USER'S GUIDE

Vaisala Ultrasonic Wind Sensor
WS425 F/G

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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 features and advantages of Vaisala Ultrasonic Wind Sensor WS425 F/G.

- Chapter 3, Installation: This chapter provides you with information on the installation and alignment procedures, and connections of the power supply and fiber optic modem.

- Chapter 4, Operation: This chapter contains information needed to operate Vaisala Ultrasonic Wind Sensor WS425 F/G.

- Chapter 5, Operating Principle: This chapter provides you with a brief explanation of the operating principles of Vaisala Ultrasonic Wind Sensor WS425 F/G and its power supply.

- Chapter 6, Maintenance: This chapter contains instructions for the basic maintenance, fault isolation and installation and removal of the field replaceable units of the Vaisala Ultrasonic Wind Sensor WS425 F/G.

- Chapter 7, Technical Data: This chapter provides the technical data of the product and lists the field replaceable units, and the accessories.

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.

Product Related Safety Precautions

The Vaisala Ultrasonic Wind Sensor WS425 F/G delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:

WARNING	Ground the product, and verify outdoor installation grounding periodically to minimize shock hazard.

CAUTION	Do not modify the unit. Improper modification can damage the product or lead to malfunction.

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.

License Agreement

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

Warranty

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

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

This warranty is however subject to following conditions:

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

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

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

a)normal wear and tear or accident;

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

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

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

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

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

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

CHAPTER 2
PRODUCT OVERVIEW

This chapter introduces the features and advantages of Vaisala Ultrasonic Wind Sensor WS425 F/G.

Product History - ASOS Program

Vaisala Ultrasonic Wind Sensor WS425 F/G was originally developed for the Automated Surface Observing Systems (ASOS) program, and due to this fact this document contains references to the ASOS.

The ASOS program is a joint effort of the US National Weather Service (NWS), the Federal Aviation Administration (FAA), and the Department of Defense (DOD). The ASOS serves as the primary weather observing network of the United States. It is designed to support weather forecast activities and aviation operations and, at the same time, support the needs of the meteorological, hydrological, and climatological research communities.

Introduction to Ultrasonic Wind Sensor WS425 F/G

Thank you for choosing Vaisala Ultrasonic Wind Sensor WS425 F/G. It measures wind speed and direction from the smallest breeze to hurricane force gales, including gusts.

The patented three transducer layout provides superior data availability and accuracy in all wind directions. The effects of temperature, humidity, and pressure are fully compensated. The sensor communicates to the system or data logger via an fiber optic connection. The message format is ASOS compatible.

The device has no moving parts, so it is virtually maintenance free. The stainless steel construction makes it resistant to contamination and corrosion. The sensor heating function of the ice-free model prevents freezing rain and snow build-ups and thus guarantees uninterrupted operations throughout the year.

Figure 1   Ultrasonic Wind Sensor WS425 F/G

Wind measurement and wind data is important in meteorology, aviation, transport safety, in ships and harbors, and also in many industrial applications. Vaisala manufactures wind sensors for all these needs, from low cost combined units to sophisticated totally heated sensors for extreme weather conditions. For more information, please contact your Vaisala representative or visit www.vaisala.com.

Ultrasonic Wind Sensor WS425 F/G Components
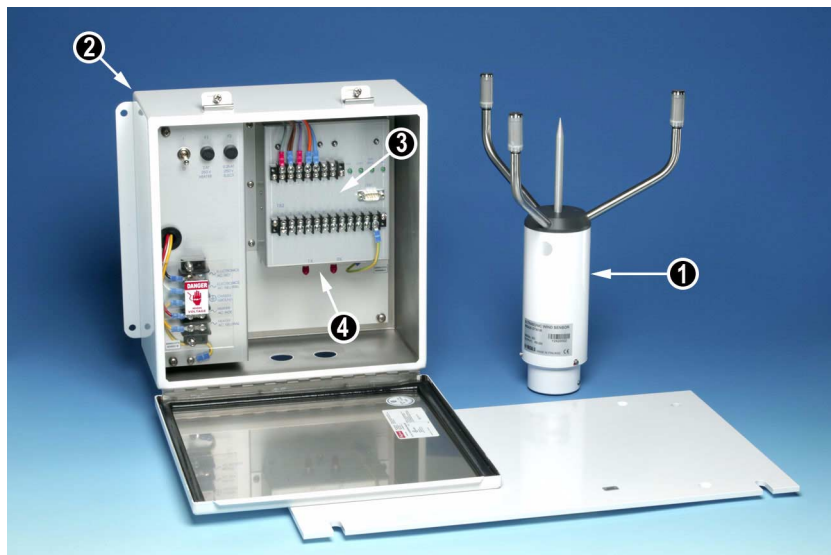
Figure 2   Components Overview

The following numbers refer to :

1 = Wind sensor

2 = Power supply

3 = Module assembly, power supply

4 = Fiber optic modem (FOM) assembly

The device consists of the following field replaceable units (FRU):

- Wind sensor, model WS425 F/G (item 1 in)
- Power supply,WS425PowerUS or WS425PowerEU (item 2)
- Module assembly, power supply (item 3)
- Fiber optic modem assembly (item 4)
- Cable assembly, sensor WS425 F/G ()

The FRUs are represented individually in Figures 3-6.
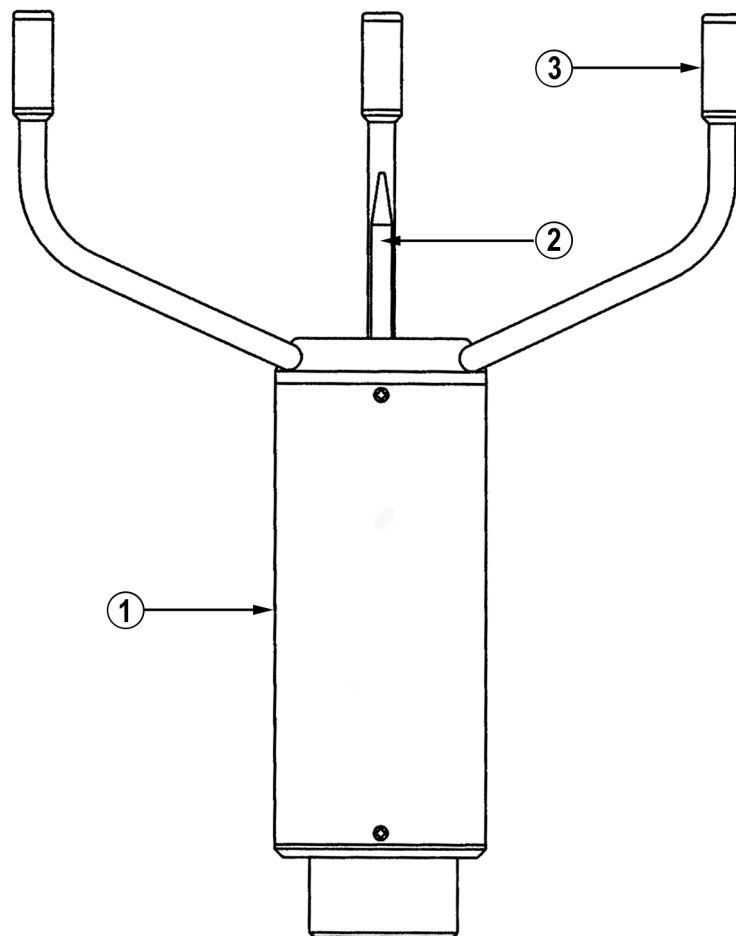
Figure 3   Schematic of Ultrasonic Wind Sensor WS425 F/G

The following numbers refer to Figure 3 on page 18:

1   =   Sensor body

2   =   Bird spike

3   =   Transducer (3 pcs)
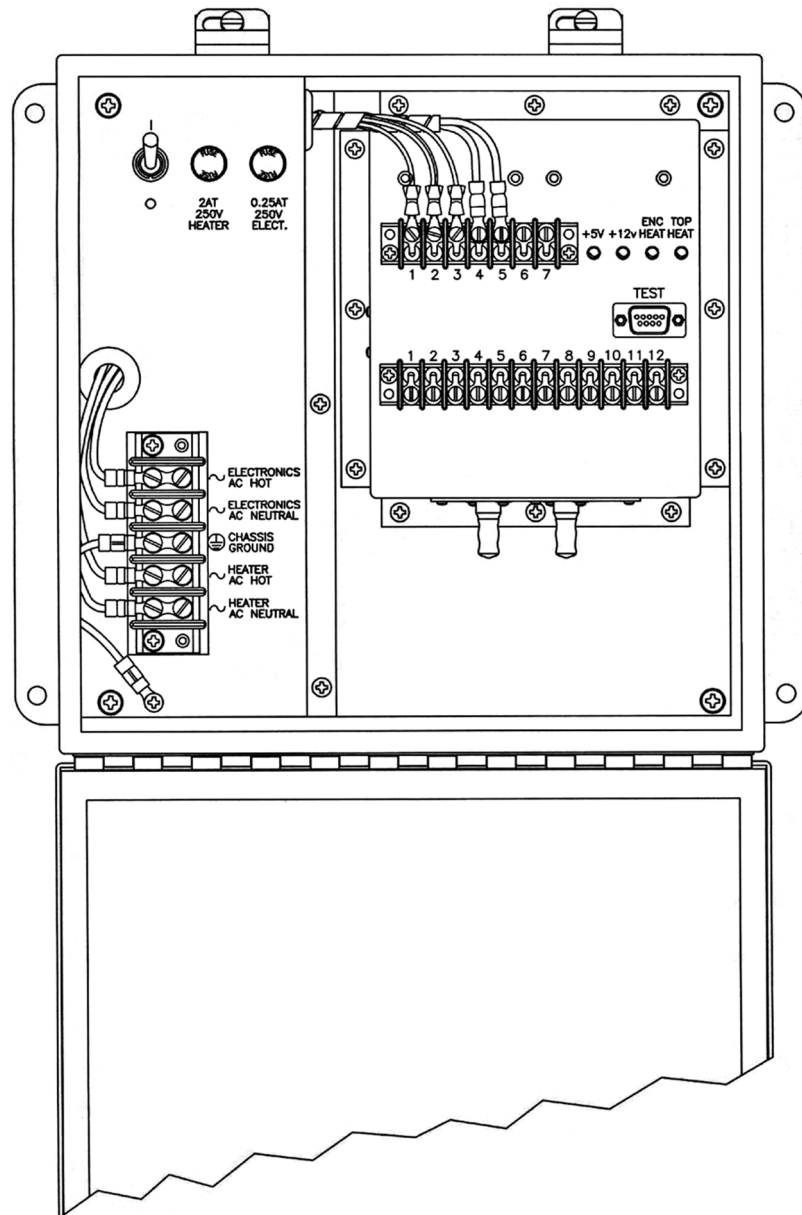
Figure 4   Ultrasonic Wind Sensor Power Supply

NOTE	Figure 4 on page 19 represents the WS425PowerUS power supply made for 115 VAC - the European model WS425PowerEU has different primary (internal) wiring and is made for 240 VAC. The customer must check local regulations concerning the correct and safe wiring of the power supply.
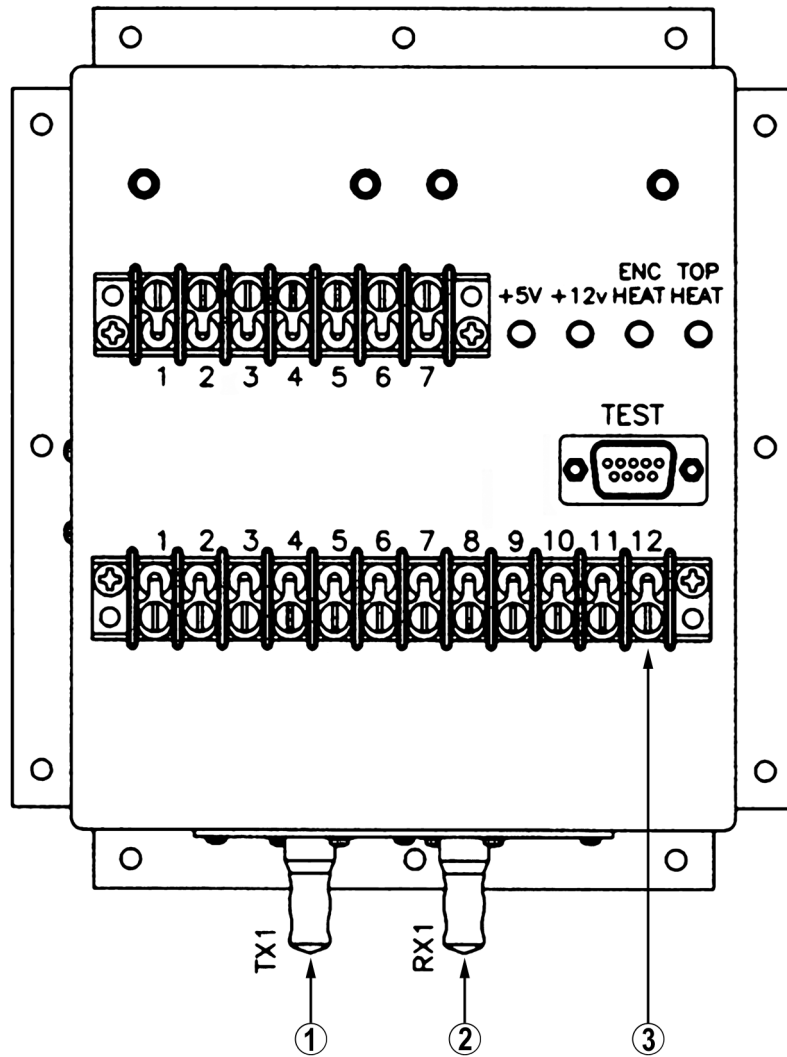
Figure 5   Power Supply and FOM Module Assembly

The following numbers refer to Figure 5 on page 20:

1   =   Fiber optic connector TX

2   =   Fiber optic connector RX

3   =   12-position terminal block (TB2, see also Figure 11 on page 30 and Table 2 on page 31)
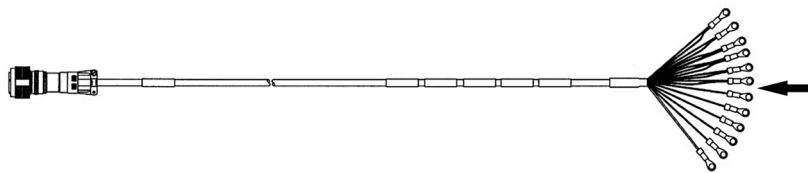
Figure 6   Cable Assembly, Sensor

The sensor interface cable assembly is 11.2 m in length. The 12 ring lugs (indicated by the arrow in Figure 6 on page 21) of the sensor interface cable are each numbered 1-12. Connect them to the correspondingly numbered terminal positions in the power supply assembly terminal block 2; see Figure 5 on page 20, Figure 11 on page 30 and Table 2 on page 31.

