Rover-X User Manual

Surface Iridium Satellite Beacon with GPS Location

Shipped From

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Specifics

This manual version is written with respect to Rover-X firmware build 11743. If you wish to acquire the latest firmware for your device, contact support@xeostech.com

Version History

Version No.	Date	Description
1.0	Jan 2024	Original Document

Regular checks for the latest manual are suggested. Be sure to check Xeos Technologies' manuals page to compare versions and download the latest version.

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Overview

The Rover-X Surface Iridium satellite mooring location beacon is intended for providing regular location information on high value assets at the surface, drifting or moored.

Rover-X makes use of the bi-directional, global, real time Iridium Satellite Short Burst Data (SBD) network in combination with GPS position location. Rover-X's sleek tubular design and internal dual Iridium/GPS antennas located at each end allow it to be easily retrofitted into a variety of surface mounts. Even surface installations which capsize may be able to transmit location information.

Inside the Rover-X is a 9603 Iridium satellite Short Burst Data core radio transceiver, a specialized low power Xeos digital controller with GPS and Iridium hardware. After being activated, the Rover-X is deployed at the surface and begins sending location messages as per the user settings. The internal battery pack provides over 1500 messages.

Rover-X is intended for surface deployments and should not be deployed in situations which exceed 100m in depth. Xeos Technologies Inc. (Xeos) manufactures other specific products for either surface, or subsurface applications to depths of 11,000m.

See xeostech.com for details or call +1 (902) 444-7650.

Preliminary Setup

Outside Diagram

1	The LEDS of the Rover-X are located here. LEDs illuminate on magnet contact, power-up and Bluetooth connection
2	The top Iridium and GPS antennae of the Rover-X are located here
3	The magnet switch for turning the Rover-X on and off is located behind the label
4	The 15-digit IMEI of the Rover-X's Iridium modem and factory serial number is displayed
5	A QR code is available to scan to download the manual on new devices
6	Two sealing O-rings are located in the middle of the Rover-X. This is where the device is opened to install batteries
7	The bottom Iridium and GPS antennae of the Rover-X are located here, used when inverted

Setting up an Iridium Account

Rover-X makes use of the Iridium Satellite Systems' Short Burst Data (SBD) service for the 9603 transceiver. This service is a global (including the Polar Regions), two-way, real-time and email-based data delivery service with a maximum outbound (from beacon) message size of 340 bytes and a maximum inbound (to beacon) message size of 270 bytes.

Rover-X end users must set up an approved data delivery account with their preferred service provider. This can only be done once Xeos has provided the user with an International Mobile Equipment Identity **(IMEI)** number, on the label of each device. Each modem has a unique IMEI that must be registered with the Iridium service provider. Xeos Technologies is one such provider, able to provide Iridium SBD data service and accounts. Please contact activations@xeostech.com for more information. Each IMEI is capable of being associated with up to five (5) unique email or IP addresses.

Rover-X makes use of a simple and robust binary protocol as the default outgoing message format. Any email application can be used to send and receive messages with the Rover-X, however, the messages from the Rover-X in this format are not human-readable.

XeosOnline is a web-based monitoring system which allows users to view and manage information from their Xeos beacons on a mapping system, as well as view the messages in a human-readable format. Sending messages and changing configuration of your devices can also be completed through this service. XeosOnline also allows for the creation of multiple kinds of message forwarders which can forward specific (or all) messages to a group of email addresses in a human-readable form.

See xeostech.com for more information.

Quickstart

Before using the Rover

- Ensure the IMEI of your device is activated through your chosen Iridium provider and intended message recipients are added to its account ahead of deployment.

Power-Up

Battery Installation

The Rover-X automatically turns on once all batteries are installed. The device must be turned off via magnet or battery removal.

Magnet

- Swipe the magnet along the **SWIPE ON/OFF HERE** label horizontally until the **GREEN LED** on the top of the device is shown. The green LED will flash again while the device completes power-up.

Confirm Transmission

- Turn the device on and place it outside in view of as much of the sky as possible.
- The unit will transmit power-up messages then one position every 10 minutes at default settings within 5 minutes of power-up for one hour.
- Confirm that these messages are being received via email and/or XeosOnline.

Operation

- When deploying the unit, power it up by swiping the magnet.
- Once the unit is confirmed to be on, it is ready to be deployed.
- Turn the Rover-X **OFF** using the same magnet method as turning **ON**, with the **RED LED** in place of the green.

Rover-X Operation

Using the Magnetic Switch

The Rover-X beacon is turned **ON and OFF** using a magnet swiped near an internal magnetic reed switch, and operation can be identified by viewing the LED through the top of the Rover-X.

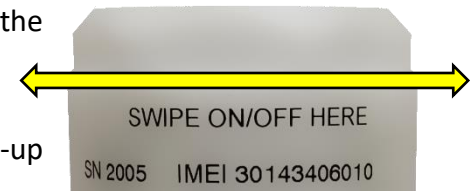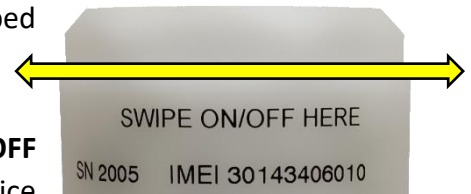To turn on the Rover-X, swipe the magnet along the **SWIPE ON/OFF HERE** label horizontally until the **GREEN LED** on the top of the device is shown. The green LED will flash again while the device completes power-up. The green LED also flashes when a Bluetooth connection is established.

Note: If a new LED sequence begins using the red LED after turning the Rover-X on and the device beeps repeatedly, this indicates a self-test failure. See the section below on failure codes.

To turn the Rover-X **OFF**, repeat the above procedure until the red LED is shown.

At any time, the magnet can be placed against the location of the reed switch **once** to see which mode the beacon is currently in; green for on, red for off.

Operational Tips

- It is important to let all LEDs stop illuminating before initiating another action.
- Cycling power for any reason, for example by using the magnetic switch to turn OFF/ON or by removing battery power, will initiate the Startup Mode.
- The beacon requires a good view of the sky for any test. It is necessary that any tests be done outside of a building, far from potential obstructions.

Installation

When installing the Rover-X there are several factors that can influence performance.

- The top or bottom of the Rover-X must be pointing toward the sky; white is top.
- Iridium and especially GPS performance may suffer if large angles of the horizon are blocked, such as if the Rover-X is next to a wall.

Messages from the Rover

There are several messages sent from the Rover-X, depending on setup and conditions. Below are examples of the most common messages.

