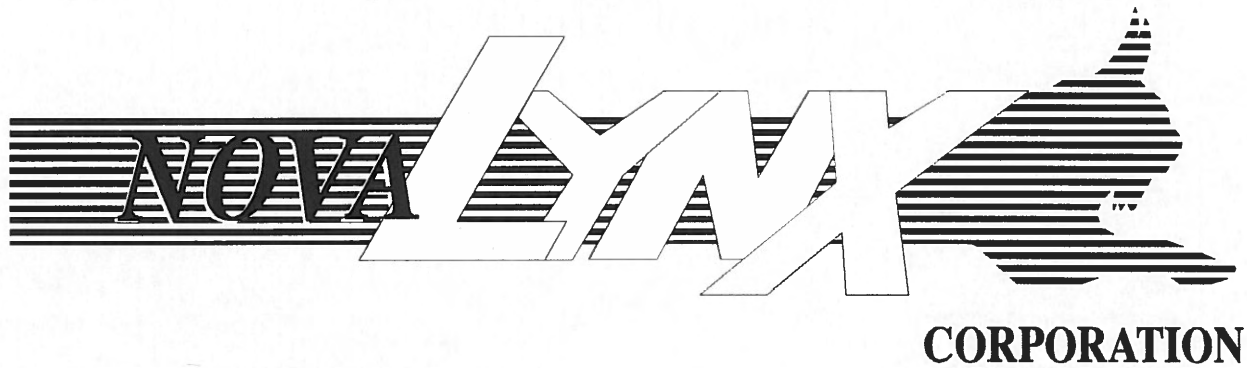


# NOVALYNX CORPORATION

MODEL: 230-AIR-HB-1A & 2A

DIGITAL HAND HELD  
BAROMETER/ ALTIMETER

INSTRUCTION MANUAL



REVISION DATE: 12/98  
ECO:

## **Receiving and Unpacking**

Carefully unpack all components and compare to the packing list. Notify NovaLynx Corporation immediately concerning any discrepancy. Inspect equipment to detect any damage that may have occurred during shipment. In the event of damage, any claim for loss must be filed immediately with the carrier by the consignee. Damages to equipment sent via Parcel Post or UPS require the consignee to contact NovaLynx Corporation for instructions.

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If equipment is to be returned to the factory for any reason, call NovaLynx between 8:00 a.m. and 4:00 p.m. Pacific Time to request a Return Authorization Number (RA#). Include with the returned equipment a description of the problem and the name, address, and daytime phone number of the sender. Carefully pack the equipment to prevent damage or additional damage during the return shipment. Call NovaLynx for packing instructions in the case of delicate or sensitive items. If packing facilities are not available take the equipment to the nearest Post Office, UPS, or other freight service and obtain assistance with the packaging. Please write the RA# on the outside of the box.

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NovaLynx Corporation warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from the date of shipment from the factory. NovaLynx Corporation's obligations under this warranty are limited to, at NovaLynx's option: (i) replacing; or (ii) repairing; any product determined to be defective. In no case shall NovaLynx Corporation's liability exceed product's original purchase price. This warranty does not apply to any equipment that has been repaired or altered, except by NovaLynx Corporation, or that has been subjected to misuse, negligence, or accident. It is expressly agreed that this warranty will be in lieu of all warranties of fitness and in lieu of the warranty of merchantability.

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## 1.0 INTRODUCTION

The Hand-held Barometer (HNB) is a small, light instrument which can accurately measure and display atmospheric pressure and pressure altitude. A microprocessor computes instantaneous readings of ambient pressure and pressure altitude from the output of an accurate pressure sensor. A standard 9-volt transistor battery powers the unit.

A five-digit Liquid Crystal Display (LCD) displays the instrument readings. Display annunciators indicate the type of data and the units of measure that are currently displayed. The instrument is operated from an easy-to-use five-key keypad.

The discussion that follows pertains to Models AIR-HB-1A and AIR-HB-2A. A Model AIR-HB-1F designed for aviation use and having Barometer and Altimeter Operating Modes only is also available. It is described in a separate Operator's Guide available from AIR, Inc.

