AIRMAR®
TECHNOLOGY CORPORATION

WeatherStation® Instrument

Owner's Guide

Models: LB100, LB150

Record the serial number found on the WeatherStation® instrument.

Serial No._____

Date of Purchase_____

17-457-01 r02 04/07/08

Table of Contents

IMPORTANT: Please read the Owner's Guide completely before proceeding with the installation.

Introduction

Thank you for purchasing Airmar's ultrasonic WeatherStation® instrument. This 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 RS485 format using the NMEA 0183 sentence structure.

Functions of the WeatherStation Instrument

- Apparent wind speed (moving sensor only)
- Apparent wind direction (moving sensor only)
- True wind speed
- True wind direction
- Magnetic compass heading
- Air temperature
- Relative humidity
- Dew point temperature
- Wind chill temperature
- Heat index temperature
- Barometric pressure
- Global positioning system (GPS)
- Vehicle speed over ground (SOG)
- Vehicle course over ground (COG)
- Heading relative to true north
- True wind chill temperature

Safety Instructions

WARNING: **Correct Installation Important**
The WeatherStation instrument must be installed and operated according to the instructions in this owners guide. Failure to do so could result in poor product performance, personal injury, and/or damage to the vehicle.

WARNING: **Electrical Safety**

The power supply voltage must be 12VDC (±3VDC). Any other voltage may damage the WeatherStation instrument and/or result in fire, causing personal injury and/or damage to the vehicle.

WARNING: **Installation Safety**
Always wear safety goggles and a dust mask when installing to avoid personal injury.

CAUTION: **Disassembly**
Do not disassemble the sensor. Removing the screws from the WeatherStation instrument will damage the waterproof seal, thus voiding the warranty.

IMPORTANT: **Compass Safe Distance**
The compass safe distance for standard and steering compasses is 0.30m (1'). Observe this distance to prevent interference to a magnetic compass.

IMPORTANT: **Battery**
Use a separate battery from the engine-start battery to supply power to the WeatherStation instrument. Voltage drops may cause the unit to lose information and/or change operating mode.

Adding External Sensors

Some WeatherStation instruments can receive data from an external relative-humidity and/or air-temperature sensor(s). The instrument automatically detects if a sensor is internal, external, or not available at all. Simply connect the external sensor(s) to the WeatherStation instrument.

- **GPS**—An external GPS can be connected instead of or in addition to the internal GPS. The WeatherStation instrument gives priority to valid external GPS data when available.
- **Compass**—If an external electronic compass is installed and working, this external compass data will override the WeatherStation instrument compass.

The Importance of Understanding True Wind Direction

When the WeatherStation instrument is stationary, the direction *from which* the wind is blowing is known as the *true wind*. The WeatherStation instrument is programed to measure the direction based upon the specific orientation of the sensor. For the WeatherStation instrument to accurately calculate the true direction of the wind, *it must be installed and oriented correctly*. (To learn more about true and apparent wind direction, see Appendix A.)

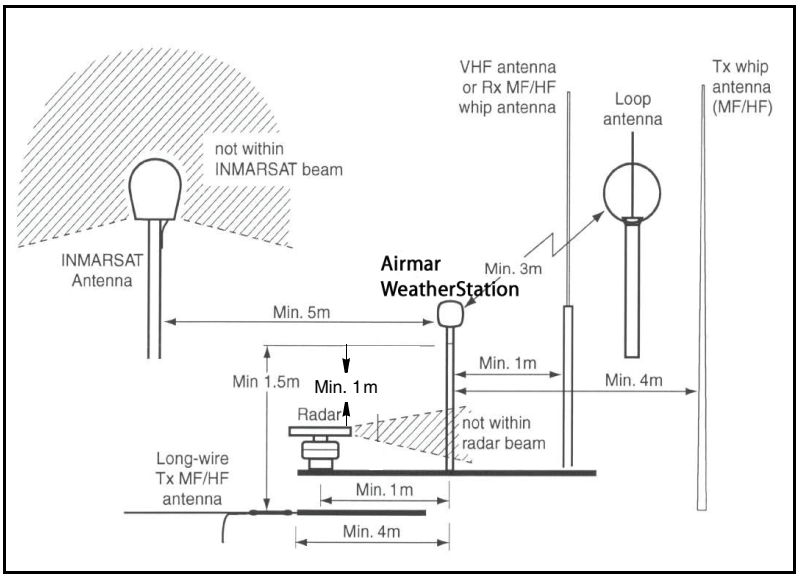

Figure 1. Antennas
Courtesy of Northstar BNT, Acton, MA

Choosing the Mounting Location

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 will vary depending on the particular equipment and how it is configured. Choose a location that balances the requirements below (see Figure 1).

