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FREQUENTLY ASKED QUESTIONS: EMESENT AURA M300/M350 RTK

DOCUMENT NUMBER: FAQ-001
REVISION NUMBER: 1.3
RELEASE DATE: 21 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.

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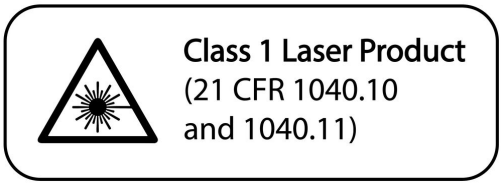
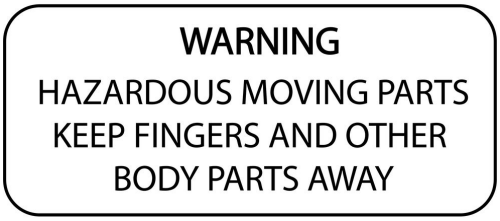
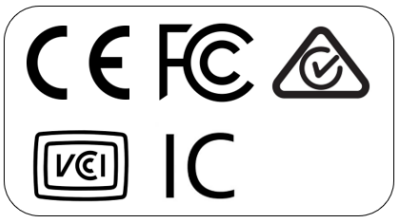






Contents

Welcome to the comprehensive FAQ guide dedicated to the RTK processing capabilities of Emesent Aura, designed for seamless integration of RTK data from base stations with the M300/M350 drone. In this guide, you will find answers to commonly asked questions regarding RTK technology, its application, and the point cloud processing workflow.

What does RTK mean?

Real-Time Kinematic

How does RTK work?

RTK (Real-Time Kinematic) systems use advanced techniques to provide highly accurate positioning solutions. They leverage the phase measurements of the signal's carrier wave in conjunction with the signal's information content. These systems rely on a single reference station or interpolated virtual station to provide real-time corrections, which can achieve up to centimeter-level accuracy. In this setup, a single base station receiver is used in combination with multiple mobile units. The base station broadcasts the phase of the carrier that it observes, and the mobile units compare their phase measurements with the ones received from the base station, enabling precise positioning.

What is CORS?

A Continuously Operating Reference Station (CORS) network is a group of RTK base stations that transmit corrections, typically over an Internet connection. The positioning accuracy is improved in a CORS network because multiple stations work together to ensure correct positioning and prevent false initialization of a single base station.

When is it better to use RTK instead of Ground Control Targets?

Given there is no need to set out or survey targets, RTK can potentially provide more accurate georeferenced scans faster when a GPS signal is available (e.g. not indoors or underground).

What are the benefits of capturing Hovermap data with M300/M350 RTK?

To enhance the accuracy of your Simultaneous Localization and Mapping (SLAM) output, georeferencing the data is essential. This process eliminates the need to close the loop when capturing data, eliminates drift, and improves the overall mapping accuracy.

It also enables the capturing of large-scale outdoor environments such as beaches, fields, and vegetation, where SLAM alone tends to perform poorly.

Additionally, if you are using the Hovermap ST-X, georeferencing allows you to capture data at higher speeds and with greater efficiency.

What is the expected level of accuracy when using RTK?

A set of experiments has been conducted to assess the robustness and correctness of georeferenced point clouds in various data collection scenarios by collecting data at different flight speeds, various flight trajectories, longer flight times, and larger mapping areas. For more information, refer to M300 RTK: Improved SLAM Accuracy and Georeferencing.

- 50% Percentile/ Median:
  - Horizontal accuracy is less than 20 mm
  - Vertical accuracy is less than 40 mm
- 90% Confidence:
  - Horizontal accuracy is less than 40 mm
  - Vertical accuracy is less than 50 mm

What hardware and software do I need to capture RTK data?