### 1.1 Handling Precautions

AIR's patented dual-diaphragm pressure sensor has extremely low sensitivity to shock, vibration, acceleration, and changes in orientation or temperature. Nonetheless, it should be treated with the care that any fine instrument deserves.

The electronics and pressure sensor are housed in an impact-resistant plastic case. The case is, however, NOT water tight. Do not immerse the instrument under any circumstances. Also note that the front cover is somewhat pliant. If you press firmly against the front of the unit, you may cause erroneous readings.

### 1.2 The Display

The Hand-held Barometer uses a liquid crystal display (LCD) which offers the following features:

- o Data readings to five digits, with decimal point and minus sign as required,
- o The current operating mode,
- o Annunciators for the units of measure, and
- o Low battery warning: BAT in lower right corner to indicate that the battery needs to be replaced.

### 1.3 Keypad

Five keys on the Hand-Held Barometer are used to turn the device on or off, to select operating modes, to select the type of units in which data are displayed, and, in some operating modes, to set values.

#### ON Key

The ON key turns the instrument on or off. The key works as a toggle switch; pressing the ON key when the instrument is off turns it on, and pressing the key when the instrument is on turns it off. When more than two minutes have transpired since any key was pressed, the instrument shuts off. (Refer to Appendix for instructions to disable this function.)

To reactivate the HHB, press the ON key. The Hand-held Barometer always remembers the operating mode and the units of measure that were displayed during the last period of use, and automatically returns to this display when the unit is turned on.

#### MODE Key

The MODE key allows you to select any of several operating modes. Each mode is identified by an annunciator on the left side of the display. Modes are presented in the cycle given in the following table:

Operating Mode	Annunciator
Barometer	↓ PRESSURE
Altimeter	↓ ALTITUDE (AS)
Temperature-compensated Altitude	↓ ALTITUDE (TC)
Differential Altitude	↓ Δ ALTITUDE
Differential Barometer	↓ Δ PRESSURE

Each time the MODE key is pressed, the display advances to the next operating mode. When the MODE key is pressed from Differential Barometer Operating Mode (Annunciator = Δ PRESSURE), the display returns to Barometer Operating Mode (Annunciator = PRESSURE).

In addition to the modes listed in the preceding table, a Pressure Adjustment Mode can be accessed from the Barometer Operating Mode (see Section 3.0).

#### Arrow Keys

Arrow keys, shown as Up (Δ) and Down (∇) keys, are used by themselves to select the units in which data readings are displayed or in combination with the SET/ZERO and/or MODE keys while the

instrument is in its various operating modes. For detailed information, see Section 2.

#### **SET/ZERO Key**

The SET/ZERO key is used by itself with the instrument in the Differential Altitude and Differential Barometer Operating Modes to set the  $\Delta$  ALTITUDE and  $\Delta$  PRESSURE readings to zero and in combination with the MODE and arrow keys to enter a known altimeter setting, altitude, or temperature. See Section 2 for details.

#### **1.4 Measurement Averaging**

The Hand-held Barometer makes four measurements each second. Each measurement displayed by the Hand-held Barometer is the average of the last eight measurements. Each time a new measurement is made, it replaces the oldest of the eight stored measurements, and is averaged with the seven previous measurements. The display is continuously updated with these new averages. Averaging of pressure and altitude readings removes short-term fluctuations from ambient pressure that are caused by wind or by rapid movement of the instrument. If a sudden, large change in pressure or altitude has occurred, followed by a period of no change, the display will be stable and accurate after 8 to 10 seconds.

## 2.0 OPERATING MODES

### 2.1 Barometer Mode

#### When and How to Select this Mode

This mode is used when you wish to measure atmospheric pressure. To select the Barometer Operating Mode, turn the HNB on and press the MODE key until the display shows PRESSURE in its upper left corner.

#### Selecting Units

Units are selected by pressing the Up or Down arrow keys. Units are presented in a cyclical fashion, allowing you to scroll up or down through all available units. The Barometer Operating Mode units are displayed to the user in the following relative order:

Unit of Measure	Annunciator
Millibars	mb
Inches of mercury	in Hg
Millimeters of mercury	mm Hg
Pounds per square inch absolute	PSIA
Kilopascals	kPa
Inches of water	in H <sub>2</sub> O

The effect of pressing the Up (▲) and Down (▼) arrow keys is shown in the Table above.