- The WeatherStation 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 such as a roof top, chimney, or tree, *be sure* to mount the WeatherStation instrument at least 2m (6') away.
- If possible, mount the WeatherStation instrument higher than any other object. Mount it a minimum of 500mm (20") above the surrounding surfaces.
- If the WeatherStation instrument has an electronic compass, it should be installed at least 1 m (3') away from any equipment creating a strong magnetic field such as a radio transmitter, engine, generator, etc.
- Because the WeatherStation instrument has a GPS, be sure it has a clear view of the sky. That is, away from any obstructions that will interfere with the GPS signals that the WeatherStation instrument *must* receive.
- Because the WeatherStation instrument has a GPS, be sure it is as far as possible from high-powered transmitting antennas to avoid mutual interference.

Mounts

The WeatherStation nut has standard 1"-14 UNS or 3/4" NPT threads.

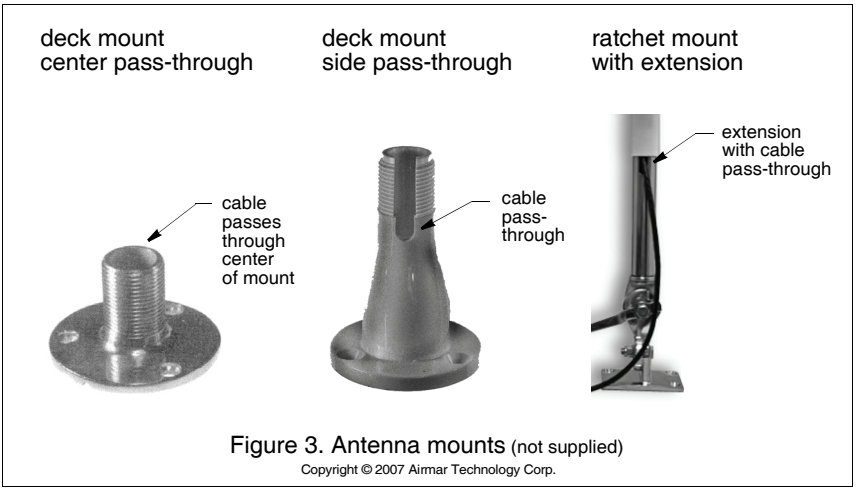

Figure 3. Antenna mounts (not supplied)

Where to Purchase

Gemeco (USA)	Tel: 843.394.3565
	Fax: 843.394.3736
	email: sales@gemeco.com
Airmar EMEA	Tel: 33.(0)2.23.52.06.48
(Europe, Middle East, Africa)	Fax: 33.(0)2.23.52.06.49
	Email: sales@airmar-emea.com

Installing

WARNING: Always wear safety goggles and a dust mask.

CAUTION: The silver metal plate and the blue film found in the wind channel of the WeatherStation instrument are essential to its operation (see Figure 4). Be careful not to scratch the plate, puncture the film, or damage them in any way.

CAUTION: 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 provided. Cutting the cable or removing the waterproof connector, except when using Airmar's junction box, will void the sensor warranty.

CAUTION: The WeatherStation instrument must be installed vertically—NOT tilted to one side. If it is tilted from the horizontal plane, there will be an error in the compass reading.

CAUTION: Do not tighten or align the WeatherStation instrument by rotating the upper cap (see Figure 3). Turning may sever internal connections and void the warranty. Grasp the lower housing below the silver metal plate. Hand-tighten only.

Figure 4. Wind channel

Permanent Mounting

1. Place the mount at the selected location. Orient any cable exit in the direction that you want the cable to travel (see Figure 5).
2. Position the mount at a 90° angle to the mounting surface. If necessary, use shims to make it level.
3. Mark the holes for the screws. If the cable will pass through the center of the mount, also mark that hole.

