

WeatherStation[®] Instrument (AM000024)

Hardware Installation Manual

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References

AIRMAR Technology Corporation:
<http://airmartechology.com/>

Introduction

The WeatherStation® Instrument PB-200 product is actually six different sensors in a single unit - without any moving parts. The compact housing is waterproof with a single removable cable. Data is output in digital NMEA 0183 and NMEA 2000® formats.

About the Hardware Installation Manual

The hardware installation manual provides instructions for the installation and mounting of the WeatherStation® Instrument as used within FT NavVision®. The chapters and sections are organized in chronological order in which the specific components must be installed and connected (where applicable).

NOTE:

This section provides only a summary of the most important safety requirements and notes, which will be mentioned in the individual sections. To protect your health and prevent damage to the devices, it is essential to read and carefully follow the safety instructions.

The hardware installation manual contains the following chapters:

- Chapter "Safety instructions" presents warning, caution and note information, which the user should pay attention to.
- Chapter "Receiving, unpacking and checking" contains instructions on how to receive, unpack or check the interface.
- Chapter "Installation and mounting" contains instructions on how to install, mount and/or wire the interface.
- Chapter "Technical specifications" contains an overview of the main features and specifications.
- Appendix A describes the basic operating and measurement principles.

Abbreviations list

CD	Compact Disc
COG	Course Over Ground
COM	Communication
DOP	Dilution of Precision
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
LED	Light Emitting Diode
LEN	Load Equivalency Number
PC	Personal Computer
SOG	Speed Over Ground
UNS	Unified National Standard
USB	Universal Serial Bus
WAAS	Wide Area Augmentation System
2D	Two Dimensional GPS Fix
3D	Three Dimensional GPS Fix

Revision history

Revisions issued since publication.

Issue	Date	Revision	Reason
1.0	24-Aug-10		First release

Safety instructions

The indications NOTE, CAUTION and WARNING have the following significance:

NOTE:

An operating procedure, practice or condition etc., which it is essential to emphasize.

CAUTION

An operating procedure, practise or condition etc., which, if not strictly observed, may damage or destroy equipment.

WARNING

An operating procedure, practise or condition etc., which, if not carefully observed may result in personal injury or loss of life.

1. Receiving, unpacking and checking

1.1 Procedure

1. Remove the transport casing
2. Visually inspect the respective parts
3. Check that all items are included in accordance with the delivery documents.
4. Check for transport damages.
In case of transport damage appropriate action must be taken against the latest carrier and the nearest certified dealer or representative should be informed.
5. Store the part in the original transport package in a dry and dust free place, if the unit is not to be installed immediately. Observe the environmental requirements stated in the specifications

NOTE:

Notify your sales representative if any of the above items is missing or damaged.

2. Installation and mounting

WARNING

- **Electrical safety**
The power supply voltage must be 12 VDC (± 3 VDC). Any other voltage may damage the product and/or result in fire, damage to the boat, and/or personal injury.
- **The WeatherStation[®] instrument is only an aid to navigation and should never be solely relied upon. It is not a replacement for traditional navigation aids and techniques. Only official government charts contain all the information needed for safe navigation.**
- **Fuse or circuit breaker**
A safe installation requires a 1 amp fast-blow fuse or circuit breaker. Failure to do so may damage the product and/or result in fire, damage to the boat, and/or personal injury.
- **Installation safety**
Always wear safety goggles and a dust mask when installing to avoid personal injury.
- **Compass safe distance**
The compass safe distance for standard and steering compasses is 1 m. Observe this distance from ferrous metals and anything that can create a magnetic field. Failure to do so may result in poor product performance, damage to the boat, and/or personal injury.
- **Calibrating the compass**
The internal compass must be calibrated on the water after the instrument is installed. Failure to do so may result in inaccurate compass readings, possibly contributing to damage to the boat and/or personal injury.

CAUTION

- **Correct installation**
The WeatherStation[®] instrument must be installed and operated according to the instructions in this owners guide. Failure to do so may result in poor product performance.
- **Disassembly**
Do not disassemble the sensor. Removing the screws from the WeatherStation[®] instrument will damage the waterproof seal, thus voiding the warranty.
- **Battery**
Make power connections to a 12 VDC power source that is isolated from the engine start battery(s). Voltage drops may cause the instrument to lose information and/or change operating mode.