### 2.2 Altimeter Mode

In the Altimeter Mode, the instrument uses the station pressure measured by the barometer to calculate the distance (altitude) of that pressure surface in the US and ICAO Standard Atmospheres from a predetermined pressure surface. This predetermined pressure surface is the Altimeter Setting.

When a correct Altimeter Setting is entered into the Hand-held Barometer, the altitude reading is the height of the barometer above mean sea level. If the sea level value of pressure in the US and ICAO Standard Atmospheres is used as the Altimeter Setting, i.e., 1013.2 mb (29.92 in Hg) is used, the altitude reading of the Hand-held Barometer is the Pressure Altitude of the station at which the HNB is used. This Pressure Altitude agrees with the actual altitude of the station only when the actual pressure is identical to that of the standard atmosphere at that altitude, which rarely occurs. When the actual altitude of the station is entered into the HNB, the Barometer calculates the correct Altimeter Setting for that time and place.

## Selecting Units

Altitude can be displayed in feet (ft) or meters (m) and the Altimeter Setting can be displayed in millibars (mb) and/or inches of mercury (in Hg). Arrow keys are used to cycle through these units in the order given in the following Table:

<u>Unit of Measure</u>	<u>Annunciator (s)</u>
feet	ft
meters	m
inches of mercury	in Hg ALT SETTING
millibars	mb ALT SETTING

Altitudes are displayed directly when the Hand-held Barometer is placed in the Altimeter Mode; Altimeter Settings are not. The letters ABCAL in bold type are displayed above and to the left of the much smaller letters ALT SETTING. To view Altimeter Setting on the HHB at this point, it is necessary to press the SET/ZERO key.

**NOTE:** Care must be taken not to press the SET/ZERO and Up or Down keys simultaneously while the Altimeter Setting values are displayed unless you desire to change the Altimeter Setting.

Any value being displayed in the Altimeter Mode can be changed by simultaneously pressing the SET/ZERO key and an Up or Down arrow key.

### Entering a Known Altitude

With the Hand-held Barometer in the Altimeter Operating Mode, the instrument may be set to a known altitude by pressing the arrow keys until the desired units (ft or m) are displayed. Change this value to the known altitude by holding down the SET/ZERO key while pressing the Up key to increase the altitude reading or the Down key to decrease the reading.

When the actual altitude of a site is entered into the HHB in this way, the resultant Altimeter Setting is the correct Altimeter Setting for that time and place. As atmospheric pressure changes, the indicated altitude will also change unless appropriate changes in Altimeter Setting are made.

### Entering an Altimeter Setting

The Hand-held Barometer may be referenced to a known Altimeter Setting by entering the Altimeter Setting obtained from a nearby airport, National Weather Service, local radio station, or other



reliable source. With the instrument in the Altimeter Operating Mode, press an arrow key until the letters ASCAL and the desired pressure units, mb or in Hg, are displayed. Set the HHB to the known Altimeter Setting by holding down the SET/ZERO key and then pressing the Up key to increase the setting or the Down key to decrease the setting. When you set an altimeter setting in one unit, the instrument automatically corrects the corresponding settings in all other units. Thus, it is not necessary to set the Altimeter Setting into the HHB in both mb and in Hg; either will suffice.

### 2.3 Temperature-compensated Altitude Mode

#### When and How to Select this Mode

The Temperature-compensated Altitude Operating Mode allows the user to estimate altitude with the Hand-held Barometer when the actual altitude is not known and the local altimeter setting is not available. By using a sea-level pressure of 29.92 in Hg, the local temperature, and a lapse rate of 6.5 °C/km, the Temperature-compensated Altitude Operating Mode estimates the altitude.