   ***Note**: If you are using a ratchet mount, be sure you have purchased an extension with a cable pass-through.*

WARNING: Always wear safety goggles and a dust mask.

4. Drill any holes for the mounting screws and the cable exit.
5. Fasten the mount in place.
6. Screw an extension pole onto the mount if desired.

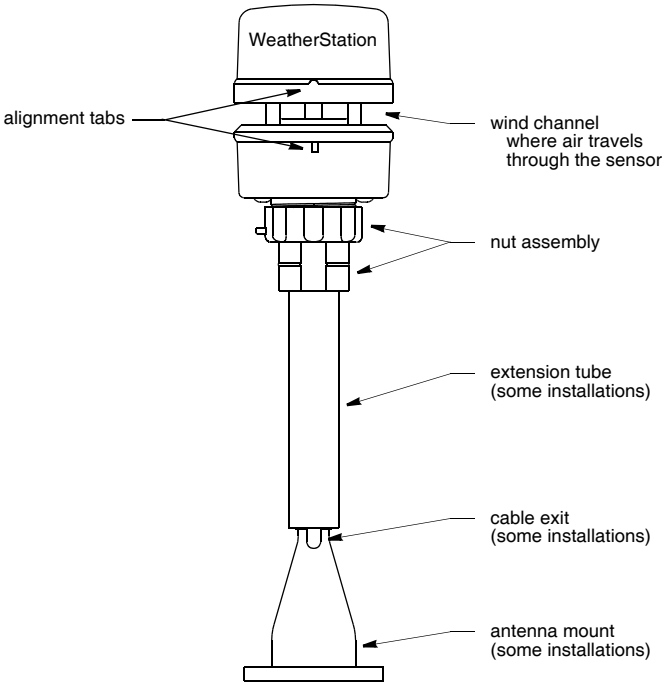

Figure 5. Permanent installation with antenna mount

Attaching the WeatherStation Instrument

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.

CAUTION: It is necessary to accurately measure the wind direction.
If mounting on a stationary surface, be sure the alignment tabs face north.
If mounting on a vehicle, be sure the alignment tabs face forward and parallel to the centerline of the vehicle.

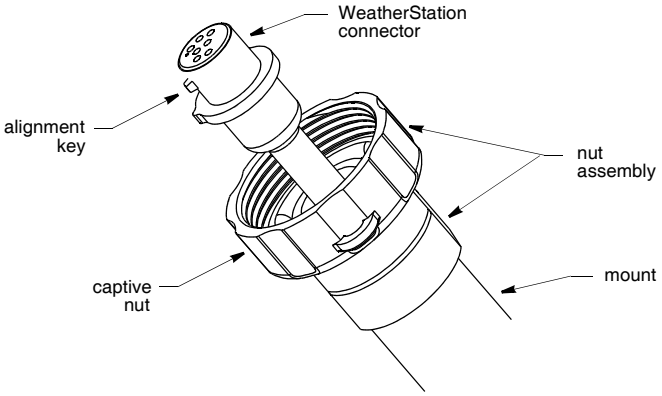

Figure 6. Attaching

1. With the nut assembly on the cable near the WeatherStation connector, thread the cable through the extension pole (if used), antenna mount, and the cable exit. Be sure to leave several inches of cable extending beyond the nut assembly (see Figure 6).
2. Screw the nut assembly onto the top of the antenna mount/extension tube. **Hand-tighten only**. Do not over tighten.
3. 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 7-pin connector into the WeatherStation instrument. The alignment key on the connector fits into a notch in the base of the WeatherStation instrument.
4. Being sure the alignment tabs are facing properly, slide the captive nut upward and screw it onto the base of the WeatherStation instrument (see Figures 5 and 6). **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 properly.*

Cable Routing & Connecting

Depending upon your application, route the WeatherStation cable to a Converter, PDA, laptop computer, or other device.

WARNING: Always wear safety goggles and a dust mask.

WARNING: The power supply voltage must be 12 VDC (±3VDC).

WARNING: The power panel must have a 1 amp fast-blow fuse or circuit breaker.

CAUTION: 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 provided. Cutting the cable or removing the waterproof connector, except when using Airmar's junction box, will void the sensor warranty.