Version

The Version message has a summary of the firmware and hardware revision of the device. It also displays reset information and the IMEI of the device.

```
Powerup: true, Ascii: Rover-X v1.0-11743. dev:4 Hw:7.1.1 SN=1000
IMEI:300434061233400 Reset Count: 15 Latest Reset Reason: 1
```

Version	
Firmware Version	Product; Major, minor, build of firmware
Hw	Hardware revision, set during assembly
SN	The unit's serial number
IMEI	The unique number of the device's Iridium modem
Reset Count	The number of resets since device was built
Latest Reset Reason	Cause of last reset

Unlock

The Rover-X uses unlock codes as a security measure to prevent unauthorized commands. The Rover-X sends this code automatically in the first Iridium session to keep the user, and XeosOnline, up to date on this code. Remember that messages are only sent to destinations that are allowed to receive them.

Any commands which do not include a valid unlock code as the first line will be ignored by the Rover, but will prompt the unit to reply with a valid unlock code to all provisioned addresses.

See below for more details on the Unlock Code.

```
Unlock Code: 19235
```

Position Message

Typical position messages are sent in compressed binary format (Type GC) to save on data usage and are parsed in XeosOnline. If XeosOnline is not used, ASCII GPS (Type AG) can be used to read position messages as plain text.

Compressed Binary Position (Type GC)

The default format for positions is compressed to save on Iridium data usage. This binary format is parsed into a readable format by XeosOnline, placing its full contents in the Message and Location Logs.

The binary format is stackable and can hold more than one position per Iridium transmission. In this situation, all recorded positions will be displayed in the Location Log in table form, while the latest position will be displayed in the Message Log.

```
Timestamp: 2023-06-20T12:00:35.001Z, Voltage Unloaded: 3.54, BatteryV:
2.62, Mode: Normal, Device Temperature (°C): -63, Message Type: GC,
Latitude: 44.714099,
Longitude: -63.604563, SNR: 45, Bearing: 0, Speed: .2880, HDOP: 24.4
```

Compressed Position	
Timestamp	Date and time in UTC of the latest position reading
Voltage Unloaded	Voltage measurement taken before powering the Iridium modem
BatteryV	Loaded voltage of the power supply; minimum battery voltage observed during the previous Iridium task
Mode	The timer in the scheduler used when the message was transmitted
Device Temperature	Temperature read before transmission (not used)
Message Type	Displays the message format being transmitted
Latitude	Latitude of fix, decimal degrees
Longitude	Longitude of fix, decimal degrees
SNR	SNR (Signal-to-noise ratio) of GPS Fix, higher is better
Bearing	Direction of movement determined by device to the nearest 22.5°
Speed	Speed measurement in kilometers per hour
HDOP	Horizontal Dilution of Precision

Each compressed message is 23 bytes in size, with an additional 10 bytes added for each additional "stacked" position.

ASCII Position (Type AG)

In ASCII position format, only the most recent fix is sent at each interval, therefore it is most efficient to have GPS and Iridium intervals equal.

```
AG, 9.67, 7.78, 0, 1686915004, 44.7466032, -63.3840900, 40.0, 38, 4,
332.9, 21.38, 3, 3.0
```

ASCII Position	
AG	Specifies the message type
9.67	Voltage measurement taken before powering the Iridium modem
7.78	Loaded voltage of the power supply; minimum battery voltage observed during the previous Iridium task
0	The timer in the scheduler used when the message was transmitted
1686915004	Unix time of the GPS position
44.7466032	Latitude, decimal degrees
-63.3840900	Longitude, decimal degrees
40.0	Altitude (m)
38	Max SNR recorded
4	Number of Satellites used during the fix
332.9	Bearing to the nearest 22.5°
21.38	Speed measurement in (m/s)
3	Time to fix (seconds)
3.0	Highest HDOP used during the fix

Default Message (Type DM)

The default message is transmitted at times when the device has no other data available to send other than its internal sensor states, where applicable. This could be because the GPS is not scheduled to run, or another factor has prevented a fix from being acquired. Since this message is shared across products, some bits will never be set.

```
Timestamp: 2023-06-21T11:02:05.000Z, Voltage Unloaded: 13.59,
BatteryV: 11.94, Mode: Inverted, isAlarm: true, Device Temperature
(°C): 0, Message Type: DM, Status: 33, No GNSS Position Stored: true
```

Default Message	
Timestamp	Date and time in UTC of the latest position reading
Voltage Unloaded	Voltage measurement taken before powering the Iridium modem
BatteryV	Loaded voltage of the power supply; minimum battery voltage observed during the previous Iridium task
Mode	The timer in the scheduler used when the message was transmitted
isAlarm	Displays if this is a state warranting an Alarm forward, if applicable
Device Temperature	Temperature read before transmission (not used)
Message Type	Displays the message format being transmitted

Status	A hex readout of the status bits that are enabled. The information following this value translates this value into sensor and/or GPS status information.

DM Status Bitmap	
Bit	**Definition**
0	No GPS position Stored to transmit (not scheduled to run at this time)
1	No GPS Signal
2	GPS Disabled (Not configured to run)
3	GPS Error Handler occurred in fix attempt
4	WS: 0 = Surfaced 1 = Submerged
5	LS: 1 = Light 0 = Dark
6	TS: 0 = Upright 1 = Inverted
7 - 63	Reserved

Watch Circle Parameters (Type WC)

At start-up, any Watch Circle parameters are transmitted, regardless if the system will be used. This is also the message that is displayed if any Watch Circle commands are used, to keep XeosOnline up to date on circle status.

```
Ascii: WatchCircle: ENABLED, Latitude: 44.000000, Longitude: -63.000000, Radius(m): 10000
```

```
                    Ascii: WatchCircle: DISABLED
```

Watch Circle Message	
WatchCircle	Shows the enabled or disabled state of the watch circle
Latitude	If enabled, the latitude portion of the position of the center of the watch circle
Longitude	If enabled, the longitude portion of the position of the center of the watch circle
Radius(m):	If enabled, the radius of the set watch circle

Communicating with the Rover-X

There are 3 ways to communicate with the Rover-X:

1. Over-the-air with XeosOnline
2. Over-the-air with Email SBD messages
3. Locally with Bluetooth

Sending Commands Using XeosOnline

Before using XeosOnline make sure that your account has been set up and your device added to your organization. Contact activations@xeostech.com for more information.

Setting up to Send

- Navigate to the Send Command window.
- From the Home Tab, choose **Menu > Send Command**

- Select the units you wish to target with commands and move
  them over to the right-hand target list using the **->** button.
- Type your command(s) into the command box and press send.
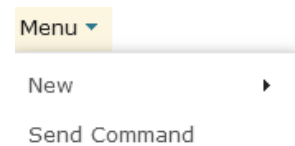
Remember to include the dollar sign (**$**) ahead of each command, and enter each command on a separate line.