Accessories

Ultrasonic Wind Sensor WS425 F/G also has the following optional accessories:

-        Fiber optic modem, FOM111
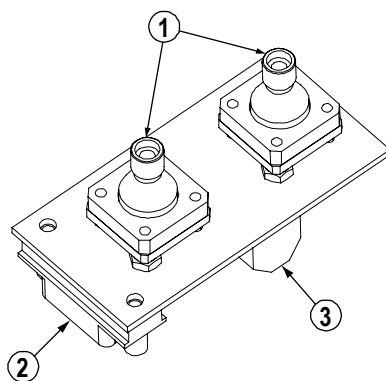
Figure 7   Fiber Optic Modem FOM111

The following numbers refer to Figure 7 on page 21:

1   =   Fiber optic connectors

2   =   RS-232 connector for PC cable

3   =   Screw wire terminals for operating voltage

When using the fiber optic connection between the Ultrasonic Wind sensor and a personal computer, two fiber optic modems are needed. One is supplied as standard with the Ultrasonic Wind sensor enclosed in the power supply module housing. The other is available from Vaisala as an optional accessory. Please note that FOM111 is supplied without a housing. If needed, the customer must source a proper housing locally.

The fiber optic cable is connected to the connectors of the fiber optic modem located in the power supply module assembly and at the other end to the connectors of the optional FOM111 fiber optic modem. The FOM111 in turn is connected to the host system personal computer/data logger via an RS-232 cable. Note that the RS-232 cable between the PC/ data logger and the fiber optic modem is different than the one used between the PC and the TEST connector in the power supply module (see Figure 5 on page 20).

A DC power supply for the fiber optic modem is also required. See Connecting Fiber Optic Cable on page 28 and Connecting Fiber Optic Modem FOM111 on page 28 for further instructions on how to make the fiber optic connections.

CHAPTER 3
INSTALLATION

This chapter provides you with information on the installation and alignment procedures, and connections of the power supply and fiber optic modem.

Required Tools

- 3-millimeter Allen wrench

- 9/16-inch crescent wrench (2 each)

- Flat blade screwdriver for #6 screw

- Phillips screwdriver for ¼-inch x 20 flathead screw

- Electrical tape

- Verifier

- Laptop with a Diagnostics Program

- RS-232 cable

- Tape measure

NOTE	Packaging materials
	The WS425 F/G sensors and power supplies are shipped in cardboard containers with custom foam pieces to support these items during the shipment. It is very important to keep all the original packing materials in case the items need to be returned for repair service in the future.
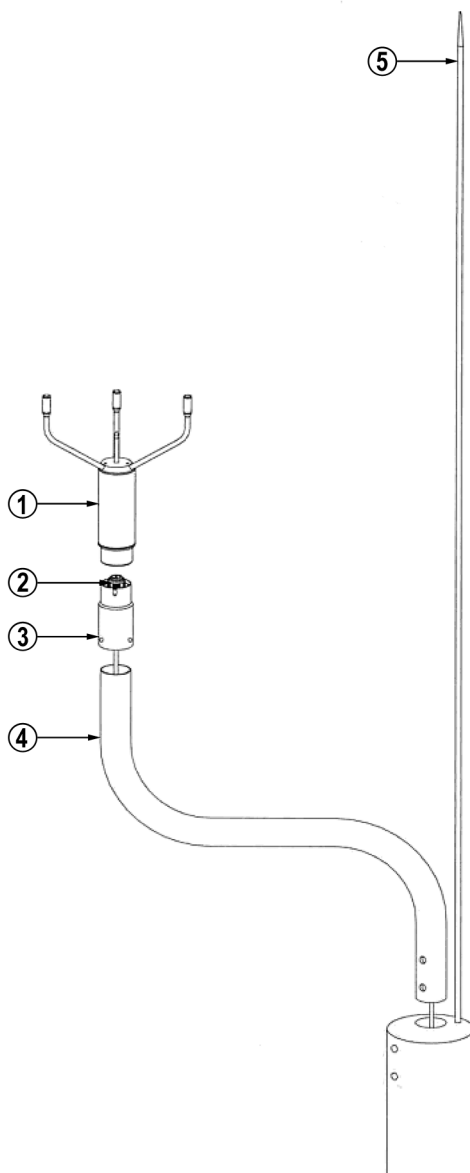
Figure 8   WS425 F/G Tower Assembly

The following numbers refer to Figure 8 on page 24:

1   =   WS425 F/G

2   =   Cable assembly

3   =   Adapter for F/G models

4   =   Mounting tube

5   =   Lightning rod (not provided by Vaisala)

Installation of Mounting Arm and Sensor Cable

1.   Tilt the tower to a horizontal position.

2.   Remove the mounting tube from the shipping container.

3.   Find the end of the mounting tube with the two cross holes.

4.   Insert this end of the mounting tube on the pole.

5.   Rotate the mounting arm in its hole until the two cross-holes in the pole are aligned with the two cross-holes in the mounting tube.

6.   Insert the bolts into the cross-holes and tighten them

7.   Remove the adapter from the sensor shipping box and place it over the mounting tube.

8.   Tighten the three set screws of the clamp at the bottom of the adapter only lightly (these will be tightened during the sensor alignment procedure).

9.   Remove the sensor cable from the shipping box.

10. At the end of the sensor cable with ring lugs, take about half of the individual wire and fold it back. See Figure 9 on page 25.

11. Feed the cable through the adapter, mounting arm, tower, tower pivot, and the conduit going to the power supply, starting with the wrapped end of the cable into the open end of the adapter at the end of the mounting arm.
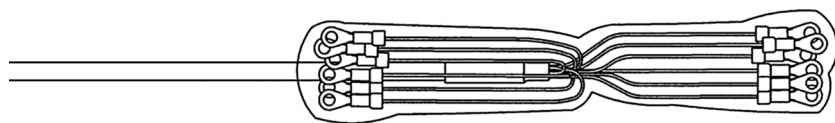
Figure 9   Sensor Cable Installation

Wrap electrical tape around the wires tightly so that later it can be easily threaded through the ½" conduit.

Installation of Wind Sensor

1. Open the sensor shipping box and remove the sensor.

2. Take the wind sensor and connect the cable connector to it. Then insert the sensor over the end of the adapter. The sensor needs to be rotated until its alignment pin slides into the slot of the adapter. Tighten the single set screw that secures the sensor to the adapter.

CAUTION	After removing the sensor from the box, do not impact the three transducers against hard objects or damage to the sensor might result.

Installation of Power Supply

Installation of Power Supply on Pole Mast

1. Take the mounting plate out of the mounting kit assembly container.

2. Take the power supply out of its shipping container.

3. Attach the power supply to the mounting plate with four flathead screws and four each flat washers, lock washers and ¼-20 nuts found in the mounting kit assembly container.

4. After these four screws are tightened, mount the entire assembly on the pole mast, using the four hex-head screws as shown in Figure 10 on page 27. The customer must provide the pole mast and the pole mast installation plate.
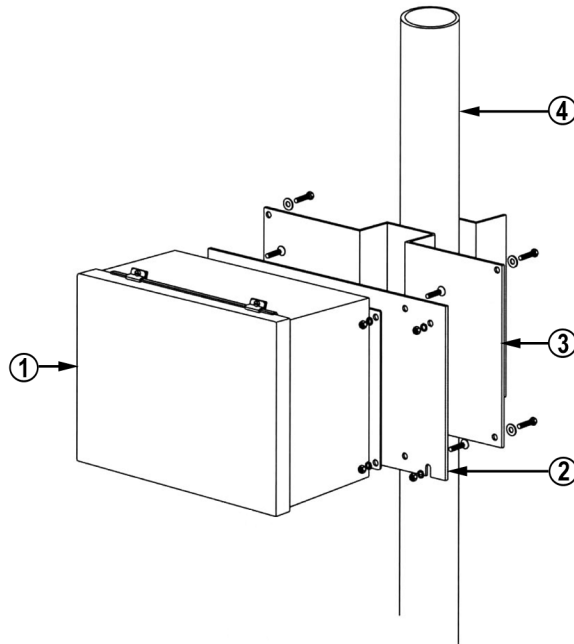
Figure 10   Power Supply and Mount

The following numbers refer to Figure 10 on page 27:

1   =   WS425PowerUS or WS425PowerEU power supply

2   =   Power supply mounting plate

3   =   Pole mast installation plate (not provided by Vaisala)

4   =   Pole mast (not provided by Vaisala)

Connecting Lightning Ground

Connect the existing ground wire to the threaded ground stud at the bottom left of the power supply with the provided lock washer and nut found in the mounting kit assembly.

Connecting Fiber Optic Cable

WARNING	The fiber optic cable and the power cable share the same conduit. Before proceeding make absolutely sure that the AC power is turned off at the host system power distribution system. Then take an AC voltmeter and measure the AC voltage between the black wire and each of the green white and yellow wires; and between the red wire and each of the green white and yellow wires. All the readings must be zero before proceeding.

1. Thread the two fiber optic cables and the five power wires through the conduit hole at the bottom right of the power supply.

2. Use the conduit nut to secure the conduit at the bottom of the power supply.

3. After removing the protective covers, connect the fiber cable marked TX to the fiber optic connector on the left.

4. Connect the fiber optic cable marked RX to the fiber optic connector on the right.

Connecting Fiber Optic Modem FOM111

1. Remove the protective covers from the optic fiber cables.

2. Connect the fiber optic cable marked TX to the correspondingly marked connector in the modem.

3. Connect the fiber optic cable marked RX to the correspondingly marked connector in the modem.

4. Connect the DC power wires to the modem screw terminals.

5. Connect the modem to a PC using the RS-232 cable. The modem is now ready for use.

Connecting AC Power

CAUTION	Make sure you have correct mains voltage power supply (WS425PowerUS or WS425PowerEU).

1. Remove the protective cover plate over the AC power terminal block.

2. Connect the AC power wires to the AC power terminal block as shown in Figure 11 on page 30, starting with the green wire. Double-check that each wire is connected as shown in Figure 11 on page 30.

3. Restore the protective cover plate over the AC power terminal block.

Connecting Sensor Interface Cable

1. Feed the sensor interface cable through the left hole at the bottom of the power supply.

2. Use the conduit-nut to secure the conduit at the bottom wall of the power supply box.

3. Connect the 12 ring lugs of the sensor interface cable to the 12-position terminal block (see Figure 11 on page 30). Follow the numbering scheme next to the terminal block and on the labels of the individual wires.
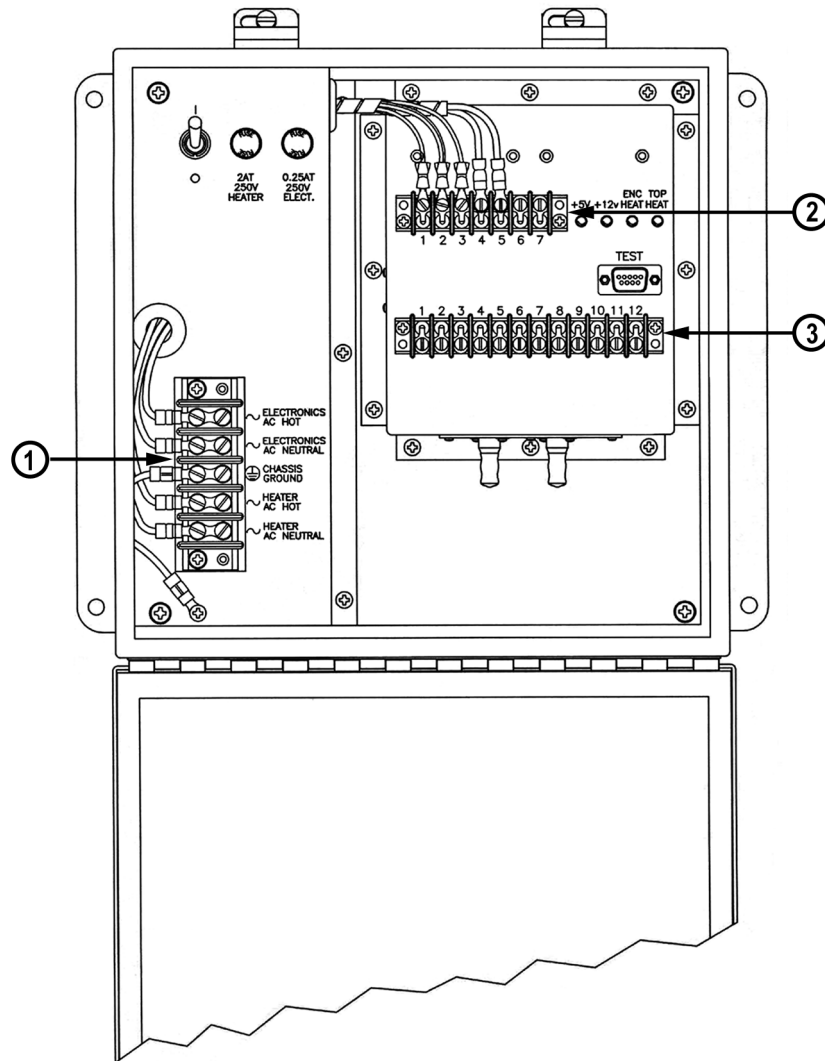
Figure 11   Power Supply Terminal Blocks

The following numbers refer to :

1   =   AC power terminal block

2   =   Terminal block 1 (TB1)

3   =   Terminal block 2 (TB2)

Power Supply Terminal Blocks

Table 1   Terminal Block 1

TB1		
Terminal	Name	Description
1	12.6 V_H1	12.6 VAC transformer, line 1
2	12.6 V_CT	12.6 VAC transformer, center tap
3	12.6 V_H2	12.6 VAC transformer, line 2
4	36 V_H1A	24 VAC transformer, line A
5	36 V_H2A	24 VAC transformer, return A
6	36 V_H1B	24 VAC transformer, line B (internally connected to 36 V_H1A)
7	36 V_H2B	24 VAC tansformer, return B (internally connected to 36 V_H2A)

Table 2   Terminal Block 2

TB2		
Terminal	Name	Description
1	TOP_HEAT	Top heater line, switched 24 VAC
2	ENCLOSUREHEATB	Two of two enclosure heater lines, switched 24 VAC
3	ENCLOSUREHEATA	One of two enclosure heater lines, switched 24 VAC
4	RETURN_36VAC_B	Heater return, ground at sensor
5	RETURN_36VAC_A	Heater return, ground at sensor
6	TOP_CTRL	To heater control, >+3 V = ON
7	ENLOSURE_CTRL	Enclosure heater control, >+3 V = ON
8	SENSOR+12V	+12 VDC to sensor
9	SENSOR_TXD	Connect to sensor TX data line
10	SENSOR_RXD	Connect to sensor RX data line
11	GND (12V Common)	Ground return from sensor
12	GND (RS232 Common)	Connect to sensor cable shield

Conducting Off-Line Test

1. Turn on the AC power to the wind sensor in your system (system power distribution).

2. Turn on the power switch in the power supply.

3. Connect a laptop to the TEST connector in the power supply with an RS-232 cable. Run the Diagnostics Program on the laptop. Choose the option that connects the sensor to the laptop with the system disconnected.

