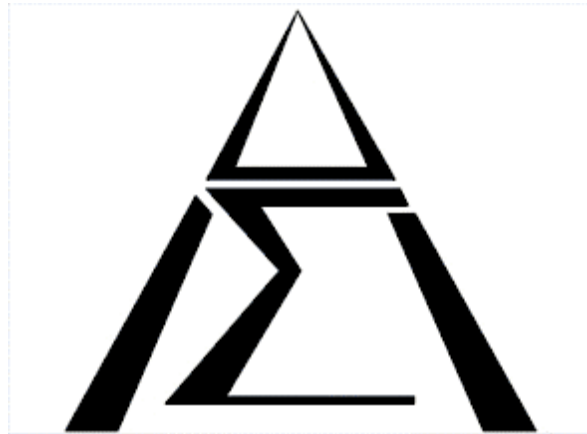


# Air Data Analyzer

## Technical Manual



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# **Air Data Analyzer**

## **Operating instructions:**

The Air Data Analyzer is a hand held, battery powered, weather sensor device. It contains a Barometer, Thermometer, Hygrometer, Oxygen Sensor (optional), Carbon Dioxide Sensor (optional), an external Anemometer (optional), 2 Switch Inputs (optional), a Real Time Clock, and battery level monitor. The functions for these sensors are accessible from the 24-key keypad on the Air Data Analyzer. Each key has an abbreviated description of what it does. Some keys contain symbols and others contain words. Some keys are used in conjunction with other keys, while some are not. The following information describes the keys and the functions they perform.

### **Free running mode (no keys pressed):**

The Air Data Analyzer will boot sampling. This means that when it is turned on, it starts sampling and will continue sampling until interrupted by a key being pressed. In this free running mode it runs in a loop; sampling all of the sensors and the clock at a rate of about 14.5 Hz. Within this loop it will also make comparisons and determine the minimum and maximum values of each sensors sampled and will keep these values in memory to be displayed later (using the STATS key). Also in this free running mode, the data from the sensors is available by issuing command to the Air Data Analyzer over the RS-232 link and it will respond to each command in real time. You can connect the COM port on the Air Data Analyzer to a computer and collect the data using the Air Data Analyzer's Windows Terminal Software. Optionally a USB to serial converter can be utilized in case your computer does not have a RS-232C Serial Port. You can also use other programs to take readings from the Air Data Analyzer, such as HyperTerminal, or ProComm.

Set the serial link parameters in the program to (optionally you must set the USB Driver to these settings): *19200 baud, 8 data bits, no parity, and 1 stop bit.*

### **Sensors Sampled in Free Running Mode:**

In the free running mode there are up to 8 sensors and clock that are sampled.

- ❑ The Barometer (BP) is the first sensor on the free running mode screen. It is read in inches or millimeters of mercury adjusted for altitude by the calibration subroutine (see Unit Setup for unit calibration). The offset will allow you to adjust the barometer to the local altitude so your barometric pressure readings will match that of the local geographic area.
- ❑ The next sensor is Air Temperature (AT). It is displayed in fractional degrees Fahrenheit (°F) or Celcius (°C)
- ❑ Next is the Relative Humidity (RH) sensor. Its reading is measured 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.

- ❑ The optional Oxygen Sensor (OXY) is a galvanic sensor, which detects oxygen by a chemical reaction, which creates a voltage that is proportional to the amount of oxygen it is exposed to. This is the only sensor on the Air Data Analyzer that will require a simple calibration (See the section called O<sub>2</sub> Cal.)
- ❑ The optional Carbon Dioxide Sensor (CO<sub>2</sub>) uses infrared technology to detect small concentrations of carbon dioxide up to 2000 parts per million.
- ❑ The optional Anemometer (Flow) sensor is an optical chopper wind velocity sensor. Air flow through the sensor will cause the impeller to spin. This impeller has holes in it which alternately block, and transmit light between a light emitting diode and a photodiode. Some internal logic cleans up the pulses and transmits them to the Air Data Analyzer where the pulses are converted to a wind velocity in feet per minute.
- ❑ Optionally there are also 2 switch closure inputs (SW1 & SW2) on the Air Data Analyzer. These inputs can be connected to a regular switch, a magnetic switch, or a relay in order to change the logic state of the 2 inputs. Care should be taken not to apply voltage to these inputs. A reverse voltage on these inputs can cause the internal polyfuse to temporarily stop conduction and a high voltage on these inputs can permanently damage the Air Data Analyzer.
- ❑ Finally the Battery (BT) fuel gauge will tell you how much life is left in the battery. When a new fully charged battery is installed, the gauge will read approximately 99 percent. The scale is linear down to approximately 25 percent. The recommended replacement of the battery is at 25 percent, however the unit will continue working down to 0 percent on the fuel gauge, with diminished accuracy. When using the wall transformer power supply the battery fuel gauge will read 99%.