Hardware

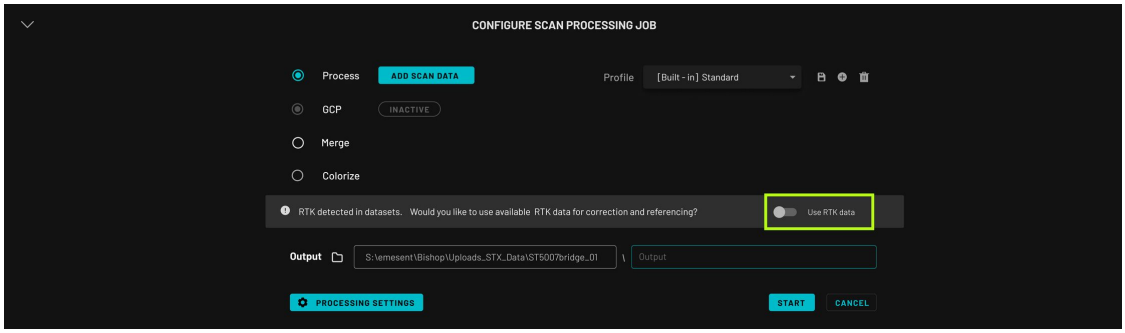
- DJI M300 / DJI M350
- GNSS mobile receiver
  - Emlid RS2+ Base Station (recommended)
  - DJI D-RTK2 (supported)
- Hovermap (HVM100, ST, and ST-X are all supported)
- Optional: 4G SIM Card Dongle for the DJI M300 controller to allow direct connection to the CORS network (for regions where this service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

Software

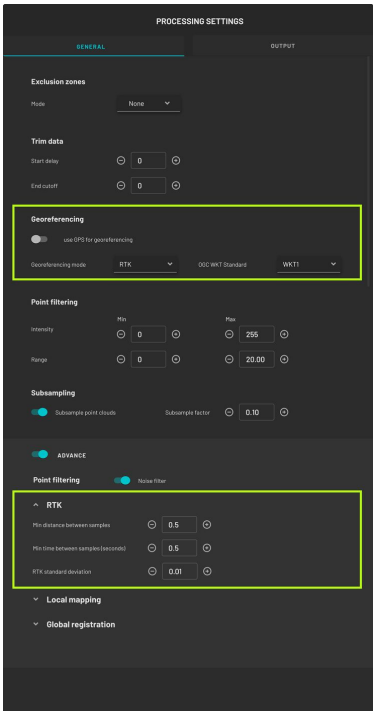
- Emesent Aura
  - M300: version 1.3 or higher with a valid RTK license
  - M350: version 1.4.1 or higher with a valid RTK license
- Emesent Commander
  - M350 only: version 1.1 or higher
- Emesent Cortex
  - M300: version 2.7 or higher
  - M350: version 3.1 or higher
- For AL0 customers:
  - It is **essential** to have the onboard DJI SDK set up on the M300/M350 to allow GPS data to be recorded by Hovermap.

What is the workflow for georeferencing a point cloud using RTK data?

The Emesent Aura user manual provides detailed instructions on how to process RTK data. The workflow is similar to standard SLAM processing, but there are a few things to keep in mind. If your bag file contains RTK data, Emesent Aura will automatically detect it and prompt you to use the data for correcting and georeferencing the point cloud.



Toggle on **Use RTK data** to bring up the **Processing Settings** panel. Proceed to fine-tune the RTK and output parameters or override RTK by changing the **Georeferencing Mode**. When done click **Save**. To exit without saving the changes, click **Close**.



Is it necessary to utilize a base station for receiving RTK correction?

For the most accurate results, the use of a local base station positioned over a surveyed point is recommended. If a surveyed point is not available, other setups can be used depending on the hardware and local infrastructure available. Four options are outlined below:

Option 1: EMLID Reach RS2+ local base station

Two base positioning methods are recommended:

- Located over surveyed point
  - or -
- RTK Fix Position using NTRIP data from the CORS network
  - Additional information on Emlid base station setup options: Placing the base | RTK Modules

> **Note**
> Access to a 4G or Wi-Fi network is required for this positioning method.

Pros

- Up to centimeter-level local accuracy (between the base station and the M300/M350)
- Access to a 4G or Wi-Fi network is not required when set up over a surveyed point
- High absolute accuracy can be achieved for the local base position using averaged readings from the CORS network (accuracy approximately 7 mm + 1 mm/km distance to connected reference station)
- Can be mounted to survey-grade tripods
- Can be used as a surveying device when connected to the CORS network (i.e. to survey the position of GCP's)

Cons

- When used as a local base station, the M300/M350 controller must remain within the local Wi-Fi range (approximately 20 m) of the RS2+ position to receive RTK correction data.
- Base station hardware purchase and setup required
- Emesent Commander cannot be directly run on the M350 RC Plus controller since its Wi-Fi is connected to the RS2+. Emesent Commander will need to be run on an external tablet rather than directly on the controller.

