emesent

M300/M350 RTK QUICK START GUIDE AND SETUP INSTRUCTIONS

DOCUMENT NUMBER: INSTR-023
REVISION NUMBER: 1.4
RELEASE DATE: 02 MAY 2024

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Using this manual

Hovermap is a powerful system that can be used as a Lidar mapping payload but also as an advanced autopilot for drones. It is therefore recommended to read the user manual thoroughly to make use of all its capabilities in a safe and productive way.

Disclaimer and safety guidelines

This product is not a toy and must not be used by any person under the age of 18. It must be operated with caution, common sense, and in accordance with the instructions in the user manual. Failure to operate it in a safe and responsible manner could result in product loss or injury.

By using this product, you hereby agree that you are solely responsible for your own conduct while using it, and for any consequences thereof. You also agree to use this product only for purposes that are in accordance with all applicable laws, rules and regulations.

The use of Remotely Piloted Aircraft Systems (RPAS) may result in serious injury, death, or property damage if operated without proper training and due care. Before using an RPAS, you must ensure that you are suitably qualified, have received all necessary training, and read all relevant instructions, including the user manual. When using an RPAS, you must adopt safe practices and procedures at all times.

Warnings

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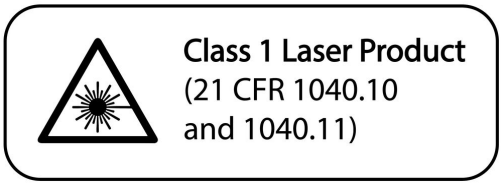
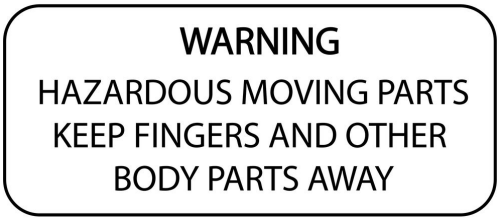
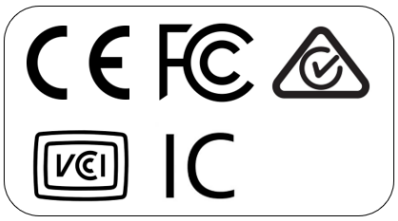
- Always be aware of moving objects that may cause serious injury, such as spinning propellers or other components. *Never* approach a drone while the propellers are spinning or attempt to catch an airborne drone.







Contents

1. Overview

In this guide, you will find step-by-step instructions on how to set up and configure the DJI D-RTK2 and Emlid Reach RS/RS2+ base stations.

RTK is crucial for various applications, such as land surveying, cartography, precision agriculture, and infrastructure development. With centimeter-level or even millimeter-level accuracy, RTK provides highly precise mapping data. Moreover, RTK helps eliminate GNSS (Global Navigation Satellite System) errors that can occur due to atmospheric conditions, satellite geometry, and signal reflections. By using a base station with a known location as a reference, RTK allows for highly accurate differential corrections.

1.1 Prerequisites

1.1.1 Hardware

- DJI M300/M350
- GNSS mobile receiver
  - Emlid RS2+ Base Station (recommended)
  - DJI D-RTK2 (supported)
- Hovermap (HVM100, ST, and ST-X are all supported)
- Optional: 4G SIM Card Dongle for the DJI M300 controller to allow direct connection to the CORS network (for regions where this service is available)

1.1.2 Software

- Emesent Aura
  - M300: version 1.3 or higher with a valid RTK license
  - M350: version 1.4.1 or higher with a valid RTK license
- Emesent Commander version 1.1 or higher (M350 only)
- Hovermap Software
  - M300: version 2.7 or higher
  - M350: version 3.1 or higher
- For AL0 customers:
  It is **essential** to have the onboard DJI SDK set up on the M300/M350 to allow GPS data to be recorded by Hovermap. Refer to the following Emesent documentation for detailed instructions:
  - Knowledge Base Video: SDK activation with the DJI M300 and Hovermap
  - Knowledge Base PDF: DJI M300 preparation for Hovermap operation

2. Emlid Reach RS2/RS2+

This section describes using Emlid Reach RS2/RS2+ as a base station to send NTRIP corrections to the DJI M300/M350 drone.

Figure 1 Emlid Reach RS2 Base Station

1. Network Status
2. Power
3. RTK Status
4. Battery Status
5. SIM
6. Extension
7. LoRa
8. USB

Refer to Base Station Activation and Setup if using the Emlid Reach RS2/RS2+ for the first time.

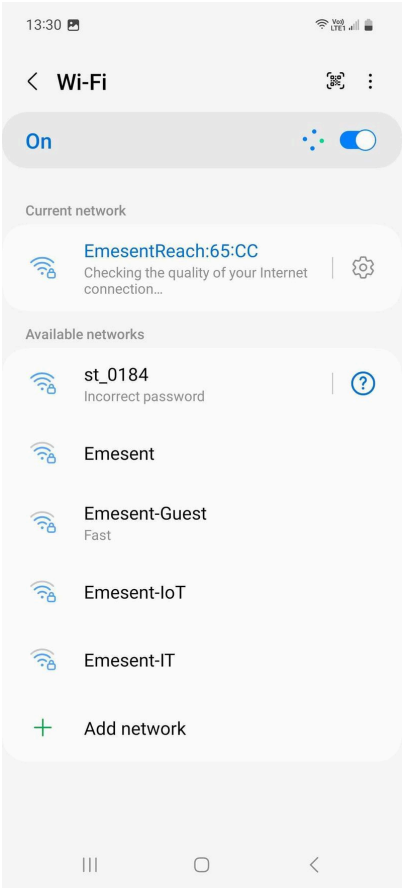
2.1 Access the Emlid Flow App

Download the Emlid Flow app on your iOS or Android mobile device.

2.2 Setup the Emlid Reach RS2/RS2+ as a Base Station

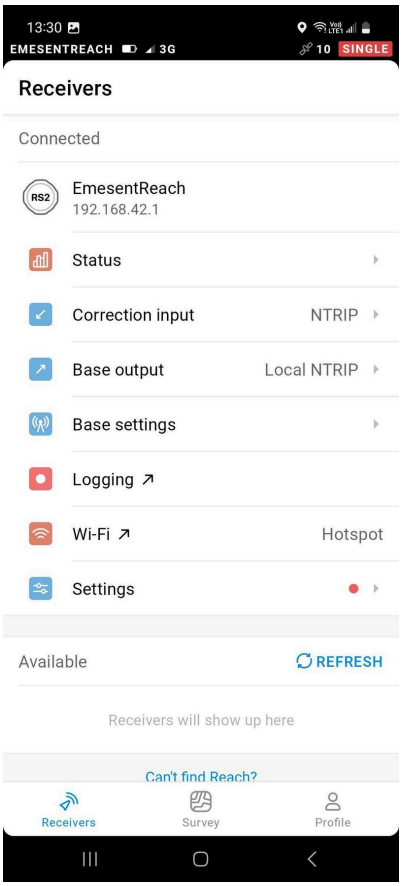
1. Attach the base station to the pole and mount it on the tripod. Make sure that the tripod is properly leveled and that you are in an open area with a clear view of the sky. This will ensure good signal reception and a fair number of available satellites.
2. Press and hold the **Power** button (see Figure 2) on the base station for 2 seconds to turn it on. When Reach is turned on, the LED lights up with a solid white light. When the point collection has started, the light flashes rapidly.
   During startup, the Emlid Reach RS2/RS2+ enters a network scan state and searches for known networks to connect to. If it doesn't find a known network, it switches to broadcast mode.

3. The lights above the **Power** button indicate the battery charge level. If the loading animation is over, proceed to connect your mobile device to the Emesent Reach RS2/RS2+ receiver via Wi-Fi. The default password is **emlidreach**.

