

*NOTICE: The AirTool Terminal Software described on pages 4, 14, 15 & 19 is not available at this time. This software will be supplied at no cost via internet download when it comes available. Delivery is scheduled for the 3<sup>rd</sup> quarter of 2005.*

# AirTool™

## Operating Instructions



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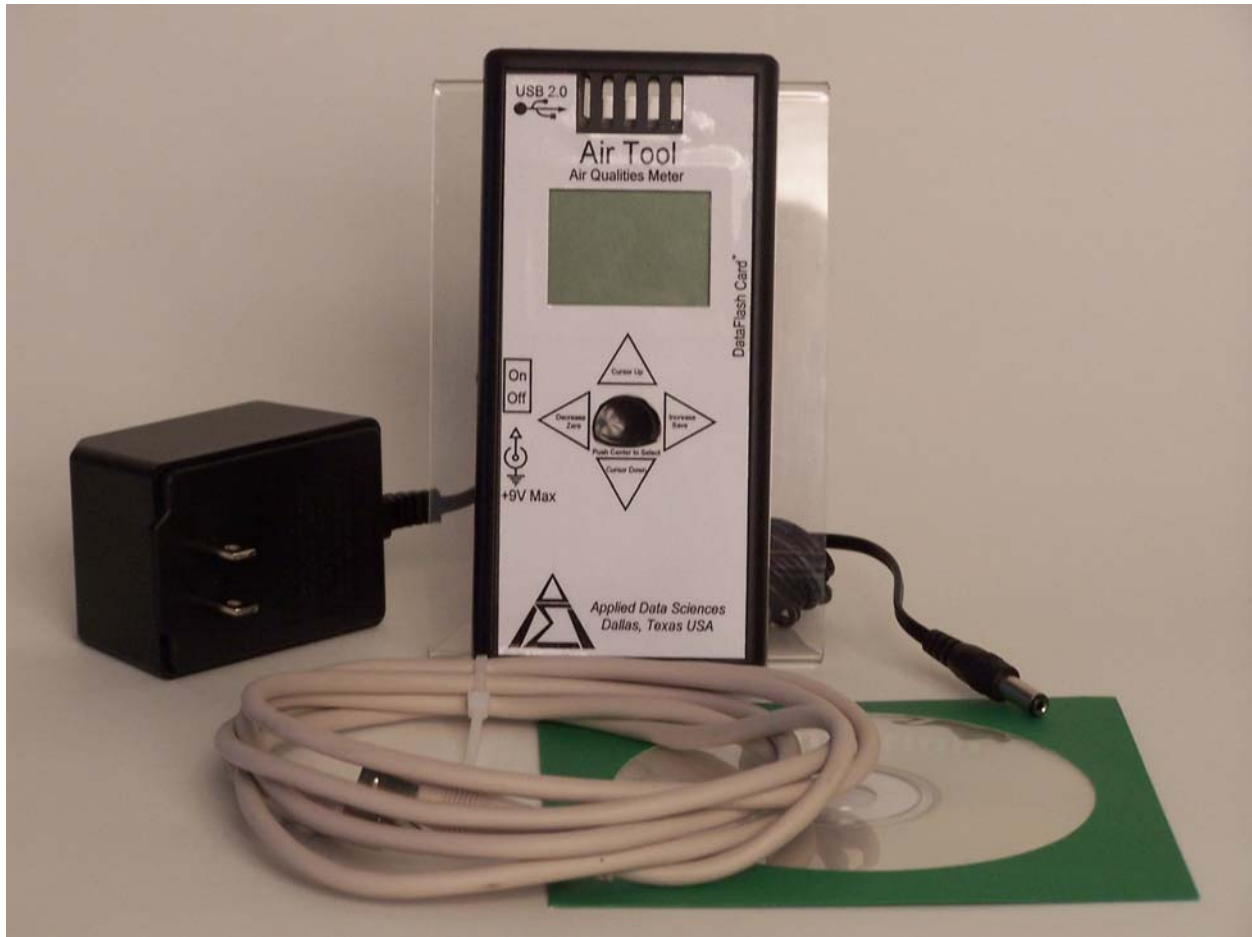
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## **AirTool™ Operating instructions:**

AirTool is a high performance, hand held, battery powered, weather sensor device. It uses a trio of sensors to measure Density Altitude, Air Density, Oxygen Pressure, Pressure Altitude, and Relative Air Density. These sensors are a pre-amplified pressure sensor for barometric pressure, linear temperature sensor and a capacitive pre-amplified relative humidity sensor. AirTool uses high performance sensors to obtain accurate readings and uses sophisticated digital filtering techniques to ensure stable high quality readings.

## Operation:

AirTool is a polled USB peripheral device. You can use the AirTool as a stand alone weather sensor meter or you can connect the USB port on the AirTool to a desktop computer and collect the data using the AirTool Terminal Software\*\*. You can also use other programs to take readings from the AirTool, such as HyperTerminal. Before you will be able to connect to the AirTool you must install the USB driver (see USB Driver Section.) **Set the serial link parameters (in the terminal program setup and in the device manager of the operating system) in the program for 19200 baud, 8 data bits, no parity, and 1 stop bit (This is a formality to satisfy the USB to Serial driver, the actual transfer rate is 12 megabits.)** AirTool is also easy to interface to third party or custom software. The interface commands are all single ASCII characters. All responses to the commands are formatted in ASCII, and are transmitted as individual numbers, each will a carriage return line feed (CRLF.)

