EMLID REACH RS3

SETUP & USER GUIDE FOR DITCH ASSIST

DITCH ASSIST

1. INTRODUCTION TO EMLID REACH RS3

Welcome to the user manual for the Emlid RS3 GNSS receiver, specifically tailored for integration with the Ditch Assist™ system. The Emlid RS3 is a state-of-the-art GNSS receiver that leverages Real-Time Kinematic (RTK) technology to deliver centimeter-level accuracy, making it an ideal choice for precision agriculture applications such as surface drainage, land leveling, and land forming. With its robust design, the RS3 ensures reliable performance even in challenging environments. This manual will guide you through the setup and operation of the RS3 in conjunction with Ditch Assist, ensuring you achieve optimal results in your land management tasks.

1.1 UNDERSTANDING HOW REACH RS3 WORKS WITH DITCH ASSIST

The Emlid RS3 is a versatile GNSS receiver that can be configured in multiple ways to suit different needs. For Ditch Assist users, the most common configurations are:

- As a RTK base station
- As a RTK rover receiving corrections from another RS3 configured as a base station
- As a RTK rover receiving corrections over NTRIP from a CORS or VRS RTK network

In the Ditch Assist setup, the rover receiver is mounted on the implement being controlled and connects directly to the Ditch Assist Control Module. The rover is configured to output specific NMEA messages, which provide Ditch Assist with the precise position information required for optimal operation.

Proper setup and operation of both the base station (if used) and the rover are crucial for obtaining reliable and accurate position data necessary for Ditch Assist functionality.

Please read through this guide thoroughly before operating your system to ensure you understand and can follow the best practices provided.

1.2 EMLID RS3 KIT COMPONENTS

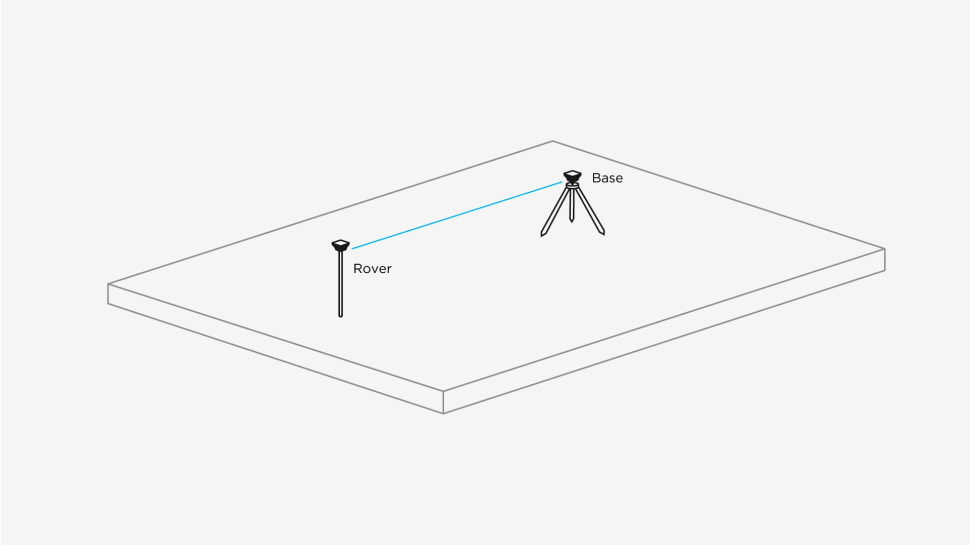
Based on your location and the options you have chosen, you will receive a combination of the following components:

 	**RS3 RECEIVER PRE-CONFIGURED & LABELED AS A BASE STATION** • Setup to average position for 2 minutes when powered on • After 2 minutes, begins transmitting RTK corrections over LoRa radio on a selected frequency • LoRa radio antenna included in case
 	**RS3 RECEIVER PRE-CONFIGURED AND LABELED AS A ROVER (PAIRED WITH BASE STATION)** • Programmed to output NMEA messages required for Ditch Assist • Configured to receive RTK corrections via LoRa radio and matched to frequency on paired base station • LoRa radio antenna included in case

 	**RS3 RECEIVER PRE-CONFIGURED AND LABELED AS A ROVER (TO BE USED FOR CORS OR VRS VIA NTRIP)** • Programmed to output NMEA messages required for Ditch Assist • Will NOT be configured for RTK correction input. User will be required to configure with their SIM card and CORS/VRS credentials - see instructions later in this manual • LoRa radio antenna included in case (but not required if using NTRIP)
	**CONTRACTOR TRIPOD** • For use with base station If you need to purchase a tripod locally, any standard contractor tripod with 5/8-11 thread will work
 	**BASE STATION EXTENSION POLE AND MOUNTING DISK** • Extension pole to raise RS3 base station receiver and provide clearance for radio antenna • Metal disk adapter to allow RS3 to securely attach to the tripod

	**DITCH ASSIST TO EMLID GPS CABLE** • Required to connect RS3 rover to the Ditch Assist Control Module • When used with Ditch Assist or Ditch Assist X, this cable also supplies continuous power to the RS3
 	**BASE STATION POWER CABLE (optional)** • Allows connection to 12V battery for continuous power for base station • (Exact design and battery clips may differ from those shown) *Note that all RS3 receivers have a high-capacity internal battery that should be sufficient for a full day's use on a full charge*

2. QUICK START - PRE-CONFIGURED EMLID RS3 BASE AND ROVER



To get started with a pre-configured Emlid RS3 receiver pair, follow these instructions. If your receivers aren't pre-configured, refer to the configuration instructions in this manual. Once you've set up the base and rover for Ditch Assist, return to this section.

1. Mount Rover RS3 Receiver on Implement

a. The rover must be mounted at a location that moves vertically in proportion to the cutting edge. The RS3 has a standard ⅝-11 thread for mounting.
b. The rover must be installed high enough that no part of the implement or the tractor will block its sky view from at least 30 degrees above the horizon.

i. A custom-fabricated mount may be required if the implement does not have a suitable mount point.

c. For excavator installations, screw the RS3 to the ⅝” threaded rod on the GPS pendulum mount included in your excavator system kit.

d. Attach the LoRa radio antenna securely to the RS3 receiver, making sure the antenna is not touching any part of the GPS mount or any other metal surface.

e. Connect GPS cable to rover receiver and Ditch Assist main harness (for use with Ditch Assist and Ditch Assist X).

DO NOT POWER ON DITCH ASSIST UNTIL THE BASE STATION IS SETUP

The Rover receivers are pre-configured to auto power ON and OFF when Ditch Assist is turned on. The rover receiver should be powered ON only after the base station is started to avoid timeouts if base corrections are not received for a prolonged period.

2. Setup Base Station RS3 Receiver

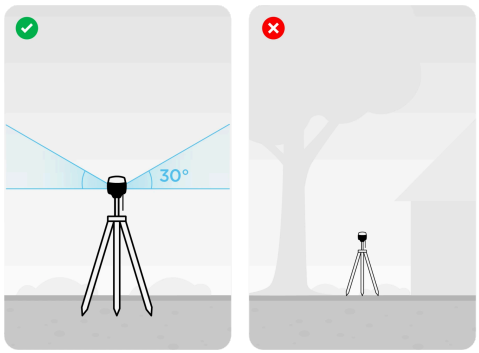
a. Select a suitable location to setup the base station:

i. Within ½ mile (800m) of your working locations

ii. Where you’ll have line-of-sight from the base station to your working locations

iii. If possible, at a higher elevation than your working locations (e.g. hilltop provided it has line-of-sight to working location)

iv. Where there are no obstructions - the base needs to have a clear sky view above 30 degrees of the horizon



b. Install RS3 Base receiver on contractor tripod

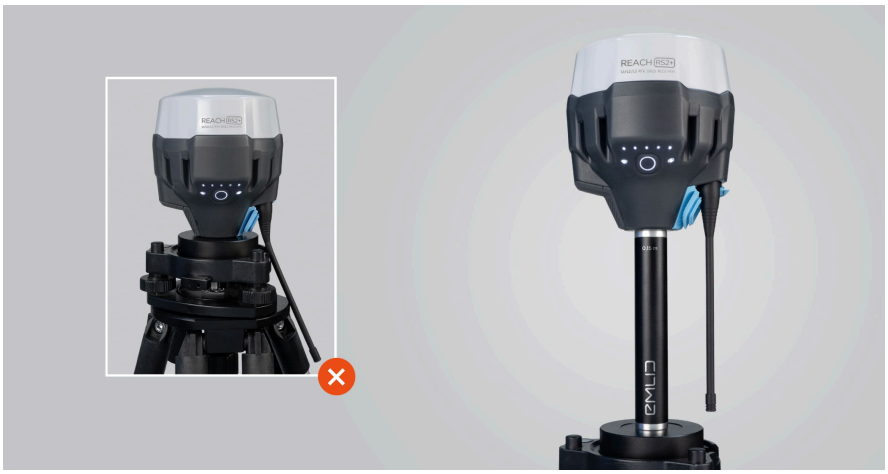
i. Fully extend tripod legs to allow receiver to be setup as high as possible above the ground

ii. Ensure tripod is level

iii. Use disk adapter, survey tribrach, or fabricated equivalent to cover opening on tripod, then attach extension pole to provide clearance for LoRa radio antenna

iv. Thread RS3 receiver onto extension pole and attach LoRa radio antenna

- Make sure the LoRa radio antenna is not bent or touching any part of the tripod assembly - this will affect RTK signals



c. Power On the Base Receiver by pressing the power button for 5 seconds

i. Only power on the base receiver once it is installed on the tripod

ii. After an initial boot process, the base receiver will begin position averaging to determine its approximate position

- The receiver will average it's calculated position for 2 minutes
- After this time the receiver will begin broadcasting RTK corrections

3. Power on the Rover Receiver (or power on Ditch Assist to auto power on the rover)

a. The rover will go through a similar boot process, and will then determine its approximate position and begin listening for RTK corrections from the base.

b. Once the Rover receiver begins receiving RTK corrections, it should achieve RTK Fixed status within a few seconds.

i. You'll hear an audible BEEP once the receiver obtains RTK fix
ii. If connected to the Ditch Assist App the Fix Quality will change to **RTK**

YOU ARE NOW READY TO BEGIN WORKING

ANY TIME YOU MOVE THE BASE STATION YOU MUST POWER IT OFF AND THEN BACK ON AGAIN ONCE IT IS INSTALLED ON THE TRIPOD AT ITS NEW LOCATION

- If you don't do this you will keep dropping RTK even if you are working very close to the new base location.
- This is probably the most common issue we run into (along with users powering up the base receiver before they install it on the tripod!).

3. The Importance of Correct Base Station Setup

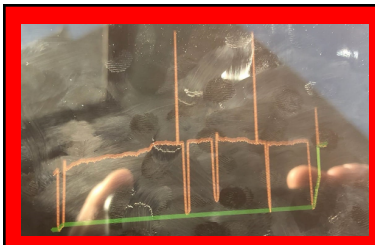
RTK is like a complex math game played by your implement's GPS receiver (the rover) to figure out where it is compared to a known location (the base station). The base station knows its location to within a few feet, and receives signals from satellites. It then compares the position it would calculate for itself if it didn't know where it was to its known position. Based on this, it sends correction messages to the rover using radio, telling it how much error each satellite signal picked up while traveling through space and the atmosphere. The rover uses these corrections to calculate its position super accurately, to within an inch of the base station.

For this math game to work, the base station needs to be set up correctly. The most important things are where you put it and making sure it knows its exact location on Earth. If you mess up either of those, you'll run into problems. It doesn't take much extra effort to make a big difference!

What NOT to do! (And how to do it the right way)

Farmer Frank got lazy and unfolded the base station tripod legs but didn't extend them, meaning it sat about 2ft high. It was also a little lopsided. He set the tripod right next to his truck at the edge of the field. Frank powered up the base station receiver and left it on the seat of the truck while it fired up, then a couple of minutes later screwed it onto the tripod. He'd also forgotten the extender pole for the tripod, so the radio antenna was a little crooked as it was bent out sideways from the tripod.

