emesent

VEHICLE RTK USER MANUAL

DOCUMENT NUMBER: UM-028
REVISION NUMBER: 1.2
RELEASE DATE: 04 NOV 2024

PREPARED BY:
EMESENT PTY LTD
LEVEL 6, BUILDING 4, KINGS ROW OFFICE PARK
40-52 MCDOUGALL ST, MILTON, QLD, 4064 AUSTRALIA

EMAIL: CUSTOMER-SUCCESS@EMESENT.IO
PHONE: +61 7 3548 9494

Copyright

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 and other platforms. We therefore recommended that you 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.

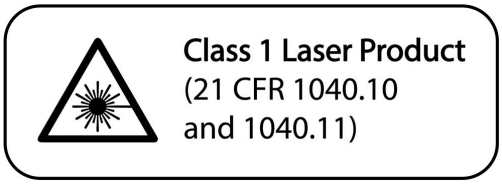
The use of Remotely Piloted Aircraft Systems (RPAS) may result in serious injury, death, or property damage if operated without proper training and due care. Before using an RPAS, you must ensure that you are suitably qualified, have received all necessary training, and read all relevant instructions,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

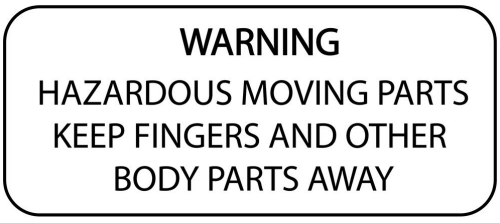
Warnings

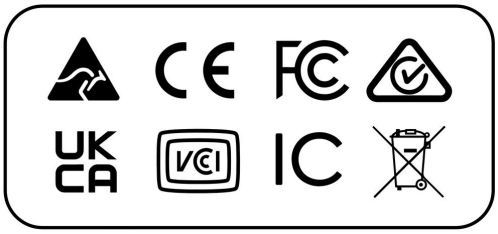
- This document is legally privileged, confidential under applicable law and is intended only for the use of the individual or entity to whom it is addressed. If you have received this transmission in error, you are hereby notified that any use, dissemination, distribution or reproduction is strictly prohibited. If you are not the intended recipient, please notify the sender and delete the message from your system.

- Do not attempt to disassemble, repair, tamper with, or modify the this product. This product contains no user-serviceable parts inside. Any disassembly of the product enclosure will invalidate the IP65 rating and disrupt the factory calibration of LiDAR. Contact Emesent for any repairs or modifications.

- 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. Introduction

The Vehicle RTK lets you georeference your vehicle-based Hovermap scans and automatically correct for SLAM drift in low-feature environments using a GNSS receiver.

> The term "GNSS receiver", used throughout this manual, refers specifically to the devices supported by Vehicle RTK. Currently, these include the Emlid RS2, RS2+, and RS3 receivers. Please refer to the "*Setup and Configuration*" section for instructions regarding these supported devices.

> **DRIVING WARNING**
> Always make sure to drive safely when operating a vehicle. Do not be distracted or use the phone/tablet to change settings while driving. Only check the GPS status when it is safe to do so.

2. Hardware Requirements

2.1 Vehicle RTK Kit

1	RTK Vehicle Mount (w/ magnetic feet)	Mechanical mount to secure the Hovermap to the vehicle with the GNSS receiver and battery mount.
2	Vacuum grip feet (x4)	Replace the magnetic feet with the vacuum mounts to attach the vehicle mount to non-magnetic surfaces.
3	100mm GNSS Spacer pole	The extension pole attaches to the RTK Vehicle Mount for mounting the GNSS receiver.
4	Spanner	Used to interchange between the magnetic and vacuum grip feet
5	Emlid GNSS cable	Lemo to Lemo cable suitable for Emlid RS2/RS2+/ RS3 GNSS receivers

6	Hovermap cable	Cable for connecting the Hovermap ST/ST-X to the Vehicle RTK Mount
*	Emlid RS2+ RTK receiver (sold separately)	The Emlid RS2+ RTK GNSS Receiver can be optionally included in the kit purchased from Emesent. Alternatively, you can use your own Emlid RTK Receiver. The Vehicle RTK Kit is also compatible with the Emlid RS2 or RS3

2.2 Other Required Hardware

1	Hovermap ST/ST-X	Emesent Mapping payload
2	Battery (v lock)	Main power source for the Hovermap and the RTK unit
3	Emlid Base Station setup	Includes the Emlid RS2+ RTK GNSS Receiver and surveying tripod. This is only required if you do not wish to use CORS.
4	Phone/Tablet	Used to configure and check RTK status

3. Software Requirements

- **Emesent Aura**
  - version 1.6 or later
- **Emesent Cortex**
  - version 3.2.2 or later
- **Emlid Flow**
  - App Store - https://apps.apple.com/us/app/emlid-flow/id1463967138
  - Google Play - https://play.google.com/store/apps/details?id=com.emlid.reachview3&hl=en_AU&gl=US

4. Setup and Configuration

This section details how to set up your GNSS receiver. Refer to Emlid's official documentation - https://docs.emlid.com/reachrs2/ - for an overview of using the Emlid RS2+.

4.1 Setup the RTK Base Station

4.1.1 Option 1: Place the local base station over a known point

A video from Emlid showing this process can be found at https://youtu.be/FilRoPVDjCs.

4.1.2 Option 2: Connect to an NTRIP server

If connecting to a base station over the internet use, the following setup steps. This process is used for:

- Government or Private CORS networks
- Local base station broadcasting over the internet (e.g. http://caster.emlid.com)
- VRS service

A video from Emlid showing this process can be found at https://youtu.be/YWz0mhOwFA.