Outgoing messages will appear in the Message Log for the commanded device.
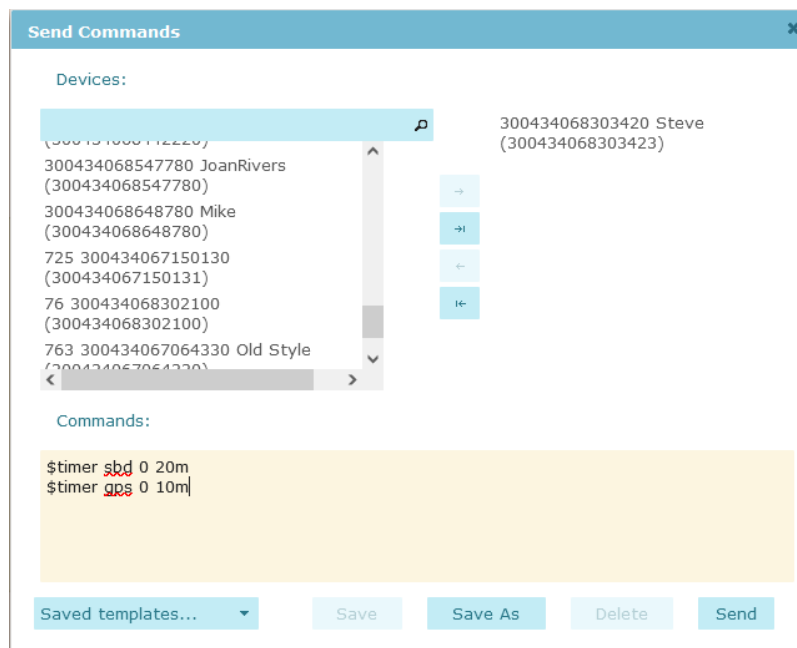
Sending Commands via Email

E-mail commands can also be used to communicate with the Rover-X when it is above water. These commands are sent as email attachments. Commands can configure the Rover-X remotely in the same way as commands sent by XeosOnline.

To receive commands from the Iridium network, the device in use must have a clear view of the sky. If the device is unable to communicate with the Iridium network, commands will remain queued for five days.

Command Format

Creating the file

To create an SBD command, open a new file in a text editor (ex. Notepad) and save it using the **.sbd** extension. Make sure the **Save as type** option is set to **All Files** to achieve this.
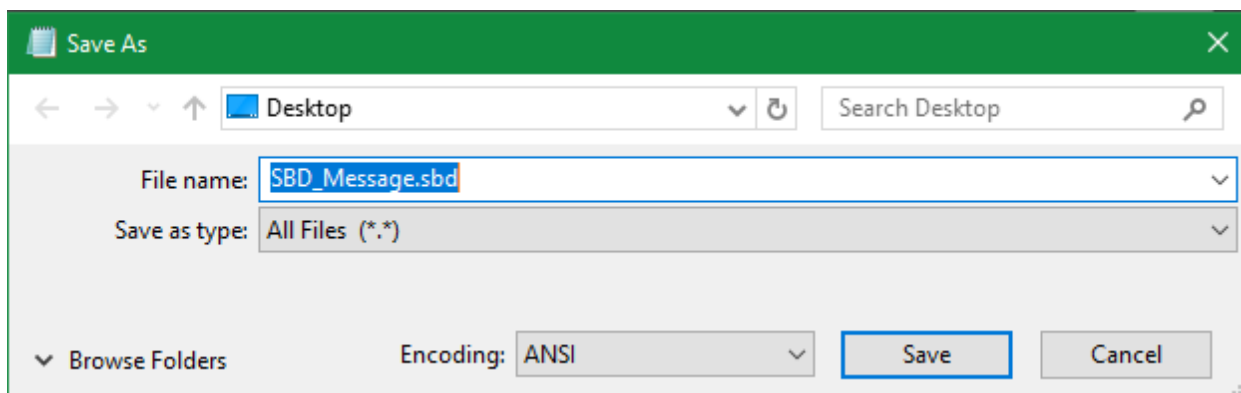
Command Structure

Commands must be structured in the following way:

1. Each command **MUST** have a dollar sign (**$**) before each command.
2. The unit's unlock code in the following format: **$unlock XXXXX**
   where **XXXXX** is the unit's five digit unlock code.
3. A list of commands, one command per line.
4. Must end in carriage return and line feed (new line).
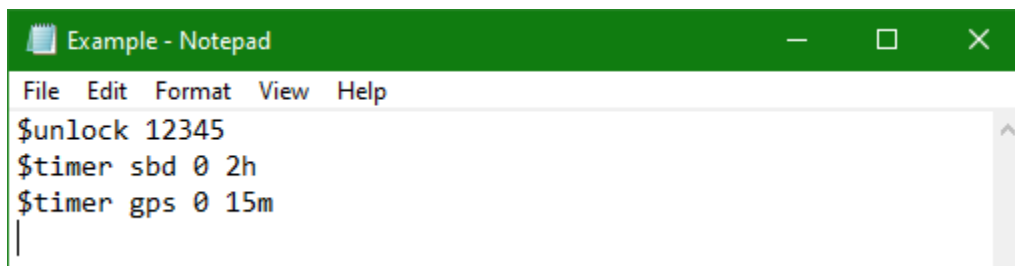
The Unlock Code

The Rover-X uses unlock codes as a security measure to prevent unauthorized commands. The unlock code is generated when first programmed, or it can be changed manually via Bluetooth or Iridium. The unlock code is sent out to all provisioned addresses associated with the Rover-X's IMEI in a plain text message at boot.

Any commands which do not include a valid unlock code as the first line will be ignored by the Rover-X, but will prompt the unit to reply with a valid unlock code to all provisioned addresses.

When using XeosOnline, unlock codes are generated automatically for all outgoing commands and should not be included. XeosOnline will also automatically update if a new unlock code should be generated. SBD commands over e-mail must include an unlock code.

Sending the Command

To send your sbd command, create a new email message with the following fields:

To:	**data@sbd.iridium.com**
Subject:	**Your device's IMEI**
Body:	**Empty**
Attachments**:**	**Your .sbd file**

A confirmation will be immediately returned from the Iridium Gateway from the address **sbdservice@sbd.iridium.com** indicating that your message is now in the message queue. It will be delivered to the device during its next Iridium check.

Commands can be sent from any email address, but responses will be returned **only** to email addresses on the unit's forwarding list.

Xeos Beacon Bluetooth App

Select Xeos products can be configured locally using the Xeos Beacon Android App. This method of communication requires no disassembly.

