Xeos Technologies Inc.

Rover User Manual

Surface Iridium Satellite Beacon with GPS Location

Version 3.3

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Shipped From

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Specifics

This manual version is written with respect to Rover firmware build 6593. If you wish to acquire the latest firmware for your device, contact support@xeostech.com

Version History

Version No.	Date	Description
1.0	Oct 2013	Original Document
2.0	Jan 2015	Rewrite, added information on updating
2.5	Oct 2017	Document overhaul
2.6	Dec 2017	Standardized Commands and Bluetooth info
2.6.1	Jan 2018	Watch Circle information edits
2.6.2	Jan 2018	Fixed error in default timers of Timer 3
2.7	Feb 2018	Added further details to Bluetooth info (New BT update)
2.8	Apr 2018	Rewrote Understanding Position Information section
2.9	Aug 2018	Added changes for version 4170, encryption
3.0	July 2019	Overhaul; messages expanded, alarm mode tips, flash memory
3.1	Aug 2019	Bluetooth internal details, low battery messages
3.2	Jan 2020	GPS firmware, Watch Circle details, Troubleshooting details
3.3	Dec 2020	Change to low battery behavior on builds 6567 and up, encryption edits

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

Table of Contents

General Description

The Rover Surface Iridium satellite mooring location beacon regularly monitors location for mobile surface assets and/or instrument moorings. Rover makes use of the bi-directional, global, real time Iridium Satellite Short Burst Data (SBD) network in combination with GPS position location. Rover's sleek tubular design and internal dual Iridium/GPS antennas located at each end cap 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 is a 9603 Iridium satellite Short Burst Data core radio transceiver, a specialized low power Xeos digital controller with GPS and Iridium hardware.

Rover 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.

Theory of Operation

The Rover is intended for providing regular location information on high value assets at the surface, drifting or moored. After being activated, the Rover is deployed at the surface and begins sending location messages as per the user settings. The internal battery pack provides over 1500 messages.

Operators can communicate with the surface deployed Rover via Iridium using email commands. Status information can be obtained, including the health of the GPS system and battery voltage. Timings are settable, and the default is one message every 3 hours. If you need to make a change to settings, the Rover will receive the command to change the timing the next time it checks for messages, as much as 3 hours after the command is sent.

Due to the location of dual Iridium/GPS antennas at **both** ends of the enclosure, the Rover will continue to try and send position messages, even when inverted or capsized.

Preliminary Setup

Outside Diagram

1	The LEDS of the Rover are located here. LEDs illuminate on magnet contact, power-up and Bluetooth connection
2	The top Iridium and GPS antennae of the Rover are located here
3	The magnet switch for turning the Rover on and off is located behind the label
4	The 15-digit IMEI of the Rover'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. This is where the device is opened to install batteries
7	The bottom Iridium and GPS antennae of the Rover are located here, used when inverted

Setting up an Iridium Account

Rover 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 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. Each 9603 modem has a unique IMEI that must be registered with the preferred service provider. For a list of service providers in your area please contact Iridium for recommendations. Xeos Technologies is also able to provide Iridium SBD data service and accounts. Please contact activations@xeostech.com for more information.

Each IMEI number is capable of being associated with up to five (5) unique email addresses (this may vary between service providers). When registering an IMEI number, please provide the service provider with a temporary Xeos testing account email address.

This account is: **xeosbeaconb@gmail.com**

This temporary email testing account can be deleted or replaced at any time after delivery of the Rover. Once the SBD account has been activated, please contact your Xeos representative and confirm this.

Rover makes use of a simple and robust binary email protocol as the default outgoing message format. Any email application can be used to send and receive messages to or from the Rover, however, the messages from the Rover in this format are not human-readable. XeosOnline is a web-based monitoring system which allows users to view and manage information from the Rover on a mapping system, as well as view the messages in a human-readable format. XeosOnline also allows for the creation of multiple kinds of message forwarders which can forward certain (or all) messages to a group of email addresses in a human-readable form.

Sending messages and changing configuration can be completed through XeosOnline. See www.xeostech.com or your account manager 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 automatically turns on once all batteries are installed. The device must be turned off via magnet or battery removal.

Magnet

- Swipe the magnet **slowly** along the **"SWIPE ON/OFF HERE"** label horizontally until the flashing **GREEN LED** on the top of the device remains solid. 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 a power-up message, and transmit one GPS fix every 10 minutes at default settings within 5 minutes of power-up for one hour.
- Confirm that these messages are being received by your email and/or XeosOnline.