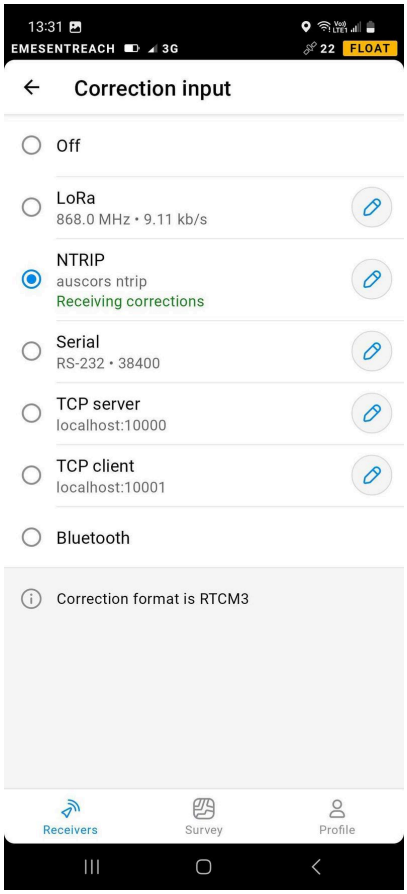


4. Launch the **Emlid Flow** application on your mobile device.

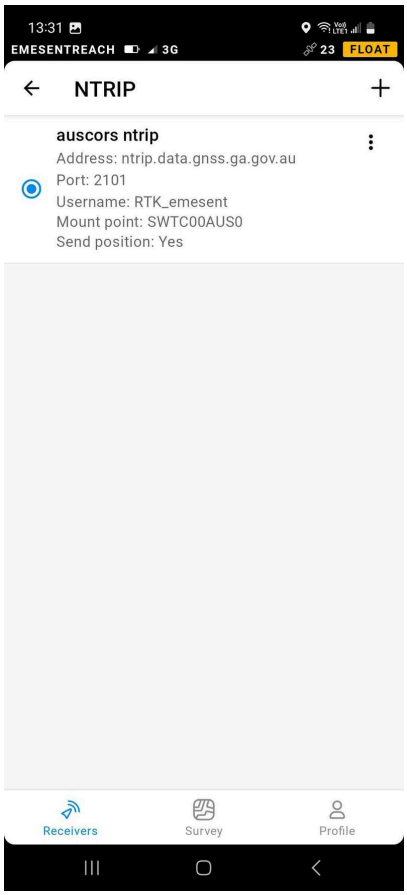
5. Tap **Correction Input** then select **NTRIP** from the list.



6. The system remembers the last connected network. Make sure that the network is shown as **Receiving corrections**.



Clicking the **Pencil** icon opens a screen where you can edit existing network connection settings. You can also click the **Plus** icon on the top right of that screen to add a network. Check with your network provider to determine the correct settings to use. Additionally, you can refer to the Geoscience Australia website and use the map provided to find the most appropriate mount point location. See GNSS Network Map. You should see the following display after you have entered the required network settings.



7. Go back to the main page and check if you have successfully connected to the network and if the Emlid Reach RS2/RS2+ is reporting back properly. If it takes a while to connect (more than 5 mins), it may be worth double-checking if the Emlid Reach RS2/RS2+ has access to mobile data.

For additional information on network settings, refer to the following instructional video:

https://www.youtube.com/watch?v=YWz0mhOwFAg

2.3 Placing the Base Station Over a Known Coordinate

1. Find the nearest survey monument to the area where you are going to conduct a survey. It may be a trig point, a survey marker, or just some reference point on site.
2. Check that it is located in an open area with a clear sky view to ensure good satellite reception.

> The absolute position of the rover is accurate only to the same level as the position of the base station. Therefore, place the receiver above the benchmark as precisely as possible.

3. Accurately place the tripod over the benchmark, checking that the tripod is approximately above the point.
4. Fix the tripod's position by deepening its legs into the ground.
5. Check the position again and make the necessary adjustments.
6. Level the tribrach.
7. Double-check that the tripod is exactly above the benchmark.
8. Mount your Reach on the tripod.
9. Open the Emlid Flow app and connect to the Base Station.
10. Go to the **Base mode** tab.
11. In the **Base coordinates** section, select **Manual** and enter the benchmark coordinates in WGS84 format.
12. Fill in the height in the corresponding field of the ReachView app.
13. Go to the **Status** tab on the base station to ensure Emlid Flow shows plenty of green satellites and the receiver has at least a **Single** solution.

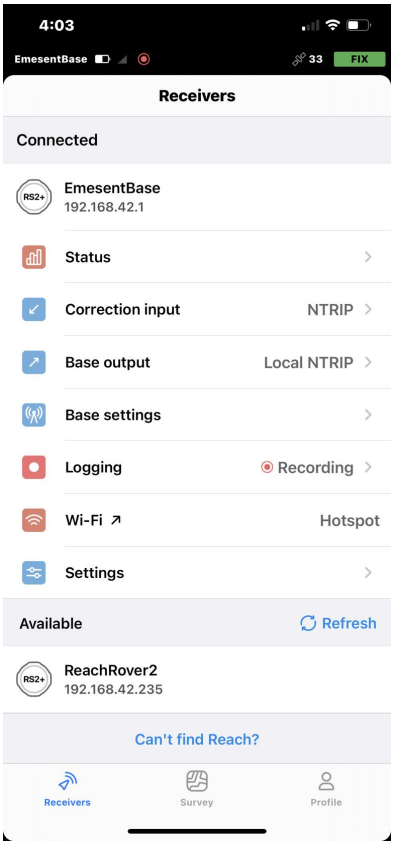
For additional information, refer to the following instructional video:

https://www.youtube.com/watch?v=FilRoPVDjCs

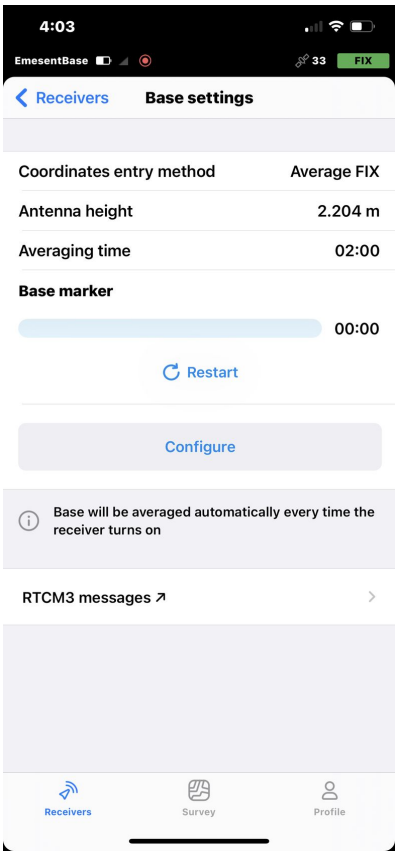
2.4 Position Averaging with FIX Solution

If a known coordinate is not available, use the "positioning averaging method" to improve the accuracy of determining the base station's position. This method involves collecting multiple position measurements over a period of time and then averaging these measurements to obtain a more precise estimate of the base station's coordinates.

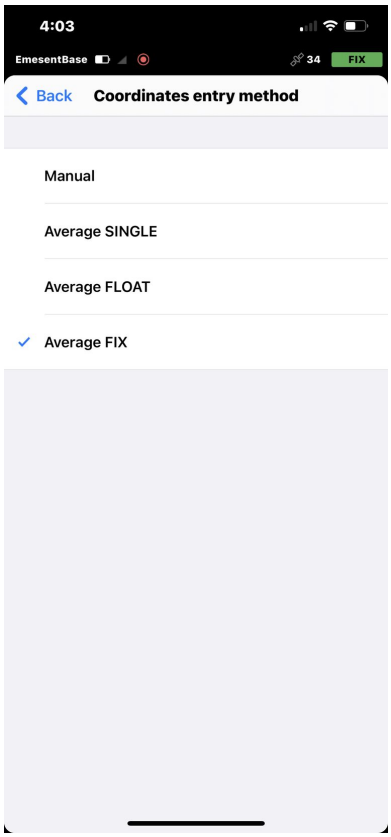
1. In the Emlid Flow app, tap **Base settings**.



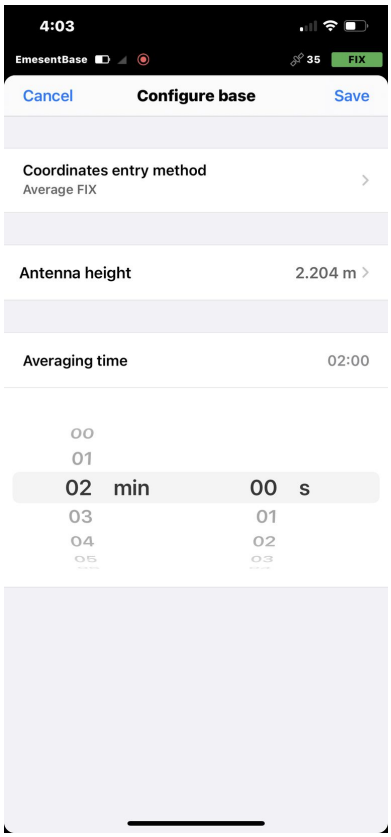
2. Make sure the **Coordinates entry method** is set to **Average FIX**. If not, tap **Configure**.



