Weather Transmitter
WXT510

USER'S GUIDE

VAISALA

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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 the product.

Contents of This Manual

This manual consists of the following chapters:

- Chapter 1, General Information: This chapter provides general notes for the product.

- Chapter 2, Product Overview: This chapter introduces the unique features and advantages of the Vaisala 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: 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

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Agreement.

Warranty

For certain products Vaisala normally gives a limited one-year
warranty. Please observe that any such warranty may not be valid in
case of damage due to normal wear and tear, exceptional operating
conditions, negligent handling or installation, or unauthorized
modifications. Please see the applicable supply contract or Conditions
of Sale for details of the warranty for each product.

CHAPTER 2
PRODUCT OVERVIEW

This chapter introduces the unique features and advantages of the
Vaisala Weather Transmitter WXT510.

Weather Transmitter WXT510

Figure 1   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 WXT Configuration Tool software and cable
- 8-pin M12 connector (also with 2 m/10 m cable)
- Mounting kit

Optional Software for Easy Settings

Windows® based WXT 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 119.

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 23.

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

WXT510 Transmitter Components
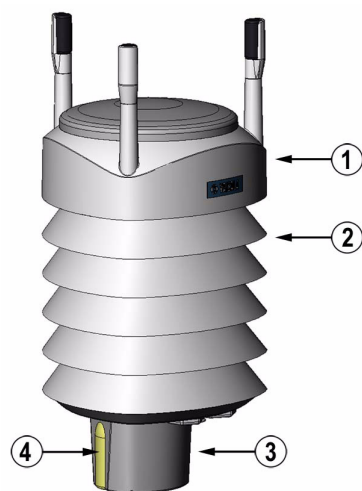
Figure 2   WXT510 Weather Transmitter

The following numbers refer to Figure 2 on page 15:
1   =   Top of the transmitter
2   =   Radiation shield
3   =   Bottom of the transmitter
4   =   Screw cover
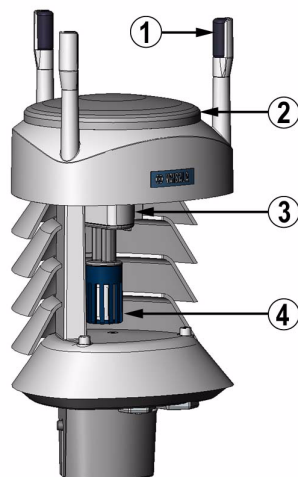
Figure 3   Cut Away View

The following numbers refer to Figure 3 on page 15:
1   =   Wind transducers (3 pcs)
2   =   Precipitation sensor
3   =   Pressure sensor inside the PTU module
4   =   Humidity and temperature sensors inside the PTU module
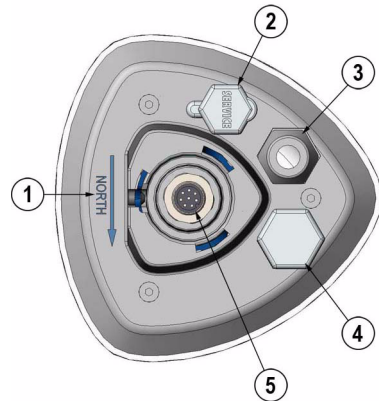
Figure 4   Bottom of the Transmitter

The following numbers refer to Figure 4 on page 16:

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)
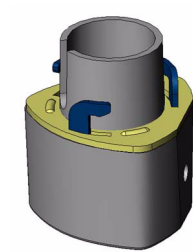
Figure 5   Mounting Kit (Optional)

Figure 6 **Service Cable (Optional)**

The following numbers refer to Figure 6 on page 17:

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

The 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 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 137 for averaging method.

Precipitation Measurement Principle

The 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 minute 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 95.

PTU Measurement Principle

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.

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 (T_h) underneath the precipitation sensor controls the heating.

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

T_h > +3 °C: heating is off,

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

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

T_h < -4 °C: 50 % heating power.

When the heating function is disabled the heating is off in all conditions, see Supervisor Message on page 100.

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 the 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 the WXT510. The rod must be properly grounded, compliant with all local applicable safety regulations.

Assembling the WXT510

1. Turn out the top of the transmitter.

2. Remove the vacuum bag protecting the PTU module.

3. Replace the top and tighten the three fixing screws that fasten the top and the bottom.
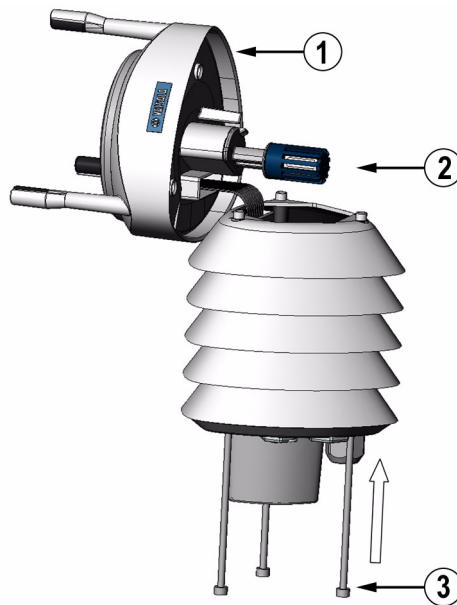
Figure 7   Assembling the WXT510

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 a Vertical Pole Mast

1. Remove the screw cover and insert the 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.
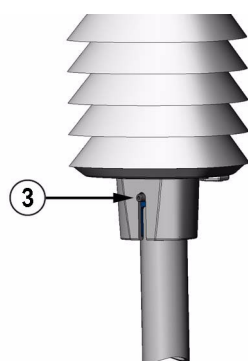
Figure 8   Location of the Fixing Screw

Mounting with a 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.
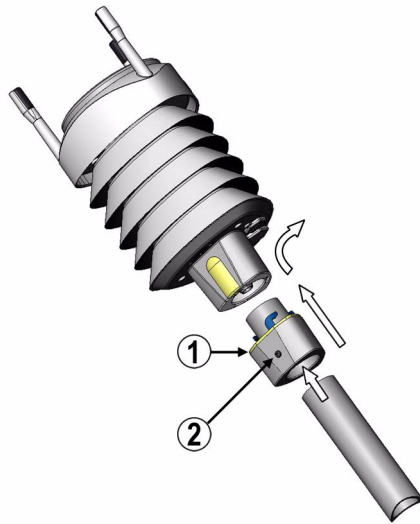
Figure 9   Mounting the WXT510 to a Pole Mast Using the Optional Mounting Kit

The following numbers refer to :

1   =   Mounting kit

2   =   Fixing screw

NOTE	When removing the 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 a Horizontal Cross Arm

1. Remove the screw cover.

2. Align the horizontal cross arm in south-north-direction, see Aligning the WXT510 on page 30. In case the cross arm cannot be aligned, make the wind direction correction as instructed in section Wind Direction Correction on page 31.