## Front Panel keypad

As the Air Data Analyzer is collecting data in free running mode, it will accumulate the minimum and maximum values for each atmospheric sensor. The values for each of these sensors will be displayed by pressing the respective **Stats** key. The front panel keypad buttons are described in the following sections. All Stats buttons will readout in English or Metric readings depending on the setting of F2 (Number System Settings Button)



**Temp Stats** will display the minimum and maximum temperature the unit has been subjected to since the unit has been turned on. Please be advised that subjecting your Air Data Analyzer to

temperatures greater than 150.0° Fahrenheit can permanently damage the unit, and subjecting the unit to temperatures below 0.0° Fahrenheit can cause the unit to stop functioning temporarily.

The temperature sensor can sense temperatures between 32.0°F and 212.0°F degrees accurately, and can sense outside that range with diminished accuracy. To sense temperatures above 150.0°F, it is recommended that a remote temperature sensor module be used. The temperature sensor is now external to the Air Data Analyzer, which insures quick temperature responses.



As with the **Temp Stats**, the Relative Humidity also has its minimum and maximum values held in memory to be displayed when this button is pressed. The range of Relative Humidity is 0.0% to 100.0%. The **Humi Stats** button will display the minimum and the maximum Relative Humidity the unit has recorded since it was turned on.

*Do not expose to or immerse the unit in water*



Also like the **Temp Stats** the Barometric Pressure minimum and maximum pressures are held in memory to be displayed when this button is pressed. These measurements are read in inches of mercury or millimeters of mercury and have an accuracy of hundredths of an inch of mercury.



This key will clear the minimum and maximum fields. This will allow the user to reset the **Stats** fields without having to turn the unit off to clear these fields. The reason for providing this key is because of the CO<sub>2</sub> sensor. It has to warm up; then after approximately one minute you can press the Clear Stats and the minimum CO<sub>2</sub> reading will be accurate.

(OPTIONAL FEATURE)



The Air Data Analyzer uses the (optional) galvanic oxygen sensor to detect how much oxygen is dissolved in the mixture we call air. A galvanic sensor depends on a chemical reaction, which produces a voltage that is proportional to the amount of oxygen it is exposed to. The sensor output is a very small voltage level and requires amplification to be read by the processor. Subsequently we need an amplifier to adjust the sensor output to the scale of the analog to digital converter. That is why it requires calibration--see section called **O<sub>2</sub> Cal**. This sensor is read as a percentage of air, for example if the reading is 20.9%, this means that 20.9 percent of the air is oxygen. The min and max stats also are read in this manner.

(OPTIONAL FEATURE)

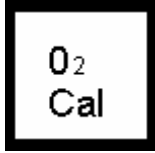


The carbon dioxide sensor (optional) in the Air Data Analyzer uses infrared technology to measure small quantities of carbon dioxide. The range of the sensor is 0 to 2000 parts per million (or 2 parts per thousand). Therefore, the maximum concentration that this sensor can measure is 2000 PPM. This is NOT the maximum concentration that can exist in the modern world. You must exercise caution when using this meter to measure concentrations of carbon dioxide in an enclosed space. If the reading is maxed out at a 2000 PPM the real concentration can be much higher. **CARBON DIOXIDE CAN KILL YOU! DO NOT PLAY WITH IT!** This is the reason why all animals, including humans, need a supply of fresh air. When animals respire they consume oxygen and exhume carbon dioxide, a waste product of respiration. If the supply of fresh air, including oxygen, is not present the level of carbon dioxide will become toxic and eventually kill the animal. The normal level of Carbon Dioxide in outside air is between 0.03% and 0.07% (300 to 700 parts per million). This meter can read up to 0.2% (2000 parts per million), however if the reading is maxed then the real level of carbon dioxide can be much greater. It is advisable to ventilate any area that causes the reading to go to maximum.