3. In the screen that displays, select **Average FIX**.

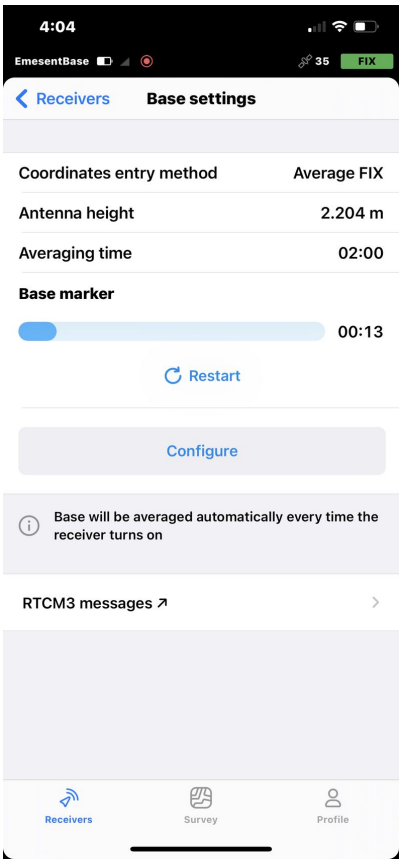


4. Set the Antenna height then specify the Averaging time.

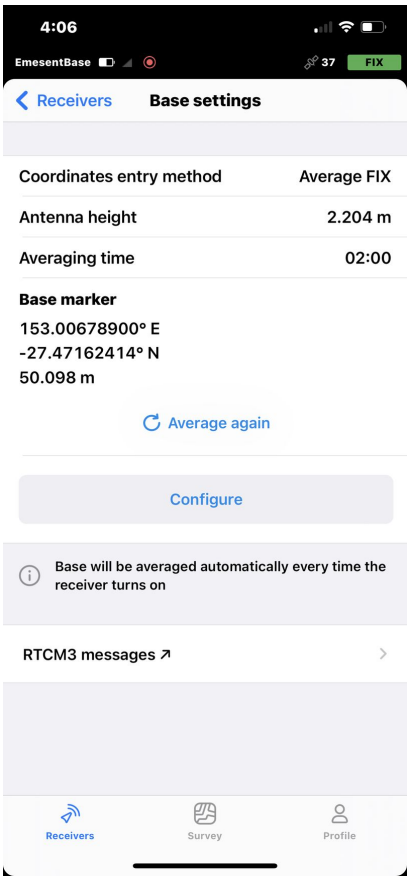


The **Antenna height** is measured from the ground to the base of the Emlid Reach RS2/RS2+. For example, if you are using a 2-meter pole and quick-tripod setup, your measured height will be 2 meters. The actual phase center of the antenna is 0.134 m higher but the receiver will include that automatically. The **Averaging time** depends on the specific requirements of the application. Short averaging periods may be suitable for applications that require rapid updates, while longer averaging periods may be preferable for applications that prioritize maximum accuracy.

5. Tap **Save** to go back to the **Base settings** page, the averaging process is started.



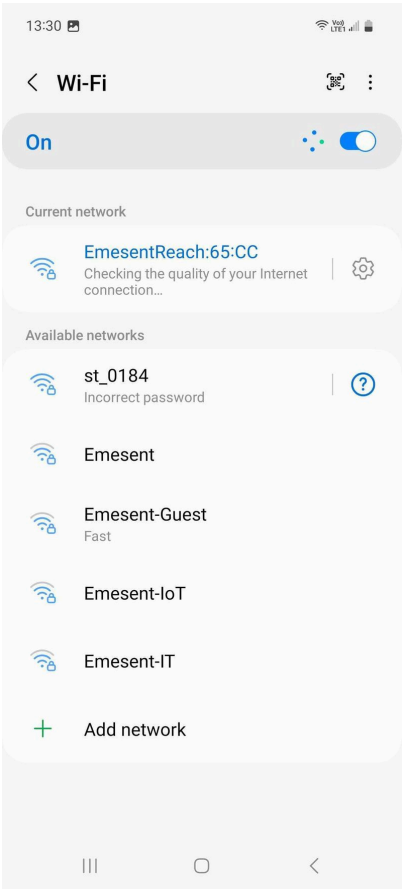
6. Once the averaging is completed, the updated base coordinates are displayed.



2.5 Connect the M300/M350 Controller to the Emlid Reach RS2/RS2+ Base Station

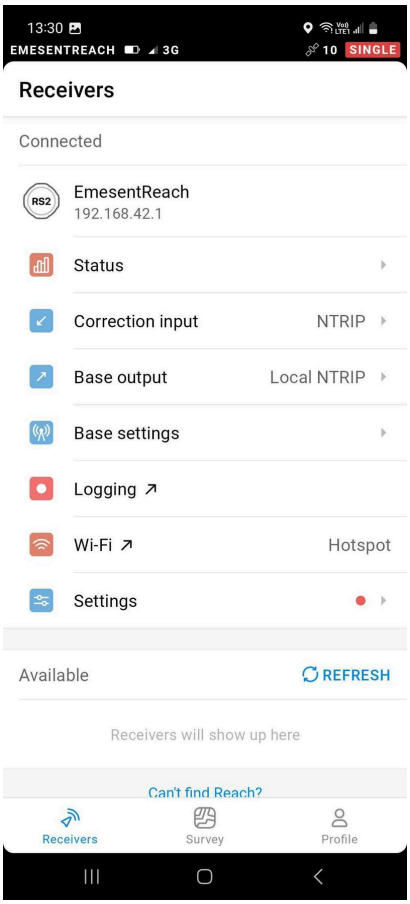
Once the base station is properly set up, the Emlid Reach RS2/RS2+ can serve as a base station for the M300/M350. Follow these steps to enable the M300/M350 to consume RTK corrections from the Emlid Reach RS2/RS2+.

1. On your mobile device, connect to the Emesent Reach RS2/RS2+ receiver via Wi-Fi. The default password is **emlidreach**.

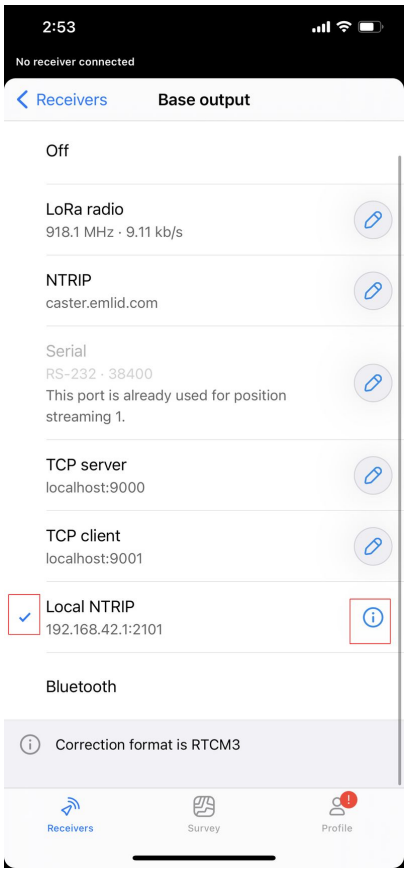


2. Launch the Emlid Flow application.

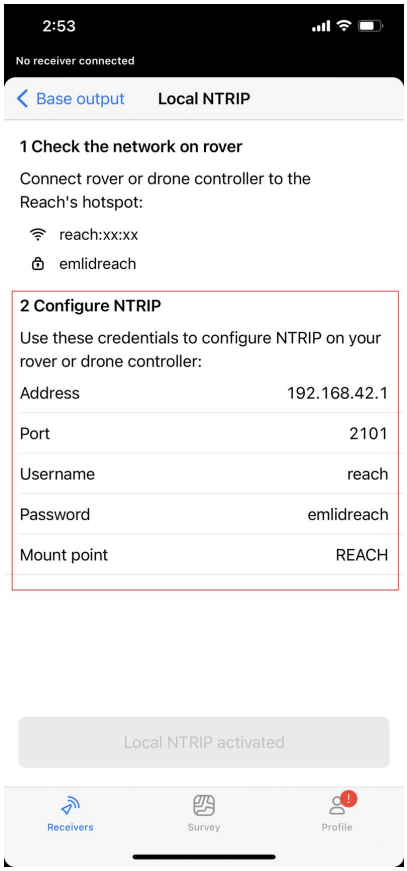
3. Tap **Base output** then select **Local NTRIP** from the list.



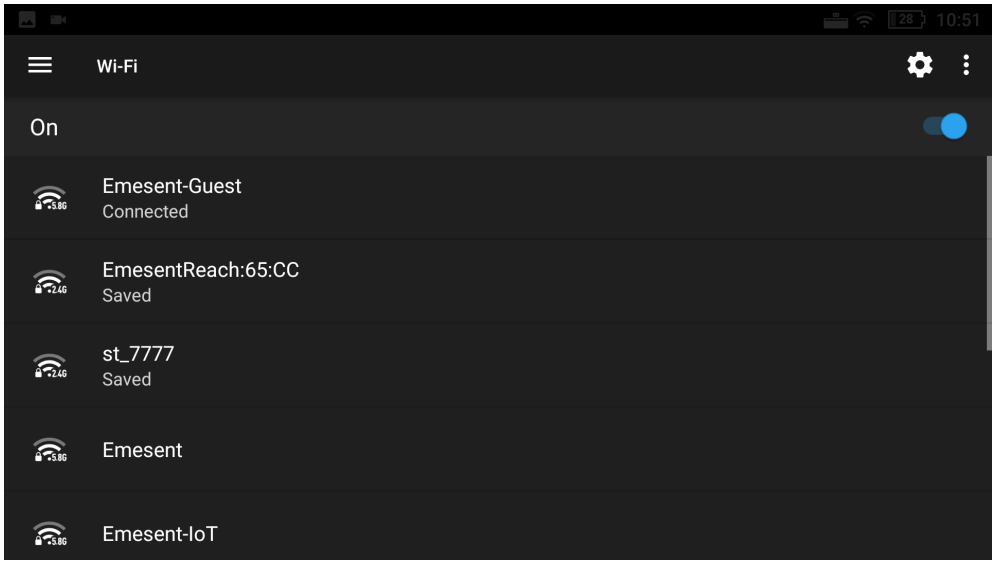
4. Click the **Information** icon on the right-hand side.