3. Mount the transmitter into the cross arm by using the fixing screw (M6 DIN933) and a nut, see Figure 9 on page 28 and Figure 10 on page 29.
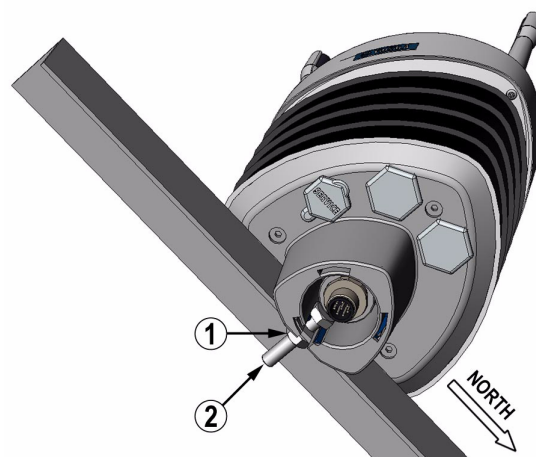
Figure 10   Mounting the WXT510 to a Cross Arm (L-Profile)

The following numbers refer to Figure 10 on page 29:
1   =   Nut
2   =   Fixing screw (M6 DIN933)
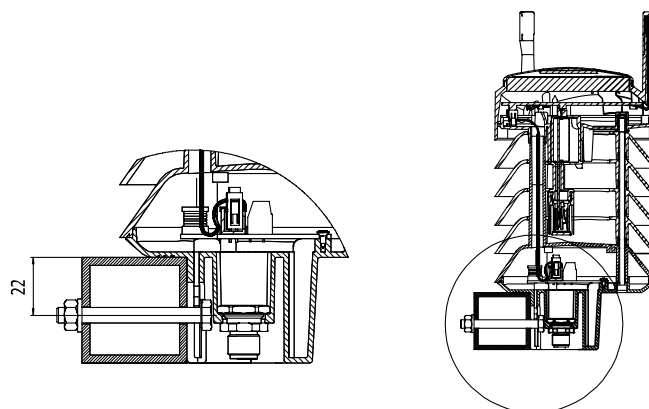
Figure 11   Mounting Screw Location in the Cross Arm

Aligning the 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.
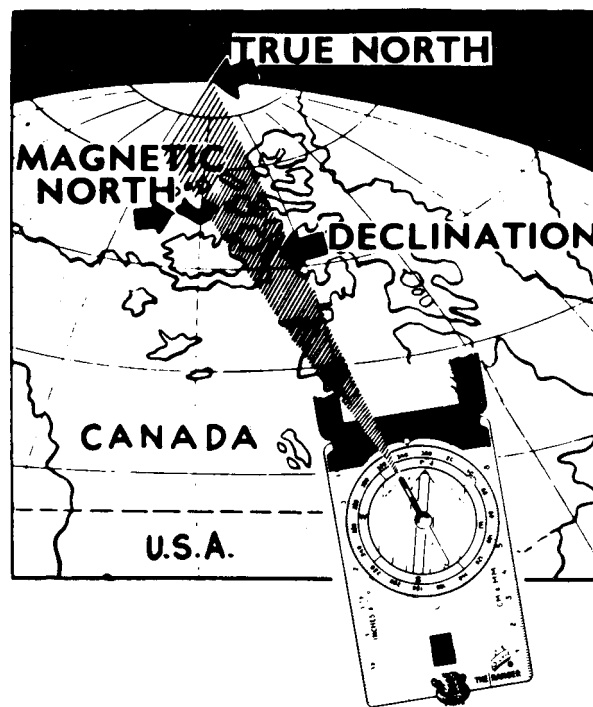
Figure 12   Sketch of Magnetic Declination

Compass Alignment

To align Weather Transmitter WXT510, proceed as follows:

1. If the 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 the 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 the WXT510.

1. Mount the transmitter to a desired position, see section Mounting on page 27.

2. Define the deviation angle from the north-zero-alignment. Use the ± sign indication to express the direction from the north line (see example pictures).

3. Feed the deviation angle to the device by using the wind message formatting command aWU,D (direction correction), see section Checking the Settings on page 87.

4. From now on, the WXT510 transmits the wind direction data by using the changed zero-alignment.
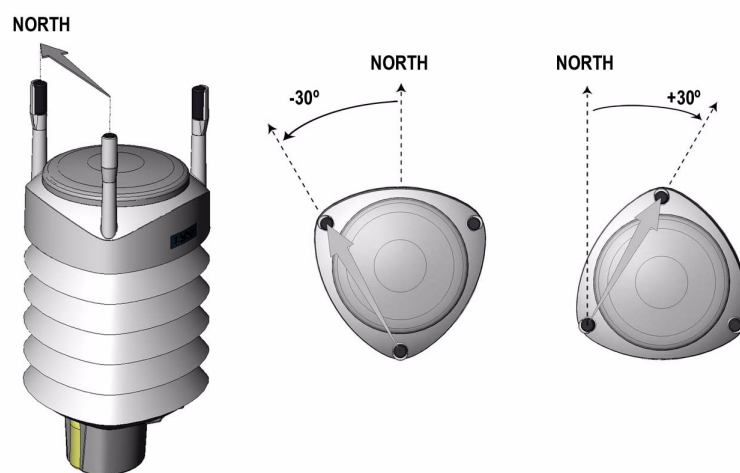
Figure 13   Wind Direction Correction

CHAPTER 5
WIRING

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

The 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 34. 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 87). 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 34).
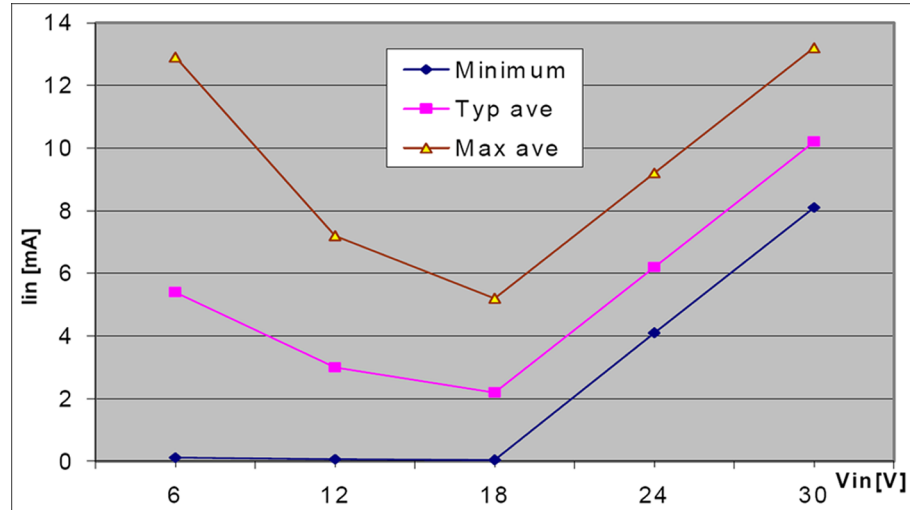
Figure 14   Average Operational Current Consumption (with 4Hz Wind Sensor Sampling)

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 ± 20 % (max 1.1 A);

- 24 VDC ± 20 % (max 0.6 A).

At approx. 16 V heating voltage level the 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 Figure 15 on page 35).

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

- 68 $V_{peak-to-peak}$ ± 20 % (max 0.6 A), for AC;

- 34 V_{peak} ± 20 % (max 0.6 A), for f/w rectified AC.
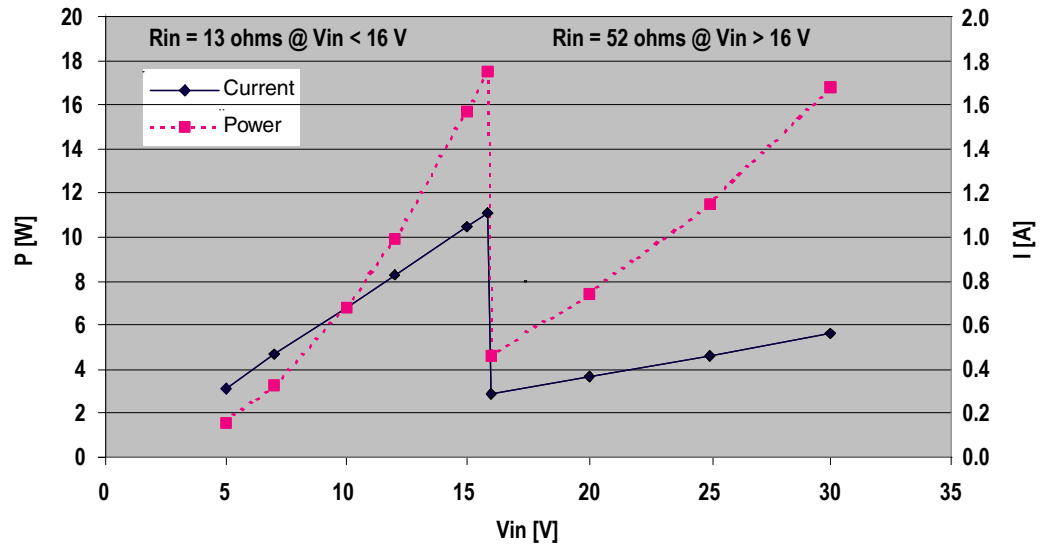
Figure 15   Heating Current and Power vs V_h