When he jumped into the tractor to start scraping, the Ditch Assist app showed he had RTK and everything looked great. But, as he ran his first survey, things didn't go so well. The survey had lots of hills and valleys, and given this was a flat field that didn't seem right.



So, Frank jumped out of the tractor, ran over to the base station, and moved it away from the truck, thinking that was the issue. But the problems continued. The system was pretty much unusable. Frank constantly lost RTK when he was trying to survey or ditch, and became so frustrated he gave up and went home to do something more productive.

There are a myriad of issues in the above scenario, and any one of them could have resulted in issues. Hopefully you spotted all of them!

Issue #1: Not Extending the Tripod Legs Fully

RTK relies on reliable delivery of correction messages from the base to the rover. Anything you can do to improve the chances of the messages making it gives you a better chance of being productive and not losing your RTK fix. **Extend the tripod legs and set the base station as high as you can!**

Issue #2: Tilted Base Station

If the tripod is tilted, the base receiver will also be tilted. While this may not seem like a big deal it will add a few extra inches of error to the base station's calculated position; small details can compound into bigger issues. **Spend a few extra seconds making sure the base station receiver is level on the tripod!**

Issue #3: Obstructed Base Station

Setting up the base station next to a truck, building, trees, grain bins, or anything else that could block the satellite signals is a big no-no. Maybe you've done it before and everything worked okay, but that doesn't mean it was right. The smarts inside modern RTK receivers can often overcome issues this creates so you never notice. But when the base station has an obstructed view to any part of the sky you always run the risk that the rover will have a hard time getting RTK fix in the first place (it may take a minute instead of a few seconds to get a fix), and it will also lose it much more easily if you go over rough terrain or even just change direction. **Always, Always, Always set up the base station where it has a completely unobstructed sky view in all directions!**

Issue #4: Incorrect Base Station Calibration

As we know, the base station needs to know its true location so it can calculate the errors and required corrections for the rover to apply. Frank powered up the base in his truck, so it probably spent a couple of minutes averaging the position of the front seat! When he moved it onto the tripod it was in a completely different location than it had set as its *true* position. Therefore, all the correction messages it was sending to the rover meant the rover was trying to determine its position in relation to the front seat of the truck, not the actual location of the base station. This is a common issue that few understand, and it results in the rover either not being able to compute a RTK fix in the first place, or losing fix constantly while working because the math just doesn't make sense. **Install the base station receiver on the tripod before powering it on!**

Issue #5: Radio Antenna Interference

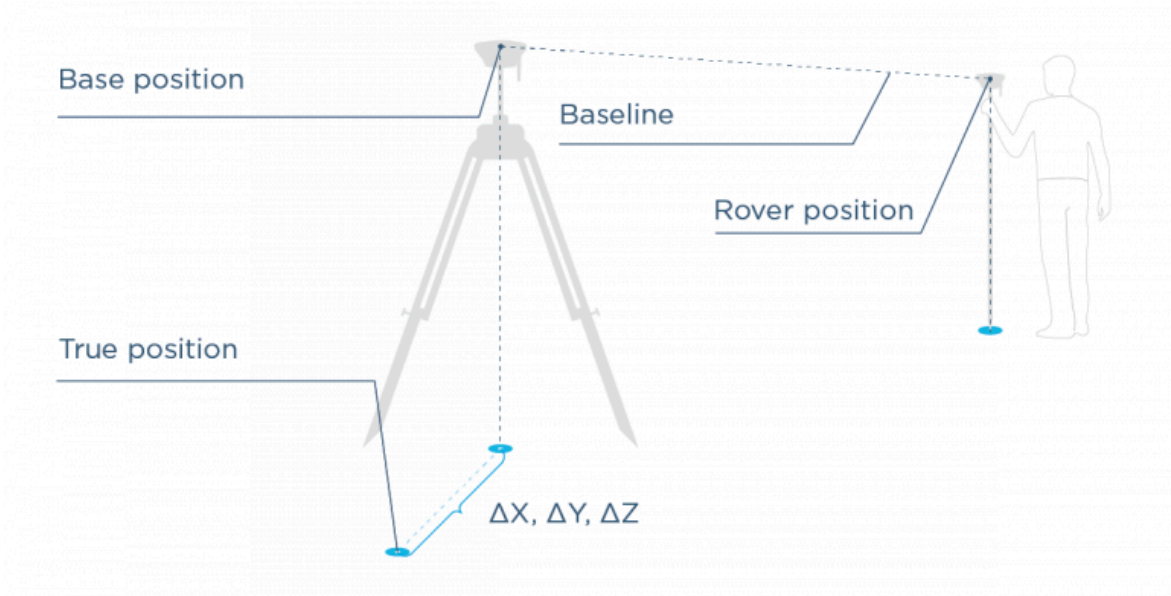
By not using an extension pole to raise the base station clear of the tripod, Frank's radio antenna was contacting the metal surface of the tripod. This probably meant radio signals were being transmitted through the tripod rather than into the airwaves. At close distances this may not have much impact, but when trying to work further away from the base, it almost definitely will, resulting in frequent loss of RTK fix. **Always use the extension pole to keep the radio antenna clear of any interference!**

Issue #6: Moving the Base Station without Power Cycling

Frank did the right thing moving the base station away from the truck, but because he didn't power it off and then on again, it continued to use the originally-calculated position as its reference point. This introduces the same error as in issue #4. **Whenever you move the base station you must power it off and on again!**

The above are the most common causes of RTK issues for Ditch Assist users. By taking a few extra minutes to avoid them you can save yourself days of lost work. Combine these best practices with making sure you install the rover receiver as high as possible on the implement, and try to work with line-of-sight to the base station, and you will minimize the chances of running into issues.

4. Understanding Base Station Shift in RTK Systems Due to Autonomous Base Positioning



When using an RTK (Real-Time Kinematic) GPS system, you work with a base station and a rover. The base station provides correction data to the rover, enhancing its positioning accuracy. However, if the base station determines its position autonomously each time it powers up, a phenomenon known as "base station shift" can occur.

We configure our base stations this way because it's the simplest method for the end user: just power on the base, wait two minutes, and you're ready to begin working. While convenient, it's important to understand how this autonomous positioning affects day-to-day positions or when moving the base station.

For most users, this isn't an issue—they survey a proposed route, complete the earthworks, and repeat this process until they shut down for the day. However, if you start a project one day and return the next, powering up your base station will cause base station shift, resulting in different elevations from one day to the next.

Read on to understand why this happens and how to overcome it.

4.1 Why Does Base Station Shift Occur?

- **Autonomous Positioning**: Each time the base station powers up, it calculates its position anew using low accuracy WAAS corrections, averaged over 2 minutes.

- **Slight Variations**: Due to the accuracy of WAAS, changes in satellite geometry, and atmospheric conditions, this calculated position can vary slightly with each power cycle, even if the base station doesn't move or you leave the tripod out in the field.
- **Impact on Rover**: While the rover maintains high relative accuracy to the base station (often sub-inch), the absolute position can shift because the base station's reference point has changed.

4.2 Relative vs. Absolute Accuracy

- **Relative Accuracy**: The precise measurement between the rover and the base station. This remains highly accurate because the rover continually adjusts based on the base station's signals.
- **Absolute Accuracy**: The exact position in a global coordinate system. This can vary if the base station's reference position changes, affecting all subsequent measurements.

4.3 Implications of Base Station Shift

- **Inconsistent Data after each Base Power Up**: Previous surveys or measurements may not align with new data because the base station's reference point has shifted.
- **Project Discrepancies**: This shift can cause issues in projects over multiple days or when the base station is moved to provide coverage to different areas on large projects.

4.4 How to Mitigate Base Station Shift

Re-survey Previously Surveyed Runs:

- **Purpose**: Ensures all data aligns with the current base station position.
- **Method**: Repeat the survey process for any proposed works after each base station power cycle.

Use Calibration Tools:

- **Nudge Function**: Place blade on location that is known to be on-grade. Nudge UP or DOWN until you are shown to be on-target. Continue working with this nudge offset for all surveys from the previous base station reference position.

- **GPS Height Calibration**: As above, but adjust the GPS to Blade / Calibration Factor value in Settings until the app shows you are on-target when the blade is resting on a previously completed piece of ground.

5. Using the Emlid Flow App to Setup your Reach RS3

Emlid Flow allows you to control Reach RS3 receivers with iOS or Android devices. Using the app, you can access your receiver over Bluetooth or a Wi-Fi network, set it up for use with Ditch Assist, or for other uses like surveying, and collect and stake out points right in the app. The connection process is similar for both iOS and Android devices.

1.1 Download Emlid Flow

To manage Reach RS3, download the Emlid Flow app on your iOS or Android mobile device from your App Store, or scan the QR code:	

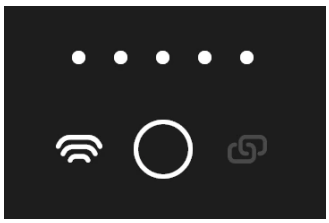
⚠ USING REACH WITH ANDROID DEVICES

Some Android devices have battery optimization enabled by default. Make sure you disable it for Emlid Flow to avoid disconnection.

You may also need to disable Mobile Data temporarily on android phones for the app to connect correctly

1.2 Power on Reach RS3

To power up your Reach, follow the steps below:

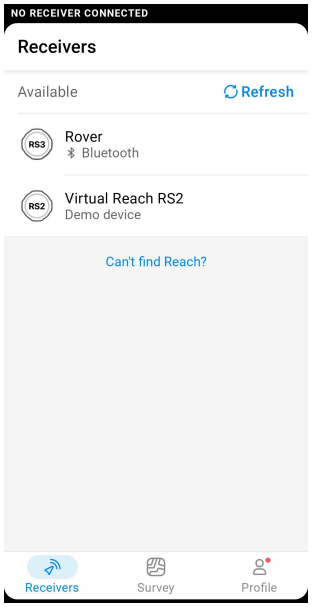
1. Hold the power button for 5 seconds to turn the unit on. 2. Wait for about 30 seconds until the Power LEDs will stop blinking and the Network LED stays solid white.	

Reach RS3 is now broadcasting Wi-Fi and is ready to connect to.

1.3a Connect to Reach RS3 via Bluetooth

From Firmware version 33 it is now possible to connect to the RS3 units via Bluetooth. This is simpler than connecting via WiFi, and as of the current version (33 beta 3) at the time of writing, works very well. If your receivers are running older firmware, you will need to follow the instructions later in this manual to connect to them and update firmware.

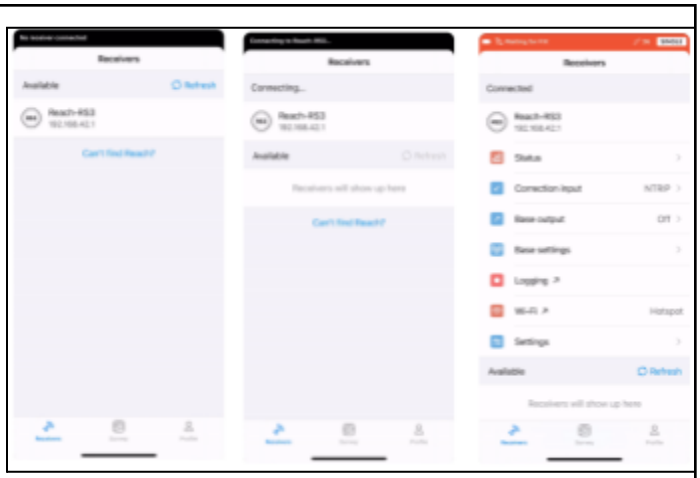
1. Ensure your firmware is at least version 33 and you have the latest version of the Emlid Flow App installed
2. Power on the Emlid receiver(s) and wait until boot is complete
3. Open the Emid Flow app. You should see any nearby Emlid devices with the Bluetooth symbol below them
4. Tap on an available Bluetooth receiver and you will be taken to its menu page.



