SmartTether™
Operating Manual

Version 5.0.0

106 Pronghorn Trail
Bozeman, MT 59718
Tel: 406-994-9354 Fax: 406-994-9218
www.anasphere.com info@anasphere.com

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The SmartTether™ system appeals to a variety of users and therefore is equipped with several features that meet each of those different needs. To take advantage of SmartTether's measurement features, the typical user can find the necessary information needed to operate the system by reading through the Quickstart Tutorial (p. 4). It may not be necessary to proceed beyond these sections. For the more complex user and more demanding application, the remainder of the manual can be used as a reference for that additional information. This manual is a great tool to get you started. It tells you what you need to get your equipment up and running and introduces its many features.

We really appreciate our customers and hope they take joy in our products as much as we do. It is Anasphere's goal to provide cost-effective products and support services to meet your needs. We always enjoy hearing from the people who use our products. Your experience is an invaluable source of information that we can use to continuously improve what we manufacture. We encourage you to contact or visit us to discuss any issues that relate to our products or your application.

1 Introduction

The SmartTether™ system is a wireless tethersonde that uses one or several modules to take measurements of the surrounding atmosphere and records that data over a period of time. The measured data in that time period can be transferred simultaneously from all modules and transferred graphically onto the user's computer. The measurement capabilities that come standard with the system are temperature, pressure, relative humidity and wind speed/direction. The module also allows the user to customize their system, so if interested, please contact Anasphere at 406-994-9354 for more information.

NOTE: SmartTether™ modules are designed to hang from the tether of an airborne platform and can therefore present a hazard to personnel and equipment on the ground if they should fall for any reason (platform failure, tether failure, or line attachment failure). Appropriate precautions should be taken to protect personnel and equipment on the ground, including the use of personal protective equipment such as hard hats.

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2 Quickstart Tutorial

The Anasphere SmartTether™ represents a revolutionary approach to gathering atmospheric profiles within the lower troposphere, using tethered blimps, balloons, or kites. It is an order of magnitude faster and less expensive as compared to traditional tethersonde systems and allows users to collect data simultaneously at multiple points along the tether. There is no limit on the number of modules that may be flown; the only limits are the lifting capacity of the platform and data rate.

The heart of the SmartTether™ is a series of wireless data modules which are attached to the tether. The data rate has been tested at 1 Hz for 6 modules. The data modules can send wireless data to a PC-based receiver on the ground. The PC can also send commands to an individual module or the entire network.

2.1 SmartTether System Product Information

System Features:

Data Modules - The heart of SmartTether™ is a series of wireless data modules which are attached to the tether. The data modules transmit their data via radio modem to the ground station receiver with a PC interface.

Measurements - SmartTether™ modules measure pressure, temperature, relative humidity, wind speed, and wind direction. The modules have extra analog and digital inputs to which other sensors can be interfaced.

Measurement Applications:

Real-time Wind Profiles - SmartTether™ was originally designed to meet the needs of researchers studying highly variable boundary layer winds. These winds can be extremely variable even over small vertical distances of 50 feet. A user can see the measurement data being collected from many units at different fixed points in the sky and that information can be instantly viewed and recorded at the user's fingertips.

Flux Measurements - Flux measurements are another area in which SmartTether™ can be applied. One approach to gathering flux measurements is to make several vertically separated measurements of the species of interest (such as carbon dioxide) from the ground to the top of the boundary layer, and then use mathematical models to calculate the flux.

Typical Applications:

- Boundary Layer Wind Profiling
- Fire Weather
- Pollution Monitoring
- Emergency Response

2.1.1 System Components

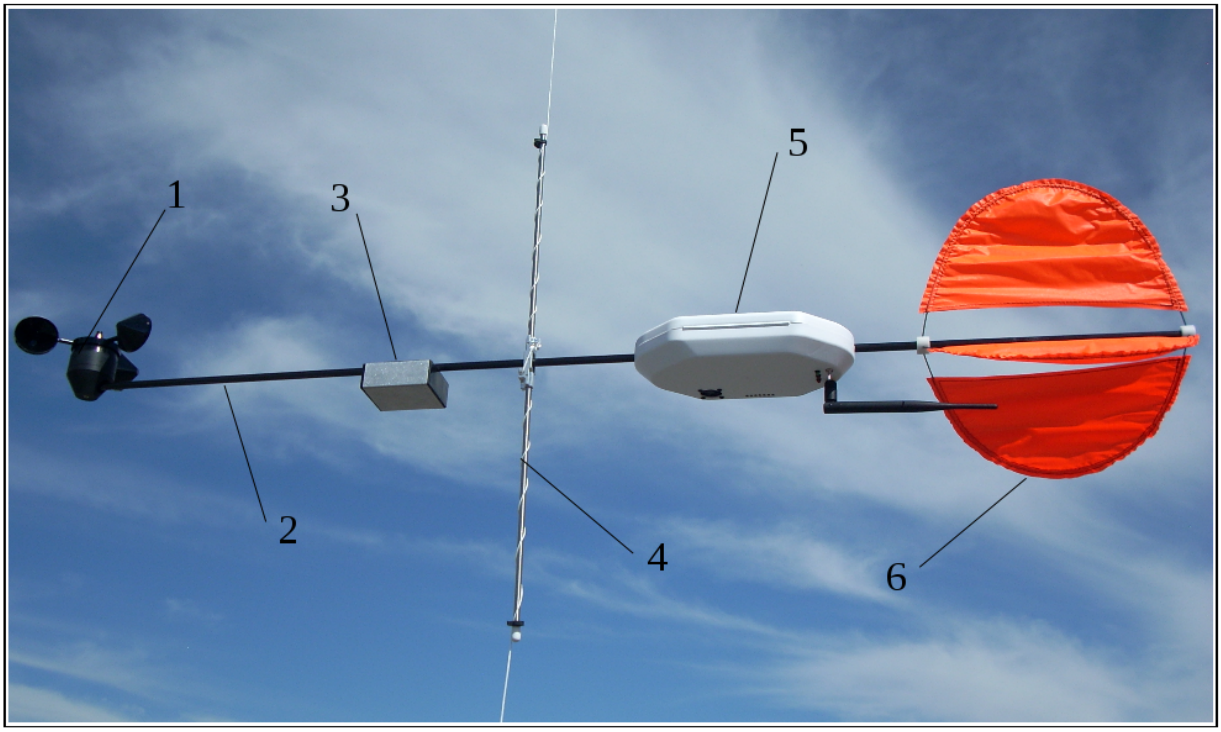

Illustration 1: Flight Module

The SmartTether module shown in Illustration 1, Flight Module on page 5 represents a fully assembled and balanced unit being operated in flight. The following indicates the different parts of the flight module:

1) Anemometer (Sonic or Cup Option Available)
2) Boom
3) Battery Compartment and Holder
4) Line Attachment Component
5) Housing with Electronics Board
6) Fins Assembly with Hubs

The electronic components can be found inside the white housing that holds the electronics board. Refer to Illustration 2, Outer Housing Components for the location and description of the components found on the bottom exterior of the housing. Refer to Illustration 3, Inner Housing Components for the location and description on the components found inside the housing on the circuit board.