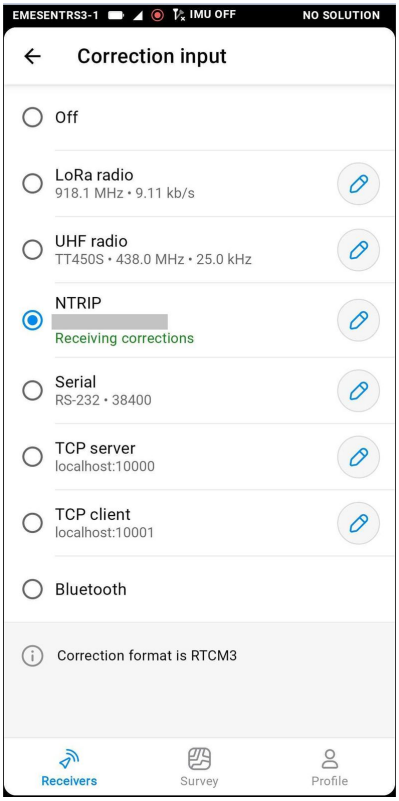
> For best results, set up a local base over a known point on the site (or nearby) where you are scanning. Connecting to a local CORS network is often more convenient if one is available nearby.

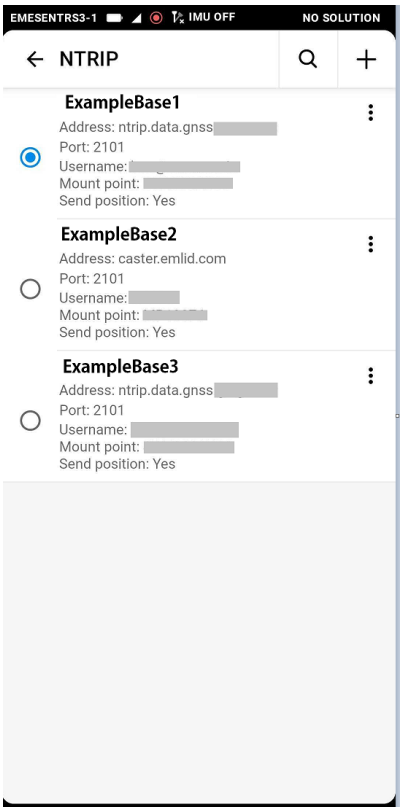
1. Gather the following information before you start. These can usually be found on the website or login page of the service you are using:

Address	IP address of the service you are connecting to. In addition to IP addresses, you can also use a domain name (website address) when configuring the connection in the Emlid Flow app. For example, http://caster.emlid.com or 164.90.243.252).

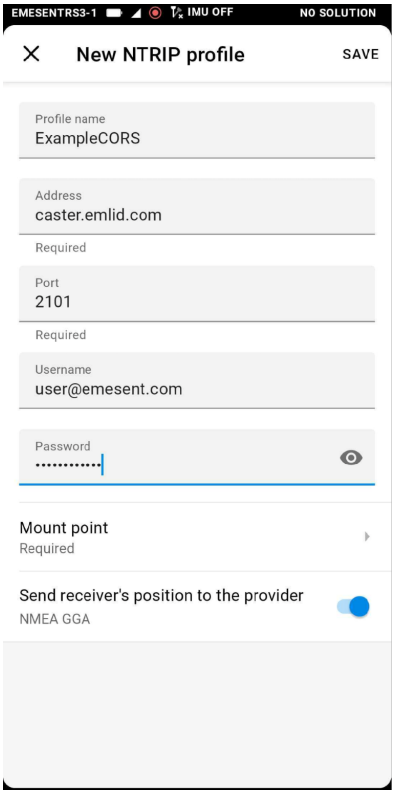
Port	The communication port that the app uses to connect to the base station. For example, the default port number is often 2101, but it can vary depending on the service provider or setup.
Username / Password	Username, Email, or other user name linked to your corrections account, and the password for authentication purposes. It may not be the same as your login username and password.
Mount point	The ID of the base station you are connecting to. For example, MP1523.

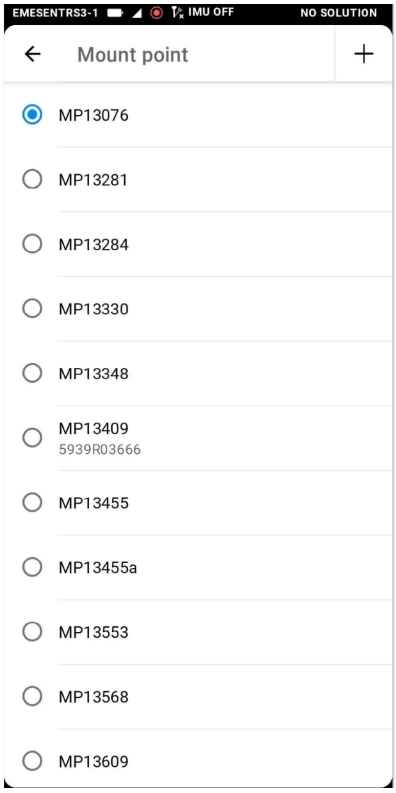
2. Turning on the base station then connect to the Emlid WiFi,
3. Launch the Emlid flow app.
4. Under Correction input, select NTRIP. Then choose a previously created mount point or create a new one by pressing the "**+**" button.





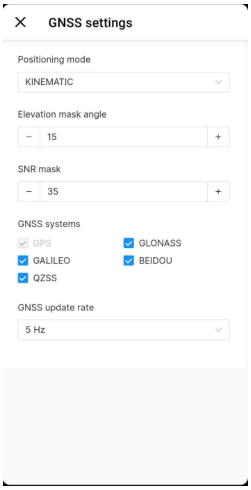
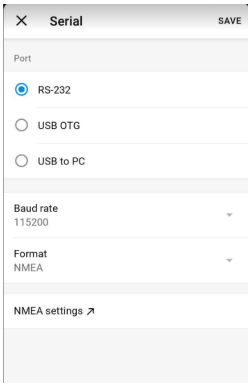
5. Enter the details gathered in Step 1 into the Edit or Add screen. Make sure to select the mount point.



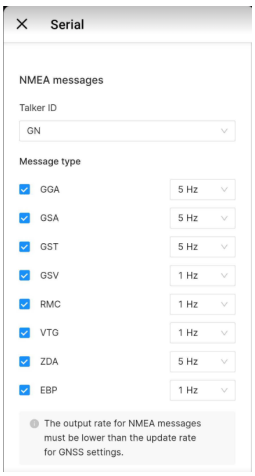


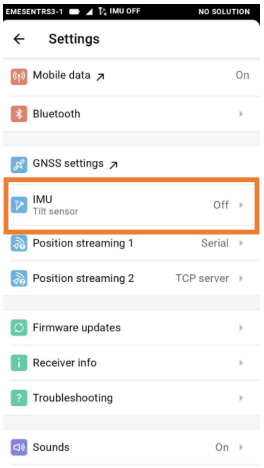
4.2 Configure the GNSS Receiver

Use the following configuration settings for your GNSS receiver to ensure RTK data is properly processed.