The Bluetooth app allows for communication, configuration, logging and firmware updates. A detailed document on how to use the application can be found here.

See the Bluetooth section for Bluetooth functionality as it pertains to the Rover-X.

The Rover-X's Scheduler

The frequency at which each task in the Rover-X is executed depends on the Rover-X's current mode. Each mode corresponds to conditions interpreted by the Rover-X's logic. The following is a simplified diagram showing when each mode is invoked at the default settings.
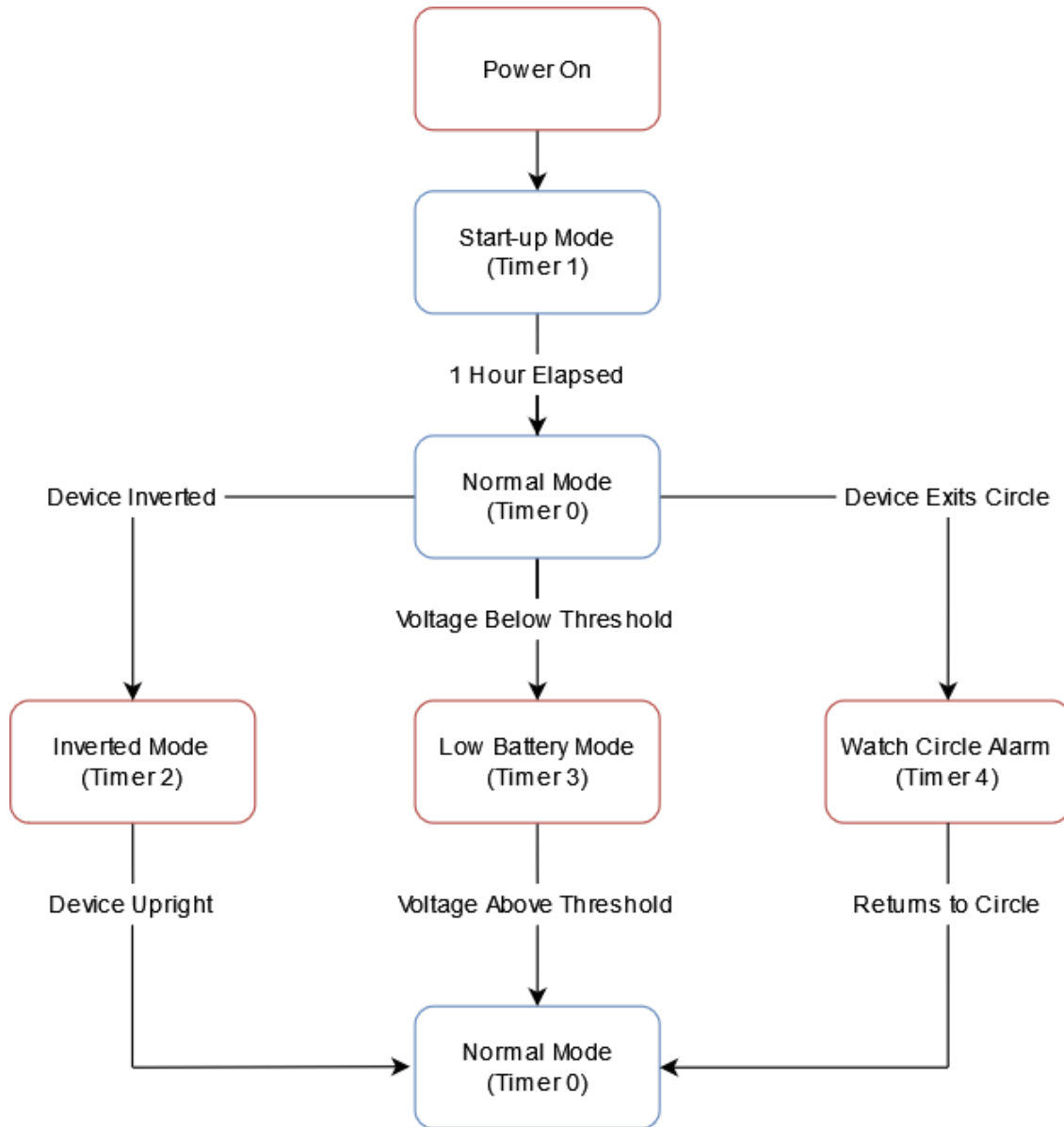
Rover-X Tasks

The Rover-X's behavior is based on multiple timed tasks. Understanding how these tasks interact is necessary to properly use the Rover-X in the field. There are three major timed tasks:

GPS

The Rover-X will search for the GPS constellation and get a location fix based on this interval. Any successful GPS fixes will be queued for the next Iridium (SBD) transmission.

The Rover-X's internal clock will also be set and adjusted based on the GPS network. The GPS interval will execute before the SBD interval if they are scheduled for the same time.

SBD (Iridium)

The Rover-X will attempt to communicate with the Iridium Gateway based on this interval. If the Rover-X successfully registers with the Iridium Satellite Constellation, Rover-X will transmit any messages queued to be sent to the user. Once this is finished it will receive any queued messages from the Iridium network, implement them, and respond, provided the proper unlock code is received with those commands.

Iridium also employs a retry scheme, in the event queued messages are not successfully transmitted. For each scheduled Iridium task, two retries are possible if necessary:
- Two minutes after the scheduled Iridium task ends, if a message was not sent.
- Five minutes after the first retry task ends, if a message still has not been sent.
- If a message still has not been sent after both retries, it is queued for the next regularly scheduled Iridium task.

TLT

The tilt sensor of the Rover-X will take regular readings to determine the orientation of the device. If the Tilt function is enabled in the Switch menu, consecutive inversions prompt the device to transition to the Inverted alarm mode, or out of that mode if readings show the device has returned to an upright position.

The tilt sensor is also used to choose the correct GPS and Iridium hardware to use when either of these tasks run, regardless of the Tilt alarm setting.

Rover-X Timer Modes

Normal Mode (Timer 0)

Timer zero is the default timer mode of the Rover-X and will be used if no other modes below apply. At default settings, the Rover-X will transmit one position every three hours. The Rover-X will continue in normal mode uninterrupted until some event prompts another mode, or the device is turned off.

Start-up Mode (Timer 1)

Start-up mode will begin when the Rover-X is powered on or reset via any method. This mode will last for a maximum of one hour, but can be interrupted by another mode (ex. Inverted).

Inverted Mode (Timer 2)

Inverted mode begins after the Rover-X has read three consecutive tilt values that cross the horizontal threshold of the device. The Rover-X then transmits two positions every ten minutes until the tilt sensor is disabled or the device is no longer inverted.

