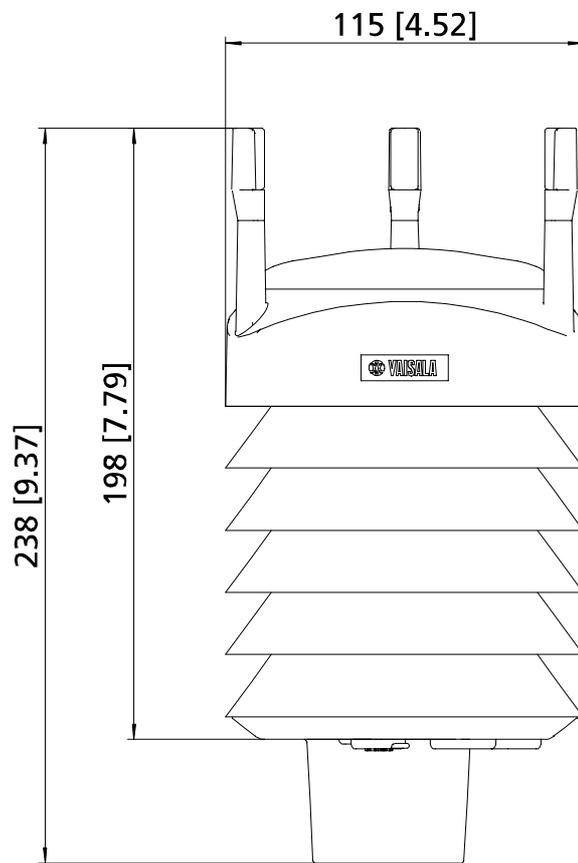


Figure 22 WXT510 Dimensions in mm [inches]

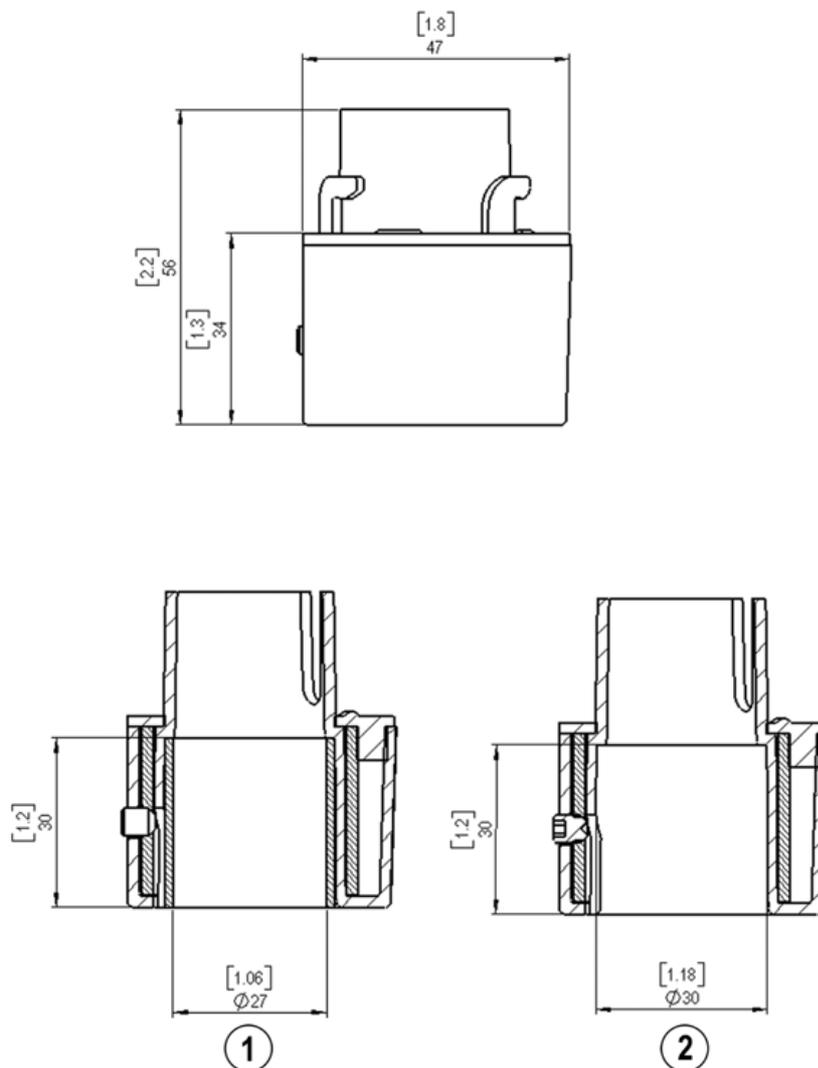


Figure 23 Mounting Kit Dimensions in mm [inches]