Setting	Value	Image
Settings → GNSS settings	• **Positioning mode:** Kinematic (only on Firmware version 30.2 or older) • **GNSS update Rate:** 5Hz	
Settings → Position Streaming 1 → Serial	• **Port:** RS232 • **Baud rate:** 115200 • **Format:** NMEA	

Setting	Value	Image

Settings → Position Streaming 1 → Serial → NMEA settings	• **Talker ID:** GN
	• **Message type**
	  ◦ **GGA:** 5hz
	  ◦ **GSA:** 5hz
	  ◦ **GST:** 5hz
	  ◦ **ZDA:** 5hz
	  ◦ **Others:** 1Hz
		

For Emlid RS3 only **Settings → IMU**	Make sure **Tilt sensor** is turned off for all Vehicle RTK use.	

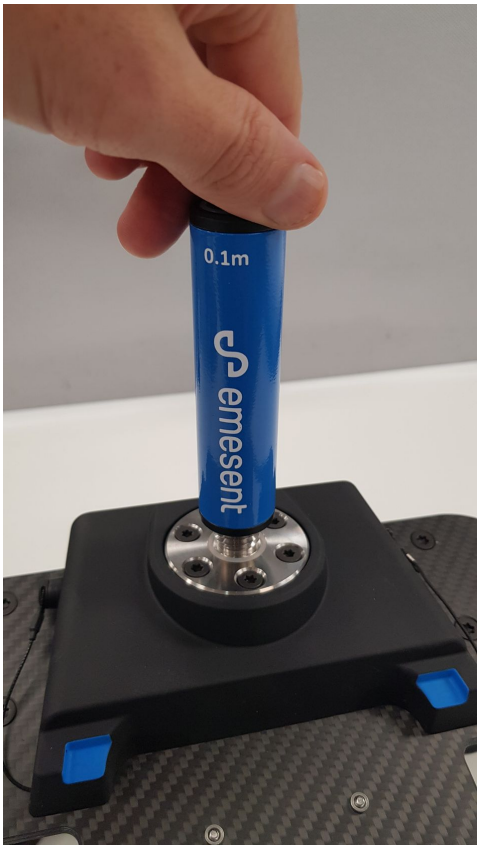
4.3 Setup the Vehicle RTK Mount

Follow these instructions to attach the GNSS receiver to the Vehicle RTK Mount.

1. Upgrade to the latest Emesent Cortex version (3.2.2 or later). Refer to https://4999118.hs-sites.com/en/knowledge/hovermap-firmware-update-instructions for more information.
2. Turn on the GNSS receiver and check that the device settings are correctly configured in the Emlid Flow app.

> The settings only need to be set up if using the GNSS receiver for the first time or if the settings have been changed for another use case.

3. Attach the spacer pole to the Vehicle RTK Mount until fully screwed in.



4. Attach the GNSS receiver to the other end of the spacer pole.

5. Install the Hovermap on the dovetail until it covers the blue parts of the mount.

6. Connect the silver GNSS cable with the lanyard to the receiver's **AUX** port then connect the other end to the Vehicle RT's surface.
7. Holding onto the sides, lower the mount until the magnets stick to the surface.
8. Realign the mount body and legs so that all magnetic feet are fastened and the Hovermap is at a desired angle.

> The RTK receiver should be roughly facing upwards but does not need to be exactly level.

9. Tighten the legs using the side handles until secure.
10. Gently pull the mount upwards to check that all feet are secure.

> Once the device is attached, avoid sliding it across the surface of your vehicle, as this could scratch the paint. Instead, lift and reposition it as needed. Instructions for safely and properly removing the mount are provided in the next section.

11. Periodically check the attachment to ensure the device remains securely fastened, especially after driving on rough roads.

4.3.1 Removing the magnetic feet from the vehicle

1. Park your vehicle safely in a clear area away from traffic.
2. Ensure the Hovermap is turned off.
3. Examine the magnetic feet for any debris or obstructions that could cause any problems during removal.
4. Firmly grasp two of the Vehicle RTK Mount legs, ensuring a stable hold.
5. Apply steady and even pressure to lift one of the legs off the vehicle's surface, without twisting or jerking to avoid damaging the paint or injuring yourself. The remaining legs should detach easily.
6. Store the Vehicle RTK Mount with the rear legs facing up and the front legs facing toward the rear legs. This minimizes the chance of the magnets aligning in a way that causes them to attract each other.

4.3.2 Using the Vacuum Feet

4.3.2.1 First-time setup

1. Remove the vacuum feet from the packaging.

2. Connect one end of the threaded adaptor to the ball joint assembly and the other end to the suction cup.

3. Lay the Vehicle RTK Mount on a sturdy surface with the magnetic feet facing upwards.

4. Slowly loosen one of the legs using the side handle until the magnetic foot is removed. Store the magnetic foot safely.

Do not loosen the leg too far or it will fall apart and require re-assembly.

5. Insert the vacuum foot into the leg with the suction pump facing outwards and tighten using the side handle.

6. Repeat the steps for the remaining vacuum feet.

4.3.2.2 Attaching the vacuum feet to the vehicle

1. Ensure that the surface is clean and free from debris.
2. Slightly loosen all four legs using the side handles until they move freely.
3. Place the mount on the vehicle and move the legs until the vacuum feet are flat on the surface.
4. Press the suction pump multiple times until the red line disappears and the foot is securely attached.
5. Tighten the legs using the side handles until secure.
6. Gently pull the mount upwards to check that all feet are secure.
7. Periodically check the attachment to ensure the device remains securely fastened, especially after driving on rough roads.

> Do not begin scanning if the red line shows on the suction pump or if the suction is lost quickly.

4.3.2.3 Removing the vacuum feet from the vehicle

1. Park your vehicle safely in a clear area away from traffic.
2. Ensure the Hovermap is turned off.
3. Pull any of the release valve tabs, on the side of the suction cup, upwards to release. Do this for all the vacuum feet.

