Product Manual - SparkPNT FPL

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Welcome

This is the online product manual for the SparkPNT FPL; a high-performance, precision, MFi certified, all-band GNSS RTK combination rover and base station. If this is your first time using the FPL, follow check out our Quick Start Guide for initial instructions on setting up the FPL as a base station or begin surveying with your mobile device. Again, thank you for purchasing our SparkPNT FPL!

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A quickstart guide for the FPL

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Quickstart

The FPL kit

This quick start guide will get you started in 10 minutes or less. For the full product manual, please proceed to the **Equipment Overview**.

For the purposes of this quickstart, you will only need a standard surveying pole, or camera monopod. No other parts (LoRa antenna, USB cable, etc.) are needed.

Are you using Android or iOS?

Android

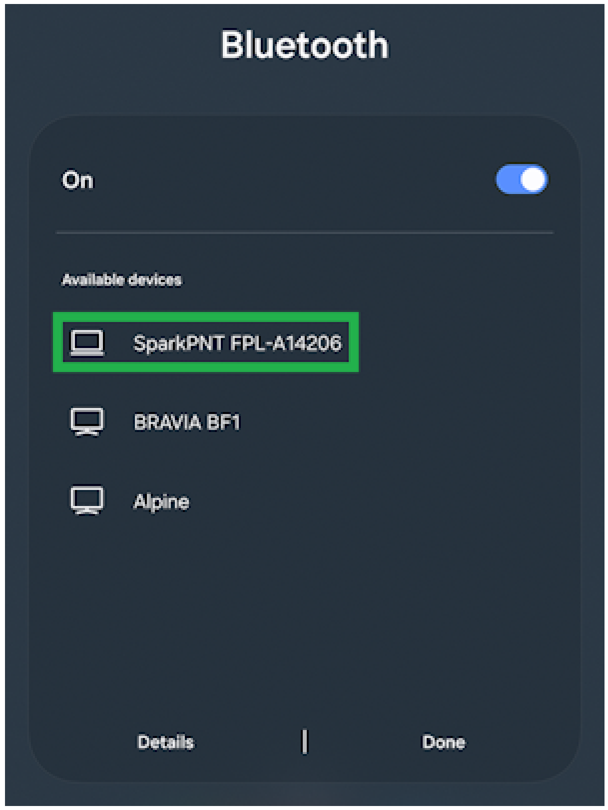
Download SW Maps for Android

1. Download SW Maps. This may not be the GIS software you intend to do your data collection, but SW Maps is free and makes sure everything is working correctly out of the box.

FPL attached to surveying pole

1. Attach the FPL to a 5/8" 11-TPI standard surveying pole or to a monopole using the included thread adapter.

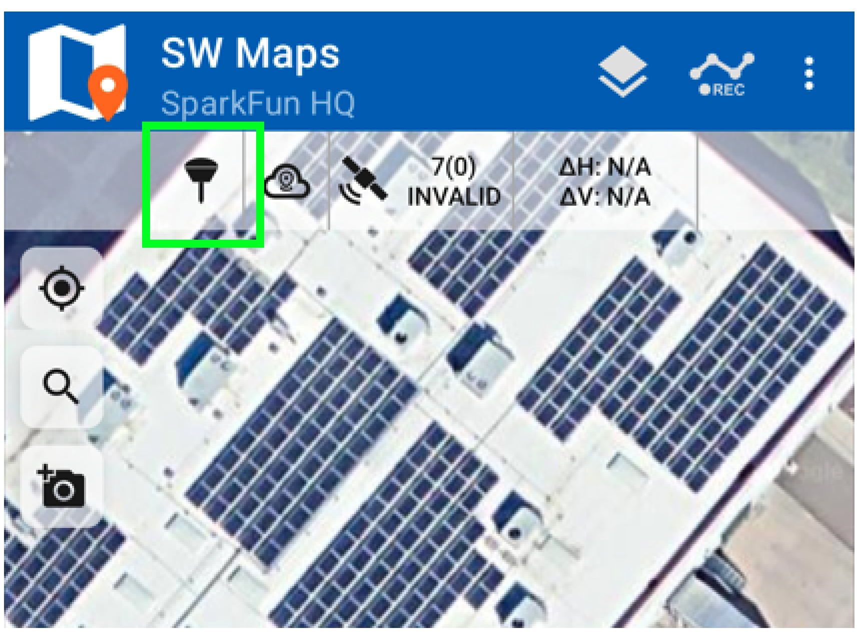
2. Turn on the FPL by pressing the Power button for 3 to 4 seconds until the display illuminates.



Bluetooth devices on Android

1. From your cell phone, open Bluetooth settings and add a new device. You will see a list of available Bluetooth devices. Select the **SparkPNT FPL-######** where the ## are the last 6 characters of the unique ID printed on the side of the device.

2. Once paired, open SW Maps. Select 'New Project' and give your project a name like *RTK Project*.



Open Receiver Settings

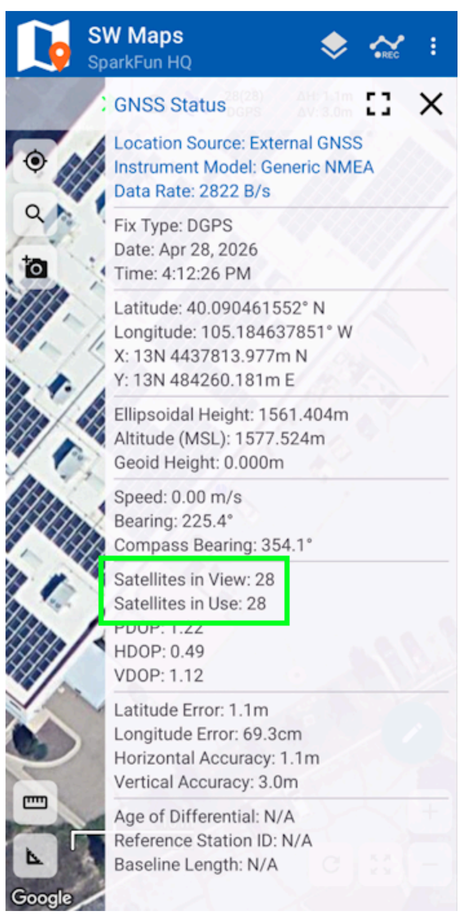
Connect to the FPL over Bluetooth

6. Press the GNSS receiver icon located next to the cloud icon in the top bar. You should see the **SparkPNT FPL-######** in the list of Bluetooth devices. Select it. Confirm that the *Instrument Model* is **Generic NMEA**, then press the `Connect` button in the bottom right corner. SW Maps will show a warning that the instrument height is 0m. That's ok.

A rover with RTK Fix and logging

7. Once connected, you should see the Bluetooth icon appear on the FPL's display. Below is a breakdown of the common icons:

- **A142** - Bluetooth MAC address used during pairing to identify the device. This is also printed on the side of the device as part of the Device ID.
- **Bluetooth Symbol** - A remote device is currently connected to the FPL over Bluetooth.
- **Down Arrow** - Correction data is detected. This is a good indicator that RTCM is correctly being received.
- **Battery Gauge** - Relative level of battery capacity remaining from 100% (three bars) to nearly exhausted (no bars).
- **Double Cross-Hair** - Estimated horizontal positional accuracy of the device in meters. A solid double cross hair icon indicates an RTK Fix.
- **Satellite Dish** - Satellites in view. Used as a general indicator of how well the device is receiving GNSS signals. This varies between 20 to 40 satellites. A satellite dish with a 'P' indicates PPP reception is enabled.
- **Bluetooth Symbol in Lower Right Corner** - Corrections can come from a variety of sources. This icon indicates the corrections being used by the GNSS receiver. In this case, corrections over Bluetooth are being used.
- **Document** - This animated icon indicates when data is being logged to microSD.



SW Maps showing SIV

8. Now put the device outside with a clear view of the sky. GNSS doesn't work indoors or near windows. Press the SW Maps icon in the top left corner of the home screen and select **GNSS Status**. Within about 30 seconds you should see 10 or more satellites in view (SIV) (see above). More SIV is better. We regularly see 30 or more SIV. The horizontal positional accuracy (HPA) will start at around 10 meters and begin to decrease. The lower the HPA the more accurate your position. This accuracy should be below 1m in normal mode.

Press the target icon in the top-left corner of the map to view your position.

You can now use your FPL to measure points with meter accuracy. If you need extreme accuracy (down to 8mm) continue reading the Corrections section.

iOS

Download SW Maps for iOS

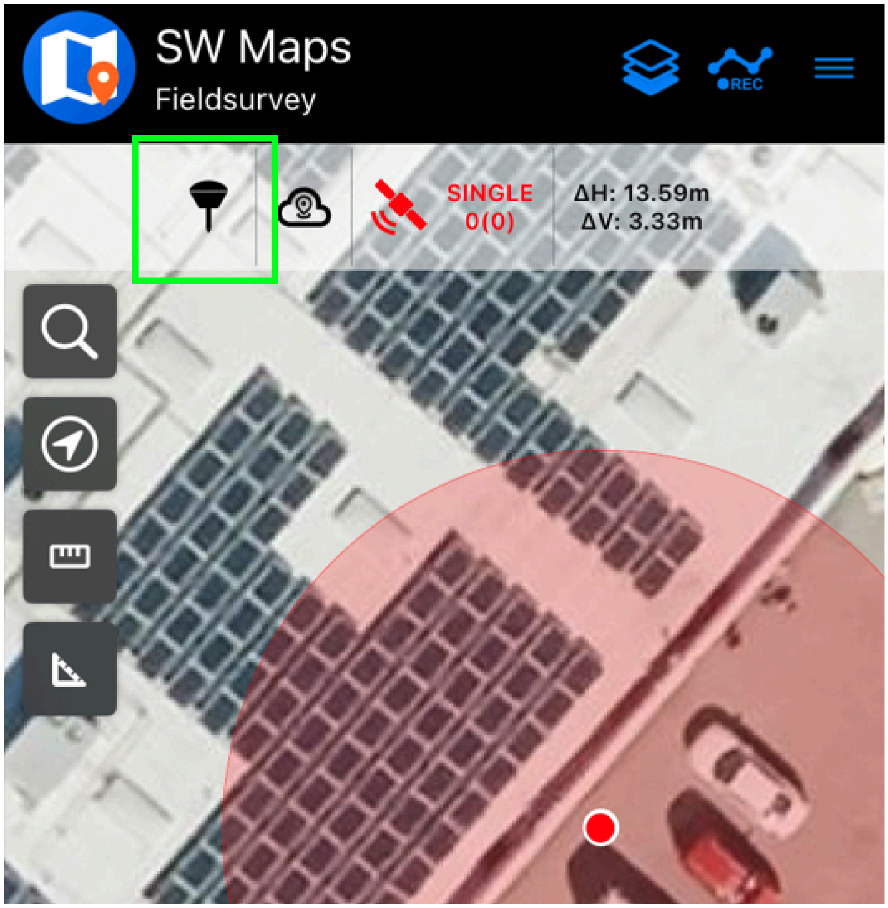
1. Download SW Maps for iOS. This may not be the GIS software you intend to do your data collection, but SW Maps is free and makes sure everything is working correctly out of the box.

FPL attached to surveying pole

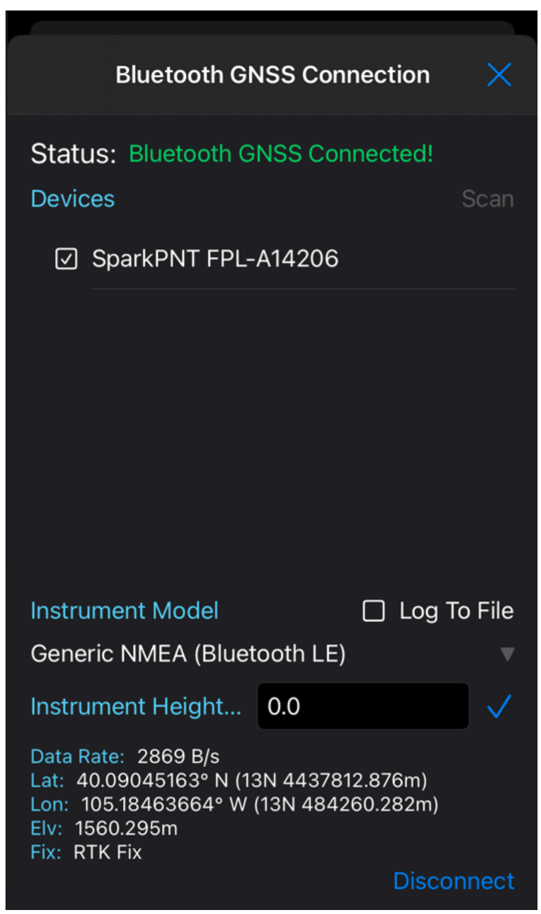
1. Attach the FPL to a 5/8" 11-TPI standard surveying pole or to a monopole using the included 5/8" to 1/4" thread adapter if needed.

2. Turn on the FPL by pressing the (⏻) power button for 3 to 4 seconds until the display illuminates.

3. Open SW Maps. Select ‘New Project’ and give your project a name like ‘RTK Project’.



Open Receiver Settings



Connect to the FPL over Bluetooth

5. Press the GNSS receiver icon located next to the cloud icon in the top bar. You will need to agree to allow a Bluetooth connection. Set the *Instrument Model* to **Generic NMEA (Bluetooth LE)**. Press **Scan** and you should see the **SparkPNT FPL-######** in the list of Bluetooth devices. Select it then press the ‘Connect’ button in the bottom right corner.

A rover with RTK Fix and logging

6. Once connected, you should see the Bluetooth icon appear on the FPL's display. Below is a breakdown of the common icons:

- **A142** - Bluetooth MAC address used during pairing to identify the device. This is also printed on the side of the device as part of the Device ID.
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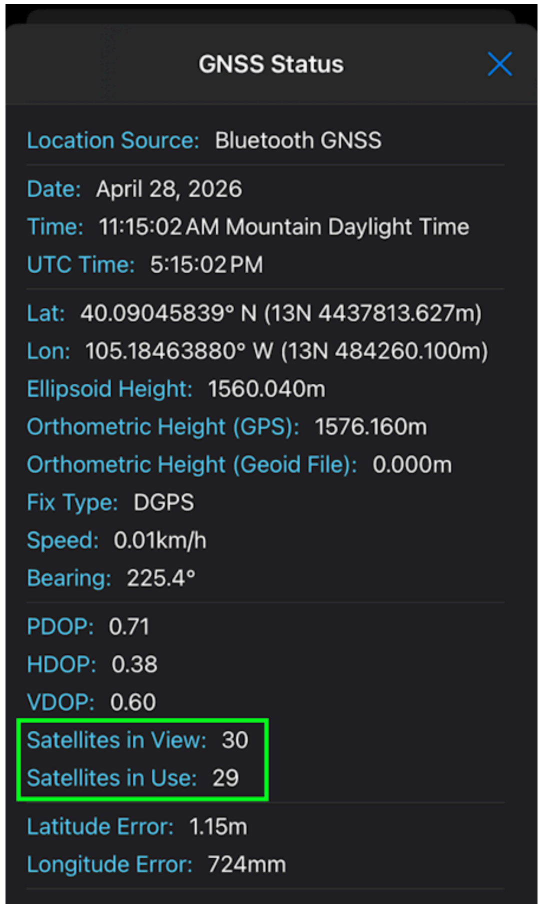
Bluetooth are being used.

- **Document** - This animated icon indicates when data is being logged to microSD.



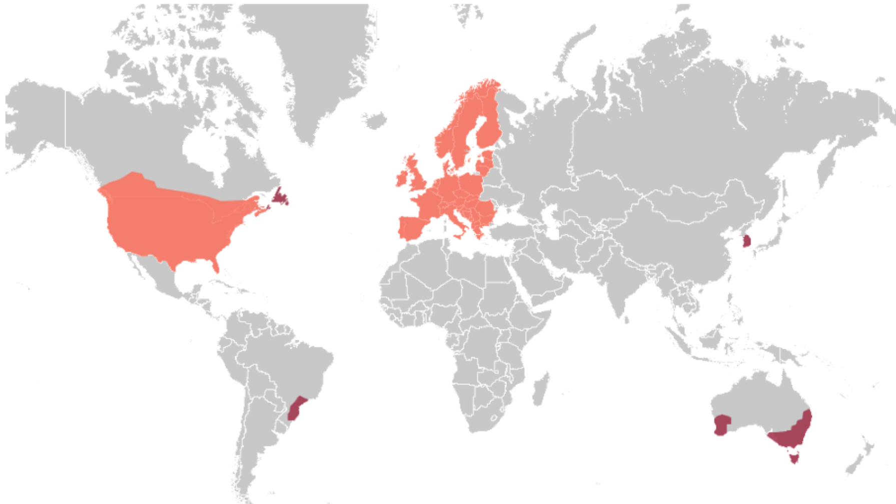
SW Maps showing SIV

7. Now put the device outside with a clear view of the sky. GNSS doesn't work indoors or near windows. Press the SW Maps icon in the top left corner of the home screen and select **GNSS Status**. Within about 30 seconds you should see 10 or more satellites in view (SIV) (see above). More SIV is better. We regularly see 30 or more SIV. The horizontal positional accuracy (HPA) will start at around 10 meters and begin to decrease. The lower the HPA the more accurate your position. This accuracy should be below 1m in normal mode.

You can now use your FPL to measure points with meter accuracy. If you need extreme accuracy (down to 8mm) continue reading the Corrections section.

Corrections

To get millimeter accuracy we need to provide the FPL with correction values. See Corrections Sources for a breakdown of the options and the pros and cons of each. For this quickstart, we'll be showing how to use PointPerfect Flex for $15 a month.



PointPerfect Flex Coverage Map

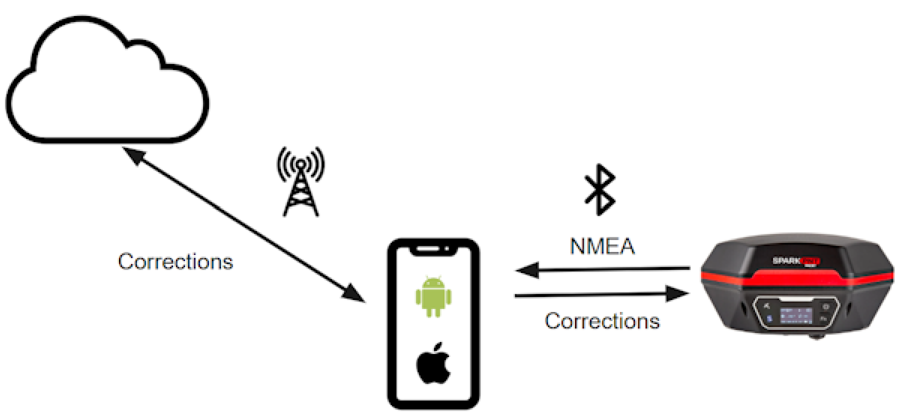
Getting Access

PointPerfect Flex over NTRIP requires a set of user name, password, and mount point credentials. Please register here to setup a monthly subscription. Most device purchases come with a trial month if you want to try it out.

An *NTRIP Client* is a small app that connects to the corrections server to get the corrections. Most GIS apps have an NTRIP Client built in.

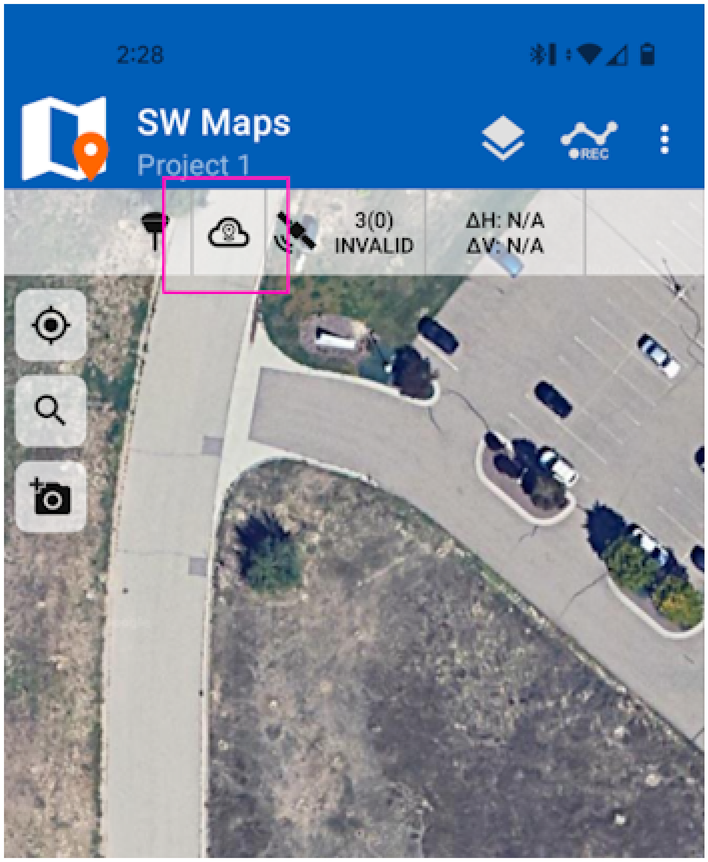
NTRIP Client

The easiest way is to use the service is with a cell phone. For this example, we'll use a phone with SW Maps but any GIS app with a built-in NTRIP Client (most do) can connect to PointPerfect.



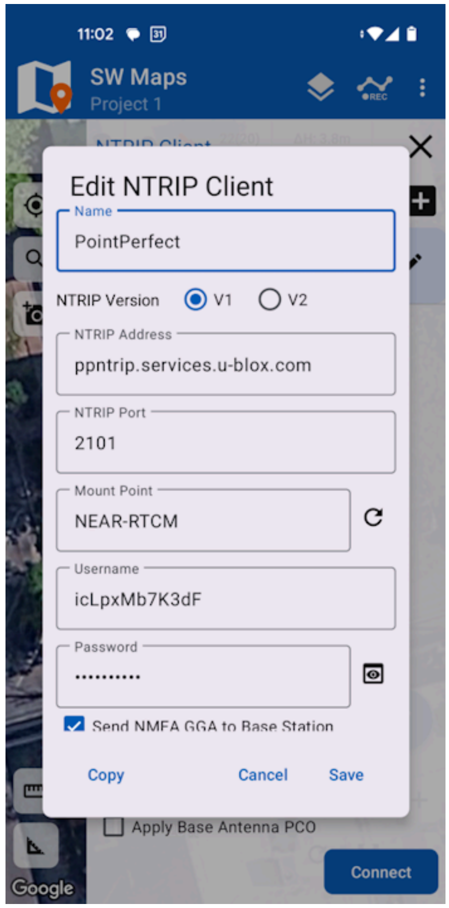
How corrections flow from NTRIP to Bluetooth

In the above image, the phone is running the NTRIP Client and the corrections are downloaded from the internet using the phone's cellular connection. Those connections are sent over Bluetooth to the FPL. The FPL gets a high-precision solution and transmits the GPS location back to the phone over Bluetooth. The phone displays the location in an app allowing work to be done.



Opening NTRIP Client settings

Above, in SW Maps select the NTRIP Client. This is the small cloud icon.

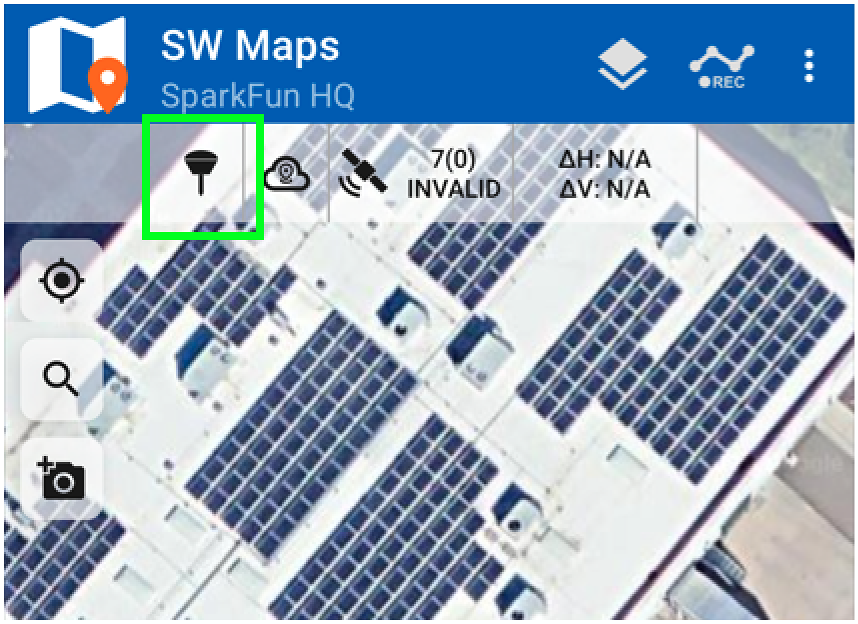


Entering NTRIP credentials

In the NTRIP Client detail window, enter the following information:

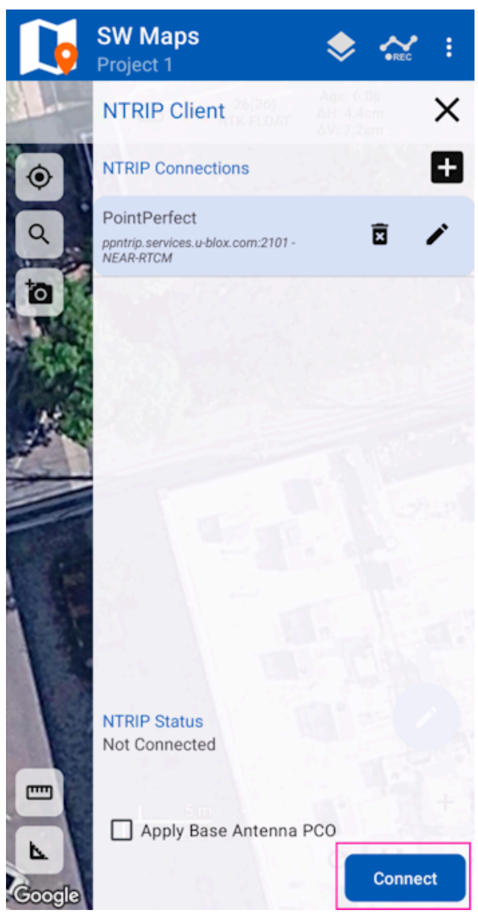
- NTRIP Version: V1
- NTRIP Server: ppntrip.services.u-blox.com
- NTRIP Port: 2101
- Mount Point: NEAR-RTCM
- Username: (provided when service was set up)
- Password: (provided when service was set up)
- Send NMEA GGA to Base Station: Please confirm this option is checked

The information can be copy/pasted from email or manually entered. Be careful to enter the data correctly. Once the credentials are entered, click Save and then Exit the NTRIP Client details window.



