Remora User Manual

Revision 1.8 - 2 September 2016

BATTERY POWERED GPS TRACKER

For the latest version of this document, pricing and other product information please contact your local Digital Matter office.

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Revision History

Rev	Date	Description
1.0	17 Nov. 2015	First revision
1.1	19 Jan. 2016	Minor typesetting corrections
1.2	4 Feb. 2016	Updated tracking settings and LED behaviour
1.3	11 Feb. 2016	Updated Recovery Mode details
1.4	23 Feb. 2016	Added *Optimise For Low Signal* parameter details
1.5	24 May 2016	Added Telematics Guru Recovery Mode details
		Added Tamper Detect details
		Added Accelerometer Settings details
		Updated *Upload On Jostle* parameter details
1.6	25 July 2016	Updated cover image
1.7	1 Aug. 2016	Amended Connectivity Settings
1.8	2 Sep. 2016	Updated *Suppress GPS Wander* parameter details

2. INTRODUCTION

The Remora is a low-profile, rugged 2G or 3G (NextG) GPS tracking device that has been designed for tracking containers, trailers, skip bins, and other assets where super-long battery life is required without sacrificing the frequency of updates and performance.

This user manual provides information commonly needed when evaluating, installing, supporting and maintaining the Remora. The manual will be updated as more functionality becomes available and as the support knowledge base grows. Please check the website for newer versions.

1. Background

The Remora is designed and manufactured by Digital Matter in South Africa and Australia. Both the device firmware and the supporting server infrastructure are written and maintained by Digital Matter.

2. Technical Specifications

For detailed technical specifications, please see the Remora Datasheet, available on the Digital Matter website. The datasheet also contains the product variants and product codes for ordering.

3. PRECAUTIONS

1. IP67 Rating

The Remora is an IP67 rated device. It is important to ensure that the device is correctly assembled to achieve the IP rating. Failure to do so may result damage to the product.

Please ensure that:

- The enclosure is not damaged before installation.
- Seals supplied with the product are correctly placed.
- Only screws supplied with the product are used.
- The guidelines for closing and sealing the product are followed.
- The device is only ever opened in a clean, dry environment.

2. Static damage

The Remora may be damaged by electrostatic discharge if not handled correctly during installation. Ensure adequate static precautions are taken while the case is open.

Take special care not to touch the ceramic GPS antenna.

3. Battery precautions

The Remora can be fitted with Alkaline or Lithium Thionyl Chloride batteries. Please ensure that you fit batteries suitable for your intended operating temperatures, and dispose of them appropriately.

- Alkaline batteries perform poorly and may leak in sub-zero temperatures.
- Alkaline batteries have a reduced shelf-life at elevated temperatures, and are more likely to develop internal shorts, leaks, or explosive internal pressures. Hot batteries should be handled with caution.
- LTC batteries work over a wider temperature range, and have twice the capacity, but must be handled carefully and cannot be disposed of in domestic waste, as they are hazardous. Please refer to the manufacturer’s datasheet for details.

Where temperature extremes are not a concern and replacement is not difficult, Alkaline batteries are recommended for their economy and ubiquity. Rechargeable batteries are not recommended, as they have poor capacity and shelf life relative to Alkalines.

4. CLOUD INFRASTRUCTURE

The Remora relies on three backend web services for operation: OEM Server, the Software Platform Front Ends, and the u-Blox AssistNow Offline servers.

1. OEM Server

The Remora connects to the OEM Server for firmware upgrades and configuration. This server is hosted by Digital Matter, but can be licensed to 3rd parties to meet special requirements.

1. Data Connectors

The OEM Server provides Data Connectors that forward data records on to the software platform of your choice, including Digital Matter's own Telematics Guru and GPS Log Book platforms.

2. Device Administration

All Digital Matter devices are fully managed over the air via the OEM Server web interface. The OEM Server seamlessly manages:

- Device firmware – firmware updates can be done remotely.
- Network ('Admin') parameters relating to critical communications.
- System parameters, including GPS parameters, IO configuration, logging options and general device behaviour settings.
- Remote debugging of devices, including data trace, detailed debug message logging, and live debug message viewing capabilities.
- Remote disconnect and reboot of devices.
- Geo-fence syncing with the devices. This allows the device to do advanced alerting and monitoring, such as geo-fence arrival and departure detection, speed limit alerting, and disabling of communications inside intrinsically safe zones such as gas plants. These features are still in development on the Remora.
- Command and message queueing for the devices, which is incorporated in the remote management and debugging applications.

2. Software Platform Front Ends

Using the OEM Server's Data Connectors, the Remora can be used with a number of Software Platforms.

Current integrations include: Telematics Guru (DM), and a number of other high profile platforms.

New platforms can be added in two ways:

- The software platform implements the DM protocols and a data connector is setup to forward the data to the platform. The two options for DM Protocols are raw data over TCP, and JSON over HTTP. Please contact DM for more information.
- DM can create a custom data connector to deliver the data in your platform's format and transport mechanism. Please contact DM for more information.

3. AssistNow Offline

The Remora relies on Aiding Data to improve GPS performance, and thereby optimise battery life. Fresh aiding data allows rapid satellite acquisition even in low signal levels.

By default, the Remora will download new aiding data every 5 days, directly from u-Blox AssistNow Offline servers. When downloads occur, they are scheduled directly after an upload attempt. Aiding data works best when fresh, but remains useable for 2-3 weeks.

5. INSTALLATION

1. SIM Installation

The SIM holder is on the top of the main board, between the two antennas.

When handling the Remora be careful not to touch the GPS antenna, to minimise the risk of damaging the sensitive GPS amplifiers with static discharge.

1. Remove the batteries, to ensure the mobile data connection is not active.
2. Unlock the sim holder by sliding the metal bracket towards the hinge.
3. The SIM should be inserted with the keyed corner on the non-hinged side, and the SIM contacts orientated down to the main board.
4. Press the SIM down, and relock the holder by sliding the metal bracket away from the hinge.
5. Reinstall the batteries. The LED next to the GPS antenna should flash briefly when the batteries are inserted. If it does not, it means the unit has not yet reset. In this case, remove the batteries for a minute or two to allow any residual charge to drain, and then reinsert them. Failure to reset the unit will prevent automatic APN detection, and proper resetting of the battery life statistics.
6. In firmware versions 1.16 and higher, the LED will flash throughout the first connection, GPS fix, and position upload, or whenever awake in Recovery Mode.

The SIM card should either have no PIN set, or should have a PIN matching the Remora's PIN. The Remora's PIN can be retrieved from the OEM Server web interface.

2. Housing Assembly

Once the SIM and batteries are installed, all that remains is to seal the housing.

1. Ensure that the clear silicon seal is in good condition, is lying flat, and is not fouled by any plastic swarf or by protruding connector cables.
2. Place the lid on the base, and gently squeeze it shut. Foam in the lid will compress against the batteries, holding them firmly in place when the unit is turned over.
3. Tighten the 10 screws to a uniform tightness. On the first assembly the screws may be quite stiff. An electric screwdriver with a torque limiting clutch is recommended.
4. The screws used are a thermoplastic screw: 3.5mm x 12mm (BN82428).

3. OEM Server

On battery insertion, the Remora will immediately connect to OEM Server to announce its presence. After the first connection it will try to establish a GPS fix, and then connect a second time to update its location. This initial GPS fix has an extended timeout of no less than 5 minutes, to give it a reasonable chance of success in an office environment.

It is essential to check that the device is connecting before placing the it in the field. Refer to the document on OEM Server Setup. If you do not see a connection within a few minutes of battery insertion, double check that the device was reset correctly (LED flashed on battery insertion), that the SIM is correctly inserted, and that you have air-time and reasonable mobile reception.

Devices will either be pre-configured on OEM (firmware, system parameters, admin parameters, connector), or the distributor will need to set them up. The setup is important for the device to perform correctly. The default settings together with the automatic APN detection give a nearly plug-and-play experience. However, the connector must be set to forward data to the correct front end, and the front end must be setup to receive the data. Until the connector is set, the majority of uploaded tracking data is silently discarded.

4. Device Installation

The Remora can be mounted on the asset to be tracked using screws, bolts, cable ties, or industrial adhesives. When choosing a mounting point, you have two competing goals:

1. To minimise the chances of the device being accidentally crushed or dislodged.
2. To maximise the GPS and mobile reception, and provide adequate ventilation.

Since the Remora is a battery powered device, reception is critical to its performance. While other members of the DM product family rely on their high quality GPS receivers for enhanced accuracy and the ability to operate in very low signal, the primary concern for the Remora is the battery used during each GPS fix.