5. Monitoring RTK Status

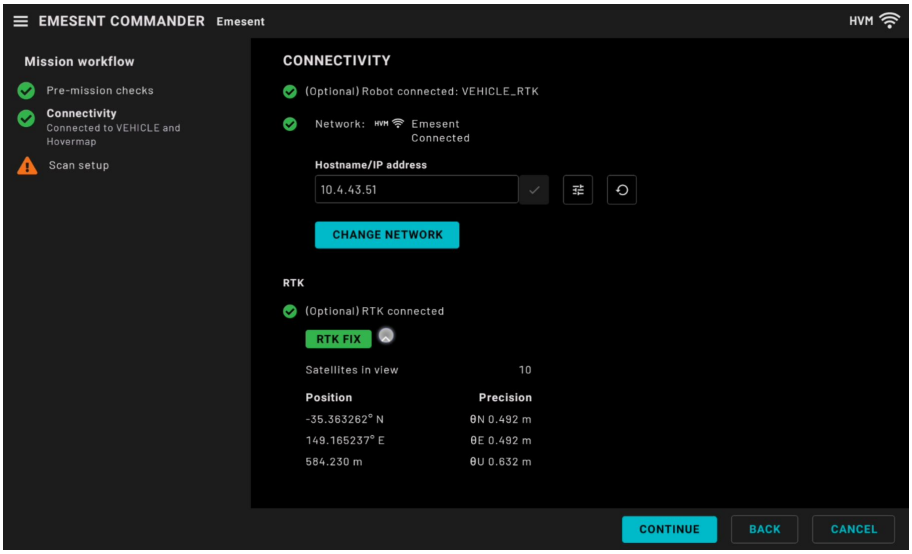
The **Emesent Commander** application provides clear visibility of the RTK status before and during the mission. This enables you to monitor RTK quality without leaving the app to check for information via the GNSS receiver's native application.

> Emesent Commander only provides RTK information from GNSS receivers connected to Vehicle RTK and Backpack RTK devices. RTK data from drones such as the M350 cannot be accessed through the application.

5.1 Mission Workflow

Before a scan is started, RTK information is provided in the **Mission Workflow**. The **Connectivity** page shows if a GNSS receiver is connected to a Vehicle RTK or Backpack RTK.

In addition, tap the drop-down arrow beside the **RTK** section at the bottom to display the RTK quality, number of satellites, position, and accuracy.



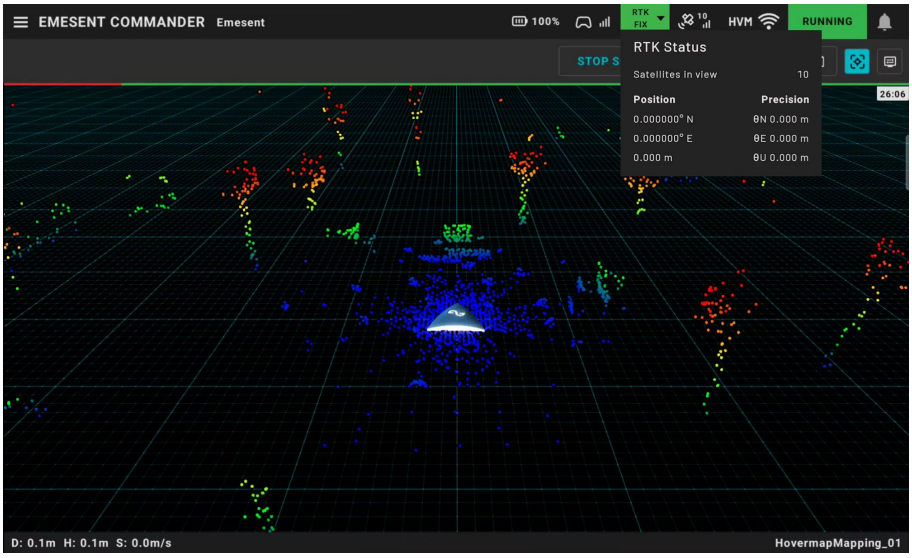
> If Emesent Commander detects a GNSS receiver is connected but is offline, you cannot continue to the next page or start the scan.

> The RTK information is updated in real-time to reflect any changes in connection status, number of satellites in use, or precision.

5.2 Main View

During the scan, the main header displays the **RTK Status** and the number of satellites from which the GNSS receiver gets signals. Tap the drop-down arrow beside the **RTK Status** to display the RTK quality, number of satellites, position, and accuracy.

> Similar to the information provided on the **Connectivity** page, the information displays changes to the RTK status in real-time. See table below for more information.



RTK Status	Description
RTK Fix	This is the best status you can achieve with RTK. It means the GNSS receiver has successfully locked onto enough satellites and received corrections that allow it to determine a very precise position. An RTK fix is highly accurate, often within a few centimeters.
RTK Float	This means the GNSS receiver is using RTK corrections to improve GPS accuracy, but it has not yet achieved a fully stable and accurate fix. There might be slight inaccuracies while the position is being refined.

RTK Status	Description
RTK Single	This status is less precise and is typically used when RTK corrections are not available or when lower accuracy is acceptable. RTK Single can also display when the GNSS receiver is not receiving corrections from the base station. If you are in an environment where RTK Fix or RTK Float is expected, and are only receiving RTK Single, check your GNSS Receiver settings to ensure corrections are configured correctly.
RTK Offline	The GNSS receiver is not sending all required GPS information to the Hovermap. This status can occur when there is a loss in communication with the base station or correction source, such as during signal dropout or when the receiver is not connected to a correction service. You can try the following troubleshooting steps: • Disconnect the GNSS receiver's cable and then reconnect it. • Ensure the GNSS receiver settings are configured correctly. • Reboot the GNSS receiver.
No GPS	The GNSS receiver is online but it has no RTK or GPS signal.

6. Expected RTK accuracy

The table below displays the approximate accuracy for each RTK status. However, it is important to note that the actual accuracy can vary due to multiple factors and the stated accuracy is not guaranteed.

For more information on the factors that affect RTK accuracy, refer to Best Practices for Using Vehicle RTK.