\*\*See notice on page 1

## Sensors:

*Notice – the Bold letters are Command Set characters described on page 11.*

- ❑ The Barometer (Baro) is a 16 PSIA pre-amplified pressure sensor. To request a barometric pressure reading from AirTool use the “**B**” or “**b**” command for barometric pressure numbers. Barometric pressure is available in English and Metric units depending on the setting of the SAE/Metric parameter in the AirTool.
- ❑ Air Temperature (Temp) is a linear temperature sensor with a range from 32.0° F to 212.0° F (0.0° C to 100.0° C). The “**T**” or “**t**” command will request the temperature from the AirTool. Air temperature is available in English and Metric units depending on the setting of the SAE/Metric parameter in the AirTool.
- ❑ Relative Humidity (Humi) capacitive pre-amplified sensor that measures humidity in a percentage from 0.0 to 100.0 percent. 0.0 being as dry as the scale gets and 100.0 being as moist as the scale gets. Relative Humidity is relative to temperature. The temperature of the air determines the amount of water vapor the air can hold. This is called Saturated Water Vapor Pressure and is expressed as a pressure in inches of mercury. Relative Humidity is the percentage of the Saturated Water Vapor Pressure that the air is currently holding. The command to request relative humidity from the DaqPod is “**H**”, or “**h**”.
- ❑ The Battery fuel gauge symbol will tell you how much life is left in the 9-volt battery. When a new fully charged battery is installed, the gauge will show all four segments. If three segments are showing the battery is between 75% and 50%, two segments the battery is between 50% and 25%, and 1 segment means less than 25%. To request the battery power level, use the “**P**” or “**p**” command.

The AirTool has an optional power jack which will allow you to connect the AirTool to an external power source. **Do Not Exceed +9 volts on the external power input jack!** The AirTool can also be powered over the USB link. When using the USB link turn off

the power switch on the AirTool. This is not necessary but there is no need to deplete the battery when the AirTool is attached to the USB Port.

- ❑ Air Density is a computed reading which is dependant on the three atmospheric sensors in the AirTool. It is the density of the air expressed in pounds per cubic foot. The algorithm for the Air Density conversion is the same algorithm which pilots use to calculate required power level for takeoff. To request the Air Density from the DaqPod use the “**D**” or “**d**” Air Density is available from the AirTool in English or Metric units depending on the setting of the SAE/Metric parameter in the AirTool
- ❑ Density Altitude is your apparent altitude with respect to the Air Density. As the air density gets lower the apparent altitude gets higher. This is not very noticeable with human senses, but your air-based machine’s performance will notice it. As the altitude gets higher the density of the air gets lower and the available oxygen gets lower. With less oxygen available to an engine (that depends on oxygen to burn fuel) will produce less power. Density Altitude is expressed in feet or meters above sea level. This compound algorithm uses all three atmospheric sensors and the Air Density algorithm to produce Density Altitude. To request Density Altitude from the DaqPod use the “**C**” or “**c**” command. Density altitude is available from the AirTool in English or Metric units depending on the setting of the SAE/Metric parameter in the AirTool.
- ❑ Oxygen Pressure is the calculated component of air which expresses the content of oxygen available in the ambient air. The basis for this measurement is that the oxygen content of outdoor air is almost always at 20.9%. To compute the actual content of oxygen we must first use the barometric pressure, temperature and relative humidity readings. The temperature will give us the saturated water vapor pressure. Then the relative humidity sensor tells us that the real water vapor pressure is some percentage of the saturated water vapor pressure. Then we can subtract the water vapor pressure from the barometric pressure and derive dry air pressure. Then we take 20.9 percent of the dry air pressure and we have the oxygen pressure. This factor alone determines how much power your engine can potentially produce. It tells you how much oxygen is available to burn fuel.
- ❑ Relative Air Density is the ratio of the current air density to the standard air density. What is considered to be standard air is 0.0765716 pounds per cubic foot, or the density of the air at sea level while the barometer sits at 29.92 inches of mercury and an air temperature of 59 degrees Fahrenheit. As the density of the air gets higher there is more oxygen available for the engine to use to burn fuel and produce power, so the RAD will tell you the density of the air relative to the standard air.
- ❑ Pressure Altitude is the physical (real) altitude relative to the air pressure. The rule of thumb for the first 10,000 feet above ground is that 1 inch of mercury is equal to 1000 feet. So sea level is 0 feet and standard air at sea level is 29.92 inches of mercury. So if we go straight up 1000 feet our barometer reads 28.92 inches of mercury. This is how AirTool calculates the pressure altitude. Due to atmospheric fluctuations, such as thunderstorms, the pressure altitude reading will change with the fluctuations and is **not an indicator of absolute altitude.**



Figure 1, AirTool LCD Display (Sampling Mode)