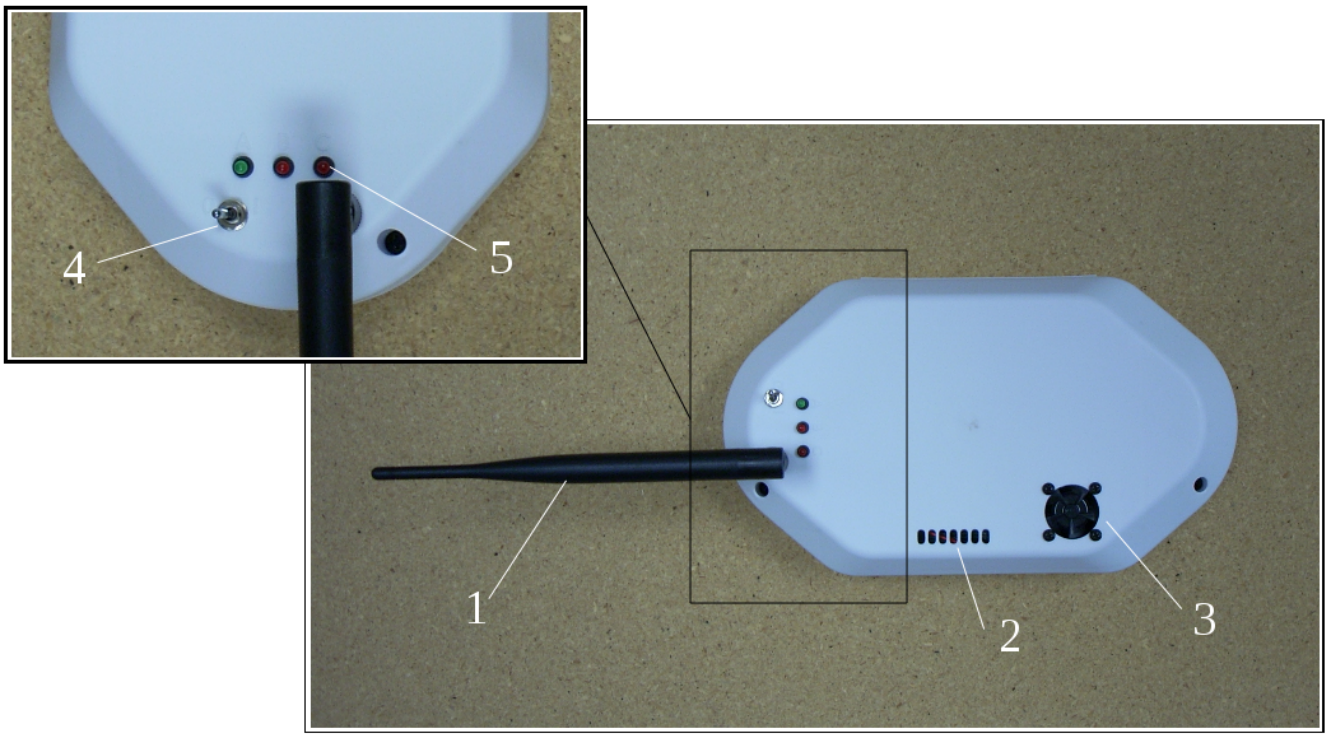

Illustration 2: Outer Housing Components

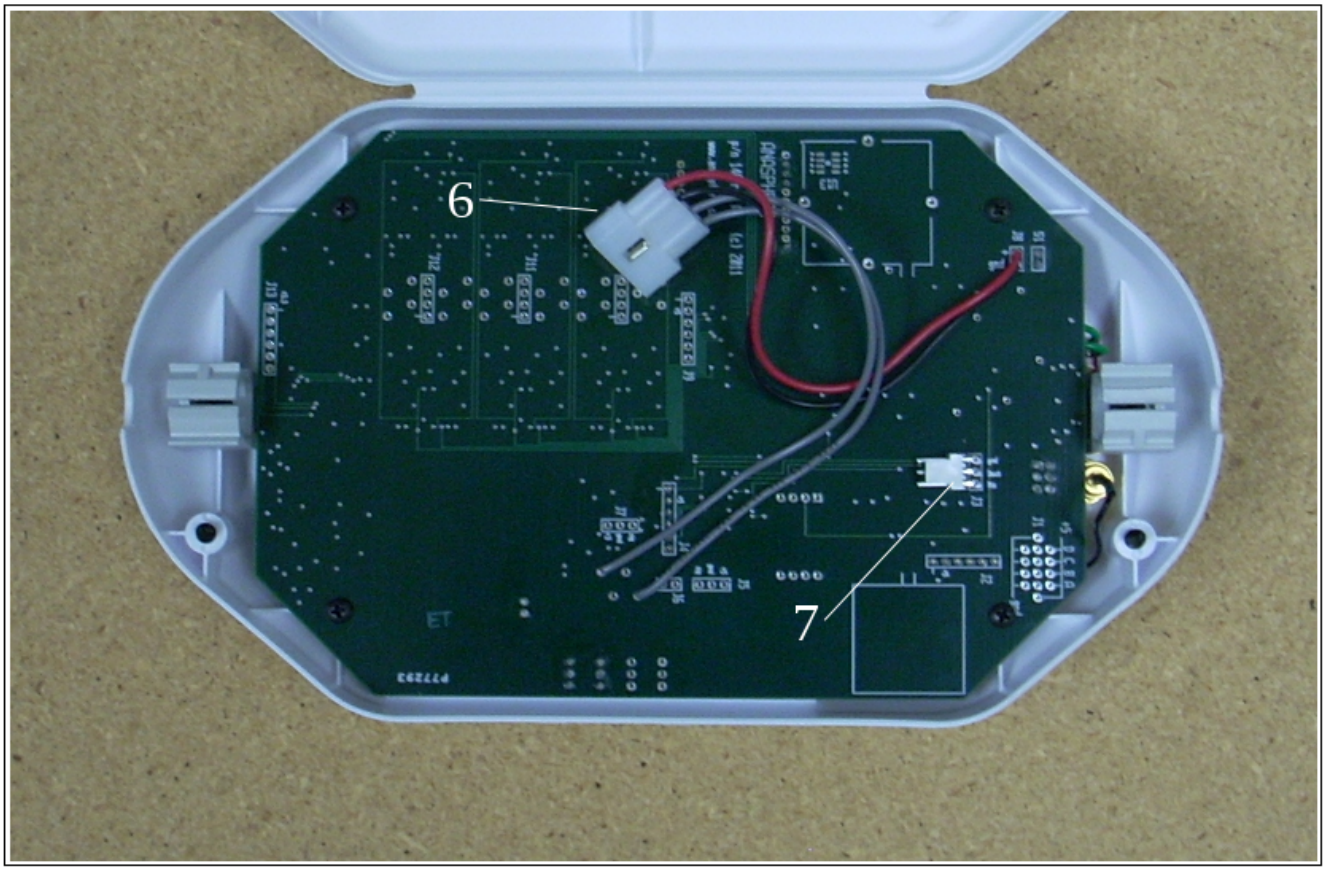

Illustration 3: Inner Housing Components

This list corresponds to Illustration 2 and Illustration 3, which show the main components that the user will work with on the housing and electronics board.