GPS Status	Approx. Horizontal Georeferencing Accuracy
RTK Fixed	3cm
RTK Float Fix	30cm
GPS	1.5 - 3m
No GPS Fix	N/A

> It is important to understand that the global (georeferencing) accuracy is different than that of local point cloud accuracy. Poor RTK quality might only slightly affect point cloud accuracy. This means that when you scan with poor RTK, the scan might be less accurate compared to the ground truth, but measurements between objects within the point cloud will still be accurate.

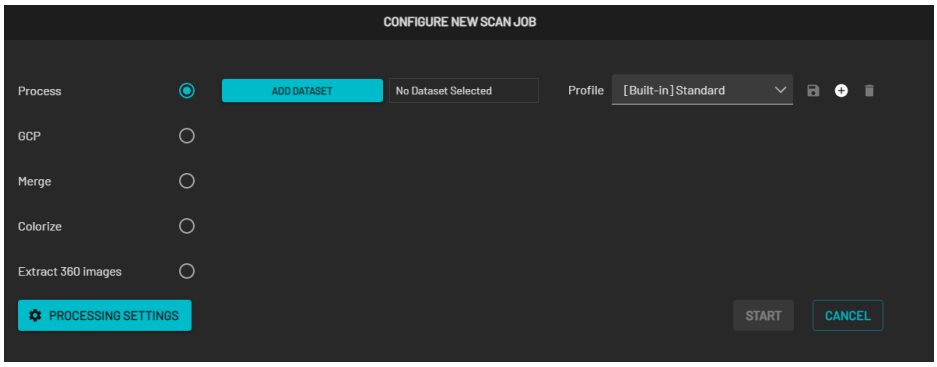
7. Processing your Scan

Once data has been captured, you can process it using Emesent Aura. Ensure your license includes the ability to process RTK datasets (SLAM and RTK). If you need to upgrade your license, contact licensing@emesent.io.

> After processing your scan in Aura, you can review the accuracy report to understand the GPS signal quality throughout your scan. For more information, refer to the RTK Accuracy Report section.

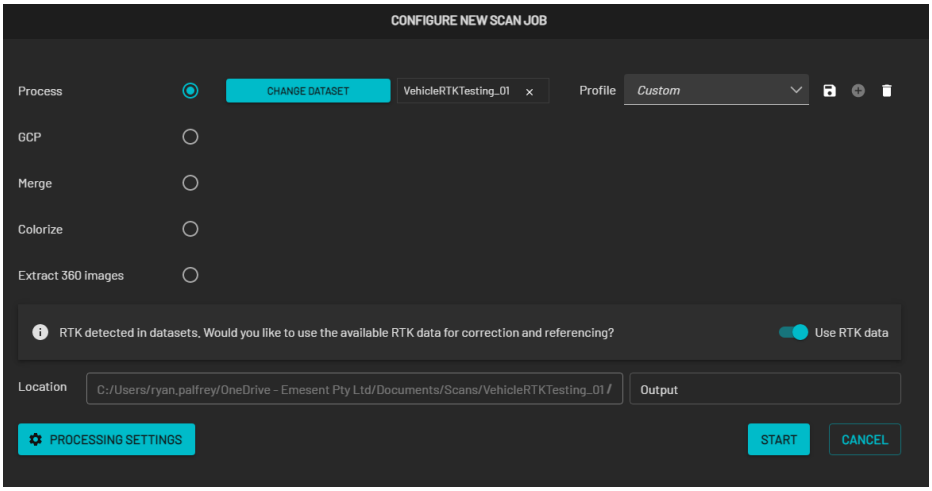
7.1 Process Scan in Emesent Aura

1. Download and install **Emesent Aura 1.6** or later.
2. Go to the **Process** tab then click **Process Scan**. The **Configure New Scan Job** panel displays.
3. Select the **Process** workflow.
4. Click **Add Dataset** then add the folder containing the raw scan file with RTK data. The **Profile** is automatically updated depending on the detected payload used in the scan.

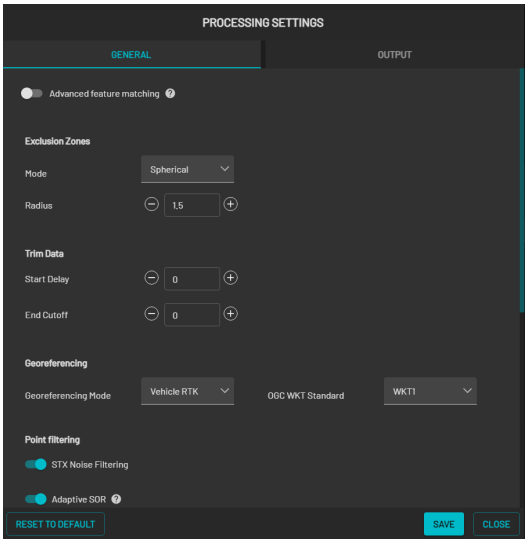


> If the Vehicle RTK data in the selected dataset is insufficient, you will be notified that georeferencing will be disabled.

5. You will be prompted once RTK is detected in your dataset. Click **Use RTK data**. The **Profile** changes to **Custom** and you will get a notification that georeferencing will be set to RTK.

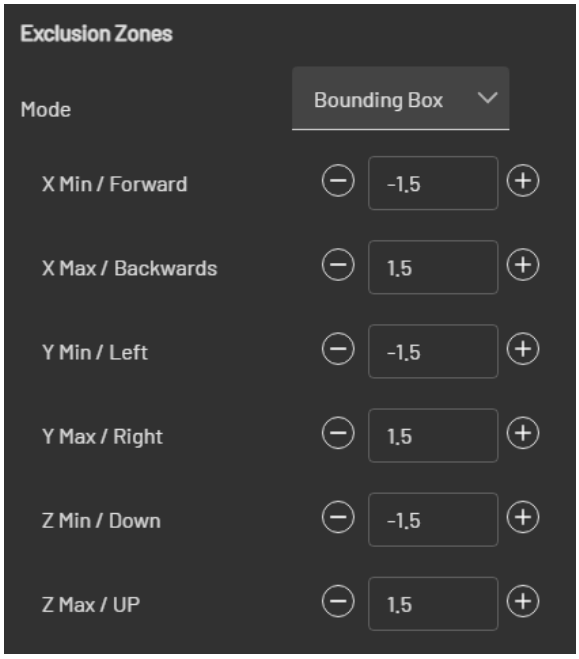


6. Click **Processing Settings** to specify any additional configuration. You will notice that the **Georeferencing mode** is auto-selected to **Vehicle RTK**. Changing to another mode will still process the point cloud, but with georeferencing disabled.