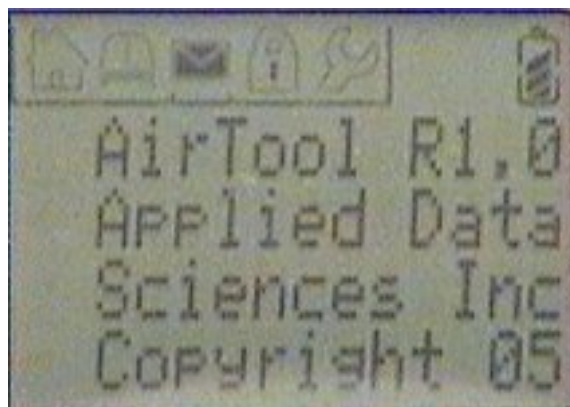


Figure 2, AirTool Revision Information

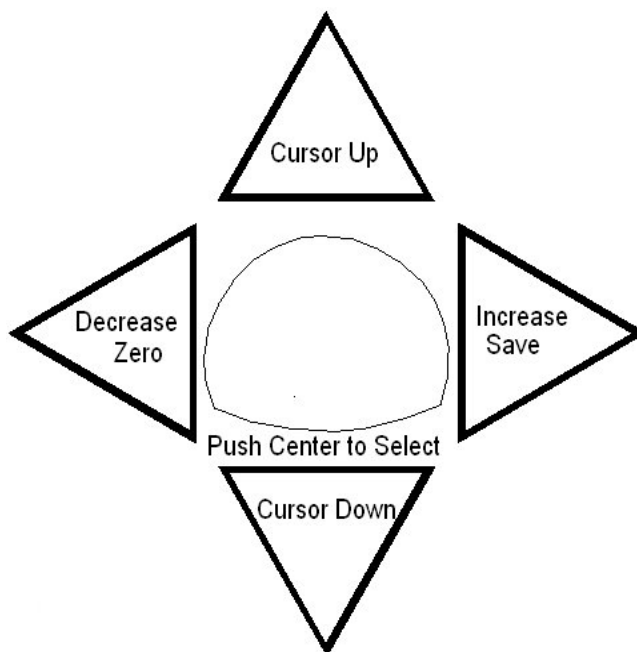


Figure 3, AirTool Navigational Switch

## Stand Alone Mode Operation:

The AirTool is equipped with a 4x12 character display which has some special symbols and a navigational switch. The Overlay on the AirTool has some symbols around the navigational switch in order to explain the way the switch works. For explanation purposes we'll refer to these symbols as up (cursor up), down (cursor down), right (increase & save), left (decrease & zero), and select (center).

AirTool starts up sampling, this means when you turn on the AirTool it is reading the sensors. You don't have to be concerned with any start-up procedures, or determine which file to load. AirTool turns on running and is ready to go. Look at the display. You see 4 rows of characters and 6 symbols on the top of the screen. The 4 rows of characters are the measured sensor data. The first three rows are fixed in place and whenever AirTool is in sampling mode they will always be there. These sensor readings are **Temperature, Humidity, and Barometric Pressure**. On the fourth row is a rotating display. By using the right and left buttons (in Sampling Mode) you can select what you want on the fourth row. The choices are:

1. Density Altitude,
2. Air Density,
3. Pressure Altitude,
4. Oxygen Pressure,
5. Relative Air Density,
6. Time, or
7. Date.

When you change this setting the new value is stored in EEPROM and will be restored if the power were to be cycled. When the AirTool is in sampling mode the **Home** symbol (left most symbol) will be dark. Other symbols on the top of the display are the **Open** book (Menu Mode), **Envelope** (device ID mode), **Lock** (no purpose yet), and **Wrench** (calibrate mode). The last symbol on the display is the **Battery** level indicator. The battery level indicator has 4 segments within its border, each representing 25% of the battery's capacity.



Figure 4, Menu Mode

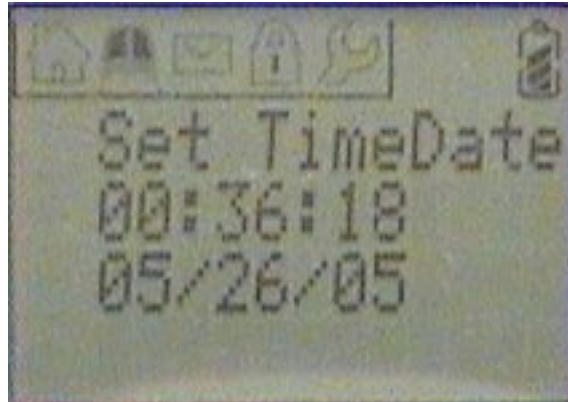


Figure 5, Set Time and Date Mode

### **Menu Mode:**

To access the Menu Mode press the select button (the center button.) AirTool will switch into the Menu Mode and you will see a list of choices. If you don't want to choose anything you can press the left button to escape from Menu Mode and go back to Sampling Mode. Inside the Menu Mode there are 4 choices:

1. Backlight,
2. SAE/Metric,
3. Set RTClock, and
4. Calibrate.

The Backlight selection is first and all you have to do is press the select button again and the backlight will toggle on/off. Note that the backlight will cause the AirTool to use more power, this will decrease the battery life and cause the AirTool to heat up slightly (not noticeable to the touch.)