1) Antenna/Radio Modem Coaxial Jack Connection
2) Airflow Vents
3) Airflow Fan
4) Power Toggle Switch
5) LEDs (A,B, & C)
6) Power /Anemometer Connection
7) Firmware Updates and Calibration Port Connection (J2)

2.1.2 Checklist of Items Included

Flight Module

- ✔ 4’ Carbon Fiber Boom w/ Anemometer Assembly
  - Cup or Sonic Anemometer (Depending on version purchased)
- ✔ White Polypropylene Housing w/ Circuit Boards
- ✔ Antenna
- ✔ Three Orange Fins
- ✔ Two Fin hubs
  - Four 4-40 x 3/16” Set Screws for Each Hub
- ✔ Line Attachment Component
  - Aluminum Rectangular Base
  - Two 12” Stainless Steel Tubes
  - Three 4-40 x 3/4” Set Screws
  - Two Plastic Snap-Grip Tube Clamps
  - Two Vinyl End Caps
- ✔ Battery Compartment
  - 8-AAA Battery Holder w/ Battery Snap
  - Three 4-40 x 1/8” Set Screws

Ground Station

- ✔ Aluminum Box Housing w/ Circuit Boards
- ✔ Antenna
- ✔ 16’ Power Jack Cable

Software

- ✔ SmartTether™ Installation CD
  - Works with Windows XP® and Windows Vista®

General

- ✔ 3 Pin Serial Adapter Cable for Flight Module
  - Used for Firmware Updates and Calibration Purposes
- ✔ 0.050 and 0.063 Hex Keys
- ✔ Extra Small Parts Bag

2.2 Before Flight

The following sections include important information needed before a flight is performed.

2.2.1 What You Will Need

The SmartTether™ system requires the user to supply some additional hardware to successfully use the system. This system is recommended for a tethered platform that has the capability to raise flight modules in the air such as balloons, blimps or kites. Anasphere is able to provide many of the recommended products that are compatible with the SmartTether™ system for an additional cost.

Additional Items Needed:

- ✔ Computer with an appropriate operating system and serial port
- ✔ 12VDC Power Source for Ground Station
- ✔ 8 AAA Batteries for Each Flight Module
- ✔ Balloon, Blimp or Kite[1]
- ✔ Helium or other gas for lifting if necessary
- ✔ Winch and Tether Line System[1]
- ✔ Sturdy Platform[1]
- ✔ 9 Pin RS-232 Cable[1]
- ✔ Streamers[1]

2.2.2 Software Installation

Included in the product shipment is a disc that contains the software required to run the SmartTether™ system. The program has been tested with Windows XP®, Windows Vista® and Windows 7®. Simply run the SmartTether setup program to install to your hard drive.

If for whatever reason the software disc is lost or damaged, the software is available for download at www.anasphere.com. Also available at this site are software updates to ensure you have the latest version of the SmartTether™ system software.

2.2.3 Flight Module Assembly

The SmartTether™ flight module is shipped partially assembled. The user needs to take the following steps to complete the assembly process. For a visual reference of a fully assembled flight module, please refer to Illustration 1, Flight Module.

1 Products Anasphere can provide for an additional cost. Please call for pricing information.

(1) Attach the Antenna. Screw the antenna onto the radio modem coaxial jack located on the bottom of the white module housing. Refer to Illustration 2 for location. Make sure the antenna is parallel with the boom and is pointed towards the back of the flight module.

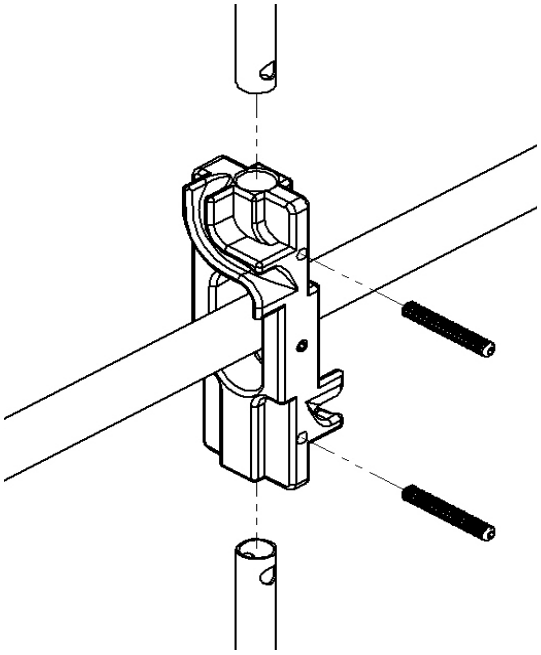

Illustration 4: Line Attachment Assembly

(2) Line Attachment. The aluminum rectangular base will be pre-installed onto the boom. The boom should have a degree of freedom to freely pivot up and down on the middle set screw. To finish the line attachment assembly, simply unscrew the top and bottom set screws enough so that both 12" stainless steel tubes can be fully inserted into the top and bottom holes of the base. Twist the tubes so that the holes in the tubes line up with the set screws. Re-screw the set screws so that both ends are completely inside the base. All set screws should set inside both side walls so the tether line has nothing obstructing its path. Refer to Illustration 4, Line Attachment Assembly as a reference. For a more permanent construction, using a thread locking substance on the set screws will keep the screws from loosening. Make sure that each tube has its own end cap and tube clamp.

(3) Fin Assembly. To assemble the fins, the user will need the supplied three fins and two hubs. Each hub has four set screws, so begin by backing out the set screws enough to clear the holes. Now take the arms of the fins and make a nice big u-shaped curve and flatten out the orange plastic material so they are flat. Start with the first fin and place the arm of the fin into one of the insertion holes of the first hub. Remember to keep the center area of the hubs clear from the arms so they do not interfere with the boom sliding into place, which can happen if the arms are pushed too far into the holes. Using the included 0.050 hex key, gently tighten down the set screws to a point where the fin cannot be removed from the hub. Take care not to crush the arms of the fins with the set screws. Repeat this process for the remaining two fins and the remaining insertion holes of the first hub. Repeat the entire process again for the other side of the arms on all three fins into the insertion holes of the second hub. Refer to Illustration 5, Tail Fin Assembly as a reference.

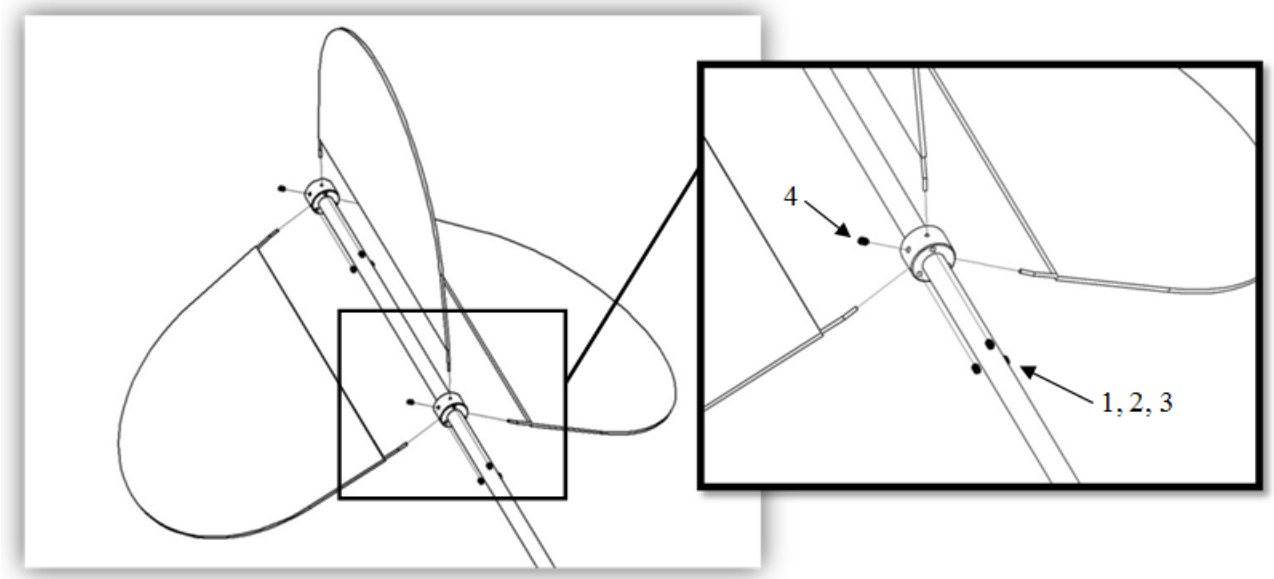

Illustration 5: Tail Fin Assembly

(4) Now slide the fin assembly onto the rear section of the carbon fiber shaft so that end of the tube is in line with the rear hub. Gently tighten down the remaining set screw on each hub to ensure the positioning of the hubs on the shaft. Be careful again not to over tighten. The included 0.050 hex key is the correct size for all the set screws. After the initial assembly of the fins and hubs, the completed assembly may be left on the boom and removed only if replacement of a fin or hub becomes necessary.