> When processing Vehicle RTK, **Point Filtering** is enabled by default while **Moving Object Filtering** is disabled. It is not recommended to use **Moving Object Filtering** when conducting a vehicle scan as the detected moving objects have a relative velocity compared to the payload, which can cause inaccuracies.

7. For some larger vehicles, you may need to change the **Exclusion Zone** to ensure your vehicle is not included in the point cloud. To do this, select the **Bounding Box** mode and adjust the values based on the size of your vehicle.



8. Click **Start** to process your scan as normal.

Once the scan is processed, all the relevant files will be in the "**Output**" folder. In addition, the georeferenced point cloud will be north-aligned with a supplied **WKT** string for transforming to WGS84.

> The output WKT always references WGS84 and will be misaligned if the base station reports in a different CRS that is not referenced to WGS84. To fix this, refer to the Reproject your Point Cloud section below.

7.2 Colorizing a Vehicle RTK Scan

When colorizing a Vehicle RTK scan, we recommend the following:

- Always use the GoPro Max 360 when colorizing Vehicle RTK.
- When scanning, position the mount with colorization in mind. The Hovermap puck, GNSS receiver, and vehicle will block the view of the GoPro and these areas will not be colorized. If colorizing the road is crucial, consider positioning the mount rotated slightly towards the side of the road so that the camera is not blocked from viewing the road.
- Remove irrelevant content from being colorized by enabling the **Image Masking** option in **Processing Settings (Colorize tab)** and using the **[Built-in] GoProMax-generic-vehicle-RTK** mask template. Emesent Aura comes with several other pre-defined masks that you can use, but you can also create your custom mask in case none are suitable for your dataset. For more information on creating a custom mask, refer to the Emesent Aura user manual.
- Maintain all points in the cloud - including those not seen by the GoPro - by disabling the **Remove Uncolored Points** option in **Processing Settings (Colorize tab)**.

7.2.1 Improving Colorization Quality

The following changes to the **Processing Settings (Colorize tab)** in Emesent Aura may help you improve colorization quality if desired for your project. Note that higher quality settings will increase processing time.

- Decrease **Visibility Gamma** to **-.0001** to increase color richness.
- Decrease **Visibility Voxel Size** to **0.01** to increase color resolution, particularly in detailed areas.
- Increase **Colorization Distance** to colorize points that are further away.

Colorization quality is also affected by the number of points you have captured. Therefore, doing multiple passes of the site at an appropriate speed will typically improve colorization quality. For more information on the recommended speed and number of passes, refer to Best Practices for Using Vehicle RTK, below.

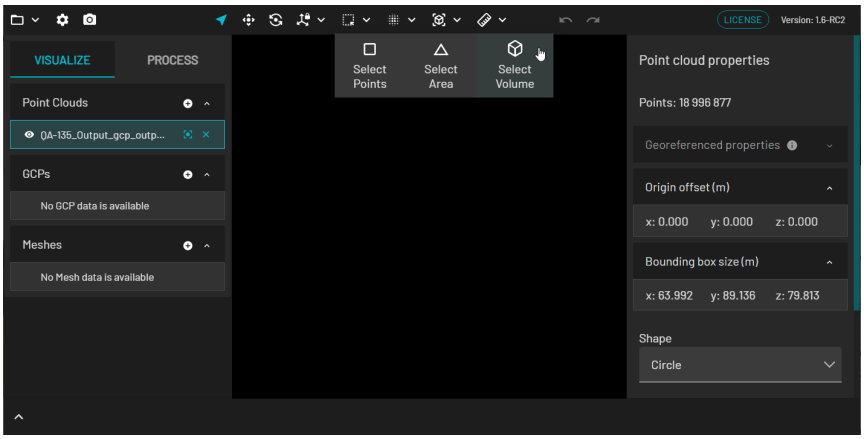
For more information on colorization generally, refer to the Emesent Aura user manual.

7.3 Cleaning your Point Cloud

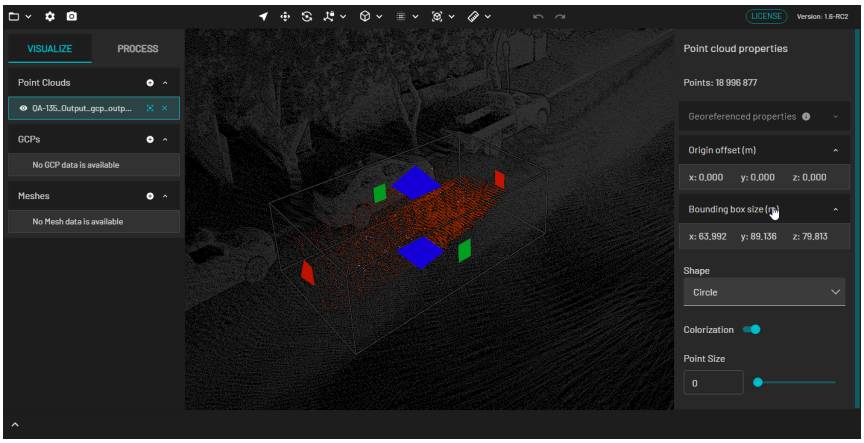
If traffic is unavoidable during your scan, you may see noise in the point cloud from other vehicles on the road. The following instruction guides you on cleaning the noise from your point cloud using Emesent Aura.

> It is not recommended to use **Moving Object Filtering** when conducting a vehicle scan as the detected moving objects have a relative velocity compared to the payload, which can cause inaccuracies.

1. Open Emesent Aura and load your point cloud.
2. In the Main Toolbar, choose **Select Volume** under **Selection Tools**.



3. Using the colored handles, adjust the bounding box to cover the area where to delete the points.



> You can use the **Rotate** tool to align the road with the bounding box if needed.

4. Press **Enter** to apply the selection. To deselect, press **Esc**.
5. Press **Delete** to delete the selected points.