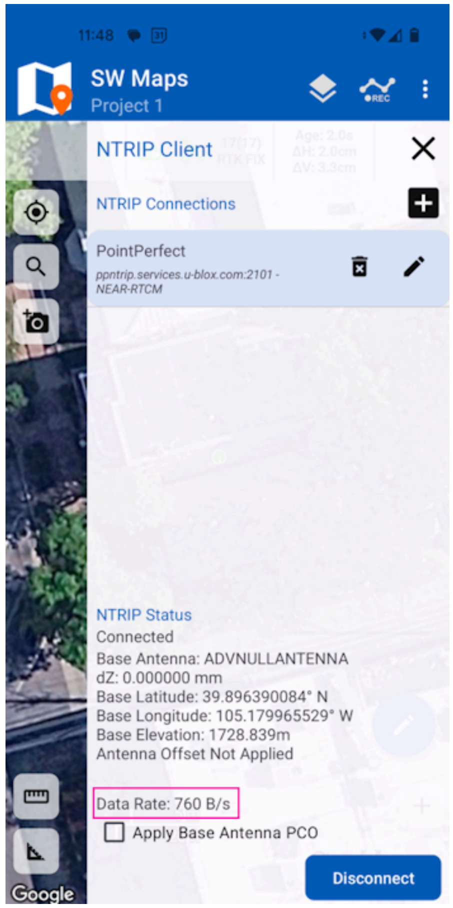
Open Receiver Settings

Next, if the GNSS receiver is not already connected, turn on the FPL and connect to it over Bluetooth by clicking on the receiver button (shown above).



List of NTRIP Clients and connect button

Once the receiver is connected, tap the NTRIP Client (cloud) icon again to open the menu. A list of clients will be shown, select the one you just entered and click 'Connect'.

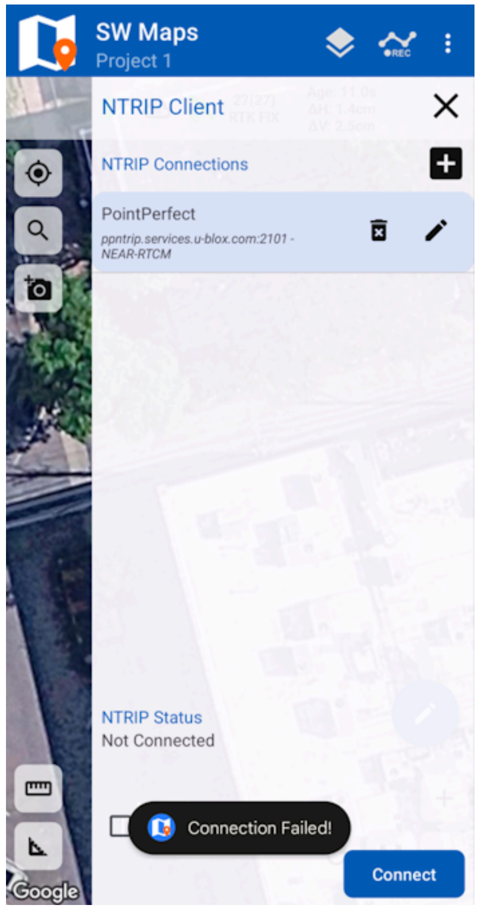


Data rate is more than 0 bytes per second

Confirm that the Data Rate section shows more than 0 bytes per second over a few seconds. The number will bounce around, but every second a few hundred bytes of correction data should be downloaded and sent to the FPL over Bluetooth. This indicates the NTRIP connection was successful.

Success! RTK Fix!

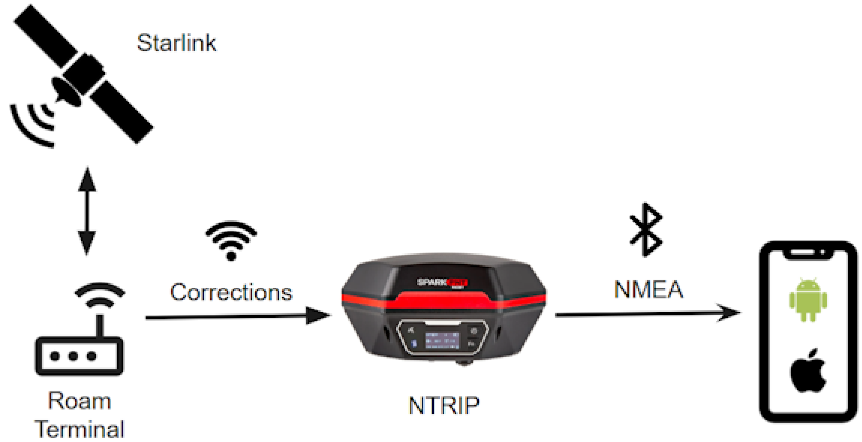
Close the NTRIP Client window returning to the main app screen and proceed outdoors and get a clear view of the sky. Above we see a successful high-precision RTK Fix with 16mm horizontal accuracy. Now you can proceed with GIS work.



NTRIP connection failure due to incorrect credentials

Above, if you get a 'Connection Failed' error it is likely that username or password was incorrect. Double check you credentials and try again.

Remote Work



How corrections flow using WiFi and Starlink to Bluetooth

What if you don't have cellular connectivity? Corrections can be obtained over any internet connection. Starlink Roam or Eutelsat KONNECT can provide internet over satellite. Once WiFi is available at the job site the FPL can be configured to connect to WiFi and get the corrections over its built-in NTRIP Client. See the NTRIP Client docs for more information.

Common Gotchas

- High-precision GNSS works best with a clear view of the sky; it does not work indoors or near a window. GNSS performance is generally *not* affected by clouds or storms. Trees and buildings *can* degrade performance but usually only in very thick canopies or very near tall building walls. GNSS reception is very possible in dense urban centers with skyscrapers but high-precision RTK may be impossible.

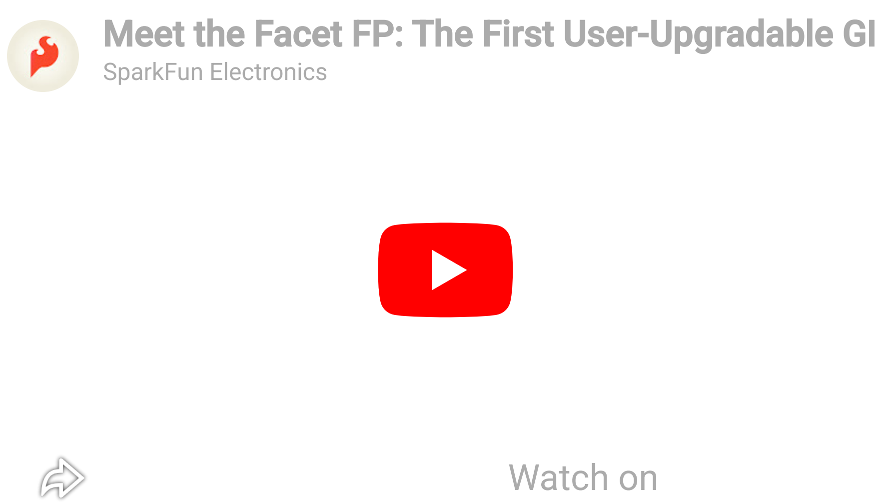
- The location reported by the FPL is the location of the antenna element; it's *not* the location of the pointy end of the stick. Lat and Long are fairly easy to obtain but if you're capturing altitude be sure to do additional reading on ARPs (antenna reference points) and how to account for the antenna height in your data collection software. The FPL's APC is 58.3mm. More information on the APC is here.

> **NOTE**
>
> This rule does not apply when tilt compensation is activated. See the Tilt Compensation for more information.

- An internet connection is required for most types of RTK. RTCM corrections can be transmitted over other types of connections (such as serial telemetry radios). See Correction Transport for more details.

Equipment Overview

The SparkPNT FPL is a cost-effective, rugged, MFi certified, all-band GNSS RTK surveying unit. Unlike other high-precision RTK surveying devices, the GNSS receiver inside of SparkPNT FPL can be easily upgraded to meet your performance requirements, match the capabilities of your fleet, or when GNSS technology improves. The FPL provides Bluetooth and WiFi connectivity to any mobile device, including Apple iOS devices with its MFi certification. We have also included a built-in 1W 915MHz LoRa radio, to transmit/receive RTK corrections directly with other line-of-sight units up to 16km (>10mi) away.



- When it comes to fleet management, configuring another device is as simple as swapping out the SD card; gone are the days of needing to copy/paste credentials and settings.
- To start surveying positions, simply pair with the FPL on any smartphone or tablet, open your preferred GIS app, and access their NTRIP corrections service using the internet/cellular connection of your mobile device.
- The SparkPNT FPL can also operate as a base station, to broadcast RTCM corrections and function as an NTRIP Caster/Server.
    - When working on a tight deadline, users can also implement our `Base Assist` function to automatically configure the base station's position in minutes. Great for scenarios, where only relatively accuracte measurements are required and not the absolute accuracy of their global position; such as surveying the layout of a building.
    - Using its WiFi capabilities, users can configure the FPL to operate as an NTRIP Caster/Server on a local WiFi network, be used as an access point, or even connect to another SparkPNT

device directly using the WiFi 2.4GHz transceiver, great for regions where the 915MHz radio can't be utilized.

> **GALILEO HIGH ACCURACY SERVICE**
>
> With built-in HAS reception on the FPL, users can operate in remote locations with no cellular or internet access. These corrections require about 15 minutes for the PPP algorithm to converge on a solution that has better than 20cm (8 inches) of accuracy. The corrections are free, provided over the Galileo GNSS constellation, and have global coverage. If internet access is available at your worksite we still recommend using land-based corrections for *much* better accuracy and faster RTK Fix times. Consider HAS to be a slow but ok backup when there is no internet.

This is all housed in an IP67 rated enclosure and constructed with an anodized die-cast magnesium body and a fracture resistant fiberglass dome. The entire kit ships in a hard-sided case with all the accessories needed to start work. We've even included extra silicon bumpers to facilitate unit identification and repair.

> **INFO**
>
> Tilt compensation is not supported by this device.

Parts List

The SparkPNT FPL comes shipped inside a hard-sided carrying case with all the accessories need for users to get right to work. Below, is an overview of all the included parts:

All the parts included in the kit.

The individual components laid outside of the carrying case.

1. Carrying Case
2. SparkPNT FPL
3. Silicone bumper set
4. USB-C Cable
5. USB-C Charger (65W)
6. Thread Adapter (1/4" to 5/8")
7. LoRa Antenna (915MHz, 2dBi)

Carrying Case

The FPL comes with a hard-sided case that includes two holes for pad locks (with shackles up to **6mm** in diameter) to keep your equipment secure.

The hard-sided carrying case.

TIP

We recommend limiting the shackle diameter to less than **6mm**; a 1/4" (6.35mm) shackle will not fit without modifying the case.

Enclosure

The FPL features a die-cast magnesium body with a fracture resistant fiberglass dome. The enclosure is IP67 rated and is waterproof to 1 meter, for up to 30 minutes.

The enclosure of the FPL.

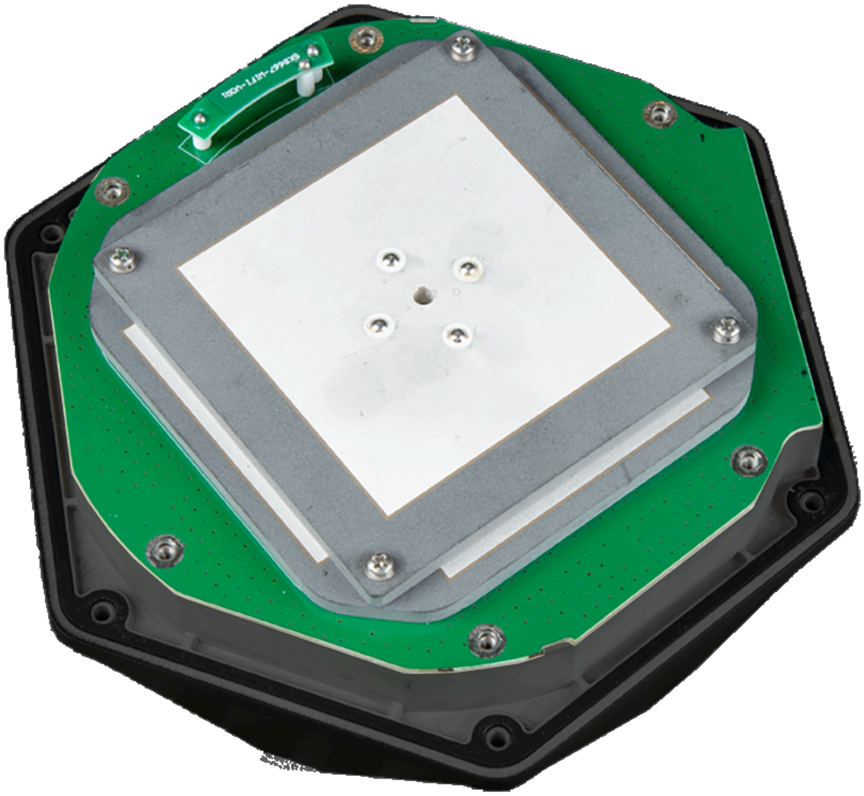
WARNING

The device should not be considered IP67 waterproof if the LoRa antenna is attached or any of the ports on the bottom are exposed. The rubber covers need to be fully seated, cover for the JST/SD card slot attached, and the TNC connector capped for the enclosure to qualify for the IP67 ingress protection rating.

The data interfaces on the bottom of the FPL, covered for the IP67 rating.

GNSS Antenna

Underneath its fiberglass dome, the FPL features a specially tuned multi-frequency (L1/L2/L5) GNSS antenna combined with a 2.4GHz BT/WiFi antenna.

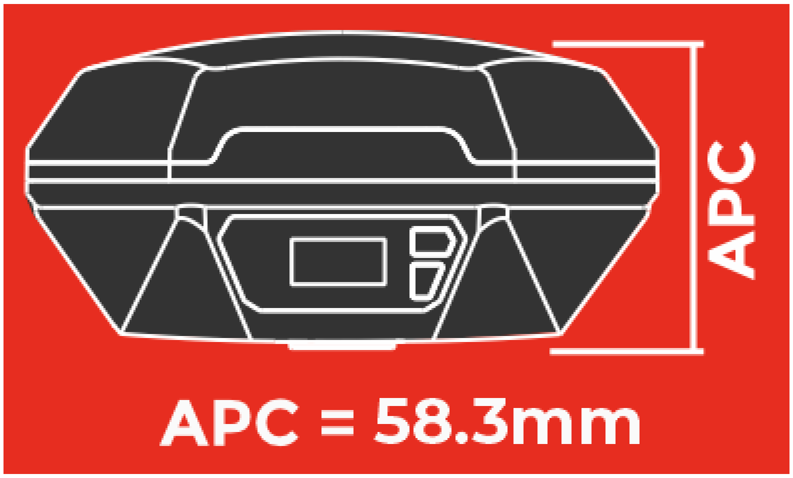


The primary L1, L2, L5 ceramic antenna inside the FPL.

> **TIP**
>
> Don't forget that GNSS signals are weak and can't penetrate buildings or dense vegetation. The GNSS antenna should have an unobstructed view of the sky.

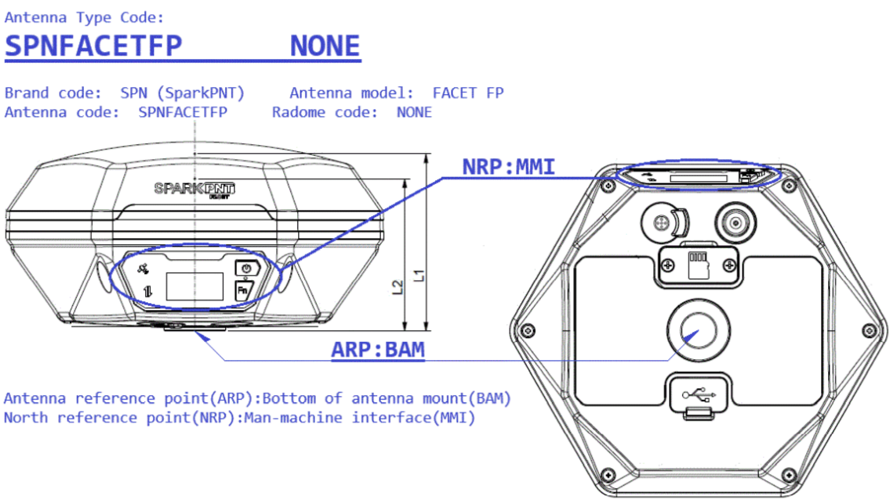
APC and NRP

The threaded mounting point at the bottom of the device serves as the device's ARP (antenna reference point). The FP has been calibrated by the NGS and the ANTEX and ANTINFO files are available.



The FPL's average APC is 58.3mm

The distance between the ARP on the FPL to the L1 APC (antenna phase center) is **65.7mm** and **50.9mm** to the L2/L5 APC. When calculating the total instrument height (pole length + APC), it is recommended to use the average between the L1 and L2 APCs which is **58.3mm**. A common pole length is 1.8m, with an APC of 58.3mm the total instrument height is **1.858m**. Enter this value into your GIS app to obtain the altitude of the point *at the tip of the pole* rather than the altitude *at the antenna element*.



The antenna reference point and north reference point on the FPL.

The display serves as the device's NRP (north reference point).

Mount Point

The bottom of the FPL features a standard 5/8"-11 TPI threaded mount point. This is commonly found on surveying equipment and is compatible with most surveying poles. For additional mounting options (ie, camera camera mounts and tripods), the kit includes a 1/4" adapter.

The 5/8"-11 TPI threaded insert on the base of the FPL.

> **INFO**
>
> The center of the threaded insert, on the plane of the device's base, serves at the ARP (antenna reference point) for the device.

Power

To power on the device, hold the (⏻) power button for a few seconds: the device will illuminate the display and beep once. To power down the device, hold the (⏻) power button for a few seconds: the device will show 'Shutting Down...' and beep three times.

Power button on the front of the device.

Battery and Charging

Users can access the USB-C port under the rubber cover on the bottom of the device.

- **Battery Charging** - The FPL supports standard USB charging and can be charged from nearly any device that has a USB port. A red LED on the front display will turn on during charging and turn off when complete. A fully dead battery will charge in about 24 hours.

- **Battery Capacity** - The FPL includes a 7.2V 6.8Ahr (48.96Whr) battery. This should allow the device to run continuously for more than 50 hours, in worst-case conditions.

OLED Display

The user interface features a 1-inch high-contrast OLED display, three status LED indicators, and two user buttons. The display is used for a variety of status indicators and provide a means to navigate the configuration menu. See the Display section for more information.

The OLED display on the FPL.

> **INFO**
>
> The user interface also serves at the NRP (north reference point) for the device.

Buttons

There are two user buttons that can be used to turn the FPL on /off or navigate the menus displayed on the OLED screen.

- Power the device on or off:
  - Hold the (⏻) power button for a few seconds: the device will illuminate the display and beep once. To power down the device, hold the (⏻) power button for a few seconds: the

device will show 'Shutting Down...' and beep three times.

- Navigate menu:
    - Open menu: From the main screen, press the (Fn) function button once to open the navigation menu.
    - Move down/next option: Press the (Fn) function button navigate down to the next option on the menu of the OLED display.
    - Select option/navigate into the sub-menu: Press the (⏻) power button to select an option or navigate into its sub-menu.

The buttons on the front of the device.

Indicators

The FPL also features three LED status indicators and an internal buzzer for audio feedback to the user.

Status LEDS

There are three LED status indicators on the front of the FPL.

The LED status indicators on the FPL.

- The GNSS icon () indicates the GNSS pulse-per-second.
  - The green LED will blink once per second when a GNSS fix is achieved.
- The Connection icon (↑↓) indicates the Bluetooth connection status.
  - The blue LED blinks once per second while waiting for a connection.
  - The blue LED will turn solid once a Bluetooth connection is made.
- The Battery charge LED is located below the power button.
  - The red LED will illuminate when attached to a charger.
  - The LED will turn off when charging is complete.

Buzzer

The FPL also includes an internal buzzer that provides audio feedback for the user. The following prompts are provided:

- Power On: Beep once
- Power Off: Beep three times
- On versions that have tilt, the buzzer will beep periodically when tilt compensation is active.

Data/Communication Connections

There are multiple data and communication connectors on the bottom of the FPL: microSD card slot, locking JST data interface, Lemo-compatible data interface, USB-C, and TNC. The microSD card slot and JST connector are both enclosed under the same cover.

The data and communication interfaces on the bottom of the FPL.

> ⚠ **WARNING**
>
> The device should not be considered as IP67 waterproof if the LoRa antenna is attached or any of the ports on the bottom are exposed. The rubber covers need to be fully seated, cover for the JST/SD card slot secured, and the TNC connector capped for the enclosure to qualify for the IP67 ingress protection rating.

USB Connector

Users can access the USB-C port under the rubber cover on the bottom of the FPL.

Users can access the USB-C port under the rubber cover on the bottom of the FPL.

- The USB-C port is most commonly accessed to charge the battery. The FPL supports standard USB charging and can be charged from nearly any device that has a USB port. A red LED on the front display will turn on during charging and turn off when complete. A fully dead battery will charge in about 24 hours.
- For more advanced users, this port can be utilized to configure the FPL, update the device and GNSS receiver firmware, and/or retrieve a diagnosis report for troubleshooting.

When connecting to the USB interface of the SparkPNT FPL to a computer, the device should automatically be detected as two COM ports. If the ports are not detected then users will need to install a USB driver to access the data or configure any settings.

> **USB DRIVER**
>
> The USB drivers for the CH342 USB-to-Serial converter can be downloaded below:
>
> - **Windows:** **Download Page for `CH343SER.EXE`**
> - **MacOS:** **Download Page for `CH341SER_MAC.ZIP`**

- 🐧 **Linux:** A USB driver is not required for most Linux based operating systems

microSD Card

The microSD card slot and JST-GH connector are covered under the same access port. To access these interfaces, unscrew and remove the cover piece. Users can insert a microSD card that is formatted with `FAT32` for cards up to 32GB, or `exFat` for cards up to 512GB. The SD card can be used to transfer user profiles between devices, log data points, and store diagnostic reports.

If a microSD card is detected, the FPL settings will be overwritten by the settings file on the card. This allows a 'golden card' to be used to reprogram a series of units and can be helpful for fleet management. A factory reset will clear the settings on the device and any setting file on the card.

The SD card slot on the bottom of the FPL.

Lemo Connector

The 5-pin Lemo-style locking connector is provided to connect the SparkPNT FPL using RS232 level serial. The connector is compatible with the interface cable. This cable can be left permanently attached allowing the device to be deployed remotely while maintaining a connection for data retrieval and device configuration. The unit remains IP66 waterproof (protected against jets of water in all directions) but cannot be submerged with this cover open.

The Lemo-style connector on the bottom of the FPL.

> **TIP**
>
> The pin connections from the SparkPNT FPL to the wires in the interface cable are listed below:
>
> - Red: `VIN` (**6VDC to 20VDC**)
> - Yellow: `RX` - RTCM and configuration data into the device in RS232 serial.
> - White: `TX` - NMEA and RTCM data output from the device in RS232 serial.
> - Black: `GND`

JST Connector

The JST interface allows communication over low-voltage TTL serial. This can be useful for connecting external high-power radios or embedded systems.