1.3b Connect to Reach RS3 via Wi-Fi

To connect to your Reach, follow the steps below:

1. Open a list of Wi-Fi networks on your smartphone or tablet.
2. Connect to a network named BASE:XX:XX, ROVER:XX:XX, or reach:xx:xx
a. We program the receivers to show up as *BASE* or *ROVER*
3. Type network password: ***emlidreach***
4. Open the Emlid Flow app.



5. Choose your unit from the list of available devices.	

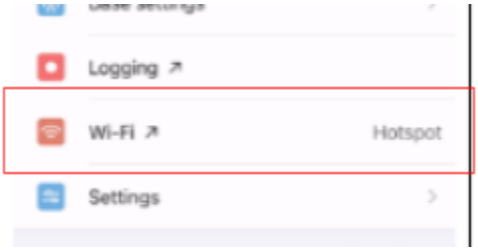
> **NOTE**
> If there is only one receiver, the app will automatically try to connect to this Reach.

6. How to Update the Software on your Emlid RS3

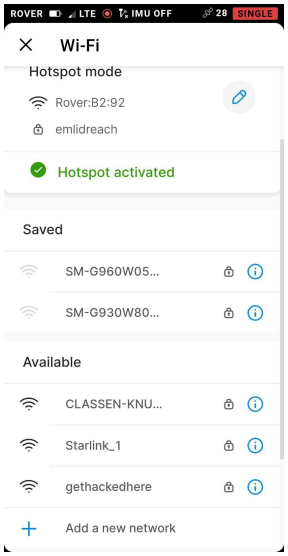
Emlid releases regular firmware updates that include new features and fixes. However, **we recommend that you don't update your firmware mid-season when you are using your system if everything is working well**. Waiting until the end of the season, or performing updates pre-season when you have time to troubleshoot any possible resulting issues will save you time and stress!

The process of updating the firmware involves connecting the Emlid device to your home or office Wi-Fi network, and then downloading and installing the latest version of the firmware. Provided you connect your phone or tablet to the same Wi-Fi network, the Emlid Flow app will be able to 'see' the receiver.

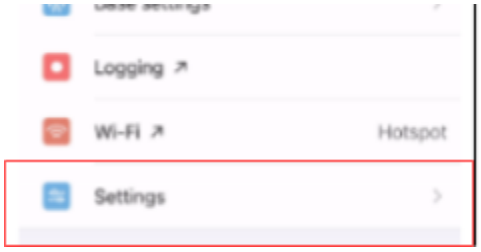
1. Connect to the RS3 via its Wi-Fi hotspot as outlined in the previous section.
2. Open the Emlid Flow app and tap on the Wi-Fi menu from the main screen.



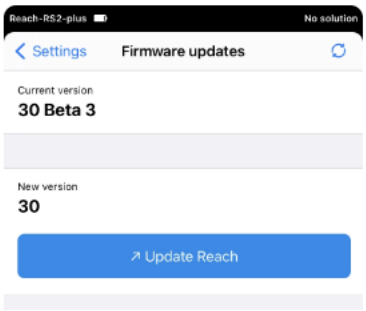
3. About half way down the page you'll see a list of available Wi-Fi networks that the receiver can connect to. Pick your home or office network, and enter your Wi-Fi password when prompted.



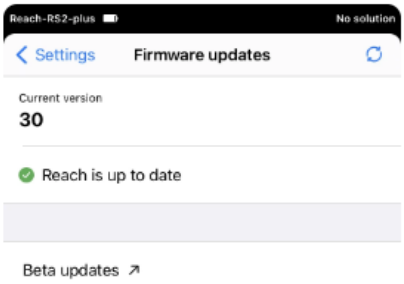
4. The receiver will attempt to connect to the Wi-Fi network. If it is successful you should see the wireless network icon next to the power button on the receiver turn solid blue. 
    a. If it flashes blue constantly, then turns white again this means the receiver couldn't connect, and you may need to reboot it, connect to it again via its hotspot, and try again. Make sure you have the correct password (it will be case sensitive).
5. Connect your phone or tablet to the same Wi-Fi network and open the Emlid Flow app on it.
    a. You should see the receiver and be able to connect to it
    b. If you have issues connecting, try force closing the Emlid Flow app and then running it again
6. On the main screen, tap Settings, then find the menu option for Firmware Updates



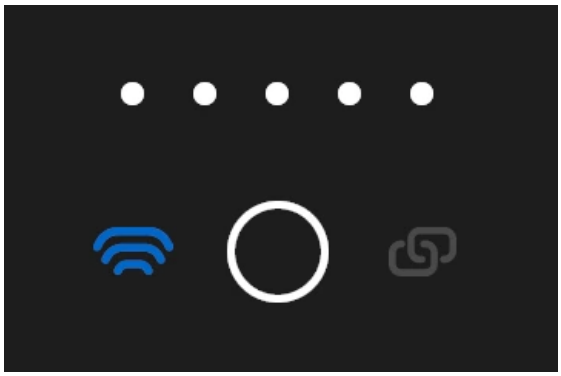
7. If a new version is available you'll be prompted to update.



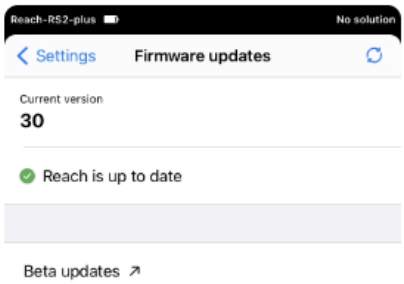
a. If no new version is available you'll see a message that you already have the latest version



8. Tap the button to update your receiver.
    a. The receiver will first download the latest version of the firmware, which may take 10-30 minutes
        i. Make sure you leave the receiver powered on and connected to Wi-Fi while it downloads the update
    b. Once the firmware is downloaded it will automatically install. The receiver will power off and restart once the update is complete.
9. After the reboot, wait for the Network LED to turn blue, showing that the receiver has joined your Wi-Fi network again.



10. Close and re-open the Emlid Flow app. You should be able to connect to the receiver again provided your phone is still connected to your home/office Wi-Fi.
11. Navigate back to the Firmware Updates screen and verify you have the latest version



12. Firmware update is now complete.

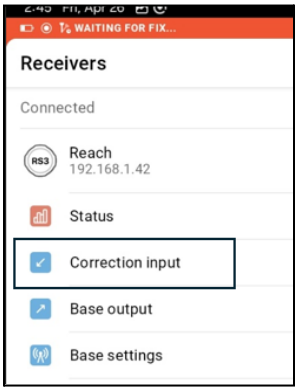
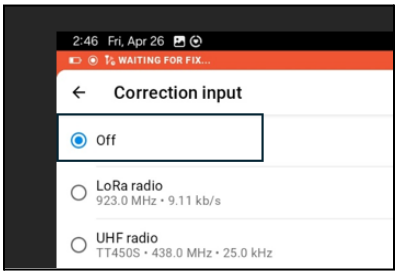
7. Setting or Restoring your Emlid RS3 receiver for use with Ditch Assist

Emlid RS3 receivers supplied with Ditch Assist should come pre-configured to work out of the box. If you need to set up or restore settings, please follow these instructions.

7.1 Base Station Setup

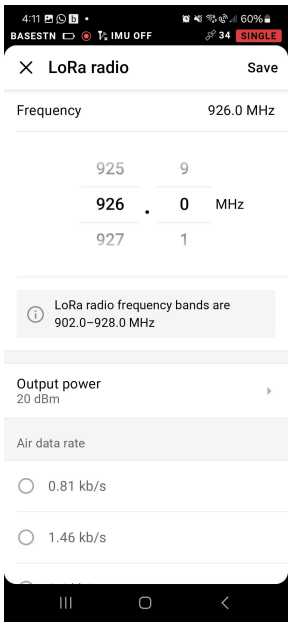
Connect the Base receiver to the Emlid Flow App. Follow the instructions in the previous section.

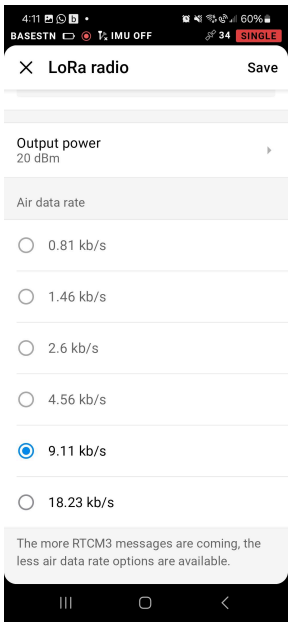
7.1.1 Base Correction Input Settings

From the main screen, navigate to **Correction Input** and turn this OFF		

7.1.2 Base Output 1 Settings

1. Navigate to **Base Output 1** settings and select LoRa radio, then tap the pencil icon
2. Select the radio frequency that the base and rover will be paired to. Write this down for future reference. We suggest trying a frequency **between 926 and 928** as these tend to be less prone to interference, however you may need to test different frequency ranges in your specific area if you find you have very poor radio range.
3. Set the Output power to **20 dBm**, and the air data rate to **9.11 kb/s**

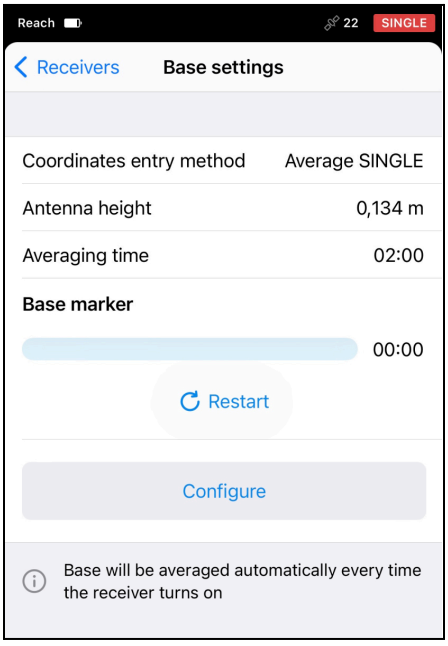




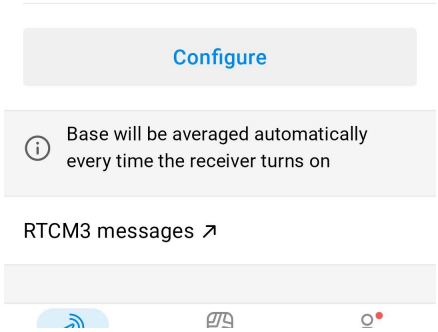
7.1.3 Base Settings

From the main screen, navigate to **Base Settings** and click ***Configure*.**

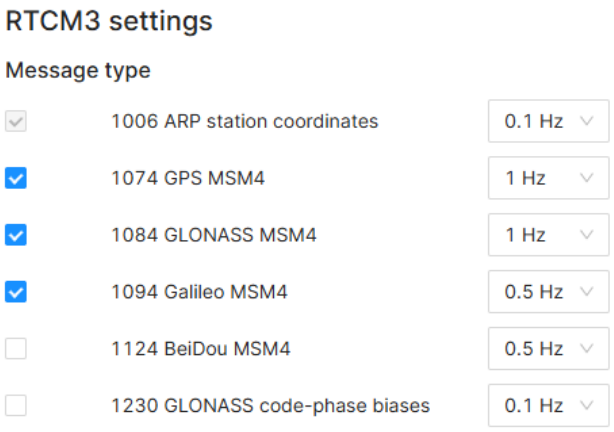
- Set Coordinates entry method to Average SINGLE for 2 minutes as shown (Antenna height doesn't matter):



Scroll down below the Configure button and tap on *RTCM3 messages*.