The Remora's industry leading GPS and GLONASS receiver is capable of aided cold-starts in less than 5 seconds. With optimal mounting it will enjoy average lock times of 2 to 3 seconds while in-trip, and average total on-times of as little as 5 to 6 seconds per fix. However, a poor choice of mounting point can extend the GPS lock time to minutes, or cause it to time out entirely. Under such conditions live tracking may no longer be feasible within a reasonable battery replacement schedule – so care must be taken when choosing a mounting point.

Battery use statistics (section 10.2) can be consulted to verify the GPS performance. The installer should be aware that live tracking in the most GPS reception-challenged installs may require foregoing the convenience of a battery powered solution for the always-on tracking performance of a hardwired solution such as a G60 or G100. However, low frequency tracking is possible even in challenging installs if appropriate GPS timeouts and update intervals are configured (section 9.2.1). In addition, the Remora's Recovery Mode allows always-on performance even in low signal, during asset recovery.

When Alkaline batteries are being used, it is important to choose a mounting point that will not result in elevated temperatures. For instance, mounting the Remora in direct sunlight on the dash of an unventilated cabin may cook the batteries, leading to abnormally short service life.

If your Remora is fitted with the magnetic tamper detection option, ensure that the magnet firmly adheres to the surface of the mount point, and aligns with the circular recess on the underside of the Remora. If it is not stuck strongly to the mount point, either magnetically or with the aid of adhesives, it may instead stick to the Remora. Ensure that it will reliably separate from the Remora during tampering, so that the alarm will be triggered.

6. MAINTENANCE

1. Battery Maintenance

When replacing the batteries, please ensure that the Remora is properly reset, so that the battery life statistics and battery level are correctly updated.

The LED next to the GPS antenna should flash briefly when fresh batteries are inserted. If it does not, it means the unit has not yet reset. In this case, remove the batteries for a while to allow any residual charge to drain, and then reinsert them. The drain time takes longest if the unit happens to be in its lowest power sleep mode, and can take two to three minutes when high voltage Lithium Thionyl Chloride batteries are fitted. However, you should find that more often than not the reset is instant due to accelerometer and GPS activity.

To maximise battery life, the LED does not remain lit after the first connect / sleep cycle following battery insertion.

Please be sure to take adequate precautions if extreme weather has caused the old batteries to leak. In particular, any leaked electrolyte and associated gases from LTC batteries should be treated with great caution, as they are highly corrosive.

2. Seal Maintenance

When replacing the batteries, please inspect the condition of the silicon seal. Seals should be replaced every 3 years to ensure reliable performance. Contact Digital Matter to obtain extra seals.

7. DEVICE SETUP

There are three sets of non-volatile settings on the Remora:

1. The Admin Parameters, which contain critical connectivity settings
2. The System Parameters, which contain regular tracking settings
3. The Device State, which persists internal state across reboots

1. Parameter Setup on OEM Server

Device setup is primarily accomplished through the OEM Server web interface at http://www.oemserver.com. The Admin and System parameters can be configured using dialogs on the website, and pushed to devices individually or in batches. Both parameters sets are subdivided into various sections, which display as separate tabs in the web interface. Most users will only need to configure one or two sections of the System parameters, and none of the Admin parameters.

When the parameters are set on the web interface, they will be downloaded by the Remora on its next upload, and take effect as soon as the current trip ends.

Further details of the Admin and System parameters are given in sections 8 and 9.

2. Device State Changes on OEM Server

There are currently two properties on the Remora that live in the Device State, and are modified by menu options on OEM Server:

- Recovery Mode can be set or cleared in the Device Operations dropdown of the Devices screen on OEM Server, or in the Manage Assets screen on Telematics Guru. Recovery Mode is an always-on live tracking mode meant for stolen vehicle recovery (see section 11).
- The Device Debug Flags control the volume of diagnostic messages logged, and can be set in the Device Operations dropdown of the Devices screen.

Since these settings are delivered by Asynchronous Message rather than through the parameter blocks, they take effect as soon as the Remora receives them, regardless of trip status. The Remora receives Asynchronous Messages on each upload, or immediately when connected in Recovery Mode.

3. Setup by SMS

The most convenient way of changing parameters is through the web interface on OEM Server. However, if the Admin Parameters are set incorrectly, the Remora is unable to connect to the server. In these cases, the Admin Parameters can be set by SMS message to establish or restore connectivity, and the device can be remotely reset.

SMS's are received after each upload attempt. To force an upload attempt when setting a unit up, reset it by disconnecting and reconnecting the batteries. You will know that you have disconnected the batteries long enough for the device to reset if the LED blinks briefly upon reconnection. The first upload attempt will take place immediately, and should be complete after 1 to 3 minutes. The device will reset after each SMS is received, leading to further LED blinks, and another upload attempt.

1. Format

The SMS text must start with a '#*' (without the quotes).

The SMS text command takes the form of a command followed by a variable list of comma separated parameters:

```
#*[<reply#>],<command>,…
```

The [<reply#>] is not yet supported by the firmware, but may be in future. Leave blank as per the examples below. In future, if specified then the device will send an acknowledgement SMS to the number. Specify '*' to reply to the number that the SMS came from.

String values are **not** contained in quotation marks.

Fields in [] are optional.

2. APN

```
#*[<reply#>],APN[,<apn name>[,<user name>,<password>]]
```

If the APN details are omitted, the APN will be erased and the device will use auto-APN.

Examples:

```
#*,APN,telstra.internet
#*,APN,custom.APN,user1,pwd1
#*,APN
```

3. Server

```
#*[<reply#>],SERVER[,<server URL>,<port number>]
```

If <server URL>,<port number> are omitted then the default OEM Server details will be used.

Examples:

```
#*,SERVER,s0.oemserver.com,8966
```

4. Reset

```
#*[<reply#>],RESET
```

Examples:

```
#*,RESET
```

8. CONNECTIVITY SETTINGS

The Remora requires a mobile data connection for configuration and telemetry upload. The settings for these critical communications functions are stored on the device in the Admin Parameters. A brand new device from the factory will ship to the distributor with default parameters, which attach to the mobile data network using the Auto-APN feature, and connect to the default OEM Server for configuration.

1. Auto-APN

Auto-APN allows the Remora to analyse the SIM card and select the correct APN details from a list that is pre-loaded in the device's firmware. This means that the Remora can be shipped world-wide without requiring special setup for SIMs.

The Remora obtains the Mobile Country Code (MCC) and Mobile Network Code (MNC) from the SIM card's IMSI. It tries to find a matching MCC and MNC entry in the list in firmware. There are multiple scenarios:

- No matching entry. The Remora will use the 'internet' APN with no username or password.
- Single matching entry. The Remora will use the details in the list.
- Multiple matching entries. The Remora will try the first entry. If it works, it will continue to use those details until the batteries are changed. If it doesn't work, it will move to the next matching entry.

Note that the IMSI is fixed on the SIM. If the SIM roams onto another network, the IMSI does not change and the Auto-APN details will be for that of the home network. For roaming, see the Multi-APN feature in section 2.

The device uses the Auto-APN feature if the admin parameter APN list is blank. See section 3.

2. Multi-APN

The Remora can be configured to roam across multiple networks and to automatically use different APN details for the roaming networks.

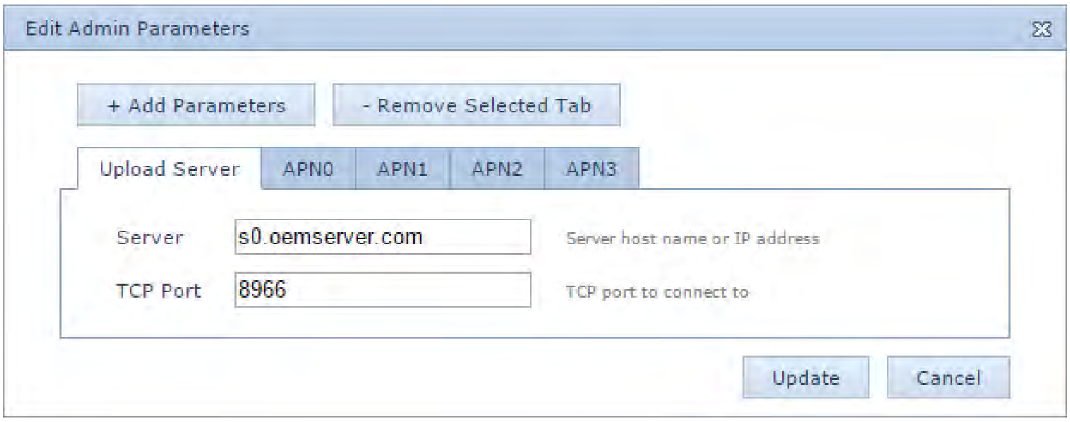
Note that this is different to Auto-APN. Auto-APN uses the SIM's IMSI, which is fixed, even when roaming. The multi-APN feature checks which network the SIM has registered on and checks the Admin Parameter list for a matching MCC MNC value.