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

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

Wiring Using the Screw Terminals

1. Loosen the three long screws at the bottom of the 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 .

5. Replace the bottom part and tighten the three screws.
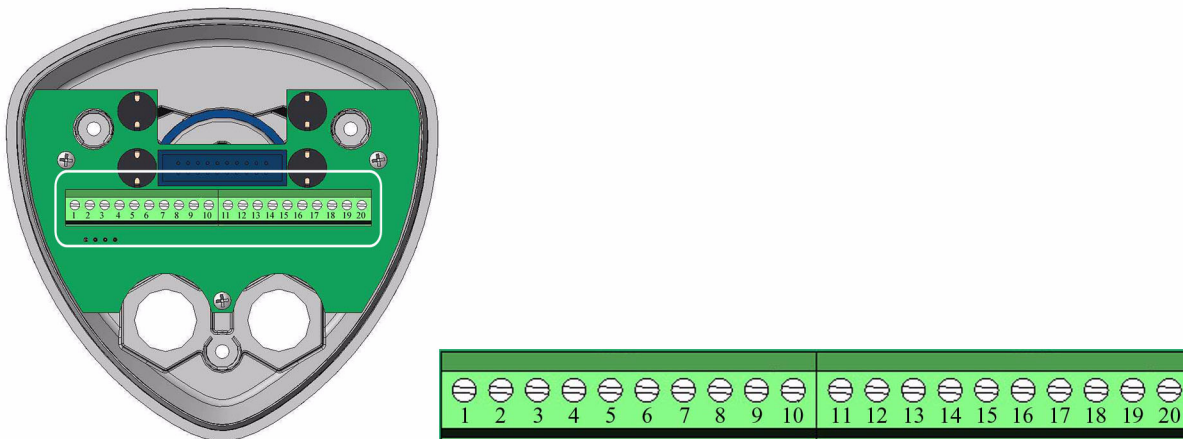
Figure 16   Screw Terminal Block

**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 the 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 the WXT510 is provided with an optional 8-pin M12 connector, the connector is located on the bottom of the transmitter, see Figure 4 on page 16. The pins of the 8-pin M12 connector as seen from outside the transmitter are illustrated in the following figure.
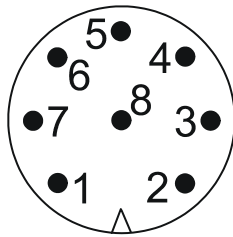
Figure 17   Pins of the 8-pin M12 Connector

The pin connections for the 8-pin M12 connector and the wire colors of the respective M12 cable (optional, 2/10 m) are listed in Table 2 on page 37.

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 the 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.
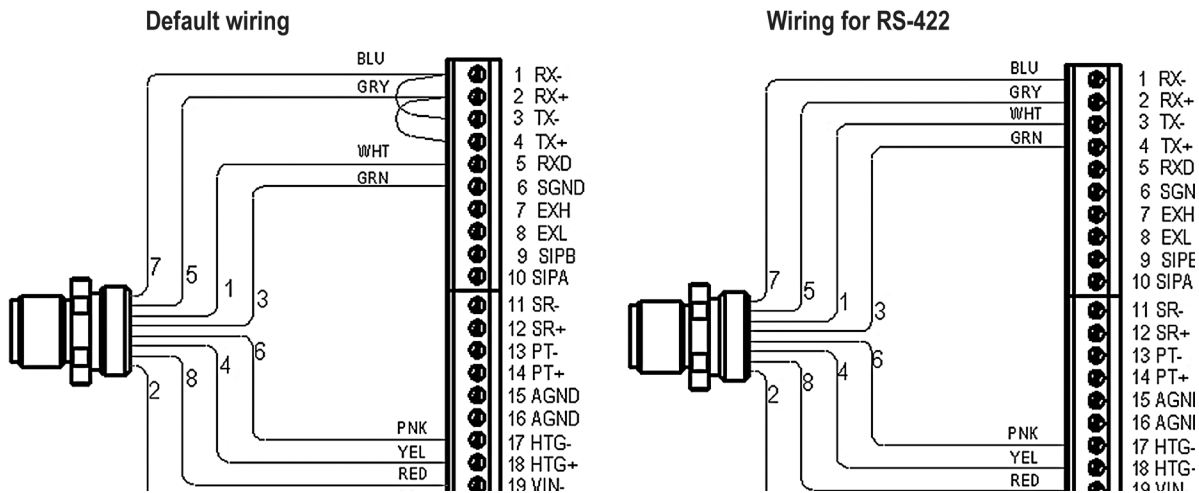
Figure 18   Internal Wiring

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 37).

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

NOTE	The true SDI-12 line requires that the Rx and Tx wires are joined together (outside the WXT510). See the interface diagrams in the next section.

Bidirectional use of the RS-485 and RS-422 i/f requires a proper adapter module between the PC and the 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: RS-232/19200, 8, N, 1. See

Data Communication Interfaces

RS-232

D9 pin number

PC RD (2)
PC TD (3)
PC GND (5)