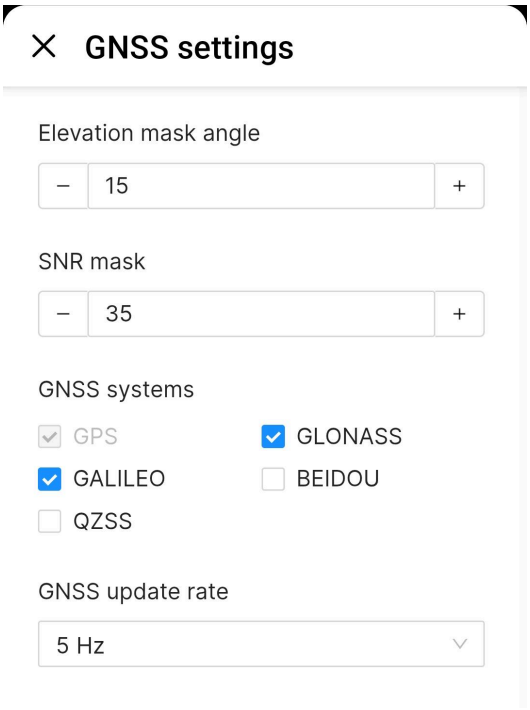


Enable **only** the first 4 Message types exactly as shown to the right and save:

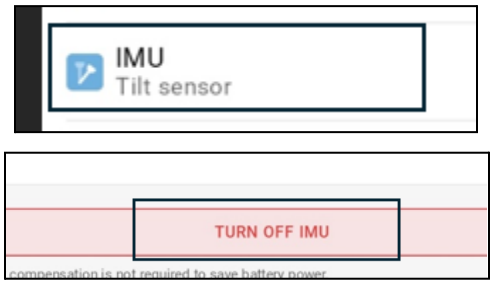


7.1.4 Base Settings > GNSS Settings

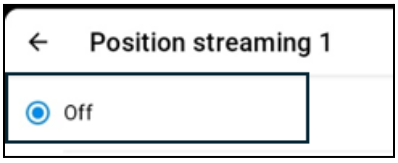
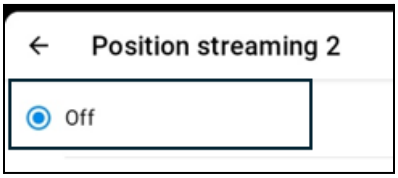
Navigate to Settings > GNSS Settings. Set exactly as shown:



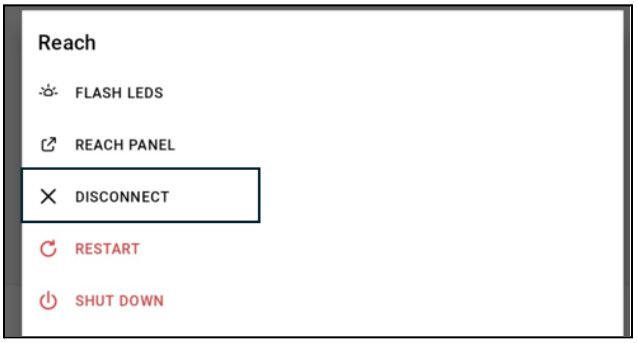
7.1.5 Base Settings > IMU

Navigate to **Settings**. Select “IMU”. Select “TURN OFF IMU”	

7.1.6 Base Settings > Position Streaming 1 & 2

Navigate to **Settings** and turn OFF **Position Streaming 1 and 2**		

Once configuration is complete, from the main screen, select the Reach icon and DISCONNECT.

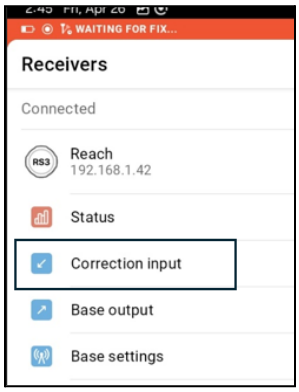
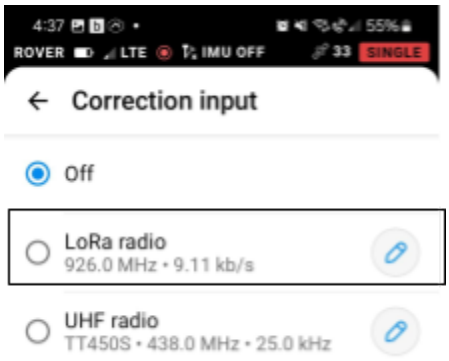


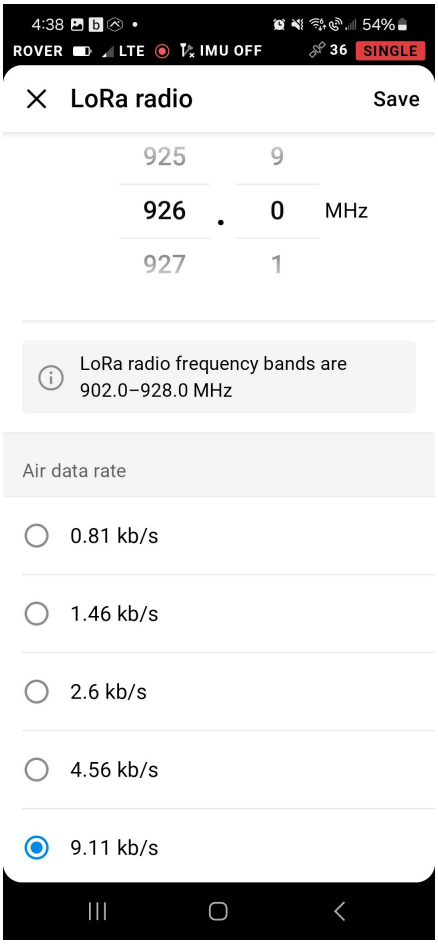
The receiver is now configured as a base station. It will average its position for 2 minutes when powered on, then begin broadcasting RTK corrections over the LoRa radio to the rover.

7.2 Rover Setup

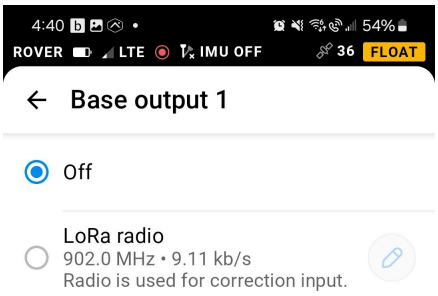
Note that the correction input settings here refer to a rover that is setup to work with a second RS3 receiver that's configured as a base station. If you are using NTRIP (CORS or VRS), refer to the later chapter for correction input configuration.

7.2.1 Rover Correction Input Settings

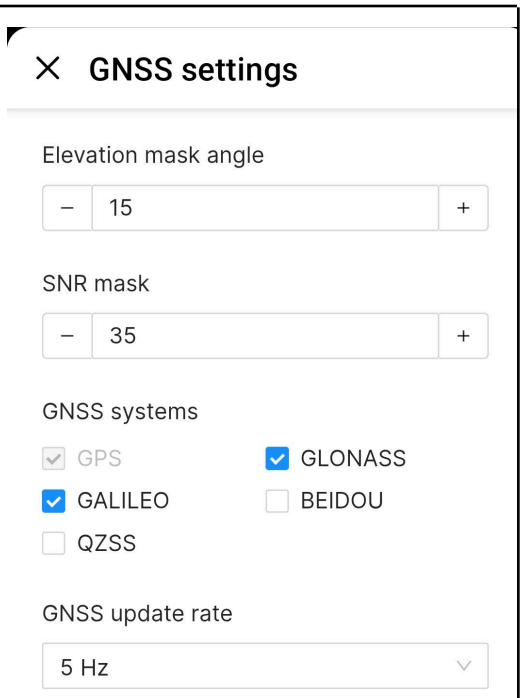
From the main screen, navigate to **Correction Input**	
Select LoRa radio, and click the pencil icon to the right	

Make sure the frequency and air data rate match those set for the base station	

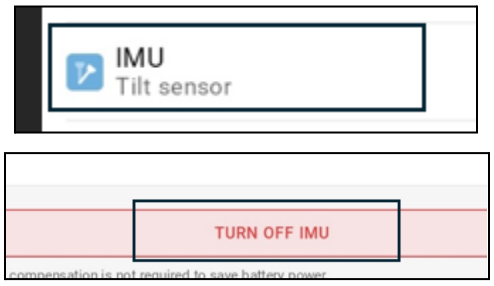
7.2.2 Rover Base Output Settings

Navigate to **Base Output 1 and 2** settings and turn both OFF	

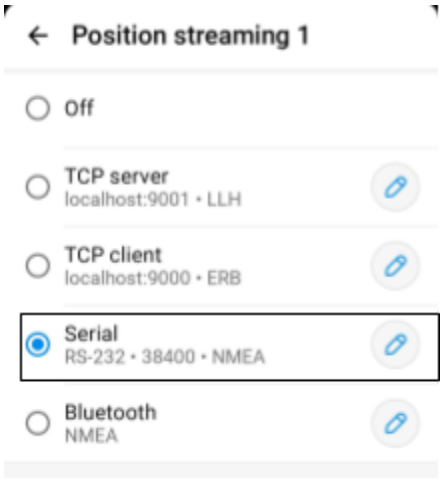
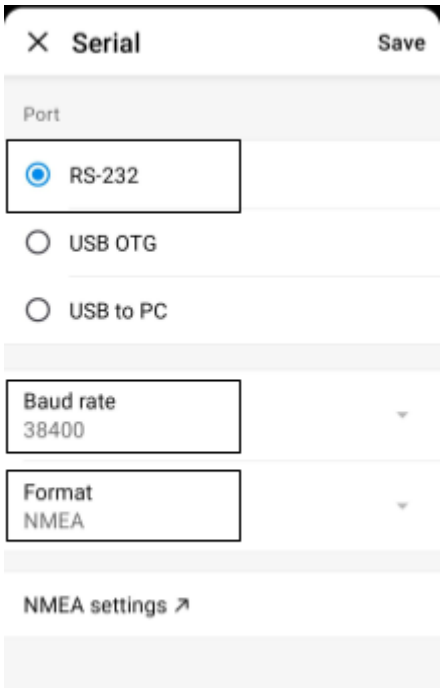
7.2.3 Rover Settings > GNSS Settings

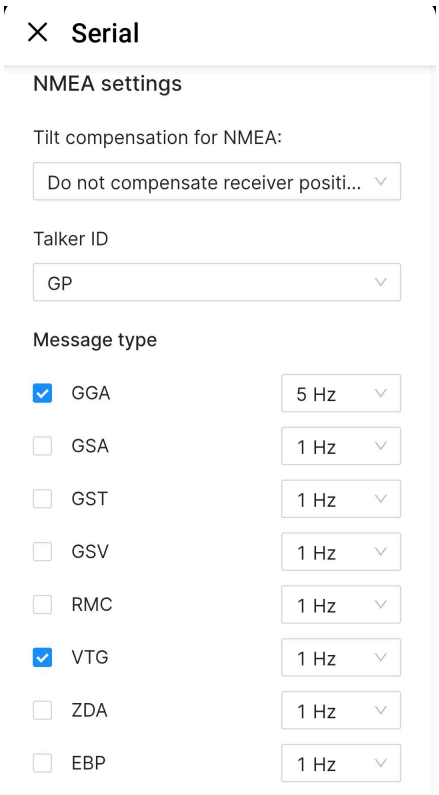
Navigate to Settings > GNSS Settings. Set exactly as shown:	

7.2.4 Rover Settings > IMU

Navigate to **Settings**. Select “IMU”. Select “TURN OFF IMU”	

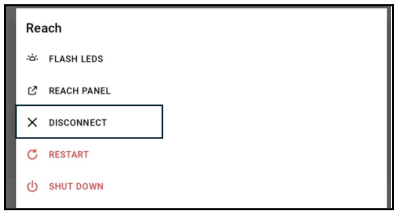
7.2.5 Rover Settings > Position Streaming 1

• Navigate to **Settings** > **Position Streaming 1** • Select Serial and tap the pencil icon	
• Select *RS-232* • Set Baud rate to *38400* • Set Format to *NMEA*	

• Tap on NMEA settings, and set as follows: ○ Do not compensate for receiver position ○ Talker ID: GP ○ GGA messages at 5Hz ○ VTG messages at 1Hz ○ ALL others OFF	

7.2.6 Settings Auto Power ON/OFF

In Settings menu, enable option to auto power on when power is supplied via the Ditch Assist GPS cable	

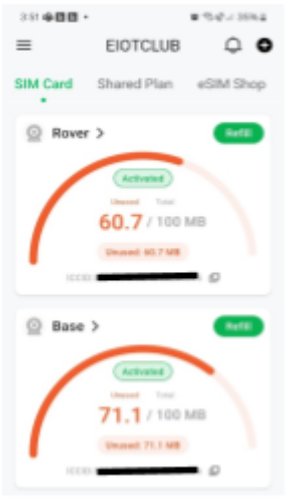
Once configuration is complete, from the main screen, select the Reach icon and DISCONNECT.	
Your rover receiver should now receive corrections from the base station and provide the required messages to Ditch Assist. Verify by connecting to Ditch Assist and viewing the GNSS info panel.	