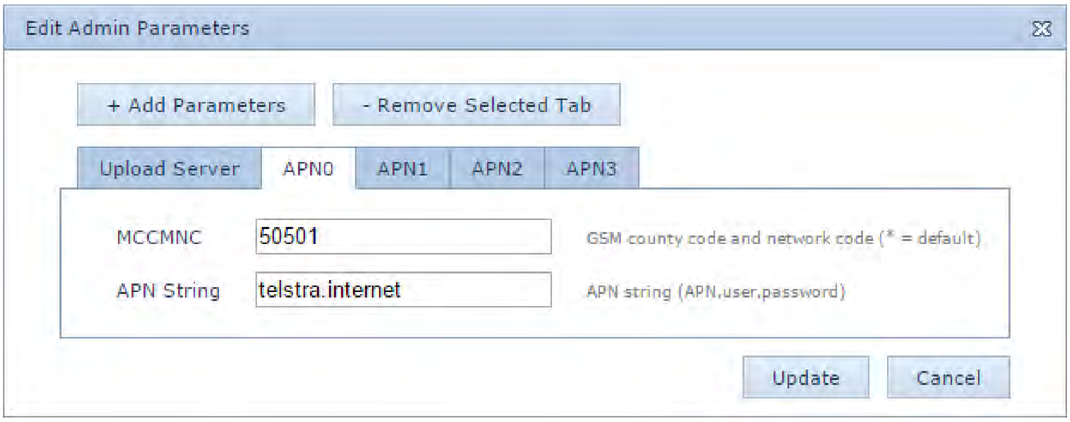
The multi-APN feature is used if the admin parameter APN list contains at least one entry. In this case, the following process is followed:

1. The APN list in admin parameters is not blank, so the device knows not to use the Auto-APN feature.
2. On each connection, the modem is allowed to register on an automatically selected (SIM appropriate) network.
3. The MCC and MNC of the current network is queried.
4. The APN list in admin parameters is scanned for the first matching entry, or the wildcard character ('*').
5. If no entries match, the default APN 'internet' is used.

3. Admin Parameters

Admin parameters are a block of parameters containing the APN and server settings. They can be configured by SMS (see section 7.3) and through the OEM Server web interface. The web interface is shown below, with all five possible parameter sections added.





In the screenshots, APN details have been supplied, so the Remora will not use the Auto-APN feature. In practise, most units will be using the default server and Auto-APN, and will not require any of the five tabs shown to be supplied.

9. TRACKING SETTINGS

1. Overview

The Remora exists to fill a particular niche in the tracking industry. Being battery powered, and IP67 rated, it can be easily attached to an unpowered or difficult-to-wire asset, and provides low to medium frequency tracking. There is very little initial install cost, and no barrier to frequent re-installs on varying assets. In exchange for these benefits, battery powered trackers introduce a trade-off between battery-life and tracking detail.

The Remora's tracking approach is therefore designed to minimise battery consumption, and allow the user to tailor the battery / detail trade-off to their requirements. Where a regular tracker such as the G60 will keep the GPS and mobile data connections powered for the duration of a trip, a battery powered tracker must spend its charge frugally if it is to last for years. It therefore spends most of its time asleep, waking briefly to determine its location, and uploading infrequently, even during trips. Carefully balancing the time spent awake and the time spent asleep is what sets the Remora apart from the competition.

Understanding the Remora's tracking modes will help you configure it to last its longest in your application, and save you time and money on battery replacements.

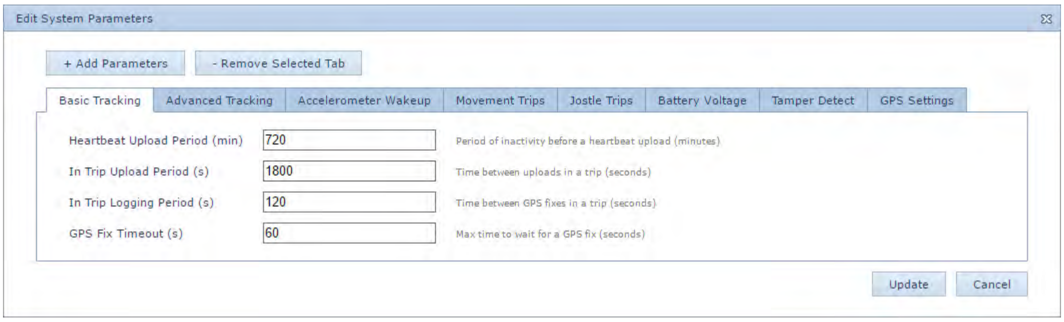
2. Basic Tracking

A typical trip tracking cycle proceeds as follows:

1. The Remora waits in a low power sleep state for accelerometer activity.
2. Once woken, it checks the GPS for movement.
3. If the GPS shows movement, a trip is started.
   The start point is immediately uploaded to the server.
   The Remora then resumes sleeping, with both the GPS and mobile data off.
4. During the trip, the Remora wakes frequently, records its position, and checks for continued movement. Every so often it uploads a batch of recorded positions.
5. Once the asset has been stationary for some time, or the GPS signal has been lost for some time, the trip is ended, and a final upload is performed.

In addition, the Remora will check in with a 'heartbeat' upload if there has been no activity for some time – typically once or twice a day.

1. Configuration



The *Heartbeat Upload Period* is the maximum time between upload attempts. If the Remora has not made an upload attempt for this long, it will attempt a GPS fix and an upload. If the GPS fix fails it will still upload using the last known position, to ensure that battery and

sensor levels are reported. However, if the upload fails (due to poor mobile signal, or exhausted air time), it will not be retried until the next heartbeat or trip related upload.

The *In Trip Upload Period* is the maximum time between uploads once a trip is in progress. It takes effect in parallel to the *Heartbeat Upload Period*. It is typically set several times larger than the *In Trip Logging Period*, so that each upload contains many data points. If an upload fails, it will not be retried until the next heartbeat or trip related upload.

If you require continuous uploads for the purpose of vehicle recovery, you should use Recovery Mode (see section 11). There is currently no support for continuous in-trip uploads outside of Recovery Mode. Upload periods of less than 5 minutes start to become very inefficient. Please contact Digital Matter for assistance if your use case requires high frequency uploads, and cannot be satisfied with a hardwired tracking solution.

The *In Trip Logging Period* is the time between GPS fix attempts. A lower logging period increases the detail of the trip, but uses more battery for GPS reception. Failed GPS fixes are not retried until the next heartbeat or trip related GPS fix.

The *GPS Fix Timeout* is the maximum time to wait for a GPS fix on each attempt. If your application has very poor GPS signal, you may need to increase the timeout to several minutes. In very good signal, it can be set as low as 10 seconds, which effectively instructs the unit to give up as soon as it loses a direct view of the sky.

A lower timeout will give improved battery life, but may lead to tracking problems when the signal is obstructed in urban environments. The default of 60 seconds should work well for installs that are not enclosed.

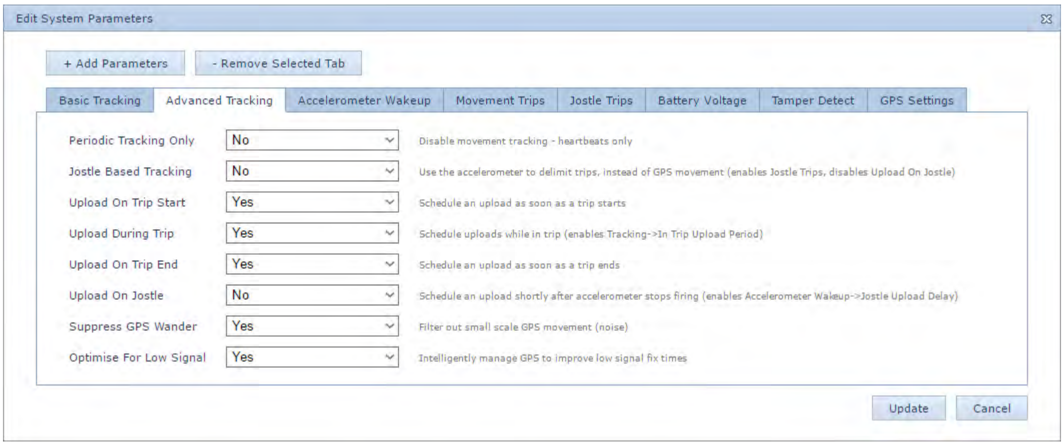
The choice of upload period and logging period, together with the Remora's mounting position, are the primary factors in determining the ultimate battery life in your application. Please see section 12 to learn how to estimate the battery life and choose appropriate periods.