1 RX-
2 RX+
3 TX-
4 TX+
5 RXD
6 SGND

RS-485

Data -
Data +

1 RX-
2 RX+
3 TX-
4 TX+
5 RXD
6 SGND

SDI-12

M12

Data in/out   Tx

Rx

GND

1 RX-
2 RX+
3 TX-
4 TX+
5 RXD
6 SGND

RS-422

Data in -
Data in +
Data out -
Data out +

1 RX-
2 RX+
3 TX-
4 TX+
5 RXD
6 SGND

**At this point, with separate Rx and Tx,
the interface can be accessed with a PC (1200, 7/E/1).**
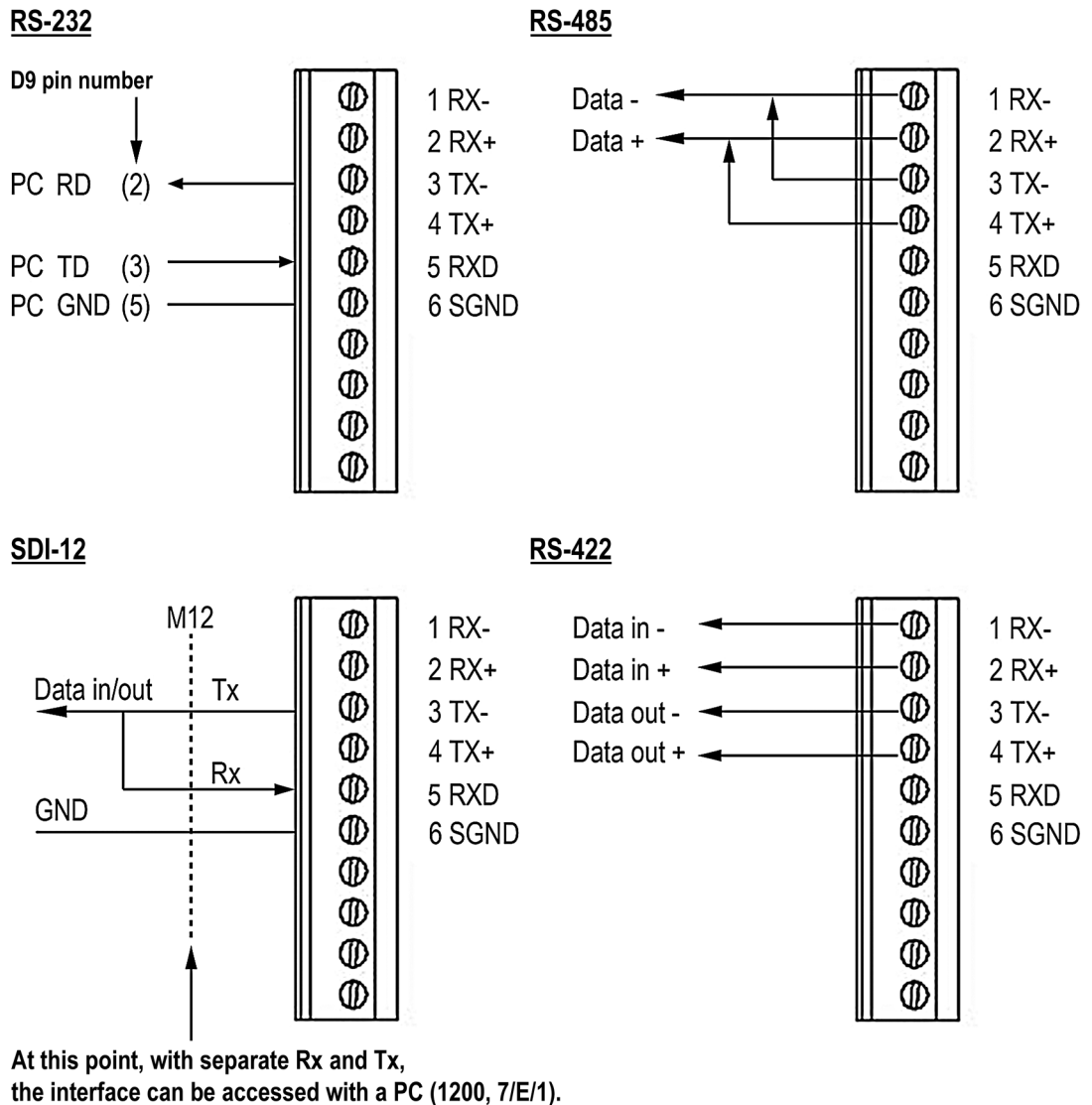
Figure 19   Data Communication Interfaces

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 10 ... 180 Ω is suitable for twisted pair lines. Resistors are connected from RX- to RX+ and from 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 μF capacitor should be connected in series with each termination resistor.

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

CHAPTER 6
COMMUNICATION SETTINGS

This chapter contains the instructions for making the communication settings.

Communication Protocols

As soon as the 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 the 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 WXT Configuration Tool or a standard PC terminal program.

The service cable is included in the WXT Configuration Tool kit, see . For a picture of the service cable, see .

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 the 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) by using a service cable.

2. Power-up the WXT510 with a 9 V battery attached to the service cable or by using the screw terminals/M12 connector.

3. Open the WXT 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 .

<table>
<tr><td>**NOTE**</td><td>Changes in the serial interface/communication protocol/baud settings take place when disconnecting the service cable or when resetting the transmitter.

If these settings are not changed during the service connection, the device will return to the serial interface/communication protocol/baud settings prior to the service connection when the service cable is disconnected.</td></tr>
</table>

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

<table>
<tr><td>**NOTE**</td><td>Hereafter the commands to be typed are presented in normal text while the responses of the transmitter are presented in *italic*.</td></tr>
</table>

Checking the Current Communication Settings (aXU)

With this command you can request the current communication settings of the 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],B=[B],D=[D],P=[P],S=[S],L=[L],
N=[N],V=[V]<cr><lf>
```

Example response in SDI-12:

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

Setting Fields

a	=	Device address
XU	=	Device settings command in ASCII and NMEA 0183
XXU	=	Device settings command in SDI-12
[A]	=	Address: 0 (default) ... 9, A ... Z, a ... z
[M]	=	Communication protocol 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
[B]	=	Baud rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
[D]	=	Data bits: 7/8
[P]	=	Parity: O = Odd, E = Even, N = None
[S]	=	Stop bits: 1/2
[L]	=	RS-485 line delay: 0 ... 10 000 ms Defines the delay between the last character of the query and the first character of the response message from the WXT510. During the delay, the line is not reserved. 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.SDI-12 v1.3 (aXU,M=S) is a low power mode as in it measurements and data output is made only when requested (except precipitation that is monitored continuously).In SDI-12 v1.3 continuous measurement (aXU,M=R) the transmitter makes internal measurements at update intervals configurable by the user, see Chapter 8, Sensor and Data Message Settings, on page 87. The data is outputted when requested.

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

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

Example (SDI-12, device address 0):

```
0XXU!0XXU,A=0,M=S,T=0,C=1,B=1200,D=7,P=E,S=1,L=25,
N=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 45. See also the examples.

Command format in ASCII and NMEA 0183:

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

Command format in SDI-12:

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

where

A, M, C, B, D, P, S,L	=	The communication setting fields, see Setting Fields on page 45.
x	=	Input value for the setting
<cr><lf>	=	Command terminator in ASCII and NMEA 0183
!	=	Command terminator in SDI-12

<table>
<tr><td>

NOTE

</td><td>

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, on page 33.

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).

</td></tr>
</table>

<table>
<tr><td>

NOTE

</td><td>

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 49.

</td></tr>
</table>

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

Changing the device address from 0 to 1:

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

Checking the changed settings:

```
1XU<cr><lf>
1XU,A=1,M=P,T=1,C=2,B=19200,D=8,P=N,S=1,L=25,N=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,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,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 87.

NOTE	Type commands in CAPITAL letters.

General Commands

In case the error messaging is disabled (see Supervisor Message on page 100), the WXT510 does not respond to the general commands given in ASCII and NMEA-formats.

Reset (aXZ)

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

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

Command format in SDI-12: aXZ!

where

a = Device address

XZ = Reset command

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

! = Command terminator in SDI-12

The response depends on the communication protocol, see examples.

Example (ASCII):

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

Example (SDI-12):

```
0XZ!0<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: aZXRU<cr><lf>

Command format in SDI-12: aZXRU!

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 (aZXRI)

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: aXZRI<cr><lf>

Command format in SDI-12: aXZRI!

where:

a	=	Device address
ZXRI	=	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 paraemters are reset also when the supply voltage is disconnected, the command aXZ is given, precipitation counter reset mode is changed or when the precipitation/surface hits units are changed.

Example (ASCII):

```
0XZRU<cr><lf>
0TX,Inty reset<cr><lf>
```

Example (SDI-12):

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

Example (NMEA 0183):

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

Example (SDI-12):

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

Example (NMEA 0183):

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

ASCII Protocol, Polled (without CRC)

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

Abbreviations and Units

For changing the units, see Chapter 8, Sensor and Data Message Settings, on page 87.

Table 5   Abbreviations and Units

Abbr.	Name	Unit	Status[1]
Sn	Wind speed minimum	m/s, km/h, mph, knots	#,M, K, S, N
Sm	Wind speed average	m/s, km/h, mph, knots	#,M, K, S, N
Sx	Wind speed maximum	m/s, km/h, mph, knots	#,M, K, S, N
Dn	Wind direction minimum	deg	#, D
Dm	Wind direction average	deg	#, D
Dx	Wind direction maximum	deg	#, D
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% power and the heating temperature is between the high and middle control limits. W = heating is on at 100% power and the heating temperature is between the low and middle control limits. F = heating is on at 50% power 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 . If you need to change the device address, see .

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 87.

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 92.