**Note:** The altitude indicated by the Hand-held Barometer in the Temperature-compensated Altitude Operating Mode will differ from the pressure altitude indicated in the Altimeter Operating Mode. This difference will depend on the manner in which the local temperature entered into the HHB differs from the temperature in the Standard Atmosphere at the pressure level measured by the HHB. If the local temperature is warmer than that of the Standard Atmosphere, the Temperature-compensated Altitude will be greater than the pressure altitude; if colder, the Temperature-compensated Altitude will be less. If the local temperature is representative of the free atmosphere at its level, the Temperature-compensated Altitude should be the more accurate of the two. An accurate air temperature measured by an airplane is more likely to be representative than an accurate temperature measured at the earth's surface.

To enter the Temperature-compensated Altitude Operating Mode, press the MODE key repeatedly until the ALTITUDE (TC) annunciator is displayed.

#### Selecting Units

Altitude readings can be displayed in feet (ft) and meters (m). Temperature settings can be displayed in degrees Fahrenheit (°F) and degrees Celsius (°C). These units are presented to the user in the following relative order:

Unit of Measure	Annunciator (s)
feet	ft
meters	m
degrees Fahrenheit	°F
degrees Celsius	°C
	TEMP SETTING
	TEMP SETTING

### Setting the Temperature

In this mode, the Hand-held Barometer should be referenced to a representative ambient air temperature. To do this, with the ALTITUDE (TC) annunciator displayed, press an arrow key until temperature is displayed in degrees Fahrenheit or degrees Celsius. Hold down the SET/ZERO key and press the Up key to increase the temperature value and the Down key to decrease the temperature value. Release the arrow key when the ambient air temperature is displayed and then release the SET/ZERO key.

Reference temperature is stored in the Hand-held Barometer memory until you physically change it. This temperature is used in both the Temperature-compensated Altitude and the Differential Altitude Operating Modes.

### 2.4 Differential Altitude Mode

#### When and How to Select this Mode

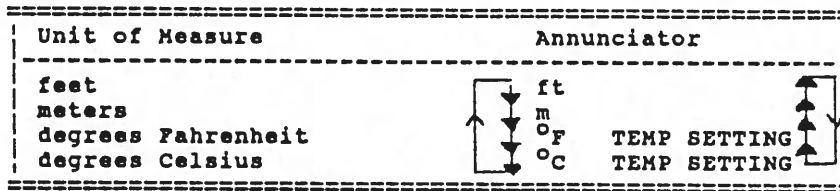
Differential Altitude Operating Mode is used when you wish to measure the difference in altitude between two pressure surfaces by barometric methods.

The Differential Altitude Operating Mode is most accurate when the instrument is referenced to a known ambient air temperature. The HHB should be taken from one location (i.e., one pressure surface) to another location (i.e., another pressure surface) expeditiously.

To select the Differential Altitude Operating Mode, press the MODE key until the display shows  $\Delta$  ALTITUDE in the lower left corner of the display.

#### Selecting Units

Changes in altitude can be displayed in ft or m. Reference temperature can be displayed in either degrees Fahrenheit (°F) or degrees Celsius (°C). These units are presented to the user in the following relative order:



### Setting the Temperature

To enter the temperature into the Hand-held Barometer while in the Differential Altitude Operating Mode, press an arrow key until °F or °C are shown on the far right of the display and TEMP SETTING is displayed in the lower right side of the display. To set the reference temperature, hold the SET/ZERO key down while pressing the appropriate arrow key to change the temperature to the known value. When you set the temperature in degrees Fahrenheit, it is automatically set in degrees Celsius and vice versa.

To obtain more accurate differential heights with the instrument in the Differential Altitude Operating Mode, you should update the temperature reference by entering the ambient air temperature at each altitude at which measurements are desired. Estimated temperatures should be used if measured temperatures are not available.

### Differential Altitude Mode

With the Hand-held Barometer in either the feet (ft) or meter (m) mode, pressing the SET/ZERO key causes the  $\Delta$  ALTITUDE display to read zero. Subsequent changes of pressure due to either changes in height of the HHB or to atmospheric pressure will be shown by the HHB as values of  $\Delta$  ALTITUDE. To minimize the effect of atmospheric pressure change, the movement of the HHB from a site at one height to a site at another height should be as rapid as possible. Once the  $\Delta$  ALTITUDE has been set to zero, all subsequent changes of height until  $\Delta$  ALTITUDE is again set to zero are summed; gains in height are positive and losses are negative.