2.1 Mounting location

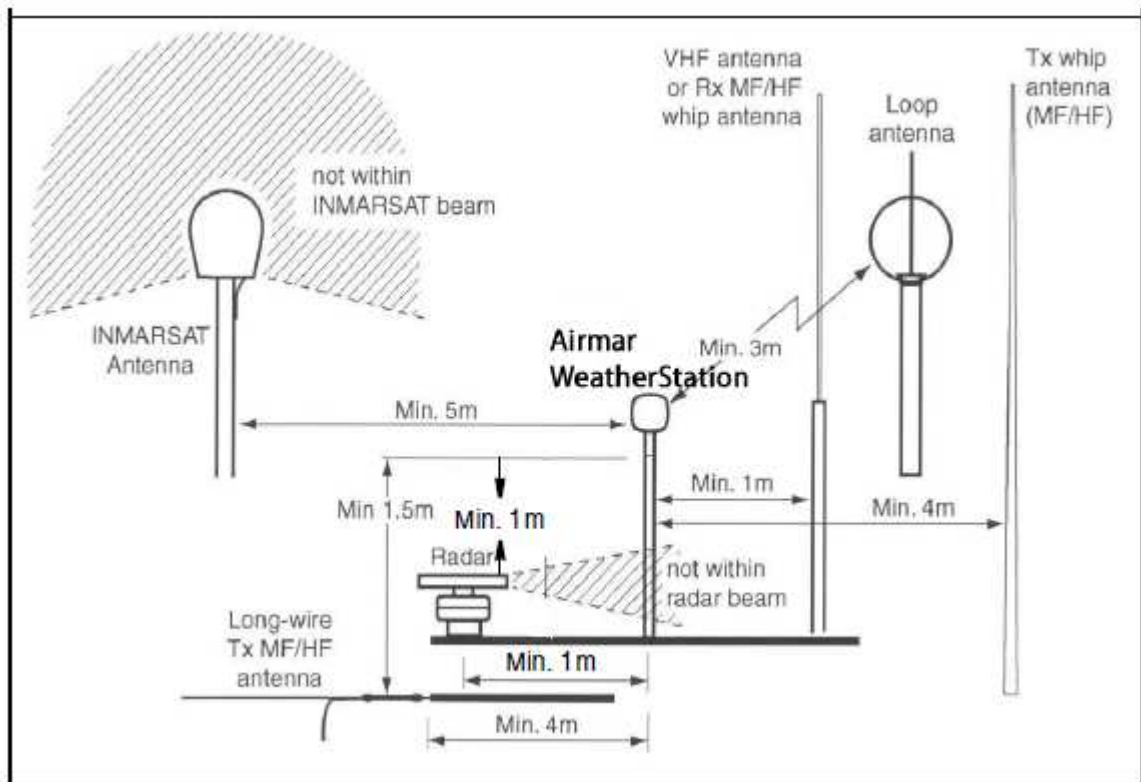


Figure 2-1: Minimum distance from WeatherStation® instrument

For accurate readings and a reliable GPS signal, selecting the best location for the WeatherStation® instrument is very important. Easy access and appearance should be secondary considerations. Since each installation is unique, the best separation distances from other equipment on the boat will vary depending on the particular equipment and how it is configured.

Choose a location that balances the requirements below (see Figure 2).

- The instrument *must* be mounted in “clear air” - away from obstructions in any direction that will interfere with air flowing through the unit. If there is an obstruction, be sure to mount the WeatherStation® instrument at least 2 m away. On land, avoid roof tops, chimneys, trees, etc.
- If possible, mount the instrument higher than any other object. Mount it a minimum of 500 mm above the surrounding surfaces.

NOTE:

The higher the WeatherStation® instrument is mounted, the less accurate the pitch and roll readings will be.

- To prevent interference to the magnetic compass, mount the instrument 1.2 m away from anything that may create a magnetic field such as: magnetized material, electric motors, electronic equipment, power/ignition cables, and batteries.
- Because the instrument has a GPS, it must be lower than any on-board INMARSAT communications antenna.
- Because the instrument has a GPS, be sure it is as far as possible from high powered transmitting antennas to avoid mutual interference.
- Because the instrument has a GPS, check for any electromagnetic shading. That is, any obstructions from other vessels or shoreline buildings that will interfere with the GPS signals that the WeatherStation® Instrument must receive.

2.2 Installation

WARNING

Always wear safety goggles and a dust mask.

CAUTION

- The blue metal plate and the blue film found in the wind channel of the WeatherStation[®] instrument are essential to its operation (see Figure 2-2). Be careful not to scratch the plate, puncture the film, or damage them in any way.
- Do not remove the waterproof connector(s) to ease cable routing. If the cable must be cut and spliced, use Airmar's splash-proof Junction Box No. 33-035 and follow the instructions supplied. Removing the waterproof connector(s) or cutting the cable, except when using a water-tight junction box, will void the WeatherStation Instrument warranty.
- The WeatherStation[®] instrument must be installed vertically - NOT tilted to one side. If the WeatherStation Instrument is tilted from the horizontal plane, it will introduce an error in the compass reading.
- Be sure the alignment tabs on the WeatherStation[®] instrument point forward toward the bow and parallel to the centerline of the boat. This is necessary to accurately measure wind direction and vessel heading.
- Do not tighten or align the WeatherStation[®] instrument by rotating the upper cap (see Figure 2-2). Turning may sever internal connections and void the warranty. Grasp the lower housing below the blue metal plate. Hand-tighten only.