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):

```
0R3,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/cm^2)
Hd	=	Hail duration (s = s)
Hi	=	Hail intensity (M = hits/cm^{2}h)
Rp	=	Rain peak intensity (M = mm/h)
Hp	=	Hail peak intensity (M = hits/cm^{2}h)
<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 95.

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 .

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 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

ASCII Protocol, Polled (with CRC)

Use the same data query commands than 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 135.

Requesting a wind data message with a CRC:

Command format: ar1xxx<cr><lf>

where

a	=	Device address
r1	=	Wind message query command
xxx	=	Three-character CRC for ar1 command (depends on the a)
<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 asked by typing a command with an arbitrary three-character CRC.

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

Command format: 0r1yyy<cr><lf>

where

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

Response:

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

where

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

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

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 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 87.

ASCII Protocol, Automatic

When ASCII, automatic 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 87, 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=0.0MIlm<cr><lf>
0r5,Th=25.0C,Vh=10.6#,Vs=10.8V,Vr=3.369VO]T<cr><lf>
```

NOTE	Stop the automatic output by changing the communication protocol to polled mode (aXU,M=P).
	Composite message aR0 can not be obtained by automatic sending.
	Polling commands aR1, aR2, aR3, and aR5 can be used also in ASCII automatic protocol for requesting data.

SDI-12 Protocol

There are two different SDI-12 modes available for providing all the functionality of the SDI-12 v1.3 standard.SDI-12 v1.3 (aXU,M=S) is a low power mode as it makes measurements and outputs data only when requested (except precipitation that is monitored continuously). In this mode all the commands presented in this chapter are available except from all the Continuous Measurement commands only aR3 and aRC3 (precipitation data requests) are available.In SDI-12 v1.3 continuous mode (aXU,M=R) the transmitter makes internal measurements at update intervals configurable by the user, see Chapter 8, Sensor and Data Message Settings, on page 87. The data is outputted when requested. 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 87.

The main difference between the two SDI-12 modes is the power consumption. In the aXU,M=S mode the power consumption is controlled by the host as the host determines when the device takes measurements (wind averaging time has also an effect on the

consumption). Between the measurements power consumption is in this mode negligible. In the aXU,M=R mode 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 in this mode. Also the power consumption between the measurements is not as low as in aXU,M=S 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 the query 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:

allccccccccmmmmmmvvvxxxxxxxx<cr><lf>

where

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

Example:

0I!013VAISALA_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 .

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 composite message with which the user can request data from several sensors with just one command. See Examples of aM, aC and aD Commands on page 70.
!	=	Command terminator

The response is sent in two parts:

The response part 1:

atttn<cr><lf>

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

a<cr><lf>

where

a	=	Device address
ttt	=	The time after which the measurement is completed (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 87.

NOTE	When the measurement takes less than one second, the response part 2 is not sent. In the 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 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 than the aM but a three-character CRC is added to the response data strings before <cr><lf>. In order to request the measured data, send data command aD 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 9 measurement parameters are requested from the 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 70.

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 composite message in which the user can request data from several sensors with just one command. See Examples of aM, aC and aD Commands on page 70.
!	=	Command terminator

The response:

atttnn<cr><lf>

where

a	=	Device address
ttt	=	The time after which the measurement is completed (seconds)
nn	=	The number of the measured parameters available (maximum number is 20)
<cr><lf>	=	Response terminator

NOTE	For changing the message parameters, units and other settings, see Chapter 8, Sensor and Data Message Settings, on page 87.

Start Concurrent Measurement with CRC (aCC)

Command format: aCCx!

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

In order to request the measured data, 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 70.

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 70.
!	=	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 (aXU,M=R) the transmitter makes measurements at internal update intervals configurable by the user. The aD command following 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 of the corresponding parameter is internally 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 87.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 6 wind parameters are enabled in the message):

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

Example 2:

Start a 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 9 parameters are available. Thus start measurement command aM can be used. Due to the response message length only 6 parameters are sent as a response to send data command aD0. Thus the remaining 3 parameters must be requested 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 15 parameters are available. Thus start concurrent measurement command aC shall be used. Three send data commands aD0, aD1 and aD2 must be sent until all the data is received.

```
0C!000515<cr><lf> (measurement ready in 5 seconds and 15
parameters available)
0<cr><lf> (measurement completed)
0D0!0+028+0.2+23.8+28.7+1009.2+0.15<cr><lf>
0D1!0+20+0.0+0.0+0+0.0+34.1+10.5+10.6<cr><lf>
0D2!0+3.368<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 the last internally updated ones and depend on the update intervals of the sensors (see Chapter 8, Sensor and Data Message Settings, on page 87).

NOTE	For using continuous measurement commands for all WXT510 parameters (wind, PTU, precipitation, and supervisor) SDI-12 v1.3 continuous measurement communication protocol must be selected (aXU,M=R).In case of the SDI-12 v1.3 (aXU,M=S) only the precipitation data can be retrieved continuously (using aR3 command). Other parameters require aM, aMC, aC, aCC + aD commands.

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 composite message with which the user can request data from several sensors with just one command.
!	=	Command terminator

The response:

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

where

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

Examples (device address 0):

```
0R1!0+323+331+351+0.0+0.4+3.0<cr><lf>
0R3!0+0.15+20+0.0+0.0+0+0.0+0.0+0.0<cr><lf>
0R!0+178+288+001+15.5+27.4+38.5+23.9+35.0+1002.1+0.00+0+
0.0+23.8<cr><lf>
```

Continuous Measurement with CRC (aRC)

Command format: aRCx!

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

Example (device address 0):

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 the 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 87.

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 135.

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 123. If you need to change the device address, see Changing the Communication Settings on page 46.

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). 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 .

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 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 the WXT510 by typing any three-characters after the $--WIQ,MWV command.

Example:

Typing the command $--WIQ,MWVxxx<cr><lf> (xxx arbitrary characters) the 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<crlf>
$WIMWV,282,R,0.1,M,A*37<cr><lf>
```

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

XDR Transducer Measurement Query

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).

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 87).

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 transducer table, Table 7 on page 84.
$x.x^1$	=	Measurement data from the first transducer
u^1	=	Units of the first transducer measurement, see the transducer table.
$c--c^1$	=	First transducer identification (id). The 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 44 (command aXU,A= [0 ... 9/A ... Z/ a ... z]^1.
...		

| an | = | Transducer type for the transducer n, see the transducer table. |

an   =   Transducer type for the transducer n, see the transducer table.

x.xn   =   Measurement data from the transducer n

un   =   Units of the transducer n measurement, see the transducer table.

c--cn   =   transducer n id. The 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 the 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 the WXT510, see example below.

Example:

Typing the command $--WIQ,XDRxxx<cr><lf> (xxx arbitrary characters) the 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 the 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
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 transducer table, Table 7 on page 84.
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 transducer table, Table 7 on page 84.
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 transducer table, Table 7 on page 84.
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/cm2, 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/cm2h, 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/cm2, 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 transducer table, Table 7 on page 84.
25.5	=	Transducer id 2 data (Heating temperature)
C	=	Transducer id 2 units (C, Heating temperature)
2	=	Transducer id for Heating temperature
U	=	Transducer id 0 type (voltage)
10.6	=	Transducer id 0 data (Heating voltage)

N	=	Transducer id 0 units (N = heating disabled or heating temperature too 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 checksum for the response.
<cr><lf>	=	Response terminator

[1] See section Supervisor Message on page 100 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^2h, I = hits/in^2h, 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 112.

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 Table 10 on page 112)
c---c	=	Text message (see Table 10 on page 112)
*		Checksum delimiter
hh	=	Two-character checksum for the query command.
<cr><lf>	=	Response terminator

Examples:

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

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

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

NMEA 0183 v3.0, Automatic

When NMEA 0183 v3.0 automatic protocol is selected, the 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

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

Sensor and data message settings can also be done by using the WXT Configuration Tool software.With this software tool you can change the device and sensor settings easily in Windows® environment. See Table 20 on page 119.