The SAE/Metric selection toggles the number system in the AirTool. The AirTool is shipped in SAE (English) Number System Mode. By selecting the SAE/Metric option the AirTool is switched to the Metric Number System Mode. This selection is stored in EEPROM and will maintain its setting in case the power to the AirTool is cycled.

Set RTClock is used to set the Time and Date in the Real Time Clock. The clock is used to apply the time/date stamp on logged data. There is a sequence to setting the RTClock once you have committed to the Set RTClock mode. The sequence starts with the Hours, use the right and left buttons to increase or decrease the Hours value. When you are satisfied with the setting, press the Increase/Save button and the sequence will move on the Minutes field. Next is Seconds, Month, Data, and Year. Now press Cursor Down to save the values and return to the Main or Sampling page. The Set RTClock sequence is a fixed sequence, if it is interrupted it must be repeated.

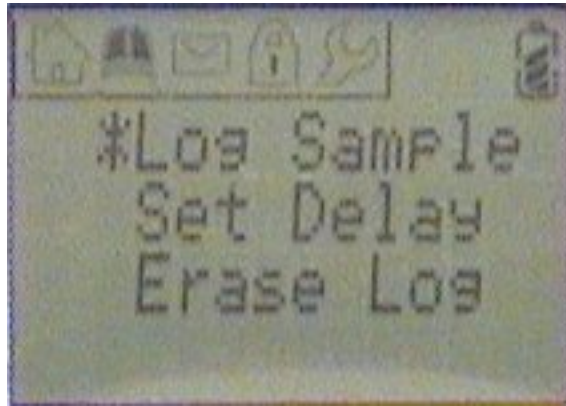


Figure 6, Logged Data Menu Mode

### Logged Data Menu Mode

To access the Logged Data Menu Mode press the Cursor Up button while the AirTool is in the sampling mode. This menu gives you access to the AirTool's data logging features. In order to retrieve the data from the AirTool you have to install the USB device driver and connect the AirTool to a desktop computer. Like in the Menu Mode you can escape from the Logged Data Menu Mode by pressing the Left Button. There are three Logged Data Menu Mode choices; Log Sample, Set Delay, and Erase Log.

The Log Sample selection lets you log a sample on demand. There is also a periodic log sample function which logs data on a regularly timed basis. However in the circumstance where you don't want to wait for a sample go to the Logged Data Menu Mode and select "Log Sample" by pressing the Center or Select button.

The time between periodic samples can be set in the Set Delay section of the Logged Data Menu Mode. In this mode you can use the right and left to increase or decrease the time between periodic samples from 1 to 60 minutes. The periodic log data function uses the real time clock to time it's samples. The data stored in the DataFlash™ Card can be retrieved by attaching the AirTool to a desktop computer, via it's USB Port, then issue the Transmit Logged Data Command (X,x). This can be accomplished with Hyper Terminal by using the capture text setting under the transfer menu in the Hyper Terminal Software. The software will ask you for a filename to save the data as and then press the start button to start capturing data. Please see the Using Hyper Terminal to Store the Logged Data Section for capturing data.

After downloading the logged data from the AirTool some may want to erase the DataFlash™ Card. This is accomplished by the Erase Log Function in the Logged Data Menu Mode. Caution! Pressing this button will completely erase the DataFlash™ Card, **ALL DATA WILL BE ERASED FROM THE MEMORY**. After pressing this button the AirTool will erase the memory of the DataFlash™ Card. You will see the block addresses increment up to 16384 to clear the entire memory.



Figure 7, Calibrate Mode

## Calibration Mode

Calibrate is the last choice in the Menu Mode. This subroutine is used to calibrate the sensors. The Calibrate Mode work simultaneously on the front panel of the device and over the USB port connected to a PC. When working from the front panel of AirTool you will have an asterisk next to the sensor that is currently selected.

Use the right and left buttons to adjust the sensor's reading. Use the up and down to select which sensor you are adjusting. The sensors are "live" in Calibrate Mode so you can see the effects of the change in real time. When you have adjusted the sensors to your satisfaction move the cursor to the bottom line and use the right button the save the changes. The left button will clear the offsets. If you enter calibrate mode and don't want to change the calibration simply move the cursor to the last line and press the right button. This will save the current calibration numbers unchanged. When you are calibrating the AirTool over the USB port by using a terminal software such as hyper terminal the AirTool will transmit a menu of commands which it responds to.

Applied Data Sciences Inc.

Calibration Routine

+,= to increase barometer  
-,\_ to decrease barometer  
H,h to increase thermometer  
C,c to decrease thermometer  
W,w to increase hygrometer  
D,d to decrease hygrometer  
S,s to save settings and exit  
Z,Z to clear offsets and exit  
BP=30.22 AT=079.0 RH=035.4

The bottom line of the calibration is live sensor data. Watch the bottom line as you are making changes to the sensor's calibration numbers. If you want to exit Calibrate Mode with out changing the calibration, first don't touch the adjustment keys, then press S or s to save the calibration numbers.

## Command Set:

Before you can issue commands to the AirTool you must install the USB driver please see the USB driver section. All commands issued to the AirTool are single character ASCII format commands. If you send the "?" character to the AirTool it will return this list of commands which it responds to.