Low Battery Mode (Timer 3)

The Rover-X will enter Low Battery mode if a string of nine batteries' voltage drops below the set threshold. This is triggered by consecutive voltages less than the threshold. This threshold can also be adjusted but has a default value:

Rover-X	11.5 VDC

Watch Circle Alarm Mode (Timer 4)

A new timer mode not used in the original Rover, the Rover-X will utilize this timer if a watch circle is set, and the Rover-X collects a position that places it outside of that circle. The Rover-X will transmit at the rate given for this mode for at least one hour, and any additional time until the point at which the device re-enters the circle, the circle is edited to place the device inside again, or the circle is deleted (**$clearcircle**).

Default Timer Settings

Timer	<T0>	T1	T2	T3	T4	T5	T6	T7	Min-Max
GPS	3h	10m	5m	1d	5m	n/a	n/a	n/a	30s-7d
SBD	3h	10m	10m	1d	10m	n/a	n/a	n/a	30s-7d
TLT	2m	30s	2m	5m	2m	n/a	n/a	n/a	5s-1d

Legend	
GPS	GPS position acquisition interval
SBD	SBD (Iridium) transmission interval
TLT	Tilt sensor check interval (if Tilt is enabled)
T0 – T7	Timer mode number
<T#>	Timer currently in use
#s/m/h/d	Interval in seconds/minutes/hours/days
Min	Minimum allowed interval for this timer
Max	Maximum allowed interval for this timer

Timers		
Timer 0	Normal	Used if no other modes are triggered
Timer 1	Start-up	Used immediately after power-up or reset (one hour duration)
Timer 2	Inverted	Used when the device is inverted
Timer 3	Low Battery	Used when the device consistently detects low voltage according to the set threshold
Timer 4	Watch Circle Alarm	Used when the device has exited its Watch Circle

- The default timer settings of the Rover-X are suitable for most use cases.
- Timers 5, 6 and 7 are not used in the Rover-X.

Timer Command

The **$timer** command will return the timer intervals all configurable settings in the form of a table.

- If a value in the table is changed, the response will only be of the row that was modified.
- If more than one value in a row is changed, the row will be transmitted the same number of times to indicate each individual change.
- If multiple values of multiple rows are changed, each row is transmitted separately.

Changing the Timers

The length of the Rover-X's various modes cannot be altered. Start-up and Surfaced modes are fixed at one hour. However, the Iridium and GPS frequency can be changed to suit the user's requirements.

The GPS and Iridium interval timers can be set independently of each other. If an Iridium session is queued but no GPS position is stored, a DM message is sent at this time.

Regardless the method being used to communicate with the Rover-X, timer commands are always the same format:

$timer SYSTEM TIMER-MODE INTERVAL

Example	Command	Timer Type	Timer Mode	Interval
1	$timer	GPS	0	1h
2	$timer	GPS	2	5m
3	$timer	SBD	0	6h

Example 1 would change the GPS interval of Normal mode to every hour.

Example 2 would change the GPS interval of Inverted mode to every five minutes.

Example 3 would change the SBD message interval of Normal mode to 6 hours.

After sending the commands from both Example 1 and Example 3, the user would receive one message every six hours containing six GPS fixes. These messages would be sent at approximately 00:00 UTC, 06:00 UTC, 12:00 UTC and 18:00 UTC.

Watch Circle

The watch circle functionality allows users to monitor the position of their mooring by receiving alarm messages when it exits the circle. This feature aids in the recovery of moorings that could break free from their planned position.

Setting the Watch Circle

The watch circle parameters can be set (or edited if already set) by using the **$setcircle** command:

<p align="center">**$setcircle Latitude Longitude Radius**</p>

The minimum radius is 50 meters, while the maximum is 15000 meters.

Example:

<p align="center">**$setcircle 47.56989 -53.55682 100**</p>

a)   **$setcircle** is the command
b)   Latitude is set to **47.56989** degrees
c)   Longitude is set to **-53.55682** degrees
d)   Radius is set to **100** meters

Upon implementing the watch circle, the Rover-X will return a Watch Circle message to confirm the configuration.

Recognition of a watch circle exit is tied to the GPS interval of the device. Once a GPS position is logged that shows the device is outside the circle, the device immediately transitions to Watch Circle Alarm mode **(Timer 5)** and transmits according to the set timer intervals of that mode until the unit re-enters the watch circle, the radius is expanded or edited with **$setcircle**, or the watch circle is disabled with **$clearcircle**.

Additional Watch Circle Information

- The watch circle's details are saved between power cycles and are transmitted at start-up. If no watch circle is set, this message simply states the watch circle is disabled.
- The settings of the watch circle can be queried with the **$getcircle** command
- The watch circle can be cleared, and thus disabled with the **$clearcircle** command
- The Watch Circle's radius can be adjusted without changing the position of the center by setting the latitude and longitude parameters to **0**, followed by the new radius.

The Rover-X's Sensors

Tilt Sensing

The Rover-X's tilt alarm is enabled by default and regularly checks the orientation of the device. If the Rover-X is tilted beyond its horizontal threshold for three consecutive readings, the device will enter **Inverted Mode**. Three consecutive readings in the upright position when in Inverted Mode will allow the device to exit this alarm state.

To disable Inverted Mode, use the command:

$switch T 0

The opposite value can be used to re-enable this feature. The Rover-X will check its orientation whenever a GPS or Iridium task occurs regardless of this setting to allow for the use of the correct antenna.

Bluetooth

The Rover-X has integrated Bluetooth hardware to facilitate local communication with the user for configuration, flash memory dumps and firmware upgrades via the Xeos Beacon Android App.

The Rover-X's Bluetooth will advertise after its self-test using a Bluetooth name set at the factory.

After the initial Bluetooth period, the device can be prompted to re-advertise for a new Bluetooth connection through a few methods:
- Reset the device
- Turn the Bluetooth on, without resetting, through a few magnet swipes
- Send the **$btpwr 1** command over Iridium to turn Bluetooth on after the next Iridium task.

In any of the above situations, Bluetooth will only run for **two minutes** after power-up or other power-on methods, plus any additional time that the user is connected with a paired device. When the user disconnects from the device, Bluetooth will run for an additional **one minute** to allow for reconnections, before turning off. The Bluetooth connection retains its own antenna, and will not interfere with positioning or transmission tasks.

Commands Summary

Below is a quick summary of commonly used commands that can be sent via Iridium or Bluetooth to acquire additional information, or configure the Rover-X. Remember to add the **$** symbol ahead of any commands.