The following numbers refer to Figure 23 on page 120:

- 1 = Mounting kit with adapter sleeve for $\varnothing 26.7$ mm mast tube
- 2 = Mounting kit without adapter sleeve for $\varnothing 30$ mm mast tube

APPENDIX A

NETWORKING

Connecting Several WXT510s on the Same Bus

Connecting several WXT510s on the same bus is possible in two ways:

1. Using SDI-12 serial interface and communication protocol, and
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 WXT510 as described in [Chapter 5, Wiring and Power Management, on page 35](#). Remember to combine the two "Data in/out" wires of each WXT510 either in the internal screw terminal inside or outside the transmitter.
2. In the data logger end, combine the "GND for data" wires of each WXT510 to the logger "GND for data" wire. Connect the "Data in/out" wires of each WXT510 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**).

WXT510s on the bus shall be assigned with different addresses (for example: **aXU,A=0,1,2, ...**). Thereafter WXT510s on the bus do not respond to the commands not assigned to them nor to the data messages sent by the other WXT510s.

Example (A bus with three WXT510s):

WXT510 #1 communication settings:

0XXU,A=0,M=S,C=1,B=1200,D=7,P=E,S=1, L=25

WXT510 #2 communication settings:

1XXU,A=1,M=S,C=1,B=1200,D=7,P=E,S=1, L=25

WXT510 #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** and **aCC** should be use 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**, **aR2**, **aR3**, **aR5**, **aR**, **aRC1**, **aRC2**, **aRC3**, **aRC5** and **aRC** available only in SDI-12 continuous protocol (**aXU,M=R**) can be used either for simultaneous measurements of the units or consecutive measurements for one unit at time. See also [SDI-12 Protocol on page 67](#).

RS-485 Serial Interface

Wiring

1. Make the RS-485 wiring of WXT510 as described in [Chapter 5, Wiring and Power Management, on page 35](#).
2. In the data logger end, combine the "Data +" wires of each WXT510 to the logger "Data +" wire. Connect the "Data-" wires of each WXT510 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, ASCII polled or NMEA query is chosen, the error messaging parameter of the supervisor message must be deactivated with **aSU,S=N** for each WXT510 on the bus in order to prevent the units responding to the commands not assigned to them.

ASCII, Polled

WXT510s on the bus shall be assigned with different addresses. (for example: **aXU,A=0,1,2, ...**).

Example (a bus with three WXT510s):

WXT510 #1 communication settings:

0XU,A=0,M=P,C=3,I=0,B=19200,D=8,P=N,S=1,L=25

WXT510 #2 communication settings:

1XU,A=1,M=P,C=3,I=0,B=19200,D=8,P=N,S=1,L=25

WXT510 #3 communication settings:

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

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

0R0<cr><lf>

1R0<cr><lf>

2R0<cr><lf>

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 transmitters. Instead, a specific Time Slot method can be used

for receiving data from several transmitters on the bus, just with a single query command.

To generate different time slots, each WXT510 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 WXT510.

Example (a bus with three WXT510s):

WXT510 #1 communication settings:

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

WXT510 #2 communication settings:

0XU,A=0,M=Q,C=3,I=0,B=4800,D=8,P=N,S=1,L=1000

WXT510 #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<cr><lf>** is sent, WXT510 #1 responds after 25 ms, WXT510 #2 after 1000 ms and WXT510 #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 transmitters are assigned with the same address. Hence the data logger, after sending the query, shall 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 messages can also be used. If WXT510 address is set to 0 (**aXU,A=0**) and all parameters are chosen except Rain peak intensity and Hail peak intensity in the precipitation message, the response to the XDR-query **\$--WIQ,XDR*2D<cr><lf>** will be like:

```
$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<cr><lf>
```

```
$WIXDR,C,24.0,C,0,C,25.2,C,1,H,47.4,P,0,P,1010.1,H,
0*54<cr><lf>
```

```
$WIXDR,V,0.000,I,0,Z,10,s,0,R,0.01,I,0,V,0.0,M,1,Z,0,s,1,R,0.0,M,
1*51<cr><lf>
```

```
$WIXDR,C,25.8,C,2,U,10.7,N,0,U,10.9,V,1,U,3.360,V,2*7D<cr><lf>
```

For the transducer IDs, see [NMEA 0183 V3.0 Protocol on page 79](#).