CAUTION: To reduce electrical interference, separate the cables from other electrical wiring and sources of electronic noise.

CAUTION: Be careful not to tear the cable jacket.

CAUTION: Use a multimeter to check the polarity and the connections to the 12VDC power supply before applying power to the sensor.

CAUTION: Coil any excess cable(s) and secure it with a zip-tie to prevent damage.

Connecting to a Converter

The Converter allows the WeatherStation measurements to be displayed on a PC by converting the data from NMEA 0183/RS485 to USB.

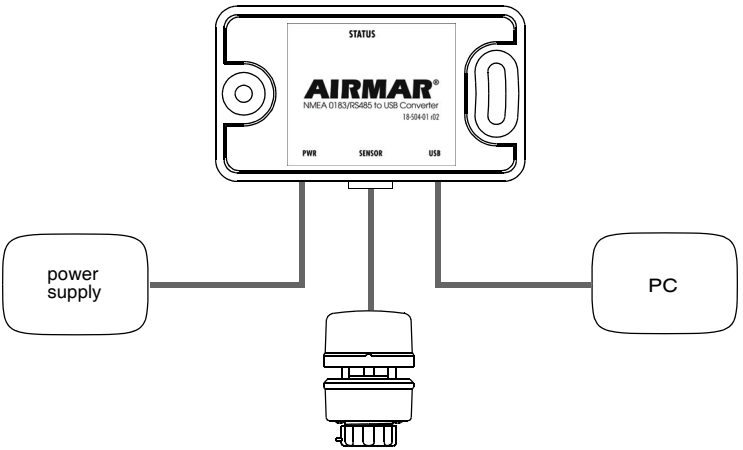

Figure 7. Converter installation

Mounting Location of the Converter

1. Select a convenient, dry, mounting location for the water-resistant Converter, a minimum of 1 m (3') from the PC (see Figure 7).
2. Hold the Converter at the selected location and mark the position of the screw holes. If the Converter will be mounted on a vertical surface, face the cables downward to avoid water seeping into the box.

WARNING: Always wear safety goggles and a dust mask.

3. At the marked locations, drill the holes for the screws. *Do not* fasten the Converter in place at this time.

WeatherStation Cable

Route the WeatherStation cable to the Converter. *Do not* connect the WeatherStation cable or fasten it in place at this time.

USB Cable

Route the USB cable coming from the Converter into the USB port on the PC. *Do not* connect the cable or fasten it in place at this time.

Power Cable

1. Route the power cable from the Converter to the power supply. *Do not* fasten the power cable in place at this time.
2. Allowing an extra 25 cm (10") for wiring ease, cut the cable to length.
3. Strip 60 mm (2-1/2") of the outer jacket and foil shielding from the cut end of the cable.
4. Cut off the bare wire flush with the cable jacket.
5. Strip 10 mm (3/8") of conductor insulation from the end of each colored wire.
6. Protect the cable's foil shielding from causing a short by wrapping electrical tape around the jacket where the wires emerge from the cable. The tape *must* overlap the wires a minimum of 6 mm (1/4").
7. Connect the wires to the power supply [12 VDC (±3 VDC) @ 0.5 amp required]. See the color code below.

Red	12 VDC +
Black	12 VDC –/ground

***Note**: the Converter is powered by the USB port and the WeatherStation instrument is powered by the power cable.*

Completing the Installation

1. Fasten the Converter in place with the screws supplied.
2. Plug the WeatherStation cable into the Converter.
3. Plug the USB cable into the PC.
4. Fasten all the cables in place.

LED Indicator Light

The green LED indicator light will flash when the Converter is operating.

Installing the Software

Follow the instructions in the *WeatherCaster™ Software Guide*.

Maintenance & Updates

Software Updates

Periodically, Airmar will release updated versions of both the WeatherStation firmware and the WeatherCaster software. Updates can be downloaded from Airmar's web site, www.airmar.com, or contact Airmar's technical support personnel for a CD.

Calibration

The WeatherStation instrument is calibrated at the factory and does not require any calibration after purchase.

Maintenance

Since the WeatherStation instrument has no moving parts, it requires minimal maintenance.

