LiteTether™ Operating Manual

Version 1.2

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Anasphere LiteTether Manual

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1.0 Introduction

LiteTether™ is a compact tethersonde system developed for boundary-layer profiling and near-surface meteorological measurements. A single flight module is deployed on the tether of a blimp, kite, or similar platform. A free Android-based app operates the system from a handheld device or tablet computer, saves data in a file, and can display data in real time. Data may be collected at up to a 1 Hz rate, and on-board data logging is an integral feature of the system.

LiteTether has been specifically designed to be as inexpensive, simple, lightweight, and rugged as possible. This is, in part, why LiteTether has a low-power radio with a limited telemetry range of 150 meters. A longer range would require a higher-powered radio and a separate ground station, and would also reduce battery lifetime. Anasphere does offer tethersondes with longer-range capabilities, and these are found in our SmartTether™ line of tethersondes.

With regard to simplicity, LiteTether is presently operated only through an Android app. This has enabled us to develop a simpler user interface than is used with our SmartTether system. This design choice also means that LiteTether, unlike SmartTether, can only operate one flight module at a time with the app. Users requiring simultaneous measurements from multiple tethersondes will find a solution in our SmartTether™ line of tethersondes.

LiteTether has been designed to offer the flexibility of incorporating additional sensors with minimal effort. A GPS receiver, analog-to-digital converters, serial ports, and counters can be added to LiteTether by the inclusion of a suitably configured daughterboard. These are not standard options, but are available upon request.

We have found LiteTether to be a very easy to use tethersonde, and trust that your user experience will be as enjoyable as ours!

2.0 System Setup

2.1 Flight Platform

LiteTether is designed to attach to the tethers of small airborne platforms such as blimps, balloons, and kites.

2.2 Android Device

A handheld device or tablet running Android 3.1 or higher is required to operate LiteTether. This device must be USB On-The-Go (OTG) capable and have serial communications capability through the USB port; not all Android USB OTG devices do. A compatible tablet is included with the LiteTether Starter Kit.

This device, paired with the Bluetooth dongle, will run the app which is used to configure and operate LiteTether. This app is available free of charge from Anasphere, and is included with the LiteTether Starter Kit.

2.3 Bluetooth LE 4.0 Dongle

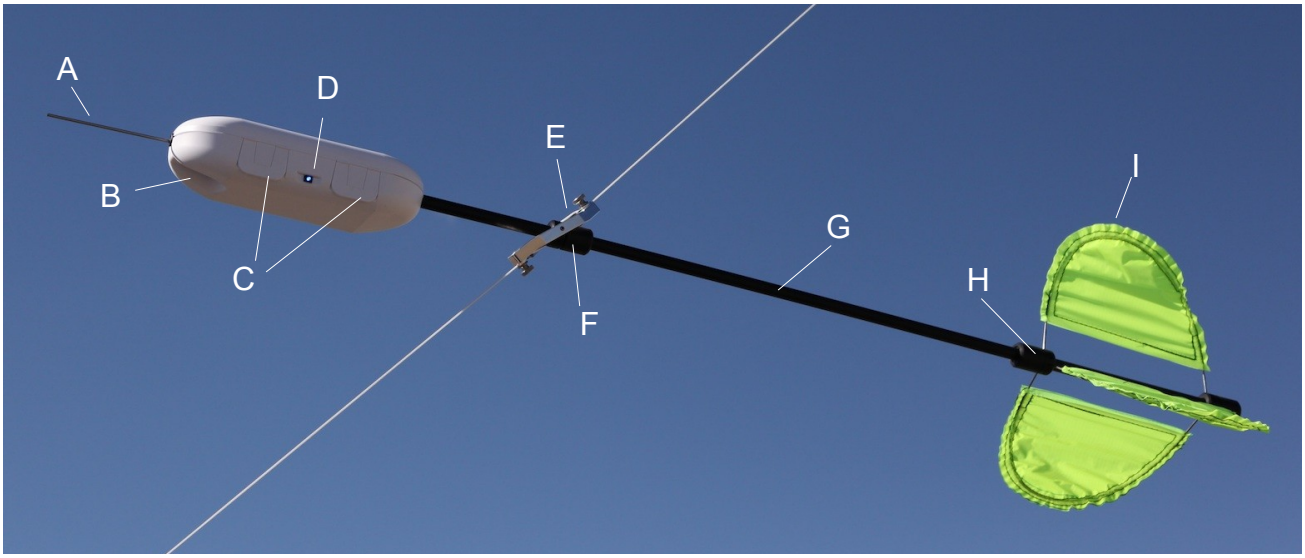
LiteTether uses Bluetooth Low Energy 4.0 (Bluetooth LE 4.0) for its radio communications. More specifically, it uses a proprietary serial data link carried over the Bluetooth link. As a result of this, Bluetooth radios which are built in to handheld devices and tablets cannot be used directly with LiteTether.