(5) The battery holder in located inside the battery compartment. Slip out the battery holder and place eight AAA batteries inside the holder. Use care with the wires when sliding the battery holder back into position. Place the wires inside the notch on the battery holder before sliding it back inside. The battery snaps need to be connected. The snaps and extra wires can be fit into the end cap when closed. Refer to Illustration 6, Battery Compartment for reference.

NOTE: Use care when storing and check the security of the set screws on fin hubs, line attachment and battery compartment before each use.

Illustration 6: Battery Compartment

2.2.4 Flight Module Power

The flight modules are powered by eight AAA cells. Any type of cell[2] may be used, though lithium AAA cells will offer the longest lifetime and lightest weight. Maximum current draw is approximately 103 mA. At sampling periods of once every 13 seconds or longer, the modules power down their 3-volt power supply for a significant fraction of the delay period to greatly conserve power (reducing draw to approximately 14 mA).

The battery holder is located inside the battery compartment. The black end caps are slip fit into place for easy accessibility to the batteries. No special tools are necessary to access the batteries; just simply pull the end cap to remove and push to get back into place. There is room inside the caps for the wires and connector to sit.

2.2.5 Ground Station Power

The ground station is powered by 7-42 VDC. The power jack cord has an auto power plug, which fits the standard power ports in most vehicles giving you a ready 12V power supply in mobile applications.

NOTE: If you do not wish to use the 12V socket in your vehicle, a wide variety of options are available. AC to DC car charger sockets are available at many retailers. These will allow you to adapt the auto power plug so it will fit in a standard 120V AC home/business outlet.

2.3 During Flight Operations

2.3.1 Operating Precautions

The following is a list that users need to be aware of during flight operations to minimize unnecessary issues:

- When using a module for the first time, or using it for the first time at a new geographic location, the compass should be calibrated.
- Calibrate the compass(es) before activating the ground station.
- Make sure that all antennas on the flight modules and the ground station are oriented horizontally to ensure the maximum transmission range as well as ensuring that a null is not created, which could potentially interrupt data transmissions to the ground station.
- Flight modules need to keep a distance of at least two feet apart from each other and ground stations when turned on and communicating.
- NEVER attach power to ground station without the antenna properly connected.

2 Lithium, alkaline or rechargeable

2.3.2 System Setup & Flight Instructions

These are the step-by-step instructions that need to be followed during flight operations. It will take you through the flight module and ground station setup and sequence. The following sections will go into more detail of the different operations.

1) Make sure the flight modules are fully assembled, equipped with battery supply and the antennas are attached in correct position; which is horizontal to the ground and in line with the boom pointing backwards. Modules should be in the off “0” position.
2) If the compasses need to be calibrated in the flight modules then do so according to Section 2.3.4 Compass Calibration.
3) Verify the antenna on the ground station is properly and securely attached to its jack. Make sure the antenna is oriented in a horizontal position so that the ground station will have maximum receiving capability.
4) Connect the computer to the Ground Station using a 9 pin RS-232 serial data cable.
5) Plug in and secure the DC auto power plug. Connect and secure the power jack to the ground station. Make sure the antenna is properly connected before attaching to power.
6) Turn on the ground station through the toggle power switch.
7) Follow the instructions indicated in Section 2.3.9 Flight Software Sequence for the PC guideline procedures during the flight operation.
8) Turn on the modules using the toggle switch accessible at the bottom of the housing unit by flipping it to the “1” position. It is good practice to activate the modules one at a time, only activating the next module when the previous module has successfully joined the network.
9) Verify power and transmission by the LEDs which are also located on the bottom of the housing unit. Learn more in Section 2.3.5.
10) Attach the module to the tether according to Section 2.3.6.

The ground station is designed to receive the flight module data and send it to your computer, where it is processed by the software. Computer to SmartTether™ Ground Station communication is accomplished through a 9 pin RS-232 serial data cable. Power is delivered to the Ground Station through the supplied power jack. There are three LED indicators on the ground station.

Transmit	
Receive	
Power	

2.3.3 Basic Startup

Turn the module on by pushing the toggle switch from “0” to “1”. At first, the green LED “A” will light for 5 seconds and then blink rapidly for five seconds; which is the part of the power-up sequence mode. After this initial blinking, the unit will initialize itself and attempt to join the SmartTether™ network and run in normal mode.

IMPORTANT: When the green LED is blinking rapidly do NOT turn the power off unless you wish to enter the compass calibration mode in Section 2.3.4.

2.3.4 Compass Calibration

To enter the compass calibration mode, hold the module in its operating orientation, with the antenna and LEDs on the bottom. Turn the module off during the power-up sequence mode, while the green LED “A” is rapidly blinking. Then, turn the unit back on. Both red LEDs “B” and “C” will illuminate for 10 seconds to indicate the module is in the compass calibration mode. During this time, slowly rotate the module one to two times in a complete circle, holding it level. This will complete the compass calibration procedure.

At the conclusion of the compass calibration procedure, the unit will again light the green LED “A” for five seconds and then offer the user the choice of re-entering this mode by rapidly blinking for five seconds. If the module is allowed to proceed past this point, it will initialize and attempt to join the SmartTether™ network.

2.3.5 LED Indicators during Operation

After the initial power up sequence, the green LED “A” is illuminated whenever the SmartTether™ module’s radio is powered up and the module is ready to communicate with the base station. During data collection with long delays, the module will turn off the radio to conserve power. In this case LED “A” will be off to indicate the module is sleeping.

The red LED “B” monitors radio communications to the base station. Every time the module sends data via radio, LED “B” will blink briefly.

The red LED “C” is the network acquired indicator. When the module is first powered up this LED will be off. Once the module is acquired by the SmartTether™ network, LED “C” will illuminate and will stay on until the module is powered off.

2.3.6 Attaching Modules to the Line

SmartTether™ flight modules can be attached at any position along the tether line. If attached correctly, then the module can pivot and rotate freely in the direction of the wind while being strongly secured. The following steps will show how a module can be properly attached to the tether line.

1) Perform an inspection of the tether line and pivot line mount. The line should be checked for fraying or any other potential weak points.

2) Make sure the line attachment component is fully assembled according to the assembly directions in Section 2.2.3.

3) Pick a location on the tether line you would like the flight module to be attached.

NOTE: Anasphere's winch system products have a line counter feature that measures the line's distance.