NOTE

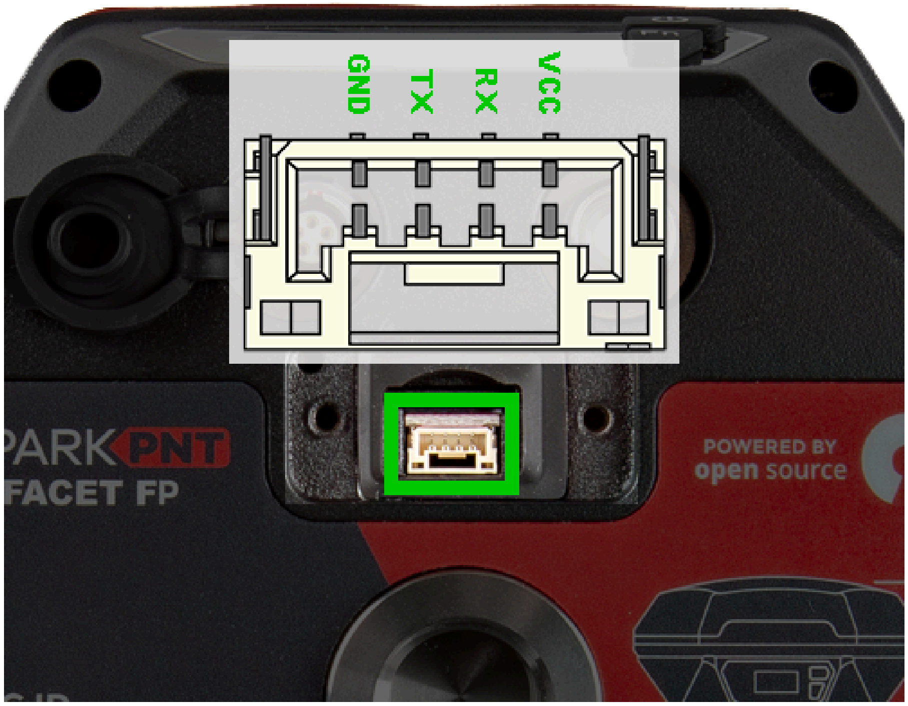
The JST connector is not recommended for long term installations as it allows water penetration. Use the Lemo-compatible connection for a waterproof connection.

The JST-GH connector on the bottom of the FPL.

TIP

The pin connections from the SparkPNT FPL to the JST wires in the JST-GHR cable are listed below:

- Red: `VIN` (**3.3VDC**)
- Green: `TX` - NMEA and RTCM data output from the device in TTL serial.
- Orange: `RX` - RTCM and configuration data into the device in TTL serial.
- Black: `GND`



The connector pinout on the FPL.

TNC Connector

The built-in LoRa radio is primarily utilized to transmit and receive RTCM corrections. For the 1W LoRa transceiver to function, users need to connect the 2dBi 915MHz whip antenna to the TNC connector on the bottom of the FPL and enable the radio setting. Running the radio *without* the antenna will not harm the unit, but ti is not recommended. When not in use, the rubber cover should be replaced on the connector to maintain the IP67 ingress rating of the enclosure.

The TNC connector on the bottom of the FPL.

The antenna screws on, finger tight, and can be used pointing straight down or at an angle as needed.

The SparkPNT FPL with LoRa antenna attached.

Specifications

- Antenna
  - L1, L2, L5, L6
    - Gain: ≥2.3dBi
    - APC (NGS Calibrated ANTEX ANTINFO):
      - L1: 65.7mm
      - L2/L5: 50.9mm
      - Average: 58.3mm
  - WiFi/Bluetooth (SPP and BLE)
    - 2.4GHz
- Enclosure
  - Ingress Protection: IP67 (1m of water for 30 minutes)
  - Materials: Magnesium body w/ fiberglass dome
  - Dual button menu system
  - Three LED indicators
  - USB-C port
  - microSD for data logging
  - TNC for 1W LoRa Radio
  - 5-pin Lemo-compatible connector for RS232 communication
  - 4-pin JST connector for TTL communication
- Battery
  - Specs: 7.2V 6800mAh (48.96Whr)
  - Charging: 2W maximum
  - Run Time: 50hrs
- Dimensions: 71 x 71 x 147mm (2.8 x 2.8 x 5.8in)
- Weight: 423g (0.93 lbs)

Equipment Setup

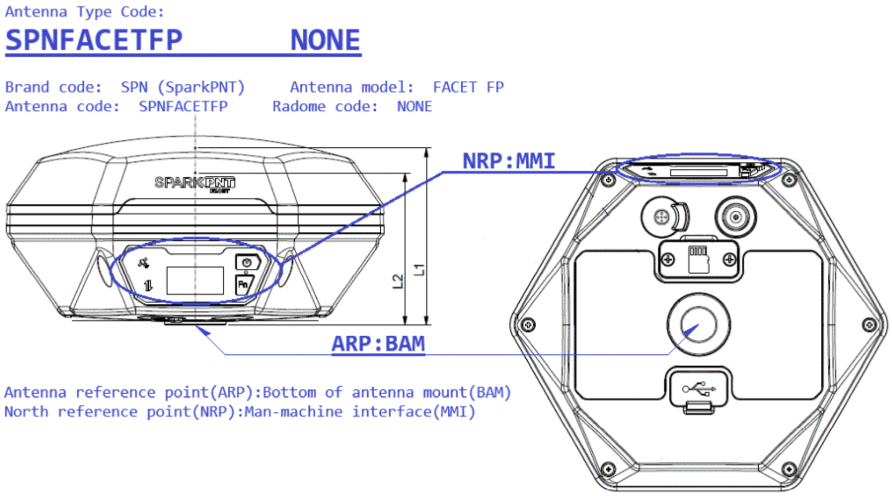
Time to get the FPL outside with a clear view of the sky!

The FPL has a standard 5/8" 11-TPI threaded base and is compatible with most surveying equipment. Users may elect to mount their mobile device (i.e. phone, laptop, or tablet) to the surveying equipment for ease of operation.

The SparkPNT FPL attached to a surveying pole.

Orientation and Alignment

For the most accurate positioning, users should align their device as vertically straight as possible using a bubble level or other leveling technique. For extreme accuracy, the FPL was calibrated by the NGS having the user interface (the device's display) facing north as defined by the device's north reference point.



The antenna reference point and north reference point of the FPL.

To correctly capture the altitude of points of interest, users should provide the pole height and distance between the ARP and APC to their GIS app. This will allow the altitude of the gathered point to be correctly calculated to the pole's point location on the ground. The FPL's antenna phase center (APC) is 58.3mm. Most users will extend their pole to 1.8m, so the resulting instrument height is 1.8m + 0.058m = 1.858m.

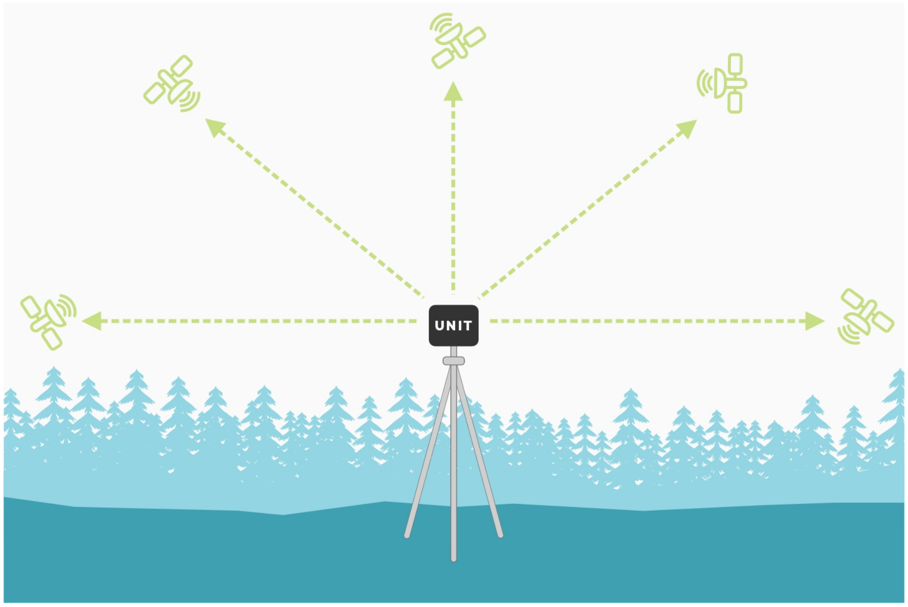
Placement and Surroundings

This section provides general placement considerations for accurate GNSS surveying. Below, are some useful examples of ideal locations for surveying.

- Ideal locations
  - Open fields
  - Hilltops
- Poor locations
  - Canyons and valleys
  - Cities or dense urban areas
  - Dense foliage

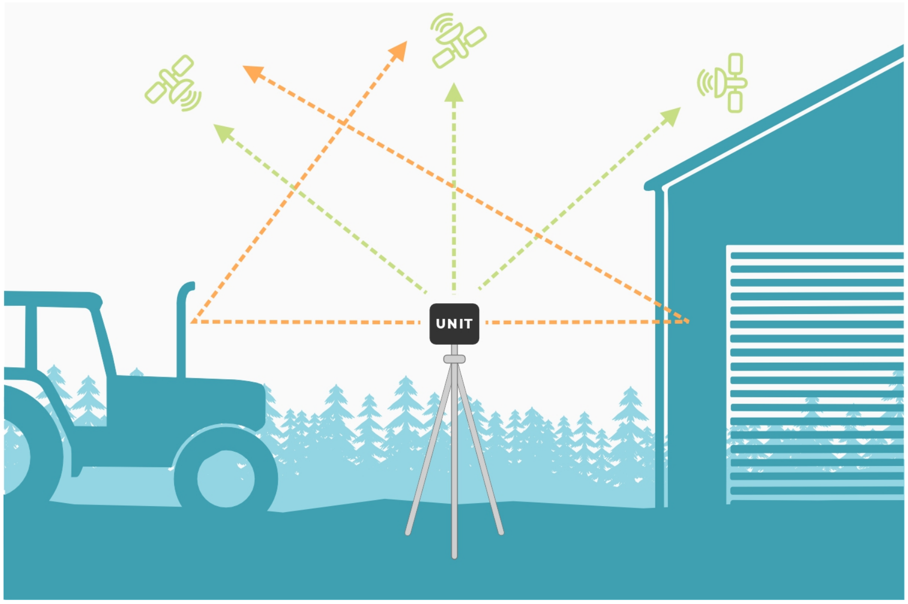
Obstructions and Multipath

For accurate GNSS surveying, the receiver works best with a wide-open, unobstructed view of the sky.



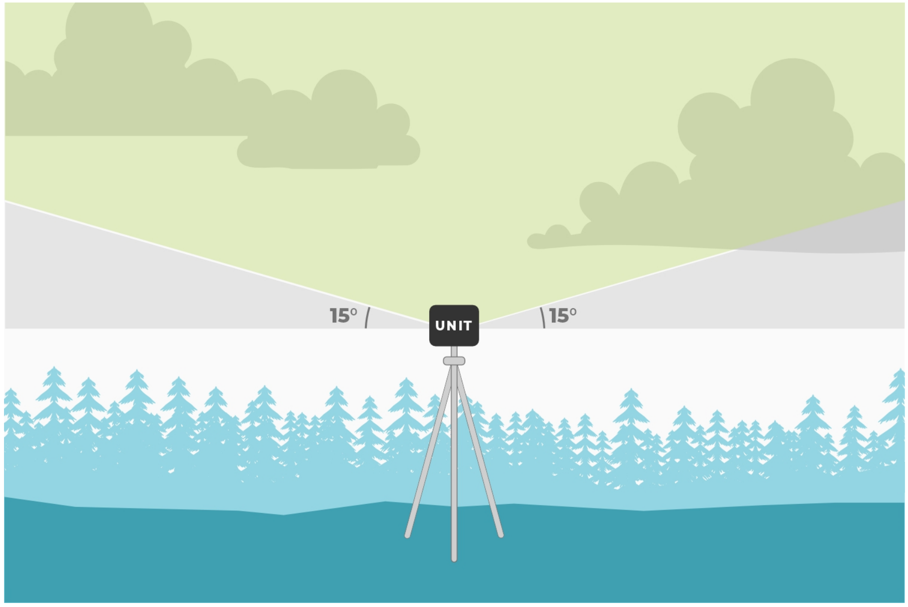
A wide-open, unobstructed view of the sky offers increased accuracy.

Obstructions can bounce signals causing 'multipath' errors. This introduces timing errors decreasing the accuracy of the receiver.



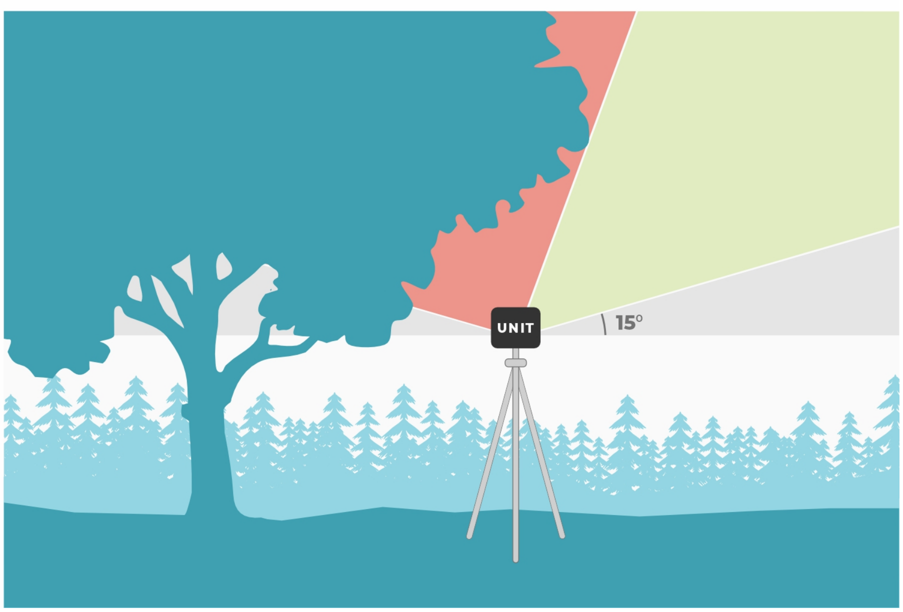
The increased signal paths introduce accuracy errors into the solution provided by the GNSS receiver.

All satellite signals must pass through the Earth's atmosphere. Any disturbance in that path (ionospheric turbulence) adds to solution errors. By default, the FPL ignores any signals from satellites positioned below, 15° above its horizon (see image). This helps reduce errors introduced from signals from low satellites having to pass through the thicker atmosphere. This setting can be *increased* to remove additional low lying signals as needed.



The FPL ignores any signals from the horizon (< 15°) and only accepts signals from above (green).

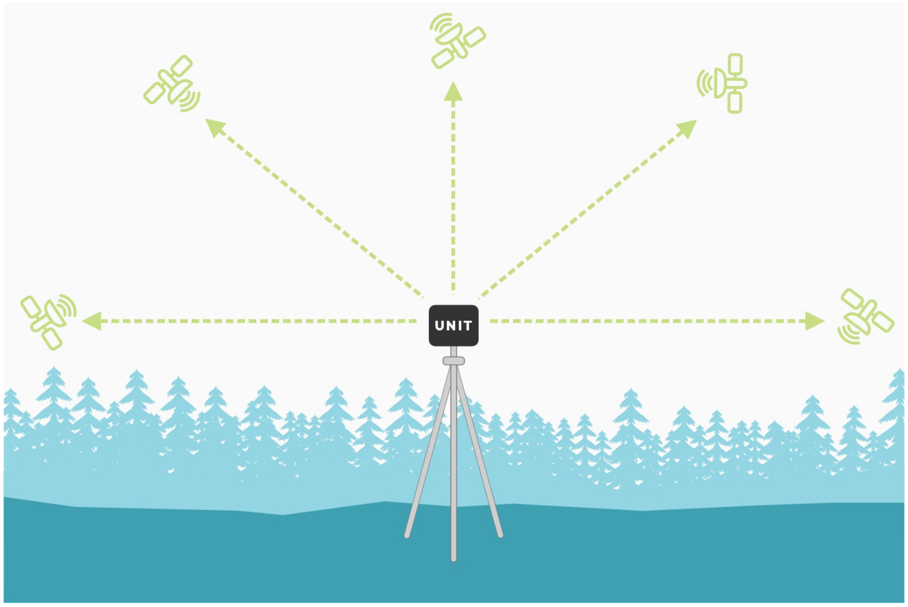
Obstructions can also reduce the strength of incoming satellite signals. By default, the FPL ignores signals lower than 10dBHz. This helps reduce errors introduced from weak signals. This setting can be *increased* to remove additional low signal strength satellites as needed.



Obstructions reduce the distribution and number of satellites used in solutions.

Dilution of Precision

The geometric arrangement of satellites, significantly influences the accuracy of GNSS solutions. A well-distributed arrangement of satellites allows for more accurate positioning by minimizing errors related to signal distortion and multipath effects. When satellites are positioned at wide angles relative to each other, the geometric *dilution of precision* improves, enhancing accuracy of the positioning solutions. Conversely, when satellites cluster closely together in the sky, it can lead to degradation in the geometric *dilution of precision* and less reliable positioning solutions. Therefore, optimal satellite geometry is crucial for achieving high-accuracy GNSS solutions.



A wide-open, unobstructed view of the sky offers increased accuracy.

Device Operation

Bluetooth Pairing

How to connect with your mobile device

Display

What all the indicators on the display represent

Configuration

A guide on the device settings and configuration

Corrections

A summary of correction interfaces and types

Firmware Updates

Update your device with the latest firmware

Operating Modes

The primary device functions

Radios

Using different radios to communicate between Rover/Base

Tilt Compensation

Using the tilt sensor

Advanced Topics

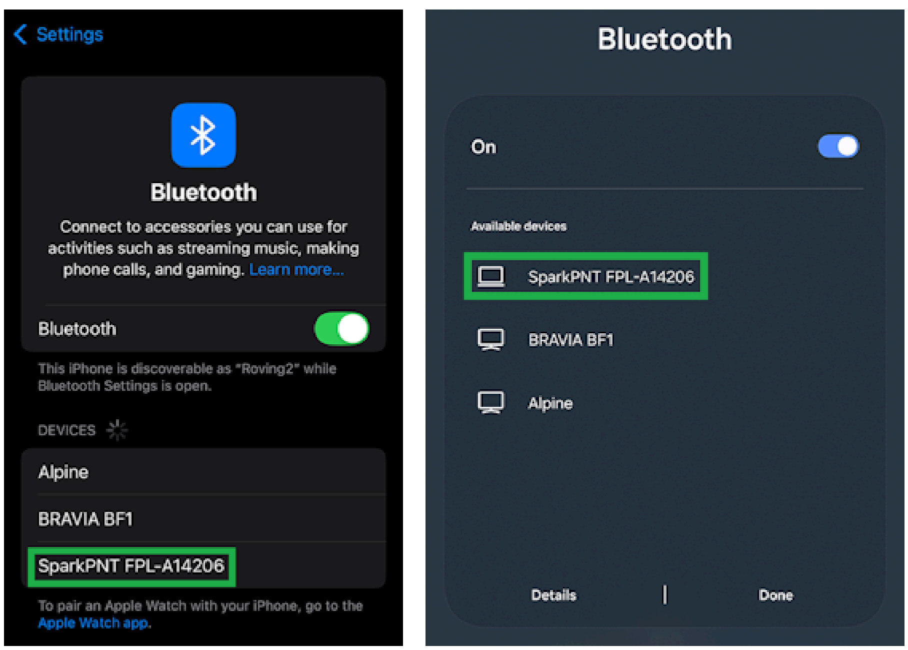
Additional features and topics

Bluetooth Pairing

In order to use the FPL with a GIS application on a phone or table, users should pair the device with their phone.

To create a Bluetooth connection, follow these steps:

1. Power the device on. Hold the (⏻) power button for more than 3 seconds. It will beep once, indicating it has turned on.
2. The Bluetooth icon (↑↓) will blink indicating it is ready for a connection.
3. On your mobile device, connect to the Bluetooth device named `SparkPNT FPL-######`; where, `######` is the last six characters of the device's ID labeled on the bottom of the device.



Bluetooth device list on iOS and Android

4. Once paired, open your favorite GIS app to begin collecting coordinate data.

Display

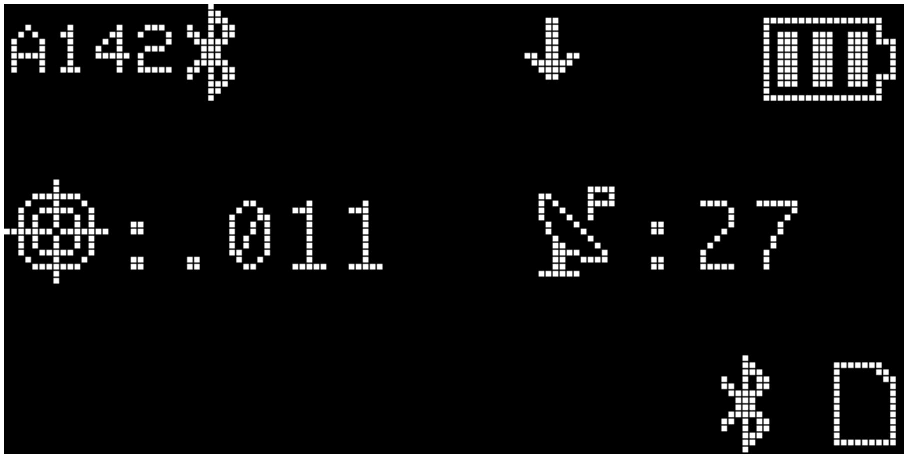
Here the the various icons and different state displays are explained in depth.

Rover

A basic rover display

The display on the FPL in rover mode will show the following:

- **A142** - Bluetooth MAC address used during pairing to identify the device. This is also printed on the side of the device as part of the Device ID.
- **Battery Gauge** - Relative level of battery capacity remaining from 100% (three bars) to nearly exhausted (no bars).
- **Cross Hair** - Estimated horizontal positional accuracy of the device in meters. A single cross hair icon indicates a standard 3D fix; a blinking double cross hair icon indicates RTK Float; a solid double cross hair icon indicates an RTK Fix.
- **Satellite Dish** - Satellites in view. Used as a general indicator of how well the device is receiving GNSS signals. This varies between 20 to 40 satellites.
- **Spinning Circle** - This animated icon indicates the system is running.



A rover with RTK Fix and logging

As devices are connected, and corrections are received, the display will indicate additional information:

- **A142** - Bluetooth MAC address used during pairing to identify the device. This is also printed on the side of the device as part of the Device ID.
- **Bluetooth Symbol** - A remote device is currently connected to the FPL over Bluetooth.
- **Down Arrow** - Correction data is detected. This is a good indicator that RTCM is correctly being received.
- **Battery Gauge** - Relative level of battery capacity remaining from 100% (three bars) to nearly exhausted (no bars).
- **Double Cross-Hair** - Estimated horizontal positional accuracy of the device in meters. A solid double cross hair icon indicates an RTK Fix.
- **Satellite Dish** - Satellites in view. Used as a general indicator of how well the device is receiving GNSS signals. This varies between 20 to 40 satellites. A satellite dish with a 'P' indicates PPP reception is enabled.
- **Bluetooth Symbol in Lower Right Corner** - Corrections can come from a variety of sources. This icon indicates the corrections being used by the GNSS receiver. In this case, corrections over Bluetooth are being used.
- **Document** - This animated icon indicates data is being logged to microSD.

Logging

The possible logging types on the FPL

The FPL can log various messages to microSD. Different messages can be enabled for different intents. This icon will change indicating the source currently being used.

- **Circle** - No microSD card is detected / no logging enabled.
- **Document with Lines** - The FPL is logging the default set of NMEA messages.
- **Document with C** - The FPL is logging a custom, user selected set of messages.
- **Document with P** - The FPL is logging the default set of NMEA and RTCM messages needed for post processing.

See the Message Rate Configuration section for information about how to log different messages.

Correction Source

The possible correction sources on the FPL

The FPL can receive corrections from a variety of sources. It will use the corrections from the highest prioritized source (see Correction Priorities for more information). This icon will change indicating the source currently being used.

- **Handheld Radio** - An external radio is providing corrections.
- **Sideways Half Circles** - The ESP-NOW radio is providing corrections.
- **Broadcast Tower** - The LoRa radio is providing corrections.
- **Bluetooth** - The Bluetooth radio is providing corrections.
- **USB** - A USB connection radio is providing corrections.
- **Double Diamond** - An NTRIP Client is providing corrections.
- **P Sign** - The PPP HAS/B2b system is providing corrections.

Base

A base transmitting

- **A142** - Bluetooth MAC address used during pairing to identify the device. This is also printed on the side of the device as part of the Device ID.
- **WiFi Symbol** - WiFi is running. This icon will blink while a connection is being attempted and will be solid when WiFi is connected.
- **Fort** - Indicates the device is in fixed base mode. A flag icon indicates the device surveyed-in the base.
- **Battery Gauge** - Relative level of battery capacity remaining from 100% (three bars) to nearly exhausted (no bars).
- **Xmitting** - Indicates the device is successfully transmitting RTCM over the available interfaces. This includes ESP-NOW, TCP, LoRa, and any serial connections, it excludes NTRIP Server.
- **RTCM** - A count of RTCM sentences transmitted. Used as a heath indicator: it should generally increase every second.
- **Satellite Dish** - Satellites in view. Used as a general indicator of how well the device is receiving GNSS signals. This varies between 20 to 40 satellites.
- **IP Address** - Once a device is connected to WiFi, its IP address will be shown. This is helpful when using a TCP Client to connect to the device.
- **Spinning Circle** - This animated icon indicates the system is running.