To communicate with LiteTether, a USB dongle which contains a Bluetooth radio capable of communicating with LiteTether is required. This dongle is included with every LiteTether Starter Kit, and is also offered separately for purchase.

Plug the dongle into the USB adapter cable supplied with the dongle, and plug that cable into the USB port on your Android device.

2.4 Flight Module

The following diagram illustrates key components of the LiteTether flight module.



System Components

A: Pitot probe for wind speed measurement.

B: Protective recess for temperature and humidity sensors.

C: Housing latches.

D: Power switch (push on / push off) and indicator LED. LED turns on when system starts, toggles state to indicate each time a command is received or a measurement is taken, and provides feedback during calibration.

E: Metal line attachment block with thumbscrews and washers to secure the line.

F: Hub which can be loosened or tightened by twisting the two ends of the hub. Holes spaced at 180 degrees are provided for set screws to secure the hub within the line attachment block. Slide this hub along the boom to balance the module.

G: Fiberglass boom.

H: Fin hubs (identical to the line attachment hub, item F). Holes spaced at 120 degrees are provided for mounting the fins.

I: Fins (ripstop nylon with steel wire supports).

3.0 Preflight Operations

3.1 System Setup

Open the flight module housing by lifting the two latches on the side of the module. Confirm that the tail boom and pitot probe mounts are secure. Install two AA batteries, and close the housing.

Turn the module on by pressing the pushbutton power switch which protrudes between the latches. Operation will be indicated by the illumination of the bright LED in the power switch.

Attach the USB Bluetooth dongle to the Android device and open the LiteTether app. Select the “Connect to LiteTether” command, and then tap the “Search” button which will appear in the upper right-hand corner. After several seconds, the screen should display an Anasphere LiteTether device in the list of found devices. Touch the LiteTether device to select it, and confirm you want the app to connect with this device.

3.2 Anemometer Calibration

The pitot anemometer must be calibrated prior to use. This is an automatic procedure which takes just over one minute. Place the LiteTether module in a sheltered environment with still air. In the app, select the “Anemometer Calibration” command. The calibration progress will be indicated by a progress bar, and can also be observed on the module which will be blinking its LED in a triple-blink pattern. After approximately one minute, the calibration will be finished and saved in the module’s memory.

Anemometer calibration can be repeated at any time, as long as the device is in still air. Calibrations are saved in nonvolatile memory, so there is no need to repeat this procedure each time the module is turned on.

3.3 Compass Calibration

The tilt-compensated electronic compass must be calibrated prior to use, and any time it is moved to a new geographic location. This procedure requires user participation, and takes a little more than two minutes. The LiteTether module should be in the general area where it will be used. In the app, select the “Magnetic Calibration” command. After a several second pause (allowing the user to put down the Android device and pick up the LiteTether module), the process begins. Progress is indicated by a progress bar on the screen.

During these two minutes, the user must manipulate the LiteTether module so that it can sample its local magnetic environment and develop tilt correction coefficients.