4. Issue the WA command. The sensor must respond with a P status.

5. Place the verifier over the sensor and completely cover it with the included bag. Pull the bag drawstrings to close it off at the sensor alignment adapter.

6. Issue five WA commands spaced at least five seconds apart. All five responses must have P status.

7. Turn off the power through the switch in the power supply before performing the alignment procedure.

Aligning the Wind Sensor

Magnetic Declination Correction

One transducer arm is permanently marked with an N for north and another with an S for south.

NOTE	Aligning might be easier if you mark the sensor body, for example, with paint or colored tape, to indicate north and south so that it can be seen from the ground.

Wind direction can be referenced to either the 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. See Figure 12 on page 33.
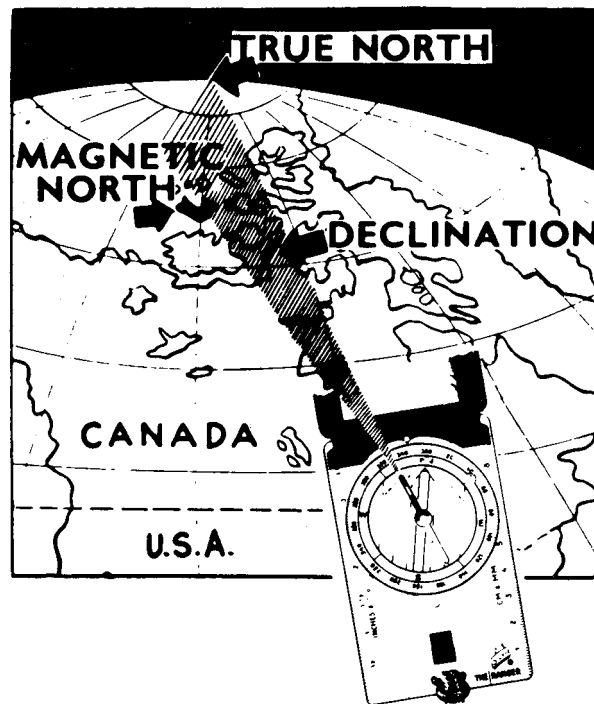
Figure 12   Sketch of Magnetic Declination

NOTE	The source for the magnetic declination must be current as the declination changes over time.

Compass Alignment with Mast Adapter

The following steps aim the wind sensor when using the 1-inch adapter for mounting:

1. Use a compass to determine that the N-S transducer heads of the ultrasonic wind sensor are exactly in line with the compass. Adjust the heads by moving them to the left or right. For the correct ground position of the installer, see Figure 14 on page 35.

2. If the alignment is not correct, lower the wind mast or tower.

3. Loosen the three set screws of the clamp at the bottom of the sensor alignment adapter and rotate the sensor so that the heads marked with the N and with the S are exactly aligned to north and south when the tower is set up. Tighten the clamp screws.

4. Raise the tower to the vertical position. shows the correct alignment.
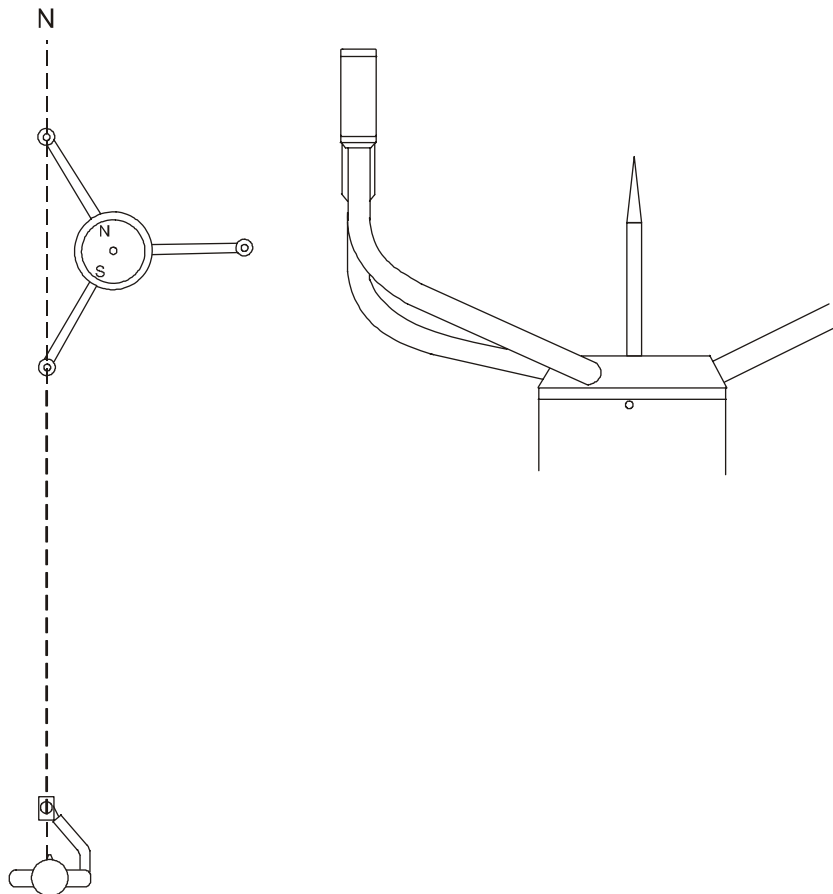
Figure 13   Correctly AlignedWS425 F/G Sensor
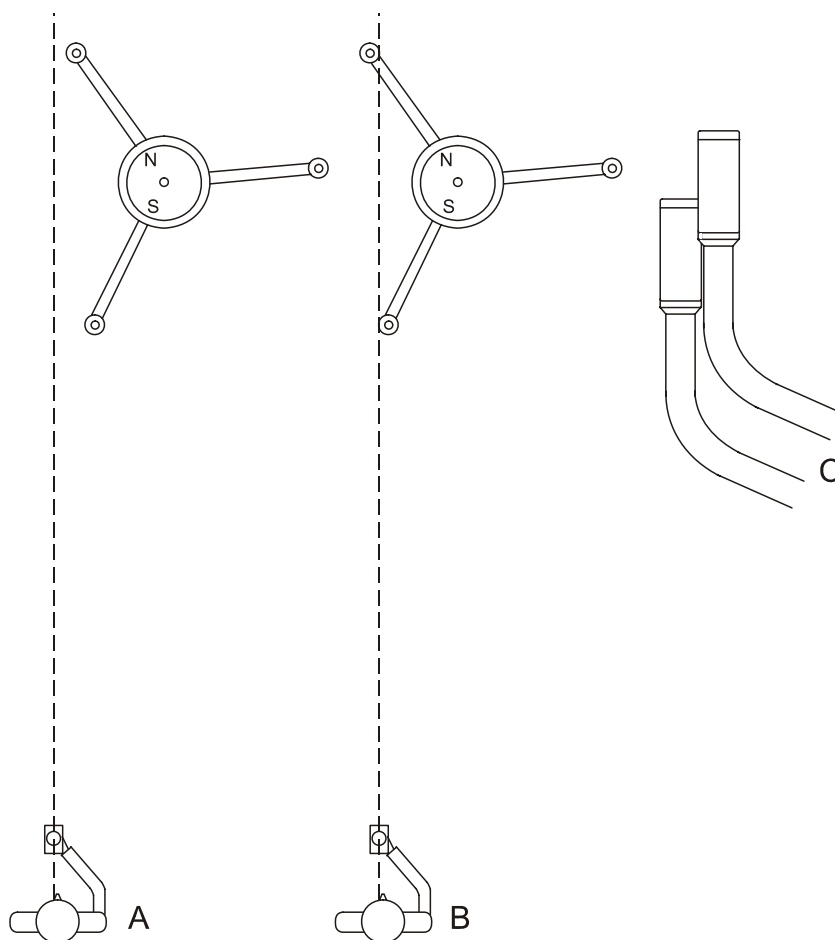
Figure 14   Adjusting the N-S Heads

The following letters refer to Figure 14 on page 35:

A = The installer is too far to the left.

B = The installer is in line with the sensor.

C = The appearance of the sensor is shown when the installer is in the correct position. The sensor, however, is not correctly aligned.

CHAPTER 4
OPERATION

This chapter contains information needed to operate Vaisala Ultrasonic Wind Sensor WS425 F/G.

Power On/Off

The power switch is located in the power supply enclosure at the top left. When turned on, the two LEDs labeled +5 V and +12 V will be turned off if their respective supply is operational. If neither is turned on, check the 0.25 A fuse and make sure that AC power is present.

System Operation

In normal system operation, the sensor communicates with the host system system via two fiber optic cables. This normal state exists when no cable is plugged into the RS-232 DB-9 connector labeled TEST in the power supply.

Diagnostic Operation

When a laptop computer is plugged into the TEST connector via the DB-9 connection in the power supply, the following states exist:

RTS	DTR	Description of States
LO	LO	Normal host system operation (TEST, connector unplugged).
HI	LO	PC talks to the sensor, host system is disconnected
LO	HI	PC talks to the host system, Sensor is disconnected
HI	HI	Host system is connected to the Sensor with the PC listening to both the transmit and receive lines

A special Diagnostics Program for the laptop PC is provided that allows RS-232 communications and sets the RTS and DTR lines to the desired states.

RS-232 Data Format

Ultrasonic Wind Sensor WS425 F/G communicates via an RS-232 serial interface. The host system sends American Standard Code for Information Interchange (ASCII) characters to the Ultrasonic Wind sensor and waits for the appropriate response. The sensor transmits an ASCII response to various interrogation commands within 250 milliseconds at 2400 bits per second. The sensor is programmable to operate at data rates 2400, 4800, or 9600 bits per second (bps). The communication link is via an RS-232 serial port interfaced to a fiber optic modem utilizing separate cables for transmitting and receiving data. Control characters and control procedures are compatible with ANSI x 3.28 and ANSI x 3.66 respectively. The data format consists of the following:

- 1 start bit

- 8 data bits

- 1 stop bit

- No parity

- 2400 bits per second, programmable to 9600 bps

- Full duplex

- Serial asynchronous

- Configures as Data Terminal Equipment (DTE)

All user configuration parameters are stored in the non-volatile memory.

Command Set

There are 18 interrogation requests that the host system and/or operator can send to the Ultrasonic Wind sensor. They are listed below. The sensor response to each command consists of a fixed-length message. In each of the command descriptions below, CR is an ASCII carriage return control character and LF is an ASCII line feed control character.

NOTE	The Ultrasonic Wind sensor only responds to upper case characters.

Table 3   Ultrasonic Wind Interrogation Requests

ASCII Request	Description
WB	Baud rate control
WFIRMWARE	Downloading firmware
WA	Average wind speed and direction message
WL	Heater function automatically controlled by sensor
WM	Heaters locked on
WN	Heaters locked off
WS	Verbose BIT results and status
WJ	Set speed and direction averaging time
WD	Report BIT status
WF	Send test data message
WR	Execute system reset
WCAL	Sensor self calibration
WH	Display sensor command Help menu
WT	Short response BIT results and status
WSST	Return static speed of sound and sonic temperature
WSTK	Calibrate static speed of sound and sonic temperature from ambient temperature
WCDV	Return sensor self calibration data
WATE	Return sensor measurement with reduced signal amplitude

The **WA** command is executed by the ASOS at an interval of between one and thirty seconds. For the **WA** command, the sensor responds to the ASOS interrogation poll within 250 milliseconds of receiving the

request. The **WD**, **WT**, **WF**, and **WR** commands are executed by the ASOS periodically to perform diagnostic checks.

The **WH**, **WS**, **WSST**, **WSTK**, **WCDV**, and **WATE** commands are primarily initiated by an operator accessing the sensor via an external laptop through the sensor's RS-232 port.

WB Command

This command is used to control the baud rate. The command format is:

WB*9600* CR LF

where

9600   = In this case, represents 9600 bps, and would be replaced with 2400 bps or 4800 bps as required to select those values for a baud rate.

CR   = Carriage return (ASCII control character)

LF   = Line feed (ASCII control character)

When the command is received, the sensor will terminate measurements and will respond with the following:

```
BAUD RATE 9600 after re-initialization CR LF
```

Please wait for the completion of configuration change save CR LF or another value instead of 9600 as chosen.

The sensor will then resume normal operations after performing a complete power up self-test. The next command character must be at the new baud rate. The character framing will remain 8 data bits, no parity, one start and stop bit. The new operating state will be maintained through power cycles in the non-volatile memory.

VFIRMWARE Command

This command is used to invoke firmware downloads. The command format is:

WFIRMWARE CR LF

The sensor will stop the current measurement activity when it receives this command, and will respond with

```
PASSWORD? CR LF
```

At this time, the sensor will expect the password in capital letters and CR LF in caps to be typed. If the password is not correct, the command will be terminated unsuccessfully with the response string:

```
INVALID PASSWORD CR LF
```

and normal operation will resume.

If the password is entered correctly, the sensor will respond with:

```
READY FOR FIRMWARE CR LF
```

At this time, the host computer must send the firmware to the sensor in a standard Intel hex format. Flow control must be accomplished by the host holding off the next record until the echo of the current record is completely and successfully received. The host may send complete records without waiting character by character for the echo check. The host will perform error recovery by checking each character in the record echo against what was sent. The host must repeat records with errors. The sensor will perform the power on a initialization sequence once the firmware download completes.