3. Advanced Tracking

The basic tracking cycle in section 2 can be modified in several ways:

- The whole trip-tracking cycle can be disabled, leaving heartbeat uploads only
- The number of uploads can be reduced to save battery
- Additional uploads can be performed in response to accelerometer activity (jostling)
- The start and end of trips can be determined using accelerometer activity, rather than GPS movement.

1. Configuration



The *Periodic Tracking Only* option disables trip tracking. In this mode, the Remora no longer wakes up in response to jostling in order to check the GPS for movement. Instead, it will stay in a low power sleep mode until the next scheduled heartbeat. For applications that only require low frequency tracking of the final location of an asset, this mode gives the ultimate battery life.

The *Jostle Based Tracking* option causes trip start and end times to be based on accelerometer movement rather than GPS movement. Usually, jostling is a trigger for a GPS check, and the GPS movement is used to delimit trips. This gives the most robust trip tracking, but cannot track very short trips. *Jostle Based Tracking* considers the asset to be in a trip so long as recent jostling has been detected, allowing run-hour monitoring on slow moving or stationary but strongly vibrating assets. However, it is prone to false trip detection compared to GPS based tracking. The *Upload On Jostle* option is not relevant to this tracking mode, as the regular *Upload On Trip End* provides similar functionality.

The *Upload On Trip Start, During Trip,* and *On Trip End* options allow you to disable the regular trip related uploads. If your application doesn't require low latency notification of trip starts, disabling the start of trip upload will save battery. Disabling *Upload During Trip* is equivalent to setting the *Basic Tracking -> In Trip Upload Period* to an infinite value. Finally, by disabling all three options, you can track trips without the overhead of trip uploads. In this case the data will be stored and uploaded during the next heartbeat.

The *Upload On Jostle* option enables additional upload logic, intended to provide location updates for movements that are too small to qualify as trips. When enabled, the Remora schedules a heartbeat upload to occur at some time after the most recent jostle. If the Remora is jostled constantly, this upload is pushed out further and further into the future, up to a configurable maximum. This effectively ensures that the final position after any small movement will be uploaded, so long as GPS reception is not lost. Beware however that constant jostling could lead to undesired uploads, each of which cost battery life.

The *Suppress GPS Wander* option filters out small movements from heartbeat uploads. When enabled, position fixes for heartbeats are compared against the last known position. If no significant movement is detected, the last known position is uploaded instead. This prevents GPS noise from causing apparent movement of stationary assets. When using *Upload On Jostle* you should disable this filtering, to reveal the small movements. Suppression is enabled by default in firmware versions <= 1.26, and disabled by default from 1.27 onwards.

The *Optimise For Low Signal* option keeps the GPS running for a short time after each fix when doing so seems likely to lower the total average fix time, and therefore the battery usage. In regular or poor signal levels, this allows fresh ephemeris data to download from

the GPS satellites, improving both the time-to-first-fix and the minimum useable signal level. However, in excellent signal levels, it may be possible to get better battery life with this option disabled.

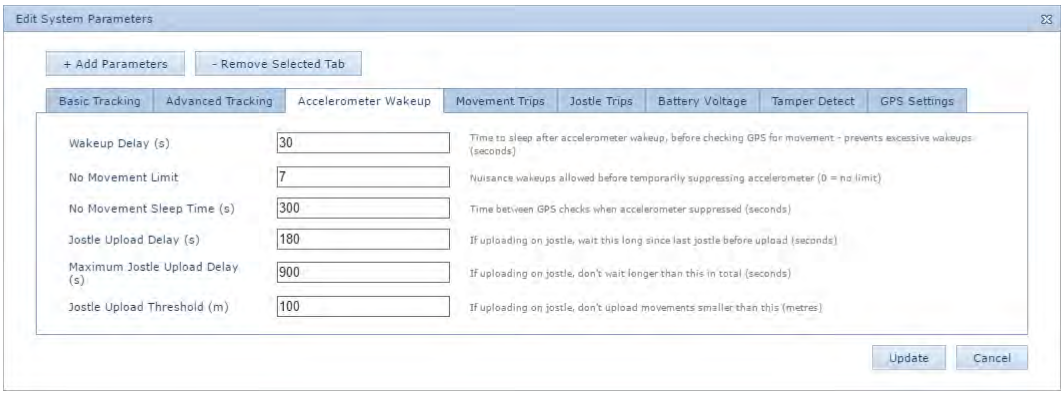
4. Accelerometer Wakeup

This section allows configuration of the wakeup rules for Basic Tracking, and the *Upload On Jostle* timeouts from Advanced Tracking. It is not applicable to *Jostle Based Tracking*.

In order to detect trip starts reliably, the accelerometer is configured to be highly sensitive, waking up on the slightest jostle. In regular GPS trip tracking mode, the Remora then checks for a legitimate trip start using the GPS. Two mechanisms are available to prevent small vibrations during asset handling from causing an excessive number of nuisance wakeups, for instance during the loading of a trailer.

1. After each wakeup, the Remora sleeps for a short, fixed, time. This limits the maximum rate of wakeups, and gives the asset an opportunity to get underway if it really is beginning a trip. In this case, the first GPS fix will be more likely to detect movement.
2. If too many jostle event are detected without any real movement being detected, the Remora will temporarily ignore the accelerometer, and sleep for a longer time before checking the GPS for movement. This provides a stricter limit on the maximum rate of wakeups.

1. Configuration



The *Wakeup Delay* is the minimum time spent sleeping after jostling has woken the Remora. It can be set to zero if low latency is required, but in most cases is best set between 10 and 60 seconds, to give the asset a chance to start moving before the GPS is activated.

The *No Movement Limit* is the maximum number of nuisance wakeups to tolerate before switching to a longer sleep time. Each time the Remora wakes up, sleeps the *Wakeup Delay*, and then finds no GPS movement, it increments a counter. When the counter reaches the *No Movement Limit*, the Remora starts to sleep the *No Movement Sleep Time* between GPS checks. It continues this for as long as the jostle continues and no GPS movement is detected.

The *Jostle Upload Delay* and *Maximum Jostle Upload Delay* are the timing parameters relevant to the *Advanced Tracking -> Upload On Jostle* option. The *Jostle Upload Delay* is the number of seconds to wait after a jostle before scheduling an upload. The *Maximum Jostle Upload Delay* prevents the upload being rescheduled (delayed) indefinitely during continuous jostling, by forcing it to take place within a specified number of seconds after the

jostling begins. The *Jostle Upload Threshold* optionally limits these uploads to those that show appreciable movement.

5. Movement Trips

This section allows you to fine-tune the requirements for trip detection in regular GPS based tracking mode. It is relevant when *Advanced Tracking -> Jostle Based Tracking* is not set.

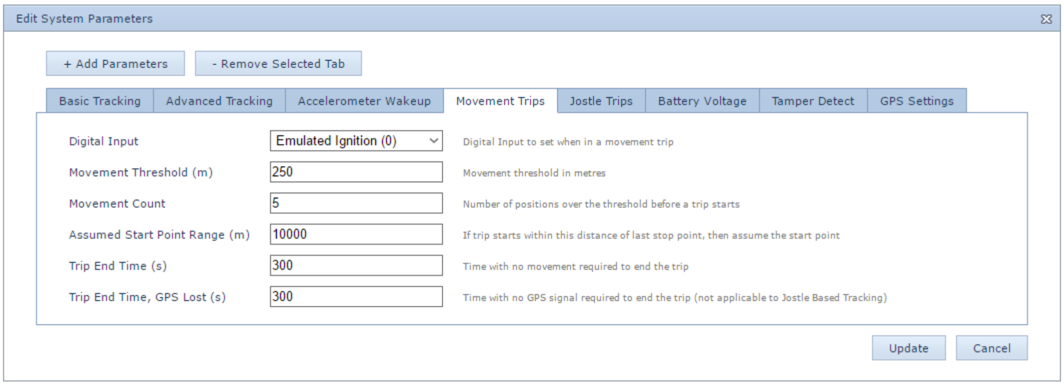
In regular GPS based tracking mode, the Remora looks at two things when checking for movement:

1. The current speed, determined by instantaneous GPS signals
2. The distance from the last known point where movement was detected

Once movement is detected, a trip is started. If the start point is close enough to the end point of the previous trip, that end point is included in the trip. The start of the trip is indicated in the upload by a special log-reason, an in-trip status flag, and optionally the assertion of a digital input. Once movement has stopped for a configured time, or GPS signal has been lost for too long, the trip is ended.

The default movement trip parameters will work for most applications, but should you need to, you can configure them.

1. Configuration



The *Digital Input* setting selects a Digital Input to assert when a movement trip is started. The default input is zero, which is the mapping for Ignition lines across the Digital Matter product line. If your Software Platform Frontend requires a specific digital input, you can remap it.

The *Movement Threshold* is one half of the movement detection decision. If a GPS point has a speed above 20 km/h, or is this many metres from the last detected movement, it is considered moving. This threshold should be more than twice the minimum GPS accuracy (*GPS Settings -> Position Accuracy*) to avoid false starts.