Figure 2-2: Wind channel

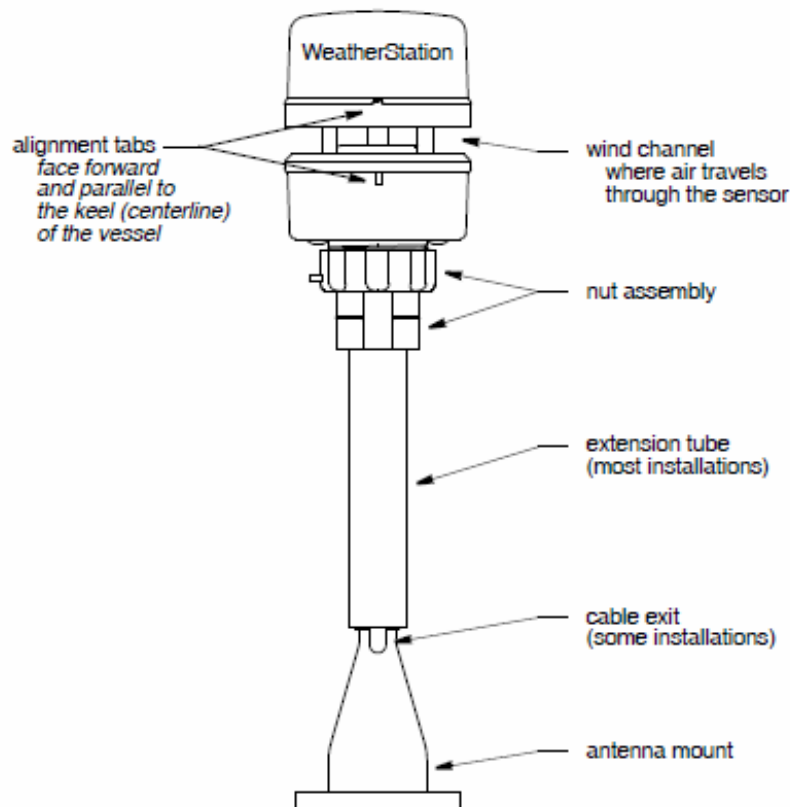


Figure 2-3: Installation

WARNING

Always wear safety goggles and a dust mask.

1. Place the antenna mount at the selected location and mark the holes for the screws (see Figure 2-3). Also, mark the hole in the center of the mount for the cable to pass through. If you are using a ratchet mount, be sure you have purchased an extension with a cable pass-through
2. Position the antenna mount at a 90° angle to the waterline. If necessary, use shims to make the mounting surface level (see Figure 2-3).
3. Drill the holes for the mounting screws and the cable exit if necessary. If the cable is to be fed through the deck, install a high quality deck gland.
4. Using purchased screws, fasten the antenna mount in place.
5. Screw an extension tube onto the antenna mount if desired.

6. With the nut assembly on the cable near the WeatherStation[®] connector, thread the cable through the extension tube (if used), antenna mount, and the cable exit. *Be sure to leave several inches of cable extending beyond the nut assembly (see Figure 2-4).*

CAUTION

If you use a thread lock, use plumber's tape. Do not use a liquid thread lock as it may weaken the plastic, causing it to swell and crack.

7. Screw the nut assembly onto the top of the antenna mount/extension tube. ***Hand-tighten only, do not over tighten.***
8. Remove the caution label from the WeatherStation[®] instrument's socket. Remove the protective cover from the connector. (Save the cap to protect the connector, when the WeatherStation[®] instrument is removed.)
Plug the 9-pin connector into the WeatherStation[®] instrument. The alignment key on the connector fits into a notch in the base of the WeatherStation[®] instrument.

CAUTION

Hand-tighten only. Do not over tighten. Be careful NOT to rotate the WeatherStation[®] instrument or loosen the nut assembly from the antenna mount/extension tube. Double check to be sure the alignment tabs are still facing forward.

9. Grasp the lower housing of the WeatherStation[®] instrument below the blue metal plate. Being sure the alignment tabs are facing forward and parallel to the keel (centerline) of the boat, slide the captive nut upward and screw it onto the base of the WeatherStation[®] instrument (see Figure 2-3 and Figure 2-4).

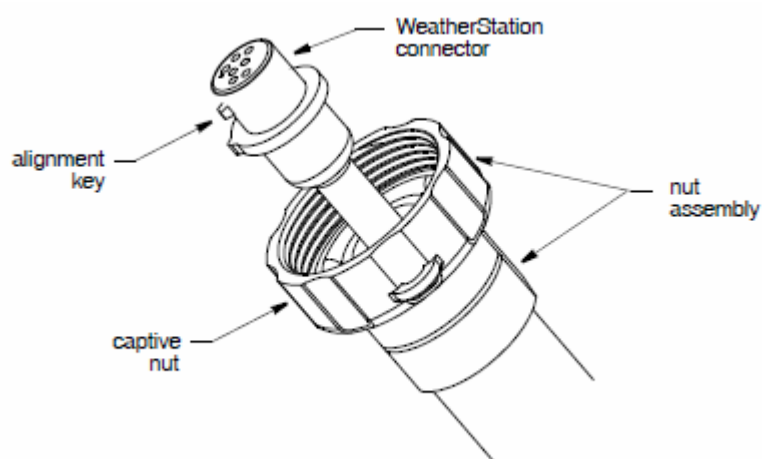


Figure 2-4: Connector

2.2.1 Cable routing and connecting

Read the safety instructions below before going to the appropriate section for your equipment.