For firmware v2.04 and above, downloading new firmware will not modify any calibration information already saved in the sensor if this calibration information is still meaningful to the new firmware. Observe the power on initialization message following the firmware download. If the new firmware requires the calibration operations to be repeated, the following message will be displayed:

```
WARNING, SENSOR IS UNCALIBRATED. PERFORM CALIBRATION
BEFORE USE.
```

If this message does not appear prior to the ready indication, you may assume the sensor calibration remains intact.

WA Command

This command requests the averaged wind speed and direction message with peak winds. The command format is:

WA CR LF

The sensor response to the **WA** command consists of the averaged wind speed and direction data, peak wind speed, and associated direction. The average wind speed is a scalar running average of the fundamental one second interval wind speed measurement made by the sensor. The average direction is a unit vector running average over the same run length set with the **WJ** command. The peak wind speed is the largest scalar running average wind speed during the number of seconds before the command set by the **WJ** command for average wind. The peak wind run interval is also set in the **WJ** command. The peak wind direction is the running unit vector average direction calculated at the same time the peak speed was found.

The command also indicates the sensor status, the averaging time for average and peak wind speed and wind direction and signal quality, which shall be a numeric value from 0 to 99 representing the data quality of processed data samples during the averaging interval. For example, a value of 99 would signify that all data samples were determined to be valid and were processed during the averaging interval. If some samples were determined to be "missing", these samples would not be processed and the reported signal quality would be a proportional value less than 99.

Example of the WA Command Message

The following is an example of the message from the wind sensor for the **WA** command:

```
WAP2131870503012.6014.7K99xx
```

Table 4   **Explanation of the WA Command Message**

Byte	Description	Value
1	Start of text	STX
2	Sensor ID	W
3	Command identifier	A
4	Sensor status (notes b, c)	P/F/H
5-7	Averaged wind direction (degrees)	213
8-10	Wind direction (degrees) @ peak wind speed	187
11-12	Averaging time for wind speed and direction (seconds)	05
13-14	Averaging time for peak wind speed and direction (seconds)	03
15-19	Averaged wind speed	012.6
20-24	Peak wind speed since last WA command	014.7
25	Wind speed units (knots)	K

Table 4   Explanation of the WA Command Message

Byte	Description	Value
26-27	Signal quality	99
28-29	Hex checksum (note a)	xx
30	End of text	ETX
31	Carriage return	CR
32	Line feed	LF

Notes:

1. Bytes 28-29 are the modulo 256 hexadecimal checksum of the ASCII values calculated for bytes 2 through 27.

2. Sensor response message status byte in all applicable messages reporting a sensor status, the status byte (byte 4) indicates the following: P (Pass) indicates that all diagnostic tests have passed and the sensor is functioning normally. F (Fail) indicates that one or more of the diagnostic tests have failed. The user can then request diagnostics and extended tests (**WD**) to further isolate the problem. H (Heater failure) indicates that the wind reading is valid but one or more built-in heater diagnostic tests have failed.

3. When the status byte is F, the wind direction fields are set to 999 and the wind speed fields are set to 999.9 in the applicable sensor response messages. This does not apply to the **WF** command response.

WL Command

This command sets the heater function to be automatically controlled by the sensor. The command format is:

WL CR LF

The sensor response to the **WL** command indicates the status of heater control after execution. In this mode the sensor automatically controls the operation of the transducer heaters, based on an internal sensor algorithm.

The response to this command is the following:

```
Heaters on automatic control CR LF
```

WM Command

This command locks the heater function ON. The command format is:

WM CR LF

The sensor response to the **WM** command indicates the state of the transducer heaters after execution. In this mode the heater has been energized by the external command.

The response to this command is the following:

```
Heater control locked ON CR LF
```

The command will energize the array heater circuit. The heaters will remain on until the power supply watch dog circuit disables them (three seconds later) to prevent damage to the sensor from overheating. The normal operation is reset by either the **WM** or **WL** command, or cycling sensor power. Note that the watch dog circuit will lock the heaters off if the command is not undone.

WN Command

This command locks the heater function OFF. The command format is:

WN CR LF

The sensor response to the WN command indicates the state of the transducer heaters after execution. In this mode the heater has been de-energized by the external command.

Notes:

1. The **WL**, **WM**, or **WN** commands override the previously executed heater control command.

2. On sensor power-up and after the **WR** command, the heater control function is initialized in the automatic mode (**WL**).

The response to this command is the following:

```
Heater control locked off CR LF
```

The command will cause the sensor to turn all heating control circuits off, disabling heating. This state will remain until either the **WR** or **WM** command is issued, or the sensor power is cycled.

WS Command

This command requests the verbose Built-In Test (BIT) results. The command format is:

WS CR LF

The command gives a textual run down of the results of all Built-In Tests (BITs). In every line except the bad reading counter, the pass/fail indication is given with the single character P or F. This is followed by the description of the parameter measured, which is followed by the actual measured value. The Bad 1 second readings counter is a running total of the number of fundamental 1 second readings that were flagged as bad by the sensor. This number rolls over to zero after reaching a count value of 65535. It is initialized to zero on each power-up or any other activity that performs a re-initialization of the sensor.

The time measurement quality indices are given for path numbers defined as follows:

- Path 0 is from south transducer to north transducer

- Path 1 is from north transducer to south transducer

- Path 2 is from north transducer to east transducer

- Path 3 is from east transducer to north transducer

- Path 4 is from east transducer to south transducer

- Path 5 is from south transducer to east transducer

A listing for the command response is given below with representative values.

```
CR LF
P Heater voltage 22.3 Volts CR LF
P Array heater resistance 4.9 Ohms CR LF
P Heaters off voltage 0.1 Volts CR LF
P Incoming supply voltage 12.2 Volts CR LF
P 5.0 volt supply 5.05 Volts CR LF
P 10 volt supply 10.2 Volts CR LF
- Bad 1 second reading counter 0 CR LF
P Path 0 signal quality index 99 CR LF
P Path 1 signal quality index 99 CR LF
P Path 2 signal quality index 99 CR LF
P Path 3 signal quality index 99 CR LF
P Path 4 signal quality index 99 CR LF
P Path 5 signal quality index 99 CR LF
```

The test limits for the various tests are as listed below:

- Heater voltage good in range 18.0 to 26.0 V

- Array heater resistance good in range 4.0 to 6.0 Ω

- Heaters off voltage good if below 0.5 V

- Incoming supply voltage good in range 10.5 to 13.5 V

- 5.0 V supply good in range 4.5 to 5.5 V

- 10 V supply good in range 9.0 to 11.0 V

- Signal Quality Index good above 50

WJ Command

This command sets the averaging time for wind speed and direction, and peak wind speed and direction. The command format is:

WJ CR LF

The sensor prompts for averaging time of one to thirty seconds for wind speed and direction and then for peak wind speed and direction.

Example:

```
Wind speed/direction averaging time = ?
```

At which time user enters selection in seconds followed by CR LF

```
Peak wind speed/direction averaging time = ?
```

At which time user enters selection in seconds followed by CR LF

The sensor will then respond with

```
Changes will start after re-initialization CR LF
Please wait for completion of configuration change save CR
LF
```

The sensor will perform an automatic re-initialization after saving changes in non-volatile memory.

Any invalid parameter entry will result in a termination of the command and resumption of normal operations after the response below is issued.

```
CR LF Command response error, operation terminated CR LF
```

WD Command

This command reports the status of the BITs. The command format is:

WD CR LF

The command is intended to be sent by the host system to get a concise report on the pass/fail status of all Built-In Tests. The response is the following:

```
STX WD PPPPPPPPPPPP CS ETX CR LF
```

where

STX	=	ASCII start of test control character (position 1)
WD	=	command identifier (positions 2,3)
P or F	=	Pass/Fail for 12 built in tests specified in **WS** command above in the order shown in the **WS** command text (positions 4-15).
CS		modulo 256 hexadecimal checksum of all characters from position 2 through the last P or F (positions 16,17)
ETX		ASCII end of text control character (position 18)
CR		ASCII carriage return control character (position 19)
LF		ASCII line feed control character (position 20)

For a complete order, description and test limits for each pass/fail status reported, see section WS Command on page 45.

WF Command

The command format is:

WF CR LF

The **WF** command returns a fixed pattern of data. This command is typically used to verify the communications link. The data fields are fixed at the following values:

Status	=	F
Wind direction	=	678

Peak wind direction   =   567

Wind averaging time   =   21

Peak wind averaging time   =   09

Wind speed   =   876.5

Peak wind speed   =   432.1

Example of the WF Command Message

The following is an example of the output from the sensor for the **WF** command:

```
WFF6785672109876.5432.1K99xx
```

Table 5   Explanation of the WF Command Message

Byte	Description	Value
1	Start to text	STX
2	Sensor ID	W
3	Command identifier	F
4	Sensor status	F
5-7	Fixed wind direction	678
8-10	Fixed peak wind direction	567
11-12	Averaging time for wind speed and direction	21
13-14	Averaging time for peak wind speed and direction	09
15-19	Fixed wind speed	876.5
20-24	Fixed peak wind speed	432.1
25	Wind speed units	K
26-27	Signal quality	99
28-29	Hex checksum	xx
30	End of text	ETX
31	Carriage return	CR
32	Line feed	LF

WR Command

This is the system reset command. The command format is:

WR CR LF

The **WR** command initiates a system reinitialization. The processor executes the initialization routine and returns the initialization message (firmware revision, sensor status).

The response to the **WR** command contains the following:

```
ASOS Ice-Free Wind Sensor CR LF
Manufactured by Vaisala USA Inc. CR LF
Model number WAS 425NWS
Firmware version 2.01 CR LF
Initializing ….CR LF
Ready CR LF
Status = P/F/H CR LF (only the correct status will be
presented)
```

The sensor performs a system reset and issues the system reset command message upon sensor power-up.

The user should hold off sending commands until the full response is received. This may take up to 30 seconds.

WATE Command

This command invokes the sensor test with reduced excitation amplitude. The command format is:

WATE CR LF

The purpose of the **WATE** command is to determine the sensor zero offset and verify that a sufficient signal-to-noise margin exists during high wind speeds.

The **WATE** command returns the sensor Signal Quality Index (SQI) measurement with a reduced signal amplitude. This command exists in sensor firmware versions v4.00 and above. The command is enhanced in sensor firmware versions v4.50 and above.

This command is typically used to verify the sensor performance during the preventive maintenance procedures. The sensor will stop the current measuring when it receives this command. After this, the transducer excitation amplitude is reduced followed by a time delay in order to clear the measurement buffers. The sensor will perform 30 test measurements in a loop with a reduced amplitude signal. To run command takes about 5 minutes. At the end of the **WATE** test, the sensor will perform a full reset when returning to normal operation.

The **WATE** command is used in conjunction with the zero wind speed verifier. If the test is performed outdoors, the supplied cloth bag must be placed over the verifier to eliminate the effect of any ambient wind. See Figure 18 on page 68. It is extremely important that the **WATE** command is performed only when the verifier is installed on the sensor.

Performing the test without the verifier (and bag if required) will produce anomalous test results and it is not a valid test. After the verifier is installed on the sensor, it is necessary to wait five minutes before performing the test. The five-minute waiting period is needed for the temperature of the verifier interior to equalize without thermal gradients.

The response to the **WATE** command is the following:

```
Performing amplitude test...
Measuring at level 48% (1)
.
.
.
Measuring at level 48% (30)
WAXXXXXX0503XXX.XXXX.XXKXXXX
P Heater voltage XX.X Volts
P Array heater resistance X.X Ohms
P Heaters off voltage X.X Volts
P Incoming supply voltage XX.X Volts
P 5 volt supply X.XX Volts
P +10 volt supply XX.X Volts
- Bad 1 second reading counter = X
P Path 0 signal quality index XX
P Path 1 signal quality index XX
P Path 2 signal quality index XX
P Path 3 signal quality index XX
P Path 4 signal quality index XX
P Path 5 signal quality index XX
Wait for reset...
ASOS Ice-Free Wind Sensor
Manufactured by VAISALA USA INC.
Model number 425 NWS
Firmware version v4.50
Internal version v4.00
Initializing...
Ready
Status=P
```

To pass the **WATE** command, the sensor response must meet two conditions:

1. The wind speed in this **WA** message must be equal or smaller than 1.0 knots.

2. The SQI value for each measurement path must be equal or higher than 90. The average from the individual SQI values must be equal or higher than 95.

Other parameter test limits are the same as with the **WS** command.

In typical operation, the **WATE** command is executed incorporation with WA command via the WATE test of the Diagnostics Program as explained in section .

WCAL Command

This is the sensor self calibration command. The command format is:

WCAL CR LF

This command is to be used in conjunction with the zero wind speed verifier and in addition, the provided bag if the operation is done outdoors. It is extremely important that it will only be performed while the verifier is installed on the sensor. Should it ever be performed accidentally without the verifier, be sure to redo this command with the verifier installed prior to the deployment. One of the command functions is to determine the sensor zero offset and save parameters to remove it. If the sensor is calibrated in the presence of ambient wind or even air conditioning flow in the office environment, an invalid zero offset compensation will result. The verifier by itself is able to keep indoor air conditioning from affecting the calibration, but not outdoor airflow. If the sensor is to be calibrated outdoors, you must cover the verifier completely with the provided bag with drawstrings snug after placing the verifier over the sensor. This command also performs measurements that will improve sensor accuracy.

The sensor will stop the current measurement activity when it receives this command, and will prompt for password. If the password is entered correctly, the sensor will respond with the following:

```
CAUTION - Anemometer calibration MUST ONLY be performed
with Vaisala Verifier and bag in place on the anemometer.
Do you wish to proceed? (Y/N)
```

At this time, the operation may be aborted by responding with N. Do not respond with Y unless the verifier and bag are already in place. If the response is Y, the sensor will respond with the following:

```
Calibration in progress CR LF
```

When the calibrate function completes successfully, the sensor response will be the following:

```
Calibration successful, saving parameters CR LF
```

The sensor will save the parameters calculated in the non-volatile memory. After the save completion, the sensor will perform a complete power on the initialization sequence.