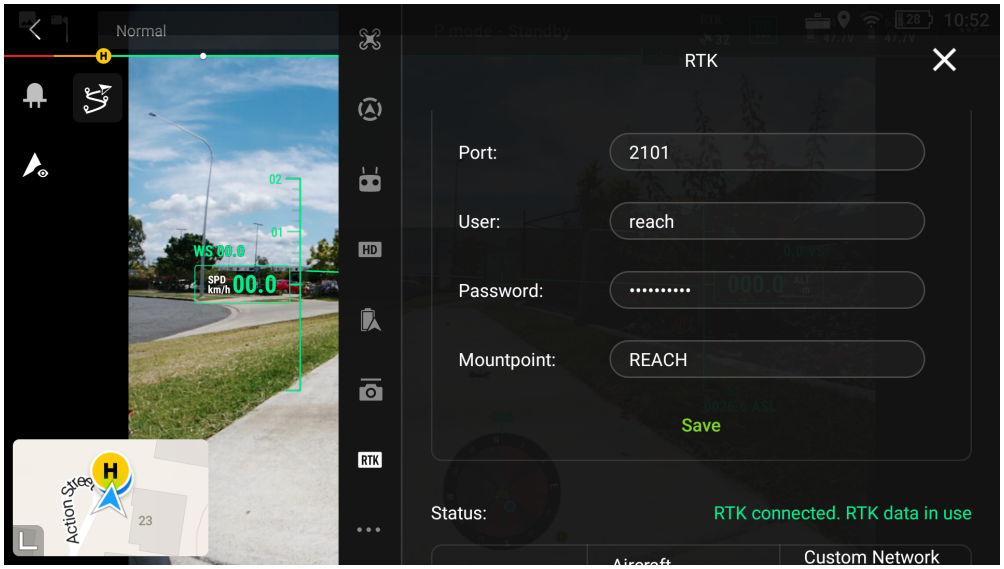
5. Make a note of the information provided. These will be used to configure NTRIP on your rover or remote controller.



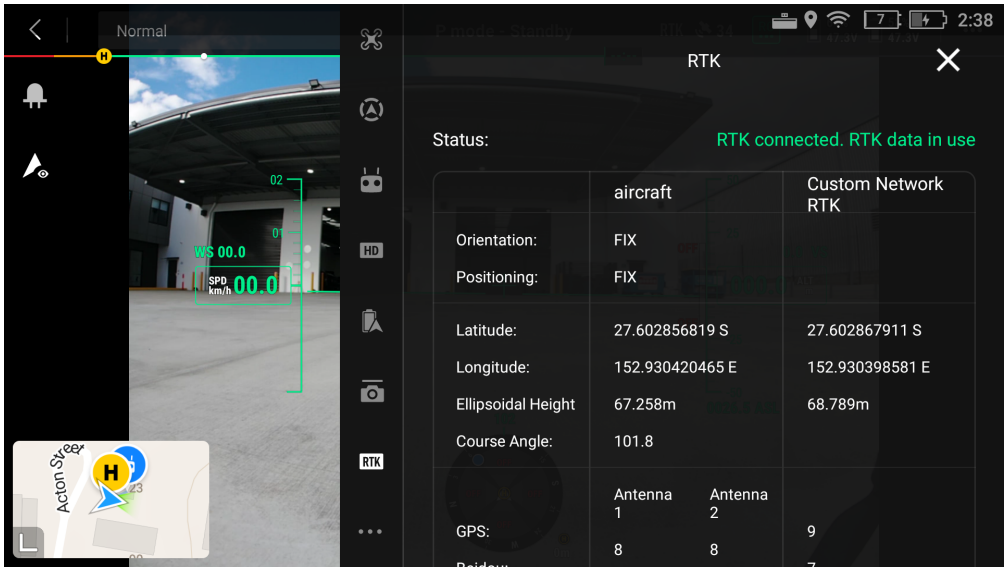
6. On the M300/M350 controller, open the **DJI Pilot Pro 2** app.
7. Tap the **Settings** button on the top right then connect the Wi-Fi network of the Emlid Reach RS2/ RS2+ base station.



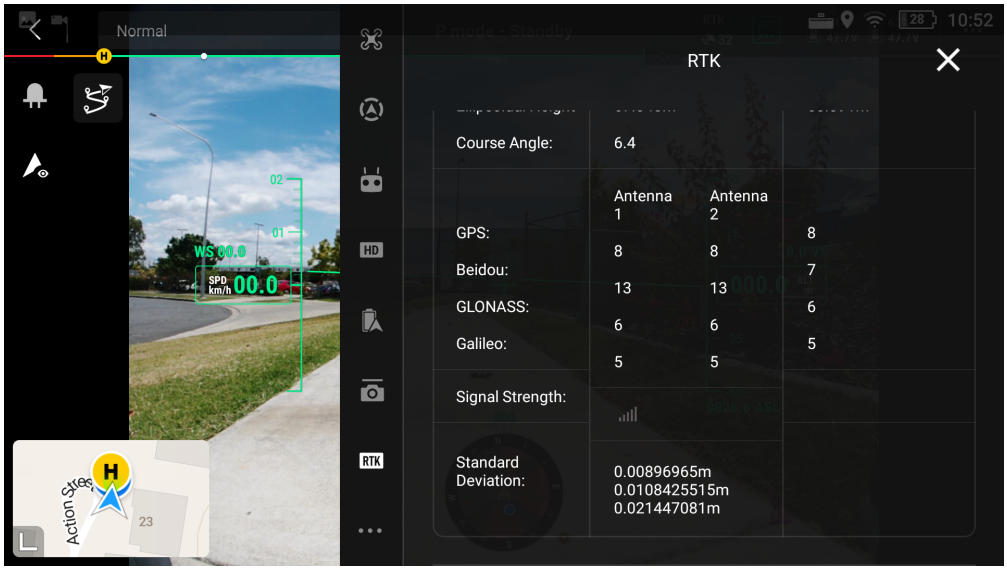
8. In the app's main display, tap the **More Settings** button (**...**) on the upper right.
9. Tap **RTK** from the menu on the left to display the **RTK Settings** page.
10. Ensure the **RTK Positioning** and **Maintain Positioning Accuracy Mode** are toggled on.
11. In the field next to **Select RTK Service Type**, tap the down arrow then select **Custom network RTK**.
12. Enter the base station details gathered in **Step 5** then tap **Save**. Wait for the **Set successfully** message to appear. In addition, the **Status** will show as **RTK connected. RTK data in use**.



13. Once you have configured the Emlid Reach RS2/RS2+ and established communications with the M300/M350 RTK Controller, refer to the **Status** screen on the controller to check your configuration for accuracy. It should display **RTK connected. RTK data in use**. Also, the RTK Status LED (see Figure 2) on the base station lights up with a solid white light.



In addition, the aircraft **Positioning** and **Orientation** should appear as **FIX** and the **Standard Deviation** should be similar to what is reported by Emlid.



You are now to perform a scan mission. It is a good practice to check the app from time to time during the mission. Tap **Correction input** and make sure the NTRIP network you are connected to shows as **Receiving corrections**.

3. DJI D-RTK2

This section covers the configuration of your DJI D-RTK2 Mobile Base Station.

> You will need to activate your DJI D-RTK2 base station if using for the first time. Refer to Base Station Activation and Setup for more information.