Option 2: DJI D-RTK2 local base station

Base positioning method:

- Located over surveyed point

Pros

- Up to centimeter-level local accuracy (between the base station and the M300/M350)
- Access to a 4G or Wi-Fi network is not required
- Distance between the D-RTK2 base position and M300/M350 controller can be extended within the DJI occusync range, as long as visual line-of-sight is maintained
- DJI RC Plus controller's Wi-Fi can still connect to Hovermap, enabling Emesent Commander to run directly on the controller.

Cons

- Requires surveyed point for accurate absolute position results
- Cannot be used as a surveying device - for either GCP's or for determining an accurate absolute position of the base station when a surveyed point is not available
- Base station hardware purchase and setup required

Option 3: 4G Dongle for the DJI M300 Smart Controller

The M300 can use the following 4G SIM Card Dongle to allow direct connection to the CORS network (for regions where this service is available):
DJI Matrice 300 PT17 - 4G Dongle ZTE MF833V SIM Card Dongle for RTK

> **Note**
> To enable 4G connectivity, turn off the Wi-Fi on the M300 Smart Controller.

Pros

- Minimal additional hardware purchase and setup required
- M300 Smart Controller is not tied to a limited distance from the local base position

Cons

- Requires 4G connectivity
- Relies on the availability of external CORS network
- Absolute accuracy depends on operator distance from the nearest reference station - positional uncertainty is accrued at approximately 1 mm/km

Option 4: DJI M350 RC Plus controller direct to CORS network

The M350 RC Plus controller can be configured to directly access the CORS network (in regions where this service is available) if a Wi-Fi network is available at the location where the mission is being conducted.

Pros

- No additional hardware purchase and setup required
- M350 RC Plus controller is not tied to a limited distance from a local base position

Cons

- Requires Wi-Fi network connectivity
- Relies on the availability of external CORS network
- Absolute accuracy depends on operator distance from the nearest reference station - positional uncertainty is accrued at approximately 1 mm/km
- Emesent Commander cannot be directly run on the M350 RC Plus controller since its Wi-Fi is connected to an external network to access CORS. Emesent Commander will need to be run on an external tablet rather than directly on the controller.

Can you use the RTK feature using an M300/M350 with Hovermap in Mapping mode (AL0)?

Yes. However, 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

What output is provided as part of the RTK workflow?

The data files generated by SLAM include all the standard output files. Additionally, there is a projection file with a **.PRJ** extension that defines the coordinate system and projection information of the output data.

> **Important**
> The RTK georeferenced data which customers should use is in the **write_global_landmark_referenced** output folder.

Can we further correct our RTK data with GCP?

It is currently not possible to use both RTK and GCP at the same time due to the complexity in determining which one is better for specific locations and situations. Assigning confidence or priority to different sections of RTK and GCP can be challenging. This is being considered as a future enhancement to Emesent Aura though there is no timeframe currently available.

Can you use our RTK feature without a drone (i.e. Mapping mode only)?

No. Ground-based RTK, currently in development, will be added in a future release.

Is RTK compatible with the M210v1 or Zoe? If not, is this in the roadmap?

Unfortunately, there are no plans to provide support for these platforms.

Does RTK work in areas without GPS coverage?

No. RTK relies on signals from the Global Navigation Satellite System (GNSS) and only works above ground. It is not suitable for underground mines or confined spaces.

How do I specify the datum in use by my RTK system?

- Currently, there is no way for customers to specify the datum in use by their RTK system. As a result, we assume that WGS84 is being used.
- If a customer has used a different datum, they need to edit the **PRJ** file and change the string that specifies the datum.

How does Hovermap use RTK data?