### 2.5 Differential Barometer Mode

#### When and How to Select this Mode

The Differential Barometer Operating Mode is used to measure the change in barometric pressure.

To use the Differential Barometer Mode, press the MODE key until the display shows  $\Delta$  PRESSURE in the upper left corner.

## Differential Pressure

To measure the change in barometric pressure using this Operating Mode, set the  $\Delta$  PRESSURE reading to zero at an initial location and time by pressing the SET/ZERO key.

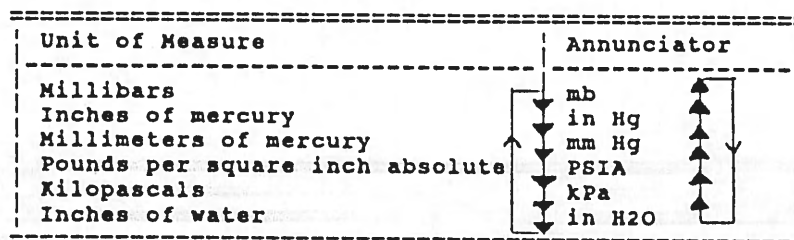
Frequently, pressure change as a function of time is an important variable. Consequently, subsequent pressure changes due to taking the instrument to a different location or due to atmospheric changes should be referenced to this initial location and time. A new location and time can be chosen as a new reference by pressing the SET/ZERO key at that location.

The display uses a minus sign to indicate that the current pressure reading is below the reference level reading.. For example, if pressure drops by 0.2 millibars, the display shows -0.2 mb, and conversely, if pressure rises by 0.2 millibars the display shows 0.2 mb.

## Selecting Units

The barometric reading can be displayed in the following units: millibars (mb), inches of mercury (in Hg), millimeters of mercury (mm Hg), pounds per square inch absolute (PSIA), kilopascals (kPa), and inches of water (in H<sub>2</sub>O).

Units are selected by pressing the up or down arrow keys. The units are presented to the user in the following relative order:



## 3.0 PRESSURE ADJUSTMENT

If a barometric pressure standard is available, the Pressure Adjustment Mode allows a pressure adjustment to be made to compensate for slight long-term drifts that may occur during normal operation. This adjustment is stored in the Hand-held Barometer battery powered memory. When the battery is changed you have to re-enter this pressure adjustment.

To use the Pressure Adjustment Mode, enter the Barometer Operating Mode by pressing the MODE key until the PRESSURE annunciator is illuminated in the upper left of the display. Then press an arrow

key until the desired pressure units are displayed. Make a careful comparison of the barometric pressure standard reading to the HHB reading, averaging readings over one minute. Determine the adjustment by subtracting the HHB value from the barometric pressure standard. The resulting difference (retaining the algebraic sign) is the adjustment value.

Press and hold down the SET/ZERO key. While holding this key down, press and hold down the MODE key. The display will show the letters "CAL" for one second and then the current pressure adjustment is displayed. (The HHB is shipped with a pressure adjustment of 0.0.)

Holding the SET/ZERO and MODE keys depressed, press the up arrow key to increment this adjustment, or the down arrow key to decrement the adjustment. The pressure adjustment must be in the range -1.28 mb to +1.27 mb (refer to Appendix for unit conversion factors). If the measured adjustment is outside this range, the accuracy of the barometric pressure standard should be verified. If the barometric pressure standard is correct, return the Hand-held Barometer to AIR, Inc. for factory recalibration.

**Note:** Care should be exercised when setting pressure adjustment values. As these values are increased (decreased) beyond the maximum allowable values (+1.27 and -1.28 mb; +0.38 and -0.38 in Hg; +0.95 and -0.96 mm Hg; +00.18 and -00.19 PSIA; +0.127 and -0.128 kPa) a jump from maximum positive (negative) to maximum negative (positive) value will occur.