### Command Functions:

- A,a = All Sensor Readings
- B,b = Barometric Pressure
- C,c = Density Altitude
- D,d = Air Density
- H,h = Relative Humidity
- L,l = Continuous Loop Mode
- M,m = Pressure Altitude
- N,n = Oxygen Pressure
- O,o = Calibrate Sensors
- P,p = Power Level Percentage
- Q,q = Revision Information
- R,r = Relative Air Density
- S,s = Log Sample in DataFlash
- T,t = Temperature
- X,x = Transmit Logged Data

The commands which solicit a specific reading have fixed formats and are always transmitted in this format. This table shows these formats and how to read them. The command will solicit a response from the AirTool which is either in SAE or Metric units depending on what the setting of the SAE/Metric parameter in the AirTool. All specific reading commands end with a carriage return linefeed.

Description	Format	SAE Response	SAE Units	Metric Response	Metric Units
Air Temperature	T or t	XXX.X	° Fahrenheit	XXX.X	° Celsius
Relative Humidity	H or h	XXX.X	% of SWVP	XXX.X	% of SWVP
Barometric Pressure	B or b	XX.XX	inches of Mercury	XXX.X	mm of Mercury
Air Density	D or d	X.XXXXX	pounds per foot <sup>3</sup>	X.XXX	kilograms per meter <sup>3</sup>
Density Altitude	C or c	+/-XXXXX	feet	+/-XXXXX	meters
Relative Air Density	R or r	XXX.X	% of Standard Air	XXX.X	% of Standard Air
Oxygen Pressure	N or n	XX.XX	inches of Hg.	XXX.X	mm of Hg.
Pressure Altitude	M or m	+/-XXXXX	altitude in feet	+/-XXXXX	altitude in meters

Figure 8, AirTool Communication Protocol

Other commands such as the "?" command cause the AirTool to transmit a long string of data. Their purpose is informational and not necessarily for automated access to the AirTool. For factory testing, quality control, and demonstration purposes there is a loop mode (L or l) which causes AirTool to go into a loop and transmit data continuously. To calibrate the AirTool use the

calibrate command (O or o) to put the AirTool into calibrate mode (see Calibration section.) To query the device firmware revision use the (Q or q) Device Information command. The AirTool Terminal Software issues a continuous stream of commands to the AirTool to communicate with it (see the AirTool Terminal Software section.) The Transmit Logged Data Command (X,x) will initiate a dump of the logged data from the AirTool.

AirTool takes samples periodically and stores them in its DataFlash Card™. To access the logged data send the Transmit Logged Data Command (X,x) to the AirTool. The AirTool will then return all the data that it has stored in the DataFlash Card™. This data will come out of the AirTool at a high baud rate, potentially 12 megabits per second, so if the amount of data is sizeable you will have to buffer the data before processing it. Generally your PC will have a sizeable buffer to do this which needs no interaction from the user. To clear the DataFlash™ Memory send the Format command (F,f) to the AirTool and it will wipe the DataFlash™ Memory with in a couple of seconds.

Logged Data Format:

English Data =\*AAAAA BBB.B CCC.C DD.DD EE:FF:GG HH/II/JJ

Metric Data =\*AAAAA BBB.B CCC.C DDD.D EE:FF:GG HH/II/JJ

\* = Start of record character

AAAAA=DataFlash™ Memory Address

BBB.B = Temperature in Fahrenheit or Celsius

CCC.C = Relative Humidity percentage

DD.DD = Barometric Pressure in inches of mercury

DDD.D= Barometric Pressure in millimeters of mercury

EE = Hour of logged sample

FF = Minute of logged sample

GG = Seconds of logged sample

HH= Month of logged sample

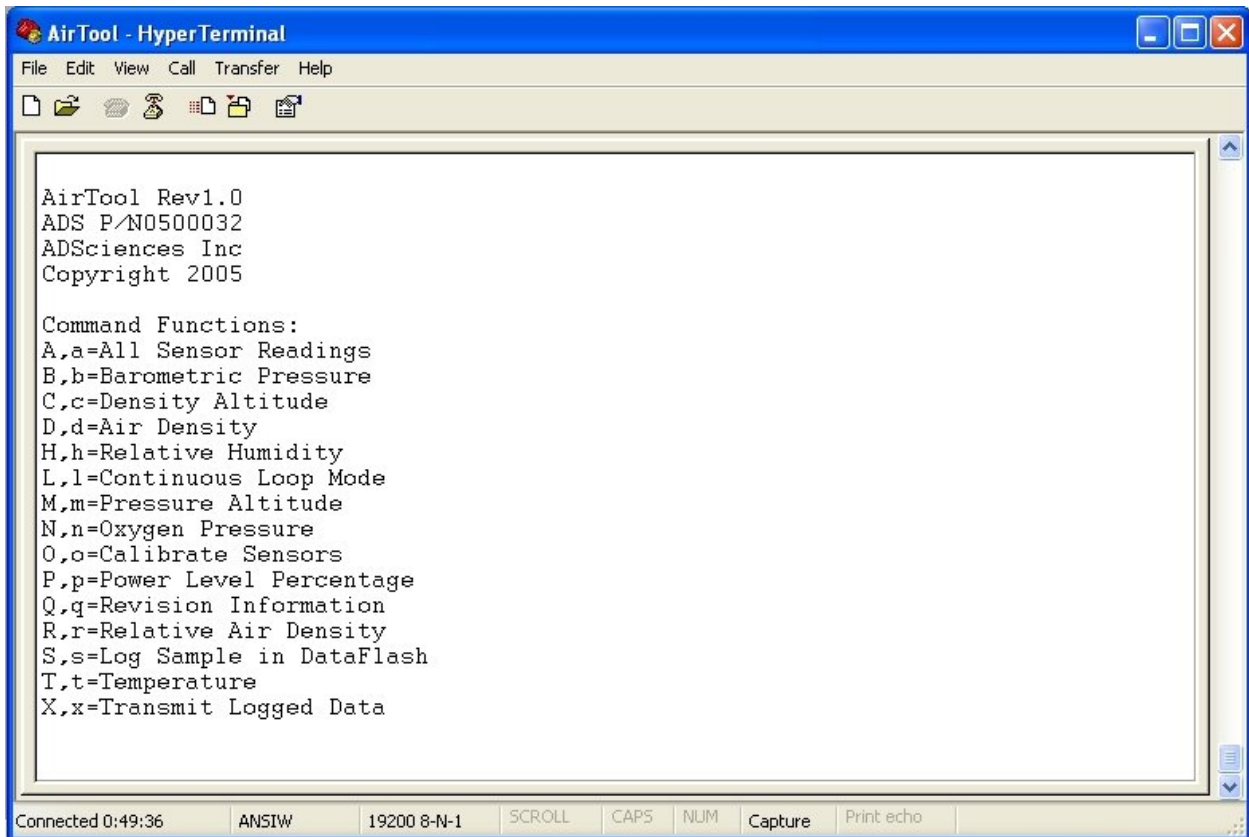
II = Day of logged sample

JJ = Year of logged sample

The end of record marker is a carriage return linefeed.

## Using Hyper Terminal to store the Logged Data:

Hyper Terminal is a terminal program which ships to Microsoft Windows operating system. This is the easiest way to save logged data from the AirTool. You will have to install the USB Drive in order to use the AirTool as a Com port (see USB Device Driver Information File section.) You can use HyperTerminal manually to solicit information from the AirTool. In the Transfer menu in the Hyper Terminal Software (see Figure 6) there is a function called Capture text. When you click on Capture Text you will get a dialog box which will prompt you to select a filename and choose a location to save the file. Make a note of what the file path is then press Start, this will start the capture process. Make sure you have the connected physically and the Hyper Terminal software is connected, and then press the X key. You should see a stream of data coming out of the AirTool, everything you see is being logged into a file with the filename you previously gave it. When the AirTool finishes sending the data go to the transfer menu in the Hyper Terminal Software, go down to capture text then press stop. This will close the file created by Hyper Terminal, and you can go look at it now.



The screenshot shows a Windows HyperTerminal window titled "Air Tool - HyperTerminal". The window has a menu bar with "File", "Edit", "View", "Call", "Transfer", and "Help". Below the menu bar is a toolbar with icons for file operations and terminal control. The main text area displays the following text:

```
AirTool Rev1.0
ADS P/N0500032
ADSciences Inc
Copyright 2005

Command Functions:
A,a=All Sensor Readings
B,b=Barometric Pressure
C,c=Density Altitude
D,d=Air Density
H,h=Relative Humidity
L,l=Continuous Loop Mode
M,m=Pressure Altitude
N,n=Oxygen Pressure
O,o=Calibrate Sensors
P,p=Power Level Percentage
Q,q=Revision Information
R,r=Relative Air Density
S,s=Log Sample in DataFlash
T,t=Temperature
X,x=Transmit Logged Data
```

At the bottom of the window, there is a status bar with the following information: "Connected 0:49:36", "ANSIW", "19200 8-N-1", "SCROLL", "CAPS", "NUM", "Capture", and "Print echo".