If the sensor returns the following response

```
Calibration failed CR LF
```

either the sensor or the zero wind speed verifier is broken. Issue the WS command to determine if any self tests have detected a sensor failure after removing the verifier and then waiting for 30 seconds. If the tests fail, the sensor must be repaired.

WH Command

This command displays the sensor command Help menu. The command format is:

WH CR LF

The **WH** command provides a list of all commands available for the sensor, with a brief description of syntax, arguments (if any), and description. This message is intended for display to a terminal connected to the RS-232 sensor port.

Command/Response Summary CR LF

CR LF

WA	Return average wind speed and direction CR LF
	Response format: CR LF
	Byte 1:	STX CR LF
	Byte: 2	Sensor ID = W CR LF
	Byte: 3	Command identifier CR LF
	Byte: 4	Sensor Status: P = PASS, F = Failed, H = Bad heater CR LF

	Byte 5-7:	Average wind direction (degrees) CR LF
	Bytes 8-10:	Wind direction at peak wind speed (degrees) CR LF
	Bytes 11-12:	Averaging time for wind speed and direction CR LF
	Bytes 13-14:	Averaging time for peak wind speed and direction CR LF
	Bytes 15-19:	Average wind speed CR LF
	Bytes 20-24:	Peak wind speed CR LF
	Byte 25:	Wind speed units (K = knots) CR LF
	Byte 26-27:	Signal quality CR LF
	Bytes 28-29:	Hex checksum CR LF
	Byte 30:	ETX CR LF
	Byte 31:	Carriage return CR LF
	Byte 32	Line feed CR LF
WL		Enable automatic heater control CR LF
WM		Lock heaters on CR LF
WN		Lock heaters off CR LF
WS		Description of BIT status CR LF
WJ		Set averaging times for wind speed/direction and peak wind speed/direction CR LF
		Enter password when prompted, then selections to the following prompts CR LF
		Wind speed/direction averaging time = ? CR LF
		Peak wind speed and direction averaging time = ? CR LF
WD		Perform and report extended diagnostic tests CR LF
WF		Return fixed data in WA command format CR LF
WR		Reset sensor CR LF
WCAL		Perform Sensor Self Calibration CR LF
WH		Display this help menu CR LF

WT Command

This command requests the short response BIT results and status. The command format is:

WT CR LF

This command is an abbreviated version of the verbose BIT results and status command. Field descriptors are omitted and only pass/fail status and measured value are reported. The command response is packed in the standard STX – body – CSUM – ETX format. The response is shown below.

Byte 1:	STX start of text ASCII control character
Byte 2:	W sensor ID
Byte 3:	T command identifier
Byte 4:	P or F for heater voltage pass or fail
Byte 5-8:	XX.X format heater voltage (volts RMS)
Byte 9:	P or F for array heater resistance pass or fail
Byte 10-12:	X.X or XX. (format as required) for array heater resistance (ohms)
Byte 13:	P or F for pass or fail on heater off voltage
Byte 14-16:	X.X format heater off voltage (volts RMS)
Byte 17:	P or F for pass or fail thermistor temperature
Bytes 18-20:	Thermistor temperature (degrees Celsius)
Byte 21:	P or F for incoming supply voltage pass or fail
Byte 22-25:	XX.X format incoming supply voltage (volts DC)
Byte 26:	P or F for 5 volt supply pass or fail
Bytes 26-29:	X.XX format 5 volt supply voltage (volts DC)
Byte 30:	P or F for 10 volt supply pass or fail
Bytes 31-34:	XX.X format 10 volt supply voltage (volts DC)
Byte 35:	ASCII hyphen character (-)
Bytes 36-40:	XXXXX format bad 1 second reading counter
Byte 41:	P or F for path 0 Signal Quality Index pass or fail
Bytes 42-43:	XX format path 0 Signal Quality Index
Byte 44:	P or F for path 1 Signal Quality Index pass or fail

Bytes 45-46:	XX format path 1 Signal Quality Index
Byte 47:	P or F for path 2 Signal Quality Index pass or fail
Bytes 48-49:	XX format path 2 Signal Quality Index
Byte 50:	P or F for path 3 Signal Quality Index pass or fail
Bytes 51-52:	XX format path 3 Signal Quality Index
Byte 53:	P or F for path 4 Signal Quality Index pass or fail
Bytes 54-55:	XX format path 4 Signal Quality Index
Byte 56:	P or F for path 5 Signal Quality Index pass or fail
Bytes 57-58:	XX format path 5 Signal Quality Index
Bytes 59-60:	XX hexadecimal ASCII for modulo 256 checksum for
	Character positions 2 through 58
Byte 61:	ETX end of text ASCII control character
Byte 62:	ASCII carriage return control character
Byte 63:	ASCII line feed control character

The array heater resistance value will be missing (99.) if either the heater on voltage is below 10 V RMS or the array heater on current is below 1 A RMS.

WSST Command

This command returns the static speed of sound and sonic temperature. The command format is:

WSST CR LF

The command responds with a return string containing the measured static speed of sound in knots with a tenth of a knot resolution, followed by an ASCII TAB control character, then the corresponding sonic temperature in degrees Fahrenheit with a tenth of a degree resolution. The return string is terminated with an ASCII carriage return and then line feed character. No descriptive text is included. The sonic temperature is not compensated for the effects of humidity on the static speed of sound. The static speed of sound output is a ten second running average of individual static speed of sound measurements calculated each second. The sensor calculates a new sonic temperature from this running average of static speed of sound each second. The sensor

response can be calibrated to a known ambient temperature with the
WSTK command below.

The output is of a fixed character length with 5 characters for the static
speed of sound and 6 characters for the sonic temperature. Positive
temperatures at or under 99.9° F will be padded with a leading zero.
This leading zero will be replaced by a minus sign for negative
temperatures.

An example of the response:

```
670.5   023.0
```

If the sensor is unable to compute the values due to a problem with the
sensor, the missing data response will be the following:

```
999.9   099.9
```

WSTK Command

This command is used to calibrate the static speed of sound and sonic
temperature. The command format is:

WSTK CR LF

The command allows the static speed of sound and sonic temperature
output products to be refined by calibration to the known ambient
temperature. This calibration command does not impact the measured
wind speed and direction accuracy in any way.

The calibration function should be done indoors in a controlled
environment. The ambient temperature input to the sensor during the
calibration operation must be an accurate measurement of the air
temperature at the sensor position at time of input. There should be little
if any ambient airflow. Typical airflow from building HVAC will not
unduly disturb the reading as long as the sensor is not directly next to or
under a register. The zero wind verifier and/or bag must not be placed
on the sensor during this calibration function. The resulting calibration
constant will be stored in the non-volatile memory and will survive
future firmware downloads as long as it is still relevant to the new
firmware.

NOTE	Do not place the zero wind verifier and/or bag on the sensor during calibration.

After the command is issued to the sensor, it will respond with the following prompt:

```
Enter actual temperature in xx.x C
```

It is most important to enter the temperature to the tenth of degree Celsius with a decimal point. A leading minus sign is allowed but is not likely needed since this should be an indoor operation. After entry of the known ambient temperature, the sensor will respond with the following:

```
Wait for new constant to be saved.
```

After a short delay, the sensor will respond with the following:

```
Configuration change saved, re-initializing.
```

The sensor will then go through the standard power on initialization routine and output.

WCDV Command

This command returns data that is calculated during the WCAL self calibration command. The command format is:

WCDV CR LF

The sensor response to this command is two rows of data. The first row of data are three ASCII TAB delimited numbers representing the zero wind speed sonic transit time average for each of the three measurement paths between transducer pairs. The values returned will change with changes in ambient temperature at the time the **WCAL** command that created them was issued. For N, S, and E representing north, south and east transducers, the side order for the three data values is S-N, N-E, then E-S.

The second row of data are six ASCII TAB delimited signed numbers representing the zero offsets the sensor will apply to each of the six raw sonic transit times measured between pairs of transducers. The data order is S to N, N to S, N to E, E to N, E to S, then S to E.

This command may be used to determine if the sensor has been self calibrated already. If the command returns three 20000 values in the first row and six 0 values in the second row, these are the default values and the sensor is uncalibrated. Be sure to run the **WCAL** command before deploying if this is the case.

CHAPTER 5
OPERATING PRINCIPLE

This chapter provides you with a brief explanation of the operating principles of Vaisala Ultrasonic Wind Sensor WS425 F/G and its power supply.

Wind Measurement Principle

The Ultrasonic Wind sensor uses ultrasonic technology. It has an on-board micro controller that captures and processes data and performs serial communications.

The wind sensor has an array of three equally spaced ultrasonic transducers in a horizontal plane. The sensor measures transit time, the time that it takes the ultrasound to travel from one transducer to another. The transit time is measured in both directions.

Transit time depends on the wind velocity along the ultrasonic path. For zero wind velocity, both the forward and reverse transit times are the same. With wind along the sound path, the up-wind transit time increases and the down-wind transit time decreases.

The microprocessor of the micro controller computes the wind velocity in a direction parallel to each possible transducer pair from the transit times using the formula:

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

where

Vw =   Wind velocity

L   =   Distance between two transducers

tf   =   Transit time in the positive direction

tr   =   Transit time in the negative direction

Measuring the six transmit times allows Vw to be computed for each of the three ultrasonic paths, which are offset to each other by 120°. The computed wind speeds are independent of altitude, temperature, and humidity even though the velocity of sound affects individual transit times because the algebra that produces the formula above cancels the effect of the static speed of sound.

Bad readings, which can happen when a large raindrop or ice pellet hits a transducer, are eliminated by a proprietary signal processing technique. The one Vw that is most affected by turbulence error is eliminated so wind speed and wind direction are calculated from the best two vectors.
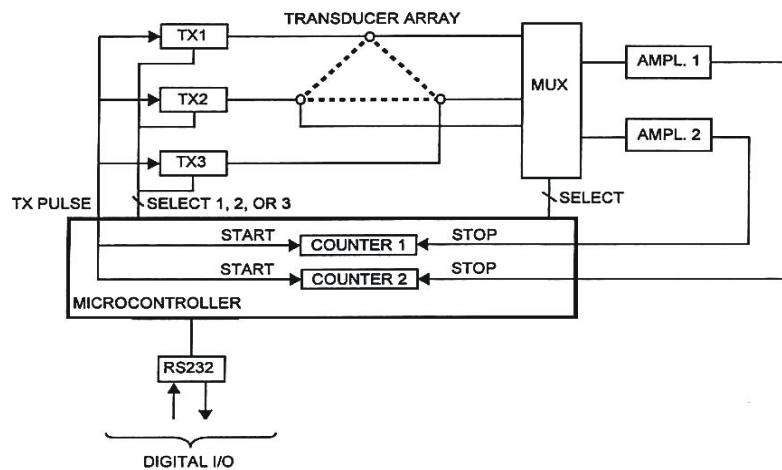
Figure 15   Ultrasonic Wind Sensor Block Diagram

Power Supply Operating Principle

The 12 V linear regulator provides power to the sensor and some internal circuits. The 5 V linear regulator powers the fiber optic modem and the internal logic. The 24 VAC heater power is switched on or off to the sensor enclosure heater and to the transducer and tube heater. The switches are solid state relays that are controlled by two heater control lines originating in the sensor.

The state of diagnostic logic is determined by the DTR and RTS lines of the maintenance ports marked TEST. With the maintenance port disconnected, the fiber optic modem is switched to the sensor (normal system operating mode). When a personal computer is connected to the maintenance port, the following states exist:

RTS	DTR	Description of States
LO	LO	Normal host system operation (TEST, connector unplugged).
HI	LO	PC talks to the sensor, host system is disconnected
LO	HI	PC talks to the host system, sensor is disconnected
HI	HI	Host system is connected to the sensor with the PC listening to both the transmit and receive lines

SENSOR I/F CABLE

12V LINER REGULATOR — +12V SENSOR POWER

5V LINER REGULATOR

AC VOLTAGE

HEATER CONTROL

24 VAC — ENCLOSURE HEATER

TRANSDUCER AND TUBE HEATERS

HEATER CONTROL FROM SENSOR

5V   5V

FIBER OPTIC I/O

FIBER OPTIC MODEM

DIAGNOSTIC LOOP — RS232 INTO SENSOR

RS232 OUT OF SENSOR

DATA IN   RTS/
DATA OUT   DTR/

TEST
MAINTENANCE
RS232 PORT

BLOCK DIAGRAM,
NWS POWER SUPPLY

Figure 16   Power Supply Block Diagram

CAUTION	US & European power supplies (WS425PowerUS and WS425PowerEU) have different primary wiring. Do not attempt to connect WS425PowerUS to 240VAC voltage or WS425PowerEU to 115 VAC voltage!

NOTE	The enclosure heat LED is always off for the model Ultrasonic Wind Sensor WS425 F/G.

Verifier Associated Operations

The sensor measures elapsed time for sound to travel from one transducer to the other. The only two parameters that affect the accuracy of the sensor are time and distance. The distance that affects the accuracy of the sensor is the distance between transducers. This distance is mechanically validated by the verifier. The verifier has to slide over the sensor without force. The zero-point calibration is ensured if the wind speed is 0.4 knot or less with the **WA** command.

Together with the verifier the reduced acoustic signal can be applied to emulate severe conditions. The reduced signal level is generated with the combination of the sensor firmware and hardware. This tests any deterioration in the following areas:

- Transmitter output power

- Transducers (transmitting and receiving)

- Receiver sensitivity

- Acoustic crosstalk

- Electrical crosstalk

- Automatic gain threshold detector

The timing reference for the time of flight measurement is controlled by a quartz crystal. The same crystal controls the baud rate for serial communications. If the crystal drifts more than a few percent, the sensor will not communicate any more.

This test gives a very high confidence that the sensor will work over its measurement range.

CHAPTER 6
MAINTENANCE

This chapter contains instructions for the basic maintenance, fault isolation and installation and removal of the field replaceable units of the Vaisala Ultrasonic Wind Sensor WS425 F/G.

Visual Inspection of Ultrasonic Wind Sensor WS425 F/G

WS425 F/G anemometer is a very reliable and rugged sensor. It has been wind tunnel tested to over 175 knots for mechanical integrity. However, the transducers are constructed of ceramic material and can be damaged by dropping or hitting the transducers. Likewise, applying enough force to bend the transducer arms will render the anemometer inoperative.

The anemometer should be kept in its protective foam shipping container until the time for the installation on the wind mast or tower. The verifier should be placed over the sensor when the sensor is installed on the tower. This provides protection to the transducers, validates that the mechanical spacing of the transducers is within specifications, and is the first step for the WATE field validation test which must be performed next before raising the wind mast or tower.

