Hardware Configuration and Installation

The dimensions for the board are provided below, in inches. Note that with the antenna installed, the total length is approximately 4.1 inches. 4-40 screw size or the metric equivalent is recommended for mounting.

The GPS receiver is the large, square ceramic part shown above. To receive GPS signals properly, it needs to be clear of metallic obstructions between it and the sky. The Featherweight tracking app provides information about GPS signal strength that can be used for validating an installation.

The antenna connector is an SMA (not reversed polarity). The antenna provides the best signal strength in the direction radiating from the side of the antenna, and worst signal strength in the direction...
pointing down the long end of the antenna. So for best results when tracking, keep your ground station antenna horizontal rather than pointed in the direction of the rocket.

**Input Power**

The Featherweight GPS Tracker is powered through the green screw terminal block. The recommended voltage range is from 3.4V to 4.5V. However, voltage from 3V to 9V can be used without damage. Carefully note the “+” and “-” polarity markings and follow them. The Featherweight Tracker can be damaged by reversing the power leads!

The recommended power source for flight is a lithium polymer, single-series battery (4.1V) with at least 150 mAhr capacity. A 400 mAhr battery is recommended. The Featherweight GPS Tracker consumes approximately 50 mA when not transmitting, and 90 mA when transmitting, for an average of approximately 75 mA. This current consumption is constant regardless of input voltage. If a 400 mAhr battery is used, that will provide around 5 hours of continuous use. Battery voltage can be monitored from within the Featherweight tracking app.

The slide switch located at the end of the board is used to turn the unit on and off. This switch is compatible with high-G flights and hard landings. However, if you would prefer to use an external switch, a wire can be soldered to a through hole via labeled “sw+” on the back side of the board as an alternative means of providing power that bypasses the slide switch and the input terminal block.

**Enclosure**

An optional enclosure can be purchased that provides protection for a tracker, a battery, and a battery charger. The input power for battery charging is a USB micro-B connector for a USB-compatible cable (not included) commonly used for charging cell phones or other devices.

When the battery door is removed, that provides access to the charger for other compatible batteries to be charged (see below). Compatible batteries have a JST connector with polarity shown below. Note that some batteries with JST plugs have the opposite polarity, so if you purchase a battery from a 3rd
Party, be sure to carefully compare the wire color to the wires on the battery that comes with the enclosure.

LEDs
The Tracker and the Ground station both have a red and a green LED, but they are used differently:

Tracker: The red LED has 2 functions: When it is quickly flashing when the unit is first turned on, that indicates that no GPS lock is available yet. After that, a steady, slow flash shows when the tracker data is being transmitted over LoRa. The unit is transmitting while the red LED is on.

The Tracker’s green LED turns on when it is receiving an ack transmission from the Ground Station or from a lost rocket. Normally the Tracker and GS are in 2-way communication, but if the two units are not set to the same frequency and tracker ID, then no acks will be sent from the GS back to the tracker. If this green light is flashing, then that means that full 2-way communications are working.

GS: The ground station red LED also flashes at power up until a GPS lock is acquired. After that, it should stay off when everything is working correctly. If the green and red LEDs flash on together once every 8 seconds, this indicates that no LoRa data has been received, and so the radio is resetting itself.

The GS’s green LED turns on while data is being received from the tracker or another ground station. The length of the on-time indicates how long it is taking for the data to be transmitted.

For both units, the red and green LEDs will turn on briefly at power-up so you can know that power is applied and that the LEDs are working.
Featherweight Interface Program Phone App (iFIP)

Nov 23 2018 update: The iFIP can now be downloaded by visiting the following link, until it is available in the app store:

https://testflight.apple.com/join/InpJx5lw

Instructions:

1. Install TestFlight app from the app store, on the iOS device you want to use
2. Click on the above link from the iOS device you want to use, to activate the TestFlight download and installation of the iFIP. The above link is also in the Featherweight Altimeters GPS website page, if you would like to navigate to it rather than typing in the above link in your iOS device.
3. Accept the conditions and continue the installation, then open the app.

The iFIP application on your phone displays data that it receives from the tracker and the ground station (GS) over Bluetooth. The first time you connect your phone to your Tracker and GS, you do this using the Scan page and the Devices page. After the setup is complete, the phone and the devices will remember each other so that they will automatically start working together once you turn them on and start the FIP.
Initial Setup:

1. Make sure that Bluetooth is turned on in your phone, and start with both units off. Open the FIP and go to the Scan page. It will look like this at first:

![Scan Page Screenshot](image-url)
2. Turn on your tracker unit (the one that will fly in your rocket). After a few seconds, sometimes up to a minute, you should see your unit show up like this:

![Tracker Unit Interface]

- **Tracker ID:** FthrWt00007
- **Serial Number:** 7 Channel: Ch 23 - 906.800
3. Click on the highlighted line, and it will bring you to a setup screen:

At the top of the screen is an ID that you enter. This is publicly-visible text string that uniquely identifies your tracker. You can use it to switch between different trackers installed in different rockets (or different rocket stages), and it is also what other people can use to know which frequency channels are occupied, and to tune in to track your rocket’s flight on their phones. This ID can be up to 11 characters long.

Next is where you can switch your unit between the operating modes tracker and ground station. Featherweight GPS units can be changed when needed, using this selection. Start with the first unit as your tracker to follow along with these instructions.