***Note for buttons: Temp, Humi, Baro, O<sub>2</sub>, and CO<sub>2</sub>***

***The minimum and maximum values for these buttons are stored in RAM and will be lost when the unit is turned off. There is no way to store these values. These values can be cleared with the Clear Stats Button.***

(OPTIONAL FEATURE)



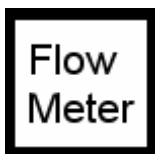
The Air Data Analyzer uses the galvanic oxygen sensor (optional) in concert with an operational amplifier to derive the oxygen percentage reading. This combination of electronic components requires calibration to adjust the gain of the operational amplifier and to adjust its output to the scale of the analog to digital converter on the microcontroller. This calibration requires the use of a calibrated oxygen mixture that is 20.9% oxygen and 79.1% nitrogen. This mixture is available at most gas supply stores. The calibration gas should be used with an isolation cup to apply the gas to the localized area of the oxygen sensor.

Calibration Procedure:

1. Press the **O<sub>2</sub> Cal.** button on the Air Data Analyzer.
2. Prepare the calibration gas, open the supply valve, and place the calibration fixture over the oxygen sensor on the Air Data Analyzer.
3. Watch for the sensor number to settle; may take 30 seconds or so.
4. Adjust the oxycal potentiometer to read 0209 on the Sensor ADC reading.
5. Close the valve on the oxygen bottle and remove the calibration cup.
6. Press escape on the Air Data Analyzer to return to Free Running Mode.

Make sure the calibration gas bottle is turned off to conserve your expensive calibration gas.

(OPTIONAL)



The anemometer is also an optional sensor. It measures air flow in feet per minute or in meters per minute. It does not require a keypad button to function. It is free running and is shown on the display (use F1 to rotate display to see Flow). The data from it is logged in the data logger memory.

(OPTIONAL)



Switch 1 and Switch 2 are also optional sensors. They do not require a keypad button to function. They are free running and are shown on the display as either ON or OFF. The data from them are logged in the data logger memory.

They are meant to be hooked up to a relay closure to sense events. Refer to drawing number 0690083.PDF for instructions on how to hook up these switches. It is very important that you do not apply voltage to these connections since they are intended for the switch closure only. Do not apply an AC voltage.



This button displays the Unit Model number, the Unit Serial Number and Software Revision. The warranty is determined by the serial number. Also displayed is the web site location where you can inquire about the warranty information. We welcome your questions, comments, and would also like to know what your application is.



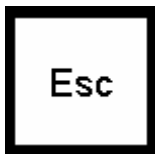
The Air Data Analyzer has the ability to log samples of data over time. This button allows the user to set the delay between samples. The default value is 15 minutes. The value is adjustable in minutes from 1 minute up to 120 minutes (2 hours.) At a rate of 1 sample per minute the logger memory will be filled after 11 days. At a rate of 1 sample every 2 hours the logger memory will be filled after 3.74 years. Use the + and - buttons to increase or decrease the delay. Use **Enter** to save the number, and **Esc** to exit the subroutine.



This button is used to set the Real Time Clock for the Air Data Analyzer. It presently works in military time only. Pressing this button will start a sequence of adjustments, which will allow you to set the time and date. The Real Time Clock has a “super cap” backup, which will allow the unit to retain the time without power for several weeks.

When the button is first pressed the cursor is on the hours field and the user can use the + and – buttons to adjust the value. When the desired value is displayed, press the **Time Set** Button again and the routine will move to minutes. Again use the + and – buttons to adjust the displayed value until the desired value is displayed and then press the **Time Set** button again to set the value.

This sequence continues through “*hours, minutes, seconds, month, date, and year*”. When the user sets the year the routine will set the Real Time Clock and write protect it so that bogus values cannot be accidentally set into the Real Time Clock.



This button is used to escape from several subroutine screens without saving the information.



This button uses an algorithm to produce an alarm sound. There are plans in the works to have the Alarm button set programmable events where the alarm will sound, such as if the temperature reaches a preset point.



This button is used in conjunction with other buttons. Its primary function is to set values such as the sample delay time and the set time sequence.



This button is used to calibrate the Air Data Analyzer. The unit will display the current sensor readings in English or Metric depending on the setting of F2. To adjust the temperature setting press the Temp Stats button then use +/- to adjust the reading. You can also adjust the relative humidity and barometric pressure readings by first pressing thier stats buttons and then using +/- to adjust the sensors. The offset value is stored in EEPROM and will be recalled for adjustment. The user can then adjust the sensors using the + and – buttons to adjust the displayed sensor readings. The **ESC** button will exit the subroutine and zero the calibration. Once the desired value is displayed the user can press the **Enter** button to write the calibration values to the EEPROM and exit from the unit setup screen.