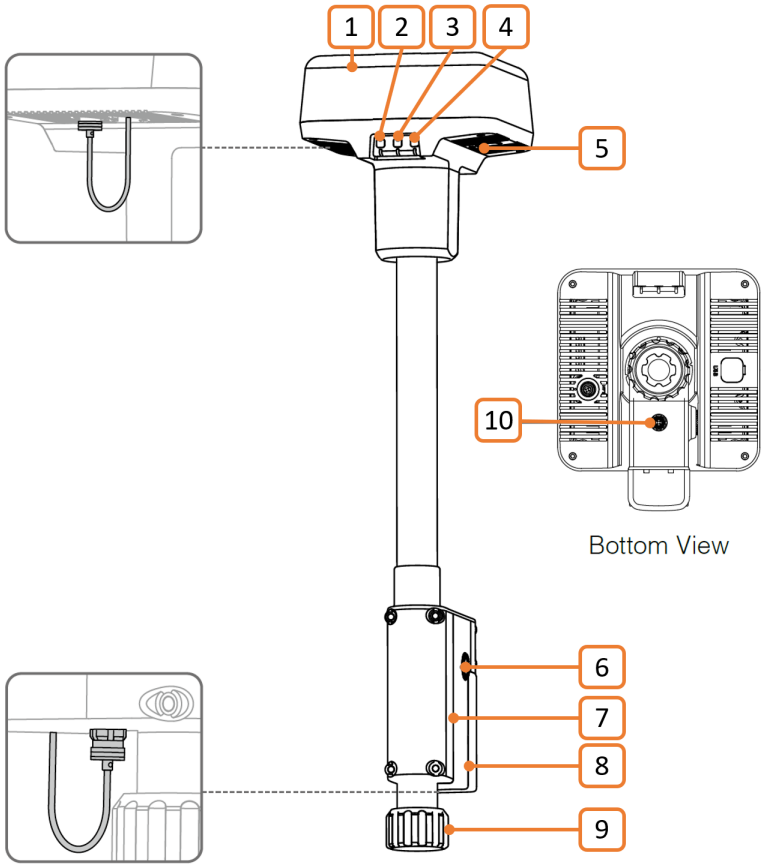


Figure 2 DJI D-RTK2 Base Station

1. Antenna
2. Link Button and LED Indicator
3. Power Button and Indicator
4. Operation Mode Button and Indicator
5. USB-C Port
6. Rosette Mount
7. Battery Compartment
8. Battery Cover
9. Lock Nut
10. External Power Port**

** Equipped with a protective cover that can be stored when the unit is in use. When not in use, cover the ports to protect the unit from moisture and dust.

3.1 Mount the DJI D-RTK2 Base Station to the Tripod

To achieve centimeter-level precision, it is essential to **set up the base station over a known location with known coordinates**. However, the system can also work without a known location, but the D-RTK2's global accuracy would be at the meter-level, which is the accuracy provided by standard GPS without RTK corrections.

Refer to the *Manually Input Coordinates* section for more information on adjusting the base station coordinates.

To mount the base station:

1. Find an open outdoor space and set up the tripod. Make sure it is stable, leveled, and has a clear view of the sky. We recommend that you follow these guidelines for optimal performance and accuracy:
    - **Tripod Position and Angle:** Once the tripod has been leveled, refrain from changing its position or angle to maintain accuracy. If any adjustments are made, it will require re-leveling.
    - **Clear Line of Sight:** To ensure a wide field of vision, confirm that there are no obstructions (such as trees or buildings) at an angle exceeding 15 degrees above the horizontal plane of the DJI D-RTK2 antenna. This prevents GNSS signal absorption or blockage.

- **Distance from Emission Sources:** Position the setup location at least 200 meters away from high-power radio emission sources, including TV and microwave stations, and maintain a minimum distance of 50 meters from high-voltage transmission lines. This separation is essential to prevent electromagnetic interference with GNSS signals.
- **Avoiding Water and Signal Interference:** Choose a location that is distant from large bodies of water and objects that may strongly interfere with satellite signal reception, thereby minimizing multi-path effects.

2. Connect the DJI D-RTK2 body to the extension rod and install the combination on the tripod.

3. Mount the battery to the base station.
4. Adjust the base station using the gradienter, ensuring the bubble is kept inside the black circle.

3.2 Power on the Base Station

Short press, then press and hold the **Power** button (refer to Figure 1) to turn on the base station. The power indicator should be in solid green. In addition, refer to the following table for the link indicators.

Link LED Color	State	Description
Red	Solid (light stays on)	System has just started / error alarm
Red	Light flashing rapidly	Battery is below 20%
Red	Light flashing slowly	Number of received satellites is 5 or less
Yellow	Solid (light stays on)	Number of received satellites is 6 to 9
Green	Solid (light stays on)	Number of received satellites is 10 or more

3.3 Switch the Base Station to Broadcast Mode

The DJI D-RTK 2 Mobile Station provides different operating modes to use with different products. For the M300/M350, the base station should be operating in Broadcast mode (Operating Mode 5).

1. Press and hold the **Operating Mode** button (refer to Figure 1) for two seconds. The indicator turns yellow and blinks once indicating the base station is ready to switch modes.

> ⓘ If no action is taken within 2 seconds, the base station will remain in the current mode.

2. Short press the button to cycle through modes. For broadcast mode, the mode light flashes green 5 times.

Operating Mode	Blinking Pattern
Mobile Base Station	Once
Stationary Base Station	Twice
Handheld Mapping Device	Three Times
Mobile Base Station (M210 RTK V2)	Four Times
Mobile Base Station (Broadcast Mode)	Five Times

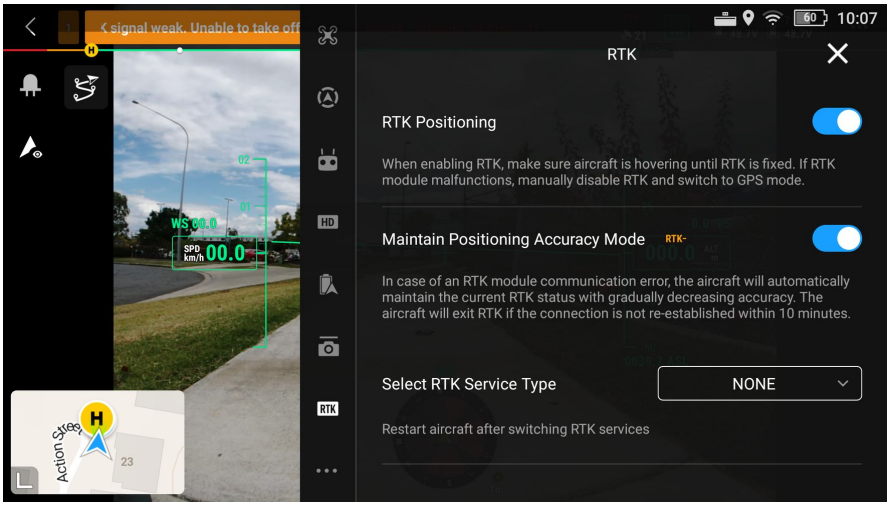
3.4 Connect the M300/M350 Controller to the D-RTK2 Base Station

Follow these steps to link the remote controller to the broadcast network of the D-RTK2 Mobile Station.

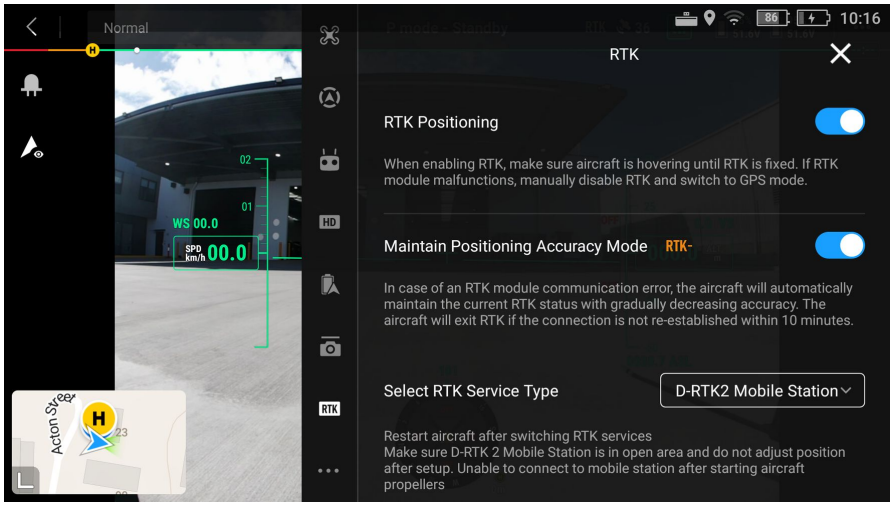
1. Mount the Hovermap to the aircraft then connect the Fischer connector to the payload. Also, ensure that the OSDK cable is secured on the top of the drone.
2. Power on the aircraft first, then the Hovermap, and then the M300/M350 controller.

> ⓘ Make sure that the D-RTK2 Mobile Station you want to connect to is in **Broadcast** mode.