The *Movement Count* is the number of consecutive moving points that must be seen to begin a new trip. These points are received in one GPS check, at the rate of one per second. The GPS check stops as soon as the movement count is reached, or a point shows no movement.

The *Assumed Start Point Range* is the maximum distance from the previous trip at which the previous trip's end point will be included as the new trip's start point. When the end point is included in this way, its timestamp is estimated based on distance, as there is no unambiguous way to determine the true start time.

The *Trip End Time* is the minimum time spent with no movement detected, before the end of trip is declared.

The *Trip End Time, GPS Lost* allows you to extend (or shorten) the end time in the event of GPS reception loss. For instance, if your asset spends significant time in a tunnel, you may wish to extend the end time to prevent trips from splitting when the tunnel is entered. On the other hand, if your asset tends to end its trips in an underground parking lot, you could shorten the end time to save battery life.

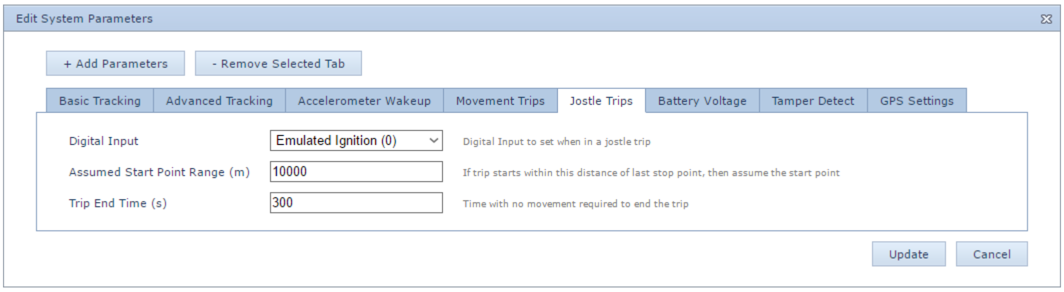
6. Jostle Trips

This section allows you to fine-tune the requirements for jostle based trip detection. It is relevant when *Advanced Tracking -> Jostle Based Tracking* is set.

In *Jostle Based Tracking* mode, a trip is started by significant sustained jostling, and continues as long as occasional jostling or significant GPS speed continues.

The default jostle trip parameters will work for most applications, but should you need to, you can configure them.

1. Configuration



The *Digital Input* setting selects a Digital Input to assert when a jostle trip is started. The default input is zero, which is the mapping for Ignition lines across the Digital Matter product line. If your Software Platform Frontend requires a specific digital input, you can remap it.

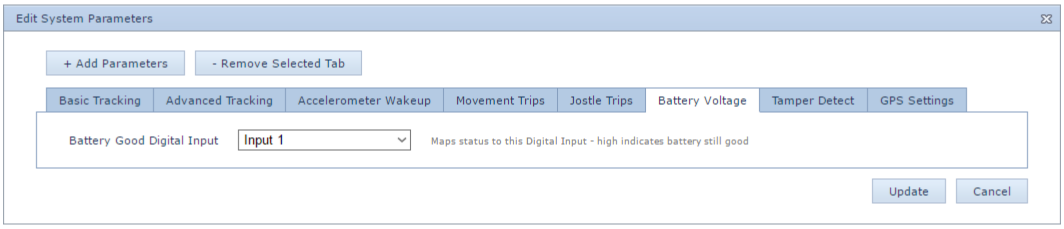
The *Assumed Start Point Range* is the maximum distance from the previous trip at which the previous trip's end point will be included as the new trip's start point. When the end point is included in this way, its timestamp is estimated based on distance, as there is no unambiguous way to determine the true start time.

The *Trip End Time* is the minimum time spent with no movement detected, before the end of trip is declared.

7. Battery Voltage

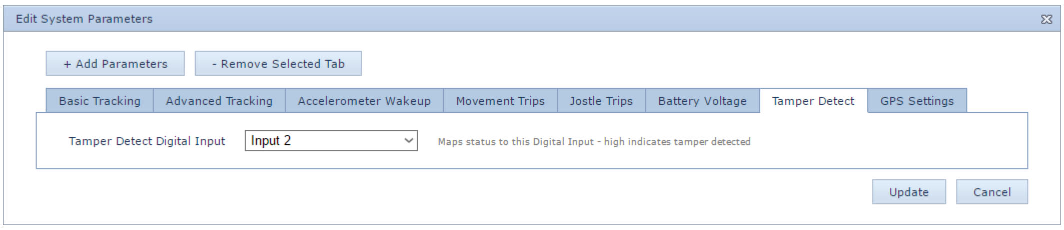
The Remora provides a 'Battery Good' indicator on a digital input, which goes low when the batteries are near their last ~7% battery life. The default mapping is to digital input 1.

It works for both Alkaline and Lithium Thionyl Chloride batteries, but may be less accurate for LTC batteries due to the considerable difficulty of gauging LTC capacities.



8. Tamper Detect

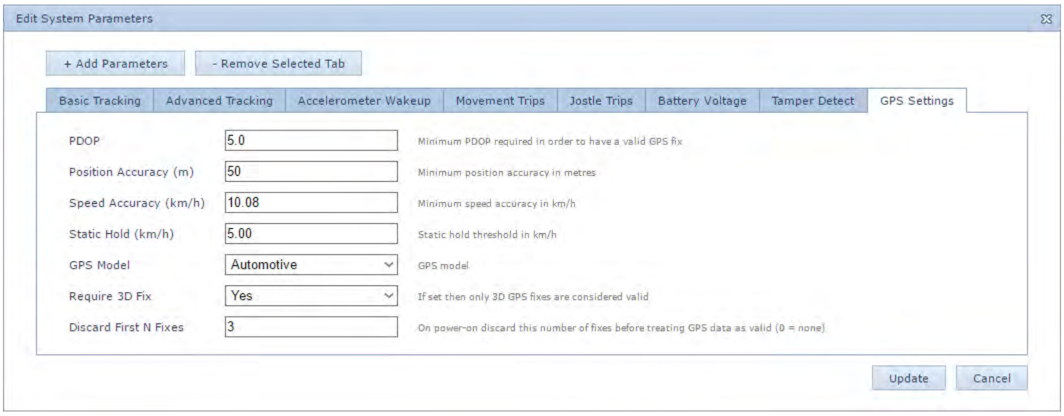
If your Remora is fitted with the magnetic tamper detection option, the 'Tamper Detect' indicator is mapped to a digital input, and goes high when the magnet is removed. The default mapping is to digital input 2.



9. GPS Settings

The u-Blox GPS module has a host of settings, most of which need no configuration. A few of these settings are exposed to allow the GPS accuracy to be fine-tuned. Most users will not need to configure the GPS.

1. Configuration



The *PDOP*, *Position Accuracy*, and *Speed Accuracy* settings allow you to configure the minimum accuracy required before the GPS is considered fixed. Lowering these values will lead to increased accuracy, at the cost of extended fix times.

The *Static Hold* threshold is the speed below which the GPS module will filter out small movements. It is similar to the *Advanced Tracking -> Suppress GPS Wander* option, but is applied in hardware by the GPS module and will only affect tracking in Recovery Mode, in which the GPS is kept on between fixes.

The *GPS Model* selects a statistical module used by the GPS hardware when filtering out noise during GPS fixes. It will only affect tracking in Recovery Mode, in which the GPS is kept on between fixes.

The *Require 3D Fix* option requires a 3D fix before the GPS is considered fixed. This is highly recommended, as 2D fixes use fewer satellites, and can be unreliable. However, if signal levels are very poor, disabling this option may improve the chance of a successful fix.

The *Discard First N Fixes* option discards a configurable number of points from the GPS if the PDOP is above 2.3. This gives the GPS some time to improve its accuracy, and lowers the chance of outlying GPS fixes slipping through the filters.

10. Accelerometer Settings

This section allows the accelerometer sensitivity to be adjusted. The defaults are suitable for most vehicles, but you may wish to decrease the sensitivity in vehicles subject to strong vibrations.

1. Configuration

The *Wakeup Threshold* option sets the G force required on any of the accelerometer axes to trigger a wakeup. The *Wakeup Count* sets the required duration of the force, with 0 being a single sample (currently at 12.5 Hz, but subject to change).

Accelerometer wakeups are used in several circumstances:

1. To trigger a GPS movement check, in regular GPS tracking mode
2. To detect a trip, in *Jostle Based Tracking* mode
3. To schedule an upload, if *Upload On Jostle* is configured

The default setting is for maximum sensitivity, and is appropriate for light vehicles. If you have a problem with constant wakeups in GPS tracking mode (see section 13.4.4), false trips in *Jostle Based Tracking Mode*, or excessive heartbeat uploads with *Upload On Jostle*, it may be necessary to increase the thresholds.