The objective of this procedure is to let the LiteTether module sample all directions in its local environment while varying its pitch and roll angles. This can be achieved by rotating the module several times while pitching and tilting it to varying degrees. For those who would like a more detailed procedure, the following is recommended.

Hold the module with one hand just behind the line attachment block and hold the rear of the tail boom (by the fins) with the other hand. When the LED illuminates, use the rear hand to spin the module about the boom axis while using the forward hand to point the module in as many different directions as possible. This includes straight up and down, right and left, forward and backward, and as many intermediate angles as can be achieved during the calibration period. Be careful to not drop the module while doing this!

At the conclusion of the process, the app will inform the user whether or not the calibration was successful. If not, repeat the above steps.

Compass calibration can be repeated at any time, as long as the user has access to the module and can manipulate it through the range of orientations needed for calibration. Calibrations are saved in nonvolatile memory, so there is no need to repeat this procedure each time the module is turned on assuming that the module is still being used in the same general area where it was calibrated.

3.4 Sampling Configuration

The “Configure LiteTether” menu allows the user to adjust simple parameters related to the LiteTether module.

Most importantly, this menu allows the user to change the sampling interval used by LiteTether for automatic operations. Intervals from 1 to 60 seconds may be selected here.

4.0 Flight Operations

Once the flight module has been set up as outlined in Section 3 (most importantly, the anemometer and compass have been calibrated), the system is ready for flight.

CAUTION: LiteTether 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.

4.1 Balancing

Flight modules are most easily balanced prior to attaching them to the line. To balance the module, first ensure that the batteries are installed. Then, loosen the plastic hub assembly that passes through the metal line attachment block by partly unscrewing the two plastic pieces (they are threaded). Once the plastic hub is loosened, it can be slid along the boom until balance is achieved. When an acceptable balance point is found, tighten the plastic hub assembly.

This is also a good time to check that the two set screws in the metal line attachment block are in place. These set screws should firmly hold the plastic hub in place but not be so tight as to prevent the module from pivoting.

Small errors in balance are allowable! If it proves too tricky to get the module to rest perfectly level, remember that the fins will work with the wind to easily compensate for any small balance errors.

4.2 Line Attachment

The flight module attaches to the line by hooking the line inside the hook at the top of the line attachment block, passing it between the knurled cam and the body of the block, around the body of the block, and finally inside the hook at the bottom of the block. Bring the cam against the line and tighten it in place with the thumbscrew.

Do not leave any slack in the line when performing this step; it should be pulled tight. If attaching to a line under high tension (for example, a kite), it is recommended that either a) an assistant pull on the line so that tension is low enough to complete the line attachment, or b) the LiteTether module be attached to the line before the lifting platform is airborne and putting tension on the line.

4.3 Data Collection

Data may be collected in two ways using the app: taking single measurements on command or automated logging. Automated logging allows users to save incoming data to a file on the Android device and to save data in the LiteTether module's on-board memory, which can be read out later to provide a complete data record from the flight. This feature is useful when operating the module beyond the range of the Bluetooth link, and prevents data loss in the event of the Android device losing power. Frame numbers allow data saved on the Android device and data from the onboard memory to be stitched together as may be required when operating out of Bluetooth range.

Single Measurements. To take a single measurement, tap the "Take Single Measurement" menu item in the app. This will bring up a screen which displays the measurement data fields. Tap the "Acquire" button to take a single measurement. This measurement is displayed on the screen and logged into the module's on-board memory.

Automated Logging. To start the automated logging process, tap the "Start Automatic Operation" menu item in the app. This will bring up a warning message that you are about to erase the module's memory and lock yourself out from further module control once automatic logging is started. Be sure you have set your desired sampling interval under "Configure LiteTether" before starting automatic logging.

During automatic logging, the Android device can display data frames as they are received. However, the user is locked out from sending further commands to the LiteTether module. See the next paragraph for data retrieval.