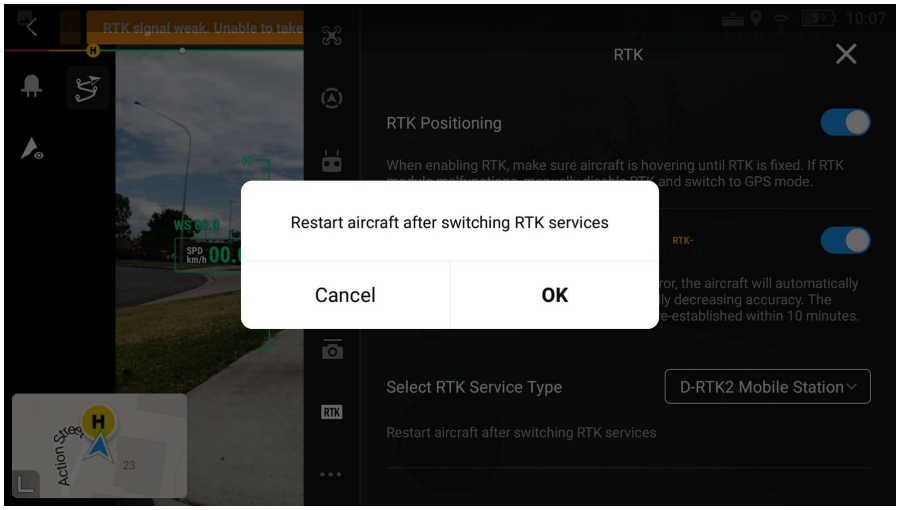
3. On the M300/M350 controller, open the **DJI Pilot Pro 2** app.
4. Tap **Enter Camera View** then close the **Pre Flight Checks** page.
5. Tap the **More Settings** button (**...**) on the upper-right of the display.
6. Tap **RTK** from the menu on the left to display the RTK Settings page.
7. Make sure that the **RTK Positioning** and **Maintain Positioning Accuracy Mode** are toggled on.



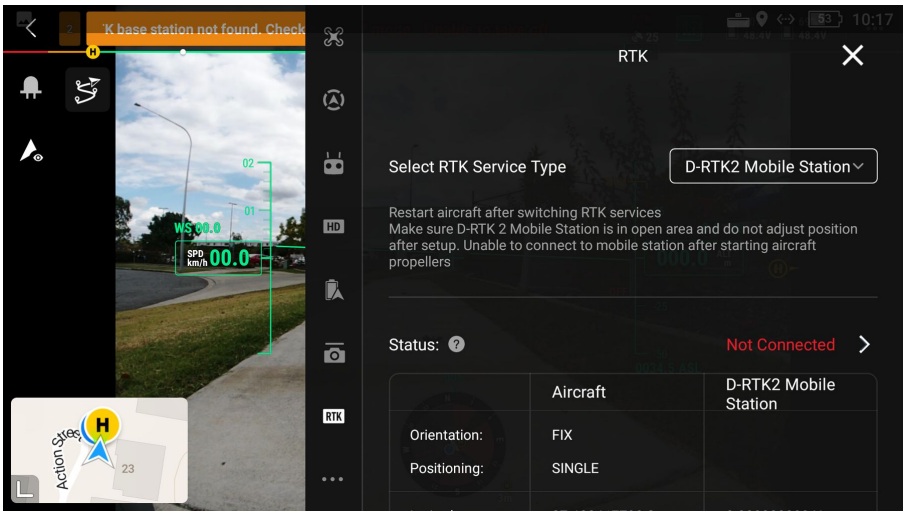
8. In the field next to **Select RTK Service Type**, tap the down arrow then select **D-RTK2 Mobile Station** to search for available base stations.



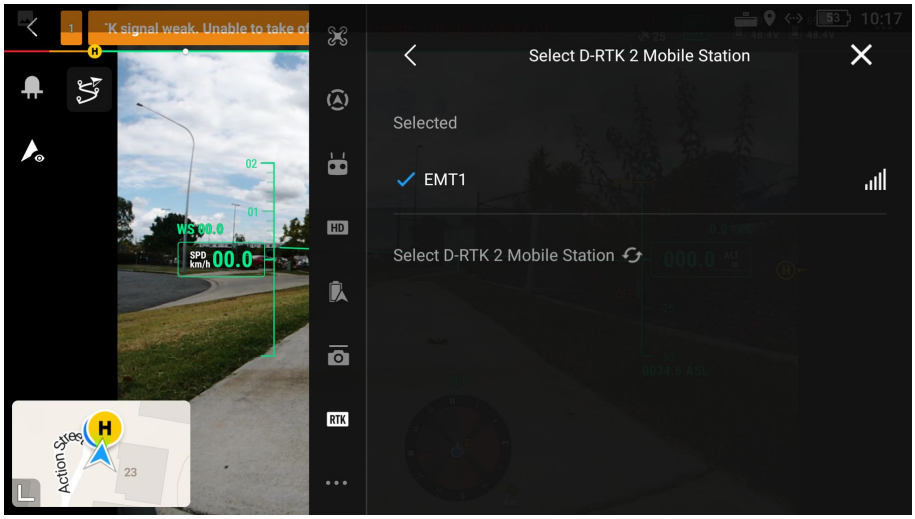
9. You will get a notification after changing the RTK service type. Tap **OK** then proceed to restart the aircraft.



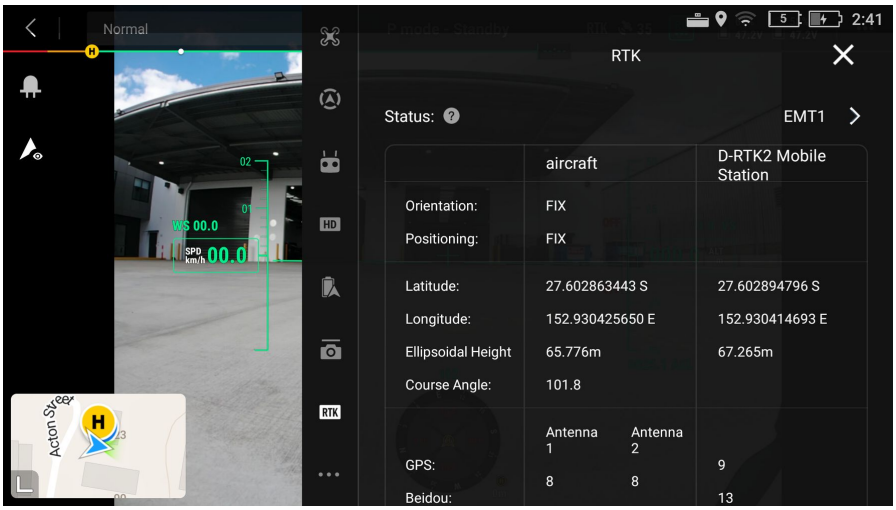
10. Scroll down to the **Status** section then connect to the base station by tapping **>** to bring up the **Select D-RTK2 Mobile Station** page.



11. Select the name of the base station to connect to and wait for the blue tick to indicate a successful connection. Go back to the main RTK settings page.



12. Once connected, the **Status** will change from **Not Connected** to displaying the name of the connected base station. Check that the **Orientation** and **Positioning** status also show as “FIX“ to indicate that the RTK module is ready and the aircraft is ready for flight.



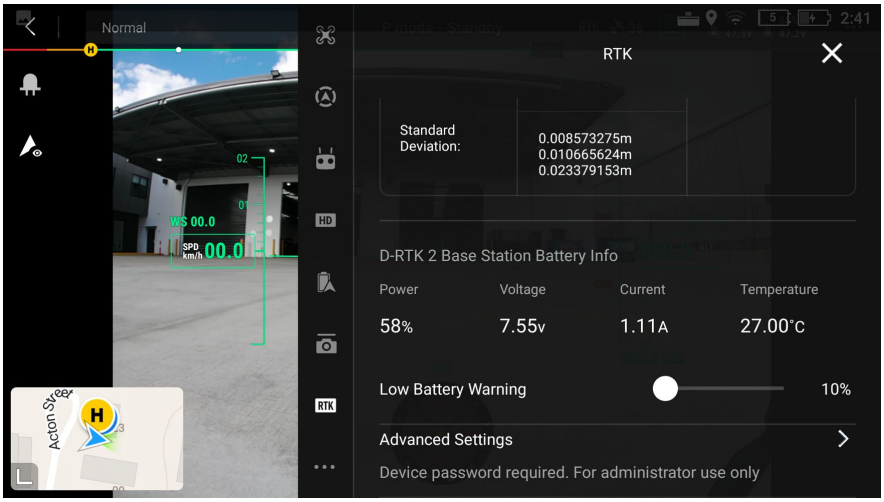
Restart the aircraft if you are experiencing connection and configuration issues.