7.3 NTRIP Setup

7.3.1 Information

Emlid RS3 receivers are shipped with internal LoRa radios for free RTK correction transmission. For longer range or interference issues, NTRIP using cellular data is an alternative. Special SIM cards with a 100MB/30-day trial are included for testing NTRIP (contact us if needed), and this should give you approximately 20 hours of use.

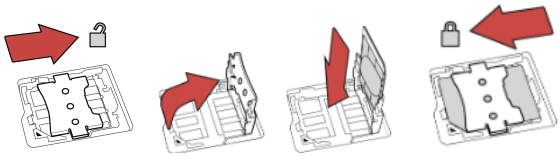
7.3.2 Activating SIM Cards

<table>
<tr>
<td>You must activate your SIM cards before using them:
• Search in your App Store for the EIOTCLUB app and install it
• Register for a free account
• Add the SIM cards to your account via the + button
○ Enter the ICC ID number printed at the bottom of the card, not the really long number at the top:</td>
<td> 
</td>
</tr>
<tr>
<td>• You should see that each SIM card has the 100MB of data available
• If you decide to continue using NTRIP, tap Refill next to each SIM and choose the required data and time
○ As a reference, each RS3 will use around 5MB per hour as either a base or a rover, so 1GB of data will last around 200 hours
○ Note that we do not provide the data plans, and they must be purchased directly from EIOTCLUB</td>
<td> 


</td>
</tr>
</table>

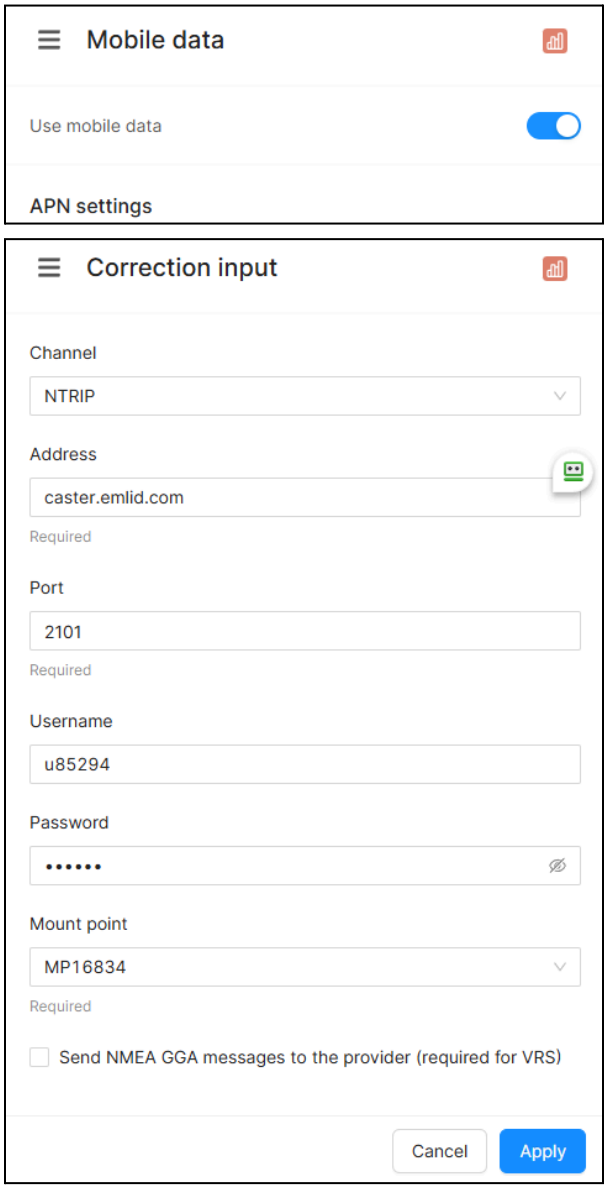
7.3.3 Base & Rover Quick Setup for NTRIP

If you received SIM cards with your RS3 receivers then your units will have been pre-programmed for NTRIP, but you will need to perform the following to switch over to NTRIP:

<table>
<tr>
<td>Break out and insert Nano SIM cards into each Reach RS3 unit, making sure you fully lock the cover to hold the SIM securely in place.</td>
<td>  </td>
</tr>
<tr>
<td>

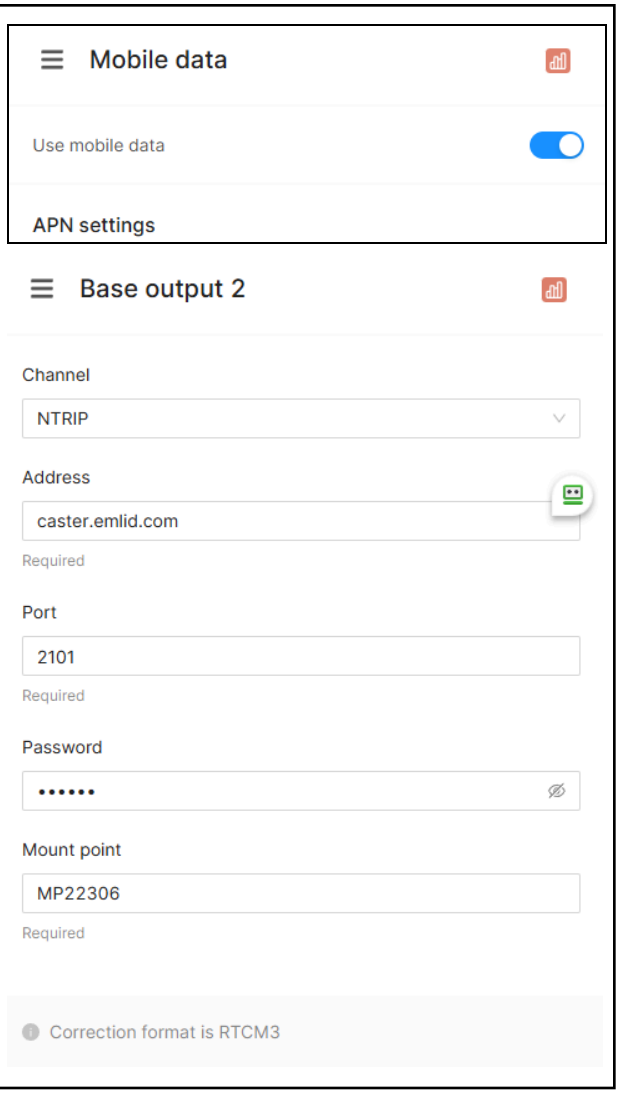
On the Rover Receiver

- Connect using Emlid Flow App
- Navigate to **Mobile Data** and turn ON the Use mobile data setting
- You should NOT need to enter any APN settings
- Navigate to **Correction Input** and change from LoRa radio to ***NTRIP***
- Confirm settings are already programmed, or enter the information you were provided for your NTRIP caster
- Hit *Apply* to Save

</td>
<td> 
</td>
</tr>
</table>

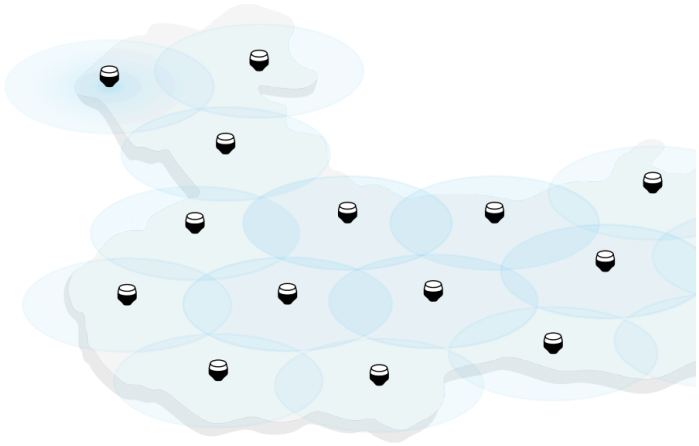
On the Base Receiver

- Connect using Emlid Flow App
- Navigate to Mobile Data and turn ON the Use mobile data setting
- You should NOT need to enter any APN settings
- Navigate to **Base Output 2**
- Confirm settings are already programmed, or enter the information you were provided for your NTRIP caster
- Hit *Apply* to save



8. CONFIGURING THE RS3 AS A NETWORK ROVER

(CORS OR VRS VIA NTRIP USING A SERVICE PROVIDER)



8.1 Introduction to NTRIP

In some regions, Continuously Operating Reference Station (CORS) and/or Virtual Reference Station (VRS) networks are available. These networks use the internet to deliver RTK corrections to rover receivers within their coverage areas using a method called NTRIP. The rover receiver needs to be connected to the internet, usually via a cellular SIM card to provide data connectivity, and then connects to the network and streams RTK corrections over NTRIP protocol from the nearest base station or a computed VRS base station.

8.2 Cautions

While this can be a very effective and cost-efficient solution to achieving very high accuracy, there are several limitations to be aware of:

- ***Baseline Distance***, or the distance between your receiver and a CORS base station, will impact the ability of your receiver to accurately calculate its position:
    - While modern GNSS receivers like the RS3 are much better than older systems at remaining accurate at longer baselines, the further you are from the base station, the less accurate you can expect to be.
    - In theory, baselines up to 36 miles (60km) are possible, but at these distances you may experience loss in accuracy, particularly elevation accuracy.
    - Longer baseline distances also result in increased time to achieve RTK fix, and higher likelihood you'll keep losing RTK fix in the event of signal obstructions or challenging environments

- ***Data Connectivity*** is also critical for NTRIP applications, and can cause significant issues even where you have strong cell service:
    - *Latency*, or the time delay between RTK correction messages being sent and received, can be high with some carriers. This means the receiver has to try to compute RTK-accurate positions using older correction information, and may result in loss of RTK altogether.
    - Cellular networks are often busy, and users are frequently disconnected and reconnected a few seconds later to manage bandwidth. While this may not impact a typical smartphone user, it can cause issues with NTRIP as the receiver needs to re-connect to the server and begin streaming corrections again - during which time you likely lose your RTK fix. Using a designated IoT or M2M SIM card can help alleviate this issue.
        - Some users in Emlid forums have reported good performance using data-only SIM cards from EIOT Club, for example.

8.3 Configuring an Emlid RS3 Receiver for NTRIP

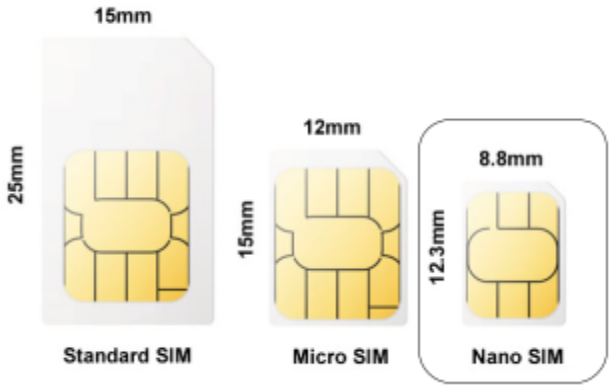
Data Connectivity

The RS3 receiver will require an internet connection in order to stream RTK corrections via NTRIP. For most users, the simplest option is to source a SIM card from their cellular provider that has a data plan attached. It's also possible to connect the RS3 to a WiFi hotspot from your cell phone, however we recommend the SIM card option over this method.