Increasing the thresholds may improve battery life by lowering the number of unnecessary wakeups, but it increases the chances of a trip start being missed.

10. ANALOG AND DIGITAL INPUTS

The Remora provides a set of virtual analog and digital inputs to which various signals can be mapped. Signal sources include physical signals, such as battery voltage, and status flags, such as trip status.

In addition, a separate set of fixed function digital status flags is provided.

1. Analog Inputs

The first ten analog inputs are signed 16 bit values. Six fixed mappings have been defined:

#	Mapping	Unit	Notes
1	Battery Voltage	mV	Open circuit (~1mA load) 50 mA load in Recovery Mode.
2	External Voltage	mV x 10	Reserved for compatibility.
3	Temperature	°C x 100	2400 = 24°C
4	GSM Signal Strength	(dBm + 113) x 0.5	0 = -113 dBm (min) 31 = -51 dBm (max)
5	Loaded Voltage	mV	Lowest voltage during inrush transient. Updated after sleeps of > 5 minutes.
6	Battery Level	% remaining x 100	Alkaline batteries only. Calculated from battery voltage minimums.

2. Battery Life Statistics

The next ten analog inputs are signed 32 bit values. The currently defined fixed mappings are all battery life statistics, which are reset when the batteries are changed:

#	Mapping	Unit	Notes
11	Successful Uploads		
12	Failed Uploads		Usually failures mean no mobile signal
13	GPS Fix Attempts		Includes failed fixes
14	GPS On Time	s	Divide by Fix Attempts for average fix time
15	Trip Count		

See section 12 to learn how to predict battery life using these statistics.

3. Digital Inputs

There are 32 digital inputs. No fixed mappings have been defined. The default (configurable) mappings are:

#	Mapping	Notes
0	Movement Trip	Indicates a trip has started due to GPS movement.
0	Jostle Trip	Indicates a trip has started due to accelerometer jostling.
1	Battery Good	Set when battery level > ~7%. Less accurate for LTC batteries than for Alkaline batteries.
2	Tamper Detect	Indicates the absence (high) or presence (low) of the optional tamper detect magnet.

Mappings are configured individually in the System Parameters (section 9).

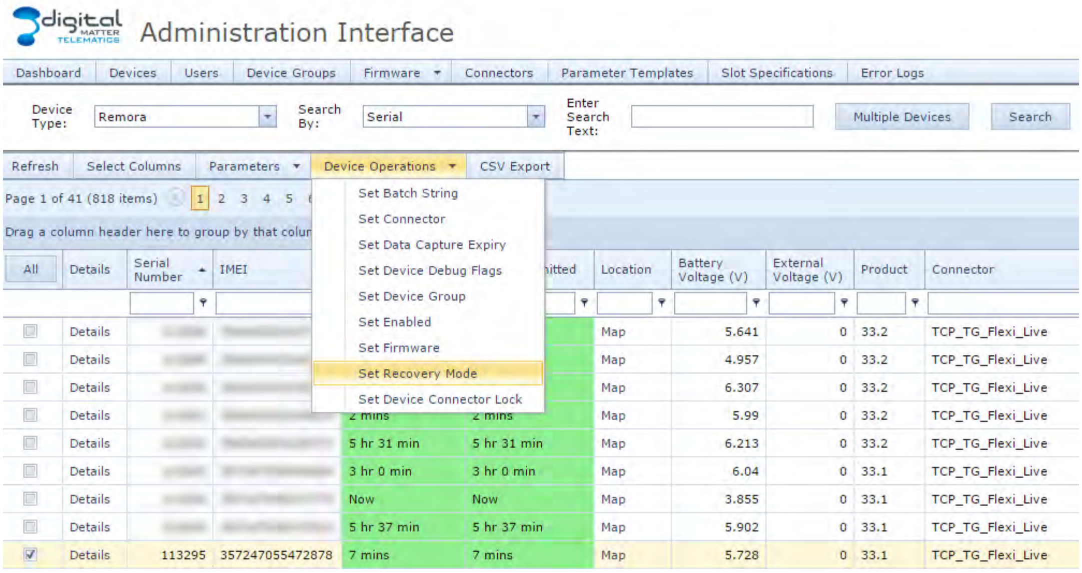
4. Digital Status Flags

The digital status flags are a separate set of fixed function digital flags that accompany the analog and digital inputs.

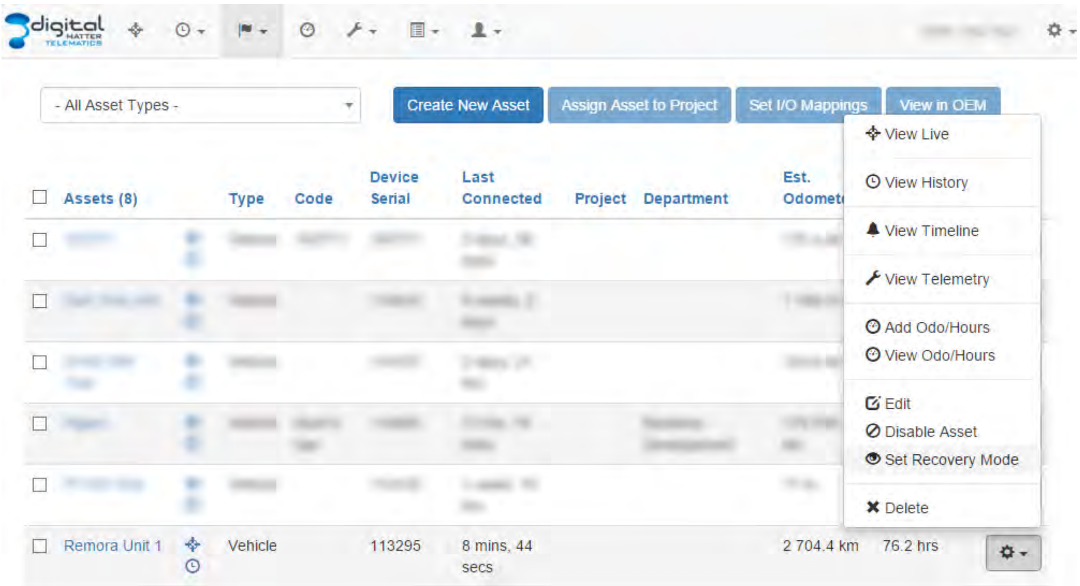
#	Name	Notes
0	In Trip	Indicates a trip has started for any reason.
1	Battery Good	Set when battery level > ~7%. Less accurate for LTC batteries than for Alkaline batteries.
2	External Voltage Good	Reserved for compatibility.
3	Connected to Server	Set if the device is connected at the time the record is logged. This is the case during Recovery Mode trips.

11. RECOVERY MODE

Recovery Mode is a power optimised low-latency tracking mode intended for stolen vehicle recovery. It can be set or cleared in the Devices screen on the OEM Server web management interface:



Or in the Manage Assets screen on the Telematics Guru platform:



Setting or clearing Recovery Mode queues an Asynchronous message for the Remora, which instructs it to change modes. The Remora receives Asynchronous Messages on each upload, or immediately when connected in-trip in Recovery Mode, and will remember the setting across reboots and battery changes.

Recovery Mode differs from the regular tracking modes in that the GPS fix and the server connection are maintained during trips. This allows the GPS to achieve its maximum

accuracy and sensitivity, and is more power efficient that constantly reconnecting to the server.

Trip tracking is done using the accelerometer, just as in *Jostle Based Tracking* mode. This allows the trips to be detected even when the GPS is being jammed. During trips, updates are sent every 30 seconds when the GPS is available, or every 60 seconds when it is jammed. Because the server connection is maintained and the last known location is sent frequently, it may be possible to track the unit using your mobile network's Location Based Services despite jamming. These services are offered by some mobile networks (through their own web portals), and provide coarse tracking of a registered SIM card.

Out of trip the unit sleeps, and heartbeats are sent every 30 minutes. The server connection is not maintained between heartbeats, both to save power and to make detection of the unit more difficult.

The tracking performance in Recovery Mode is excellent, but the battery will run down more quickly in this mode. A full battery should last 40 to 100 hours in-trip, or more than a month out-of-trip.

Users should also beware of the possibility of overrunning their mobile data limits while attempting to recover a vehicle, due to the higher than usual data volumes.

12. BATTERY LIFE PREDICTION

The Remora's ultimate battery life depends on a number of factors:

- The type and brand of batteries
- The temperature of operation
- The GPS and mobile signal strength
- Most importantly, the frequency of logging and uploading

The Remora is designed to be used with Alkaline batteries, which provide roughly 7 Ah in normal temperatures. Each second the GPS is on, each upload attempt, and each byte of data uploaded, uses a fraction of this 7 Ah. Since there is a limited total capacity, you must decide what trade-off of battery life, detail, and latency suits your application.