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<c
r><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:

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

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

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 ... 900 seconds
Defines the period over which the wind speed and direction averaging is calculated. See also Appendix D, Wind Measurement Averaging Method, on page 137 for averaging method.

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

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

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

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

<cr><lf> = Response terminator

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

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

Changing the Settings

You can change the following settings:

- parameters included in the wind data message,

- update interval,

- averaging time,

- speed unit,

- direction correction, and

- NMEA wind formatter.

Make the desired setting with the following command. Select the correct value/letter for the setting fields, see Setting Fields on page 89. See the examples.

Command format in ASCII and NMEA 0183:

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

Command format in SDI-12:

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

where

R, I, A, U, D, N	=	The wind sensor setting fields, see Setting Fields on page 89.
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, Amax = 60 s.

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

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

Changing the measurement interval to 60 seconds:

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

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

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

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

Changing the wind parameter selection:

```
0WU,R=01001000001001000<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.

The bits 1-8 determine the parameters included in the message obtained with the following commands:
-ASCII: aR2 and ar2
-NMEA 0183: $--WIQ,XDR*hh
-SDI-12: aM2, aMC2, aC, and aCC2
-SDI-12 continuous: aR2 and aRC2

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

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 93. See the examples.

Command format in ASCII and NMEA 0183:

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

Command format in SDI-12:

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

where

R, I, P, T	=	The pressure, temperature and humidity sensor setting fields, see Setting Fields on page 93.
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>`

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:

The bits 1-8 determine the parameters included in the messages obtained with the following commands:
-ASCII: aR3 and ar3
-NMEA 0183: $--WIQ,XDR*hh
-SDI-12: aM3, aMC3, aC3, aCC3
-SDI-12 continuous: aR3 and ar3

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

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 50.
		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-second 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 97. 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 97.
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 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=0.0M<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.

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

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

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 23.
Heating disabled: Heating is off in all conditions.

<cr><lf>   =   Response terminator

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

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

Example (SDI-12, device address 0):

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

Changing the Settings

You can change the following settings:

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

Make the desired setting with the following command. Select the correct value/letter for the setting fields, see Setting Fields on page 102. 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 102.
x	=	Value for the setting
<cr><lf>	=	Command terminator in ASCII and NMEA 0183
!	=	Command terminator in SDI-12

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

Disabling the heating and error messaging:

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

Example (SDI-12, device address 0):

Changing the update interval to 10 seconds:

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

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

Composite Message

The parameters to be included in the composite message aR0 can be defined in the parameter selection fields of each parameter (aWU,R, 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 message with average wind direction, average wind speed, temperature, humidity and pressure data when the original composite 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 message:

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

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

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

The final composite 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.
2. Loosen the three screws at the bottom of WXT510.
3. Pull out the top of the transmitter.
4. Release the small white flap and remove the PTU module.

5. Connect a new PTU module (order code WXT510PTUSP), replace the top and tighten the three bottom screws.
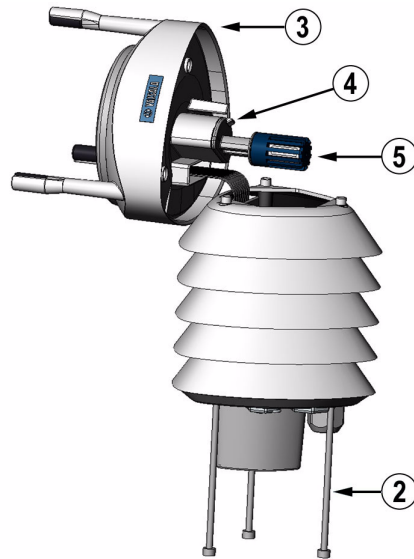
6. Turn the power on.

Figure 20 **Replacing the PTU Module**

Factory Calibration and Repair Service

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

Vaisala Service Centers

NORTH AMERICAN SERVICE CENTER

Vaisala Inc., 10-D Gill Street, Woburn, MA 01801-1068, USA.

Phone: +1 781 933 4500, Fax +1 781 933 8029

Email: 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

ASIAN 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

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.	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.	Wrong wiring or operation voltage not connected. Baud rate/start bits/parity/stop bit settings do not match between the device and the host.	Check the wiring and operation voltage, see Chapter 5, Wiring, on page 33. 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.
	Incorrect <cr><lf> settings in the terminal program.	In ASCII and NMEA protocols both <cr> and <lf> are required after each command. Check that your terminal program sends both when pressing enter.
Connection works but data messages not available.	Wrong device address in a SDI-12 command or a mistyped SDI-12 command (in SDI-12 a mistyped command is in no way responded). A command mistyped in ASCII/ NMEA mode while error messaging/text messages is disabled (aSU,S=N).	Request the device address with ?! command and then retype the command now with the correct address. Check the data query commands from Chapter 7, Getting the Data Messages, on page 49. Enable the error messaging using the WXT Configuration Tool or any terminal by setting aSU,S=Y, then try the command again.