> Deletion cannot be undone. Ensure you assess the selected points from multiple angles before confirming deletion. Also, make sure the bounding box is not touching the road.

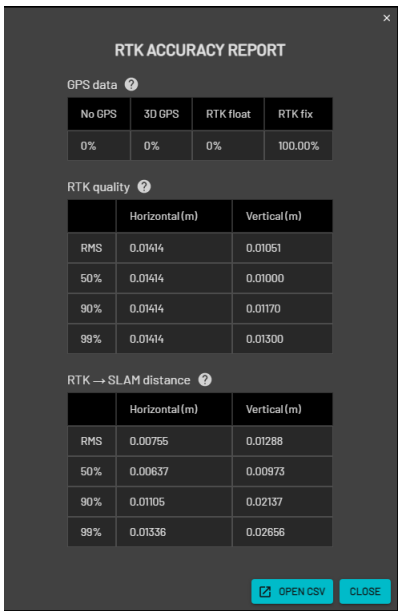
7.4 Reproject your Point Cloud

Reprojection in Emesent Aura is an automated workflow that allows for RTK scans to be processed with the correct coordinates by simply selecting the target coordinate reference system (horizontal) and converting from ellipsoidal height to orthometric height using a GEOID model (vertical). This can be done via **Processing Settings** when processing raw data or **Export reprojection** from the **Project menu** if exporting a georeferenced point cloud.

For more information on the reprojection workflow, refer to https://4999118.hs-sites.com/en/knowledge/working-with-point-clouds-reproject-your-point-cloud.

7.5 RTK Accuracy Report

A report is generated as part of the output to aid in understanding how well the GPS and SLAM were aligned during the scan. Click **View** beside the output CSV file to display the **RTK Accuracy Report**.



> In Emesent Aura, only a summary of the report is provided, which is usually sufficient. Click **Open CSV** to view a more detailed report from your native CSV application.

The report is categorized into the following sections:

- **GPS data:** Percentage of the GNSS receiver's scan time in each GPS state.
- **RTK Quality:** Accuracy of the GNSS position reported.
- **RTK → SLAM distance:** Reported distance between the GNSS and SLAM trajectory after correction.

> To view the accuracy report from a previously processed dataset, drag and drop the CSV file into the **Viewport**.

8. Best Practices for Using Vehicle RTK

8.1 Mounting Position Recommendations

When mounting the Vehicle RTK Kit, consider the project requirements to ensure the collected data is useful.

We recommend mounting the kit on **top of your vehicle** to enable the Hovermap to cover a wider area and create a more even point density. However, the kit is designed to be mounted anywhere on the vehicle.

> **DRIVING WARNING**
> Always drive safely when operating a vehicle. Check your local laws and regulations about mounting equipment to a vehicle, particularly equipment in the driver's field of view.
> Do not mount the Vehicle RTK Kit to your vehicle in a way that contravenes local laws.

8.1.1 Questions to consider when assessing your project

1. **What is the area of focus**? Place the mount in an area of your vehicle where it gets the best visibility of the relevant features. For example, mount on the left or right of the vehicle to get a higher point density of a street curb.
2. **What are the color requirements?** If using our 360 color mount, putting the mount on the top of the car will maximize the FOV of the camera and create the most even colorization in the point cloud. If colorizing the road is crucial, consider positioning the mount rotated slightly towards the side of the road so that the camera is not blocked from viewing the road.
3. **Are there obstructions on your vehicle?** For vehicles with antennas, roof racks, or other mounted equipment, consider the impact of these obstructions on the Hovermap's view of the environment, and adjust your setup accordingly.
4. **Will your line of sight be blocked?** Ensure the vehicle can be safely operated and you are not contravening local laws about vehicle-mounted equipment.

Emesent Aura provides built-in masks to ensure the vehicle is not included in the point cloud. However, you may need to create a custom mask based on the location of the mount and the size/shape of your vehicle. For more information on creating a custom mask, refer to the Emesent Aura user manual.

8.2 Speed and Passes Recommendations

DRIVING WARNING
Always ensure you drive to the road conditions and comply with local traffic laws.

Depending on your project requirements, you may need to drive the site multiple times to achieve sufficient point density. If you are using a 360 Colorization Kit, higher point density will also improve the colorization quality.

The Vehicle RTK Mount will work successfully with multiple passes up to 60kph (37mph) but **it is recommended to scan at 40kph (25mph) for best results**. As your vehicle speed increases, the data collected by the Hovermap is sparser, and more passes are needed to achieve the same point density.

Detail Required	Recommended Speed	Recommended Passes
Medium detail	40kph	1-2
High detail	40kph	3-4

Driving during off-peak hours with less traffic than usual can improve coverage.

8.3 Maximizing Georeferencing Accuracy

GPS quality is impacted by many factors, which can affect the georeferencing accuracy. While Emesent's Wildcat SLAM can compensate for poor-quality GPS signals to create a locally accurate point cloud, it cannot improve georeferencing accuracy. Accordingly, the GPS quality you can achieve at the site will determine the georeferencing quality.

Some of the key factors to consider are outlined below. To learn more about RTK, review the Emlid documentation at https://docs.emlid.com/reachrs2/rtk-quickstart/rtk-introduction/.

Factor	Description
Clear line of sight	A clear line-of-sight view of the satellites is the minimum requirement for GPS to work effectively for position calculation and signal tracking. Buildings, tall structures, trees, etc., can block signals, impact satellite geometry, and result in poor positional estimation.
Baseline length	Generally, each additional kilometer of baseline length will decrease georeferencing accuracy by 1mm. The recommended maximum baseline length is 10km, though acceptable results can be achieved with a baseline of up to 25km depending on the project requirements. Select a closer CORS base station (if available) or use a local base station setup to reduce the baseline length.
Receiver configuration	It is critical to configure your receiver appropriately to receive GPS corrections that can be used by Hovermap.
Urban canyons	In addition to blocking out the view of satellites, tall buildings can reflect GPS signals which can cause errors when the GPS receiver is calculating its position.
Man-made interference	GPS signals can be interfered with by man-made sources such as GPS repeaters, TV broadcast stations, signal jamming devices, and personal privacy devices.
Satellite arrangement	Satellites constantly orbit the Earth, and different configurations can cause slight variances in precision.