SIM Card Method

Install SIM Card

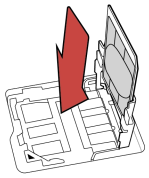
1. Source a SIM card from your chosen cellular provider
    - You'll need a **Nano SIM** (most SIM cards can be punched out to various sizes, including Nano)



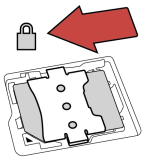
- The carrier network needs to support LTE data (the RS3 will also use 2G and 3G service if LTE is unavailable).
  - Most Canadian carriers will work. In the US all carriers except Verizon and their subsidiaries should work

2. Insert the Nano SIM into the RS3 by carefully sliding the metal cover to the right, then lifting the cover on the SIM card slot:

3. Insert the SIM card into the slot in the underside of the metal cover. It will only fit correctly one way:



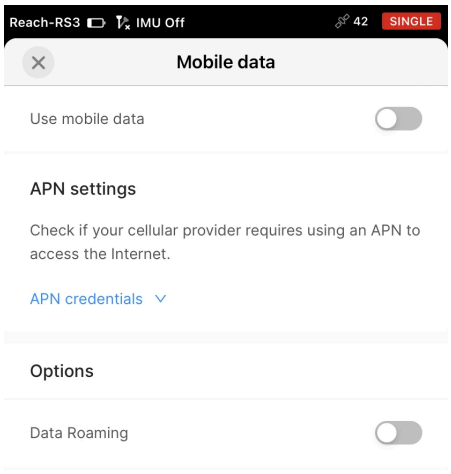
4. Return the slot cover into the horizontal position and slide left to lock the slot:



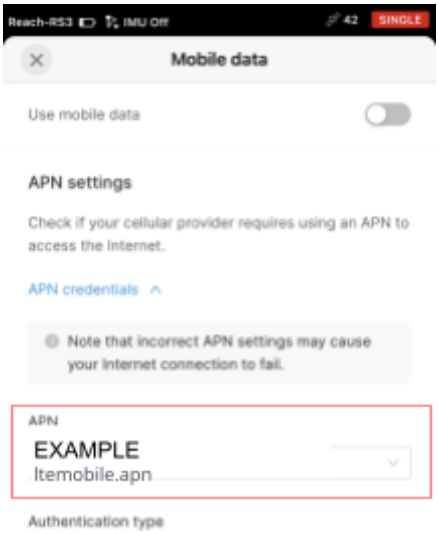
Configure RS3 to use SIM card for Data

1. Connect to the RS3 receiver via the Emlid Flow App (see how here)

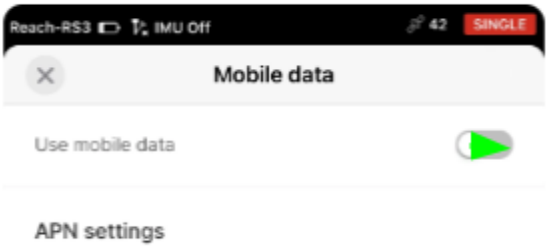
2. In Settings, navigate to Mobile Data



3. Configure APN settings (required for most carriers)
    a. This Guide has good information on North American carrier APN settings
    b. Enter the APN and tap Apply



4. Turn Mobile Data ON



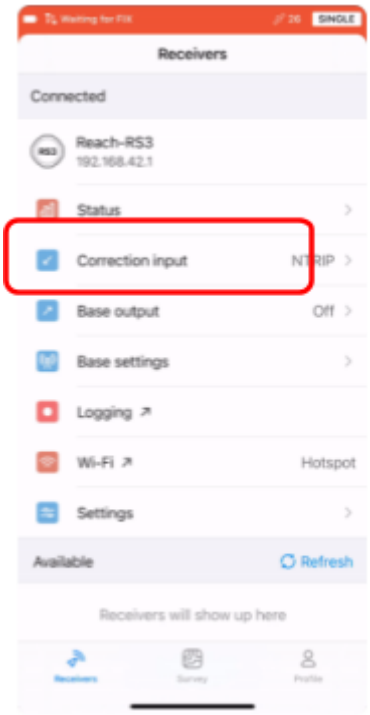
5. Enable Data Roaming
    a. Even if you won't be roaming, some SIM cards do not function unless this is checked

6. Verify data connectivity
    a. If everything is correct, you will see network bars and connection type next to the battery icon

Configure NTRIP Settings

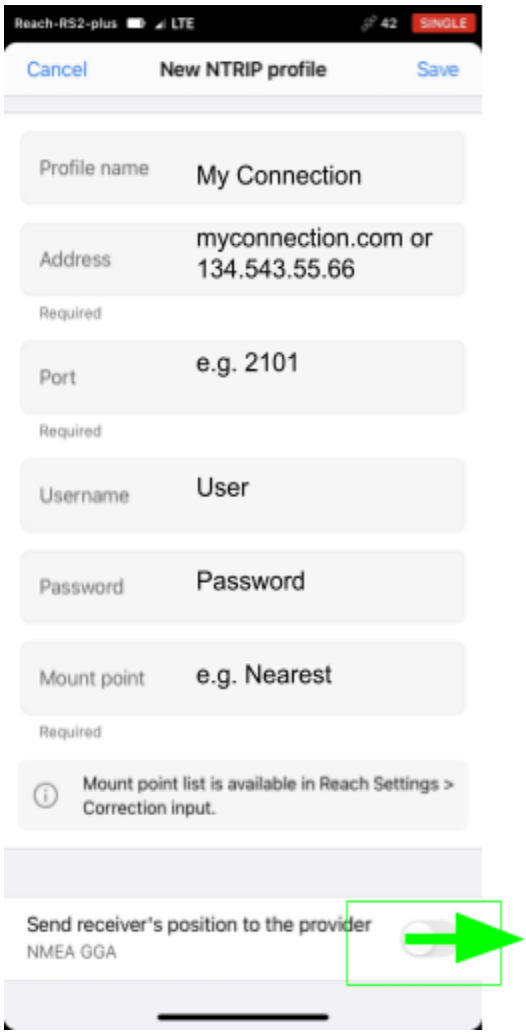
You will require account credentials from your NTRIP service provider in order to connect to and stream RTK corrections. Contact your provider if you do not have these.

1. Navigate to the Correction Input settings

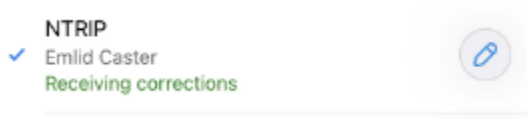


2. Select NTRIP then tap on the pencil icon

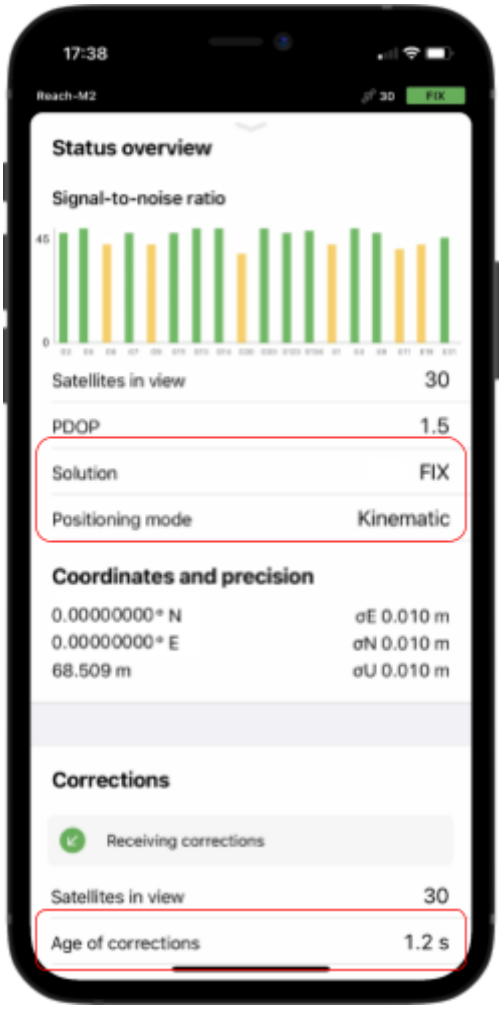
3. Complete the information using the credentials from your provider
    a. Address can be either a URL or an IP address
    b. *Stream* is another name for Mount Point
    c. Turn ON the option to send receiver position to the provider if you are using VRS or Nearest base station



4. Verify corrections are being received
    a. After a few seconds you should see Receiving corrections message on the Correction Input screen



5. View Receiver Status
    a. Return to the main screen and navigate to Status
    b. You should see a FIX solution and your correction age should stay around 1-3 seconds



You are now receiving RTK corrections via NTRIP

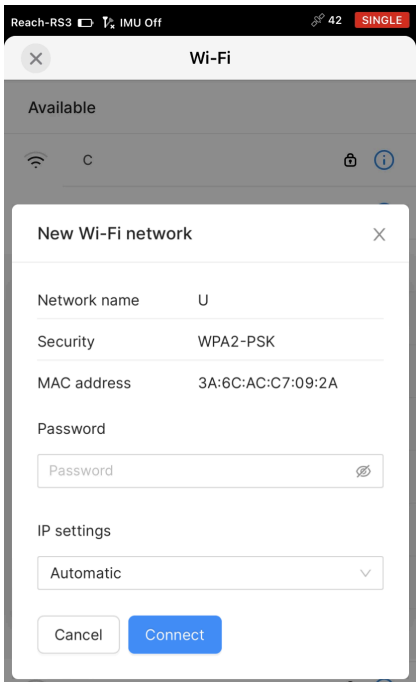
9. Tips & Tricks for Advanced Users

9.1 Connecting Emlid receivers to your home/office/shop Wi-Fi

Instead of connecting directly to the receiver's Wi-Fi hotspot (which has no internet connectivity), it is also possible to configure your receivers to automatically connect to your Wi-Fi network whenever it is in range. Note that receivers will only look for known Wi-Fi networks when they first power up, so you may need to reboot your receiver if you bring it into a Wi-Fi network area.

Once the Emlid is connected to Wi-Fi, you can access it via the Emlid Flow app on any device that is also connected to the same Wi-Fi network. This is a great way to keep your receivers updated with the latest software as they can check for and download any new updates via your Wi-Fi connection. It's also a good option if you want to setup your own NTRIP and need to connect the base station to internet where it will be setup (see info on this below).

To connect to and remember your Wi-Fi network, simply connect to the receiver via Emlid Flow (see previous instructions), navigate to Wi-Fi settings, and enter the SSID and password of your Wi-Fi.



9.2 Setting up your own NTRIP Caster

We now provide complimentary Caster setup for any Emlid owners that purchase their receivers with a Ditch Assist kit - see the earlier section for information, and contact us if you require assistance.

It is possible to set up your own NTRIP service with a pair of RS3 receivers. Using Emlid's free cloud-based Caster, you can set up your base station at a fixed location where it has internet access (or use a SIM card) and connect it to the caster. Then, configure your rover to receive corrections from your base station via the caster. This allows you to achieve significantly longer baseline distances, potentially covering your entire land base from a single base station location (provided you have reliable cellular data coverage of course).

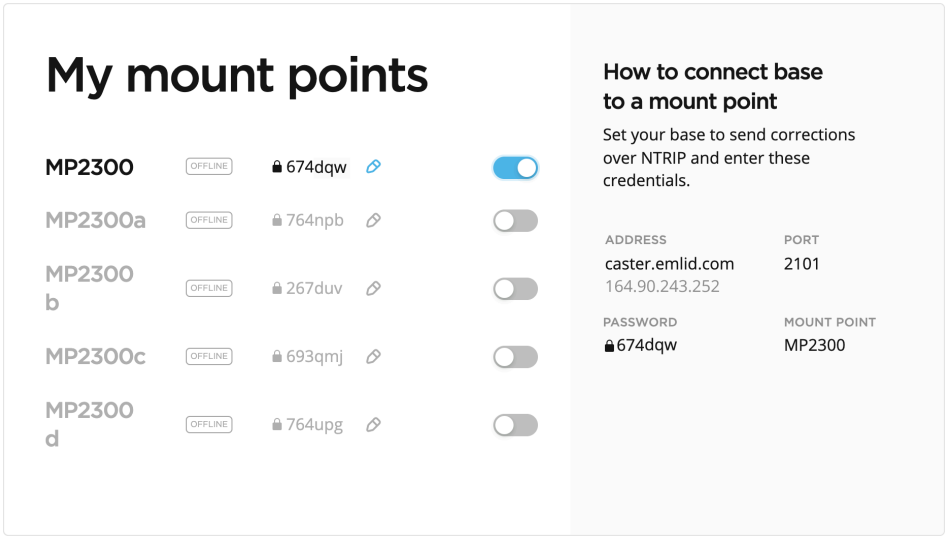
The instructions below assume you have already set up your base station in a fixed location and connected it to the Internet using a SIM card or by pairing it with a Wi-Fi network available at the location it will be set up (do this via Wi-Fi settings in the Emlid Flow app).