CAUTION: The silver metal plate and the blue waterproof film found in the wind channel of the WeatherStation instrument are essential to its operation (see Figure 8). The blue waterproof film protects the transducers, so *be careful* to keep it intact. Do not to scratch the metal plate or damage it in any way.

IMPORTANT: Keep the wind channel free of *SPIDER WEBS*, insects, dirt, and other debris.

Figure 8. Wind channel

Where to Purchase

Gemeco (USA)	Tel: 843.394.3565
	Fax: 843.394.3736
	email: sales@gemeco.com
Airmar EMEA	Tel: 33.(0)2.23.52.06.48
(Europe, Middle East, Africa)	Fax: 33.(0)2.23.52.06.49
	Email: sales@airmar-emea.com

Troubleshooting

- Is there power to the WeatherStation instrument?
- Are all the connections tight?
- Is the cable-run free of kinks?
- Is the wiring correct?
- Are there any obstructions in the wind channel of the WeatherStation instrument? Keep it free of spider webs, insects, dirt, and other debris. Be careful not to puncture the blue waterproof film or scratch the silver plate.
- Is there ice on the WeatherStation instrument?
- For a GPS fix, does the WeatherStation instrument have a clear view of the sky?

Appendix A—How the WeatherStation Instrument Works

About the 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 9). 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.

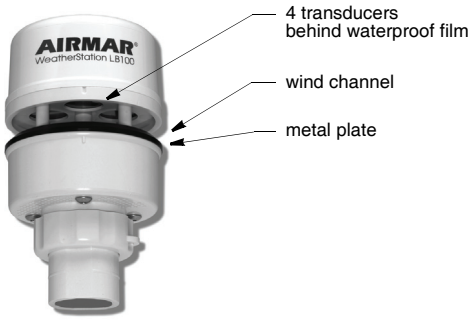

Figure 9. WeatherStation instrument ultrasonic wind sensor

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. It is the result of two motions—the actual motion of the air (the true wind) and the motion of the vehicle. If the vehicle 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. This angle can be referenced to true or magnetic north, the front of the vehicle, or any point that is programed into the software. Both true and apparent wind use these same references.

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

Now, consider the more complicated situation of a vehicle proceeding at 15 MPH with a *true* wind of 15 MPH blowing from the side (see Figure10). To an observer on board, the *apparent* wind would be 21.2 MPH blowing from an angle 45° off the front.

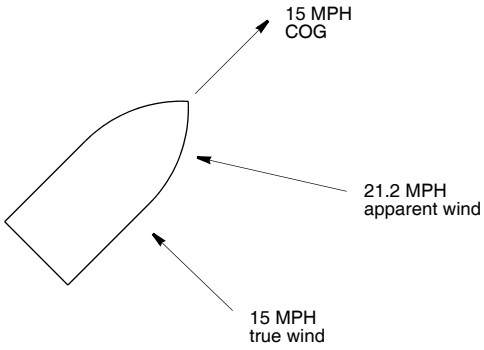

Figure 10. Apparent wind

In order to calculate the true wind speed and direction when on board a moving vehicle, it is necessary to know the apparent wind speed and direction, the speed and course over ground of the vehicle, the compass heading, and the local magnetic variation. Note that heading and course are not the same thing. Heading is the direction the vehicle is pointing, while course is the direction the vehicle is traveling. On land, heading and course may differ only when the vehicle is stationary. 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 Global Positioning System 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 vehicle 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 vehicle reaches a steady-state condition, traveling in a straight line at a constant speed.

About the Electronic Compass

The WeatherStation instrument includes a pair of magnetoinductive sensors that measure magnetic field strength in two axes on the horizontal plane of the WeatherStation instrument. From these measurements, it calculates the resultant magnetic heading angle, thereby providing a built-in 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 lights. 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.

Although the WeatherStation compass is a 2-axis device, the earth's magnetic field occurs in three dimensions. That is, part of the earth's magnetic field is oriented in the vertical direction. The closer one's location is to the north or south pole, the stronger this vertical component becomes in comparison to the horizontal components. The effect this has on the WeatherStation instrument is to introduce an error in the compass reading if the WeatherStation instrument is tilted from the horizontal plane. Therefore, it is important when installing the WeatherStation instrument to ensure the support pole is mounted vertically, and not tilted to one side. Also, keep in mind that when your vehicle experiences pitch and roll, the compass heading will be affected accordingly.