Some cautions and inspection criteria for the field personnel are listed below:

1.   Do not rotate the transducers. Rotating the transducers will destroy the array of the ultrasonic anemometer. A soldering spot can be

seen on each ceramic transducer. The soldering spots on the ceramic transducer must be oriented outside the array. For the correct alignment, see Figure 17 on page 67. Do not rotate the transducer if the soldering spot is not in the correct location. Replace the anemometer.

2. Do not pull the transducers. Pulling the transducers will destroy the array of the ultrasonic anemometer. The black RTV sealant can be seen between the bottom of each transducer and the transducer mounting arm. The RTV sealant must be free of damage and it must provide a good seal between the transducer and the transducer mounting arm. If this seal is damaged, water may enter the anemometer.

3. Do not strike or bend the transducers. Striking or bending the transducers will destroy the array of the ultrasonic anemometer. All the transducers should be parallel to each other. For the correct alignment, see Figure 17 on page 67.

4. The verifier should slide over the transducers without excessive force. This validates that the mechanical spacing of the transducers is within specifications.

5. Do not scrape or touch the transducers with sharp objects. Cutting the silicon rubber sleeve on the transducer affects the acoustical matching layer of the transducer and destroys the array of the ultrasonic anemometer. The silicon rubber transducer sleeve must not be damaged.

6. Do not attempt to remove the center bird spike. Attempting to remove it will destroy the array heating circuit of the ultrasonic anemometer.
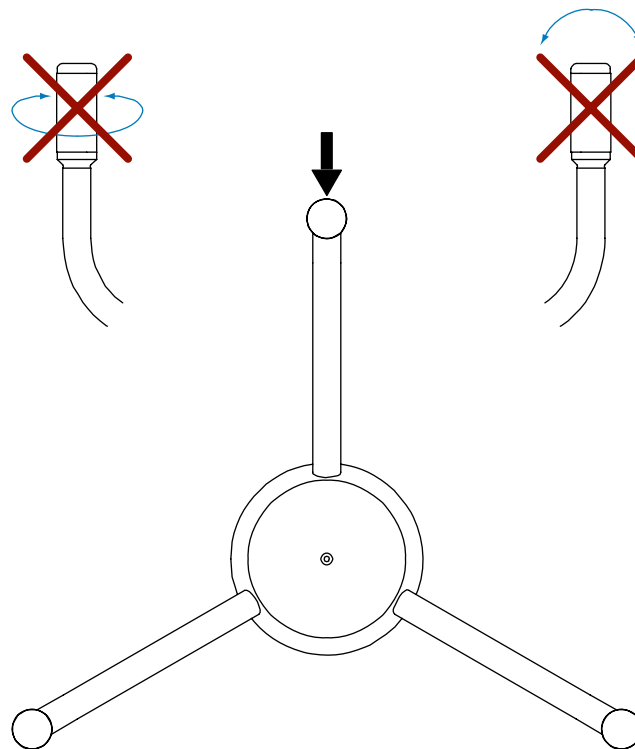
Figure 17   Solder Spot and Sensor Handling

NOTE	Orientation of the solder spot is indicated by the thick black arrow in Figure 17 on page 67. Do not rotate, pull, strike, bend, scrape, or touch the transducers with sharp objects.

Preventive Maintenance

It is recommended that preventive maintenance be performed every 12 months.

- Laptop computer

- RS-232 cable with DB9 connector

- Diagnostic Program (to run on laptop computer)

- Verifier and Cloth Bag

Equipment needed:

Figure 18   Field Verifier

Figure 19   Field Verifier with Cloth Bag

CAUTION	This procedure must be performed on a relatively calm day when it is safe to lower the wind mast or tower.

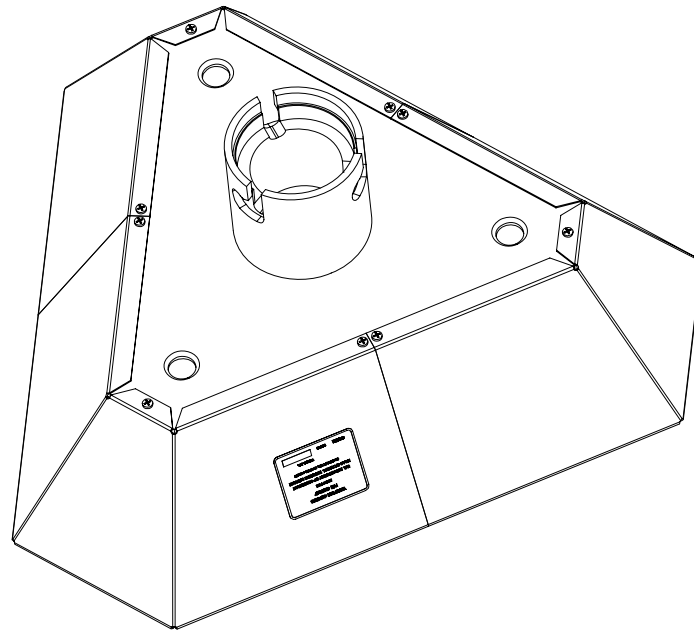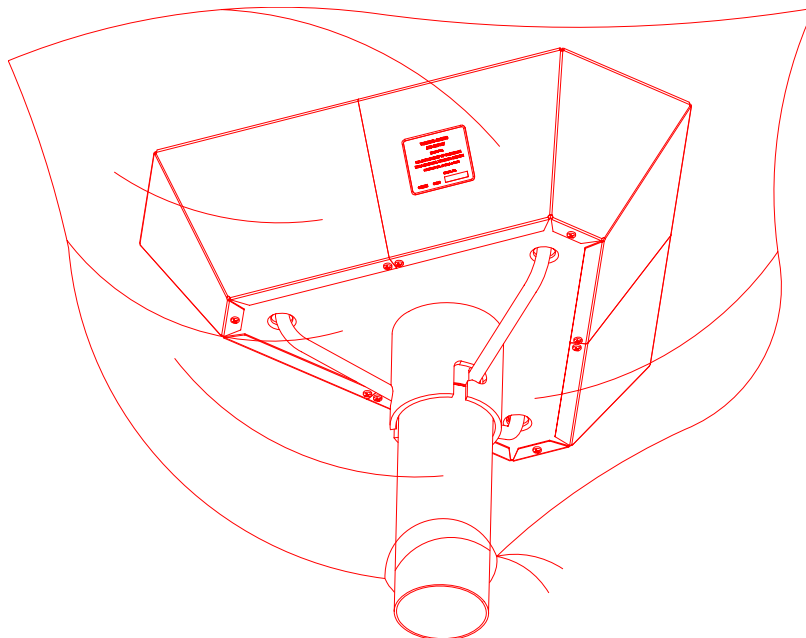| **CAUTION**	It is very important that the wind sensor be taken off line during this entire procedure or else erroneous wind speeds will be reported into the your system.

1. Open the cover of the power supply.
2. Connect the laptop computer via the RS-232 cable to the TEST port.
3. Run the Diagnostics Program after your system is disconnected. Issue the **WA** command and verify that the sensor responds with a data string starting with WA. If it does not respond at all, check all the connections.
4. Lower the wind mast or tower and put the verifier over the sensor. The verifier must be completely covered by the cloth bag, since ambient airflow may effect the sensor readings.
5. Issue the **WATE** test in the Diagnostics Program. The sensor must respond with:

    `WATE Test Passed.`
6. Replace the sensor if it has failed this test.
7. Remove the verifier from the sensor and raise the wind mast or tower.
8. Issue two more **WA** commands and make sure they have P status and the reported wind speed and direction values are reasonable when compared to the estimated actual condition.
9. Disconnect the laptop. This automatically returns the sensor into the normal operating mode. Close the power supply door.

Corrective Maintenance

The following flow charts may be used to diagnose problems with the wind system.

If the sensor is not responding to the system polls, start with the flow chart in .

If the sensor is responding to the **WA** command but the status is F, start with the flow chart in .

If the sensor is responding to the **WA** command but the status is H, start with the flow chart in .

Figure 20   Fault Isolation Flow Chart: Sensor Not Responding Part 1

General Notes
1. Disable AC mains source before replacing Power Supply.
2. Turn Power Supply power switch to "off" before replacing Sensor or Sensor Interface Cable.
3. After replacement, return of system power is always implied. Wait for Sensor initialization "Ready" response before proceeding.