4) Begin by taking one of the plastic snap–grip tube clamps and placing it around the tether line and the stainless steel tube just underneath the rubber end cap. Tighten by pushing together the interlocking teeth with your fingers, about three or four "clicks". To remove, use fingers to push teeth ends sideways in opposite directions and this will separate the teeth.

5) Keep the line tight and wrap the tether line around the upper stainless steel tube clockwise for about five or six complete turns.

6) Keeping the line tight, wrap the tether line into the curved track on the front face of the aluminum rectangular block. Wrap the line around to the side of the main block and into the curved track on the back face of the block.

7) Keeping the line tight, continue to wrap the tether line around the bottom stainless steel tube in the same clockwise direction for about five or six complete turns.

8) End by taking the second plastic snap-grip tube clamp and placing it around both the tether line and the aluminum tube just above the rubber end cap. Tighten by pushing together the interlocking teeth with your fingers, about three or four "clicks". To remove, use fingers to push teeth ends sideways in opposite directions and this will separate the teeth.

9) Refer to Illustration 7, Line Attachment Diagram for a visual reference of proper line mounting.

10) Let the SmartTether™ unit hang free on the tether and check to make sure that the shaft is balanced on the line according to Section 2.3.7.

NOTE: Make sure there are no sharp edges or ends do not come into contact with the tether line.

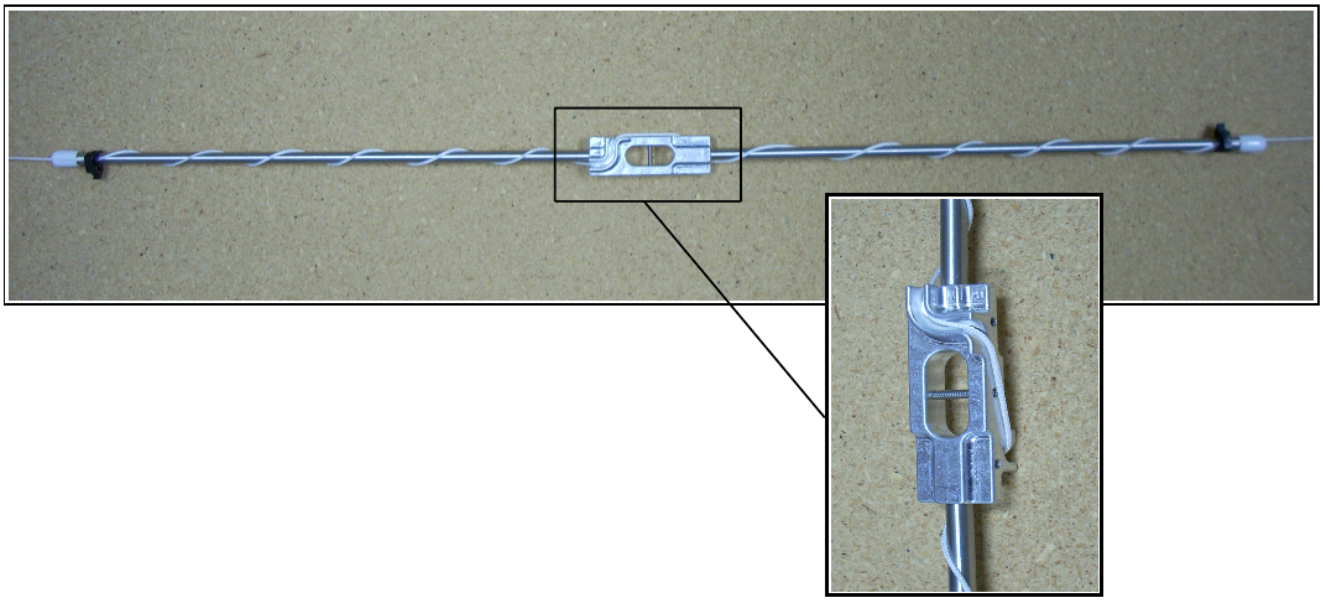

Illustration 7: Line Attachment Diagram

2.3.7 Balancing

Balancing is critical for correct operation. Imbalance may occur when there is a weight difference with the supplied batteries. When the module is secured to the tether line make sure that the boom balances level. This should only be done when the batteries are in place. If the module is titling more weight in one direction, then there are two options available for adjustments.

The first and easiest way for a small adjustment is to slide the battery compartment forward or back on the boom. This can be done by loosening the three set screws on the plastic piece attached to the battery compartment, sliding it into a better position and then re-tightening the set screws. It should be noted that the housing will only move as far as the electrical wires allow it. There is about 1 ½" inch of total play with the battery compartment. In most cases, this adjustment is enough to correct the problem.

If necessary, another adjustment can be done by sliding the housing forward or back on the boom. With enough force the housing should be able to slide. Otherwise, in order to access this adjustment, the user needs to open the housing be removing the two screws holding it closed. Inside the housing at both ends of the housing are click-snap tube clamps. A flat-bladed screwdriver can be used to loosen the clamps which anchor the housing in place onto the boom. Once loosened the entire housing unit can be moved up or down the boom to acquire the correct balance. Care should be taken to not jerk or put tension on any of the electrical wires while sliding the housing for balancing purposes. When the correct location is achieved, simply tighten the clamps again with your fingers to secure in place.

Once balancing is achieved and the module is properly attached to the tether line, it is ready to send up to take measurements.

Repeat the balancing steps for every SmartTether™ module.

2.3.8 Markers

User should tie the appropriate markers along the tether line. A marker can be made using a 12-ft long piece of 2-inch wide surveyor's marking tape tied around the line to yield two co-located 6-ft long streamers.

NOTE: In most regions of U.S. airspace, flights over 150 feet require markers to be placed every 50 feet on the line, with an area of at least 2 square feet. Check the FAA regulations for the appropriate marking requirements, notice requirements, and altitude limitations for the airspace you will be operating in.

2.3.9 Flight Software Sequence

1) Open the SmartTether™ program. You will be greeted with the altitude settings dialog.
2) Choose how module altitudes will be calculated. Your choices are:
   - Fixed: Choose this if your blimp will be parked at a fixed altitude. You will be given the opportunity to enter altitudes for each module at acquisition time.
   - Dynamic: Choose this if you will be adjusting the altitude of your blimp dynamically during run time but are willing to park one module at the ground level. Enter a base elevation for the lowest module in meters. Altitudes of the remaining modules will be calculated in real time based on pressure, temperature and humidity readings. This is the more accurate dynamic altitude mode.
   - Fully Dynamic: Choose this if you will be adjusting the altitude of your blimp dynamically during run time and all modules must be attached to the tether. The base elevation will be taken to be the elevation at ground level. All module altitudes will be calculated in real time based on pressure, temperature and humidity readings. Because conditions change over time altitude calculations may drift without a fixed reference module.

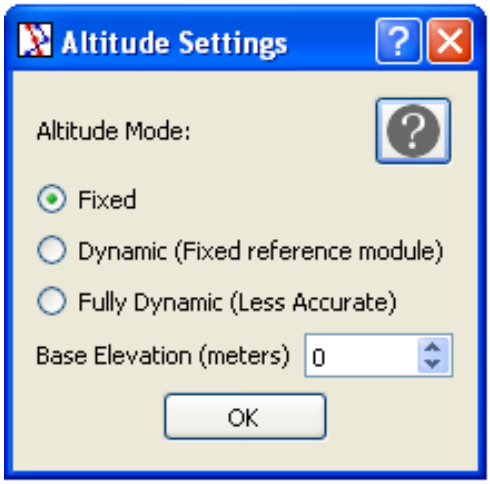

Illustration 8: Altitude Settings Dialog

   The base elevation is the elevation at ground level. It may be set to zero, in which case altitudes will be calculated as meters above the ground. If the base elevation is set to the actual elevation above sea level the module altitudes will also be calculated as elevation above sea level.