Figure 9, Hyper Terminal Software

*\*\*See notice on page 1*

## AirTool Terminal Software:

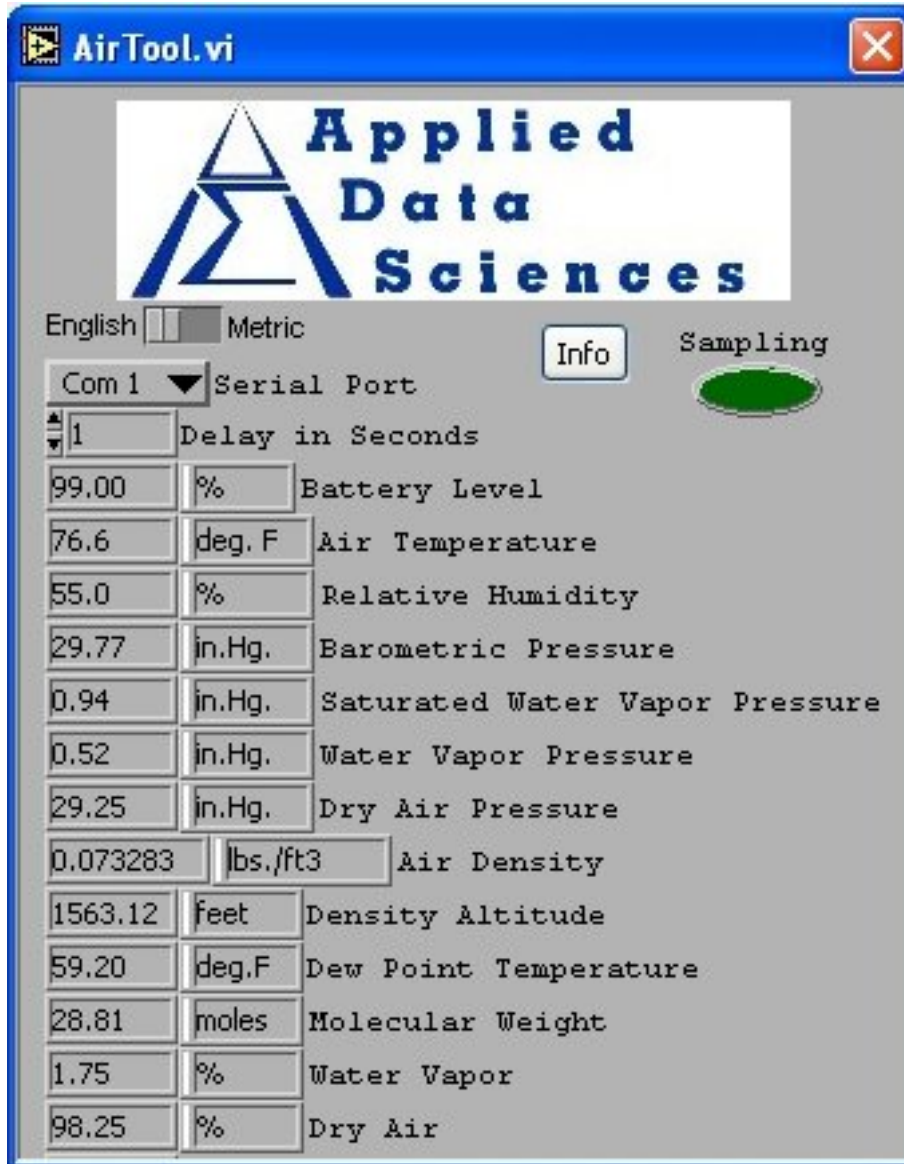


Figure 10, AirTool Terminal Software

The AirTool Basic Terminal Software is included free with the AirTool. Its function is to be a low cost interface for users who want automated access to the AirTool. The software runs in a loop, continuously monitoring the AirTool. As it receives the raw data, it will display the values and also refresh the computed values. The ring control labeled “Serial Port” sets the COM Port under windows using the same COM number as Windows, please see the USB Driver section. The slide switch above the readings will toggle all the readings from English units to Metric

units and back. The “Info” button will request the unit information from the AirTool and put it in a pop-up window. The “X” button will close the Terminal Program and LabView Runtime Engine. Incidentally, LabView is the software which was used to build the AirTool Terminal Software. The Terminal software requests the temperature, humidity and barometric pressure from the AirTool. The rest of the values that you see on the Terminal Software are calculated. When using the AirTool Terminal Software the AirTool should be set to English units, then the Terminal Software will do the conversions to Metric numbers.

Polled readings:

1. Air Temperature (in degrees Fahrenheit)
2. Relative Humidity (as a percentage of saturated water vapor pressure)
3. Barometric Pressure (in inches of mercury)
4. Battery Level (in a percentage of maximum)

Computed readings:

1. Saturated Water Vapor Pressure (in inches of mercury)
2. Water Vapor Pressure (in inches of mercury)
3. Water Vapor Percentage (percentage of air which is water vapor)
4. Dry Air Pressure (in inches of mercury)
5. Dry Air Percentage (percentage of air which is dry air)
6. Molecular Weight (represents weight of single air molecule)
7. Dew Point Temperature (temperature where humidity exceeds saturated water vapor pressure and water droplets come out of the solution called air)
8. Air Density (mass of air computed in weight per volume)
9. Density Altitude (the apparent altitude based on weather conditions)

## USB Device Driver Information File:

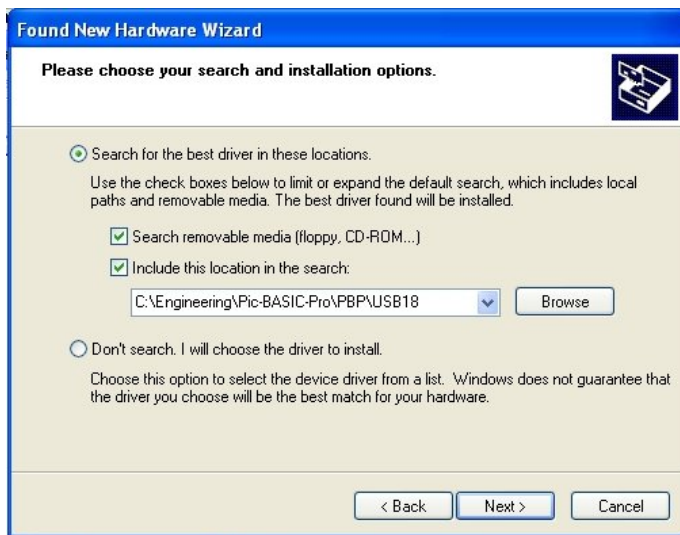
**It is important to install the USB Device Driver before attempting to communicate with the AirTool.** When you first plug the USB Cable into an AirTool the operating system will pop up a bubble that says "New Hardware Found. PBPCDC Communications Port". The PBPCDC is the identification code inside the AirTool. In order for the operating system to talk to the AirTool we need to give it an information file to tell the operating system what this device is and define how to communicate with it. The operating system will then pop up an installation block which looks like this:



There is no need to have the operating system search for a driver. Take the disk that came with the AirTool and place it in your CD-Rom drive. In the Found New Hardware Wizard click "No, not this time" button and then next.