3.5 Manually Input Coordinates

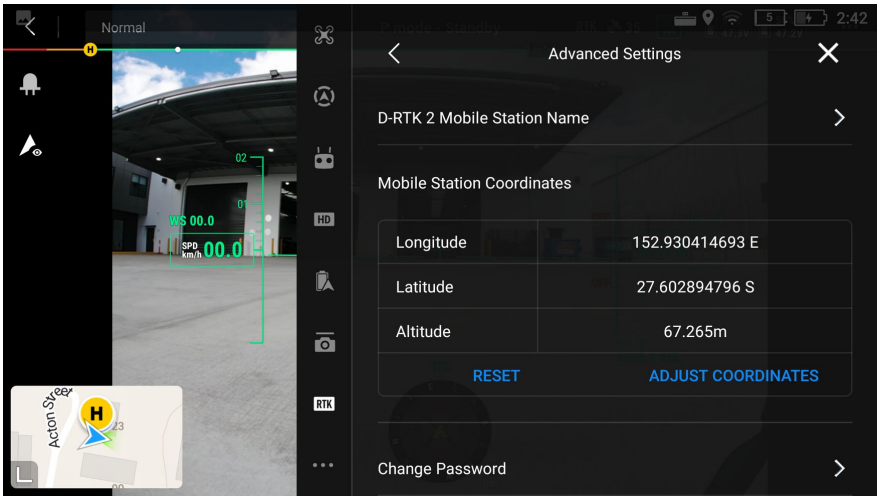
It is crucial to have accurate base station coordinates as drone RTK readings are computed relative to the base station location. This can be obtained by setting up the base station over a known surveyed point or manually adjusting the base station coordinates.

To adjust coordinates:

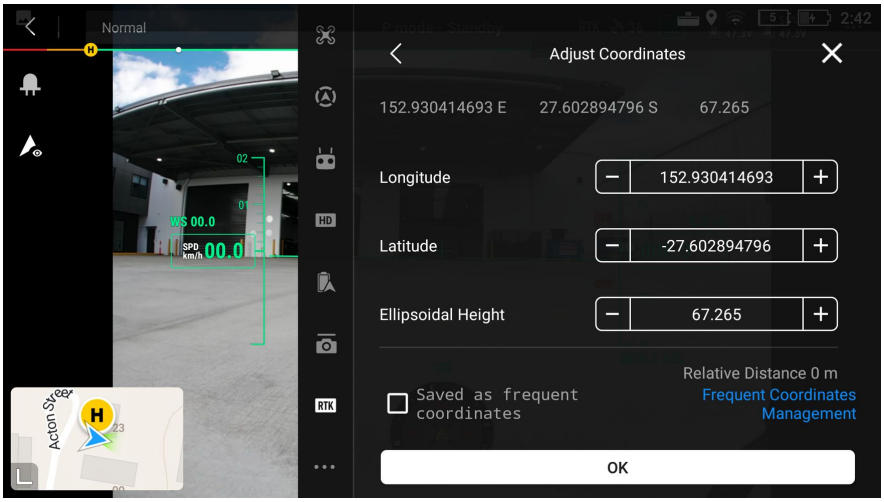
1. Scroll to the bottom of the RTK Settings page.
2. Tap **Advanced Settings** then enter the administrator password for the D-RTK2 mobile base station (default password is **123456**).



3. In the Advanced Settings page, tap **Adjust Coordinates**.



4. Input the current location information of the mobile station and tap **OK** to record the location in the system.



> If the input values for Broadcast Mode are over 15m away from the actual DJI D-RTK2 Mobile Station coordinates, they will not be accepted. In case the DJI D-RTK2 Mobile Station is restarted after the input coordinates have been successfully set, those coordinates will only be used if the difference between the actual and the set coordinates is less than 5m. Otherwise, the actual positioning coordinates will be used.

You are now ready to perform a scan mission.

4. Base Station Activation and Setup

This section covers the setup and/or activation of the DJI DRTK-2 and Emlid Reach RS2/RS2+ base stations for first-time use.

4.1 DJI D-RTK2 Mobile Base Station

4.1.1 Activate the DJI D-RTK2 Mobile Base Station

1. On your PC, launch **DJI Assistant 2** then click the **DRTK-2** icon.
2. In the window that appears, click **Start Activation**.

> **Note**
> The DJI Assistant 2 app can be downloaded from the **DJI Download Center** web page:
> https://www.dji.com/au/downloads
> You only need to activate the mobile station once, when connecting to the app for the first time.

4.2 Emlid Reach RS2/RS2+

4.2.1 Setup Emlid Reach RS2/RS2+ for the First Time

To setup the RS2/RS2+, follow the recommended instructions found here:

https://www.youtube.com/watch?v=Miy8L_1AgCQ

The instructional video covers the process of starting the RS2/RS2+ for the first time.

- Checking the battery level and charging the device
- Powering the device
- Connecting to a Wi-Fi network
- Updating the firmware

5. Capture and Process RTK Data

5.1 Perform a Mapping Mission

Capturing RTK data requires your Hovermap to be connected to an RTK-capable platform such as the M300 or M350. In addition to this requirement, you must have the following essentials in place to ensure a smooth and successful mapping mission:

- **Fully-charged Hovermap Battery:** Make sure that the Hovermap's battery is fully charged. A drained battery could result in a premature end to your mission or data loss.
- **Emesent Commander Installed:** Ensure that the Emesent Commander application is installed on your tablet. The app should be up-to-date with the latest software version to guarantee optimal performance.
- **Full-charged Android Tablet:** Your tablet should also be fully charged to prevent any interruptions caused by a sudden loss of power.

To perform a mapping mission

1. Connect Hovermap to a battery or other approved power source. Hovermap doesn't come with an internal battery, so it will either need to be platform-mounted or powered by an external battery.
2. Press the power button to power on Hovermap. The LED will change from OFF to a flashing red indicating that the Hovermap is initializing.
3. After completing initialization, the status LEDs will flash orange and then switch to a slow pulsing Emesent blue. This indicates that the Hovermap is now ready to scan. Ensure that Hovermap is positioned in a way that allows the LiDAR sensor to rotate freely.
   If, after 30 seconds, the status LEDs are not a slow pulsing blue, the start-up checks have been unsuccessful. If this happens, please restart your Hovermap.
4. Use the Emesent Commander application to access the Mission workflow.
   a. Launch the application then tap either **Connect to Hovermap** or the red Wi-Fi icon on the top banner.
   b. Look for **ST_xxxx**, **HVM_xxxx**, or **LRR_xxxx** (where **xxxx** = Hovermap device to connect to) in the list of networks.
   c. Select that network then enter the Wi-Fi password (**hovermap**).

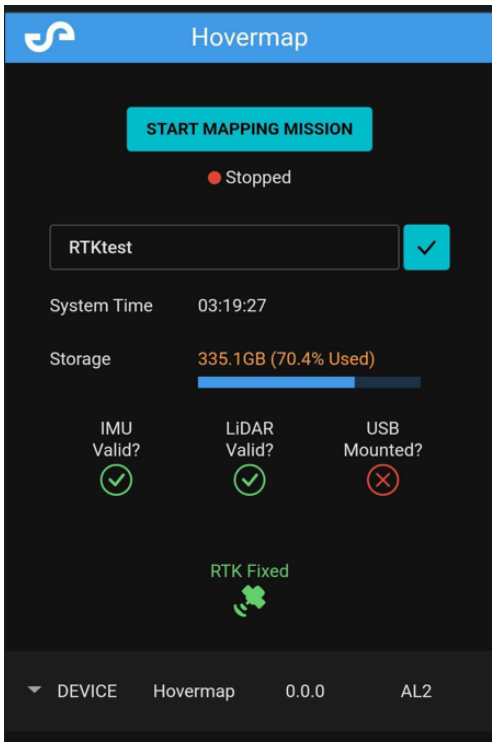
d. Once the connection is established, you will hear an audio message indicating that you are “Connected”. The red banner is removed from the landing page.

5. Complete the required pre-mission checks then tap the **Start Scan** button on the **Scan setup** page of the Mission Workflow.
   The LiDAR sensor will start spinning. The status LEDs will start by flashing green, and will then change to a slow green pulse. When the status LEDs start to pulse, keep Hovermap still for the first 10 seconds. This gives Hovermap time to start to build a map and to position itself within its environment.
   Warning: This step is essential! If Hovermap is moved before it has collected enough points to start mapping its environment, it won’t be able to create a map successfully.
6. Once you have given Hovermap time to position itself, you can start your scan.
7. To end the mission, tap the **Stop Scan** button (or short press the power button) in the Emesent Commander app. The LiDAR sensor will stop spinning after a few seconds, and the status LEDs will return to a slow pulsing blue. Hovermap is now ready for another scan or data retrieval.
8. Download the data from Hovermap by inserting a USB flash drive into the USB port at the back of the unit. The status LEDs will change to a flashing light blue while the data is being transferred to the USB flash drive. All data that has not previously been transferred will be copied to the USB flash drive.
   Note: You can only download data when Hovermap is on standby (a slow pulsing blue).
   To retrieve data, the USB flash drive must be formatted in an exFAT file format.
9. Once the transfer is complete, the status LEDs will return to a slow pulsing blue. The USB flash drive can now be removed.
   Note: Scans are stored internally until they are deleted manually.
10. Shut down Hovermap by pressing the power button for at least 4 seconds (or until the status light turns off) to shut down Hovermap.