WARNING

- Always wear safety goggles and a dust mask to avoid personal injury.
- The power supply voltage must be 12 VDC (± 3 VDC).
- A safe installation requires a 1 A fast-blow fuse or circuit breaker.

CAUTION

- To reduce electrical interference from other electrical wiring and any on-board equipment with strong magnetic fields such as radar equipment, radio transmitters, boat engines, generators, etc., separate the cables by at least 1 m.
- Do not remove the waterproof connector(s) to ease cable routing. If the cable must be cut and spliced, use Airmar's splash-proof Junction Box No. 33-035 and follow the instructions supplied.
Removing the waterproof connector or cutting the cable, except when using a water-tight junction box, will void the instrument's warranty.
- Be careful not to tear the cable jackets when passing them through bulkheads and other parts of the boat. Use grommets to prevent chaffing.
- Use a multimeter to check the polarity and the connections to the 12 VDC power supply before applying power to the instrument.
- Coil any excess cable(s) and secure with cable ties to prevent damage.
- Make power connections to a 12 VDC power source that is isolated from the engine start battery(s). Voltage drops may cause the instrument/receiver/sensor to lose information and/or change operating mode.

2.2.2 Connecting to an NMEA 0183 display

1. Route the sensor cable to the display. *Do not fasten the cable in place at this time.*
2. Connect the WeatherStation[®] instrument to the display in one of two ways.
 - **Connector** - If your sensor cable came with a connector on the display end, and it can be plugged into the port on your NMEA 0183 display, do so now. Coil any excess cable and secure it with cable ties to prevent damage. Fasten the cable in place.
 - **No connector** - If your sensor cable does not have a connector on the display end, it must be hard wired. Refer to the user manual that came with your display and connect the colored wires as shown in the table below and Figure 2-5.

WeatherStation function	Sensor cable wire color	Display function
NMEA input A/+	Yellow	NMEA output A/+ (see NOTE 2)
NMEA input B/-	Orange	NMEA output B/-
NMEA output A/+	White	NMEA input A/+
NMEA output B/-	Blue	NMEA input B/-
12 VDC +	Red (see NOTE 1)	12 VDC + (see NOTE 3)
12 VDC -/ground	Black	12 VDC -/ground
Shield	Bare	Shield

NOTE 1:

The WeatherStation[®] instrument must be supplied with 12 VDC (± 3 VDC) at 0,5 A.

NOTE 2:

If your display does not have NMEA 0183 output connections, the yellow and orange wires are not needed and their ends should be taped separately (alternatively, yellow and orange wires can be connected to an external sensor).

NOTE 3:

The display power may be wired directly to the sensor cable, or it may be wired separately.

No Connector—Wiring

1. Allowing an extra 25 cm for wiring ease, cut the cable to length.
2. Strip 60 mm of the outer jacket and foil shielding from the cut end of the cable.
3. Strip 10 mm of conductor insulation from the end of each colored wire.
4. Protect the cable's foil shielding from causing a short by using heat-shrink tubing around the jacket where the wires emerge from the cable. The tubing must overlap the wires a minimum of 6 mm.
5. Connect the wires to the display (see Figure 2-5).
6. Fasten the cable in place.
7. Your installation is complete. To begin receiving data, refer to the user manual that came with your display.