This chapter will assume the use of regular, good quality Alkaline batteries, in mild weather. If your application is subject to temperature extremes outside of the usual 0 - 55 C°, you may see reduced battery life with Alkaline batteries. If you have decided to use Lithium Thionyl Chloride batteries, you should see roughly twice the battery life of Alkalines.

1. Modelling the Battery Life

Neglecting self-discharge, jostle wakeups, and heartbeats, we can approximate the battery life with a simple equation. First we must define some quantities:

$$
\begin{aligned}
C &= \text{The total battery capacity, in Ah} \\
W &= \text{The number of weeks of operation} \\
C_{upl} &= \text{The cost of an upload connection, in Ah} \\
C_{rec} &= \text{The cost of uploading a record, in Ah} \\
C_{gps} &= \text{The cost of a second of GPS on time, in Ah} \\
T &= \text{The number of trips a week} \\
L &= \text{The average length of a trip, in seconds} \\
P_{log} &= \text{The logging period, in seconds} \\
P_{upl} &= \text{The upload period, in seconds} \\
t_{gps} &= \text{The average GPS on-time per fix, in seconds}
\end{aligned}
$$

We can now write:

$$C = Uploads \cdot C_{upl} + Records \cdot C_{rec} + Records \cdot t_{gps} \cdot C_{gps}$$

Which shows the three components of the battery capacity – upload connections, uploaded records, and GPS time. Each upload connection costs battery, even before records are uploaded, simply to establish and tear down the connection.

We now need to calculate the number of uploads and records in terms of trips per week:

$$Uploads = TW\left(2 + \frac{L}{P_{upl}}\right)$$

$$Records = TW\left(2 + \frac{L}{P_{log}}\right)$$

The twos come from the uploads at the start and end of each trip (which are optional). Putting these all together, we get:

$$\frac{C}{TW} = \left(2 + \frac{L}{P_{upl}}\right)C_{upl} + \left(2 + \frac{L}{P_{log}}\right)\left(C_{rec} + t_{gps}C_{gps}\right)$$

Which reads – '*Cost per trip* equals *uploads* times *cost of uploads*, plus *records* times *cost per record*'. We can now use this implicit equation to either calculate the battery life from the parameters, or choose the parameters to give a target battery life.

To directly calculate the battery life, we solve for W:

$$W = \frac{C/T}{\left(2 + \frac{L}{P_{upl}}\right) C_{upl} + \left(2 + \frac{L}{P_{log}}\right)\left(C_{rec} + t_{gps} C_{gps}\right)}$$

To choose P_{log} and P_{upl} from a given W, we solve for P_{upl}, graph the equation, and then pick a point on the graph:

$$P_{upl} = \frac{C_{upl}}{\frac{C}{WTL} - \frac{2}{L}\left(C_{upl} + t_{gps} \cdot C_{gps} + C_{rec}\right) - \left(t_{gps} \cdot C_{gps} + C_{rec}\right)/P_{log}}$$

2. Examples

The most important unknown variable in the above equations is t_{gps}, the average GPS on-time per fix. The other variables are given by your use case, chosen by you, or reasonably well known, but the average GPS time is best measured.

The average GPS time will depend strongly on the Remora's mounting position, on the conditions in which the asset travels (urban canyons, underground parking lots, heavy rain, jamming signals), and also on the number of trips per day. Frequent fixes are likely to be much faster than occasional fixes, due to the orbital data being fresh in the GPS memory.

A domestic vehicle will typically average between 13 and 19 seconds doing just a few trips a day, while a freight haulier driving for 8 hours a day will see averages on the order of 3.5 seconds.

See sections 10.2 and 13.4.1 for details on calculating the average GPS on-time from the battery life statistics of a Remora in the field.

1. Cost Constants

Based on preliminary data, we believe the cost constants to be approximately:

	Cost (Ah)
C_{upl}	620×10^{-6}
C_{rec}	4.2×10^{-6}
C_{gps}	7.5×10^{-6}

2. Example 1: Domestic Vehicle Tracking

We wish to track a vehicle that makes 12 trips per week, of approximately 30 minutes each. If we set the logging period to 60 seconds, and the upload period to 300 seconds, what kind of battery life can be expected? We will assume an average GPS on-time of 15 seconds, and 7 Ah Alkaline batteries.

$$W = \frac{C/T}{\left(2 + \frac{L}{P_{upl}}\right) C_{upl} + \left(2 + \frac{L}{P_{log}}\right)\left(C_{rec} + t_{gps} C_{gps}\right)}$$

$$W = \frac{7/12}{\left(2+\frac{30\cdot 60}{300}\right)\cdot 620\text{E-}6 + \left(2+\frac{30\cdot 60}{60}\right)(4.2\text{E-}6 + 15\cdot 7.5\text{E-}6)}$$
$$W = 67 \text{ weeks}$$

What if one year isn't good enough, and we require a two-year battery life?
What combinations of logging and upload period will make the battery last that long?
We can use the second form of the equation to make a graph of possible solutions:

$$P_{upl} = \frac{C_{upl}}{\frac{C}{WTL} - \frac{2}{L}(C_{upl} + t_{gps}\cdot C_{gps} + C_{rec}) - (t_{gps}\cdot C_{gps} + C_{rec})/P_{log}}$$

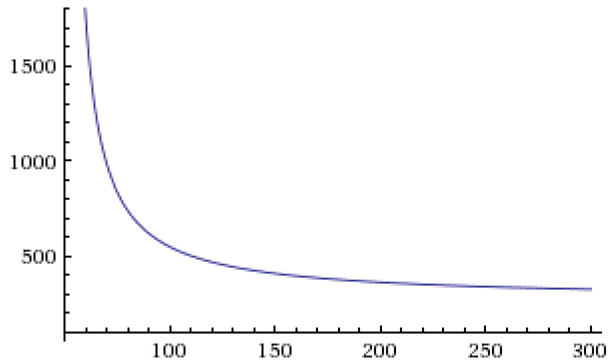
$$P_{upl} = \frac{620\text{E-}6}{\frac{7}{(2\cdot 52)\cdot 12\cdot(30\cdot 60)} - \frac{2}{30\cdot 60}(620\text{E-}6 + 15\cdot 7.5\text{E-}6 + 4.2\text{E-}6) - (15\cdot 7.5\text{E-}6 + 4.2\text{E-}6)/P_{log}}$$

$$P_{upl} = \frac{620\text{E-}6}{3.12\text{E-}6 - 819\text{E-}9 - 117\text{E-}6/P_{log}}$$

$$P_{upl} = \frac{620\text{E-}6}{2.30\text{E-}6 - 117\text{E-}6/P_{log}}$$

The final equation is now in a form that is easily graphed by a tool such as OSX's Grapher, Excel, or https://www.wolframalpha.com.

Plotting the graph on Wolfram Alpha, using plot 620e-6/(2.30e-6 - 117e-6/x) x=55..300 y=55..1800, produces:



The upload period (in seconds) is on the y-axis, and the logging period is on the x-axis. Any point on the graph should give a 2-year battery life. Rounding the upload period up to a multiple of the logging period, we can use any of the following combinations:

Logging Period (s)	Upload Period (s)
60	1771 < 30x60 = 1800
100	549 < 6x100 = 600
200	362 < 2x200 = 400
320	320

3. Example 2: Freight Tracking

If a freight trailer makes 16 trips per week, of approximately 3 hours each, what tracking and upload periods will give a one-year battery life? We will assume an average GPS on-time of 3.5 seconds, and 7 Ah Alkaline batteries.

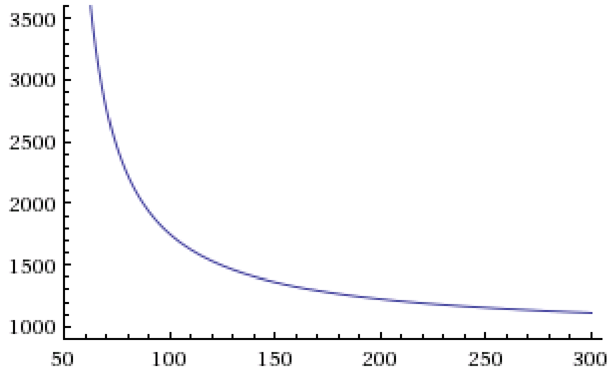
$$P_{upl} = \frac{C_{upl}}{\frac{C}{WTL} - \frac{2}{L}\left(C_{upl} + t_{gps} \cdot C_{gps} + C_{rec}\right) - \left(t_{gps} \cdot C_{gps} + C_{rec}\right)/P_{log}}$$

$$P_{upl} = \frac{620\text{E-}6}{\frac{7}{52 \cdot 16 \cdot (3 \cdot 60 \cdot 60)} - \frac{2}{3 \cdot 60 \cdot 60}(620\text{E-}6 + 3.5 \cdot 7.5\text{E-}6 + 4.2\text{E-}6) - (3.5 \cdot 7.5\text{E-}6 + 4.2\text{E-}6)/P_{log}}$$

$$P_{upl} = \frac{620\text{E-}6}{779\text{E-}9 - 120\text{E-}9 - 30.5\text{E-}6/P_{log}}$$

$$P_{upl} = \frac{620\text{E-}6}{659\text{E-}9 - 30.5\text{E-}6/P_{log}}$$

Once again using Wolfram Alpha, we obtain:



Which gives the following options:

Logging Period (s)	Upload Period (s)
60	4115 < 69x60 = 69m
120	1532 < 13x120 = 26m
210	1207 < 6x210 = 21m
300	1112 < 4x300 = 20m

13. TROUBLESHOOTING

1. No Connection On Battery Insertion

If a device is not connecting, it is usually SIM or power related.