Command	Parameters	Description
timer	---, or component	Display the entire configuration of all intervals of all systems, in all modes.
switch	X 1/0	Switch component X on/off. No parameter lists all components and their states
settings	---	Show all settings and thresholds
status	---	Returns the timer mode the device is currently using
unlock	---	Returns the unlock code of the device
sysInf	---	GPS and Iridium pass/fail summary
iss	---	Display Iridium performance metrics
viewsensor	---	Display latest sensor readings
batterythresh	X	Set the value the loaded voltage has to be lower than to trigger Low Battery mode, in **millivolts**
tiltorientation	X	Set the angle at which the device determines it is inverted (See Tilt Sensing)
btPwr	1	Bluetooth power on, for two minutes.
btName	NAME	Set the Bluetooth name for the device.
ver	---	Show firmware/hardware version, product type, IMEI etc. Equal to the initial message after a reset.
FactoryDefaults	---	Reset all to settings to defaults. The device does **not** reset.
ResetNow	---	Restarts the system. The effect is the same as restarting via the magnet

Deployment of the Rover

Below are installation tips for the Rover:

- Ensure that the Rover-X is moored with the white end of the enclosure facing up.
- The top of the Rover-X must have as good a view of the full sky as possible.
  - Alongside a wall or tall obstruction will cause coverage to suffer.
  - For concealed deployment, the antenna surface must not be obstructed by metal or wood. Thick amounts of other materials may also cause interference.
- Rover-X should not be deployed near (less than 1 metre) other transmitters.

Maintenance

Batteries

The internal battery pack in the Rover-X holds 18 AA batteries. There is no provision for external power.

Choosing Batteries

While the battery pack can hold and operate with any AA battery, some battery models might experience failure and are not recommended for use. **Duracell batteries are not recommended** since the seal is more apt to fail and cause leakage in higher temperature conditions.

1. Xeos recommends the **Energizer L91 Lithium** battery, or the **Energizer EN91 AA alkaline** battery. **Do not mix battery types.**
2. All new batteries should be used for each new deployment.
3. Each battery should be tested with a battery tester or voltmeter to ensure none of the cells are defective or discharged. Individual cells with a voltage measuring less than 1.5 V should be discarded.

When not in use, the Rover-X should not have batteries installed, **especially during storage.**

Adding/Replacing Batteries

The batteries are configured in 6 columns of 3 batteries each.

Each column is labelled to show the correct orientation the batteries should be installed. Take care to orient the batteries correctly as the columns alternate direction. Yellow labels indicate batteries that are inserted negative side up.

Incorrect battery installation will activate the self-test failure mechanism.

Tip: To avoid false self-test failures during battery installation, insert the **yellow-labelled columns last.**

The battery pack column is magnetized to ensure the batteries stay in place properly.

To add/replace batteries:
- Open the housing
- Remove old batteries by pulling the bottom batteries from the springs, and sliding the rest down with a single shake.
- Slide the new batteries into each column with respect to its labelling for correct orientation

Once all the batteries have been replaced, the enclosure pieces can be reassembled, taking care to inspect and seat the O-Rings first.

O-Rings

O-rings are critical to the waterproof nature of the Rover-X. O-rings should be visually inspected to make sure they are properly seated in the groove and to ensure there is no visible damage to the O-ring.

If the O-rings pass visual inspection and have been deployed for 2 months or less, the O-rings do not need to be replaced.

If the O-rings fail visual inspection or have been deployed for longer than 2 months, the O-rings should be replaced prior to re-deploying the Rover.

Inside the Rover-X's acetyl housing, there are two (2) O-rings:

1) 568-138 90D DURO BUNA (Top, White Section)
2) 568-137 90D DURO BUNA (Bottom, Black Section)

To replace an O-Ring:
- Remove the old O-ring using a soft tool (toothpick) to avoid scratching the o-ring groove.
- Clean all dirt away from the threads and grooves where the old O-ring was seated using a lint-free cloth, cleaning alcohol, and a soft brush.
- Apply a thin layer of O-ring lubricant (Molykote 111 from Dow Corning) to the new O-ring
  - For the outer ring, gently slide the new O-Ring down over the threads of the black section of enclosure and into the O-ring groove, above the lip of the enclosure.
  - For the inner ring, gently slide the new O-Ring down inside the white section of enclosure until it is seated in the O-Ring groove.

Note: It is very important to be aware of where the O-ring is sitting in the two O-Ring locations. If the O-ring is not sitting perfectly in its groove, there will not be a perfect seal and could cause fatal damage to the unit.

Recovery and Storage

Once the Rover-X is recovered, it is important that it be stored and maintained properly for future deployments.

As soon as possible after the Rover-X is recovered, all batteries should be removed and discarded.

The Rover-X should be cleaned and inspected for corrosion or water ingress. O-rings should be visually inspected.

Any concerns should be discussed with Xeos support (+1-902-444-7650 or support@xeostech.com) prior to storage.

The Rover-X should be stored as follows:

- Dry location
- Assembled, **without batteries** but with O-rings in place
- Ambient temperature of -40° C to +85° C
- Either horizontal or vertical storage is permitted

Troubleshooting

Red LED flashing, Rover-X beeping.

Indicative of a self-test failure. The red LED of the Rover-X will display a [self-test failure code](#) relating to the source of the failure.

- The most likely cause of failure is battery-related.
  - If batteries were inserted too slowly, an empty tap may have been read. Reset the device with a magnet or by removing one battery from each of the yellow-labelled chambers, and restore them to their positions.
  - Check for batteries that are inserted incorrectly (wrong direction).
  - Check for batteries that are too low a voltage. If any tap of three batteries is read below 3.6V, this causes a self-test failure.

No Iridium messages (assuming no self-test failure)

- Determine the nature of the issue (antenna-related, system related or location-related)
  - Ensure the device's Iridium IMEI is active on the Iridium network with your service provider.
  - Ensure the device is provisioned to send messages where intended.
  - Flip the Rover-X to use the bottom Iridium antenna, and check for transmissions in Inverted Mode (assuming device is using default settings).
  - Change the location of the device; place the device in an area with as much total view of the sky as possible.

Messages are not readable (in binary)

Messages are in compressed binary format by default; use the **$gpstype 2** command to change the format to ASCII.

No GPS/poor GPS

- The Rover-X will transmit a DM type message in place of a position message if no position was acquired for any reason. The DM message will display the likely source of the issue; not scheduled to collect a position, an error in the GNSS system, or low signal.
- Change the location of the device; place the device in an area with as much total view of the sky as possible.
- Flip the Rover-X to use the bottom GPS antenna to determine the nature of the issue (antenna-related, system related or location-related).