5.2 Check GPS/RTK Status via Web UI

GPS and RTK status can be checked via the Web UI so there is no need to keep the Emlid Flow application open after the initial setup.

To check GPS/RTK status once you have connected to your Hovermap's Wi-Fi network, open an internet browser then type **hover.map** into the address bar. The GPS/RTK status is displayed at the bottom of the screen.



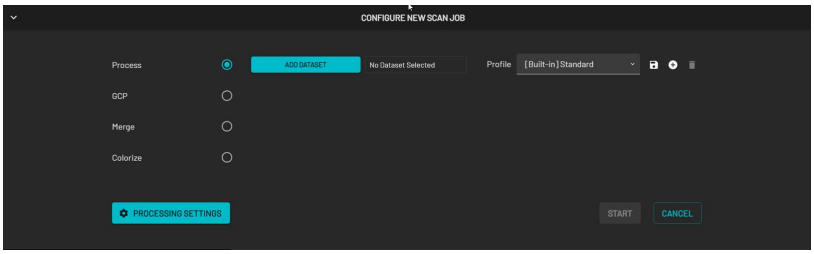
> This feature can only be accessed through Hovermap Software 3.1 (or later versions).

5.3 Process RTK Data

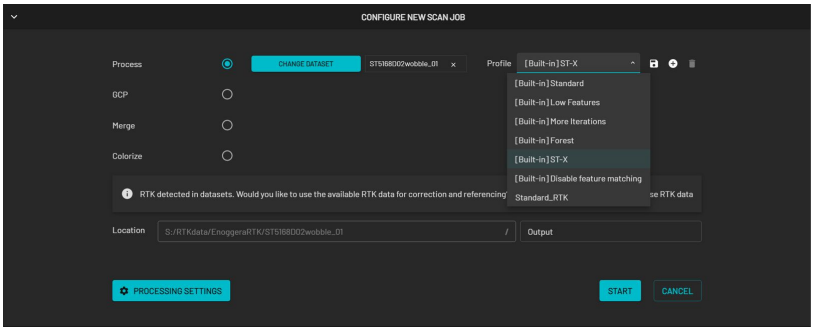
Once the data has been retrieved from Hovermap, it is in a raw state and will need to be processed. Use Emesent Aura to create a rich 3D point cloud. Emesent Aura supports georeferencing a scan using RTK data via the M300/M350.

> Ensure you have correct version of Emesent Aura to be able to process RTK data.
>
> - M300: version 2.7 or higher
> - M350: version 3.1 or higher

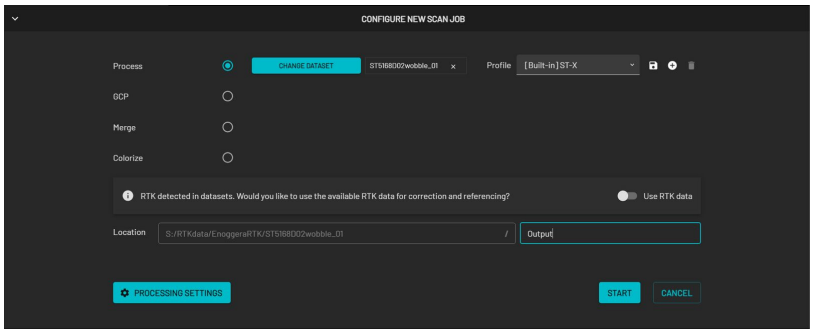
1. Launch the Emesent Aura software application. You will need an RTK license to access the feature.
2. Go to the **Process** tab then click **Process Scan**.
3. Select the **Process** option then click **Add Dataset**.



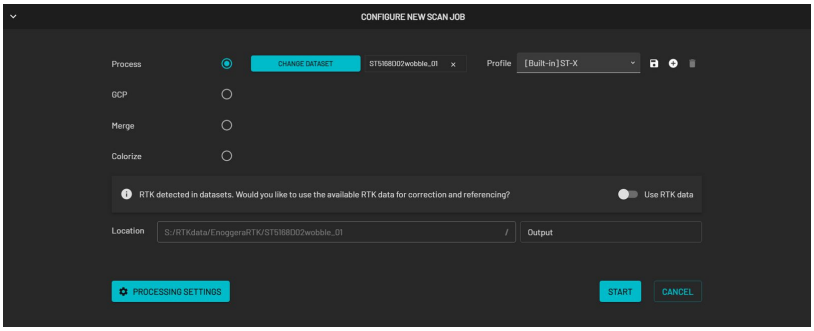
4. Browse for the folder that contains the point cloud dataset to be processed. Select that folder.
5. Select the processing profile to use.



6. In the **Location** field, enter the preferred name for the output folder. Emesent Aura will create this folder, which stores all the processed results and data, as a child directory within the raw scan folder.

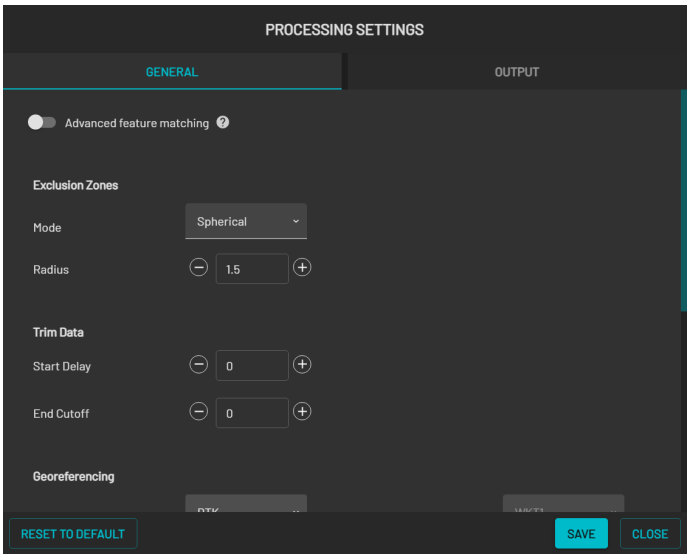


7. If RTK data is detected in your dataset, toggle on **Use RTK data** when prompted to use the real-time
corrections provided by the RTK system to improve the accuracy of the georeferencing of the point cloud data.

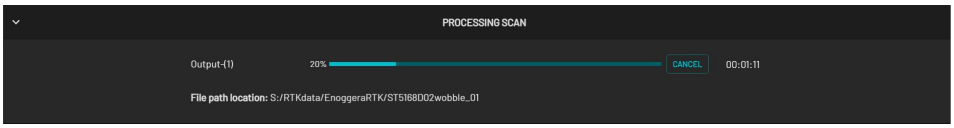


8. In **Processing Settings**, proceed to fine-tune the RTK and output parameters or change the **Georeferencing Mode**. When done click **Save**. To exit without saving the changes, click **Close**.

> If you have selected a built-in profile, you will be prompted to create a new profile to be able to save the changes.

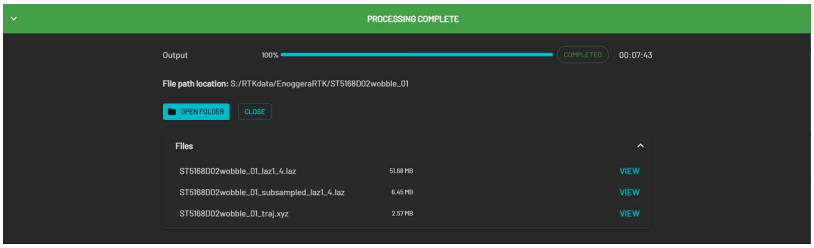


9. Click **Start** to begin processing. The **Configure New Scan Job** panel is replaced with the **Processing Scan** panel and shows a progress bar showing how far along you are in your processing job. In addition to the progress bar, the elapsed time of the processing job is shown to the right.



The directory file path below the progress bar provides a way to identify the dataset source. This is useful if simultaneously processing multiple jobs with the same output folder name. Copying the file path and pasting it on your computer's file explorer allows you to access the completed files without having to wait for the processing job to be completed.

10. Once the processing job has finished, the bottom panel displays the generated files.



11. Click **View** beside each generated file to load them into the Viewport for analysis or further editing. The following main files are generated:

    - Full point cloud
      The point cloud with the complete set of data points. The output file type varies depending on the profile used in generating the point cloud. The filename includes the output folder name with the output file type appended to it.
      For example: *Output_laz1_4.laz* where the output file type is PointCloud LAZ (1.4) and the file is located in the “Output” folder.
    - Subsampled point cloud
      The point cloud containing a subset of points from the original point cloud dataset (based on Subsample Factor value in Processing Settings). This output is only generated if Subsample Point Clouds is enabled in the Output tab of the Processing Settings panel.
    - Trajectory file
      The data file containing the recorded movement or path of the Hovermap as it acquired the point cloud data.

emesent

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