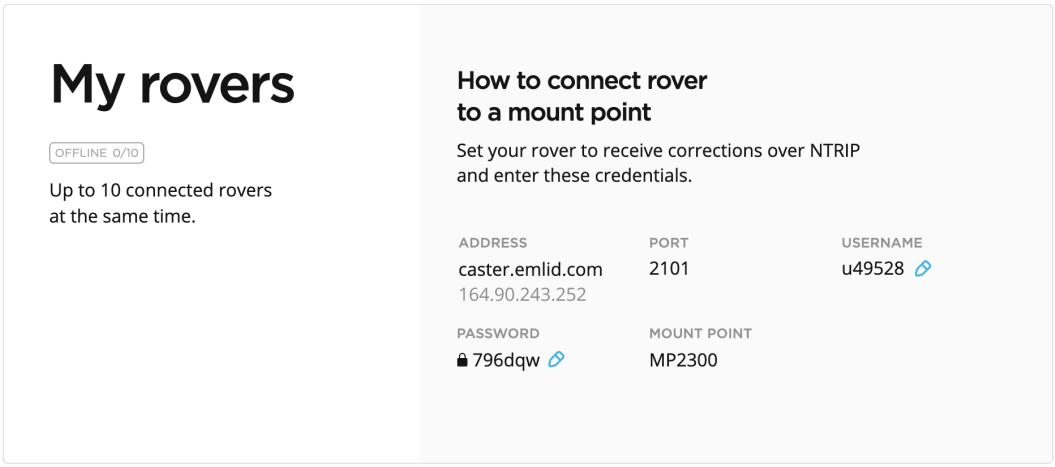
Workflow

Get access to Emlid Caster
To get access to Emlid Caster, follow the steps below:

1. Go to caster.emlid.com.
2. Sign up or login if you already have an Emlid account.

Get your Credentials
After you sign up or sign in, you'll see 5 mount points and 10 rovers. Each mount point is a base station, and each rover is a...rover. The free version of Emlid Caster let's you have up to 5 base stations and 10 rovers connected at any time - you'll probably only need one of each!

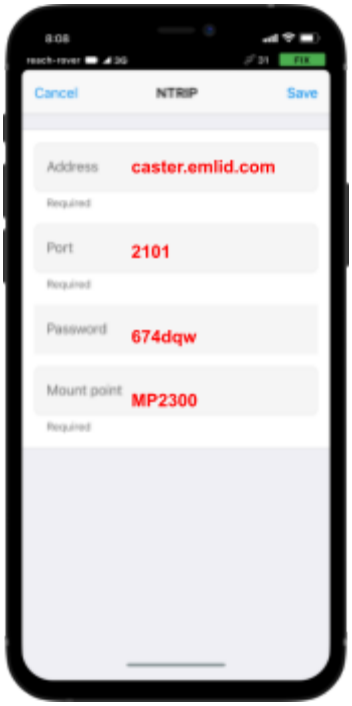




3. Turn ON the first mount point. Take note of the mount point name (in above example it is MP2300) and password (674dqw). You'll need these to configure the base and rover.

Configure Base Station

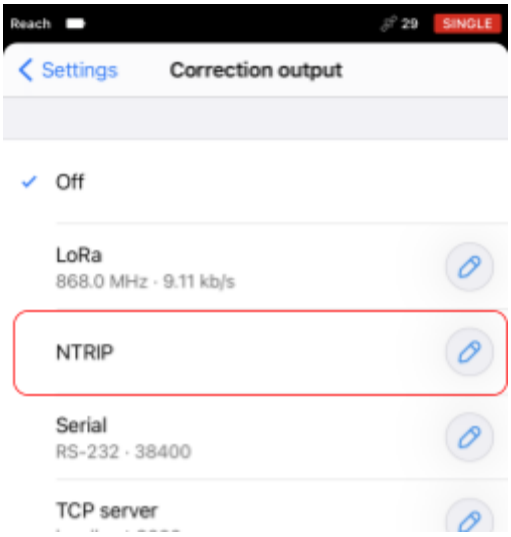
4. Connect to the Base receiver using the Emlid Flow App
    a. Navigate to Settings > Correction Output and select NTRIP
    b. Enter credentials from the Emlid Caster page and tap *Save*, for example:



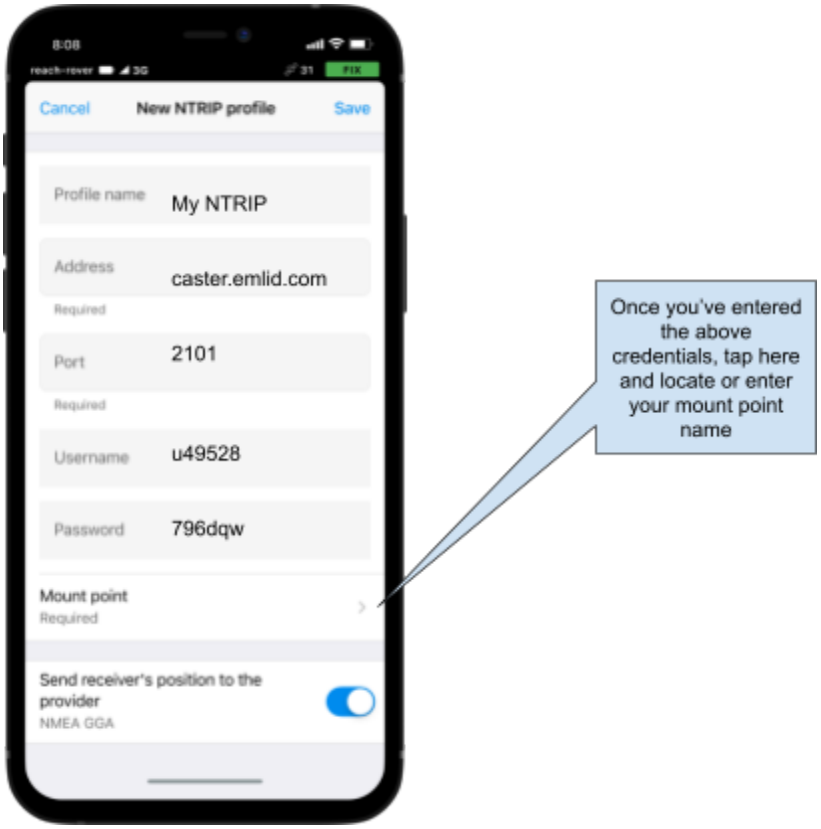
5. Check on the Emlid Caster webpage that your mount point is online - if it is you are ready to connect your rover!

Configure Rover

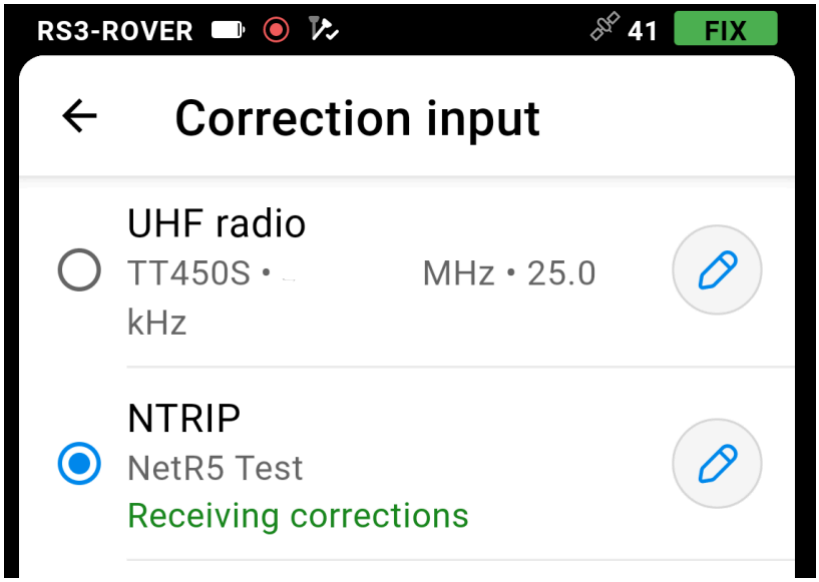
6. Assuming your rover is already internet-connected via a SIM card (if it isn't, see previous instructions on configuring for NTRIP), configure it to connect to your base station via the caster:
    a. Connect to the Rover via Emlid Flow app
    b. Navigate to Settings > Correction Input and select NTRIP
    c. Tap on the pencil icon



d. Add a new profile using the credentials provided from the Emlid Caster page:



7. Save and return to the Correction Input screen. If configuration was successful, you should be receiving corrections from your base station via NTRIP (if you see a message saying waiting for corrections then either your rover isn't connected to the internet, or something isn't right in your configuration).



9.3 Determining Accurate Base Position

If you are setting up an Emlid receiver as a permanent, fixed base station (such as for NTRIP), it's a good idea to set it with its true, real-world accurate position. It's possible to compute the base position to around 1cm accuracy by setting it to log special data (called RINEX) for 24 to 48 hours, and then submit these log files to a government or private online processing service. These processing services will send you back an email containing the precise coordinates and elevation of the base station that you can then program into it.

In the event you ever need to move or replace the base station, by using precise base positioning you won't see any shift in rover positions.

There are several methods, and these are all well documented by Emlid at https://docs.emlid.com/reachrs3/base-setup/determining-base-position/ with a good starting point being the NOAA OPUS service.

9.4 Surveying using the Emlid Flow App

In this context, "surveying" means actual surveying, like a land surveyor, rather than running a survey using Ditch Assist! While we don't officially support or endorse this, and we certainly don't expect our dealers to either, the RS3 receivers are fully-functional survey-grade RTK GNSS, and in the right hands can easily be used to perform a variety of

land surveying functions. The Emlid Flow app includes simple survey capabilities for free, and there is also the option to subscribe and unlock advanced functionality that rivals any professional survey data collector software.

We suggest you head to the Emlid documentation at https://docs.emlid.com/emlid-flow/preparing-projects/ to get started if this is something you'd like to try.