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 WXT 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 41.
Some parameters are missing from the data messages.	The formatting of the data messages is not what you expect.	Format the data messages of the concern by using the WXT Configuration Tool or any terminal program. See Chapter 8, Sensor and Data Message Settings, on page 87.
An error message as a response to a command.	See section Error Messaging/ Text Messages on page 111.	See section Error Messaging/ Text Messages on page 111.

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 103.

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 87, 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 49.
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 109. In case of constant error, please contact Vaisala Service Center, see Vaisala Service Centers on page 108.

Rain and Wind Sensor Heating Control

The supervisor message aSU (see Supervisor Message on page 100) shows you continuously monitored information about rain and wind sensor heating (heating temperature Th and heating voltage Vh).

The heating temperature should stay above 0 °C when the heating is on (except in extremely cold conditions where the heating power is not sufficient). The heating voltage Vh should correspond to the heating voltage supplied. If there is a remarkable deviation, check the wiring. Note that wire gauge 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 Vh measurement behaves as follows:
	While heating is off, Vh indicates the positive peak value (V_p) of the heating voltage waveform.
	While heating is on, Vh indicates:
	- 0.35 x V_p in case of AC voltage
	- 0.70 x V_p in case of f/w rectified AC voltage

Operating Voltage Control

The supervisor message aSU (see Supervisor Message on page 100) shows you continuously monitored supply voltage level (Vs). In case of deviations between the supplied voltage and monitored voltage, check the wiring and the power supply.

Technical Support

For technical questions, contact the Vaisala technical support:

E-mail   helpdesk@vaisala.com
Fax   +358 9 8949 2790

CHAPTER 11
TECHNICAL SPECIFICATIONS

This chapter provides the technical data of 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

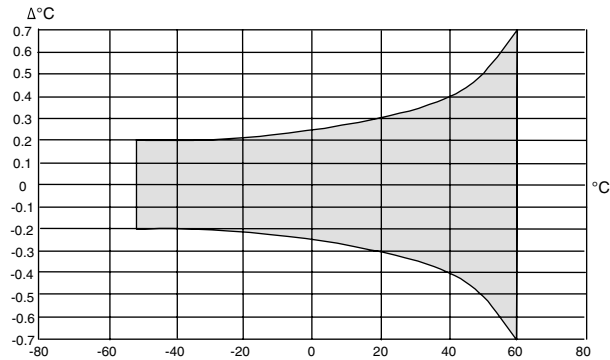| Property	Description/Value
Range	-52 ... +60 °C (-60 ... +140 °F)
Accuracy (for sensor element) at +20 °C (+68 °F) For accuracy over temperature range, see the following graph	±0.3 °C
Output resolution	0.1 °C (0.1 °F)
Units available	°C, °F

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 measuring interval	1 ... 3600 s (= 60 min), at one second steps

Table 14   Wind

Property	Description/Value
Wind speed range response time available variables accuracy output resolution units available	0 ... 60 m/s 0.25 s average, maximum, and minimum ±0.3 m/s or ±2 % whichever is greater 0.1 m/s (km/h, mph, knots) m/s, km/h, mph, knots
Wind direction azimuth response time available variables accuracy output resolution	0 ... 360° 250 ms average, maximum, and minimum ±2° 1°
Measurement frame averaging time update interval	1 ... 900 s (= 15 min), at one second steps, on the basis of samples taken at 4, 2 or 1 Hz rate (configurable) 1 ... 3600 s (= 60 min), at one second steps

Table 15   Precipitation

Property	Description/Value
Rainfall	cumulative accumulation after the latest auto or manual reset
collecting area	60 cm2
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), hits
units available	hits/cm2, 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)
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	5^1 ... 30 VDC
Average power consumption minimum maximum typical	 0.07 mA @ 12 VDC (SDI-12) 13 mA @ 30 VDC (constant measurement of all parameters) 3 mA @ 12 VDC (with default measuring intervals)
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
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 + 10 % 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

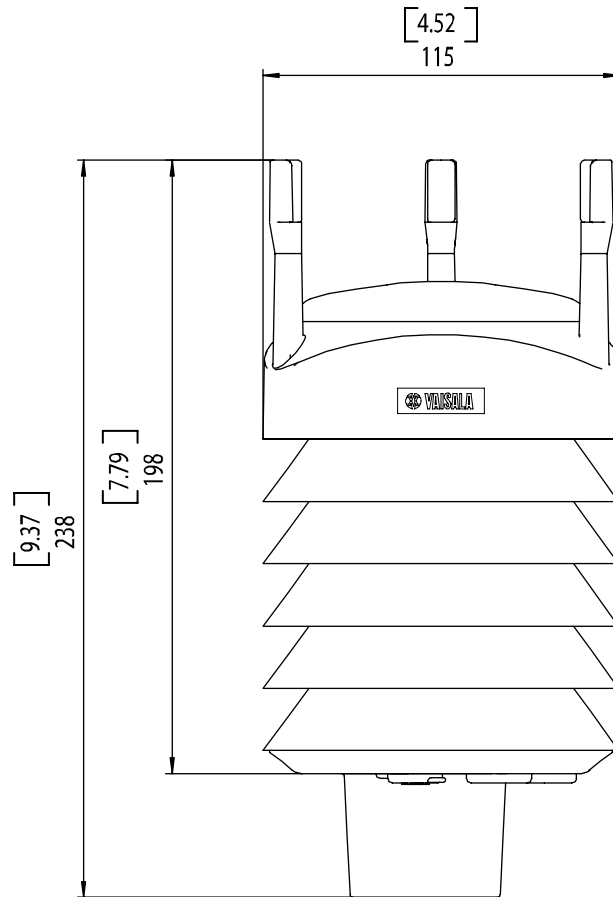| Order code	Description
WXT510PTUSP	WXT510 PTU module
215194	WXT Configuration Tool and service cable
212792	Mounting kit
215191	8-pin M12 connector (female) with 2 m cable
215193	8-pin M12 connector (female) with 10 m cable
215190	Bushing accessory kit
214692	WXT510 Radiation shield (5 pcs)
WXT510BOTTOMSP	WXT510 Bottom plate (with M12 connector)

Dimensions

Figure 22   WXT510 Dimensions in mm [inches]

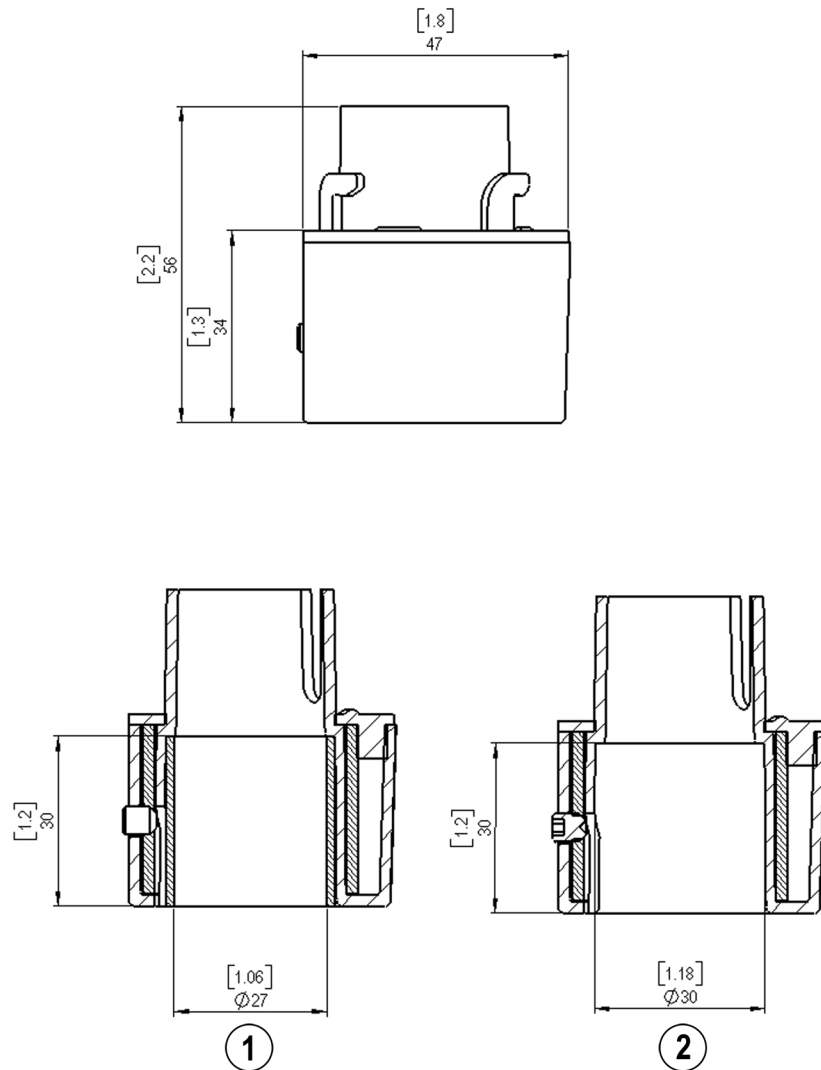**Figure 23   Mounting Kit Dimensions**

The following numbers refer to Figure 23 on page 112:

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

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

APPENDIX A
NETWORKING

Connecting Several 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 the WXT510 as described in Chapter 5, Wiring, on page 33. 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).

The WXT510s on the bus shall be assigned with different addresses (for example: aXU,A=0,1,2, ...). Thereafter the 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 eiher for simultaneous measurements of the units or consecutive measurements for one unit at time. See also .

RS-485 Serial Interface

Wiring

1. Make the RS-485 wiring of the WXT510 as described in .

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 SDI-12 v1.3 (aXU,C=1,M=S) or SDI-12 v1.3 continuous (aXU,C=1,M=R).

The WXT510s on the bus shall be assigned with different addresses (for example, aXU,A=0,1,2, ...). Thereafter the 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 eiher for simultaneous measurements of the units or consecutive measurements for one unit at time. See also

NOTE	No matter which communication protocol ASCII polled or NMEA query is chosen the error messaging parameter of the supervisor message must be disactivated 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

The 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,B=19200,D=8,P=N,S=1,L=25

WXT510 #2 communication settings:
1XU,A=1,M=P,C=3,B=19200,D=8,P=N,S=1,L=25

WXT510 #3 communication settings:
2XU,A=2,M=P,C=3,B=19200,D=8,P=N,S=1,L=25

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

0R0<crlf>

1R0<crlf>

2R0<crlf>

NMEA 0183 v3.0, Query

The NMEA 0183 query messages do not contain device address
information. Individual query commands can thus not be directed to
different 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
the WXT510.

Example (A bus with three WXT510s):

WXT510 #1 communication settings:
0XU,A=0,M=Q,C=3,B=4800,D=8,P=N,S=1,L=25

WXT510 #2 communication settings:
0XU,A=0,M=Q,C=3,B=4800,D=8,P=N,S=1,L=1000

WXT510 #3 communication settings:
0XU,A=0,M=Q,C=3,B=4800,D=8,P=N,S=1,L=2000

Now, when the XDR-query command $--WIQ,XDR*2D<crlf> is sent, the WXT510 #1 responds after 25 ms, the WXT510 #2 after 1000 ms and the 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 the 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<crlf> 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<crlf>
$WIXDR,C,24.0,C,0,C,25.2,C,1,H,47.4,P,0,P,1010.1,H,
0*54<crlf>
$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<crlf>
$WIXDR,C,25.8,C,2,U,10.7,N,0,U,10.9,V,1,U,3.360,V,
2*7D<crlf>
```