Next is your selection of a frequency channel. When you first get your unit, a frequency channel will already have been assigned that is likely to be unused by other people. You can keep this channel or select your own. The tracker remembers the frequency and the TrackerID, which will be unchanged until you come back to this screen to change them.
4. When you have made your selections, select “Save” and the FIP will command the unit to use these settings. When the new settings have been confirmed, you will see a screen like the following:

![Connect screen](image)

(Temporary note: Sometimes it may take up a minute for the settings to get changed)
5. After you change the settings, you should see them reflected in the Devices page like the following:

(Temporary note: in early revisions of the firmware, it may take more than one attempt to set all of the settings to their final value. If you see in the devices list that one of your settings was not saved, go back and try again and it should take the new setting on the next attempt)

6. Repeat the above steps for your ground station. Set the frequency and the TrackerID to the same values you used for the Tracker. This will enable 2-way LoRa communications between your two units, so that the tracker can send the data it needs to the ground station, and the ground station can respond so that the Tracker can determine if it has lost LoRa contact, for example if the line of sight is blocked after landing.
The two images below show the devices list after another tracker unit, serial number 11, is turned on, and then after it is set up to be used as a ground station for the first unit, serial number 7:

7. Now the initial setup is complete, and from here the units can be used together for tracking

Tracking pages:
The FIP currently has 3 pages that can be used to monitor and find your rocket:

GPS page
The GPS page is used to make sure that both units have a good GPS signal and fully charged battery before the flight. The left side shows the ground station and the right side shows the tracker.
The colored bars show how many satellites are being tracked (The whole outlined box represents 24 satellites), and how strong the signal is to each satellite. The table below explains the color code.

<table>
<thead>
<tr>
<th>Color bar</th>
<th>Signal Strength (dB-Hz)</th>
<th>Signal Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange</td>
<td>Less than 24</td>
<td>Weak, can result in 10s of meters horiz. error</td>
</tr>
<tr>
<td>Yellow</td>
<td>24 to 32</td>
<td>O.k. Can add small amount of inaccuracy</td>
</tr>
<tr>
<td>Green</td>
<td>32 to 40</td>
<td>Good Full accuracy available.</td>
</tr>
<tr>
<td>Blue</td>
<td>40 and Over</td>
<td>Very good. Full accuracy with margin</td>
</tr>
</tbody>
</table>

Both the number of satellites and how strong they are can affect how accurate the GPS solution is, and how robust it is to sudden accelerations like launch. Don’t worry if the weakest satellites are yellow or
orange; the receiver will prioritize its stronger satellites in its solution. This graph is useful for evaluating whether your rocket materials and/or paint might be reducing your available GPS performance, for example a carbon fiber airframe

**Comm Page**  
(To be updated after formatting is improved. The first 2 lines are counters for how many packets and acks have been transmitted and received.

The signal strength in dB milliWatts is on the 3rd line)

The third line is the LoRa signal strength. The LoRa radio works down to a signal strength of about -130 dB. You can estimate how much more range you have if you are comfortable using some radio terminology and a simple equation. For example, if you measure a signal strength of -90 dB on a 5,000 foot high flight, you know that you have 40 dB of margin. Every 2 dB of signal corresponds to 1 dB of range, so 40 dB of signal strength corresponds to 20 dB of range. Every 10 dB is a factor of 10, so 20 dB of range margin on a 5,000 foot flight means that you could still make the link work for a flight 100x longer than that, or 500,000 feet.

**Track Page**  
(To be updated after formatting is improved)

**LoRa™ Radio Range**

The radio in the Featherweight GPS Tracker uses LoRa™ spread-spectrum technology, which gives the tracker the longest range available in GPS trackers. A Featherweight GPS tracker was used to track a rocket to over 137,000 feet altitude and 145,900 feet total range in September 2017 above the Black Rock Desert.
Standard output power and standard stub antennas were used at both ends of the link, and the rocket installation configuration was far from ideal. Even so, the signal strength information indicated that there was still substantial margin available for even longer range, even out to the edge of space (100 Km). As long as there is a clear line of sight between you and tracker, your Featherweight GPS Tracker will have enough range to communicate. After landing, however, it is common for the signal to be lost because of terrain interrupting the line of sight. In these cases, just track to the last location and the signal can be automatically re-acquired.

Lost Rocket Capability (future feature)

Monitoring Other Rockets (future feature)

Data Logging (future feature)

Spoken telemetry (future feature)

Mapping (future feature)

Troubleshooting

Units not seen in device list or scan page
1. Make sure that both units are powered (verify by watching for LEDs)
2. Verify that the phone’s Bluetooth is on (look for the black Bluetooth icon in the upper right of the screen)
3. Look for a device in both the device list and the scan page

**Units show up on device list but there’s no tracker data**

1. Make sure that both units are on the same frequency, and have the same TrackerID
2. Make sure both units have antennas connected
3. Make sure that one unit is set to be a ground station and the other is a tracker
4. If the ground station is showing green flashes approx. once per second, the LoRa data link is working, so verify the BlueTooth (see above)

**Units are communicating (packet counts increasing in comm window) but the GPS information is grayed out**

1. The GPS receiver is not getting an adequate signal. Move objects away from the antenna and move to an open location with a clear view of the sky.
2. GPS acquisition can take up to a minute in good signal conditions, or several minutes in a location without a good view of the sky.