   Press OK when done. You can re-enter this dialog be selecting "System | Set Altitude Mode" any time before module acquisition has occurred.

3) Make sure the base station is connected to an available serial port on your computer and turn it on. This may require a special adapter cable, especially if using a laptop, as most newer

models do not have a serial port. A USB to serial adapter cable is generally available at most local electronics stores.

4) Select “System | Acquire Modules” to begin module acquisition. Select the correct serial port from the presented dialog and press OK.

5) The system will configure the base station and present you with a module acquisition dialog. Turn on the first module and wait for it to appear in the dialog. This will be the first (highest) module to attach to the tether. This step takes several seconds for each module.

6) If you have selected fixed altitude mode, there will be an Alt (m) column. Enter the module's altitude in meters directly into this column.

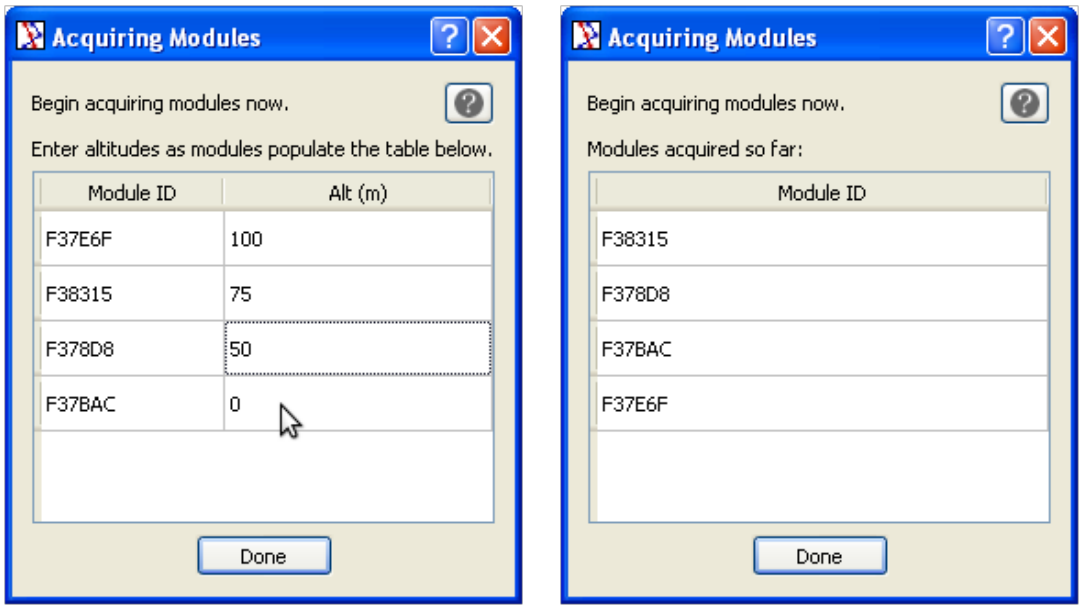

Illustration 9: Module Acquisition Dialogs

7) This module may now be attached to the tether. Repeat steps 5 – 7 for each module.

- Acquire each individual station one at a time.
- Never allow antennas from two running units to be within 18 inches of each other.

8) Press “Done” only when all modules are acquired.

9) The main window has a graph area, a data area, and a status bar with indicators. By clicking the mouse on the splitter between this areas and dragging, the size of the data area can be grown to accommodate data from all modules at once, or shrunk to devote more space to the graph.

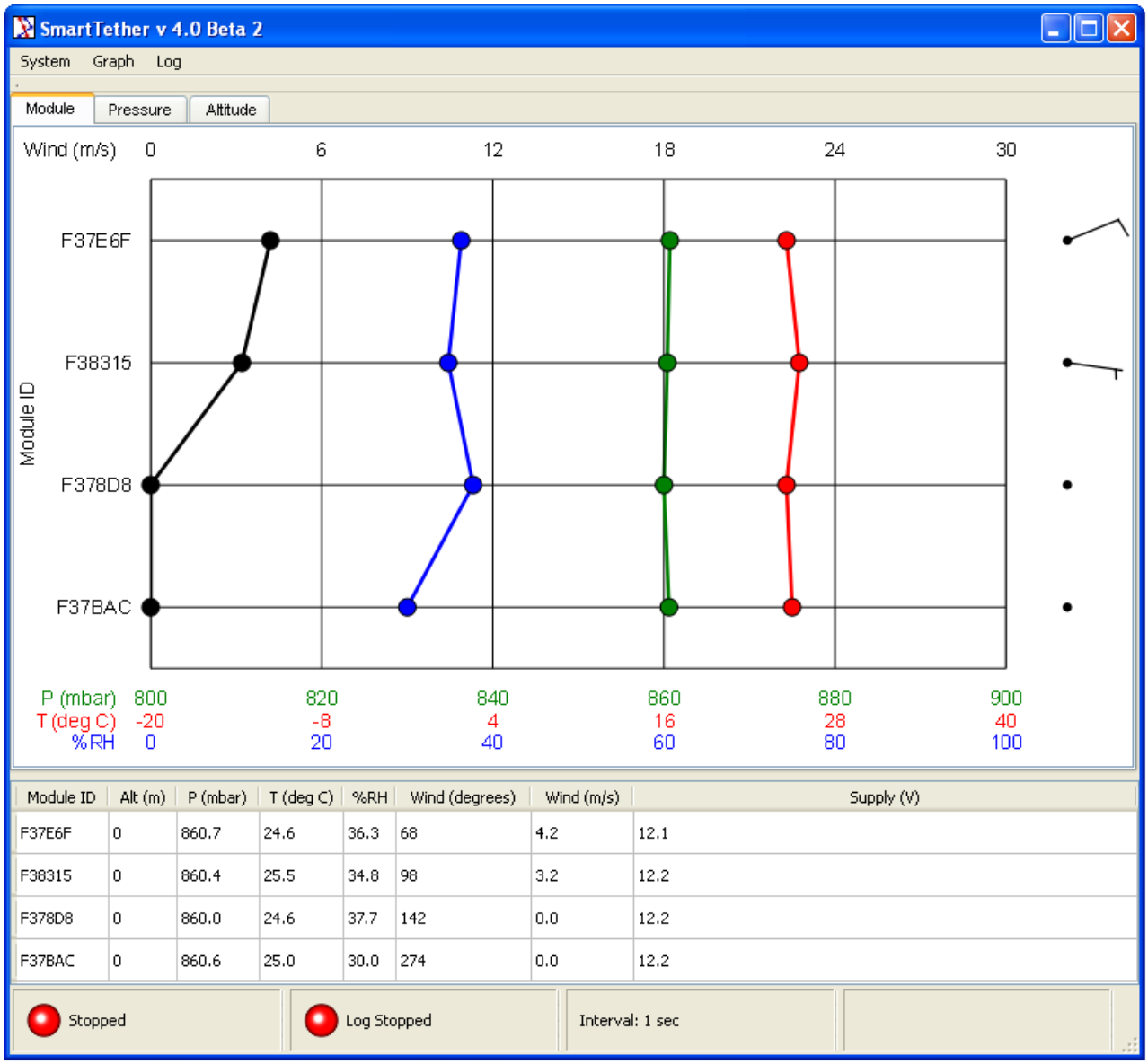

Illustration 10: Software Main Window

10) The data area has the following fields.