For the transducer IDs, see .

The maximum transducer ID is three when the 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<crlf> 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<crlf>
$WIXDR,C,23.5,C,4,C,24.3,C,4,H,49.3,P,4,P,1010.1,H,
3*59<crlf>
$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<crlf>
$WIXDR,C,25.8,C,6,U,10.6,N,4,U,10.9,V,5,U,3.362,V,
6*78<crlf>
```

The third 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<crlf>
$WIXDR,C,23.5,C,8,C,24.3,C,9,H,49.3,P,8,P,1010.1,H,
8*5F<crlf>
$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<crlf>
$WIXDR,C,25.8,C,10,U,10.6,N,8,U,10.9,V,9,U,3.360,V,
10*7C<crlf>
```

Now the response messages of all three 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,B=4800,D=8,P=N,S=1,L=25

WXT510 #2 communication settings:
0XU,A=1,M=Q,C=3,B=4800,D=8,P=N,S=1,L=25

WXT510 #3 communication settings:
0XU,A=2,M=Q,C=3,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<crlf>
$WIXDR,C,24.0,C,0,C,25.2,C,1,H,47.4,P,0,P,1010.1,H,
0*54<crlf>
$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<crlf>
$WIXDR,C,25.8,C,2,U,10.7,N,0,U,10.9,V,1,U,3.360,V,
2*7D<crlf>
```

The query for 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<crlf>
$WIXDR,C,23.5,C,1,C,24.3,C,2,H,49.3,P,1,P,1010.1,H,
1*59<crlf>
$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<crlf>
$WIXDR,C,25.8,C,3,U,10.6,N,1,U,10.9,V,1,U,3.362,V,
2*78<crlf>
```

The query for 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<crlf>
$WIXDR,C,23.5,C,2,C,24.3,C,3,H,49.3,P,2,P,1010.1,H,
2*5F<crlf>
$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<crlf>
$WIXDR,C,25.8,C,4,U,10.6,N,2,U,10.9,V,2,U,3.360,V,
3*7C<crlf>
```

If needed, for making the 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.
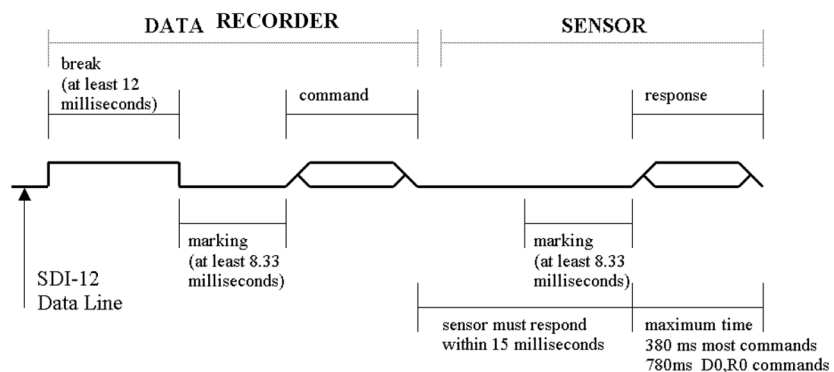

Figure 24   Timing Diagram

- 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.
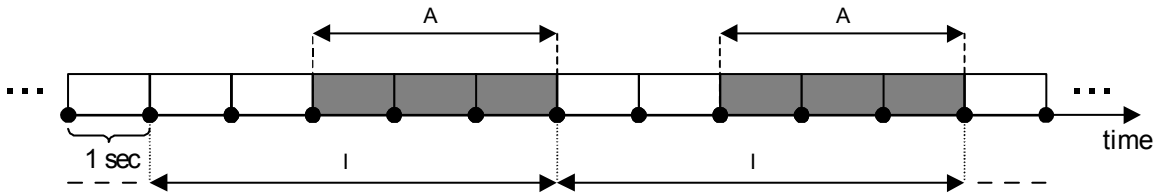
Case 2   I < A, all other communication protocols than SDI-12 (aXU,M=S). In this example I=2 sec and A=5 sec.
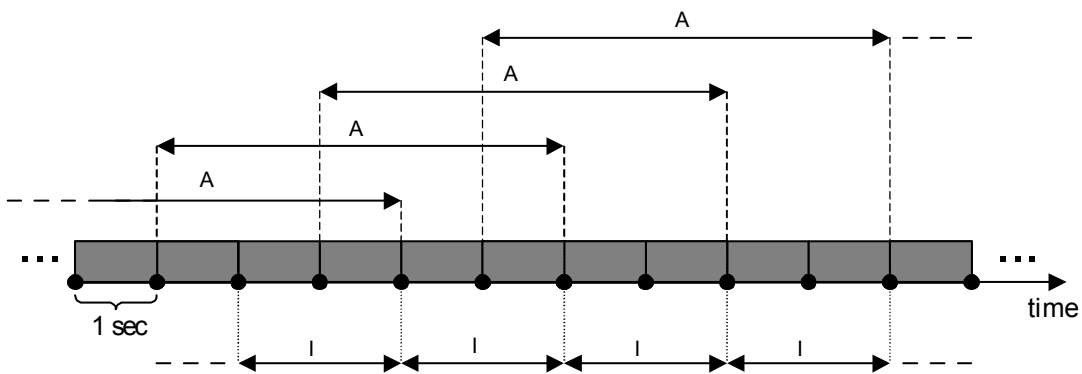
Case 3   Communication protocol SDI-12 (aXU,M=S). In this example A=3 sec. I does not have any function in this protocol.

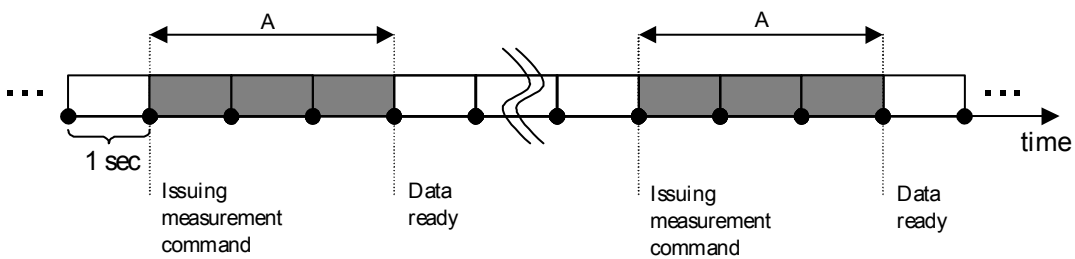**Figure 25**   **Wind Measurement Averaging Method**

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.