To exit the Pressure Adjustment Mode and return to the Barometer Operating Mode, release the MODE key and the SET/ZERO key. Verify your adjustment by comparing the current Hand-held Barometer reading to the barometric pressure standard. Hand-held Barometer readings (averaged for one minute) and those of the barometric pressure standard should now be equal.

## APPENDIX

### REPLACING THE BATTERY

The Hand-held Barometer is shipped with a 9-volt battery installed. This should be replaced when the BAT annunciator is constantly illuminated. A 9-volt alkaline battery, NEDA No. 1604A (Eveready No. 522) should be used. A new alkaline battery should last for approximately 80 hours of continuous usage.

**Note:** When replacing the battery, the pressure offset from Calibration Operating Mode is lost. BEFORE REPLACING THE BATTERY, RECORD THE PRESSURE OFFSET VALUE. REPLACE THE OLD BATTERY WITH A NEW BATTERY (DESCRIBED BELOW). REENTER THE OFFSET VALUE IMMEDIATELY AFTER REPLACEMENT. Any other user-entered values, such as temperature or altitude must also be reentered.

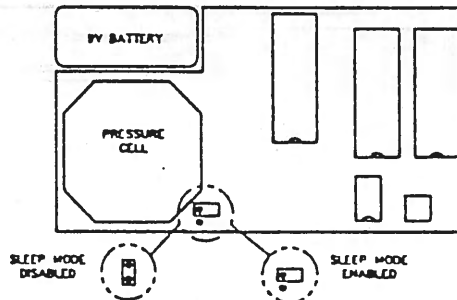
To replace the battery, loosen and remove the four phillips-head screws from the back cover. Lift off the back cover. The battery will be visible in the lower left corner of the instrument. Remove the old battery, gently prying the connector on the battery terminal up and off the battery.

Snap two-position battery connector onto the new battery and set the new battery into position. Replace the back cover and tighten the four screws. Turn the unit on by pressing the ON key and verify that the LCD works properly and BAT annunciator is no longer visible. Reenter the pressure offset and other appropriate values.

### THE SLEEP STATE JUMPER

To conserve power, an internal jumper is set to enable a sleep state. With this jumper on one pin only (the setting at shipment), the Hand-held Barometer will automatically shut off when more than two minutes have transpired since any key was pressed. Changing the jumper position allows the instrument to turn off only when the ON key is pressed.

To set this jumper, loosen and remove the four phillips-head screws from the back cover. Lift off the back cover. The following



As shipped from AIR, Inc., the jumper covers one pin only, and does not connect to the second pin. This jumper position causes automatic shut down after two minutes.

To disable automatic shut down and allow the Hand-held Barometer to turn off only when the ON key is pressed, install this jumper on both pins.

After you have set the jumper position, replace the back cover and tighten the four screws.

**SPECIFICATIONS: HAND-HELD DIGITAL BAROMETER/ALTIMETER**

<b>MODEL NO.</b>	<b>AIR-HB-1A</b>	<b>AIR-HB-2A</b>
<b>Temperature</b>	+5 to 40°C 40 to 105°F	-25 to 50°C -15 to 120°F
<b>Pressure</b>		
(mb)	600 to 1100	Same as 1A
(in. Hg)	17.7 to 32.5	
(mm Hg)	450 to 825	
(in. H <sub>2</sub> O)	241 to 442	
(PSIA)	8.7 to 16	
(kPa)	60 to 110	
<b>Pressure Accuracy</b>		
(mb)	±0.5	Same as 1A
(in. Hg)	±0.015	
(mm Hg)	±0.4	
(in. H <sub>2</sub> O)	±0.20	
(PSIA)	±0.007	
(kPa)	±0.05	
<b>Pressure Resolution</b>		
(mb)	0.1	Same as 1A
(in. Hg)	0.001	
(mm Hg)	0.1	
(in. H <sub>2</sub> O)	0.01	
(PSIA)	0.001	
(kPa)	0.01	
<b>Altitude</b>		
(feet)	-2300 to 13,800	Same as 1A
(meters)	-700 to 4200	
<b>Altitude Resolution</b>	1.0 ft (0.1 m)	Same as 1A
<b>Size</b>	1.2x3.6x5.7 in (3.0x9.1x14.5 cm)	Same as 1A
<b>Weight</b>	10 oz. (280 g)	Same as 1A
<b>Power</b>	Standard 9 V Alkaline Transistor Battery	Same as 1A

**Note:** Custom Calibration over increased ranges is available at additional cost. Maximum pressure range is 225 to 1100 mb or altitude range -2,300 to 36,200 ft. Consult factory for details.