- Module ID is unique to each unit, but can be overridden using the module's RS-232 serial interface as described in section 3.
- Altitude is reported in meters.
- Pressure is reported in mbar.
- Temperature is reported in degrees Celsius.
- Humidity is reported in % RH.

- Wind direction is reported in degrees.
- Wind speed is reported in m/s.
- Supply voltage is reported in volts.

11) The graph area has 3 tabs. The “Module” tab shows data vs. module identifier. Select “Pressure” to show data vs. measured pressure, or “Altitude” to show data vs. module altitude. This can be done at any time.

12) Scale the graph area as needed using the submenus under “Graph”. This can be done at any time.

13) Select “Graph | Wind Barb Units” to change the windbarb units. Valid options are knots and meters per second. This can be done at any time.

14) Select the data interval with “System | Data Interval”. This can only be changed while the system is stopped. Note that when the system runs the modules may power down their radios during long data delays to save power. When stopping the system the software waits for the modules to “wake up” before allowing you to enter new run parameters.

15) Select “System | Run” to start polling modules for data. The status bar indicator changes to green in response. Note that you must separately start logging in order to save data to a file.

Illustration 11: Software Status Bar - Running

16) Select “Log | Begin” and create a new log file. This will create a tab-delimited text file. The default extension is “.csv”, which makes it easy to import into a spreadsheet program later. Note that the log indicator in the status bar changes to green to indicate data is being saved.

Illustration 12: Software Status Bar - Logging

17) You can pause logging by selecting “Log | Pause”. The status bar indicator changes to yellow and logging is suspended. Restart the log by unchecking the “Log | Pause” menu item.

Illustration 13: Software Status Bar - Log paused

18) Enter a comment in the log file by selecting “Log | Comment”. This is useful when you wish to correlate some observed event with the data that was recorded at that time. Choose “Single” to add this comment to the next data line only. Choose “Repeating” to add to all future data lines. You can also clear a previously set repeating comment.

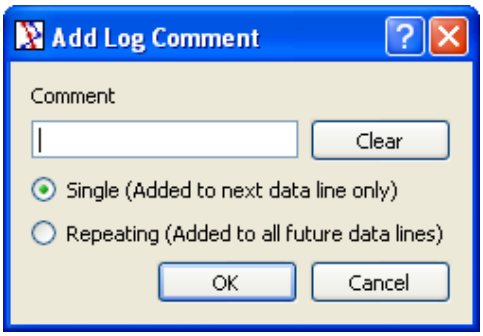

Illustration 14: Log Comment Dialog

19) You can stop writing to the current log by selecting “Log | Stop”. You can start a new log with “Log | Begin”.

20) Select “System | Stop” to finish polling for data. This action will complete at the end of the current data interval.

21) When you are done collecting data and are ready to bring the modules down and turn them off it is safe to exit the SmartTether program.

3 Optional Flight Module Setup and Calibration

Each SmartTether™ module has a unique ID tag which is reported to the SmartTetherTM software. The user can override this tag to present a descriptive name instead. The user can also override the factory sensor calibrations, although this is not expected to be necessary.

To perform these operations, the user must connect a serial port to the 3-pin connector (J2) inside of the module. The module must be opened to use this port. An adapter cable which connects this port to a standard 9-pin RS-232 connector is included with the SmartTether™ system. Port settings are 9600 baud, 8 data bits, no parity, 1 stop bit. Output signal levels used on this port are 0 VDC and 5 VDC; the vast majority of current serial ports will accept these signals without any problem. Input signal levels can be tolerated up to standard RS-232 levels. Once the module is connected, the user can enter the calibration and setup menu using any standard terminal program, such as HyperTerminal.

With the terminal program running, turn on the module. The module will present a short hello message such as:

```
Anasphere SmartTether 5.0.0
Unique ID: F378D8
```

Within the next 5 seconds, type a capital “C”. This will enter the calibration and setup menu.

```
M: Set module ID [F378D8]
T: Calibrate temperature
P: Calibrate pressure
U: Calibrate humidity
A: Calibrate anemometer
S: Show settings
F: Restore factory settings
```

If a “C” character is not received within 10 seconds, the module will continue with normal operation. If the window to enter the menu is missed, be careful not to power off the module while LED “A” is blinking rapidly unless you intend to enter compass calibration mode. Once LED “A” is solid on, it is safe to cycle power and enter the calibration menu.

Type a capital “M” to set a custom module ID. Up to 12 characters may be entered. For example, here the user has set the module ID to “Module 1”. User input is shown in bold.

```
M
User ID: Module 1
Module 1

M: Set module ID [Module 1]
T: Calibrate temperature
P: Calibrate pressure
U: Calibrate humidity
```

```
A: Calibrate anemometer
S: Show settings
F: Restore factory settings
```

The new ID shows in the menu afterward.

Custom calibrations can also be applied to the temperature, pressure, humidity and windspeed sensors by typing “T”, “P”, “U” and “A” respectively. Calibration constants are coefficients A, B and C to be applied to the quadratic equation:

$$Y = AX^2 + BX + C$$

X is the raw sensor reading, and Y is the calibrated result. The temperature and pressure sensors read out calibrated numbers directly and do not need an external calibration applied. Therefore the coefficients A, B and C applied to these sensors are 0, 1 and 0, respectively. The user can modify these if needed. The humidity sensor and anemometer need a linear calibration applied. Therefore coefficient A is 0 and B and C are set at the factory to get a calibrated result.

Here is an example where the user has applied a custom calibration to the temperature sensor.

```
T
Temperature A: 0
0.00000E00

Temperature B: 1.2
1.20000E+00

Temperature C: -0.5
-5.00000E-01
```

The user can show all factory and user settings with the “S” command.

```
S
Factory settings:
User ID: F378D8
Temperature 0.00000E00  1.00000E+00 0.00000E00
Pressure          0.00000E00  1.00000E+00 0.00000E00
Humidity          0.00000E00  3.27800E+01 -2.63599E+01
Anemometer  0.00000E00  7.63000E-01 3.70000E-01

User settings:
User ID: F378D8
Temperature 0.00000E00  1.20000E+00 -5.00000E-01
Pressure          0.00000E00  1.00000E+00 0.00000E00
Humidity          0.00000E00  3.27800E+01 -2.63599E+01
Anemometer  0.00000E00  7.63000E-01 3.70000E-01
```

Finally, the user can restore the system to its factory configuration with the “F” command.

```
F
Factory settings restored
```

This will set the ID back to the module’s unique ID and set all calibrations back to their factory defaults.

4 Technical Specifications

4.1 Ground Station

Digital Output: RS232, 9 Pin, bi-directional

Ground Station Power Supply: 7-42 VDC, unregulated, at 500 mA.

4.2 Flight Modules

Flight Module Power Supply: 8 AAA cells

- Lithium Batteries such as Energizer L91 Ultimate Lithium are recommended
- Alkaline and rechargeable cells are also acceptable but will have shorter lifetimes.

Operating Lifetime at 1 Hz: With 8x AAA lithium cells: approx. 11.6 hours

With 8x AAA alkaline cells: approx. 9.3 hours

- Lifetime may vary depending upon factors, including battery manufacturer and temperature.
- Lifetime may be extended up to 7 times by reducing sampling rates- rates of once every 13 seconds or slower have maximum power savings.