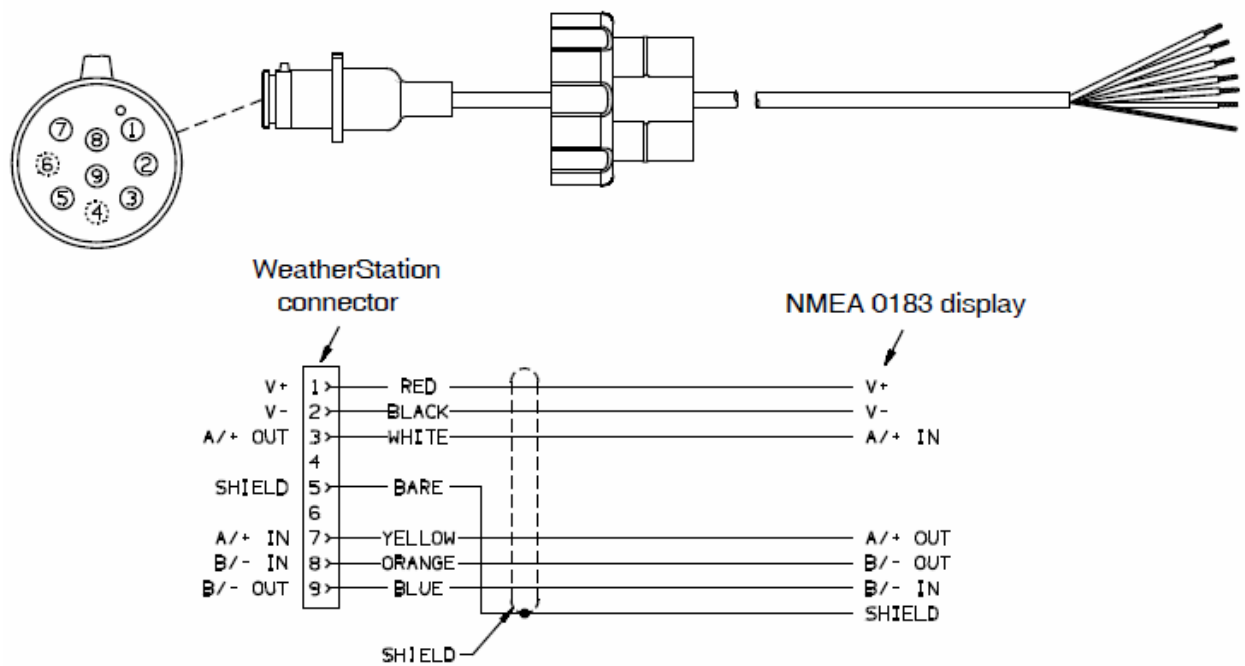


Figure 2-5: NMEA 0183 sensor cable

2.2.3 Connecting to an NMEA 2000® Network

CAUTION

Only two termination resistors are required on an NMEA 2000 network. More than two will degrade the bus performance.

Route the sensor cable to the NMEA 2000 network. Plug the NMEA 2000 connector into the network node (see Figure 2-6). Coil any excess cable and secure with cable ties to prevent damage.

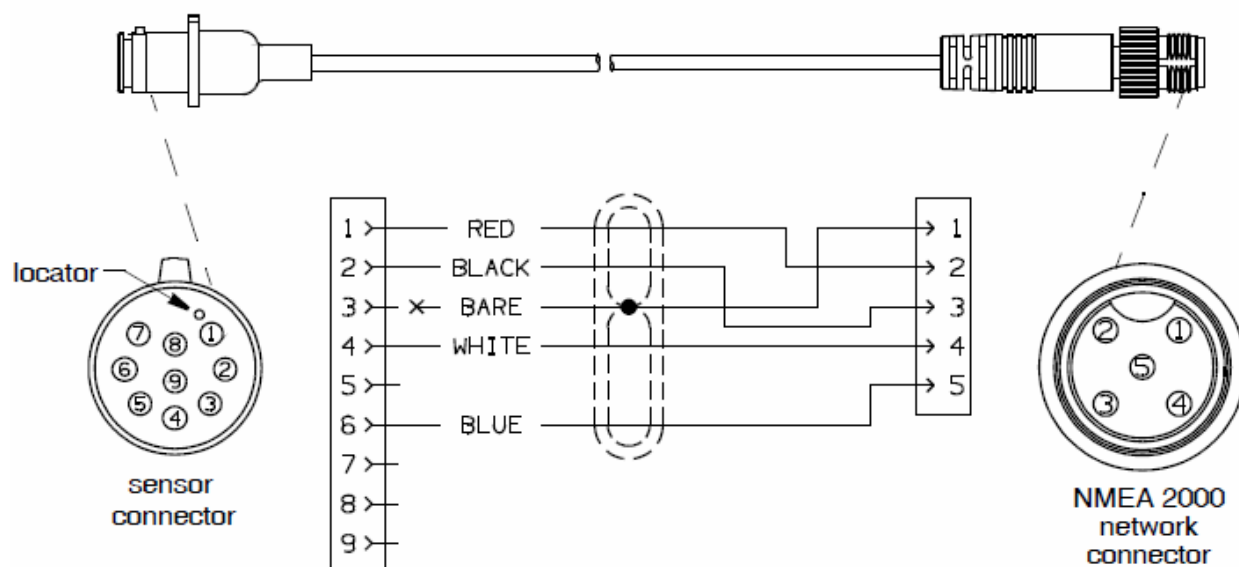


Figure 2-6: NMEA 2000 sensor cable - 6 m

NOTE:

Sensor cables longer than 6 m have a termination resistor built into the sensor connector (see Figure 2-7).