A base casting

- **A142** - Bluetooth MAC address used during pairing to identify the device. This is also printed on the side of the device as part of the Device ID.
- **WiFi Symbol** - WiFi is running. This icon will blink while a connection is being attempted and will be solid when WiFi is connected.
- **Up Arrow** - Correction data is sent. This is a good indicator that RTCM is correctly being uploaded.
- **Fort** - Indicates the device is in fixed base mode. A flag icon indicates the device surveyed-in the base.
- **Battery Gauge** - Relative level of battery capacity remaining from 100% (three bars) to nearly exhausted (no bars).
- **Casting** - Indicates the device is successfully connected to a Caster over WiFi. This is what to expect to see when the NTRIP Server is successfully running.
- **RTCM** - A count of RTCM sentences transmitted. Used as a heath indicator: it should generally increase every second.
- **Satellite Dish** - Satellites in view. Used as a general indicator of how well the device is receiving GNSS signals. This varies between 20 to 40 satellites.
- **IP Address** - Once a device is connected to WiFi, its IP address will be shown. This is helpful when using a TCP Client to connect to the device.
- **Spinning Circle** - This animated icon indicates the system is running.

Type

The possible base types on the FPL

The FPL can enter base mode in Fixed or Survey-In. This icon will change indicating the base type currently being used.

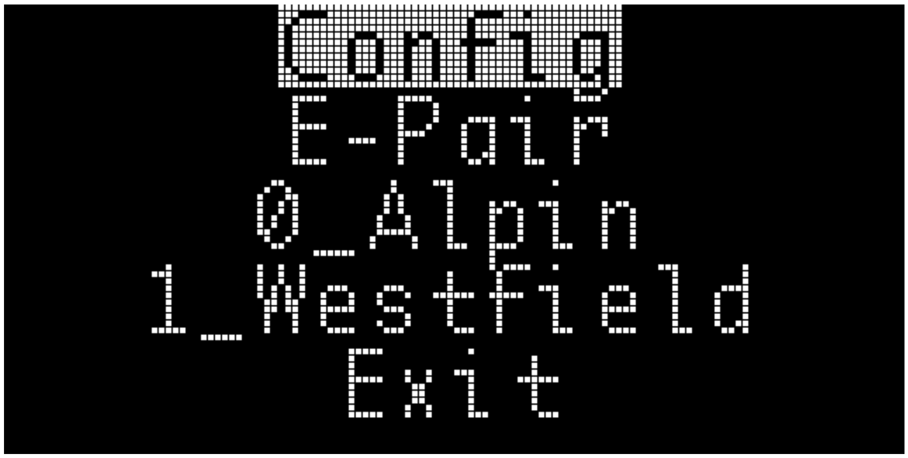
- **Fort** - The base is using fixed coordinates.
- **Flag** - The base is using surveyed-in coordinates.

Menu

The display menu system

Pressing either button will open the menu system. Pressing the (Fn) button will move down; pressing the (⏻) power button will select the menu item. The menu will timeout and exit if no entry is made.

- **Base** - Enter Base mode as it has been configured.
- **BaseCast** - Override the base configuration and enter Base Casting mode.
- **BaseAssist** - Override the base configuration and enter Base Assist mode.
- **Rover** - Enter Rover mode as it has been configured.
- **Config** - Enter Configuration mode.



Profiles on the display menu

- **E-Pair** - Enter ESP-NOW pairing mode.
- **0_Aplin** - Any named profiles will be shown on the menu list. This allows a user to quickly switch entire system configurations for different work sites.
- **Exit** - Exit the menu system.

Configuration

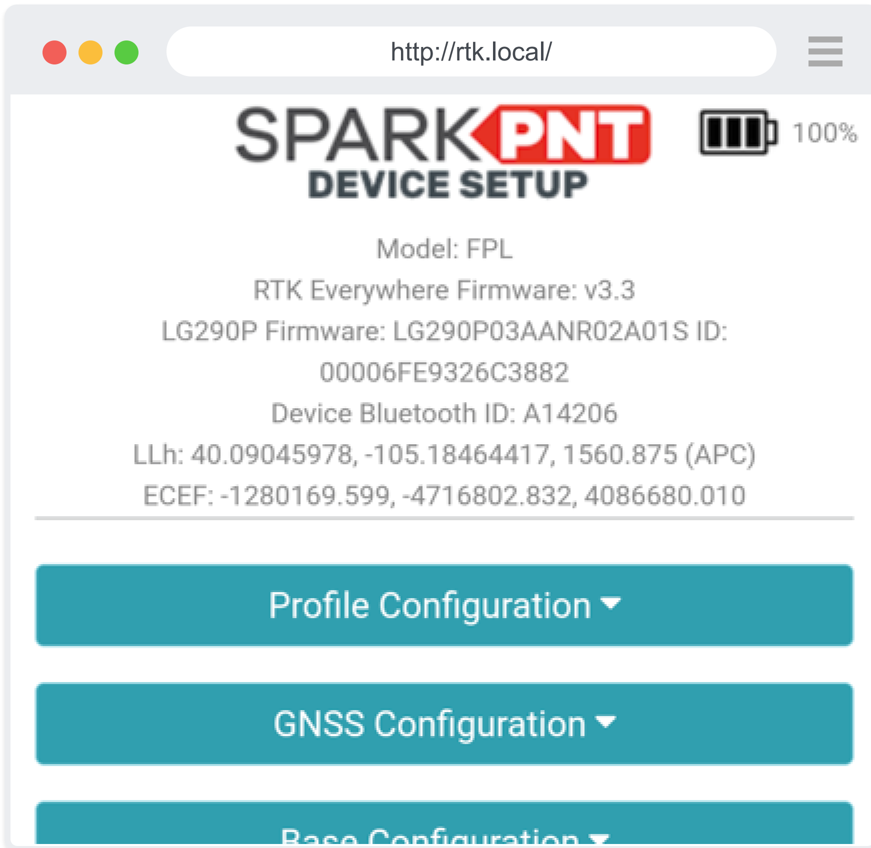
A device in Access Point configuration mode

Once a device is put into configuration mode the display will show the SSID being broadcast as well as the IP address. By default, the FPL will broadcast an access point called `RTK Config ######` with the IP address `192.168.4.1`.

A device in WiFi configuration mode

If **Configure Mode** is set to `WiFi` the FPL will attempt to connect to the given WiFi network. If a connection is made, its SSID will be shown along with the IP address that was issued to the FPL.

Configuration



The FPL Configuration Interface

The FPL is very powerful, flexible, and can be configured in a variety of ways. This section covers *all* the various settings on the FPL.

Connecting

To change the configuration of the FPL a cell phone or other WiFi capable device connects to the FPL over WiFi. Once connected, the phone will be auto-forwarded to the configuration page using a captive portal. If auto-forwarding fails, users can access the configuration webpage from a browser using the `http://rtk.local` address.

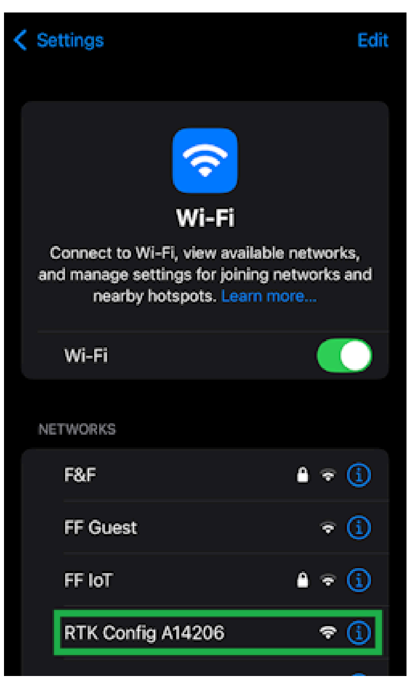
To get into configuration mode, follow these steps:

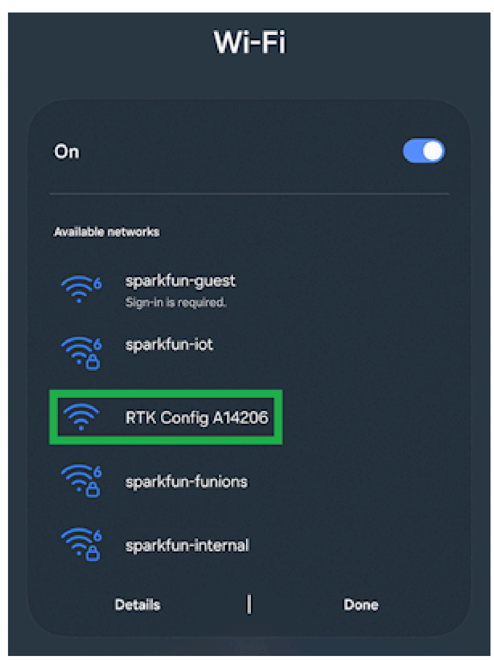
1. Power the device on. Hold the (⏻) power button for a few seconds. The FPL will beep and illuminate the display indicating it has turned on.
2. From the main screen, press the (`Fn`) function button once to open the navigation menu.
3. Press the (`Fn`) function button to navigate down until 'Config' is highlighted on the menu of the OLED display.

A device in Access Point configuration mode

4. Press the (⏻) power button to select the menu item. The device should display the `SSID: RTK Config ######` and the associated IP address.

5. On your mobile device, connect to the WiFi network named `RTK Config-######`. Upon connecting, your phone may warn you that the WiFi network is not connected to the internet. This is normal; stay connected and open a browser.



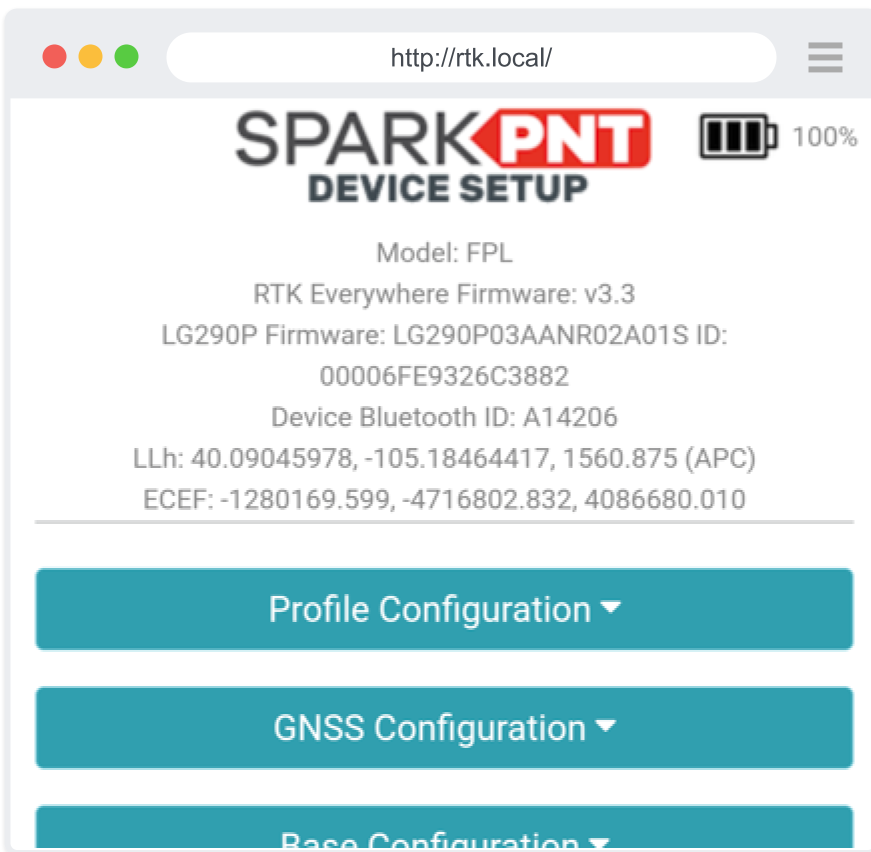


Selecting the WiFi network on iOS or Android

> **WARNING**
>
> If you have problems, try disabling mobile/cellular data on your mobile device. The device or browser might be using the cellular connection for its internet access; however, we want to disable this setting to ensure that your mobile device remains on the WiFi access point for the browser.

6. Once the browser is opened, you should be automatically re-directed to the configuration webpage. If not, open a browser (Chrome is preferred) and type **http://rtk.local** into the address bar.

System Information



Browser with `rtk.local` webpage

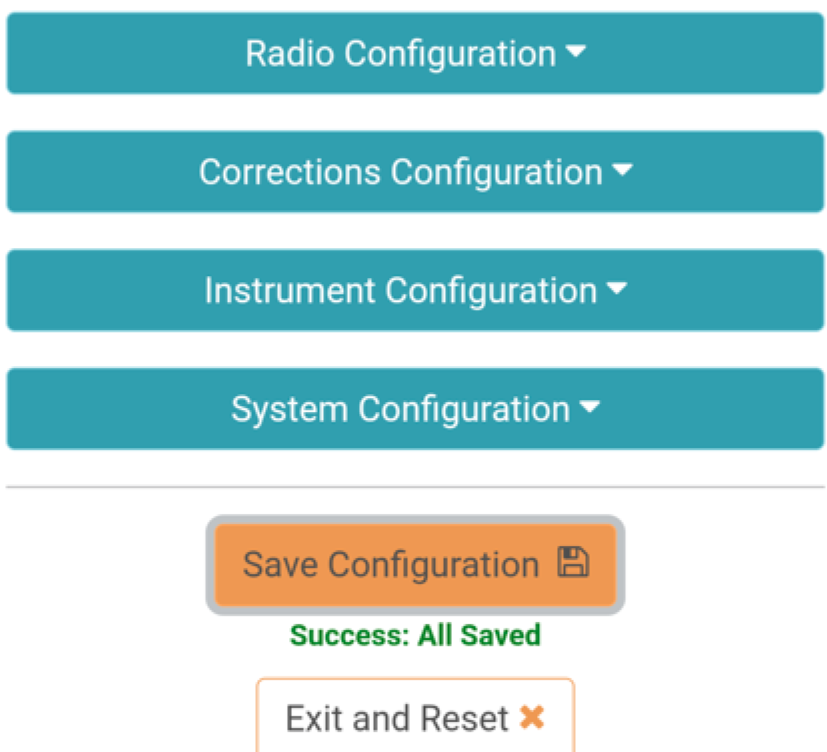
The page heading shows a variety of information:

- **Model** - The model of the device

- **RTK Everywhere Firmware** - The main system firmware version
- **LG290P Firmware** - The GNSS receiver firmware version and its serial number
- **Bluetooth ID** - The MAC address broadcast during pairing
- **LLh** - The device's current position in Lat/Lon/Alt coordinates
- **ECEF** - The device's current position in geodetic coordinates
- **Battery** - The current battery level

Save and Reset

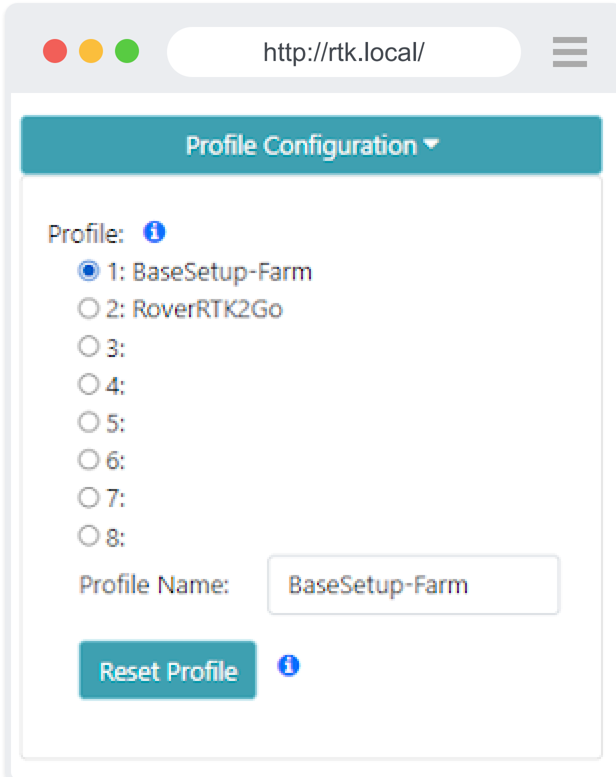
After the desired settings have been changed, scroll to the bottom of the configuration page and click the `Save Configuration` button. A `Success : All Saved` message will confirm that settings have been saved. Once all settings have been modified, press the `Exit and Reset` button to reset the device using the new settings.



Save and Reset buttons

Profiles

The `Profile Configuration` menu is very powerful. Profiles are handy for saving multiple device configurations for various tasks and/or end-users. Users can store up to eight profiles, with user-specified names. Selecting a different profile will immediately load that profile's settings into the Web Config interface. Upon exit, the device will then use those new settings.

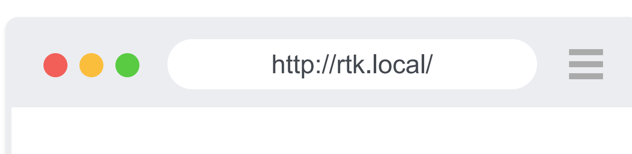


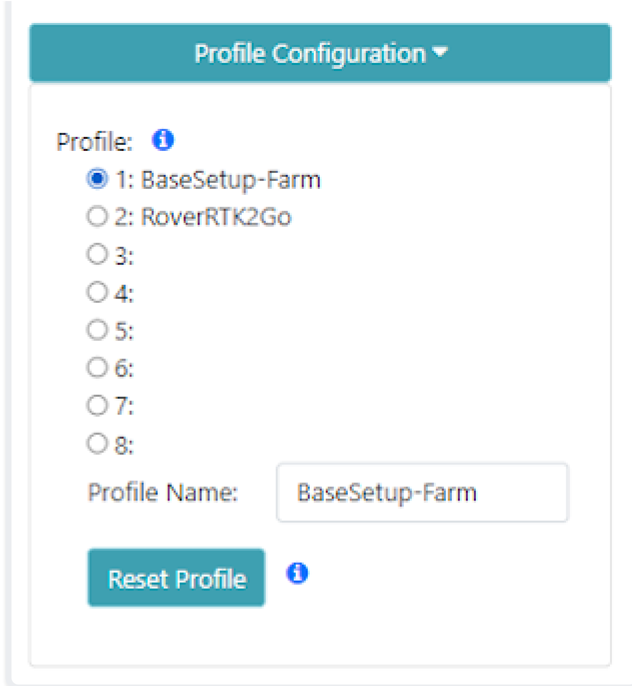
*The **Profile Configuration** menu*

> **WARNING**
>
> If a profile name is changed:
>
> 1. Users must click the `Save Configuration` button.
> 2. Once the `Success : All Saved` message appears, the webpage needs to be reloaded.

Create or Rename Profile

Select a bullet, then enter a new name in **Profile Name**.





Renaming the first profile to ***BaseSetup-Farm***

Scroll to the bottom of the configuration webpage and click the `Save Configuration` button. Once the `Success : All Saved` message appears, reload the webpage to update the configuration settings. With the webpage refreshed, open the `Profile Configuration` menu; the profile should be selected and named **BaseSetup-Farm**.

Configure a Profile

Once the profile has been loaded, changing the settings is straight forward.

1. Select the bullet of the profile you'd like to configure.
    - Under the `Profile Name:` section of the menu, a `Loading. Please wait...` message will appear.
2. Once users have verified that the profile has loaded properly, scroll down to change any of its configuration settings.

After the desired settings have been changed, scroll to the bottom of the configuration page and click the `Save Configuration` button. Once the `Success : All Saved` message appears more changes can be made or `Exit and Reset` to use the new settings.

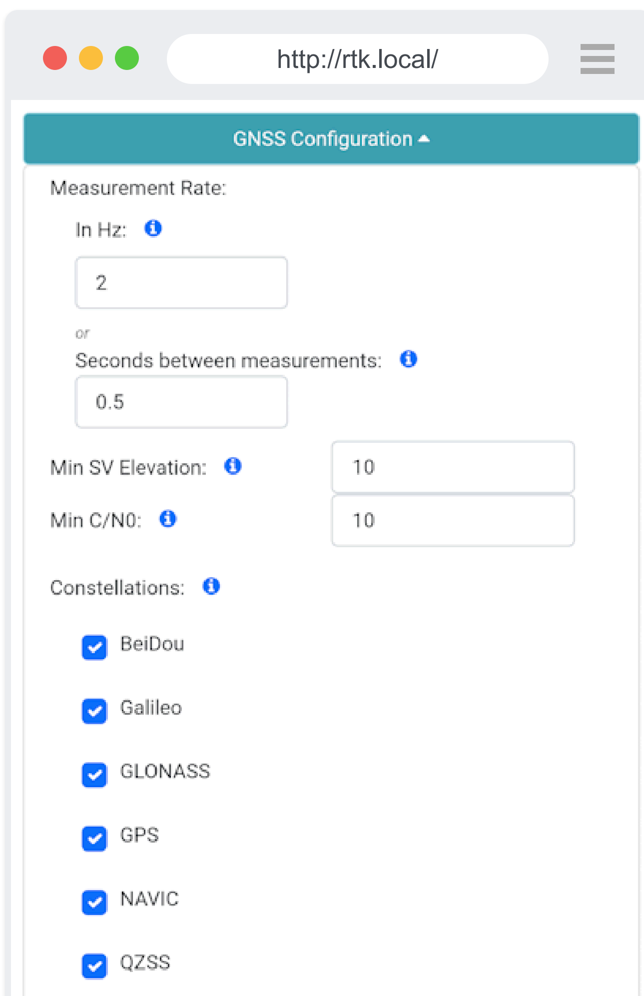
Reset a Profile

Users can reset a profile to the device's factory settings. Select the profile from the menu, then click on the `Reset Profile` button. A `Resetting profile.` message will appear briefly. Once it has vanished, scroll to the bottom of the configuration webpage and click the `Save Configuration` button. Once the `Success : All Saved` message appears, reload the webpage to update the configuration settings.

> **NOTE**
>
> Profiles are shown on the display allowing a user to quickly change the device's settings with a few clicks of the front display buttons.

GNSS and Rover Settings

Users can change the settings for the GNSS receiver during rover operation. This includes the measurement rate, elevation mask, signal to noise ratio mask, constellations selection, PPP services and settings, NTRIP Client setup, and GNSS messages to report.



*The **GNSS Configuration** menu*

Measurement Rate

This is the number of fixes or location solutions reported by the receiver each second and includes all enabled messages. As this number increases, the amount of data that must be transmitted over the Bluetooth (or other) connection increases linearly. Increasing the measurement rate beyond 10Hz can lead to data loss if the connection is noisy.

Min SV Elevation

Minimum elevation in degrees for a GNSS satellite to be used in a fix.

Min C/N0

Minimum satellite signal level to be used in a fix.

Constellations

The receiver is capable of concurrently receiving signals from multiple satellites across multiple constellations. Some applications dictate the need to turn off certain constellation reception. Deselecting a given constellation will cause the receiver to ignore those signals preventing them from being used during position calculations. By default, all are enabled.

PPP Service

Use PPP corrections provided over the Galileo or BeiDou constellations. Once enabled, various settings are shown.

- Datum - Select the datum to be used during PPP convergence. WGS84, PPP Original, CGCS2000
- Timeout - PPP timeout before fallback. 90 to 180 seconds. Default: 120s
- Horizontal/Vertical Convergence - The required horizontal and vertical accuracy the solution must achieve before it is considered 'converged'.

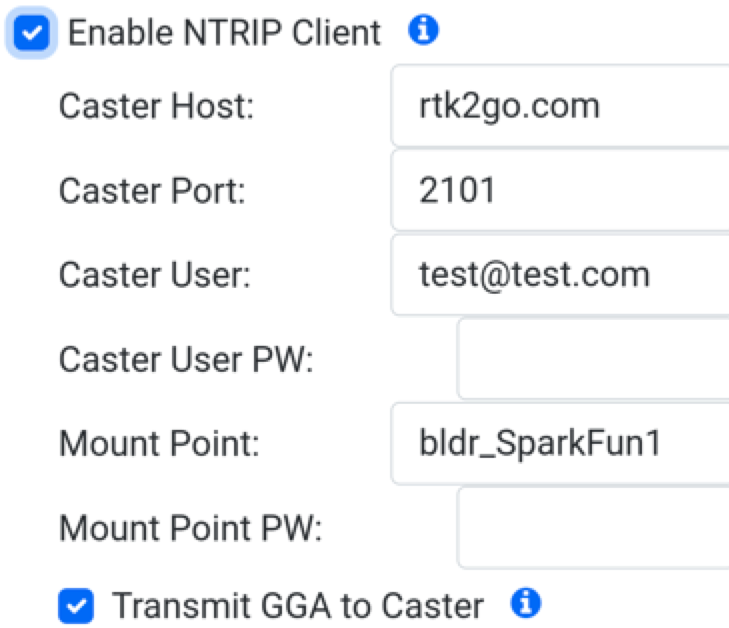
MSM7 RTCM Selection

Use MSM7 format RTCM messages if enabled, MSM4 otherwise.

Min SV Elevation

Minimum elevation in degrees for a GNSS satellite to be used for RTCM corrections.