Check that:

- The SIM is installed with the correct orientation, and the holder is properly latched.
- The SIM PIN is either not set, or is set to the Remora's PIN.
  The PIN can be retrieved from the OEM Server web interface.
- The SIM has credit / airtime
- The APN is set correctly.
  A new Remora will be set to Auto-APN unless your distributor has made special arrangements. An in-service Remora may have been configured with a specific APN in the past. To be certain, you can SMS the APN settings (see section 7.3).
- The batteries aren't flat. New Alkalines have an open circuit voltage of 6.3 V.
  Old Alkalines will read below 5 V.
- The Remora was reset correctly.
  The LED next to the GPS antenna will flash briefly on battery insertion if the Remora was reset correctly. If it doesn't, remove the batteries to allow any residual charge to drain, and then reinsert them. Reset is usually instant due to accelerometer and GPS activity, but if the Remora happens to be sleeping you may need to keep the batteries disconnected for up to 3 minutes.

2. Missing Updates in the Field

If a Remora has not reported when it should have, it is likely experiencing loss of mobile signal. Because the Remora is designed to maximise battery life, retries are kept to a minimum. If there is a network glitch or the device is out of coverage, it will only try to upload for 3 minutes. If it times out, it will go to sleep and only retry on the next scheduled upload. This may be on the heartbeat (typically 12 or 24 hours) or on the start of the next trip.

3. Forcing a Connection

There is no way to initiate a connection remotely because when the device sleeps, it switches off its modem. You will need to wait for the next scheduled connection – either a heartbeat or trip start.

If you have the unit in your hands, you can force a connection by resetting it. Bear in mind however that disconnecting the batteries to force a reset will also reset the battery life statistics. If the magnetic tamper detection option is fitted, a less invasive method is to trigger the tamper detection, which will cause an immediate upload.

If the unit is configured for *Jostle Based Tracking*, you can provoke a trip start or end upload simply by jostling it, then letting it lie still.

Finally, if the *Upload on Jostle* feature has been activated and the *Jostle Upload Threshold* has been disabled, so that not movement is required, you can jostle the unit and wait the configured *Jostle Upload Delay*.

4. Short Battery Life

If you have chosen appropriate logging and upload periods (section 12), but are still experiencing shorter than expected battery life, there are several possible causes.

1. Poor GPS reception

When the GPS signal is low, position fixes take much longer, resulting in shorter battery life. You can check your average time-to-first-fix using the battery life statistics reported in the Analog Inputs (section 10.2). An average time of 3 seconds is excellent, and times above 18 seconds are poor.

For detailed GPS troubleshooting, GPS debug message can be enabled on OEM Server. When the debug level is set to Info, GPS debug messages will appear in the log. In addition to individual fix times, signal level diagnostics whenever a fix takes longer than 36 seconds, or the GPS decides to stay awake after a fix to collect more satellite information. Please note that while debug messages are enabled, uploads will use extra battery life.

The diagnostics look like this:

Example	Description
Debug[GPS][Info]: TTFT=0s	Time taken for GPS to determine the time. Usually 0 or 1 seconds.
Debug[GPS][Info]: TTFF=3s PDOP(x10)=23 3Dfix=1	Time taken for a basic GPS fix. Usually between 1 and 36 seconds.
Debug[GPS][Info]: Valid=3s PDOP(x10)=23 3Dfix=1	Time taken before a GPS fix passes additional validity filters. Usually TTFF + 0 to 3 seconds.
Debug[GPS][Info]: ORB 54,4,10	Known orbitals. In this example, of 54 possible orbitals, 4 are known in detail, and the knowledge is useable for the next 10 x 15 minutes. Detailed orbital knowledge is not required for a fix, but can speed up the process.
Debug[GPS][Info]: SAT22 43402,43723,40663 …	Tracked satellites. In this example, 22 simultaneous channels are active (locked or searching). The best ten satellites are listed, with the first two digits of each number being the signal to noise ratio – 43, 43, and 40 dB. Strengths above 25 are useable, above 35 are good, and above 45 are excellent.

2. Temperature Extremes

Temperatures in excess of 55 C° shorten the shelf life of standard Alkaline batteries. The higher the temperature, the faster the self-discharge. Temperatures below 0 C° lower Alkaline battery performance for the duration of the cold spell, by slowing down electrolyte reactions. This causes the activity during the cold spell to use extra power, and can prevent uploads if the battery is nearly empty.

If your application requires frequent exposure to temperature extremes, you should consider using Lithium Thionyl Chloride batteries. LTC batteries are typically rated from -20 to 85 C°. They last twice as long as Alkaline batteries, but are more expensive, and must be disposed of as hazardous waste.

3. Battery Failure

Alkaline batteries will sometimes fail early due to manufacturing defects or abuse. Typically, one or two of the four batteries will develop an internal short, and self-discharge over the course of several days. This manifests itself as a sudden drop in the battery level graph that isn't explained by GPS or GSM activity. When the batteries are recovered and their voltages measured, the failed cells will show low or negative voltages, while the good cells will still show unused capacity. Because there are four cells in series, a failure rate of 0.1% in the individual cells will translate to a 0.4% incidence of early battery replacement.

To lower the failure rate, be sure to buy new batteries of a quality brand. Batteries marketed as 'industrial' tend to be fresher, and may have gone through better testing than their domestic counterparts. Temperature extremes may also contribute to failure rates, so favour installation sites that are well ventilated.

4. Constant Wakeups

When the Remora is configured to for trip tracking, it wakes up whenever the accelerometer detects jostling. The accelerometer is very sensitive, so vibrations during handling, for instance during the loading of a trailer, can cause undesired wakeups. Each wakeup ultimately causes a GPS fix that checks for movement, and uses a fraction of battery life. The solution is to increase the wakeup delays detailed in section 9.4.

To verify that a unit is experiencing excessive wakeups, Control debug messages can be enabled on OEM Server. When the debug level is set to Info, the Remora will report each wakeup and fix attempt. Please note that while debug messages are enabled, uploads will use extra battery life.

It is also possible to view the average wakeup statistics without enabling any debug messages. The Remora will periodically output a debug message containing a breakdown of the battery life statistics that is more detailed than the statistics available on the Analog Inputs. These messages can be viewed in the device logs on OEM Server. In firmware version 1.25, they look like:

Debug[GEN][Crit]:
Stats:1142,110471,112,20160,14272,49574,302,18120,525,18900,586,82,0,6147,9870,0

The listed numbers, in order, are:

- Successful uploads
- Seconds spent in successful uploads
- Failed uploads
- Seconds spent in failed uploads
- Successful GPS fixes
- Seconds spent in successful GPS fixes
- Failed GPS fixes
- Seconds spent in failed GPS fixes
- GPS orbital download attempts
- Seconds spent downloading GPS orbitals via GPS
- **Number of accelerometer wakeups**
- **Number of actual trips**

- Number of uploads due to *Upload On Jostle*
- Battery voltage, in millivolts (-1 if unknown)
- Battery capacity, in hundredths of a percent (-1 if unknown)
- Number of wakeups for *Upload On Jostle*

By dividing the number of wakeups by the number of actual trips, you can determine the average level of nuisance wakeups. A ratio between 1 and 10 is typical for a Remora that is not subject to high levels of jostling while out of trip.

5. Poor Trip Start Performance

In some cases, trip starts may be far beyond the trip start threshold (default 250m). There are two possible causes:

- The GPS may have taken a long time to lock, due to poor signal.
  This can be addressed by improving the Remora's mounting point.
- The Remora may have experienced too many nuisance wakeups due to jostling, and decided to ignore the accelerometer for a while, as detailed in section 9.4. The default *No Movement Sleep Time* is 5 minutes, which allows for a fair amount of travel. You can adjust these timeouts for higher detail, at the cost of decreased battery life.