Device is transmitting too frequently/not enough

- Check timer intervals with the **$timer** command
- Each DM or position message contains the Timer Mode currently in use.
- Change timer interval as required

Device is going into alarm when it should not (Watch Circle or Inversion)

- Watch circle centre is in the wrong location or an unsatisfactory radius
    - **$setcircle X Y Z** to change circle and radius
    - **$setcircle 0 0 Z** to change radius only
- Inversion triggered when the device has overturned and is using a different antenna than the last time that it transmitted.
    - While the Rover-X will indicate that it is Inverted mode when an Orientation Change happens, Timer 2 will not be used if the inverted event is turned off with **$switch T 0**

Self-Test Failure Codes

The Rover-X will show a repeating LED code after power-up if any systems that are tested fail. In the event that there are multiple systems that meet the failure criteria, only the higher priority system's failure code will be displayed. These sequences are Morse Code, using the first letter of the system.

Below are these codes, with the highest priority system at the top.

Voltage	• • • —
Iridium	• •
GNSS	— — •
Flash Memory	• • — •
EEPROM	•
Bluetooth	— • • •
Accelerometer	• —

Appendix A: Technical Specifications

Mechanical	
Material	Polyoxymethylene (Delrin)
Dimensions	21.41 cm L x 6.35 cm D (8.43" L x 2.5" D)
Mass (Alkaline)	1055g Out of Water
	378g In Water
O-rings	568-138 90D DURO BUNA (Top, White Section)
	568-137 90D DURO BUNA (Bottom, Black Section)
Seal Lubrication	Molykote 111

Electronics	
Digital Controller	Xeos Rover-X
GPS Receiver	uBlox MAX-8C0
Iridium Hardware	9603 Modem

Electrical	
Battery Complement	18 AA batteries (lithium or alkaline)
Voltage Input	9 – 32V
Nominal Voltage	13.5V
Battery Capacity	3.0 Amp Hours (alkaline)
	5.8 Amp Hours (lithium)
Idle	1.2 mW
GPS Acq., 30s Avg.	150 mW
Iridium Tx, 30s Avg.	1.35 W
Iridium Tx, Peak	1.5 A
Bluetooth Connected	3.6 mA

Environmental	
Operating Temperature	-40° C to +60° C (-40° F to 140° F)
Storage Temperature	-40° C to +85° C (-40° F to +185° F)

Specifications subject to change without notice.

Appendix B: Supplemental Messages

Various commands to the Rover-X have responses with a multitude of information. Below are some of these responses.

System Information Message

An Information message will send a synopsis of the latest GPS and Iridium statistics from the device. This message will always be in ASCII format regardless of message format settings and approximately 80 bytes, depending on value sizes.

All values are set back to zero at reset/power-up.

This message can be prompted using **$sysinf**

```
V=11.28/10.89 T=0.000 SNR=35 nSats=4 GPS:12/0/115 Ird:16/15/1034 RSSI=5
```

Information Readout	
V=11.28/10.89	Battery voltages unloaded/loaded
T=0.0	Most recent temperature measurement, not used
SNR=35	MaxSNR (Signal-to-Noise ratio) of the last GPS attempt
nSats=4	Number of connected satellites during last GPS attempt
GPS:12/0/115	Quantity of GPS attempts/GPS session fails/Seconds total GPS on-time
Ird:16/15/1034	Quantity of Iridium messages/Quantity of Iridium sessions/Seconds total on time for the Iridium modem
RSSI=5	Last signal strength of the last Iridium transmission reported back from the modem. Always a number between zero and five; five being the strongest signal.

Switch Response

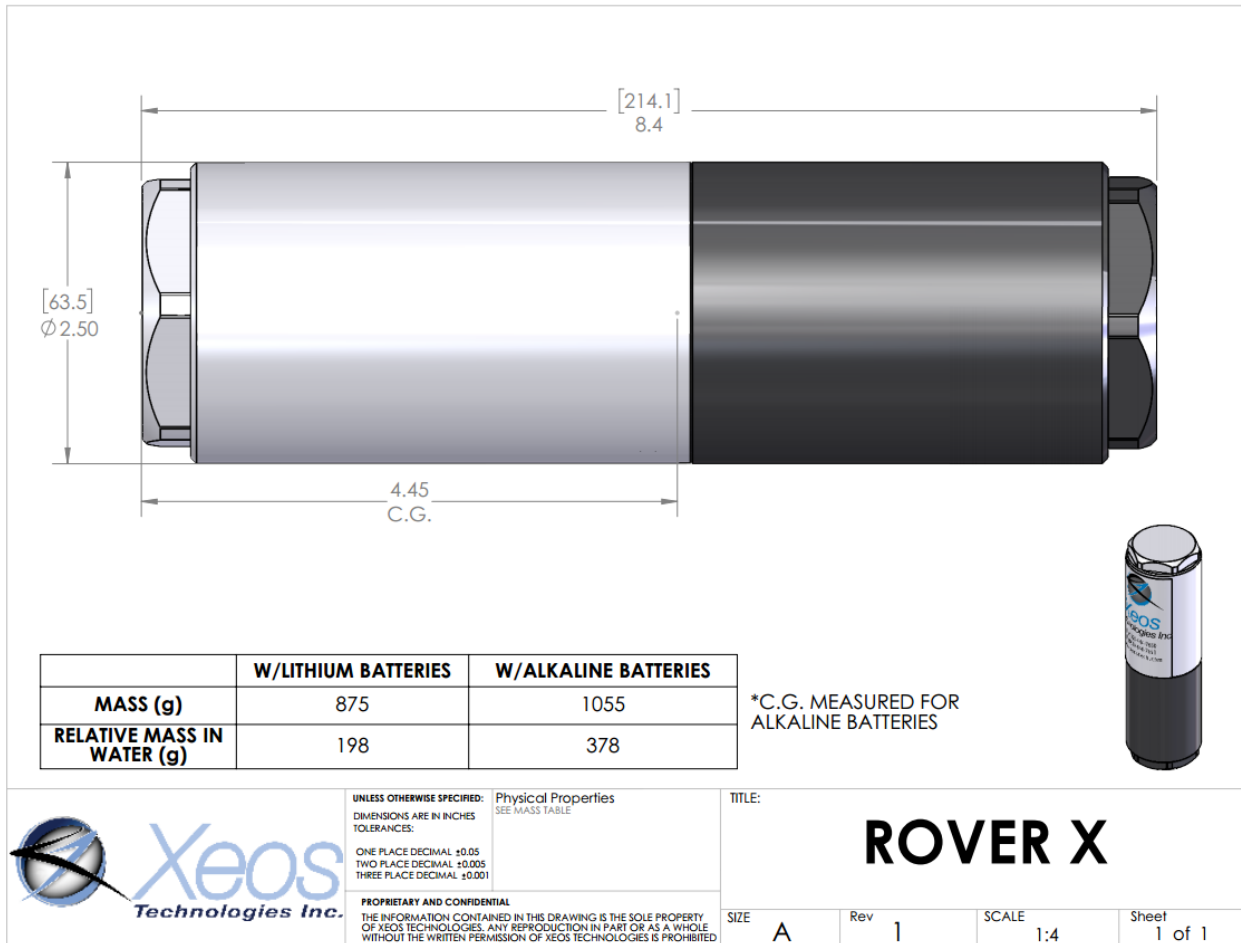On using the **$switch** command with no arguments, the device will return a YES or NO for the state of each system that can be enabled/disabled:

```
Ascii: SWITCH: Y = ULGCB N = T
User Enable / Disable Settings: (Switch)
e...............GPS(G): YES
e.......Watch Circle(C): YES
e......Tilt Activate(T): NO
```

When any of the states of these systems is changed, the same message is sent in response.