NTRIP Client

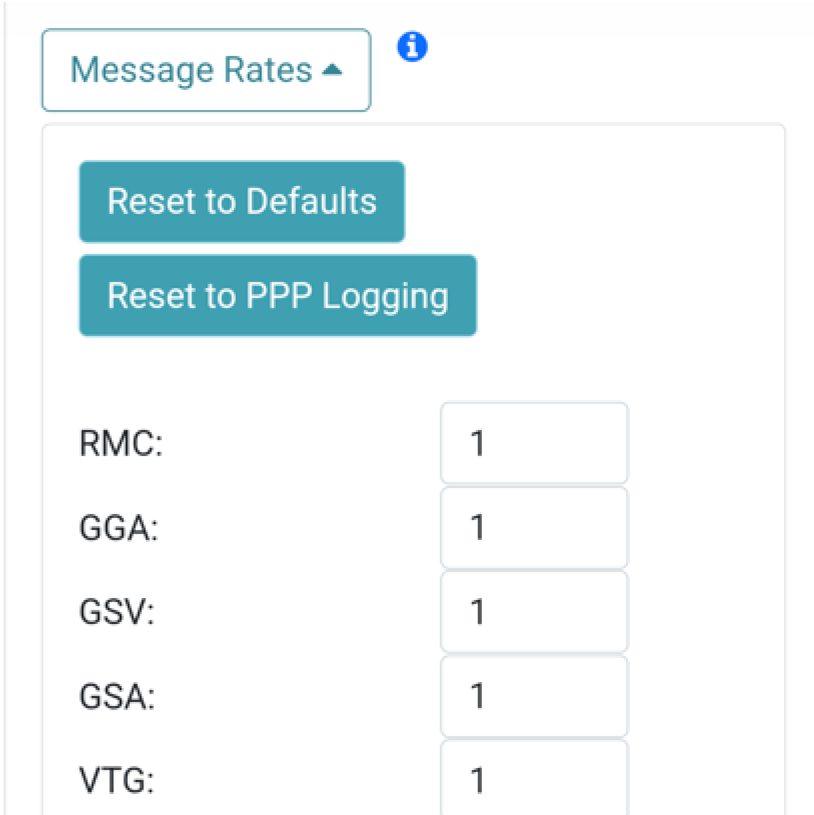


NTRIP Client settings on the configuration page

Use the internal NTRIP Client to download correction data from a casting service. The device must be provided with WiFi credentials and be within WiFi range at all times. Use this setting only if your GIS app doesn't have an NTRIP Client built-in.

Transmit GGA to Caster - Some casters require a regular position update from the rover (GGA message) so that the caster can automatically select the nearest available correction data.

Message Rates



Rover Message Configuration

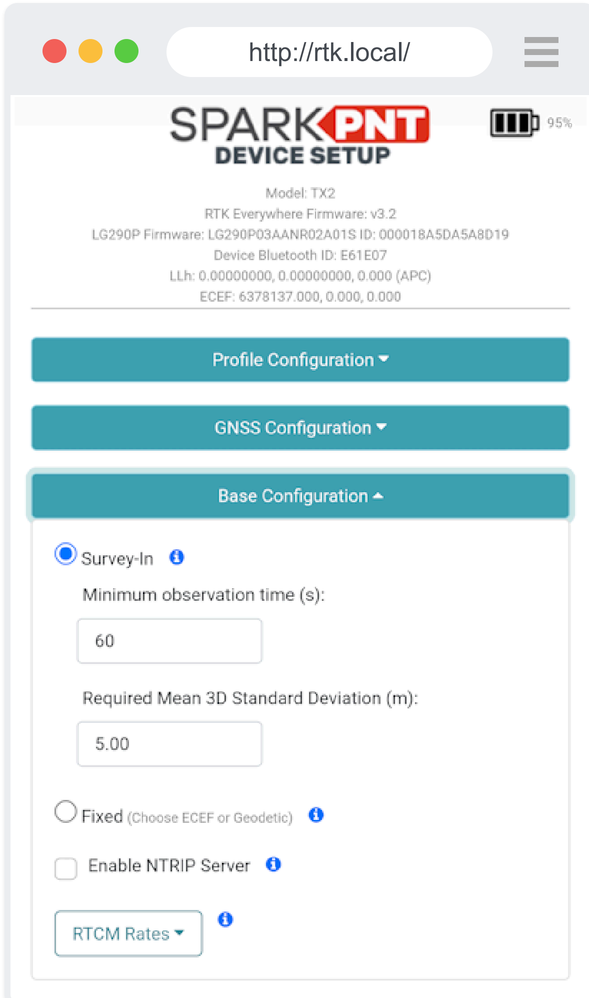
NMEA and RTCM are the two most commonly reported types of message but the GNSS receiver can output *many* additional messages. Each message rate controls which messages are disabled (0) and how often the message is reported (1 = one message reported per 1 fix, 5 = one report every 5 fixes).

Reset to Defaults will return all messages to the factory default rates. The default messages are a handful of NMEA messages (RMC, GGA, GSV, GSA, VTG, GLL, GST, etc.) and varies between models. RTCM *can* be enabled while the FPL is in Rover mode.

Reset to PPP Logging will set all messages to the required messages for post processing. This is commonly a handful of NMEA messages (RMC, GGA, GSV, GSA, VTG, GLL, GST, etc) as well as RTCM messages (1005, 107X, 108X, 109X, 111X, 112X, 113X, etc.) and varies between models. This mode is commonly used for logging during a Site Located Base when a static unit's location is processed to a very high accuracy for future use as a base.

Base Station

Users can configure the settings for operating as a base station. Additionally, users can enable the device to function as an NTRIP Server and and configure the RTCM messages that are reported while in Base mode.



*The **Base Configuration** menu*

The base station's location can be provided with two methods, which affect the absolute-accuracy of its produced corrections:

- **Survey-In:** The base station configures its location, based on an average of measurements made over a specified time frame. This is used to provide corrections to a rover where the absolute-accuracy of the rover's position isn't necessary and relative-accuracy of its measurements are sufficient.
    - For example, aerial surveys, mapping trails and campsites, or drafting construction plans where the accuracy of measurements in relation to one another *(i.e. relative-accuracy)* is important. However, the location of those positions, in relation the planet Earth *(i.e. absolute-accuracy)* is irrelevant.
- **Fixed:** Users can provide a fixed position for the base station's location in [ECEF] or [geodetic] coordinates. This is used to provide RTK corrections to rovers, for the most accurate surveying

results in relation to fixed coordinates on the planet Earth.

- For example, surveying property lines, locating or installing utilities, or other applications where the accuracy of measured positions must be repeatable.

> **INFO**
>
> Any errors in the base station's location, are propagated directly into the rover through the RTK corrections. Therefore, if the base station is off by 2m in a specific direction; all the RTK measurements from a rover, using that base station, will also be off by 2m in the exact same direction.

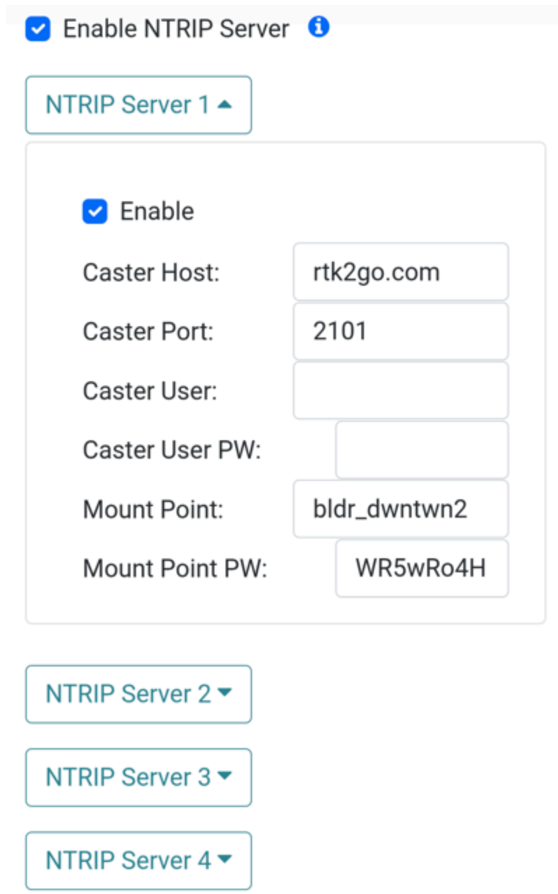
Survey-In

If the precise location of a base station is not known it may be obtained by ‘surveying’ the location. The base is fixed in one place and takes approximately 60 seconds worth of readings to obtain a best fit location based on the measurements. This method achieves ~30cm accurate position but can vary. Increasing the Minimum Observation Time and/or Required Mean Deviation will increase accuracy but only to a point. Better accuracy is achieved with long-term logging and post processing. Default: 60s and 5.0m. Limits: 60 to 600s, 1.0 to 5.0m.

Fixed

If the location of the base is known it can be entered in either ECEF or Geodetic coordinates. In this mode the receiver will immediately begin outputting RTCM correction data. A fixed position is best obtained with PPP (please see our tutorial) or with post processing against a reference station. The location can be entered using ECEF or Geodetic coordinates. A list of commonly used coordinates can help a user quickly switch between known site 'markers'.

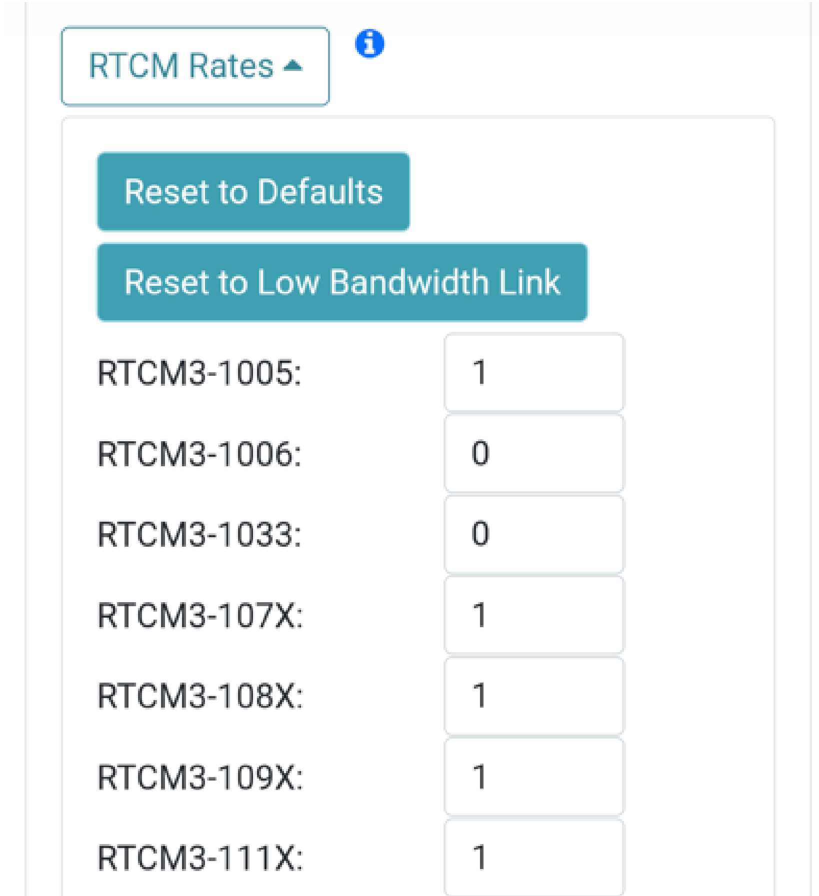
NTRIP Server



NTRIP Server settings

Enable up to four NTRIP Servers. Some Casters require a user and password, others require only a mount point and mount point password. RTK2Go and Emlid are two free-to-use casters.

Message Rates



Base Message Configuration

Because a Base's purpose is to broadcast RTCM data, a separate set of RTCM message rates are used during Base mode. The GNSS receiver can output a variety of RTCM messages while in Base mode. Each message rate controls which messages are disabled (0) and how often the message is reported (1 = one message reported per 1 fix, 5 = one report every 5 fixes). While in Base mode:

- The FPL will *only* send the RTCM messages configured in this Base settings section and send them out over the enabled transport methods. It is not beneficial to send NMEA or other non-RTCM messages over the radio link (Bluetooth, TCP, LoRa, etc) so these messages are stripped out to reduce the link traffic.
- If a microSD card is inserted, the FPL will log *the combined* messages set in the Rover section as well as all the RTCM messages set in the Base RTCM settings. The RTCM messages in the Rover section are ignored. This is helpful if a base station needs to be post-processed for its location.

Reset to Defaults will return all messages to the factory default rates of one report every second. The default messages are a handful of RTCM messages (1005, 107X, 108X, 109X, 111X, 112X, 113X, etc.) and varies between models.

Reset to Low Bandwidth Link will set the factory RTCM messages rates to one report every 2 seconds (1005 is set to one report every 10 seconds). This mode is designed for radio links that have lower bandwidth. Because a Rover does not need corrections *every* second, this reduced transmission rate lightens the traffic on the transport link.

PointPerfect Service

INFO

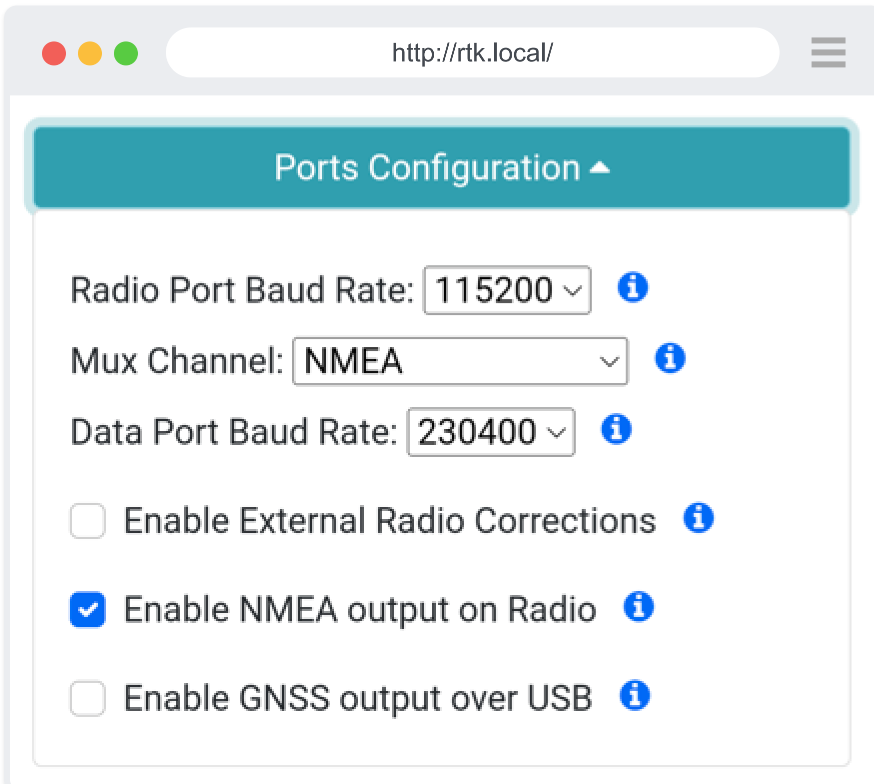
This section is deprecated. Most users will register for the monthly $15/month PointPerfect service. Once registration is complete, the user is given NTRIP Credentials that will be entered directly into their GIS app. This section is maintained for users who use the older MQTT/IP service.

If users have a device that has been whitelisted for the MQTT/IP service, they can enable their Point Perfect service here.

The `Point Perfect Configuration` menu

Ports

The FPL can communicate over various external connections. This section controls type and settings for those interfaces.



The `Ports Configuration` menu

Radio Port Baud Rate

The FPL has a 4-pin locking JST connector located under the microSD cover that communicates over TTL serial. This RADIO port is connected directly to a UART on the GNSS receiver allowing output of NMEA or RTCM, and receiving RTCM corrections. This setting controls the communication baud rate.

Mux Channel

This is deprecated.

Data Port Baud Rate

The FPL has a 5-pin Lemo-compatible connector that communicates over RS232 serial. This setting controls the baud rate used for communication.

Enable External Radio Corrections

Enable this setting if an external packet radio is connected to the 4-pin JST RADIO connector. This configures the GNSS receiver to accept RTCM directly into its UART, circumventing the Corrections Priorities system.

Enable NMEA output on Radio

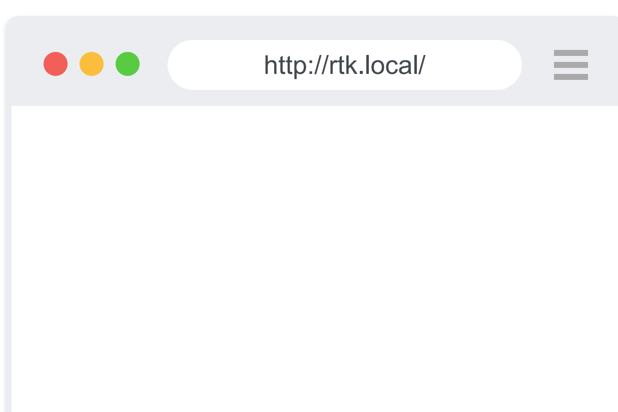
Enabling this setting introduces NMEA sentences into the data sent to the RADIO connector. For some setups, this is extra data that is not needed by the rover that can overwhelm low-bandwidth packet radios. By turning off NMEA, the radio can perform better because it has less data to transmit to the Rover.

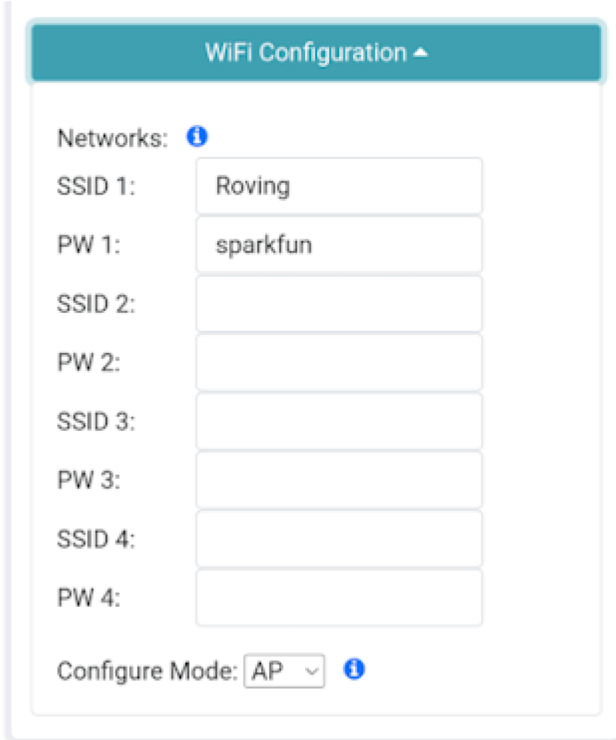
Enable GNSS output over USB

> **NOTE**
>
> If this setting is enabled, use `+++` to exit this mode and re-open the serial menu system.

The USB-C connector primarily outputs status messages and allows serial configuration. Enabling this setting will send all GNSS output (generally NMEA but also RTCM) to the USB serial connection.

WiFi





The `WiFi Configuration` menu

Networks

The WiFi menu allows a user to input credentials of up to four WiFi networks. WiFi is used for a variety of features on the RTK device. When WiFi is needed, the RTK device will attempt to connect to any network on the list of WiFi networks. For example, if you enter your home WiFi, work WiFi, and the WiFi for a mobile hotspot, the RTK device will automatically detect and connect to the network with the strongest signal.

Additionally, the device will continue to try to connect to WiFi if a connection is not successful. The connection timeout starts at 15 seconds and doubles with each failed attempt. For example, 15, 30, 60, etc seconds are delayed between each new WiFi connection attempt. Once a successful connection is made, the timeout is reset.

WiFi is used for the following features:

- NTRIP Client or Server
- TCP Client or Server
- Firmware Updates
- Device Configuration (WiFi Configure Mode only)

Configure Mode

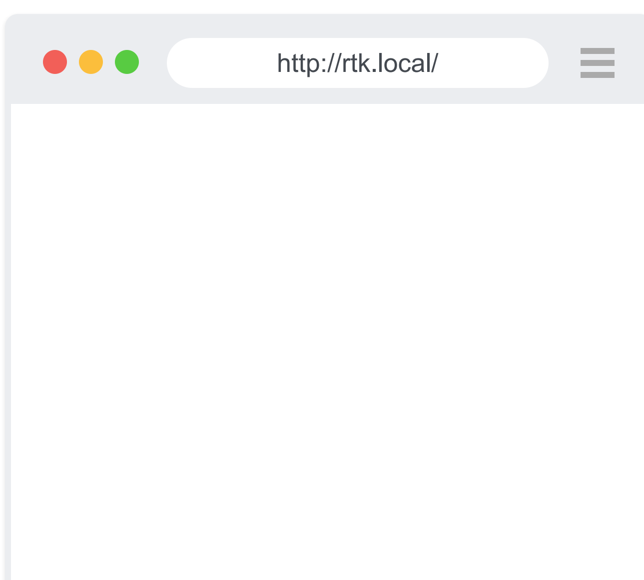
When a user enters `Config` from the display menu, the device will start broadcasting a WiFi Access Point called `RTK Config ######`. If this setting is set to WiFi, the device will instead attempt to connect to one of the given local WiFi networks. The **AP** setting is best for in-field configuration. The **WiFi** setting is used when other services (such as NTRIP Client or TCP Server) need to connect to a local network or cellular hotspot for easier access.

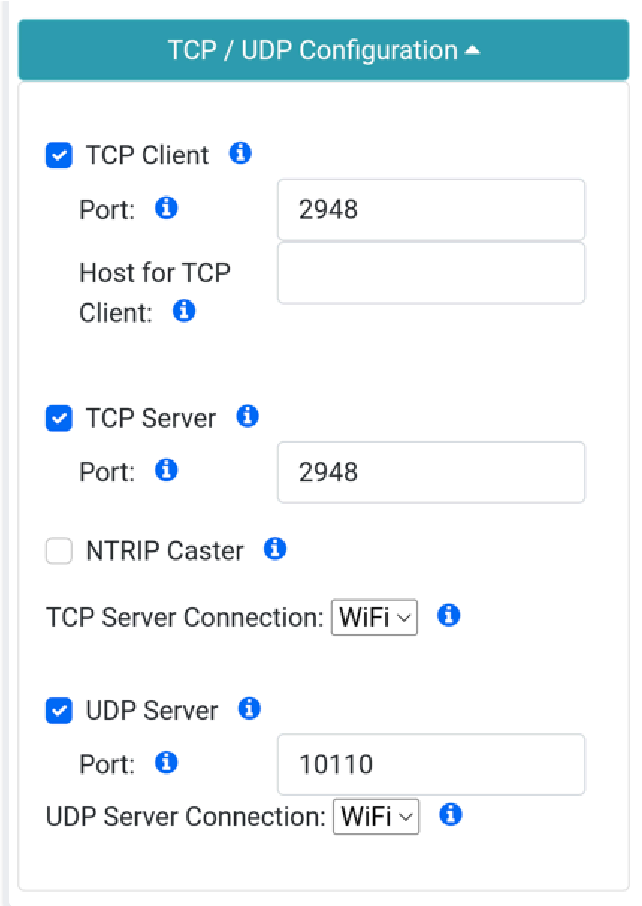
- `AP`: The device provides a WiFi access point for other devices to connect to it. This is useful for configuring the device in remote locations, where a WiFi network is not available.
- `WiFi`: The device access the WiFi networks configured in its settings. This is useful for connecting to a local WiFi network (including cellular hotspots) to configure settings and/or update the firmware.

> **INFO**
>
> The FPL is only compatible with 2.4GHz WiFi networks. It cannot connect to the higher speed 5GHz networks. On iOS devices, be sure to enable 'Maximize Compatibility' to allow 2.4GHz connections.

TCP/UDP

Most GIS apps use Bluetooth for collecting NMEA data from the FPL. In certain applications, it is preferred to connect to the FPL over TCP or UDP. This section focuses on the delivery of NMEA messages via TCP and UDP.





The `TCP/UDP Configuration` *menu*

TCP Client/Server

The RTK device supports connection over TCP. The TCP Client or Server operates over WiFi and sends position data to one or more clients. Some Data Collector software (such as Vespucci) require that the FPL connect as a TCP Client. Other software (such as QGIS) require that the FPL connect as a TCP Server. Both are supported.

If either Client or Server is enabled, a port can be designated. By default, the port is 2948 but any port 0 to 65535 is supported.

NTRIP Caster

When this setting is enabled, the device will turn on a TCP Server on port 2948. Any incoming requests made by an NTRIP Client will be accepted and responded to as if the FPL is an NTRIP Caster, including the transmission of a Mount table. This feature allows devices, such as a DJI drone controller, to connect to the FPL setup as a base, and receive corrections over NTRIP.