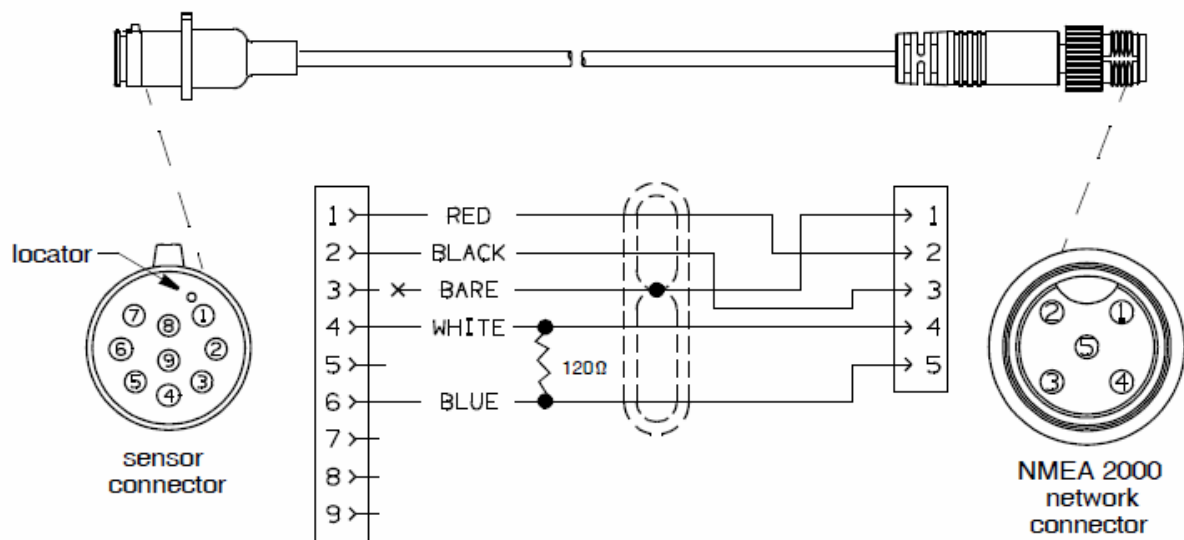


Figure 2-7: NMEA 2000 sensor cable - 10 m

3. Technical specifications

3.1 NMEA sentence commands

Sentence	Description
\$GPD TM	Datum Reference
\$GP GGA *	GPS Fix Data
\$GP GL L	Geographic Position –Latitude/Longitude
\$GP GSA	GNSS DOP and Active Satellites
\$GP GSV	GNSS Satellites in View
\$HCH DG	Heading, Deviation and Variation
\$HCH DT	Heading True
\$WIM DA *	Meteorological Composite. Barometric Pressure, Air Temperature, Wind Direction, Wind Speed
\$WIM WD	Wind Direction and Speed, with respect to north
\$WIM WV *	Wind Speed and Angle, in relation to the vessel's bow / centerline (relative)
\$WIM WV	Wind Speed and Angle, in relation to the vessel's bow / centerline (theoretical)
\$GPR MC	Recommended Minimum Specific GNSS Data
\$TIROT *	Rate of Turn
\$GP VTG *	Course Over Ground and Ground Speed
\$WIV WR	Relative Wind Speed and Angle
\$WIV WT	True Wind Speed and Angle
\$YXX DR	Transducer Measurements: Wind Chill and Vessel Attitude
\$GP ZDA *	Time and Date
\$PFEC, GPatt *	Heading, Pitch, and Roll
\$PFEC, pidat	

* These sentences are enabled at the factory.

3.2 Baud rate

WeatherCaster software needs the baud rate to be set as follows:

NMEA	Baud rate
NMEA 0183 USB converter	4800
NMEA 0183 combiner	38400

3.3 Load Equivalency Number

LEN..... 13

Appendix A – How the WeatherStation instrument works

Ultrasonic wind sensor

The ultrasonic wind sensor (an ultrasonic anemometer) measures apparent wind speed and direction. The WeatherStation® instrument contains four ultrasonic transducers, visible through the four holes in the top of the sensor's wind channel (see Figure 3-1). These transducers operate in pairs—one transducer injects a pulse into the air. The pulse bounces off the metal plate at the bottom of the wind channel and is carried by the wind to arrive at the listening transducer a short time later.

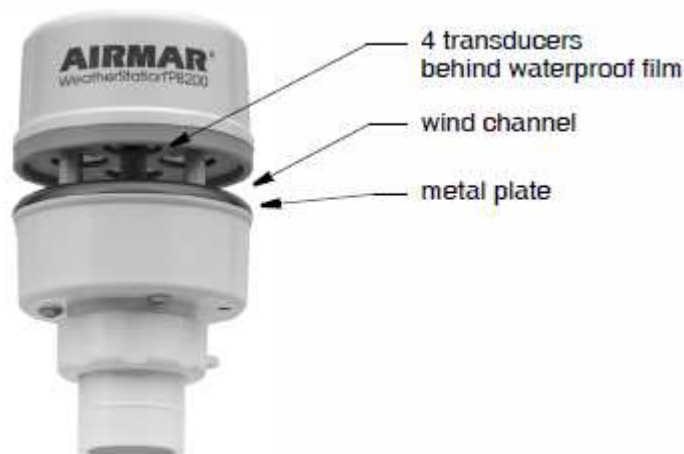


Figure 3-1: Ultrasonic wind sensor

When there is no wind, the pulse travels at the speed of sound from the sender to the receiver. Whenever the wind is blowing in that direction, the pulse will arrive sooner than if the air is still. Similarly, whenever the wind is blowing in the opposite direction, the pulse will arrive later than if the air is still. The four transducers take turns in sending and receiving pulses. A microprocessor within the WeatherStation® instrument then combines the measurements from all four transducers to calculate the resultant wind speed and direction. Throughout this process, the sensor monitors the air temperature, to compensate for the fact that the speed of sound in air changes with temperature.