Data Retrieval. To retrieve the data saved in LiteTether's memory, turn the module off and on again. At this point, all commands are again accessible to the user. Select "Retrieve Tether Data" from the app menu. This will allow you to transfer all of the logged data from the LiteTether module to the Android device, where it can be handled as a plain text .txt file. This file can be viewed on the Android device, transmitted electronically, or saved to a removable memory card. Data frame numbers may be used to stitch this data set together with other data saved on the Android device.

Frame Numbering. The frame counter is only reset when a new automatic logging operation is started. Otherwise, the counter follows a continuous loop from 0 to 65,535 and back to 0 again. Several frames may be used in the course of conducting a pitot anemometer calibration.

Processing Data with Frame Numbers. The onboard memory wraps around in the event it is used to log for a longer period of time than it is capable of holding, so in other words it only contains the most recent data. In these cases, where the memory

has wrapped around, the frame numbers in the file retrieved from the LiteTether module may not be continuous. For example, the logged file may start with frame 4450, go up to 4890, then switch to 4105 through 4449. In this case, simply cut and paste the later part of the file (frames 4105-4449) to the front of the file to obtain a continuous record of frames 4105-4890.

Similarly, the data which was saved on the Android device itself (in a file separate from the downloaded log file) may contain frames 3885-4260. This illustrates a case where the module was operating within Bluetooth range, and then was elevated out of range of the Bluetooth link. Working from the preceding example, the two files may be spliced together using the frame numbers to obtain a continuous record of frames 3885-4890.

Data Format. The .txt files save the data in raw telemetry format. The format of this data is as follows. This information will allow the user to write a script or formulas to process the data.

The telemetry frame is comma delimited, and ends in a carriage return (ASCII code 13) and line feed (ASCII code 10). All numbers are ASCII digits. Each field is preceded by one or two capital ASCII letters identifying the frame.

The standard telemetry line looks like this. < and > characters merely break up the fields for readability and are not included in the transmissions.

F<frame>,P<pressure>,T<temperature>,U<relative humidity>,S<speed>, D<direction> <13><10>

F frame: integer 0-65535, rolls over after reaching 65535

P pressure: pressure in millibars x 10, so divide by 10 to get pressure to 0.1 mb

T temperature: + or – sign followed by temperature in degrees C x10, so divide by 10 to get 0.1 C resolution

U relative humidity: relative humidity x 10, so divide by 10 to get RH to 0.1%

S speed: speed in meters/sec x 10, so divide by 10 to get speed to 0.1 m/s

D direction: 0-359 degrees

5.0 Technical Specifications

5.1 Mechanical and Environmental

Mass without batteries: 240 grams
Mass with batteries: 260-280 grams depending on battery type

Operating temperature range: -40°C to +50°C

Maximum wind speed: There is no defined maximum wind speed. Modules have been tested for stability up to 20 m/s but will remain stable at higher speeds. The anemometer will stop indicating above its maximum value.

5.2 Electrical

Power consumption: 110 milliwatts average (38 mA at 3.0 V)

Power Supplies: There are two power supply options: either install two AA batteries in the on-board holders, or supply 0.65 – 6.5 volts DC via J1 on the circuit board (no connector is provided, but the pads are marked with polarity).

Operating Lifetime: Two AA lithium cells (Energizer L91) can operate the LiteTether module for approximately 80 hours at 1 Hz.

Maximum telemetry range: 150 meters (this is for live telemetry; there is no range restriction when using LiteTether in automatic logging mode).

Sampling Period: 1 second to 60 seconds, adjustable in 1 second increments

Logging Capacity: 128 kilobytes memory, capable of holding 2 hr 16 min of data in basic configurations.