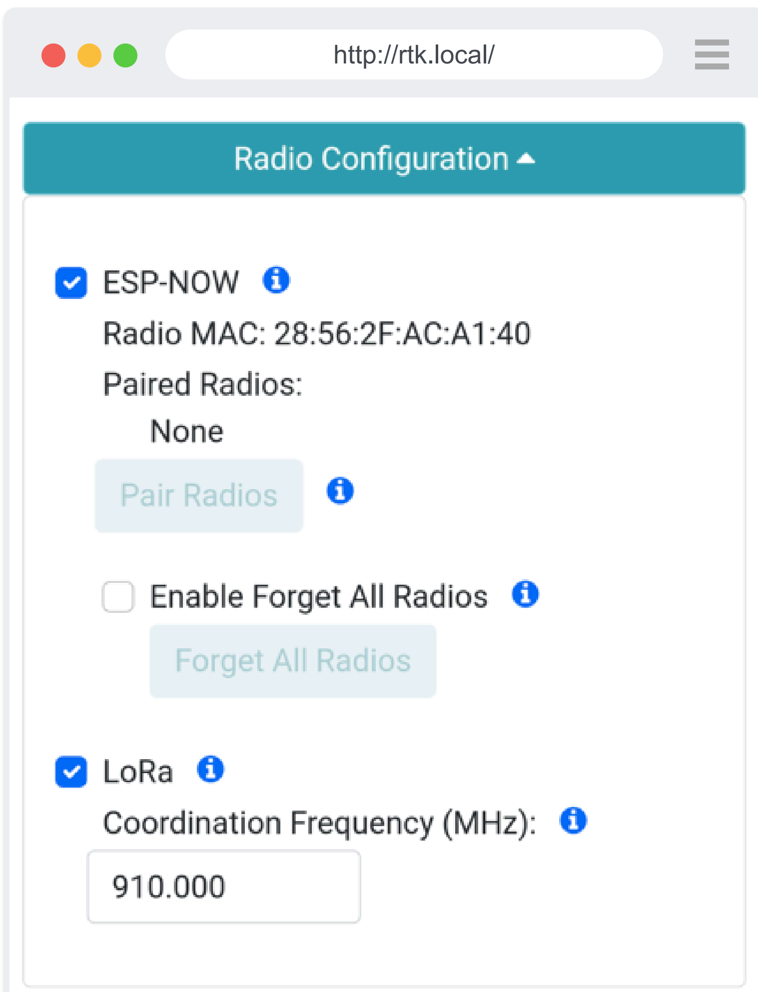
TCP Server Connection

TCP Server can connect over a local WiFi network connection, or by becoming an Access Point (hosting its own WiFi network). Use this option to select between the type of WiFi to use for TCP Server broadcasting. **WiFi** is customarily used when the FPL connects to a hotspot so that a GIS app can then obtain NMEA over TCP. **AP** is customarily used when a rover in the field (such as a DJI controller) needs TCP or NTRIP access in the field to a temporary base.

UDP Server

NMEA messages can be broadcast via UDP. If enabled, the UDP Server will begin broadcasting NMEA data and any enabled GNSS messages over the specific port (default 10110).

Radio Settings



The `Radio Configuration` menu

ESP-NOW

Enable ESP-NOW to allow device to device communication over 2.4GHz. See ESP-NOW for more information.

> **NOTE**
>
> Enabling ESP-NOW has ramifications when using Bluetooth. Don't enable before reading the ESP-NOW section.

LoRa

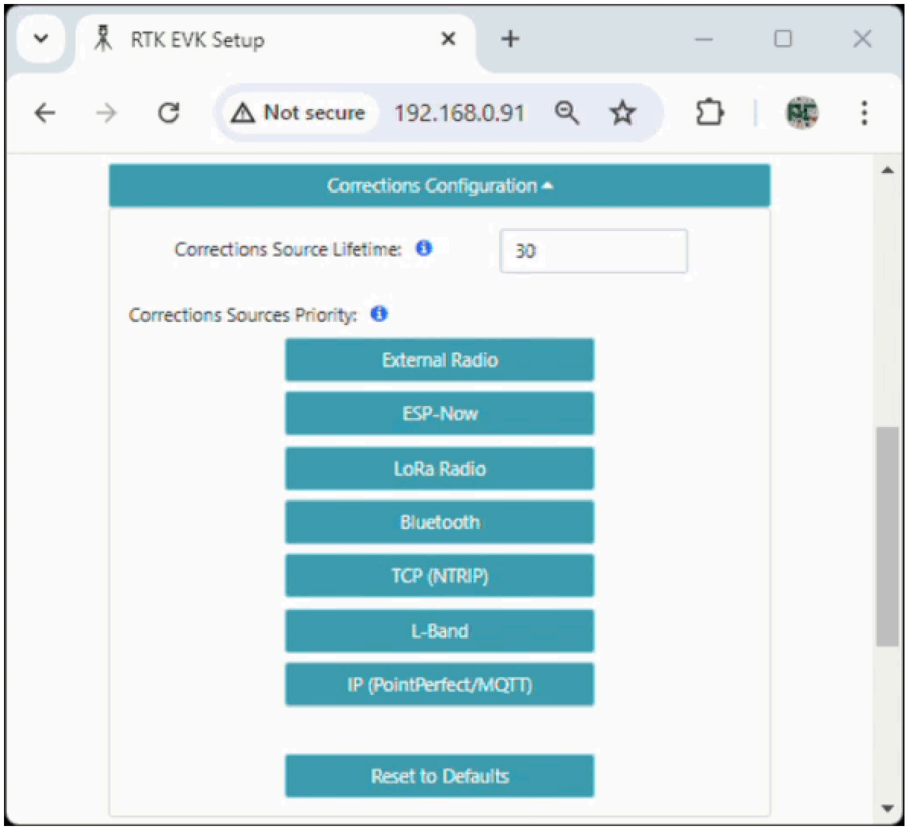
Enable to allow a base station to transmit corrections over the internal 1W LoRa radio to rovers.

> **NOTE**
>
> Enabling LoRa increases power consumption. Don't enable before reading the ESP-NOW section.

Coordination Frequency

The base and any listening rovers must use the same coordination frequency to communicate. The LoRa radio uses frequency hopping (FHSS) to be FCC compatible. Between transmissions, the base and rovers will return to this frequency to get their next frequencies to use. Modify this frequency if other equipment are causing interference.

Correction Priorities



The FPL can receive corrections from multiple interfaces (Bluetooth, LoRa, WiFi, etc). In order to prevent the receiver from obtaining corrections from multiple sources and confusing the receiver, a type of 'air-traffic controller' is used. The *Corrections Priorities* menu allows a user to specify which correction source should be given priority. For example, if corrections are provided through ESP-NOW and an NTRIP Client simultaneously, the corrections from the NTRIP Client will be discarded because the ESP-NOW source has a higher priority. This prevents the RTK engine from receiving potentially mixed correction signals.

Below is the list of possible sources (not all platforms support all sources) and their default priorities. These generally follow the rule that a shorter distance between Rover and Base leads to more accurate, and therefore more valuable, correction data. Users can modify these priorities as they see fit, but the defaults are as follows:

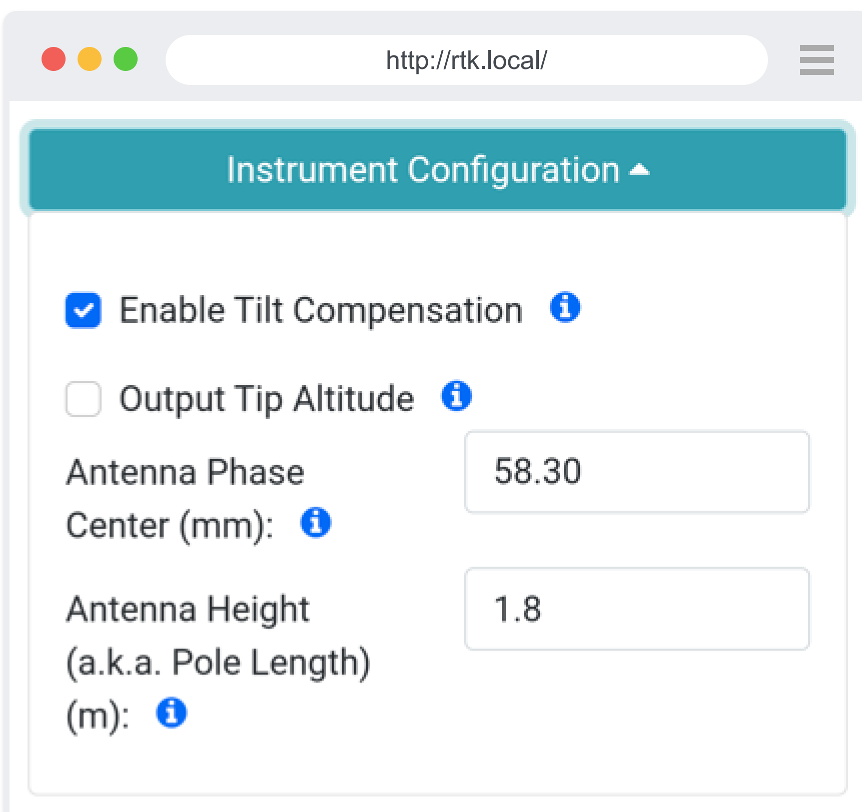
- External Radio (100m OSR Baseline) - Two external high-power packet radios communicating directly between a Rover and Base.
- ESP-NOW (100m OSR Baseline) - Two RTK devices communicating directly between a Rover and Base over the built-in 2.4GHz radios.
- LoRa Radio (1km OSR Baseline) - Two RTK devices communicating directly between a Rover and Base over the built-in LoRa radios.

- Bluetooth (10+km OSR/SSR Baseline) - A Rover obtaining corrections over Bluetooth to a phone/tablet that has an NTRIP Client.
- USB (10+km OSR/SSR Baseline) - A Rover obtaining corrections over USB to a phone/tablet that has an NTRIP Client.
- TCP (NTRIP) (10+km OSR/SSR Baseline) - A Rover obtaining corrections over WiFi to a NTRIP Caster.
- PPP HAS/B2b (100km SSR Baseline) - A rover obtaining corrections from the E6/HAS or B2b signal.
- L-Band (100km SSR Baseline) - Not available on the FPL
- IP (PointPerfect/MQTT) (100+km SSR Baseline) - Not available on the FPL

The interface control is as follows:

- Clicking a source increases its priority
- Clicking the highest priority source makes it the lowest priority
- Clicking `Reset to Defaults` will restore the priorities to their default setting

Instrument



The `Instrument Configuration` menu

Here users can configure the APC (antenna phase center) and antenna height (pole length) for the combined instrument height value.

Enable Tilt Compensation

On models that incorporate a tilt sensor, tilt compensation will begin when the device has RTK Fix and is rocked back and forth to complete the calibration. The tilt sensor can be disabled if needed.

When the FPL is in tilt compensation mode, it *must* lower the altitude of the readings to where the point of the pole rests on the ground. If the APC or pole length are set incorrectly, the altitude and location readings during tilt compensation will be inaccurate. If your GIS app has an 'Instrument Height' setting, be sure to set the app setting to 0m while the FPL is in active tilt compensation.

Output Tip Altitude

By default, the FPL outputs the location of the spot slightly inside the dome where the GNSS signals are received. This spot is accurate to a few millimeters when an RTK Fix is achieved. The FPL's 'location' as seen in the GIS app is this spot hovering above the earth. The GIS app usually has a setting to input 'Instrument Height' which will subtract this altitude above the ground so that gathered points are points on the ground (not ~1.85m in the air). Enabling this setting will cause the FPL to subtract the APC + Pole Length from the GNSS altitude, and report the tip altitude to the GIS app. This setting is generally only used when a GIS app *does not* have an 'Instrument Height' setting.

APC

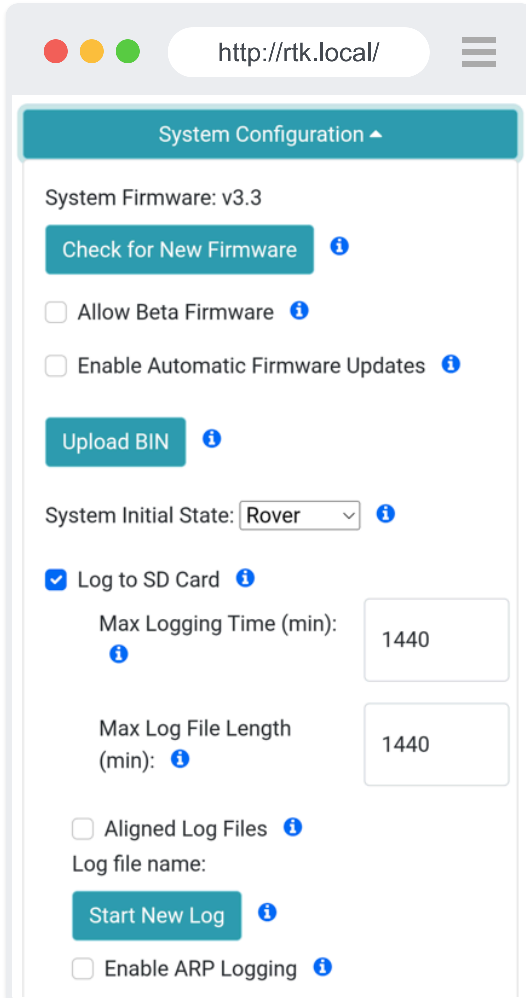
The Antenna Phase Center is the distance from the ARP (antenna reference point) on the bottom of the FPL to the point where GNSS signals are received. This value has been calibrated by the NGS and should not be modified in most instances.

Antenna Height

The antenna height is set by the user when extending the surveying pole. The measurement should be provided in meters, with the length of the surveying pole from its bottom tip to the ARP (antenna reference point) of the mounted device.

System Configuration

Users can access the devices system settings to upload new firmware, check and update the firmware through a WiFi network, configure its operating modes, the Bluetooth settings, buzzer, units of measurement, and factory reset.



The `System Configuration` menu

Check for New Firmware

Pressing this button will cause the unit to attempt to connect to WiFi and check for new versions of firmware. If new firmware is available, the button will change to `Update to vX.Y.Z` allowing the user to update the firmware.

Allow Beta Firmware

Enabling this setting will allow upgrades to firmware that is in development. Beta firmware should not be used in the field as it is not considered stable.

Enable Automatic Firmware Updates

If enabled, the unit will check for new firmware periodically for new firmware. This is useful if a device is deployed in a permanent environment where zero-administration is needed.

Upload BIN

If selected, the user will prompted to select a binary firmware file from their local system. The firmware will be uploaded and loaded onto the unit.

System Initial State

The FPL will enter this mode at boot.

Log to SD Card

If a microSD card is detected, the FPL will begin logging all GNSS messages including NMEA and any additionally enabled messages such as RTCM.

Once the **max log time** is achieved, logging will cease. This is useful for limiting long term, overnight, static surveys to a certain length of time.

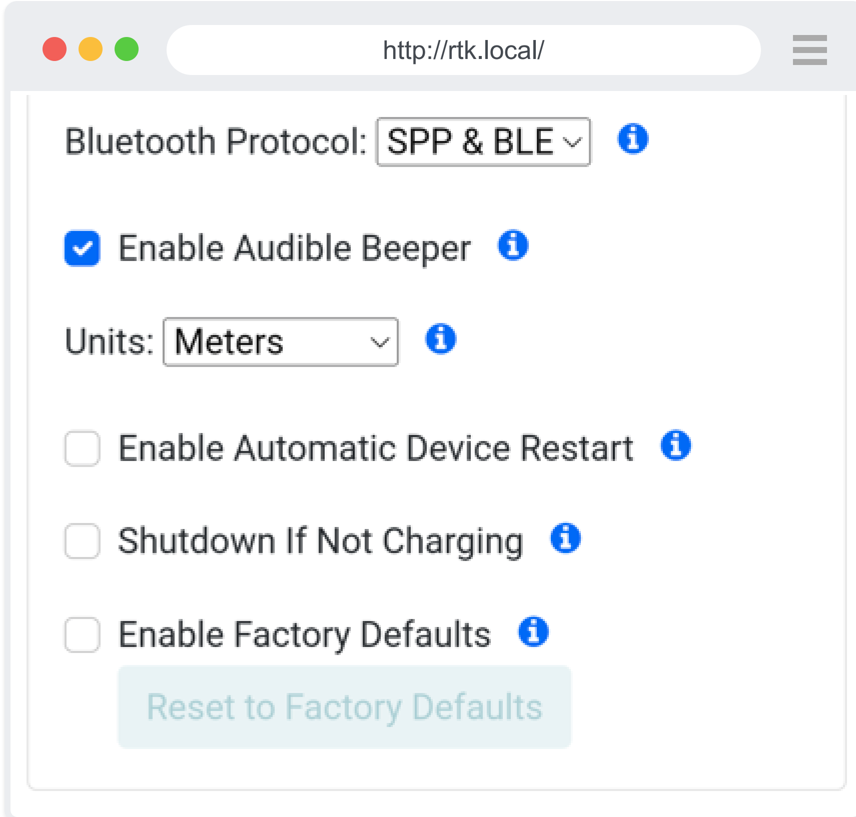
Once the **length of time** is achieved, a new log will be created. This is useful for creating multiple logs over a long survey.

If **Aligned Log Files** is enabled, log files will be aligned to the Max Log File Length. Only possible if the Max Log Length is an integral fraction of 24 hours.

Log file name will show the current log file.

Start New Log will force the creation of a new log.

If **Enable ARP Logging** is enabled, the Antenna Reference Position from RTCM 1005/1006 will be added to the log.



The `System Configuration` menu

Bluetooth Protocol

The FPL will simultaneously broadcast over Classic Bluetooth (SPP) and Bluetooth Low Energy (BLE). If needed, the Bluetooth radio can be limited, or disabled.

Enable Audible Beeper

Allow internal buzzer to give audio feedback to the user.

Units

Display and print units in meters or feet. This does not affect NMEA output, only internal device prints and displays.

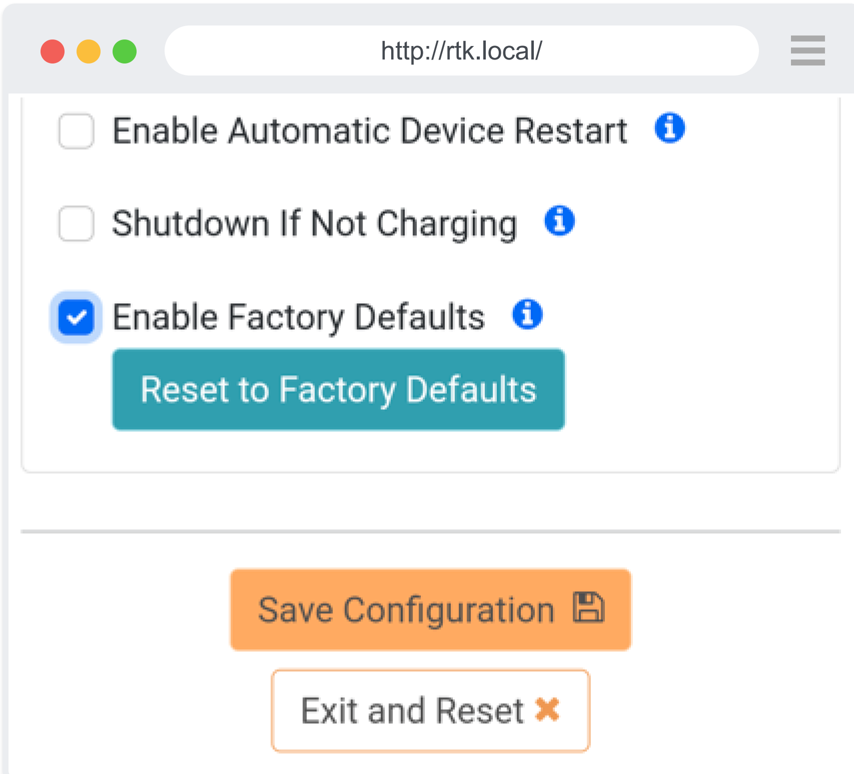
Enable Automatic Device Restart

If enabled, device will periodically restart. This is helpful when deploying a device in a remote location.

Shutdown If Not Charging

If enabled, device will turn off if no external charger is present. This is helpful when deploying in machinery or where a user may forget to turn the device off.

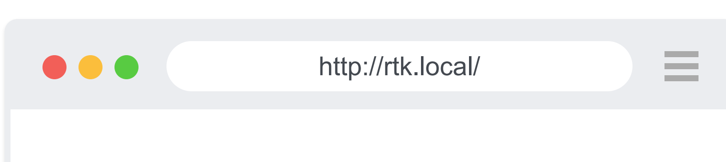
Factory Reset

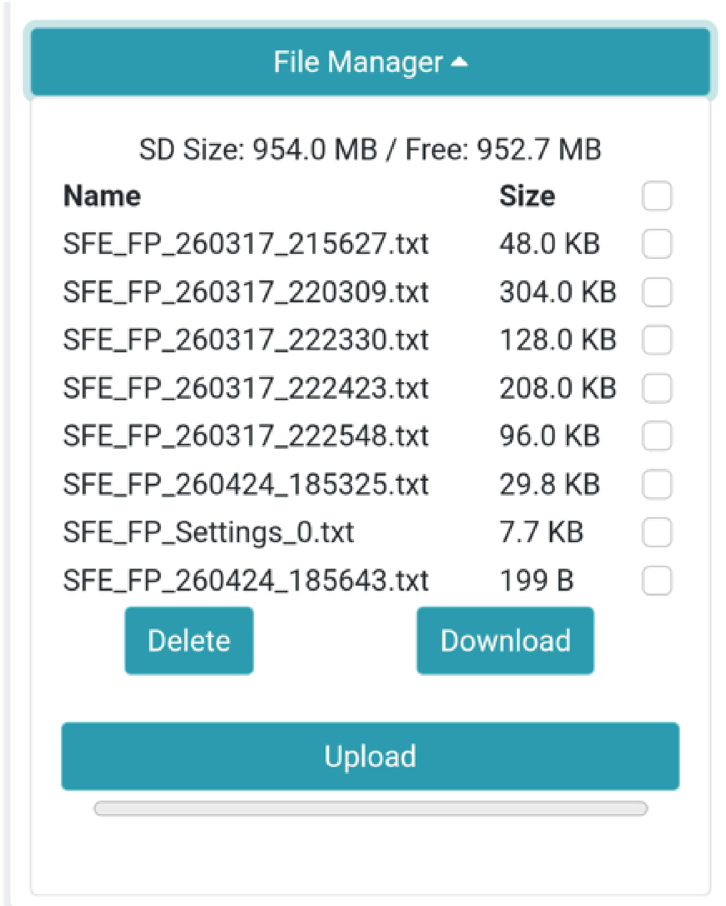


The `File Manager` menu

A Factory Reset will erase any user settings and reset the GNSS receiver to default settings. Any setting file associated with the current profile is removed, but logs on SD are maintained. To prevent accidental reset select the `Enable Factory Default` option, then click on the `Reset to Factory Default` button. A `Defaults Applied. Please wait for device reset...` message will appear next to the button. The Web Configuration interface will close and the device will beep once indicating it has reset.

File Manager





The `File Manager` menu

If an SD card is detected, the contents will be shown in the File Manager section. Here, users can delete, download, and upload files as needed.

Corrections

To get millimeter accuracy the FPL must be provided with correction values. Corrections, often called RTCM or RTK corrections, help the GNSS receiver refine its position calculations. Corrections can be obtained from a variety of sources and are transported through different methods.

Correction Sources

> **TIP**
>
> The majority of users will subscribe to a correction service through a monthly subscription like PointPerfect or through a network provided by their state.

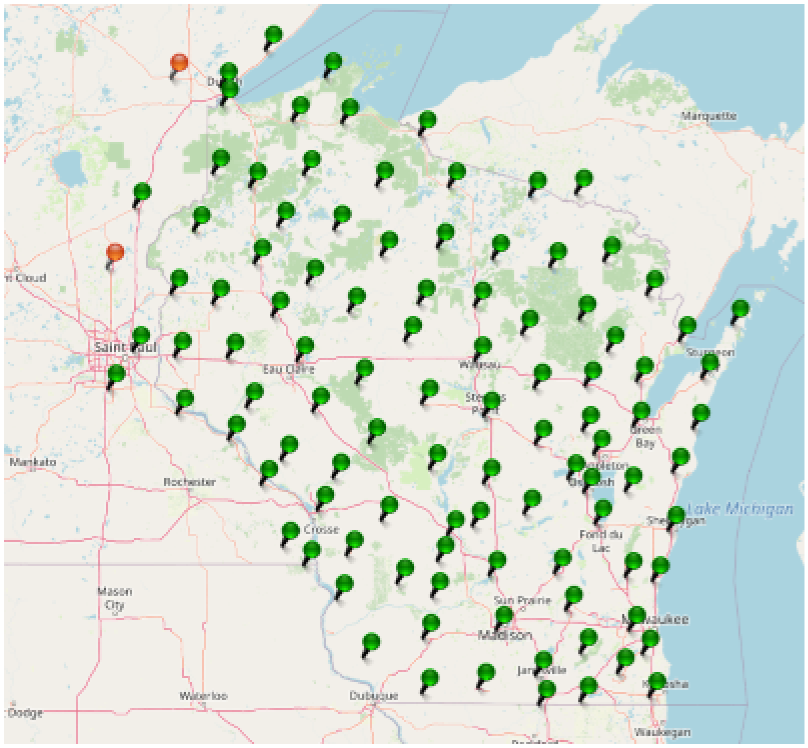
Correction sources fall into three general categories: Commercial, Public, and Civilian Reference Stations.

Commercial Reference Networks

These companies set up a large number of reference stations that cover entire regions and countries. They are often easy to use but require a monthly subscription.

- PointPerfect ($15/month) - US, EU, as well as parts of Australia, Brazil, and South Korea. Note: This is an SSR service.
- Onocoy ($25/month) - US, EU, Australia, and many other partial areas
- PointOneNav ($150/month for "True RTK") - US, UK, EU, KOR, AUS, NZ, and JP
- Skylark ($29 to $69/month) - US, EU, Japan, Australia
- SensorCloud RTK ($100/month) partial US, EU
- Premium Positioning (~$315/month) partial EU
- KeyNetGPS ($375/month) North Eastern US
- Hexagon/Leica ($500/month) - partial US, EU

Public Reference Stations



Wisconsin has a free state-wide corrections network

Be sure to check if your state or country provides corrections for free. Many do! Currently, there are 16 states in the USA that provide this for free as a department of transportation service. Search 'Wisconsin CORS' as an example. Similarly, in France, check out CentipedeRTK. There are several public networks across the globe. NTRIP-List is a good source but be sure to google around!