Appendix C: Engineering Diagram

	W/LITHIUM BATTERIES	W/ALKALINE BATTERIES
MASS (g)	875	1055
RELATIVE MASS IN WATER (g)	198	378

*C.G. MEASURED FOR ALKALINE BATTERIES

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:

ONE PLACE DECIMAL ±0.05
TWO PLACE DECIMAL ±0.005
THREE PLACE DECIMAL ±0.001

PROPRIETARY AND CONFIDENTIAL

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Physical Properties
SEE MASS TABLE

TITLE:

ROVER X

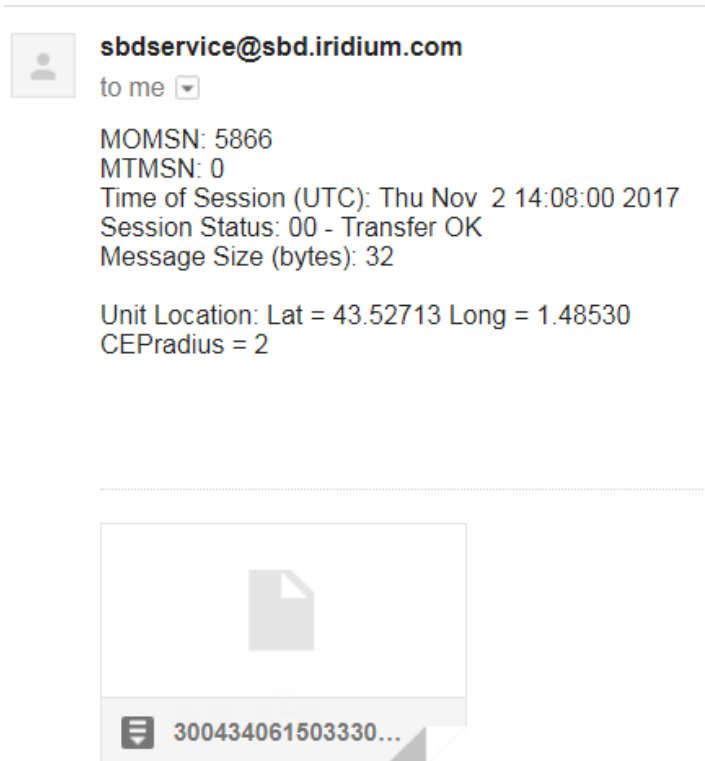| SIZE	Rev	SCALE	Sheet
A	1	1:4	1 of 1

Appendix D: Raw Iridium Information

Iridium Doppler position

The Iridium Gateway calculates the Iridium transceivers' position on earth when it receives a transmission, using Doppler technology. As a result, it is often very inaccurate. This location is only visible to users getting emails directly from the XMI-X, as opposed to emails forwarded by XeosOnline. An example of a "raw" Iridium message via email is below and will always have the IMEI of the device in the subject line, regardless of its name on XeosOnline.

sbdservice@sbd.iridium.com
to me

MOMSN: 5866
MTMSN: 0
Time of Session (UTC): Thu Nov 2 14:08:00 2017
Session Status: 00 - Transfer OK
Message Size (bytes): 32

Unit Location: Lat = 43.52713 Long = 1.48530
CEPradius = 2

300434061503330…

sbdservice@sbd.iridium.com	All messages from Iridium devices come from this address.
MOMSN: 5866	Mobile Originating Message Serial Number; each individual message has its own incrementing serial number. A mobile originating message is one that comes **from** the Iridium device.
MTMSN: 0	Mobile Terminating Message Serial Number; like the MOMSN, messages **to** Iridium devices (like commands) also have an incrementing serial number. Since the message in the example is from an Iridium device, the MT number is zero.
Time of Session (UTC)	The time the message arrived at the Iridium Gateway

Session Status	Each message will have a code determined by how well the message was received; codes 00, 01 and 02 are acceptable and will always have their code name (ex. Transfer OK) next to this number.
Message Size (bytes)	The size of the actual message sent by the Iridium device, which is in the attachment in the email.
*Unit Location	The Doppler position of the device as estimated by Iridium's network. It is **NOT** the GPS position measured by the device.
*CEPradius = 2	The numerical value of how accurate the above position is; with a value of 2, This means that using the Lat/Long that the body has supplied, Iridium is 80% confident (always 80%) that the device sending the message is within a circle, 2 kilometers in radius, with the Lat/Long given as the centre of that circle. The higher the CEPradius value, the larger the circle and therefore the less accurate that position.

*These items can be enabled/disabled by your Iridium provider if desired.

Global Positioning System

Location information generated by the device itself is embedded in the SBD attachment sent via the Iridium Gateway and can only be seen through the XeosOnline system or situations where the position information is sent in a plain-text format (XeosOnline message forwarder or using the **$gpstype** command). This position information is accurate to within several meters of the true position.

Warranty, Support and Limited Liability

Xeos Technologies Inc. warranties the Rover-X Beacon to be free of defects in material or manufacturing for a period of one year following delivery. Liability is limited to repair or replacement of the defective part and will be done free of charge.

LIMITED WARRANTY: Xeos Technologies Inc. warrants that the product will perform substantially in accordance with the accompanying written materials for a period of one year from the date of receipt.

CUSTOMER REMEDIES: Xeos Technologies Inc. entire liability and your exclusive remedy shall be at Xeos Technologies Inc. option, either (a) return of the price paid or (b) repair or replacement of the product that does not meet Xeos Technologies Inc. Limited Warranty and that is returned to Xeos Technologies Inc. with a copy of your receipt. This Limited Warranty is void if failure of the product has resulted from accident, abuse, or misapplication. Any replacement product will be warranted for the remainder of the original warranty period or ninety (90) days, whichever is longer.

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