The maximum transducer ID is three when WXT510 address is 0. Hence, assigning address 4 for the second and address 8 for the third WXT510 on the bus the following responses to the XDR-query **\$--WIQ,XDR*2D<cr><lf>** will be obtained from these transmitters (same message parameter configuration):

The second transmitter (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<cr><lf>
```

```
$WIXDR,C,23.5,C,4,C,24.3,C,4,H,49.3,P,4,P,1010.1,H,
3*59<cr><lf>
```

```
$WIXDR,V,0.000,I,4,Z,0,s,4,R,0.00,I,4,V,0.0,M,5,Z,0,s,5,R,0.0,M,
5*67<cr><lf>
```

```
$WIXDR,C,25.8,C,6,U,10.6,N,4,U,10.9,V,5,U,3.362,V,6*78<cr><lf>
```

The third transmitter (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<cr><lf>
```

```
$WIXDR,C,23.5,C,8,C,24.3,C,9,H,49.3,P,8,P,1010.1,H,
8*5F<cr><lf>
```

```
$WIXDR,V,0.000,I,8,Z,0,s,8,R,0.00,I,8,V,0.0,M,9,Z,0,s,9,R,0.0,M,
9*61<cr><lf>
```

```
$WIXDR,C,25.8,C,10,U,10.6,N,8,U,10.9,V,9,U,3.360,V,
10*7C<cr><lf>
```

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

NOTE

WXT510 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: WXT510 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**, **aR2**, **aR3**, **aR5**, **aR**, **aR0** and their CRC-versions **ar1**, **ar2**, **ar3**, **ar5**, **ar** and **ar0** also in NMEA 0183 protocol. The responses to these commands will be in standard NMEA 0183 format. and the transmitters shall 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 WXT510s, data requests with combined data message query commands; the same message parameter configuration as in the previous example):

WXT510 #1 communication settings:

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

WXT510 #2 communication settings:

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

WXT510 #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 WXT510 #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<cr><lf>*

*\$WIXDR,C,24.0,C,0,C,25.2,C,1,H,47.4,P,0,P,1010.1,H,0*54<cr><lf>*

*\$WIXDR,V,0.000,I,0,Z,10,s,0,R,0.01,I,0,V,0.0,M,1,Z,0,s,1,R,0.0,M,1*51<cr><lf>*

*\$WIXDR,C,25.8,C,2,U,10.7,N,0,U,10.9,V,1,U,3.360,V,2*7D<cr><lf>*

The query for WXT510 #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<cr><lf>*

```
$WIXDR,C,23.5,C,1,C,24.3,C,2,H,49.3,P,1,P,1010.1,H,  
1*59<cr><lf>
```

```
$WIXDR,V,0.000,I,1,Z,0,s,1,R,0.00,I,1,V,0.0,M,2,Z,0,s,2,R,0.0,M,  
2*67<cr><lf>
```

```
$WIXDR,C,25.8,C,3,U,10.6,N,1,U,10.9,V,1,U,3.362,V,2*78<cr><lf>
```

The query for WXT510 #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<cr><lf>
```

```
$WIXDR,C,23.5,C,2,C,24.3,C,3,H,49.3,P,2,P,1010.1,H,  
2*5F<cr><lf>
```

```
$WIXDR,V,0.000,I,2,Z,0,s,2,R,0.00,I,2,V,0.0,M,3,Z,0,s,3,R,0.0,M,  
3*61<cr><lf>
```