Because the compass heading is used in the calculations for true wind, any errors in the compass heading will also produce errors in the reported true wind speed and direction. This is adjusted for in the WeatherStation instrument by using the GPS-sourced course over ground when the vehicle is moving.

About 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 (that is, 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.

About the 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.

About the Relative Humidity Sensor

The WeatherStation instrument contains a capacitive cell humidity sensor that measures the relative humidity of the air. Humidity refers to the amount of water vapor in the air. Relative humidity is the percentage of saturation of the water vapor in the air. It is the ratio of the moisture content of the air to the saturated moisture level at the same temperature and pressure.

About Dew Point

Dew point is the temperature at which the water vapor in the air begins to condense into a liquid. If the air were gradually cooled while maintaining constant moisture content, the relative humidity would rise until it reaches 100%. The air temperature at this point of saturation is called the dew point.

If the air is dry enough, it is possible to have a dew point that is below freezing. The dew point is then sometimes referred to as the frost point.

The WeatherStation instrument calculates dew point from the measured air temperature and relative humidity sensor readings.

About 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 building. 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 (32°F) 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 a moving vehicle. The *true* wind-chill temperature indicates what the wind chill would be for a stationary individual.

Wind chill temperature is only defined for temperatures at or below 10°C (50°F) and wind speeds above 3MPH.

By default, transmission of wind-chill data is disabled by the WeatherStation instrument. When used with WeatherCaster, the wind-chill data will be automatically enabled.

About the Barometric Pressure Sensor

The WeatherStation instrument contains a temperature-compensated, silicon, piezoresistive, 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 Global Positioning System

Some WeatherStation instruments have a built-in 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 (two dimensional) 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 has 16 channels to track satellites and will use up to 12 satellites in computing a position 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 vehicle, 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.)

Appendix B—Technical Information

NMEA 0183 Sentences

Datum Reference	$GPDTM
GPS Fix Data	$GPGGA *
Geographic Position L/L	$GPGLL
Standard GNSS DOP and Active Satellites	$GPGSA
Standard GNSS Satellites in View	$GPGSV
Heading, Deviation, Variation	$HCHDG
Heading Relative to True North	$HCHDT *
Meteorological Composite	$WIMDA *
Wind Speed & Direction with respect to north	$WIMWD
Apparent Wind Speed & Direction with respect to front of vehicle	$WIMWV(R) *
True Wind Speed & Direction with respect to front of vehicle	$WIMWV(T)
Recommended Minimum GNSS	$GPRMC
Course Over Ground (COG) & Speed Over Ground (SOG)	$GPVTG *
Apparent Wind Speed and Direction	$WIVWR
Wind Chill & Heat Index Temperature	$WIXDR(A) *
Pitch & Roll	$WIXDR(B) *
Date & Time	$GPZDA *
Attitude	PFEC

* These sentences are enabled by default.

Additional Data Available from the WeatherStation Instrument

There are parameters that the WeatherStation instrument can make available to the user. Usually, more data is available from the WeatherStation instrument than can be displayed in a reasonable format on a screen. Also, if all the data was continuously transmitted to the display, the update rate would be too slow and could not keep up with WeatherStation measurements. Consequently, some parameters are transmitted while others are not, based on a pre-selected list (the NMEA 0183 sentences with an asterisk). Note that those parameters not transmitted are, nevertheless, retained in the WeatherStation instrument. For more detailed information, see the “Technical Manual” on the WeatherStation CD.

Acronyms & Abbreviations

CD	Compact Disk
COG	Course Over Ground
DOP	Dilution Of Precision
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
PC	Personal Computer
SOG	Speed Over Ground
USB	Universal Serial Bus
WAAS	Wide Area Augmentation System
2D	Two Dimensional GPS Fix
3D	Three dimensional GPS Fix

Glossary

Firmware	The software within the WeatherStation hardware
WeatherCaster	The PC application program

Trademarks

Airmar® is a registered trademark of Airmar Technology Corporation.
WeatherCaster™ is a trademark of Airmar Technology Corporation.
WeatherStation® is a trademark of Airmar Technology Corporation.

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