10. Troubleshooting

10.1 RTK Issues

Most troubleshooting issues encountered with Emlid GNSS receivers relate to loss of RTK fix while operating, or difficulty getting RTK fix in the first place. Most of these issues are also the result of users not adhering to the best practices outlined in this user guide. Here are the most common issues we encounter:

Issue Description	Why this is an Issue	How to Fix It
Base station set up next to a building, trees, or other obstruction	Blocks base station receiver view of the sky, and also causes multipath where satellite signals bounce off objects before reaching the receiver. RTK fix may take longer to obtain, and is easily lost - your Ditch Assist may go in and out of RTK fix a lot. RTK elevations may fluctuate significantly, even when it shows you have RTK in the app.	Make sure you set up your base station in an open area with nothing obstructing the horizon above 30 degrees in any direction.
Base station tripod not fully extended	The higher you can set the base station receiver, the better the radio link will be. By not fully extending the tripod legs you will limit radio range and performance, resulting in loss of RTK fix at the rover.	Always fully extend the base station tripod legs, and aim to keep the base station receiver at least 5ft above the ground.
LoRa antennas not installed	Without LoRa antennas installed on base and rover, you won't be able to get RTK fix more than around 50ft from the base.	Always install LoRa antennas when using LoRa for RTK corrections
Rover receiver installed too low on implement	Sky view obstructed by tractor cab and/or implement. LoRa radio signals are also likely to be obstructed. Results in frequent loss of RTK fix and difficulty	Mount the rover antenna high enough that it has a clear view of the sky from 30 degrees above the horizon and where the radio signals won't be

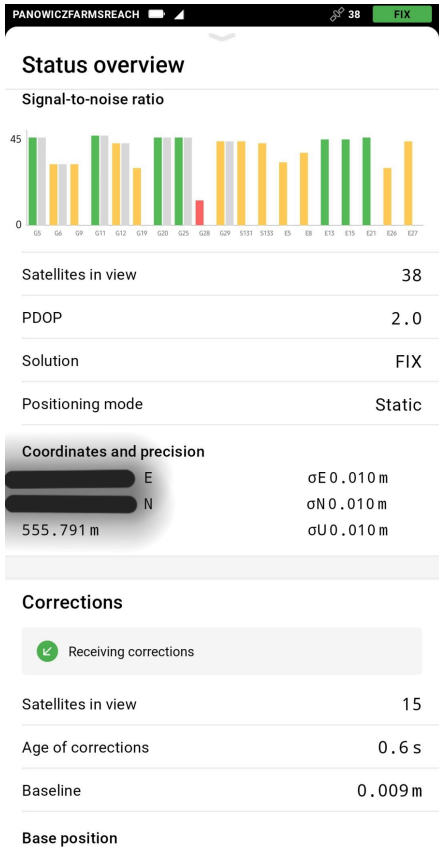
	regaining fix once lost.	obstructed by the implement or tractor during operation
Trying to work too far from base station	LoRa radios used in Emlid RS3 receivers transmit up to several miles in ideal conditions. However, landscapes usually aren't ideal, and because these radio signals travel horizontally they can get blocked by small hills and ridges. When you get too far from the base, your corrections may drop sporadically, meaning your receiver goes in and out of RTK fix.	Work closer to the base station, ideally within half a mile or less. Move the base to a different part of the field when you are ready to work on a different area.
Base station powered on before being set up on tripod	When you power on your base station, it immediately begins averaging its position for 2 minutes. If you move it during this time, the averaged position may end up very inaccurate. Your rover may not be able to account for this much inaccuracy in the base position, and will have a very hard time obtaining and maintaining RTK fix when you try to go to work.	Always install the base receiver on the tripod before you power it on.
Radio Interference	Most consumer radio devices operate in the license-free 900 - 925 MHz range, including Wi-Fi, walkie talkies and radios, and other RTK base stations in the area. This can cause signal interference, resulting in loss of range between base and rover or blocking signals altogether even at close range. We typically program receivers for frequencies in the lower 900 MHz range as this is usually less congested, but in some areas this may not be the case.	Place the base station away from any possible sources of radio interference. Turn off in-cab radio devices or any other devices that may cause interference. Try changing radio frequency on base and rover (e.g. if range is poor at 900.5 MHz, try 905.5 MHz, etc). Contact us to order a higher gain LoRa radio antenna for the base and rover.

10.2 Understanding Correction Age

The age of corrections, or the time since the last valid correction message was received by the rover is one of the best ways to check for communication issues when operating in RTK. This applies when you use your own base station, or when you are connecting via NTRIP to a CORS or VRS network. RTK calculations require real-time correction information so the rover can solve complex equations to determine its exact position in relation to the base or reference station, and even a few seconds can make the difference between RTK fix and going into Float (not accurate enough for use with grade control).

Using the Emlid Flow app, you can easily connect to your Rover receiver and view the correction age in real-time.

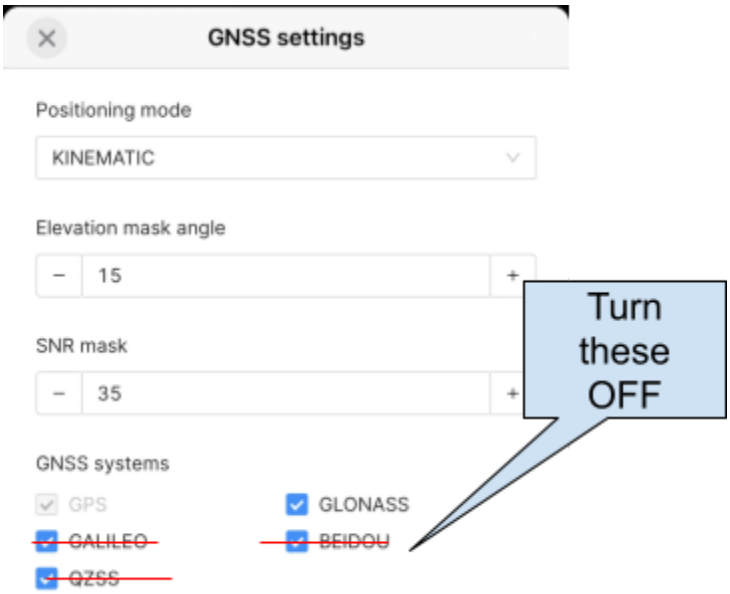
The Age of corrections should be less than 3 seconds most of the time. The base transmits corrections at 0.5Hz, or once every 2 seconds, so if you see the correction age regularly reaching 4 or 5 seconds, this indicates a probable issue with some messages not being received. Once the correction age goes over 5 or 6 seconds you may experience noticeable loss in accuracy, and your receiver may lose RTK fix altogether until the correction age comes back down.



Things to try if Correction Age is Consistently High

- If using a base station, try moving closer. If this improves correction age, you may be at the limits of range based on current terrain and radio environment.
- Make sure there is **line-of-sight** between your base and rover.

- Try **changing radio frequencies** on both base and rover. Sometimes changing frequency by a few MHz can make a big difference in range and improved correction ages
- Using a **lower Air Data Rate** will potentially increase the effective transmission distance between base and rover. However it also reduces the number of messages that can be sent and received. Therefore, try the following:
    - Set the Air Data Rate to **4.56 kb/s** on both the base and rover in LoRA Radio Settings
    - Go to GNSS Settings on the base receiver and disable all but GPS and GLONASS



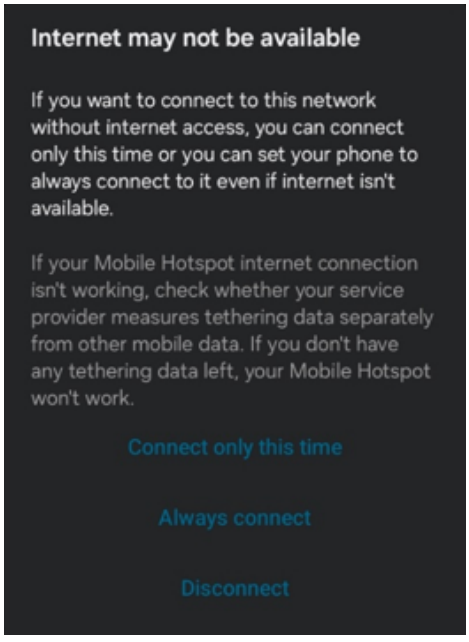
    - This will stop the base using these satellite constellations, meaning fewer RTK correction messages will be sent. The trade-off is you'll have fewer satellites to use for the RTK position
    - If this results in improved range, try turning GALILEO back on and test again - if you maintain consistent correction age under 3 seconds then leave it set like this, if it bottlenecks then turn it back off and continue with GPS and GLONASS only
- If you are using CORS or VRS the issue is likely related to the cellular network. Try a different cell provider if possible, or ask them about dedicated data-only SIM cards - these have higher data priority than standard voice+data SIM cards and often experience lower latency and better performance.
    - Some users in Emlid forums have reported good performance using data-only SIM cards from EIOT Club, for example.

10.3 Issues Connecting to Receivers using Emlid Flow App

Some users have reported issues trying to connect their phone to either the base or rover receiver via the Emlid Flow app. While some issues seem related to particular phones, with older or low cost Android devices being particularly prone, these are usually related to the way your phone/device prioritizes internet connectivity over connecting to a source that does not provide internet.

When you connect your phone or tablet to the Emlid receiver's Wi-Fi hotspot, there is no internet connection available. Your phone will likely try to revert back to using cellular data or connecting back to another known Wi-Fi network where internet is available. Battery optimization in some Android devices also causes some issues. If you have issues connecting to your Emlid receiver(s) via the Emlid Flow app, try the following:

1. **Turn OFF mobile data on your device**. This prevents it from bypassing the Wi-Fi connection to the Emlid and remaining connected to cellular data in the background.
2. On Android devices, **disable battery optimization or power saving** settings temporarily.
3. On Android devices, **wait on the Wi-Fi connection screen** for a message warning you about the Emlid device not having internet connection. Once this appears, choose 'Always Connect' or 'Connect Only This Time' to authorize the connection.

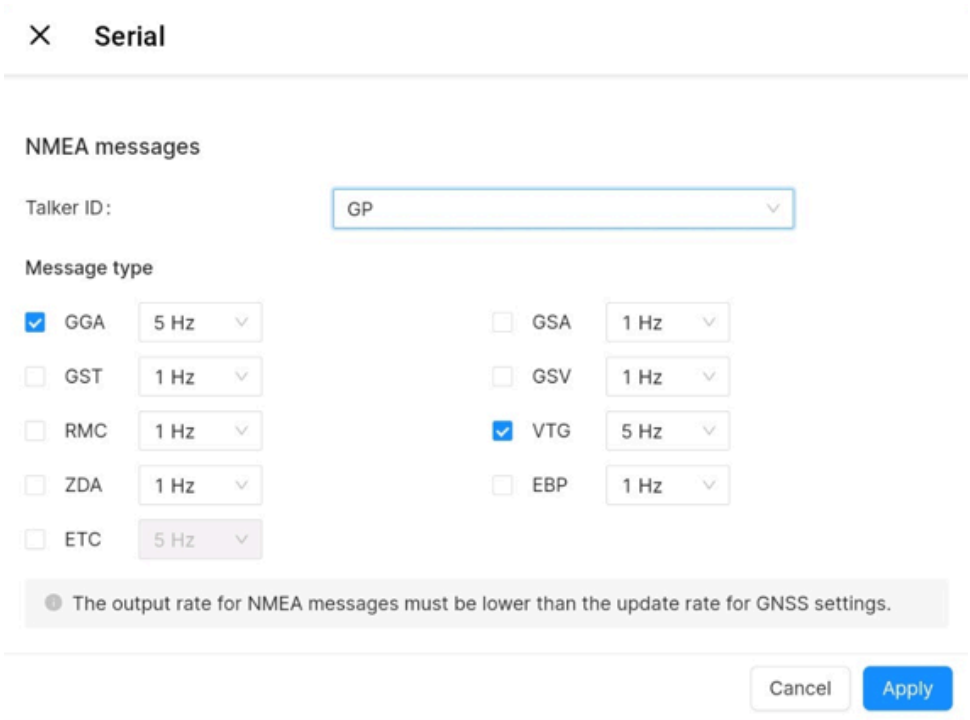


4. **Reboot** both your phone/tablet and the Emlid receiver and try connecting again. Reboots can solve a myriad of problems!
5. **Check that other devices aren't connecting to the Emlid receiver's Wi-Fi**. While it should be okay to have multiple connections at once, sometimes this does cause problems. Turn off Wi-Fi or forget the Emlid receiver's Wi-Fi SSID on other devices in the vicinity.

10.4 Ditch Assist - Specific Troubleshooting

Additional NMEA Messages Enabled

A known issue is that when additional NMEA messages are enabled, Ditch Assist may experience errors such as reported elevation values jumping by a considerable amount once every second. When using your Emlid receiver with Ditch Assist it is important to ensure that only GGA and VTG messages are enabled, and that all others are turned off. Make sure your Position Output 1 settings look like this:


Serial
NMEA messages
Talker ID:
GP
Message type
GGA
5 Hz
GSA
1 Hz
GST
1 Hz
GSV
1 Hz
RMC
1 Hz
VTG
5 Hz
ZDA
1 Hz
EBP
1 Hz
ETC
5 Hz
The output rate for NMEA messages must be lower than the update rate for GNSS settings.
Cancel
Apply