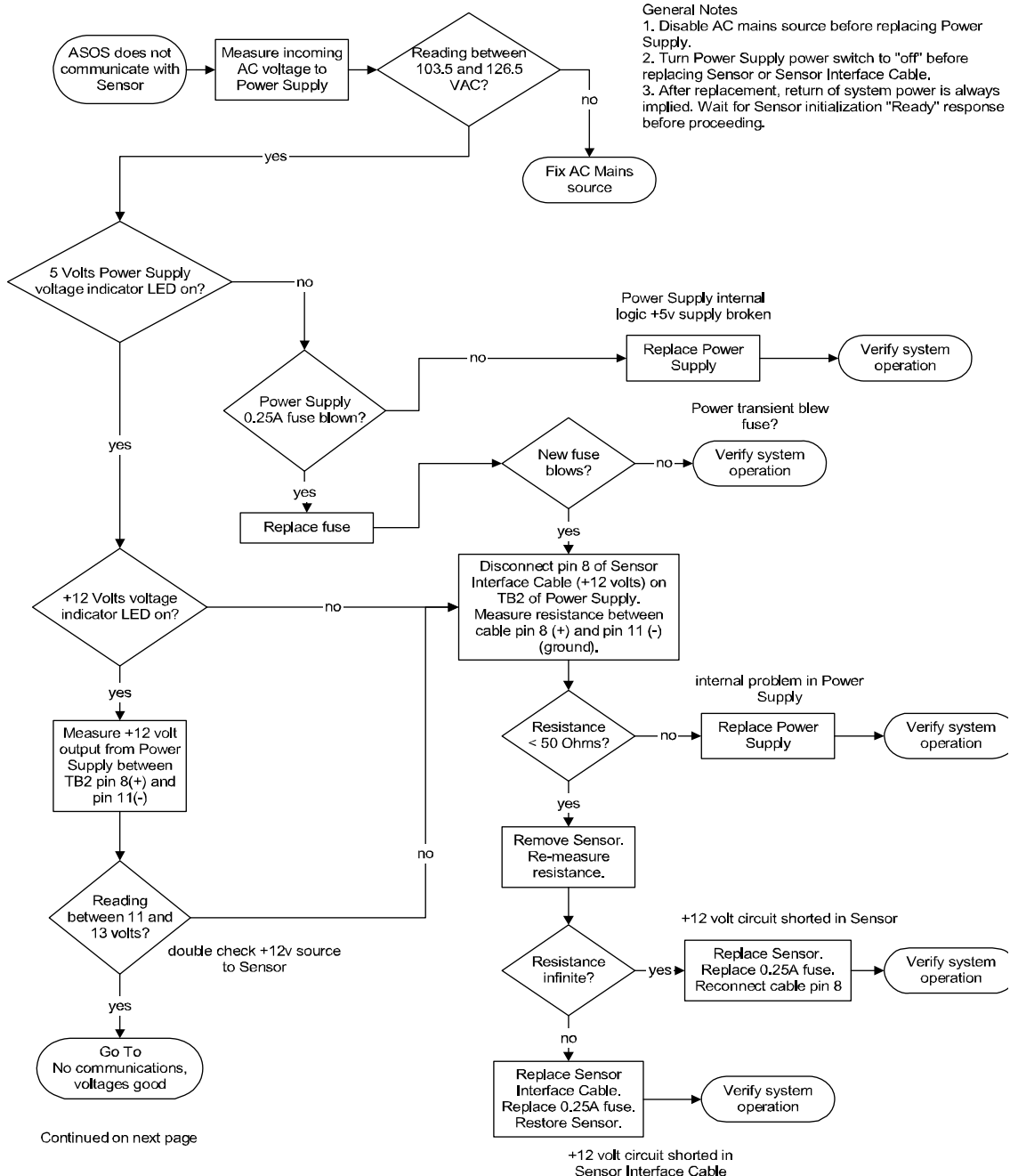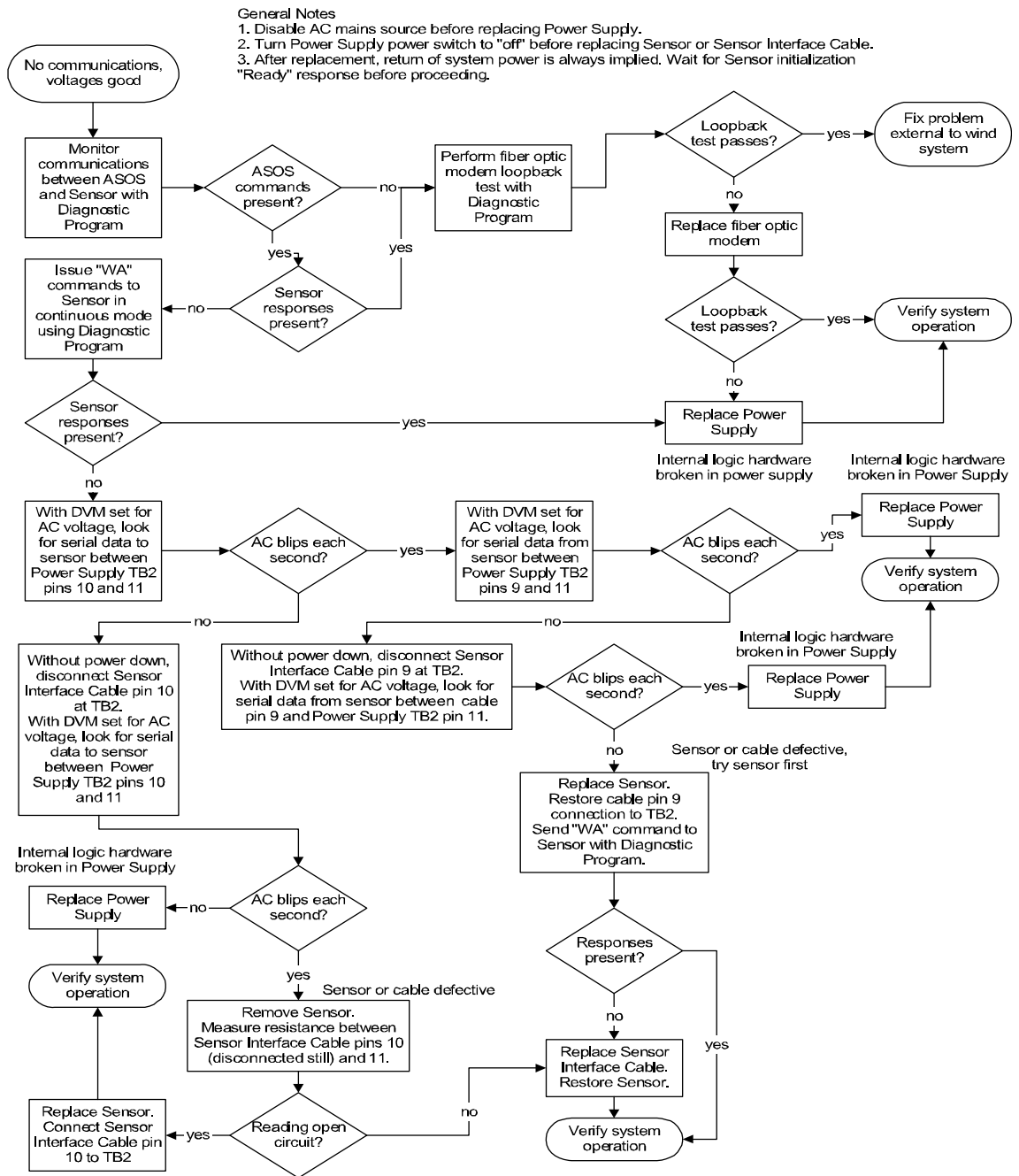**Figure 21   Fault Isolation Flow Chart: Sensor Not Responding Part 2**
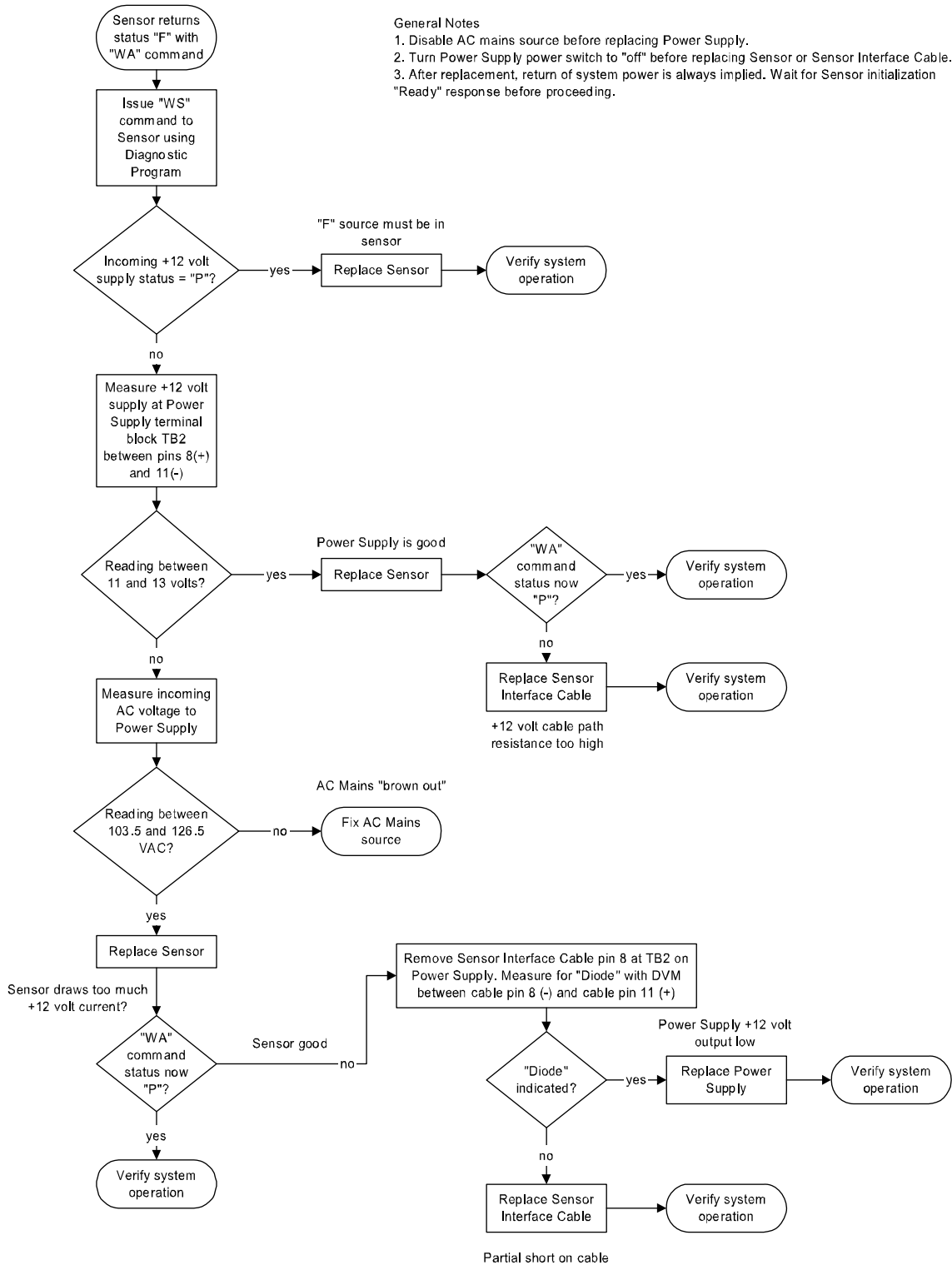
Figure 22   Fault Isolation Flow Chart: Sensor Responds with F Status
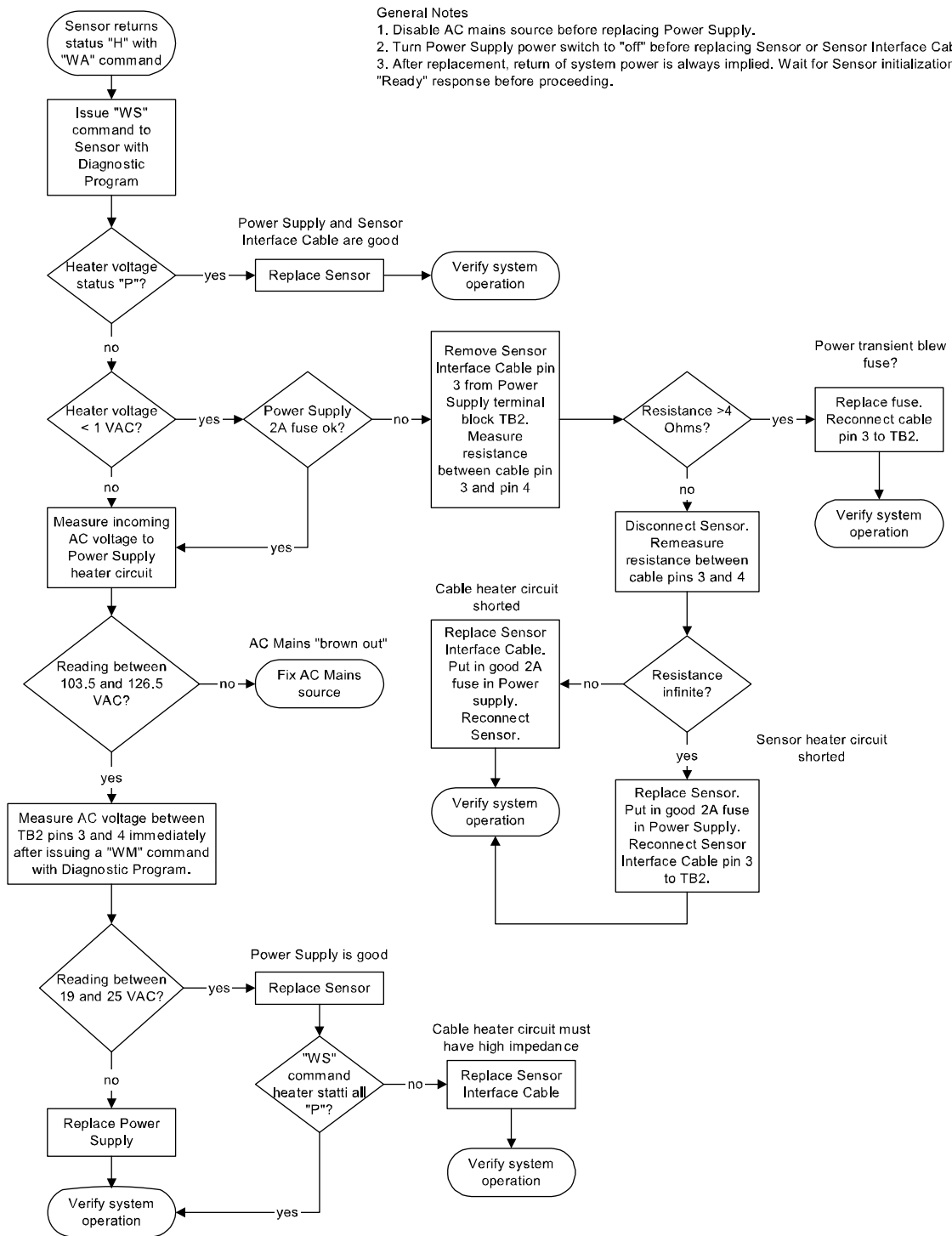
Figure 23   Fault Isolation Flow Chart: Sensor Responds with H Status

Wind Sensor Removal and Installation

Removal Procedure

1. Open the power supply cover and turn off the power.

2. Tilt over the wind mast or tower to access the sensor.

3. On the adapter, loosen the single screw close to the sensor. Do not loosen any of the three screws that are used to fasten the adapter to the mounting tube (see Figure 3 on page 18). Loosening these screws will make sensor alignment necessary.

4. Pull the sensor out of the adapter.

5. Disconnect the cable from the sensor.

Installation Procedure

1. Connect the cable to the sensor.

2. Slide the sensor into the adapter making sure pin on the sensor slides into the slot on the alignment adapter.

3. Tighten the single screw close to the sensor.

4. Turn on the power switch in the power supply.

5. Connect a laptop to the TEST connector in the power supply via an RS-232 cable.

6. Run the Diagnostics Program on the laptop. Choose the option that connects the sensor to the laptop with the system disconnected.

7. Issue the **WA** command. The sensor must respond with a P status.

8. Place the verifier over the sensor. The verifier must be completely covered by the included sack, since ambient airflow may effect the sensor readings.

9. Issue five **WA** commands spaced at least 5 seconds apart. All five responses must have a P status.

10. Remove the verifier.

11. Raise the wind mast or tower.

12. Unplug the laptop.

13. Close the power supply enclosure door.

Power Supply Removal and Installation

CAUTION	Installation requires power supply with correct primary wiring depending on mains voltage used (WS425PowerUS for 115VAC/60Hz and WS425PowerEU for 240VAC/50Hz)

WARNING	To make absolutely sure that the power is turned off, open the power supply door and measure the AC voltage between the black wire and each of the green white and yellow wires; and between the red wire and each of the green, white and yellow wires. All readings must be zero.

CAUTION	Observe the 3 inch minimum bending radius limitation on the fibers. Do not bend them more sharply than at a 3-inch radius.

WARNING	The fiber optic cable and the power cable share the same conduit. Before proceeding make absolutely sure that the AC power is turned off at the your system power distribution. Then take an AC voltmeter and measure the AC voltage between the black wire and each of the green white and yellow wires; and between the red wire and each of the green, white and yellow wires. All readings must be zero before proceeding.

1. At your system power distribution, turn off the power to the wind sensor.

2. Remove the protective cover over the AC input terminal block.

3. Disconnect the five power wires from the terminal block. Then disconnect the two fiber optic cables.

4. Disconnect the 12 wires of the sensor interface cable from the terminal block.

5. Loosen the two conduit nuts and pull the two conduits out of the power supply bottom. Also remove the grounding wire from the ground stud. Make sure not to pull the fiber optic cables.

6. Remove the power supply with its mounting plate from the tower by removing the top screws and loosening the two bottom screws. See Figure 4 on page 19.

7. Remove the power supply from the mounting plate by loosening the four flat head screws.

8. Use the same four screws and mount the new power supply to the mounting plate.

9. Tighten the four screws down.

10. Lift this assembly and slide the two slots at the bottom of the mounting plate over the two mounting screws that were left on the tower.

11. Re-install the two screws near the top of the mounting plate. Tighten all four screws that secure the mounting plate to the wind mast or tower.

12. Connecting ground wire

    Using the existing ground wire, connect it to the threaded ground stud at the bottom left of the power supply.

13. Connecting fiber optic cable

    Feed the two fiber optic cables and the five power wires through the conduit hole at the bottom right of the power supply. Then use the conduit nut to secure the conduit at the bottom of the power supply. After removing the protective covers, connect the fiber cable marked TX to the fiber optic connector on the left. Then connect the fiber optic cable marked RX to the fiber optic connector on the right.

14. Connecting AC power

    Connect the five power wires to the terminal block as shown in Figure 11 on page 30 starting with the green wire. Double-check that each wire is connected as shown in Figure 11 on page 30. Place the protective cover plate back over the terminal block.

15. Connecting the sensor interface cable

    First thread the sensor interface cable through the left hole at the bottom of the power supply. Then use the conduit-nut to secure the conduit at the bottom wall of the power supply box.

    Connect the 12 ring lugs of the sensor interface cable to the 12-position terminal block as shown in Figure 11 on page 30.

16. Conducting off-line test

    Turn on the AC power to the wind sensor.

    Turn on the power switch in the power supply. Connect a laptop to the TEST connector in the power supply with an RS-232 cable.

Run the Diagnostics Program on the laptop. Choose the option that connects the sensor to the laptop with the system disconnected. Issue the **WA** command. The sensor must respond with a P status. Now place the verifier over the sensor. Issue five **WA** commands spaced at least five seconds a part. All five responses must have P status.

Power Supply Module Removal and Installation

WARNING	The fiber optic cable and the power cable share the same conduit. Before proceeding make absolutely sure that the AC power is turned off at the power distribution system. Then take an AC voltmeter and measure the AC voltage between the black wire and each of the green white and yellow wires; and between the red wire and each of the green, white and yellow wires. All readings must be zero before proceeding.