5.3 Sensors

Pressure: resolution 0.1 mb, accuracy 0.5 mb, range 0-1100 mb
Temperature: resolution 0.125°C, accuracy 0.5°C, range -55 to +125°C
Relative Humidity: resolution 0.1%, accuracy 1.7%, range 0-100%
Wind Speed: resolution 0.1 m/s, accuracy 0.5%, range 0-14 m/s (at sea level), 0-22 m/s (at 5,000 ft MSL); extended ranges with reduced resolutions are available.
Wind Direction: resolution 1 degree, accuracy 2 degrees

5.4 Maintenance

To ensure the function and longevity of your LiteTether 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 housing, fins, boom, hubs, and line attachment) may be wiped down with a damp cloth to remove external dirt and debris. Additionally, after using LiteTether it is recommended that the batteries be removed from the flight module.

CAUTION: The temperature and humidity sensors are exposed in the recess under the nose of the module. While these sensors are tolerant of incidental contact, avoid the use of any liquids, solvents, or lubricants near them.

6.0 System Options

LiteTether has been designed to offer the flexibility of incorporating additional sensors with minimal effort. The following options are not standard, but can be included when ordering LiteTether modules. These options are enabled by the inclusion of a suitably-configured daughterboard which is installed on top of the main LiteTether circuit board. A minimal weight and power penalty is incurred by the inclusion of the daughterboard, and maximum sampling rate may be affected as well.

The additional sensors themselves will of course add their own weight and power needs. LiteTether can supply a very limited amount (several milliamps) of either 3.3 volt or 5 volt DC power to external sensors, but in most cases it is recommended that additional sensors have their own power supply. Contact Anasphere if you have specific power supply questions.

All of the following options are supported but are non-standard. Contact Anasphere to specify the inclusion of any of these when ordering a system. In most cases, these upgrades must be completed at Anasphere.

6.1 GPS

A GPS receiver can be installed to provide an alternate source of altitude data or time and location stamps. Contact Anasphere to specify the desired GPS fields.

6.2 Analog Signals

One or two 12-bit analog-to-digital converter channels can be provided. The range is shared for both converters, and can be either 0-3.3 or 0-5 volts DC.

6.3 Serial Ports

Two bidirectional serial ports are available. These can be used for direct RS-232 input (either logic- or standard-level signals), RS-232 output (either logic- or standard-level signals), or RS-485.

6.4 XDATA

LiteTether may be set up to receive data packets from XDATA-configured instruments or to send its data to a radiosonde able to accept XDATA packets. LiteTether is capable of operating in the middle of an XDATA daisy chain.

6.5 Counting

A single channel capable of counting pulses over a defined period is available.

6.6 Miscellaneous

The above options provide for the interfacing of a wide variety of instruments to LiteTether for supporting measurements. For example, particle counters can be interfaced via either the serial or analog ports. Geiger counters can be interfaced via the counting port.

7.0 Troubleshooting

No communications or erratic operation. Replace the batteries. Note that the LED in the switch may still illuminate even if the batteries are nearly depleted.

App cannot acquire the module. First, verify that the Bluetooth USB dongle has been acquired by the app; you can do this by tapping the USB symbol in the upper right-hand corner of the app screen. Second, it is possible that the Android device does not support serial communications. Try a different Android device.

Wind speed is erroneous or zero. First, ensure that the pitot anemometer has been recently zeroed in still air. Second, ensure that both ends of the flexible plastic tube that connects the pitot tube to the pressure sensor are securely attached. The pressure sensor is under the board, and you will have to remove the brass screws holding the circuit board in place to inspect this connection. If it has come off, it goes back on the upper port of the pressure sensor (the one farthest above the circuit board surface).

CAUTION: The circuit board is sensitive to static electricity. If removing or handling the circuit board, be sure to do so in a static-safe location.

Wind direction (compass) values are erroneous. Re-calibrate the compass, and ensure no large metal objects (cars, etc.) are nearby which could distort the local magnetic field. Be sure you are using batteries of the same type as you are using in flight. Try using the more specific calibration procedure in section 3.3 if you have been using a more random selection of orientations.

8.0 Additional Information

8.1 Technical Support

We are available to answer your questions by phone (406-388-4177) or email (support@anasphere.com, info@anasphere.com).

8.2 Liability Disclaimer

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.

8.3 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.

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