By depressing this key, you can view the logged records that are stored in the Air Data Analyzer's EEPROM Memory. After you press the View Log button you will be presented with the first record in the EEPROM. Notice that on the top line of the display it say's "Viewlog Address00000", this indicates that you are looking at page 0 in the viewlog. Each page is 2 logical addresses, so the next page is address 2, and so on. Use the + and – buttons to page through the stored records. Depending on the setting of the F2 (Number System Settings Button) you could have English or Metric formatted data in the log. The algorithm will interpret the number system of the data and display it in the correct format even if English and Metric values are mixed.



Air Data Analyzer has the ability to record log samples incrementally over time or manually at the press of a button. The time between recorded samples can be set in the **Delay Set** subroutine. Some users will wish to hand log samples. The **LOG Sam** button will force the unit to record a sample from each of the atmospheric sensors and the clock every time it is pressed, up to 16,384 samples. The record will be written into non-volatile EEPROM memory. These records can be accessed using a Desktop Computer and the **Dump LOG** button.



This button will dump the EEPROM memory contents via the RS232 port so it can be transferred to an external device such as a Personal Computer. The logged information can be transferred from the Air Data Analyzer by using the Terminal Program or by using a generic software package like HyperTerminal. The port settings for the Desktop Computer's serial port are; 19200 baud, 8 bit data, 1 stop bit, and no parity. This function will transmit all the valid data and end the routine when it detects that the last sample has been sent. When using the ADA Terminal Software the Dump Log Routine will start automatically when the user presses the Upload Data button in the terminal software. When the last sample is detected the Terminal Software will automatically produce a "Save As" dialog box for saving the logged data to a file. The filename for the data by default is AirData 12-15-2004.txt where the date is replaced with the current system date. The data is stored as a database so it can be easily imported to a spreadsheet for analysis. Each field in the record is comma delimited. Each record is separated from other records with a carriage return/line feed. A single sample equals 1 record.



This button clears the EEPROM memory that is used to store log samples. The EEPROM will hold stored samples when the power is turned off or when the battery dies. The **Clear Log** button will reinitialize these memory locations to all zeros. When the **Clear Log** button is

pressed the unit will give the user a choice of clearing the EEPROM or Exiting without clearing the EEPROM. Pressing **Esc** key will cause the program to exit from the clear log utility screen without clearing the EEPROM. Pressing **Enter** key will start clearing pages at zero and count up to page 512 (the end of the EEPROM). As it is clearing the memory sequentially, the user can stop the function at any time by pressing ESC.



Rotate Display Button. On the display of the Air Data Analyzer there are some sensor readings that remain constant. Line 3 of the display is able to rotate. F1 controls this function. Normally displayed on line 3 is Air Density and Density Altitude. If you press F1 one time it will display the optional sensor readings from the Carbon Dioxide and Oxygen sensors. The unit will store the setting for F1 in the Eeprom memory and when the unit is powered off and back on it will retain its setting.



Change Number System setting button. Pressing this button will toggle the default number system for the unit. The unit ships with English unit by default. Press F2 once and the number system setting toggles to Metric. Press it again and the unit reverts to English. The setting for this button is also stored in the Eeprom and will retain its setting when the power is toggled.



This button is reserved for special functions, which are not yet defined.



The Back Light Button is a toggle switch to turn on the backlight. Press it once to turn on the backlight and press it again to turn off the backlight. Using the backlight will cause the unit to warm up, thus causing erroneous temperature readings. It is our recommendation that the backlight stay off most of the time, not just to conserve battery power, but also to prevent erroneous temperature readings.



This button is used in conjunction with other buttons to allow the user to adjust the time and delay setting. Its function increases the indicated value.



This button is used in conjunction with other buttons to allow the user to adjust the time and delay setting. Its function decreases the indicated value.

## Commands and Output Data Format

The Air Data Analyzer is a polled device, if you send it a command it will respond as quickly as it can process the command. The output data is a standard ASCII data. Depending on the command the Air Data Analyzer will return numeric values or numeric values with alphanumeric descriptors. A list of the commands and their responses is below.