- RTK data samples are re-projected onto a tangent plane around a point in the scan area using a Transverse Mercator projection to minimize distortion caused by the earth's curvature. This projection is described in the **PRJ** file provided alongside the point cloud, rather than an EPSG code.
- Customers are currently required to re-project the data to their preferred CRS using third-party software (e.g., QGIS, Global Mapper), but future Emesent Aura releases may handle this.
- RTK-derived constraints for the SLAM solution are generated using RTK data samples with minimum distance and time intervals, The minimum time intervals can be adjusted using advanced processing parameters.
- Any RTK data samples from low-quality RTK fixes are rejected.
- During SLAM processing, the RTK-derived constraints are considered using a fixed Standard Deviation that describes the uncertainty in the constraint position. Advanced processing parameters can be used to adjust the Standard Deviation. The LiDAR also provides constraints, so both Lidar and RTK constraints are considered during SLAM processing.

How do I apply a GEOID to my data?

We are using ellipsoid height and customers will need to use third-party party software to apply a GEOID.

What software can I use to help me with re-projecting my data?

Reprojection is supported on Emesent Aura version 1.6 or later. Refer to the Emesent Aura user manual for instructions on reprojecting your data.

How do we deal with scaling of the processed RTK data?

The output point cloud will be in a transverse Mercator projection instead of a Universal Transverse Mercator Projection (UTM). The transverse Mercator projection will have a unity (1.0) scaling and use a local origin calculated from the RTK values. As a result, the point cloud coordinates will have smaller

values than UTM, there will be no scaling applied to the point cloud. See "*What software can I use to help me with re-projecting my data?*" for how to move the point cloud to another projection.

Does RTK work with color?

Yes.

Can multiple RTK datasets be merged?

No. This is being considered as a future enhancement to Emesent Aura though there is no timeframe currently available.

What is 'Advanced feature matching' and why is it disabled by default for RTK data processing?

The **Advanced feature matching** stage in SLAM processing provides a better output for most environments. However, for RTK data, disabling this stage reduces error distribution and provides a better output.

What impact does the dropout of RTK have on point cloud processing if it occurs at any moment during the flight?

The parts of the trajectory that lack reliable RTK data are excluded from processing. Mapping on those sections will be based solely on SLAM. However, the availability of RTK data on other parts of the trajectory results in a better outcome than pure SLAM.

What is the best practice for capturing RTK data to get the best possible results?

Speed and Altitude

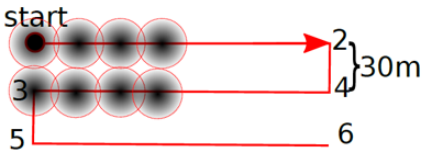
To obtain a high-quality point cloud output, it is recommended to fly at a certain speed and altitude. While flying at higher speeds and altitudes can result in a good output, it is best to follow the recommended speed and altitude mentioned below:

- **For Hovermap ST-X**
  - Speed: 6 m/s
  - Altitude: 30 m
- **For Hovermap ST and HVM100**
  - Speed: 3 m/s
  - Altitude: 20 m

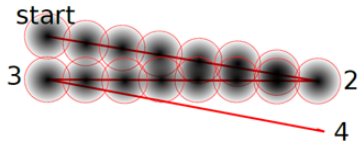
Flight Path

To achieve the best results with the Hovermap and M300/M350 RTK, it is recommended to use a lawnmower pattern with traverses at a maximum of 30m intervals. However, in the case of poor RTK, introducing more zigzags and overlaps can help to improve the accuracy of the point cloud. You can refer to the diagrams below for more details.

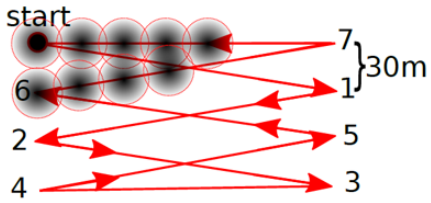
RTK Standard Deviation is low (<15mm)



RTK Standard Deviation is moderate (15mm ~25mm)



RTK Standard Deviation is high (>25mm)



In situations where the scan being captured exceeds the M300/M350 drone's battery life, what practices are considered the most effective or recommended?

Based on our observations, some customers have reported positive outcomes by switching out batteries on the M300/M350 while simultaneously carrying out a Hovermap scan. However, we have not validated this practice and cannot guarantee its success for all customers. If this method does not work, third-party software will be required to merge multiple RTK Hovermap datasets.

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