## EQUATIONS

Mathematical equations are used by the Hand-held Barometer to calculate the output parameters.

Pressure in millibars is calculated by a fifth-order polynomial equation with temperature dependent cross product terms. The equation is used to convert raw data to a numeric pressure value.

### Altitude Equations

The equation relating pressure and height used in the HHB Altimeter is:

$$H = 11880.33 [P_r^n - P_o^n] \quad (1)$$

Where:  $H$  = vertical distance in meters between the pressure surfaces  $P_r$  and  $P_o$   
 $P_o$  = station pressure measured by the instrument in mb,  
 $P_r$  = the Altimeter Setting in millibars, and  
 $n = -Ra/gM = 0.190263$ : in which  $R$  is the universal gas constant,  $a$  is the temperature lapse rate,  $g$  is the acceleration due to gravity, and  $M$  is the molecular weight of air.

If  $P_r = 1013.25$  mb, Eq. 1 is the equation used to calibrate pressure altimeters in the US Standard Atmosphere between sea level ( $H = 0$ ) and the top of the troposphere ( $H = 11000$  m). The temperature lapse rate,  $a$ , is  $-0.0065$  °C/m).

An altimeter may be made to yield the actual height of a site by setting  $P_r$  to the correct Altimeter Setting. The HHB calculates a correct Altimeter Setting for a site when the height of the site is set into it while it is in the Altimeter Mode.. Eq. 2 is Eq. 1 solved for Altimeter Setting.

$$P_r = [P_o^n + K * H]^{1/n} \quad (2)$$

Where:  $P_o$  = site pressure measured by the instrument in mb,  
 $n = 0.190263$ ,  
 $K = (P_{s1} * a) / T_{s1}$ ,  
 $P_{s1}$  = standard sea level pressure in mb (1013.25),  
 $a$  = standard lapse rate in deg K per meter  
( $-0.0065$  °C/m),  
 $T_{s1}$  = standard sea level temp. in deg K (288.15),  
 $K = 8.41727E-5$  when pressure is measured in millibars  
and height in meters, and  
 $H$  = station elevation in meters.

The equation for temperature compensated altitude (models AIR-HB-1A and AIR-HB-2A) is:

$$H = ( T_0 / 0.0065 ) * ( ( [ 1013.25 / P_0 ] ** 0.19026 ) - 1 )$$

Where: H = station elevation in meters,

P<sub>0</sub> = site pressure as measured by the instrument in mb,

T<sub>0</sub> = site temperature in deg K as measured by the operator.

When using this mode the operator may correct the altitude reading by adjusting to the site ambient air temperature.

The equation for differential altitude (models AIR-HB-1A and AIR-HB-2A) is:

$$DH = ( T_0 / 0.0065 ) * [ ( P_s / P_0 ) ** 0.19026 - 1 ]$$

Where: T<sub>0</sub> = site temperature in deg K as measured by the user,

P<sub>0</sub> = site pressure as measured by the instrument in mb,

P<sub>s</sub> = set equal to P<sub>0</sub> whenever the differential altitude is zeroed with the SET/ZERO key.

#### CONVERSION CHART

1.0 inch of mercury	= 33.86	millibars
1.0 millimeter of mercury	= 1.33	millibars
1.0 pound sq. in. absolute	= 68.94	millibars
1.0 kilopascal	= 10.00	millibars
1.0 inch of water	= 2.49	millibars
-----		
1.0 meter	= 3.28	feet
1.0 foot	= 0.305	meters
-----		
degrees K	= 273.15 + deg C	
degrees K	= 273.15 + 5/9 (degrees F - 32)	
degrees C	= 5/9 (degrees F - 32)	