If you choose to install the driver automatically it will take the operating system a few moments to find where the driver is. Or you can specify where the driver information file is. The file you are looking for is called `pbpcdc.inf`.



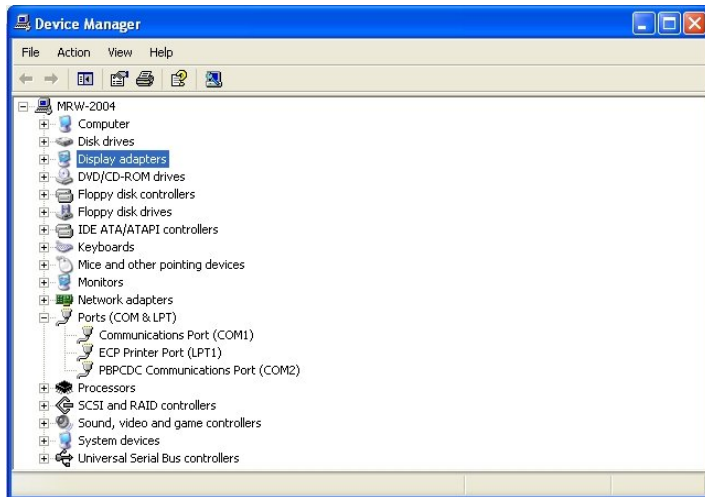
At this point in the setup you can have the operating system search for the driver information file or you can find it manually.



When you get this screen about windows testing, press "Continue Anyway."



When the "Found New Hardware Wizard" is done you will see this screen.



When the AirTool is attached to the USB port you will see the PBPCDC Communications Port under the Device Manager / Ports.

*\*\*See notice on page 1*

## **AirTool Terminal Software Installation**

Insert CD labeled “AirTool Terminal Software” into your CD-ROM drive.

The disk should auto run the setup program, if it does not then

Go to the disk's directory and run a program called setup.exe

The setup program will prompt you to select an installation directory.

Choose the directory and press finish.

The installation program will create a program group for AirTool and place it on your desktop.

To run the software double click on the AirTool Icon.

Select the com port using the ring control for the com port.

## **AirTool**

### **Product Specifications**

Processor:	Microchip PIC18F4550-I/PT
Processor Speed:	48 Megahertz
Program Memory:	16384, 16 bit words (32 kilobytes)
Processor RAM:	2K bytes
Processor EEPROM:	256 bytes
Processing Speed:	12 MIPS
Air Density Calculation:	+/- 1% accurate, in Pounds per Cubic foot
Density Altitude Calculation:	+/- 1% accurate, in Feet above sea level
Pressure Sensor:	Fujikura XFAM-115KPAR
Pressure Range:	0 PSIA to 16 PSIA
Pressure Resolution:	0.01 inches of mercury
Temperature Sensor:	National LM34CAZ
Temperature Range:	32.0° F. to 212.0° F.
Temperature Resolution:	0.1° F
Humidity Sensor:	Honeywell HIH-3610-001
Humidity Range:	0.0% RH to 100.0%RH
Humidity Resolution:	0.1%
Voltage Requirement:	9 Volt Battery
Battery Size Requirement:	Standard 9-Volt Alkaline, or Lithium
Current Requirement:	28 MilliAmps
Power Consumption:	92.4 MilliWatts
Optional Power Source:	9 Volt, 200 mA, Wall Transformer

## **AirTool Limited Manufacturers Warranty**

Applied Data Sciences will honor a limited warranty on this product for a period of one year after the purchase date. This warranty covers manufacturer's original parts and workmanship. If this product fails, the manufacturer will repair or replace the unit within the warranty period.

Upgrades are not covered by the warranty, and are treated as purchasing additional parts or software. Out of warranty repair charges are a minimum ½ hour at \$35 per half hour.

Practices that will void the warranty are as follows:

- ❑ Immersing the AirTool in water.
- ❑ Exposing the AirTool to microwave radiation.
- ❑ Exposing AirTool to temperatures above 150°F while in operating mode.
- ❑ Intentional physical damage.
- ❑ Applying more than 9 volts or voltage of the wrong polarity to the AirTool power input jack.

In order to maintain your AirTool warranty, use only the power supply which has been provided with your unit? Do not, under any circumstance, put your AirTool in a hot oven, a microwave oven, a fireplace or a barbecue. AirTool is not heat proof and excessive heat will completely destroy it, and will void the warranty. Also, AirTool is not waterproof, so Do Not immerse in water or any other liquid, especially flammable liquids.

For Information on repairs, upgrades, or questions contact:

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