The removal and installation of the power supply electronic module requires the following tools:

1. #2 Phillips screwdriver

2. ¼-inch width flat blade screwdriver

3. 5/16-inch open end wrench

Removal Procedure

1. Remove five wires from terminal block TB1. Tie the wires from above, so that they are out of the way and protected from damage.

2. Remove the 12 sensor cable wires and the ground wire from terminal block TB2. Tie the sensor cable off to one side, so that it is out of the way and protected from damage.

3. Remove two optical fibers from the fiber optic modem TX and RX connectors. Tie the optical fibers to one side, so that they are out of the way and protected from damage. Observe the 3-inch minimum bending radius limitation of the fibers, do not bend them more sharply than at a 3-inch radius.

4. Remove 11 of the 12 Phillips head mounting screws that hold the module in place. Leave the screw in between the fiber optic modem

TX and RX fiber connectors in place. Save the ground wire for use when installing the new module.

5. While holding the module so that it will not fall, remove the last Phillips head screw and remove the module.

Installation Procedure

1. While holding the module so that it will not fall, install the Phillips head screw in between the fiber optic modem TX and RX fiber connectors. Tighten it until it is almost snug, do not fully tighten it at this time.

2. Install the Phillips head screw and ground wire, between the fiber optic modem RX fiber connector and the corner of the module. Do not tighten it at this time.

3. Connect the opposite end of the ground wire to terminal 12 of TB2. The lug should be upside down under the terminal screw, to allow room for the sensor wire #12. Do not tighten it at this time.

4. Install the remaining 10 Phillips head mounting screws that hold the module in place.

5. Once all 12 screws are in place, tighten them.

6. Untie the optical fibers and connect them to the corresponding RX and TX connectors on the fiber optic modem. Observe the 3-inch minimum bending radius limitation of the fibers, do not bend them more sharply than at a 3-inch radius. Tighten them gently.

7. Untie the sensor cable and connect the first 11 of the 12 sensor wires to the terminals with the corresponding numbers 1 through 11.

8. Connect the #12 sensor wire to terminal 12 of TB2, along with the ground wire.

9. Untie the wiring for TB1 and connect the gray wire to terminal 1, brown to 2, violet to 3, orange to 4 and blue to terminal 5.

FOM Assembly Removal and Installation

The removal and installation of the power supply fiber optic modem assembly requires the following tools:

1. #1 Phillips screwdriver

2. ¼-inch width flat blade screwdriver

3. 5/16-inch open end wrench

Removal Procedure

1. Open the power supply door and turn off the power to the wind sensor.

2. Remove the 12 sensor cable wires and the ground wire from terminal block TB2. Tie the sensor cable off to one side, so that it is out of the way and protected from damage.

3. Remove the two optical fibers from the fiber optic modem TX and RX connectors. Tie the optical fibers to one side, so that they are out of the way and protected from damage. Observe the 3-inch minimum bending radius limitation of the fibers, do not bend them more sharply than at a 3-inch radius.

4. Remove the four #4 Phillips head mounting screws that hold the fiber optic modem assembly in place and remove the assembly.

5. Remove the two #4 Phillips head screws that retain the DB-9 cable connector in the connector on the fiber optic modem assembly and disconnect the cable from the fiber optic modem.

Installation Procedure

1. While holding the fiber optic modem, plug in the DB-9 cable and install the 2 #4 Phillips head screws to retain the cable connector in the connector on the fiber optic modem.

2. Install the four #4 Phillips head screws to secure the fiber optic modem assembly to the power supply module assembly.

3. Untie the optical fibers and connect them to the corresponding RX and TX connectors on the fiber optic modem. Observe the 3-inch minimum bending radius limitation of the fibers, do not bend them more sharply than at a 3-inch radius. Tighten them gently.

Sensor Interface Cable Removal and Installation

1. Open the power supply door and turn off the power to the wind sensor.

2. Lower the wind mast or tower.

3. On the adapter, loosen the single screw close to the sensor. Do not loosen any of the three screws that are used to fasten the adapter to the mounting tube (see Figure 3 on page 18). Loosening these three screws would make a solar noon alignment necessary.

4. Pull the sensor out of the adapter.

5. Disconnect the cable from the sensor and gently put the sensor some place where it can't get hit accidentally.

6. Open the power supply door and disconnect the sensor interface cable (12 ring lugs). Wrap electrical tape over wires tightly folding half forward and half bent back on cable so it can be easily pulled through the ½" conduit.

7. Remove the cable from the wind mast or tower. It has to be pulled out of the conduit first and then pulled out of the top of the pole. Tape up both tightly with electrical tape.

8. Remove the new sensor cable from the shipping container. One end of the cable has ring lugs. On this end take about half of the individual wires and fold them back.

9. Feed the cable through the adapter mounting arm, pole, pole pivot and the conduit going to the power supply starting with the wrapped end of the cable into the open end of the adapter as the end of the mounting arm.

10. In the power supply, connect the 12 ring lugs of the sensor interface cable to the 12 position terminal block.

11. Take the sensor and connect the top end of the sensor interface cable to it. Insert the sensor into the adapter and tighten the set screw that secures the sensor to the adapter.

12. Turn on the power switch in the power supply.

13. Connect a laptop to the TEST connector in the power supply via an RS-232 cable.

14. Run the Diagnostics Program on the laptop. Choose the option that connects the sensor to the laptop with system disconnected.

15. Issue a **WA** command. The sensor must respond with a P status.

16. Place the verifier over the sensor. The verifier must be completely covered by the included sack, since ambient airflow may effect the sensor readings.

17. Issue five **WA** commands spaced at least 5 seconds apart. All five responses must have a P status.

18. Remove the verifier.

19. Raise the wind mast or tower. Disconnect the laptop and close the power supply door.

Firmware Download

NOTE	Optional Diagnostics Program is required for firmware download.

Download Procedure

1. Open the cover of the power supply. Connect the laptop computer via the RS-232 cable to the TEST port.

2. Run the Diagnostics Program after the host system system is disconnected. Issue the **START TEST Continuous Data** button and verify that the sensor responds with wind data. If it does not respond at all, check all the connections and the Diagnostics Program baud rate.

3. Issue the **Download Firmware** button in order to open a separate window for the Download Module.

4. Issue the **Begin Download** button for a hex file selection of the download. After selecting the hex file, a new window is opened.

5. Send **WFIRMWARE** command for the sensor if not performed automatically. This step depends on the version of the Diagnostics Program.

6. Enter the password. During the firmware download, the sensor should not be disturbed or disconnected. After a successful download, the sensor baud rate is given. You will need this value later in step 9.

7. Issue the **Close** button to return to the **Main** window of the Download Module.

8. Issue the **Close** button to return to the **Main** window of the Diagnostics Program.

9. Select the sufficient Commport baud rate based on the value given at step 6 by using one of the **2400**, **4800**, or **9600** and the **Change Commport Baudrate** buttons.

10. Issue the **START TEST Continuous Data** button to get data from the sensor.

11. Issue the **STOP TEST Continuous Data** button.

12. Select the desired sensor baud rate if not valid already by using of the **2400**, **4800**, or **9600** and **Change Sensor Baudrate** buttons.

13. Issue the **START TEST Continuous Data** button to get data from the sensor.

14. Issue the **STOP TEST Continuous Data** button.

15. Issue two more **WA** commands and make sure they have P status and that the reported wind speed and direction values are reasonable when compared to the estimated actual condition.

16. Disconnect the laptop. This automatically returns the sensor to the normal operating mode with the sensor communicating to the host system system. Close the power supply door.

If the operator of the laptop computer is not able to receive data from the sensor after step 10, then step 9 should be repeated followed by the procedure in the usual order.

Recovery Procedure

If the operator is not able to pass step 10 in the acceptable way, the Diagnostics Program should be closed. Restart the Diagnostics Program by running the following procedure:

1. Run the Diagnostics Program. Issue the **START TEST Continuous Data** button and verify that the sensor responds with wind data.

    - If YES, then go to step 8.

    - If NO, then continue from step 2.

2. Issue the **STOP TEST Continuous Data** button.

3. Select a new Diagnostics Program baud rate by using **9600** and **Change Commport Baudrate** buttons.

4. Issue the **START TEST Continuous Data** button

    - If YES, then go to step 8.

- If NO, then continue from step 5.

5. Issue the **STOP TEST Continuous Data** button.

6. Select a new Diagnostics Program baud rate by using **4800** and **Change Commport Baudrate** buttons.

7. Issue the **START TEST Continuous Data** button and verify that the sensor responds with wind data.

 - If NO, then replace the sensor according to the instructions in section Wind Sensor Removal and Installation on page 74.

8. Issue the **STOP TEST Continuous Data** button.

9. Select the desired sensor baud rate by using one of the **2400**, **4800**, or **9600** and **Change Sensor Baudrate** buttons.

10. Issue the **START TEST Continuous Data** button and verify that the sensor responds with wind data.

11. Issue the **STOP TEST Continuous Data** button.

12. Issue two more **WA** commands and make sure they have P status and that the reported wind speed and direction values are reasonable when compared to the estimated actual condition.

13. Disconnect the laptop. This automatically returns the sensor to the normal operating mode. Close the power supply door.

Technical Support

For technical questions, contact the Vaisala technical support:

E-mail   helpdesk@vaisala.com

Fax   +358 9 8949 2790

Vaisala Service Centers

If the product needs repair, please contact the Vaisala Service Center in your region or closest to you and then proceed as instructed. Contact information for Vaisala Service Centers is given below.

NORTH AMERICAN SERVICE CENTER

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

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

E-mail: us-customersupport@vaisala.com

EUROPEAN SERVICE CENTER

Vaisala Instruments Service, Vanha Nurmijärventie 21 FIN-01670 Vantaa, FINLAND.

Phone: +358 9 8949 2658, Fax: +358 9 8949 2295

E-mail: instruments.service@vaisala.com

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Vaisala KK, 42 Kagurazaka 6-Chome, Shinjuku-Ku, Tokyo 162-0825, JAPAN.

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CHAPTER 7
TECHNICAL DATA

This chapter provides the technical data of the product and lists the field replaceable units, and the accessories.

Field Replaceable Units

Table 6   **Field Replaceable Units of Ultrasonic Wind Sensor WS425 F/G**

Item Name	Order Code
US 60 Hz wind sensor, model WS425 F/G (with adapter)	WS425G7A4A
EU 50 Hz wind sensor, model WS425 F/G (without adapter)	WS425F7A1A
115 VAC power supply, WS425 F/G	WS425PowerUS
240 VAC power supply, WS425 F/G	WS425PowerEU
Module assembly, power supply WS425 F/G	4257023
Fiber optic modem	FOM111
Cable assembly, sensor WS425 F/G	4253100
Installation kit for ASOS, WS425 F/G	4257100
Field verifier assembly, WS425 F/G	WS425VerifierB

Specifications

Table 7   **Wind Speed**

Property	Description / Value
Measurement range	0 ... 165 knots
Starting threshold	virtually zero
Delay distance	virtually zero
Resolution	0.1 knots
Accuracy (range 0 ... 125 knots)	±0.26 knots or 3 % of reading, whichever is greater

Table 8   **Wind Direction**

Property	Description / Value
Measurement range	0 ... 360°
Starting threshold	virtually zero
Delay distance	virtually zero
Resolution	1°
Accuracy (wind speed 2 ... 125 knots)	±2°

Table 9   Outputs

Property	Description / Value
Communication media	optical cable, RS-232 for service mode
Message format	NWS ASOS compatible
Baud rate	2400, 4800, and 9600
Available averages	1 ... 30 s
Response time (continuous measurement)	1 s

Table 10   General

Property	Description / Value
Operating voltage	115 VAC / 60 Hz or 240 VAC / 50 Hz
Power consumption (max. heating)	150 W
Operating temperature	-62 ... +55 °C (-80 ... +130 °F)
Material body, arms, power transducer heads	 stainless steel silicone rubber
Dimensions (h × w × d) sensor power supply	 350 × 250 × 286 mm 340 × 342 × 165 mm
Weight sensor power supply	 1.7 kg 12.5 kg
Approvals	CE

Accessories

Table 11   Accessories

Description	Order Code
Power supply US power supply for 115 VAC EU power supply for 240 VAC	 WS425PowerUS WS425PowerEU
Cable assembly, sensor	4253100
Installation kit for ASOS	4257100
Field verifier assembly	WS425VerifierB

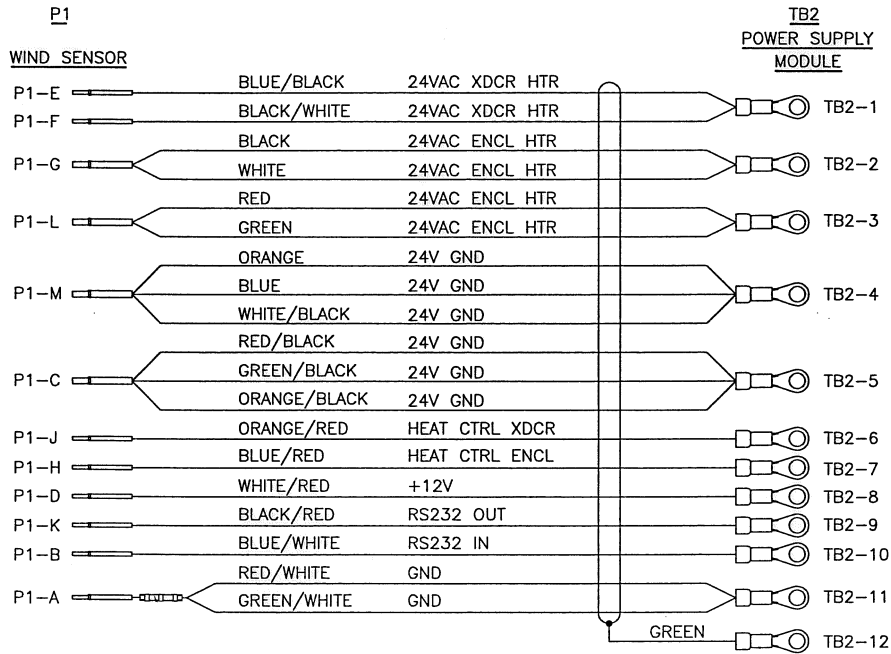| **CAUTION**	US and EU power supplies have different primary wiring, do not connect US power supply to 240 VAC voltage or EU power supply to 115 VAC voltage!

Drawings

Figure 24   Sensor Cable Wiring Diagram