Understanding true and apparent wind

The WeatherStation® instrument has the unique ability to display both *true* and *apparent* wind. *True* wind is the actual motion of the air relative to the earth.

Apparent wind is the wind which an observer experiences while moving or on board a boat. It is the result of two motions—the actual motion of the air (the true wind) and the motion of the boat. If the vessel is not moving, then the true and apparent wind will be the same.

There are two components to any wind measurement: speed and direction. By convention, the wind direction is an angle representing the direction *from* which the wind is blowing. Sometimes this angle is referenced to true or magnetic north, and sometimes it is referenced to the bow of the vessel. Both true and apparent wind use these same references.

Consider the case of a vessel proceeding at a speed of 15 knots in calm air. An observer on board would experience a wind of 15 knots from dead ahead. This *apparent* wind would be due solely to the motion of the boat. If a *true* wind of 15 knots was blowing from the stern, an observer would experience dead calm—no *apparent* wind. That is because the boat is moving at the same speed and in the same direction as the surrounding air.

Now, consider the more complicated situation of a vessel proceeding at 15 knots with a *true* wind of 15 knots blowing from the side (see Figure 3-2). To an observer on board, the *apparent* wind would be 21.2 knots blowing from an angle 45° off the bow.

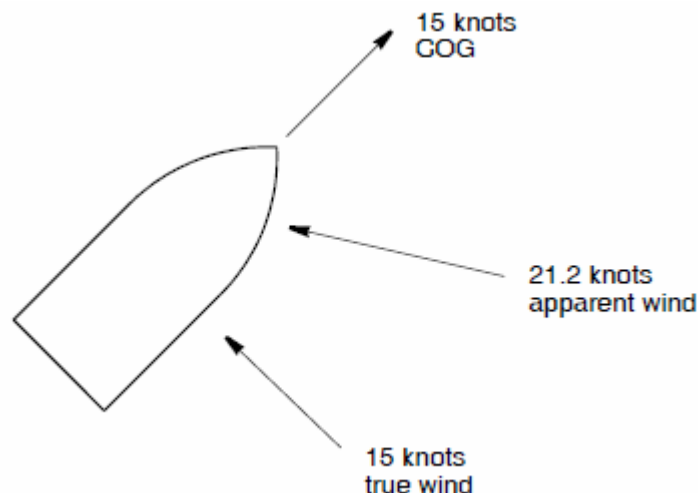


Figure 3-2: Apparent wind

In order to calculate the true wind speed and direction when on board a moving vessel, it is necessary to know the apparent wind speed and direction, the speed and course over ground of the vessel, the compass heading, and the local magnetic variation.

Note that heading and course are not the same thing: heading is the direction the bow of the vessel is pointing, while course is the direction the vessel is traveling.

Heading and course may differ due to the effects of wind and current. The WeatherStation® instrument can provide true wind speed and direction only if all of the data is available.

The speed and course over ground must be provided by a GPS receiver—either built-in or networked.

The heading may be provided by either the built-in electronic compass or by an external networked compass.

Because true wind is calculated using the data from several sensors, its accuracy depends on the accuracy of all the raw data used in the calculation.

For instance, if the electronic compass is located near iron or a similar magnetic disturbance, the heading will be incorrect, and the true wind calculation will therefore be in error, perhaps by quite a bit.

In another example, the speed and course over ground provided by the GPS receiver are averaged over time. If the boat is performing maneuvers, changing speed and/or direction, then it will take a few seconds for the SOG and COG values to "catch up".

The reported true wind values will therefore also be incorrect until the vessel reaches a steady-state condition, traveling in a straight line at a constant speed.

Electronic compass

The WeatherStation[®] instrument includes three magneto inductive sensors that measure magnetic field-strength in three axes relative to the instrument. From combined measurements of the three-axis magnetic and tilt sensors, it calculates the resultant magnetic heading angle, thereby providing a built-in three-axis electronic compass.

Like all magnetic compasses, the WeatherStation compass will be affected by any ferrous or magnetic materials in the vicinity, such as metal structures, motors, speakers, etc. It will also be affected by nearby electric fields, such as the wiring for navigation lights or radar domes.

These nearby sources of magnetic interference will distort the magnetic field and produce errors in the compass heading. These errors are known as magnetic deviation.

Magnetic variation and true heading

The earth acts like a giant magnet, with a magnetic north pole and a magnetic south pole. The axis of the magnetic poles is offset approximately 11.5° from the axis of the earth's rotation. Therefore, the earth's magnetic north and south poles are in different locations than the earth's geographic north and south poles. In addition, the earth's magnetic field is non-uniform, and changes over time.