8.4 Choosing between CORS networks and a base station

A CORS network subscription is preferable if:

- You do not want the extra expense of a base station.
- Your local area has a good quality CORS network.

> CORS networks have the additional benefit of requiring less equipment and a shorter setup and configuration.

A base station is preferable if:

- You require the highest accuracy georeferencing.
- Your local CORS network is poor quality.
- Your closest CORS network base is more than 10km* away.

> *****Depending on georeferencing accuracy requirements. Up to 25km can work for lower accuracy use cases.*

8.5 Using Ground Control Points

Using GCPs is necessary if your accuracy requirements are greater than what is obtained using RTK, and there is a need to further constrain the point cloud.

In addition, use GCPs if you want to verify the georeferencing accuracy achieved through RTK. Comparing the coordinates of the GCPs in the point cloud against their known coordinates allows you to assess the accuracy of the RTK georeferencing process.

The table below sets out the expected accuracy for each GPS status to help you decide whether GCPs are needed. The accuracy can vary for many reasons and the stated accuracy is not guaranteed.

GPS Status	Approx. horizontal accuracy
RTK Fix	3cm
RTK Float	30cm
GPS	1.5-3m
No GPS Fix	N/A

8.6 Merging RTK Data and Correcting RTK Data with GCP

Merging RTK data or further constraining RTK data with GCPs are currently not supported in Emesent Aura. The following third-party software can be used with Hovermap RTK data to achieve this.

- TerraScan - https://terrasolid.com/products/terrascan/
- Cyclone 3DR - https://leica-geosystems.com/products/laser-scanners/software/leica-cyclone/leica-cyclone-3dr

9. Troubleshooting

9.1 Scanning with Vehicle RTK

Issue	Potential cause(s)	Potential solutions
When configuring the Emlid, it isn't receiving corrections in the Emlid Flow app	The Emlid settings are misconfigured.	Ensure the receiver is configured with the correct settings. Also, check if the NTRIP details (i.e. IP address, user name, password) are spelled/entered correctly. If using a SIM card, turn off the device, remove and re-insert the SIM card, and restart. Restart the device. If issues persist, contact Emesent support.
The vacuum mounts are difficult to attach to the vehicle	The legs are not loose enough.	Gently loosen the mount legs until they move freely. Then, place the mount on the vehicle and tighten it.
When the Emlid is plugged into the Hovermap, Web UI shows 'No GPS'	The Hovermap was turned on before the Emlid. The Emlid is not turned on. The Emlid cable is not fully inserted.	Remove the receiver cable and re-insert. Ensure the receiver is configured with the correct settings. Reboot the receiver. Reboot Hovermap.
Web UI shows 'RTK Error'	The Emlid settings are misconfigured.	Ensure the receiver is configured with the correct settings.

Issue	Potential cause(s)	Potential solutions
I'm not getting RTK Fix I'm seeing No GPS Fix	Correction is settings are not configured properly. The baseline length is >15km. The current environmental conditions are not ideal for obtaining a good-quality RTK signal.	Georeferencing accuracy decreases by approximately 1mm for every kilometer of baseline length. Select a closer CORS base station if one exists, or use a base station setup to reduce the baseline length. Refer to the Best Practices for Using Vehicle RTK section to understand impacts on RTK signal.
I do not see the RTK status in Emesent Commander	The Emesent Commander does not currently support showing RTK status.	Use the Web UI to see the RTK status.

9.2 Processing Vehicle RTK Data

Issue	Potential cause(s)	Potential solutions
Processing the scan with RTK is causing the scan to "split"	The **Advanced feature matching** setting is disabled. The receiver is returning a high-confidence incorrect GPS data due to an urban canyon or other environmental conditions.	Go to the **Processing Settings (General tab)** and enable **Advanced feature matching**. Review the site to determine if tall reflective buildings may be interfering with the GPS signal.
I'm seeing my vehicle throughout the point cloud	The bounding box is not large enough to exclude the vehicle from the point cloud.	Go to the **Processing Settings (General tab)**. Under **Exclusion Zone,** change the **Mode** to **Bounding Box** and adjust the values based on the size of your vehicle.
I'm seeing slips or drifts in my scan	You are driving more than 60kph.	If appropriate, drive more slowly.

Issue	Potential cause(s)	Potential solutions
There is “banding” of the point cloud, where aspects of the cloud have high point density and others have very few points	When driving too fast, the Hovermap does not have sufficient time to scan the area.	If appropriate, drive more slowly to allow Hovermap to collect more data Do more passes over the scan area to increase point density.
Vehicle RTK data is not in the desired coordinate system	The scan has not been reprojected.	Reproject the scan into your desired coordinate system.
Colorization is low-quality	Low point density A mask is applied to the area requiring colorization.	Increase point density by driving more slowly or doing multiple passes over the scan area. Review the extracted frames to determine if the desired area has been masked. Change the mask if necessary. Change the orientation of the Hovermap during scanning to ensure the GoPro MAX 360 camera has a sufficient view of the area.
Areas of my point cloud I expect to be colorized are not colorized	A mask is applied to the area requiring colorization. The area requiring colorization is too far away	Review the extracted frames to determine if the desired area has been masked. Change the mask if necessary. Change the orientation of the Hovermap during scanning to ensure the GoPro MAX 360 camera has a sufficient view of the area. Go to the **Processing Settings (Colorize tab)**. Under **Processing Quality**, increase the **Colorization Distance** value.

Issue	Potential cause(s)	Potential solutions
Moving object removal is removing too much of the point cloud	While traveling quickly, stationary points in the Hovermap's point cloud can appear to move, triggering the Moving Object Removal filter.	It is not recommended to use **Moving Object Filtering** when conducting a vehicle scan as the detected moving objects have a relative velocity compared to the payload, which can cause inaccuracies.

emesent

PREPARED BY:
EMESENT PTY LTD
LEVEL G, BUILDING 4, KINGS ROW OFFICE PARK
40-52 MCDOUGALL ST, MILTON, QLD, 4064 AUSTRALIA

EMAIL: CUSTOMER-SUCCESS@EMESENT.IO
PHONE: +61 7 3548 9494