Command Functions:

Q,q = Device Information

```
Returned:   Air Data Analyzer Firmware Rev.1.2 <cr> <lf>
            Applied Data Sciences Inc. <cr> <lf>
            Copyright 2004, All Rights Reserved <cr> <lf>
            Built April 19, 2005 in USA <cr> <lf>
```

P,p = Battery Power Level

```
(P): 99<cr> <lf>
```

L,l = Dump Logged Information

Issuing this command results in a long stream of strings of data comprised of the logged Data stored within the Air Data Analyzer. This stream of strings has this format:

English Format:

```
Temp=077.4F Baro=29.60InHg Humi=056.7% Oxy=20.9% CO@=0425PPM 13:56:15 04/19/05<cr><lf>
```

Metric Format:

```
Temp 025.2C Baro=751.8mmHg Humi=056.7% Oxy=20.9% CO@=0425PPM 13:56:18 04/19/05 <cr><lf>
```

At the end of the stream of strings there will be a stop command which tells the Terminal Software to quit acquiring data. It's format is: Stop <cr> <lf>

A,a = All Sensors

```
Returned(A,a): Baro=29.66InHg Temp=077.1F Humi=056.1% CO2=0452PPM OXY=20.9%<cr><lf>
```

This command returns the same data with descriptors for both the upper and lower case commands. This is the main command used by the Air Data Analyzer Terminal Software.

## O,o = Adjust sensor offset values

Applied Data Sciences Inc.  
Sensor DC Offset Subroutine  
+ 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  
Baro 29.81 Temp 071 Humi 29

The Adjust Sensor Offset Values should only be used with Hyper Terminal for calibrating the Air Data Analyzer, see calibration section.

## B,b = Barometric Pressure In.Hg.

Returned Data English

(B,b): 29.55

Returned Data Metric

(B,b): 753.1

## T,t = Temperature in Fahrenheit

Returned Data English

(T, t): AT 071.1 F

Returned Data Metric

(T, t): AT 021.3 F

## H,h = Relative Humidity

Returned(h): RH 034 %

(H): 34

*<cr><lf> indicates the two functions carriage return and line feed*

## **Air Data Analyzer Terminal Software Installation**

Insert CD labeled “Air Data Analyzer Terminal Software” into your CD-ROM drive.

Go to the disks 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 Air Data Analyzer and place it on your desktop.

To run the software double click on the Air Data Analyzer Icon.

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

Next choose one of the functions.

## **Air Data Analyzer Product Specifications**

Processor:	Microchip - PIC18F452-04/L
Processor Speed:	4 Megahertz
Program Memory:	8192, 14 bit words (14 kilobytes)
Processor RAM:	384 bytes
Processor EEPROM:	256 bytes
Data Logger EEPROM:	256K bytes
Processing Speed:	1 MIPS
Display:	Microtips MTC-S20400XRGHS-5
Oxygen Sensor Range:	0% to 100%
Oxygen Sensor Accuracy:	+/- 1%
Carbon Dioxide Sensor:	Telaire Model 6004
Carbon Dioxide Sensor Range:	0 to 2000 parts per million in air
Carbon Dioxide Sensor Accuracy:	+/- 40 parts per million (3% of entire range)
Pressure Sensor Range:	0 PSIA to 16 PSIA
Pressure Sensor Accuracy:	+/-1%
Temperature Sensor Range:	32° F. to 212° F.
Temperature Sensor Accuracy:	+/-1%
Humidity Sensor Range:	0% RH to 99%RH
Humidity Sensor Accuracy:	+/-1%
Voltage Requirement:	6 to 18 Volts
Battery Size Requirement:	Standard 9 Volt Alkaline
Current Requirement:	140 milliamps
Power Consumption:	700 milliwatts
Optional Power Source:	9 Volt, 200 mA, Wall Transformer
Real Time Clock:	Dallas DS1302 RTC
Clock Backup:	220 milliFarad super cap

## **Air Data Analyzer 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 manufacturers original parts and workmanship for the period of one year after the purchase date. If this product fails, the manufacturer will repair or replace the unit within a period of one year after the purchase date.

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:

- ❑ Immersing the Air Data Analyzer in water.
- ❑ Exposing the Air Data Analyzer to microwave radiation.
- ❑ Exposing Air Data Analyzer to temperatures above 150°F while in operating mode.
- ❑ Intentional physical damage.
- ❑ Applying more than 18 volts, or voltage of the wrong polarity to Air Data Analyzer power input jack.

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

For Information on repairs, upgrades, or questions contact:

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