Sensors:

Pressure:	resolution 0.1 mb (tenths place significant)
	accuracy .5 mb
	range 0-1100 mb
Temperature:	resolution 0.125C
	accuracy 0.5C
	range -55 to +125 °C
Relative Humidity:	resolution 0.1%
	accuracy 3%
	range 0-100%
Wind Speed:	resolution 0.1 m/s
	accuracy 1 m/s or 5%, whichever is greater
	range 0-59 m/s4
Wind Direction:	resolution 1 degree
	accuracy 2 degrees

Extra Channels:	analog: 0-5 volt channels
	12-bit analog-to-digital conversion
	digital: 5-volt CMOS logic level input

*Extra channels may be enabled on request. Please contact Anasphere for details.

Data Rate:

1 Hz maximum, adjustable in one second intervals

Module Mass:

No batteries:	624 grams
With 8x Alkaline AAA cells:	737 grams

4.3 Maintenance

In order to ensure the function and longevity of your SmartTether™ system some basic maintenance steps are required. When not in use, it is recommended that the system be stored in a cool, dry place. If desired external system components (i.e., the system fins, main housing, shaft, and anemometer) may be wiped down with a damp cloth to remove external dirt and debris. Additionally, after using the SmartTether™ system it is recommended that the batteries be removed.

5 Troubleshooting

5.1 Harmful Interference

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

6 Technical Support

Technical support is available to help you troubleshoot any potential problems or answer any technical questions you may have about your SmartTether™ system. Live support is available Monday through Friday 9am to 5pm MST, excluding federal holidays, at 406-994-9354. Also e-mail inquiries are accepted at the following addresses: support@anasphere.com and info@anasphere.com.

7 Additional Information

7.1 Serial Communications

There are two communications ports used by each module. One is a direct, hard-wired link, and the other is the RF link.

7.1.1 Direct Serial Link

This link is available through the 3-pin connector (J2) inside of the module. The module must be opened to use this port. An adapter cable which connects this port to a standard 9-pin RS-232 connector is included with the SmartTether™ system. This port is used to calibrate the SmartTether™ module and to assign it a custom ID tag, which will display in the SmartTether™ software and log file. Port settings are 9600 baud, 8 data bits, no parity, 1 stop bit. Output signal levels used on this port are 0 VDC and 5 VDC; the vast majority of current serial ports will accept these signals without any problem. Input signal levels can be tolerated up to standard RS-232 levels.

7.1.2 Radio Modem Link

This link is only on the board, and is directly between the microcontroller and the radio modem. LED “B” blinks whenever the module sends data through the radio.

7.2 Extra Channels

The SmartTether modules offer extra analog (input) and digital (input or output) channels which can be used for adding additional user-supplied sensors or devices. The number of extra channels available depends on module configuration. These channels are sampled (if an input) or controlled (if an output) once every measurement cycle. The default module configuration has these extra channels disabled.

Connections to the extra channels are made through the J1 port along the side of the circuit board. Power (+5 VDC, maximum recommended current draw 300 mA for user-supplied items) and ground are available at each extra channel connection point. Extra channels may thus be

connected using 0.1-inch pitch 3-pin connectors. SmartTether version 3.1 and 3.2 modules use some of these channel locations for sensors and other features. Contact us if you wish to implement any extra channels.

7.3 Notices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception then refer to Troubleshooting (p. xx) for the appropriate measures.

FCC Compliance

Contains FCC ID: MCQ-XBEEXSC

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (i.) this device may not cause harmful interference and (ii.) this device must accept any interference received, including interference that may cause undesired operation.

RF Exposure

WARNING: This equipment is approved only for mobile and base station transmitting devices. Antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

FCC approved Antennas

WARNING: This device has been tested with Reverse Polarity SMA connectors. Antennas must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions).

7.4 Liability

Responsibility for the consequences of using the hardware/software and for the intended or achieved results of its use rests solely with the purchaser.

In no event shall Anasphere, Inc. or any person involved in the creation, production, or distribution of this Anasphere, Inc. product be liable for any claim of damages, including but not limited to any damages assessed against or paid by you to any third party, arising from the use, quality or performance of such Anasphere, Inc. product including hardware, software, firmware, or documentation, even if Anasphere, Inc. or any such person has been advised of the possibility of damages for any claim by any other party. Some states do not allow the limitation or exclusion of liability for incidental or consequential damages, so the above limitations may not apply.

The purchaser understands and agrees that Anasphere, Inc. is not responsible or liable for damage to equipment caused by the use of its products.

Purchaser understands that it uses Anasphere, Inc. products at its own risk and agrees to indemnify, defend, and hold harmless Anasphere, Inc. from any and all claims arising from the use of its products.

7.5 Warranty

Anasphere, Inc. warrants this product to be free from defects in materials and workmanship for a period of 6 months from the date of shipment. During the warranty period, Anasphere, Inc. will, at its option, either repair or replace products that prove to be defective.

This warranty shall not apply to any defect, failure or damage caused by misuse, abuse, improper application, alteration, accident, disaster, negligence, use outside of the environmental specifications, improper or inadequate maintenance, normal wear, or incorrect repair or servicing not performed or authorized by Anasphere, Inc.

Appendix A: Alternate Live Data Handling

Occasionally our customers wish to process live data using their own programs. Starting with version 4.0, the SmartTether software makes data available via a named pipe as it is received from the flight modules. While the SmartTether software is running another process may read the data from the pipe. A minimal example program follows, written in c, which will read from the pipe and print data to the screen.

```
#include <windows.h>
#include <stdio.h>
#include <conio.h>

#define BUFSIZE 512

int main()
{
  HANDLE hPipe;
  char  receiveBuffer[BUFSIZE];
  BOOL   fSuccess = FALSE;
  DWORD  charactersRead;
  LPTSTR lpszPipename = TEXT("\\\\.\\pipe\\SmartTether");

  // Try to open a named pipe
  hPipe = CreateFile(
                lpszPipename,   // pipe name
                GENERIC_READ,   // read access
                0,              // no sharing
                NULL,           // default security attributes
                OPEN_EXISTING,  // opens existing pipe
                0,              // default attributes
                NULL);          // no template file

  if (hPipe == INVALID_HANDLE_VALUE)
    {
      printf( TEXT("Could not open pipe. GLE=%d\n"), GetLastError() );
      return -1;
    }

  printf("\nConnected to server.\n");
  do
    {
      // Read from the pipe.
      // This call blocks until at least 1 character is ready.
      // A real application may need to run this in a separate
      // thread or use overlapped (asynchronous) I/O.
      fSuccess = ReadFile(
                    hPipe,    // pipe handle
                    receiveBuffer,    // buffer to receive reply
                    (BUFSIZE-1)*sizeof(char),  // size of buffer
                    &charactersRead,  // number of bytes read
                    NULL);    // not overlapped
```

```
        if ( ! fSuccess && GetLastError() != ERROR_MORE_DATA )
        {
          printf( TEXT("\nReadFile from pipe failed. GLE=%d\n"),
                    GetLastError() );
          return -1;
        }

        //Null-terminate the received string
        receiveBuffer[charactersRead] = '\0';

        //Print the string to the console
        printf( TEXT("%s"), receiveBuffer );

      } while ( ! _kbhit());  //Continue until the user hits a key

    CloseHandle(hPipe);
    printf("\nFinished\n");
    return 0;
}
```

Note that the name of the pipe is “\\.\pipe\SmartTether”. The data format is tab-delimited text.