Magnetic variation, also known as magnetic declination, is the angle between magnetic north and true (or geographic) north, at the observer's current location.

A magnetic compass measures heading with respect to magnetic north. To convert this magnetic heading to true heading (i.e. heading with respect to true north), the magnetic variation must be added to the measured magnetic heading value.

Because magnetic variation changes with location and gradually over time, it is necessary to calculate the magnetic variation using the user's present position and the current date.

Therefore it is necessary to have a GPS with a fix in order to provide magnetic variation and heading with respect to true north.

Air temperature sensor

The WeatherStation[®] instrument includes a built-in negative-temperature coefficient thermistor that measures the ambient air temperature. This NTC thermistor is located in a thermally isolated region of the WeatherStation[®] housing that is open to the outside air.

Wind chill temperature

Wind chill is a term that describes the heat loss on the human body resulting from the combined effects of low temperature and wind. As wind speed increases, heat is carried away from the body at a faster rate, causing a reduction in skin temperature. Because the face is the part of the human body that is most likely to be exposed, the wind-chill index is adjusted for the average adult face.

The concept of wind chill does not apply to inanimate objects, such as a boat. The only effect that wind chill has in this case is to shorten the time it takes the object to cool to the actual air temperature—wind chill does not cause an object to cool below that temperature.

For example, fresh water freezes at 0°C regardless of what the wind chill is.

The WeatherStation[®] instrument calculates two values for wind-chill temperature: one using the apparent wind-speed, and one using the true wind-speed. The *apparent* wind-chill temperature is relevant to what an observer is currently experiencing on the vessel.

The *true* wind-chill temperature indicates what the wind chill would be if the vessel were not moving. Wind chill temperature is only defined for temperatures at or below 10°C and wind speeds above 2.6 knots.

By default, transmission of wind-chill data is disabled by the WeatherStation[®] Instrument. When used with WeatherCaster software, the wind-chill data will be automatically enabled.

Barometric pressure sensor

The WeatherStation[®] instrument contains a temperature-compensated, silicon, Piezo-resistive, pressure sensor. It measures atmospheric pressure for use as a digital barometer.

While a single measurement of air pressure at a given location has little value, the trend of changing pressure and wind over time can be a useful tool in performing basic weather forecasting.

About the GPS

Some WeatherStation[®] instruments have a built-in Global Positioning System (GPS) with their own antenna, receiver, and position determining electronics. The GPS receiver receives radio signals from a constellation of orbiting satellites maintained by the U.S. government.

By accurately measuring the time it takes for a transmission to travel from each satellite to the receiver, the unit is able to determine the distance between the satellite and the receiver. When the distance is known to three satellites, the unit is able to calculate the latitude and longitude of the receiver. This is known as a 2D fix. If the distance is known to four or more satellites, then the unit is additionally able to calculate the altitude of the receiver.

This is known as a 3D fix.

The GPS receiver in the WeatherStation[®] instrument takes approximately one minute on average to achieve a position fix after power is first applied. This is known as the "time to first fix."

The GPS receiver synchronizes itself to the atomic clocks on board each satellite. This allows the GPS receiver to accurately determine the date and time as well.

If the GPS receiver is mounted on a moving vessel, its changing position over time allows the speed and course over ground to be calculated. The course reported by a GPS is always with respect to true north.

The ability of the WeatherStation[®] instrument to calculate true wind speed and direction depends on the presence of a GPS fix. If the GPS receiver is not tracking at least three satellites, then the WeatherStation[®] instrument will be unable to provide true wind data (apparent wind data should always be available, regardless of the status of the GPS receiver.)

Certain models of the WeatherStation[®] instrument do not include a built-in GPS receiver. In this case, if the true wind capabilities of the WeatherStation[®] instrument are desired, it will be necessary to connect the output from an external NMEA 0183-capable GPS to the NMEA input on the WeatherStation Instrument 25, in order to enable the true wind capabilities of the WeatherStation[®] instrument.

Even if your WeatherStation[®] instrument includes a built-in GPS receiver, you may wish to use a separate external GPS receiver instead, for the determination of true wind. If the WeatherStation[®] instrument receives speed over ground and course over ground (SOG and COG) data on its NMEA input from an external GPS, these data will override the data from the built-in GPS for the purpose of calculating true wind speed and direction. In addition, the WeatherStation[®] instrument will automatically suppress transmission of GPS messages from its own built-in GPS receiver.

True wind relative to water

If a fix from a GPS receiver is not available, it is still possible for the WeatherStation[®] Instrument to determine a value for true wind, if the speed of the vessel through the water is known. In this case, it is necessary that a water-speed sensor with an NMEA output (such as an Airmar Smart[™] Sensor) be connected to the NMEA input on the WeatherStation[®] instrument.

The WeatherStation[®] instrument's calculation for true wind relative to water makes the significant simplifying assumption that the vessel's course is the same as its heading. That is, the effects of wind and current on the motion of the boat are ignored. The direction of the true wind relative to water is referenced only to the bow of the vessel, not to true or magnetic north.



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