Civilian Reference Stations

A privately owned base station

You can set up your own correction source. This is done with a 2nd GNSS receiver that is stationary, called a Base Station. There is just the one-time upfront cost of the Base Station hardware. See the Creating a Permanent Base document for more information.

Galileo HAS

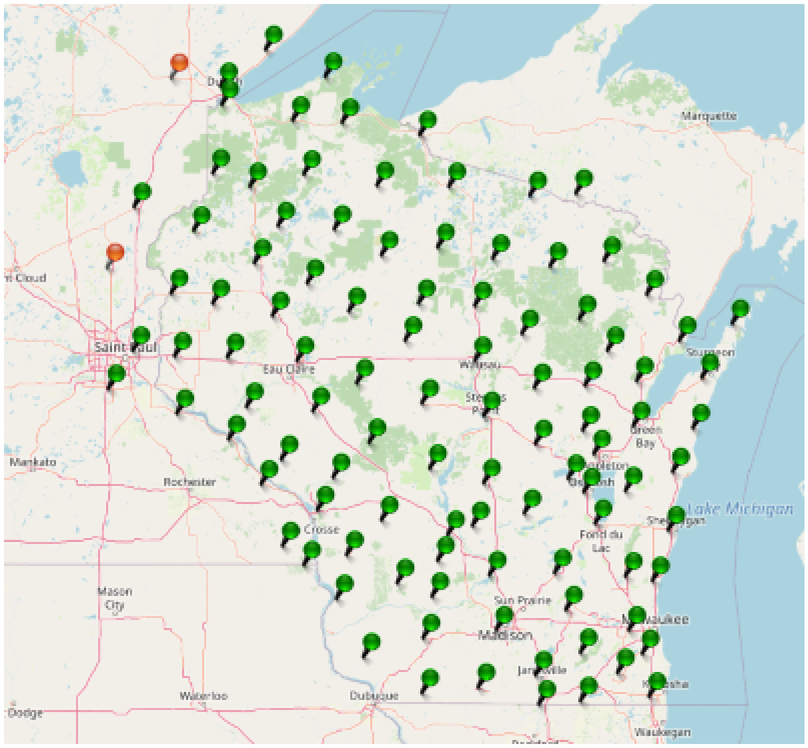
High-Precision GNSS Without Internet? Galileo H
SparkFun Electronics

Watch on

The European Union launched a free correction service called High Accuracy Service or **HAS** starting in 2023. The service is delivered over the E6 frequency. In general, this service will greatly improve accuracy to receivers but is lower accuracy than an OSR or SSR-based RTK Fix. These corrections require about 15 minutes for the PPP algorithm to converge on a solution that has better than 20cm (8 inches) of accuracy. The corrections are free, provided over the Galileo GNSS constellation, and have global coverage. If internet access is available at your worksite we still recommend using land-based corrections for *much* better accuracy and faster RTK Fix times. Consider HAS to be a slow but ok backup when there is no internet.

OSR vs SSR

Not all companies providing correction services use the same type of corrections. There are two types: OSR and SSR.



State Wide Network of Continuously Operating Reference Stations (CORS)

Observation Space Representation (OSR) is the classic type of corrections network. This is a collection of base stations located at regular intervals across a geographic area. Corrections coming from this type of network provide the highest RTK accuracy (14mm or less is common when located within 10km of a base station) with the minimum convergence time (the time you have to wait before the GNSS receiver can achieve RTK Fix). Normal convergence time for an OSR is a few seconds. However, because a CORS has to be placed every few 10km, these type of networks are expensive to install and maintain. An OSR network is prone to holes or gaps in the network where a base station is not sufficiently close to maintain RTK Fix. Imagine an autonomous semi-trailer truck driving across hundreds or thousands of miles; an OSR network is extremely difficult to set up that maintains the full coverage needed for highly kinetic applications.

PointOne Nav, and Skylark Nx RTK are examples of an OSR.

Coverage map for PointPerfect SSR based service

State Space Representation (SSR) covers huge areas, sometimes entire continents. SSR combines the readings from a handful of base stations and creates a model for the region. This model extrapolates the needed corrections for a given area. These corrections are 'good enough' for many applications. Because SSR requires far fewer base stations, they are often a much lower-cost service. The RTK Fix accuracy is lower (20mm is possible but 30-60mm is common), and the convergence time increases considerably. Convergence time for an SSR can be 180 seconds or more.

The PointPerfect and Skylark Cx are examples of an SSR.

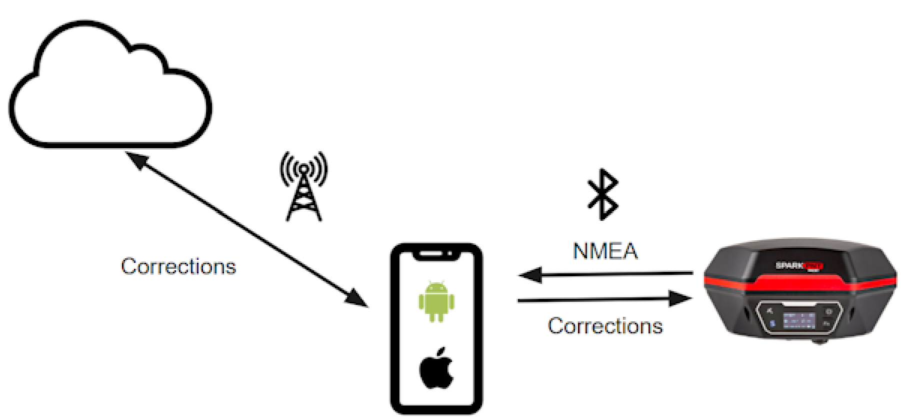
Transport Methods

> **TIP**
>
> The majority of users will use their phone and send corrections from their GIS app's NTRIP Client, over Bluetooth, to the FPL.

Once a correction source is chosen, the correction data must be sent to the FPL. This section describes the various methods to move correction data into the FPL. These are sorted from most common to least.

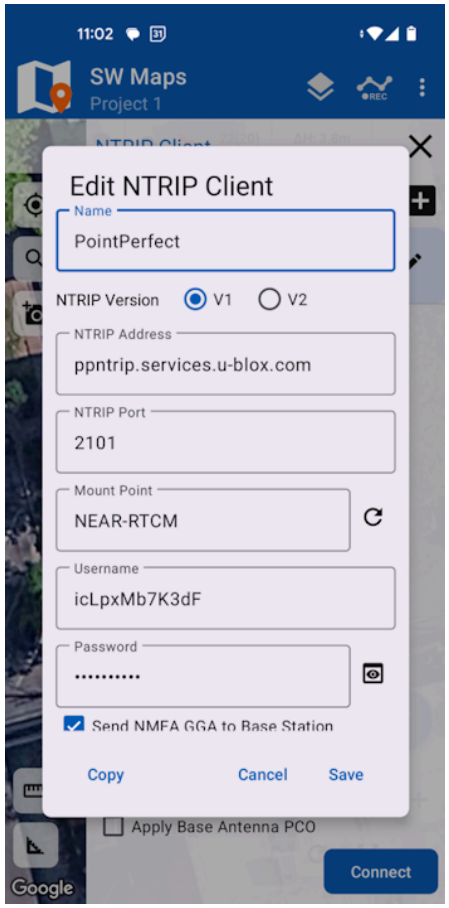
RTK calculations require RTCM data to be delivered approximately once per second. The RTCM serial data is approximately 1000 bytes per second but varies depending on the GNSS receiver and its settings. If RTCM data is lost or not received by a rover, RTK Fix can still be maintained for around 30 seconds before the device will enter RTK Float mode. If a transport method experiences congestion (ie, cellular latency, Serial Radios dropping packets, etc) the rover(s) can continue in RTK Fix mode even if correction data is not available for multiple seconds.

Bluetooth



How corrections flow from NTRIP to Bluetooth

Using a cell phone is the most common way of transporting correction data from the internet to the FPL. This method uses the cell phone's built-in internet connection to obtain data from an NTRIP Caster and then pass those corrections over Bluetooth to the RTK device.



Entering NTRIP credentials

Shown above are SW Map's NTRIP Client Settings. Nearly all GIS applications have an NTRIP Client built in so we recommend leveraging the device you already own to save money. Additionally, a cell phone gives your rover incredible range: a rover can obtain RTCM corrections anywhere there is cellular coverage.

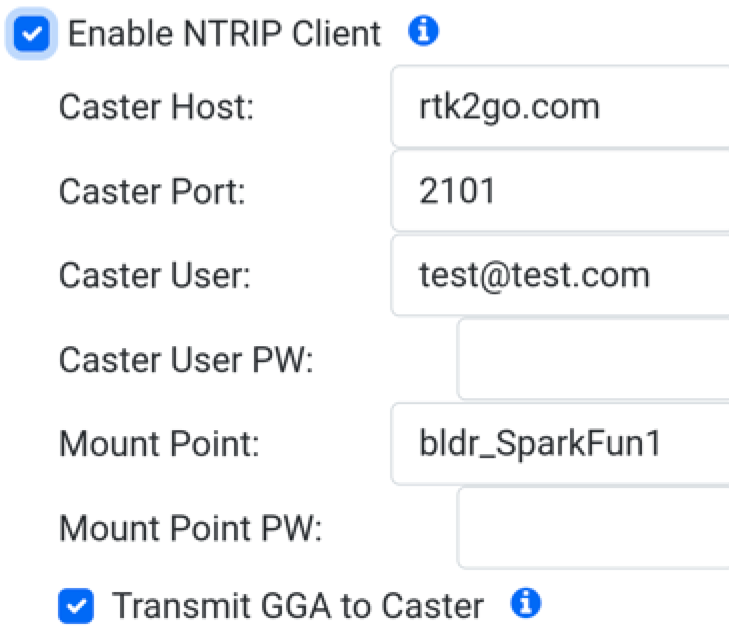
Cellular can even be used while the FPL is being used as a base. We have seen some very inventive users use an old cell phone as a WiFi access point. The base unit is configured as an NTRIP Server with the cellphone's WiFi AP credentials. The base connects to the WiFi, and the RTCM data is pushed over WiFi, then over cellular, to an NTRIP Caster.

WiFi

How corrections flow from NTRIP using WiFi to Bluetooth

The FPL can connect to a WiFi network (usually a hotspot) and then use the FPL's built-in NTRIP Client to get corrections over WiFi. This set up is most often used when a GIS app *does not* have an NTRIP Client built into it. The cell phone is the connection to the internet, allows for incoming devices to connect over WiFi, and connects to the FPL over Bluetooth to obtain the highly accurate NMEA data.

NTRIP Client

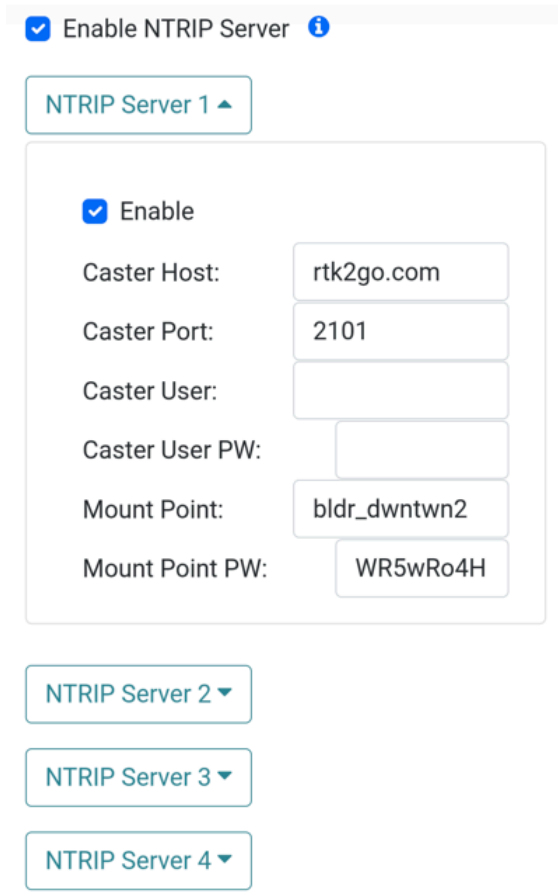


NTRIP Client settings on the configuration page

An **NTRIP Client** is a method for getting corrections from the internet *into* the FPL. While most users will use a GIS app that has a built-in NTRIP Client, some applications do not. In that case, the FPL can be set up as an NTRIP Client. The RTK device will connect to a given WiFi network and begin downloading the RTCM data from the given NTRIP Caster. This is useful only if the Rover remains in RF range of a WiFi access point. Because of the limited range, we recommend using a cell phone's hotspot feature rather than a stationary WiFi access point for NTRIP Clients.

See NTRIP Client Configuration for setup specifics.

NTRIP Server



NTRIP Server settings on the configuration page

The FPL also has an NTRIP Server feature. This is most often used when the FPL is acting as a base. An **NTRIP Server** is a method for sending corrections from the FPL *out* to the internet. In this mode, the FPL will connect to WiFi and broadcast its correction data to the internet. The NTRIP Server connects to something called an NTRIP Caster. Any number of rovers can then access this data using their own NTRIP Clients.

Up to four NTRIP Servers can be entered. The FPL will attempt to connect to each server and send data. This is helpful if you wish to participate in networks that reward users for their data (i.e. Onocoy, Geodnet, etc.) while simultaneously broadcasting the correction data to a public network (i.e. RTK2Go, Emlid, etc.) for use as your own personal base.

See NTRIP Server Configuration for setup specifics.

LoRa

The FPL contains a 1 watt Long Range (LoRa) radio capable of transmitting RTCM from a single base to multiple rovers. See the LoRa Radio page for more information.

ESP-NOW

The FPL contains a 100 milliwatt radio capable of transmitting RTCM from a single base to multiple rovers. See the ESP-NOW Radio page for more information.

Remote Internet

What do you do if you need to get an RTK Fix but there is no internet service? How can users obtain corrections in remote areas? Space based internet providers such as Eutelsat KONNECT or Starlink Roam can be used to gain internet connectivity in remote areas to then connect to a standard NTRIP corrections source. Checkout our video on how we put Starlink in a briefcase and used its $5 standby service for NTRIP based corrections.

Post Processing

If real time kinematics is not needed, the FPL can log raw GNSS satellite data onto a microSD card where it can be post processed into very accurate location data.

Firmware Updates

Over time SparkPNT will release new firmware to add and improve functionality of the FPL and its subsystems. This section describes how to update the firmware for each supporting component.

Configuration page with system version numbers

The firmware versions are shown in the Configuration header. The most current versions are as follows:

- ESP32 - v3.3
- LG290P - v2.1
- LoRa - v3.0.1

See Check for New Firmware in the Configuration section to check for and update the firmware on these systems.

Operating Modes

The FPL will power on and enter either Rover or Base mode.

Rover

A *Rover* is the part of an RTK system that receives corrections from a *Base*. By default, the FPL will operate as a GNSS receiver that is expected to move, the *Rover*.

3D Fix

Within 30 seconds the FPL will gather the GNSS signals and begin outputting a location solution. The quality of this solution is generally 1 to 2 meters in accuracy. All GNSS receivers can achieve this level of fix.

RTK Float

High precision GNSS receivers have the unique capability to receive corrections from a base and enter RTK Float. This is usually for only a few seconds while the GNSS receiver resolves any ambiguities in the high-precision calculations.

RTK Fix

RTK Fix is the goal for most deployments. This mode is achieved when the GNSS receiver combines GNSS signals with corrections. Because the GNSS system is dynamic and the ionosphere experiences turbulence throughout the day, the FPL will need to be fed corrections over Bluetooth or WiFi every few seconds to maintain an RTK Fix. Corrections can be obtained through different interfaces. See Correction Sources for a list of different sources.

Base

A *Base* is the part of an RTK system that transmits corrections to a *Rover*. A Base does not move, and must know where it is in the world so that it can calculate the differences between the

Temporary Bases are generally setup for a short amount of time (a day or less) and require less up-front work than a permanent base, but generally have lower accuracy.

Survey-In Base

A Survey-In Base is the default mode for a device when it enters Base mode. The GNSS receiver will monitor its location for approximately 60 seconds. After 60 seconds, generally speaking, the readings are averaged together and that location result is used as the 'fixed' location. All rovers receiving the corrections from this base will be relatively very accurate, but the absolutely accuracy will be low. Said differently, if the Survey-In result is incorrectly 0.7 meters to the west, all rover locations will be 0.7m +/-10mm to the west.

Once the survey-in is complete, the FPL will begin outputting RTCM correction data. The RTCM can be transported over a variety of different methods including NTRIP Server, LoRa, ESP-NOW, serial, etc. See Transport methods for more information.

Augmented Survey-In Base

An Augmented Survey-In Base is where a temporary base is set up to Survey-In its location but is simultaneously provided RTCM corrections so that its Survey-In is done with very precise readings. An augmented base running a Survey-In removes much of the relative inaccuracies from a Rover-Base system. We've found an Augmented Base varies as little as 50mm RMS between intra-day tests, with accuracy within 65mm of a PPP of the same location, same day.

To set up an augmented base the RTK device should be located in a good reception area and provided with RTCM corrections. Let it obtain RTK Fix from a fixed position (on a tripod, for example) in Rover mode. Once an RTK fix is achieved, change the device to temporary Base mode (also called Survey-In). The device will take 60 seconds of positional readings, at which point the fixed position of the base will be set using RTK augmented coordinates. At this point, corrections provided to the base can be discontinued. The Base will begin outputting very accurate RTCM corrections that can be relayed to a rover that is in a less optimal reception setting.

Similarly, a PPP service such as Galileo HAS or BeiDou B2b can be used to increase the accuracy during the Survey-In. The RTK device should be located in a good reception area and allowed to reach PPP convergence (10+ minutes). Once converge, change the device to temporary Base mode (also called Survey-In). The device will take 60 seconds of positional readings, at which point the fixed position of the base will be set using PPP augmented coordinates. The Base will begin outputting very accurate RTCM corrections that can be relayed to a rover that is in a less optimal reception setting.

Site Located Base

A site located temporary base is when a RTK device is deployed over a position, commonly a stake in the ground, each day that work needs to get done, then the equipment is removed to prevent theft or abuse. A site located base has nearly the accuracy of a permanent base, but requires a one-time investment of a few hours of work to configure.

The first step is to log raw GNSS data for a few hours, then submit it to a processing service to remove as many ambiguities and increase the location accuracy as much possible. With a few hours of logging, location accuracies can be better than 10mm. Once the staked location is known, a base can be quickly redeployed over that known spot during future site visits. The benefit of this longer, logged site survey over a 'Survey-In' style base is the increase in absolute accuracy.

Each day that work needs to be done, the RTK device should be carefully located over the stake or monument with the known coordinates. The RTK device is configured to operate in 'Fixed Base' mode with the coordinates reported by the PPP service, and the base will immediately begin transmitting corrections over whatever transport methods are enable: for example, NTRIP Server, ESP-NOW, LoRa, WiFi AP, etc. Any rover receiving corrections from this type of base will be both relatively and absolutely accurate with the accuracy reported in PPP service report.

How to Complete a Site Located Base

Any of the SparkPNT products can be used to do a site located base. For products that have a microSD interface, the raw satellite data is recorded to the log file. For products that don't have a microSD interface, the device must be connected over USB to an external device capable of logging - this is most often a laptop or tablet.

Enable Raw Logging

Above, the Messages Menu, shown on the RTK Postcard, allow PPP logging to be enabled.

PPP logging

Above, the RTK Postcard displays the 'P' logging icon indicating raw signals are being logged.

For the RTK Postcard and RTK EVK, raw logging must be enabled and a microSD card inserted. Once enabled, the logging icon should show a 'P'.

For the RTK Torch, raw logging must be enabled, then the USB port must be configured for GNSS output. Once complete, you will see a stream of NMEA sentences in readable characters, as well as a mix of non-readable binary characters.

For the RTK Facet mosaic, a RINEX output stream must be created and a microSD card inserted.

Logging of data should run for as many hours as is possible. 4 hours is generally considered a minimum, with diminishing returns after 12 hours. The PPP service report will include an estimate of the inaccuracy so if greater accuracy is needed, a longer survey can be re-run.

Once a log of raw GNSS data is obtained, it needs to be processed with RTKCONV.

Note: RTK Facet mosaic users can skip the following RTKCONV step because a RINEX file was directly recorded and can be used with most post processing services.

Settings in RTKCONV

We must convert the RTCM contained in the log files to RINEX data the post processing services understand. Download RTKLIB. As of writing, this was v2.4.3. RTKLIB is a collection of tools commonly used to manipulate raw GNSS data. Navigate to the bin folder and open *RTKCONV*. Select the log file that needs to be converted to RINEX. In the above example, the text file is RTCM 3 format, and we enabled 30 second intervals. This decimation process is important: it selects a reading every 30 seconds, removing any extra readings in between. Most PPP services automatically decimate to 30 seconds so this will not result in accuracy loss but will *significantly* reduce your file sizes allowing much faster processing.

RTKCONV Options

Above, press the **Options** button and be sure all GNSS signals are enabled and the GPS, GLO, and GAL constellations are selected. Not all PPP services can use this extra data but it's better to have recorded them. If you used a SparkFun SPK6618H (antenna code `SFESPK6618H`) or TOP106 antenna (antenna code `SFETOP106`), you can include an antenna code for additional ambiguity resolution.

Press convert.

Start time window

When the Start Time window opens, press the File Time button and then OK.

OBS output file

Once complete, an OBS file should be output. Zip the OBS file with the ZIP tool of your choice.

CSRS Login

Log in to CSRS.

Settings in the CSRS

Enter your email address and select ITRF as the Processing Mode. Upload the ZIP file of the OBS. Processing can take a few minutes up to a few hours.

Output from CSRS

Above, we see the location as well as the accuracy estimate of 4mm, 3mm, and 14mm of the lat/lon/alt. When work needs to be done at the site, the RTK device is set on the known location, then configured as a 'Fixed Base' with the PPP location coordinates.

Fixed Base

Permanent Bases are the gold-standard for accuracy. They require extra work to set up, but can used for years with proper maintenance.

In Fixed mode, the coordinates of the antenna must be known with great accuracy and need to be entered into the FPL. These can be entered in ECEF or Geographic coordinates. Once the device has been configured, a user enters Base mode by changing the mode in configuration or through the display menu. Once base mode begins, the FPL will immediately begin outputting RTCM correction data. The RTCM can be transported over a variety of different methods including NTRIP Server, LoRa, ESP-NOW, serial, etc. See Transport methods for more information.

Base Cast

BaseCast Menu

Base Cast mode enables the following settings:

- Enables Base mode
- Enables NTRIP Caster mode
- Enables TCP on port 2101
- Enables WiFi AP mode on IP 192.168.4.1

This is helpful when using the FPL in conjunction with a drone controller that expects connectivity to a near by Base over WiFi. All of these settings can be set manually; Base Cast mode just provides a quick and easy way to put the FPL into the default mode compatible with most drone controllers.

This mode can be entered from the System Menu, using the display menu, or by setting the System Initial State to BaseCast in configuration mode.

Base Assist

BaseAssist Menu

Base Assist mode is used to force the FPL to use its immediate location as the fixed location base setup. Said differently, while in Rover mode, if this mode is selected, the FPL will copy its current location and begin a fixed base with the current location. The benefit to an Assisted Base is that it allows a base to be established very quickly on site and all the Rover to be *relatively* accurate to the base. If you are staking out the relative locations of plants, trees, buildings, etc this mode allows the relative distances and locations of those points to be accurate to around 10mm. However, because the base location was not found with great accuracy, those locations will all be off from the absolute global accuracy.

Radios

For many use cases, a Base/Rover setup is not needed. Most users will utilize a corrections service and obtain corrections over an NTRIP Client inside a GIS app. This section is for users who prefer or must use a base to transmit corrections to a rover.

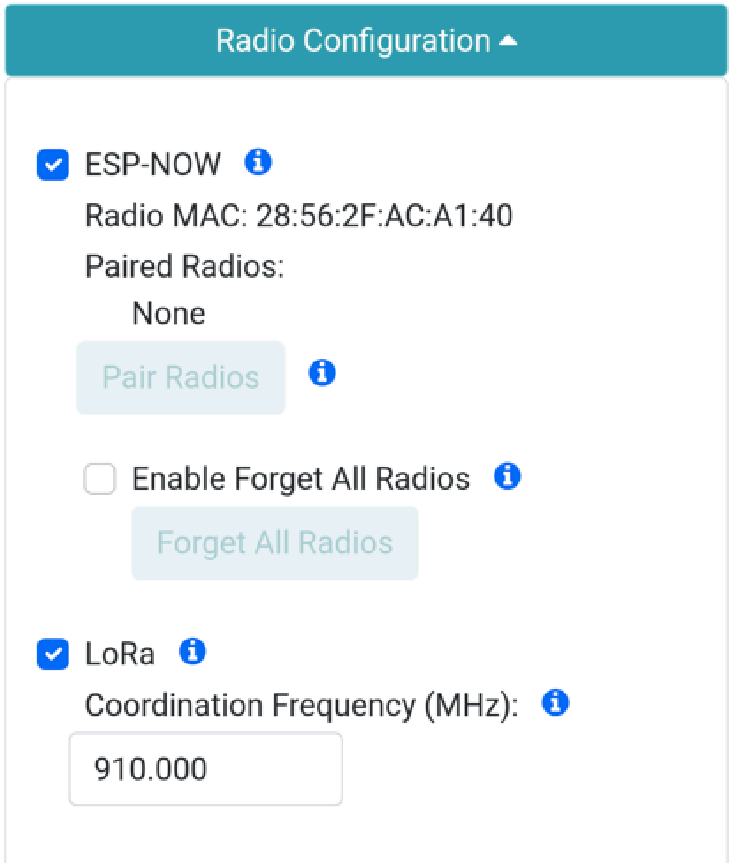
The Transport Methods section covers how the different methods work, this section goes into the specifics about each radio and how it is configured.