```
$WIXDR,C,25.8,C,4,U,10.6,N,2,U,10.9,V,2,U,3.360,V,3*7C<cr><lf>
```

If needed, for making the transducers 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:

- a serial data line,
- a ground line, and
- a 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.

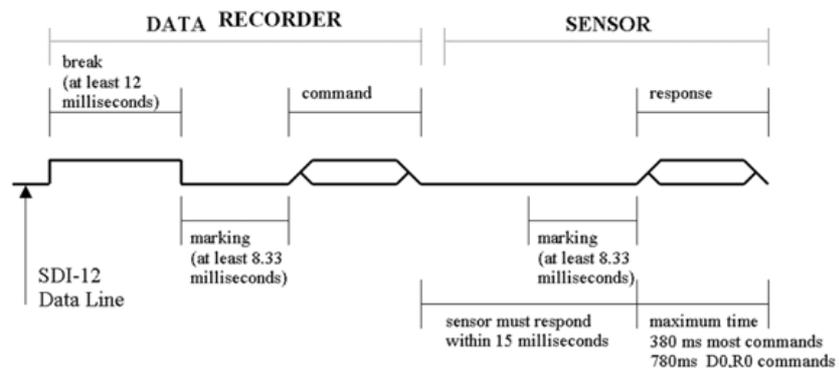


Figure 24 Timing Diagram

- 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

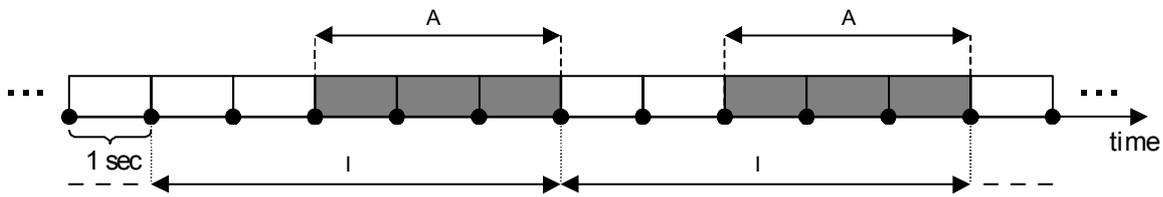
The checksum is the last field in the NMEA sentence and follows the checksum delimiter character "*". It is the 8-bit exclusive OR of all characters in the sentence, including "," and "^" delimiters, between but not including the "\$" or "!" and the "*" delimiters. The hexadecimal value of the most significant 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

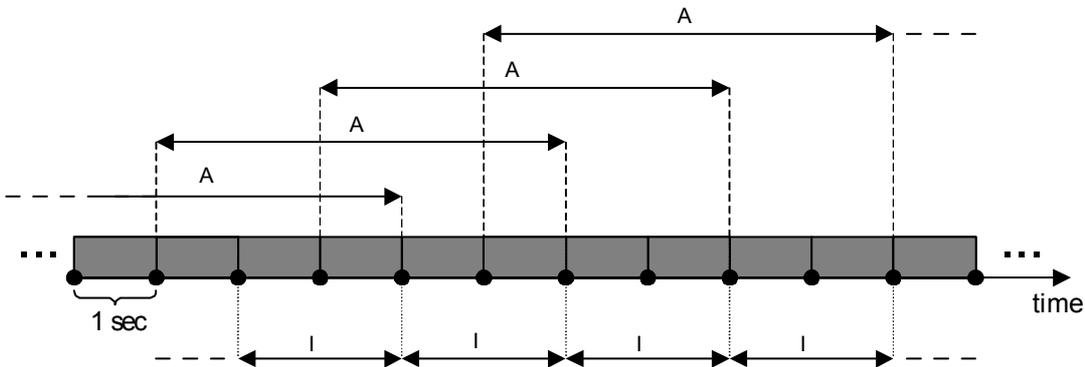
WIND MEASUREMENT AVERAGING METHOD

The following three figures 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.

Case 1 $I > A$, all other communication protocols than SDI-12 (aXU,M=S). In this example $I=5$ sec and $A=3$ sec.



Case 2 $I < A$, all other communication protocols than SDI-12 (aXU,M=S). In this example $I=2$ sec and $A=5$ sec.



Case 3 Communication protocol SDI-12 (aXU,M=S). In this example $A=3$ sec. I does not have any function in this protocol.

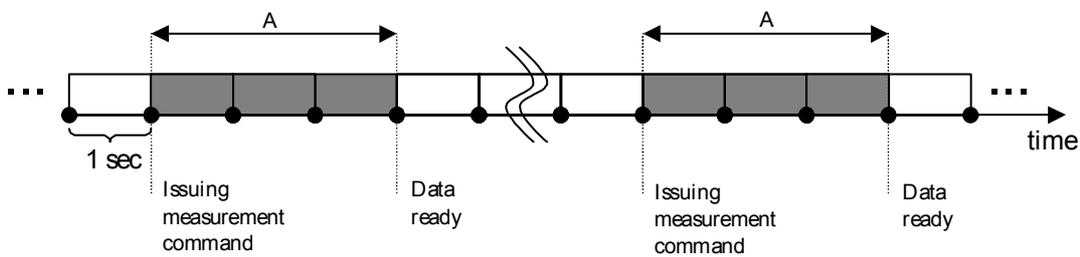


Figure 25 Wind Measurement Averaging Method

NOTE

Grey boxes indicate that the measurement is in progress during the corresponding second.

Update (= internal calculation) is always made in the end of the update interval.

In the auto sending protocols (ASCII automatic (+ CRC) and NMEA automatic) outputting the data messages is synchronized to take place immediately after the update.

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.

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.



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