ESP-NOW

ESP-NOW has a range of around 250m (845ft)

The FPL has a built in 100mW radio that uses 2.4GHz and is capable of transmitting/receiving RTCM from a single base to multiple rovers. The range is not great, but it's free!

ESP-NOW is a 2.4GHz protocol that is built into the internal ESP32 microcontroller; the same microcontroller that provides Bluetooth and WiFi. ESP-NOW is most useful for connecting a Base to Rover (or multiple Rovers) without the need for an external radio. Simply turn two SparkFun RTK products on, enable their radios, and data will be passed between units. Additionally, ESP-NOW supports point-to-multipoint transmissions. This means a Base can transmit to multiple Rovers simultaneously.



Radio configuration menu

Enable the ESP-NOW radio on the configuration page by opening the Radio menu and enabling ESP-NOW. No further configuration is required. No external antenna is required.

ESP-NOW is a radio included in every SparkPNT product and works well, but it has a few limitations:

1. Limited range. You can expect two RTK devices to be able to communicate approximately 250m (845 ft) line of sight but any trees, buildings, or objects between the Base and Rover will degrade reception. This range is useful for many applications but may not be acceptable for some applications. We recommend using ESP-NOW as a quick, free, and easy way to get started with Base/Rover setups. If your application needs longer RF distances consider cellular NTRIP, WiFi NTRIP, LoRa, or an external serial telemetry radio.
2. ESP-NOW can co-exist with Bluetooth but reception using Bluetooth SPP (aka Bluetooth Classic) is limited. When a user is connected over Bluetooth to the FPL while simultaneously running ESP-NOW, a fraction of incoming ESP-NOW data will be lost due to conflicts with Bluetooth. The best solution is to connect to the FPL over BLE.
3. ESP-NOW can co-exist with WiFi, but both the receiver and transmitter must be on the same WiFi channel. This is usually only a problem if the Base is also connecting to WiFi to run an NTRIP

Server. If problems arise, it is recommended to disable features on the base and rover that require WiFi (NTRIP, TCP, etc.).

By default, the ESP-NOW radios use the broadcast address to transmit all data from the base to any rovers in the area that also have their ESP-NOW radio enabled. If multiple teams are operating in the area, a base and and any number of rovers can be paired so that only those devices can hear each other.

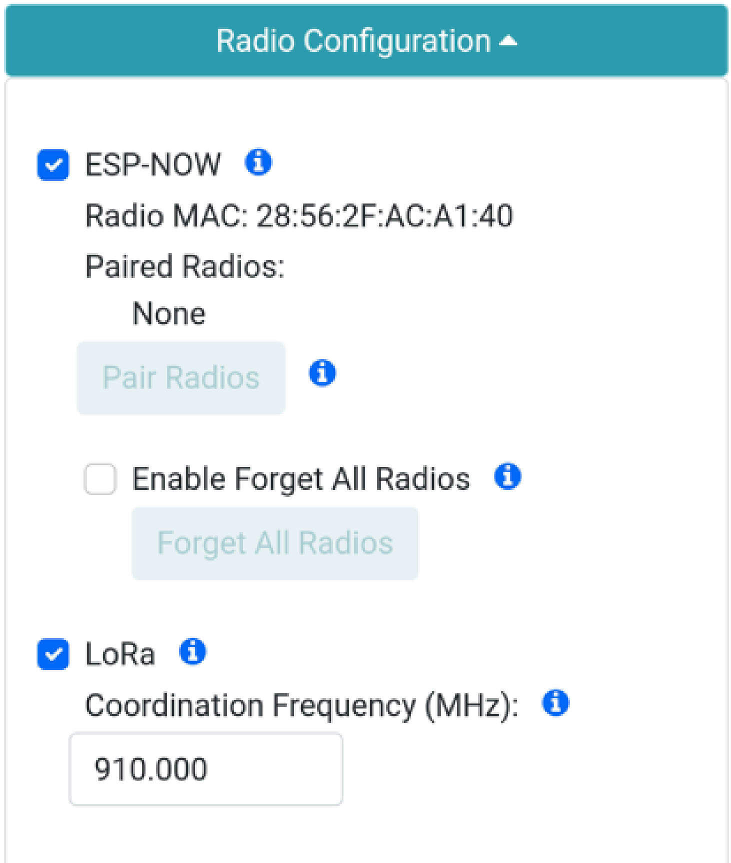
LoRa

LoRa has a range of around 16km (10 miles)

Miles of RTK Accuracy Using LoRa
SparkFun Electronics

Watch on

The FPL contains a powerful 1 watt long range (LoRa) radio capable of nearly 10 miles of line-of-sight range.



Radio configuration menu

Enable the LoRa radio on the configuration page by opening the Radio menu and enabling LoRa. No further configuration is required.

Coordination Frequency - This frequency is used by both rover and base radios to coordinate the frequencies that they will hop to during data transmission. Any rover will be able to hear any base with the same coordination frequency. If there are multiple teams operating in the same vicinity, set the base/rovers of the teams to different coordination frequencies so that they do not interfere with each other.

As more satellites are seen, more correction data is generated by the base GNSS receiver. Lowering the messages transmitted by using the Reset to Low Bandwidth Link button on the Configuration page can reduce traffic on the LoRa link and increase reliability.

FP with external LoRa antenna attached

The included 915MHz antenna must be attached to the FPL for transmission or reception.

Known limitations:

- The LoRa radio operates frequencies 902MHz to 928MHz. No HAM radio license is needed to legally operate this device in the United States. Please check your local laws to confirm 915MHz frequency radios are allowed.
- The LoRa radio is powerful, but it is not magic. The usable range is quite large compared to ESP-NOW or other 100mW packet radios, but it is impossible to predict how the FPL's LoRa radio will perform in a given environment. Dense materials including concrete, hills, earth berms, and water will block the signal.

Tilt Compensation

Tilt Compensation

The FPL does not have a tilt sensor. See the -T models.

Advanced Topics

These are features for advanced set ups.

Enabling 2.4GHz compatibility on an iOS device.

:::2.4GHz Limited The FPL uses 2.4GHz only. iPhones and some WiFi networks operate at higher 5.5GHz frequencies. Be sure to enable 'Maximize Compatibility' on iOS devices to allow 2.4GHz connections. :::

L-Band Service

Some companies broadcast an extra signal over geosynchronous satellites in something called the 'L-Band' which is really just a catch-all name for any broadcast between 1GHz and 2GHz. Because GNSS satellites broadcast their signal at ~1.57GHz (L1) and ~1.23GHz (L2), it is beneficial to broadcast an extra signal near these frequencies because the GNSS receiver hardware can be adapted to pick up this extra signal. Depending on the company, this signal adds additional correction data that can allow a GNSS receiver to obtain much higher accuracy than L1/L2/L5 positioning alone. But because broadcasting on satellites is exorbitantly expensive, the signal is often encrypted to force users to pay a subscription fee. The benefit of L-Band corrections is that they can cover an entire country or continent with corrections, without the need for internet connectivity, allowing for remote location to be surveyed, or scientific research conducted.

Base/Rover Setup

A base can be set on site and surveyed in with high accuracy in about 12 hours. Once that is completed a base can transmit corrections to the rover allowing the rover to obtain RTK Fix with high absolute accuracy. The connection between the rover and base can be accomplished with a variety of options. Please see Correction Transport for more information.

Resources & Support

Technical Support

A beginner's guide to get your device up and running

Warranty and Returns

A full listing of our terms of service, warranty, returns process, etc.

Repair Manual

A disassembly guide to replace or repair damaged components

Technical Resources

Reference documentation and product specifications for technical users

Technical Support

If you need technical assistance or more information on a product that is not working as you expected, please head over to our SparkPNT Forum. Feel free to check out our troubleshooting tips, below, for some suggestions on common topics. By posting on the forum you benefit other users with similar questions. It also gives us feedback as a whole about where our products and documentation need improvement.

> **ACCOUNT REGISTRATION REQUIRED**
>
> On your first visit to our forum, you'll need to create a Forum Account to post questions.

Order and Shipping Issues

If your order was damaged, misplace, or is missing any parts, please email our support team at `support@sparkpnt.com`. However, if your order was placed through one of our distributors please contact them first to resolve any issues.

> **INFO**
>
> For damaged or missing parts, please include a picture of your package's condition on arrival or inside the case, showing missing items to help expedite the process.

Troubleshooting Tips

Below are some tip to troubleshoot common issues that users may come across.

Galileo HAS

When utilizing corrections from the Galileo High Accuracy Service (HAS), users should expect an initial convergence time of 12 to 15 minutes and an accuracy of ~10 cm.

Battery Life

When fully charged, the device should be able to operate continuously for over 50 hrs.

> **INFO**
>
> It should be noted that the battery's capacity and efficiency will degrade over its lifetime. This is affected by several factors that include, but are not limited to the number of duty-cycles, discharge and charge rates, operating and storage temperatures, chemistry, manufacturing quality and defects, etc.
>
> Users can order and replace their battery; check out our disassembly instructions.

Warranty and Returns

We want you to get outside and get work done. For technical questions or support use the SparkPNT forums. If something is not right with a product, please contact us at `support@sparkpnt.com`. All products are covered with a 12 month warranty. If you need to have a unit serviced or checked out, contact us with your order number and a description of what's wrong and we will issue an RMA number. Once the unit is received, we repair or replace the product as quickly as possible. Most repairs take less than a week.

Right to Repair

SparkPNT is built on the premise that a user owns the device they paid for. (It's silly we even have to write those words!) We will never lock our customers into a walled garden. We will never sell hardware that is intentionally cobbled just to make you pay for a seat heater. We will never use 'security' screws or glue to try to prevent user repair. We provide repair documentation and replacement parts to make sure you can continue to use your device as long as you own it. We will do our best to our customers as long as it is possible.

Repair Manual

This guide is provided to assist users that need to repair a unit.

> **CHECK YOUR WARRANTY FIRST**
>
> We love DIYer's but products are covered by a 12 month warranty so check with us to see if a device is still covered or not. SparkPNT can also do out-of-warranty repairs for a very reasonable fee.

Remove the Dome

The FPL can be opened by removing the six Phillips head screws located on the bottom of the enclosure.

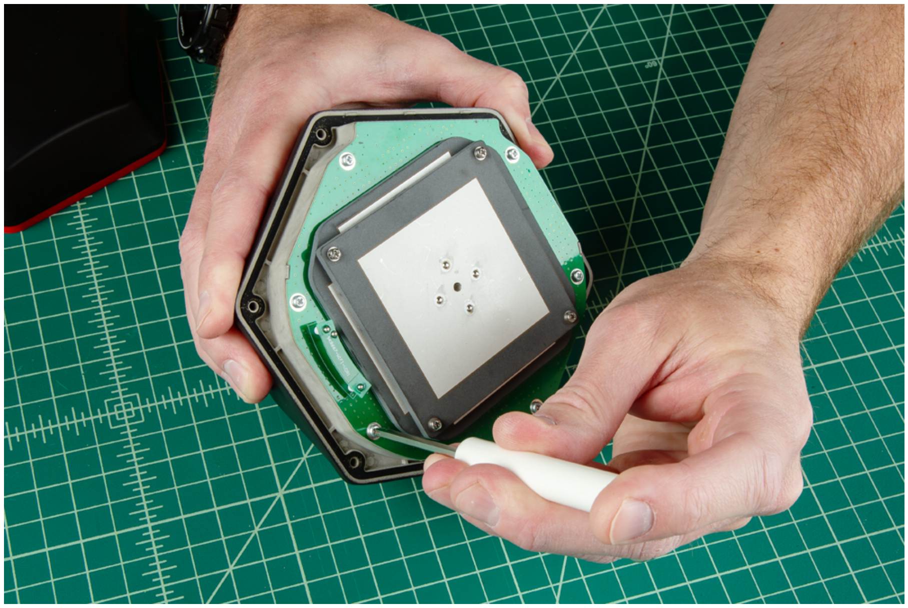
Remove the screws to release the top cover

Once unscrewed, the plastic cover should come off, exposing the ceramic GNSS and WiFi/Bluetooth antennas underneath.

For aiding in identifying units, or in the case where the gasket has become dirty or damaged, the colored silicone gasket can be replaced once the enclosure is opened. With the dome removed, take off the old gasket and slot in a new one.

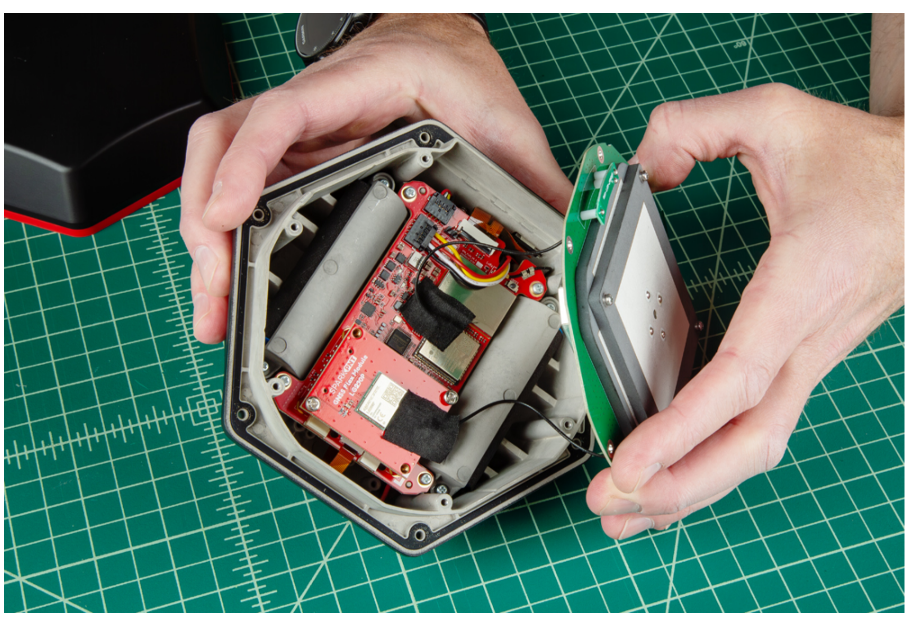
Remove the Antenna Stackup

Once the antenna cover is removed, users can access the six Phillips head screws holding the antenna PCB in place.



Remove the screws holding the antenna

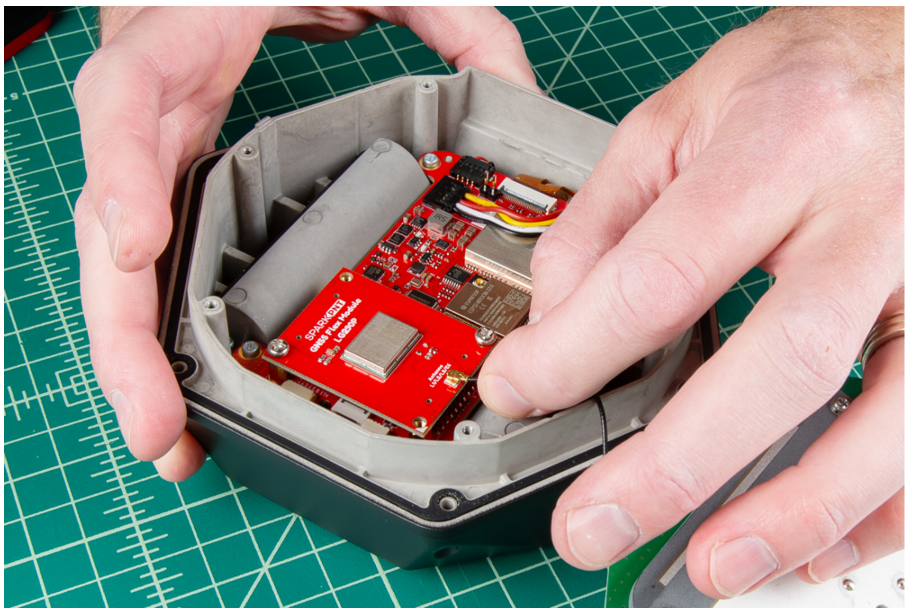
With the screws removed, gently and very carefully lift the upper PCB antenna off the enclosure. There are two U.FL cables underneath the antenna, users will need to disconnect the cables from the mainboard PCB and GNSS Flex module.



Carefully lift the antenna off the enclosure

> **TIP**
>
> Be careful removing the antenna element as there are U.FL cables attaching the antenna to other components.

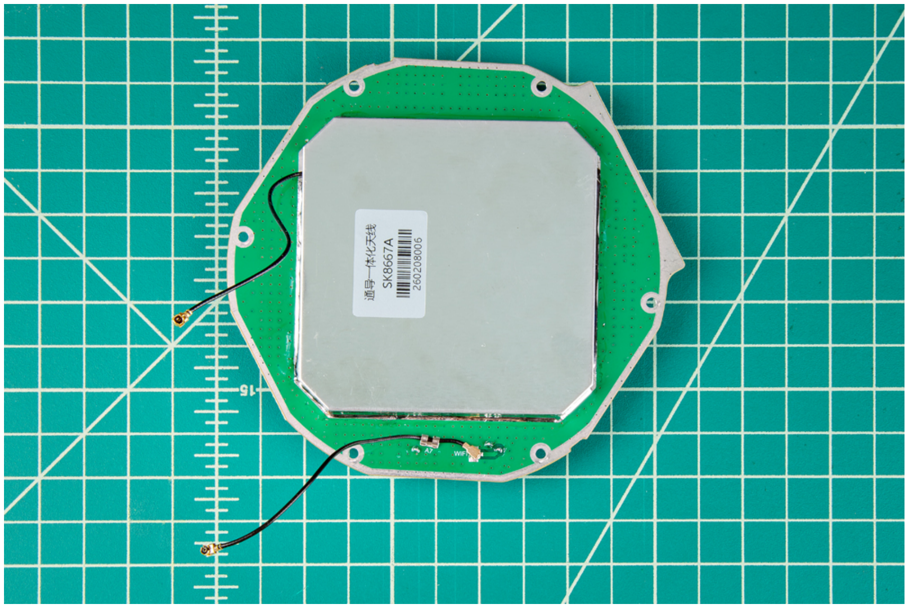
The U.FL connectors are held in place with a piece of tape, which must be removed to access them. Set the tape to one side so that it can be reused. Carefully disconnect the U.FL cable by lifting up on the black cable as close to the U.FL connector as possible. Users may want to use a U.FL tool to avoid damaging the connection.



Disconnect the U.FL cables from the GNSS and Mainboard

Swap Antenna

With the antenna element removed, users can replace the part as necessary.



The antenna element, removed from the FPL

> **INFO**
>
> - The U.FL cable for the GNSS antenna will lead directly to the large metal cover of the antenna element.
> - The U.FL cable for the WiFi/Bluetooth antenna will lead directly to the PCB of the antenna element.

Reattach Antenna

Once you have replaced all the necessary components, reconnect the U.FL cables from the antenna element to the mainboard and GNSS Flex module.

Reconnect the U.FL cable to the GNSS Flex module

Align the U.FL cable above the connector. Once in place, gently press straight down with an index finger. There should be a satisfying snap when the connector engages.

The U.FL cable that comes from the large metal cover of the antenna element needs to be connected to the GNSS Flex module. Meanwhile, the U.FL cable for the WiFi/Bluetooth antenna that is attached directly to the PCB of the antenna element, should be connected to the mainboard.

U.FL cables attached to the FPL

After the cables have been connected, replace the tape that was removed, this helps keep the cables in place.

U.FL cables attached to the FPL

Rotate the antenna element until in sits flat against the enclosure. The PCB of the antenna fits in only one orientation.

The antenna element aligned with the enclosure

Secure the antenna and the enclosure cover with the screws that were removed earlier.

> **TIP**
>
> - Don't forget to attach the silicone bumper with the enclosure's cover.
> - Be careful when threading these screws back into the cover. Over tightening or cross threading the screws into their holes, can strip out the screw head or eventually weaken the material fastening the screw.

Remove the GNSS Flex Module

Once the antenna stackup has been removed, users can access the Phillips head screws holding the GNSS Flex module in place.

Remove the screws holding the GNSS Flex module

Swap Modules

For users that are just upgrading or replacing the GNSS Flex modules, carefully remove the GNSS Flex module. It is connected to the main board with two sets of 2x10-pin headers. Go slow! Rock the module edge back and forth until it starts to release, then pull straight up.

Remove the GNSS Flex module from the FPL

With the old GNSS module removed, insert the new GNSS Flex module. Be careful align the Flex module correctly as the header pins are symmetric. The alignment indicator on the GNSS Flex module *(circled below)*, should align with the white indicator on the main board. Once aligned, press straight down until it is seated. Replace the screws to hold the module in place.

Replace the GNSS Flex module

TIP

- Ensure the position of the alignment indicator on the GNSS Flex module, is pointing away from the display interface.
- Be careful when threading these screws back into the cover. Over tightening or cross threading the screws into their holes, can strip out the screw head or eventually weaken the material fastening the screw.

Remove the Mainboard PCB

Disconnected the cables from the mainboard

Use your fingernail to 'flip up' the back of the two ribbon connectors. This will release the ribbons. Use a pair of tweezers to remove the ribbons. Disconnect the colored wire cables with five pins by gently pulling on it. Leave the 4 pin colored wire cable in please.Remove the U.FL cable by sliding it sideways out of the crimp holder, then lifting slightly to release it from the U.FL connector. Then, remove the four Phillips head screws holding the mainboard PCB in place to free the board.

> **NOTE**
>
> The U.FL cable for the LoRa cable in secured in place with a wire crimp. Users should be able to slide the cable sideways out of fixture. Be careful not to damage the cable or surrounding components.

Connected the cables on the mainboard

Above, once the mainboard has been unscrewed, pinch the remaining 4 pin colored wire connector with tweezers or fingers to allow it to release.

Replace the Mainboard PCB

Inserting the 4-pin cable

Once the unit has been serviced, shown above, first reconnect the 4-pin colored wire connector by pressing it back into place. Now screw the mainboard back into the enclosure.

Disconnected the cables from the mainboard

Once the mainboard is screwed down, use a pair of tweezers to insert the brown ribbon cables into their connectors. Using a finger or the handle of the tweezers, flip the latches down to secure the ribbon cables in their two connectors.

Reconnect the U.FL connector by lining the cable directly over the connector, then gently pressing down. There should be a satisfying snap when the connector engages. Slide the U.FL cable sideways into the cable silver cable clip.

Reconnect the 5 pin colored wire cable.

There components properly reassembled in the enclosure

Above is an example of the components properly assembled, including the GNSS Flex module. Note the GNSS module needs two screws to hold it into place before re-attaching the antenna.

> **TIP**
>
> Be careful when threading these screws back in. Over tightening or cross threading the screws into their holes, can strip out the screw head or eventually weaken the material fastening the screw.

Remove the Battery Plate

With the mainboard removed, the battery cover can be removed. Remove the four Phillips screws from the battery retainer plate.

Remove the screws from the battery retainer plate

The 7.2V LiPo battery pack can be replaced and users can access the interface connections located on the bottom of the SparkPNT FPL.

Replace the battery and/or service the connections

> **TIP**
>
> Be careful when threading the screws back into the cover. Over tightening or cross threading the screws into their holes, can strip out the screw head or eventually weaken the material fastening the screw.

Technical Resources

Reference Documents

The latest firmware and technical documentation for the device

Product Specifications

The hardware specifications for the device

Reference Documents

Latest Firmware

- The RTK Everywhere Firmware is open source. This repo houses the firmware and users are encouraged contribute feature ideas and bug reports.
- The RTK Everywhere Firmware Binaries contains the compiled binaries for the main firmware, as well as the latest firmware for the subsystems (GNSS, IMU, LoRa, etc). Users should use the firmware update method to load these binaries.

Technical Documentation

The following datasheets, manuals, and documents are available for the SparkPNT FPL:

- All SparkPNT Product Documents.
- LG290P GNSS Receiver Datasheet

Product Specifications

- Antenna
    - L1, L2, L5, L6
        - Gain: ≥2.3dBi
        - APC (NGS Calibrated ANTEX ANTINFO):
            - L1: 65.7mm
            - L2/L5: 50.9mm
            - Average: 58.3mm
    - WiFi/Bluetooth (SPP and BLE)
        - 2.4GHz
- Enclosure
    - Ingress Protection: IP67 (1m of water for 30 minutes)
    - Materials: Magnesium body w/ fiberglass dome
    - Dual button menu system
    - Three LED indicators
    - USB-C port
    - microSD for data logging
    - TNC for 1W LoRa Radio
    - 5-pin Lemo-compatible connector for RS232 communication
    - 4-pin JST connector for TTL communication
- Battery
    - Specs: 7.2V 6800mAh (48.96Whr)
    - Charging: 2W maximum
    - Run Time: 50hrs
- Dimensions: 71 x 71 x 147mm (2.8 x 2.8 x 5.8in)
- Weight: 423g (0.93 lbs)