Operation

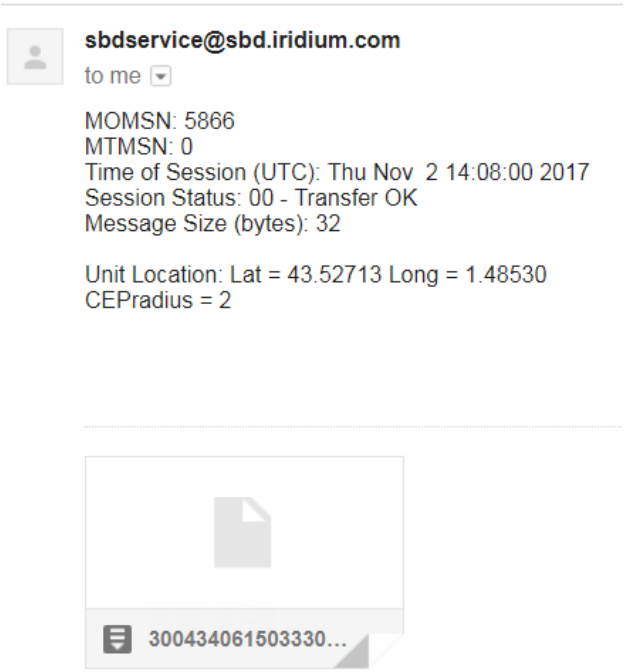
- When deploying the unit, power it up by swiping the magnet.
- Once the unit is confirmed to be on, it is ready to be deployed.
- Turn the Rover **OFF** using the same magnet method as turning **ON**, with the **RED LED** in place of the green.

Understanding Position Information

There are two types of position information which will be sent via the Iridium Gateway.

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 Rover, as opposed to emails forwarded by Xeos Online. 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	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 Xeos Online system or situations where the position information is sent in a plain-text format (XeosOnline message forwarder or using the **$msgenable** command). This position information is accurate to within several feet of the true position.

```
Timestamp: 2018-04-11T19:20:10.001Z, BatteryV: 10.38, Latitude: 44.714227, Longitude: -63.604954, Vul: 11.88
```

Additional Models

ROBY

The ROBY model is a modified Rover unit, designed for surface tracking of oil spills. The ROBY incorporates a highly visible urethane foam float and user-configured watch circle functionality to keep track of spill movement.

The ROBY functions identically to the Rover except for the removal of the inverted alarm mode and different timer intervals. Therefore, the ROBY will transmit consistently from either end until it has exited its designated Watch Circle area.

On/Off Modes

Using the Magnet

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

To turn the Rover ON, begin swiping the magnet slowly up and down at the location of the reed switch. The reed switch is located directly behind the Swipe On/Off Here label.

To turn the Rover OFF, repeat the above procedure with the magnet and watch the LED change from green to red. A red flashing LED indicates the device is powering down; continue to swipe the magnet until you see a solid red LED. A solid red LED indicates that the device is turned OFF.

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. A red LED indicates the device is turned OFF. A green LED indicates the device is turned ON.

If the batteries are low, or if some of the batteries have been inserted incorrectly, the Rover will sound a quick intermittent beep and flash the red LED at the top for 5 minutes, or until the batteries have been corrected or replaced. If this behavior persists even if the batteries are full and oriented correctly, this indicates a **SELF-TEST FAILURE**. Contact support@xeostech.com if this occurs.

- It is important to let all LEDs stop illuminating before initiating another action.
- Cycling power for any reason, for example by using the switch to turn OFF/ON or by removing battery power, will initiate the Startup Mode.

LED Indicators

The top of the Rover (and bottom of ROBY) use red and green LEDs to show their on/off status. It is also to be used as an indicator for when the magnetic switch is used to turn the device on/off. This same LEDs are also used during self-test failure or Bluetooth connection.

Unit Status Indicators	
Action: Turn On	Swipe Magnet back and forth across topside until LED is solid green
Action: Turn Off	Swipe magnet back and forth across topside until LED is solid red
Check Status	Swipe magnet once across topside (red is off, green is on)

Other Indicators	
Flashing 4 Hz **on power-up**	Device powering up, performing self-test
Flashing 0.5 Hz **after power-up**	Self-test failure
Flashing 4 Hz **on Bluetooth Connection**	Device acknowledging Bluetooth is connected

Messages From the Rover

Version

The **$ver** command will return a summary of both firmware and hardware versions:

```
Powerup: true, Firmware Version: Rover v1.27-6593. dev:4 , Hardware Revision: 5.1-0, Serial: 1114,
GPS Version: 5xp__5.7.12-P3_SDK.GCC_N96-012400+5xpt_5.7.12-P3.KCC, Iridium Version: TA19002,
Reset Reason(s): Count=10, Current=(S), Prev=(cleared)
```

Version Readout	
Firmware Version	Product; Major, minor, build of firmware
Hardware Revision	Hardware revision, set during assembly
Serial	The unit's serial number
GPS Version	Firmware version of GPS chip
Iridium Version	Firmware version of Iridium modem
Reset Count	The number of resets since firmware was uploaded
Current	Cause of last power off
Previous	Cause of previous power off, not used in Rover

Position Message

Typical position messages are sent in compressed binary format (Message Type 10) to save on data usage and are parsed in XeosOnline. If XeosOnline is not used, GPS Text Short (Message Type 0) can be used to read position messages as P-Type.

Compressed Binary Position

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 transmit more than one position per Iridium transmission. In this situation, all recorded positions will be displayed in the Location Log, while the latest position will be displayed in the Message Log.

```
Timestamp: 2020-12-08T18:20:10.001Z, BatteryV: 12.42,
Latitude: 44.714253, Longitude: -63.604806, Voltage Unloaded: 13.32
```

Message Log Readout	
Timestamp	Date and time in UTC of the latest position reading
BatteryV: 5.49	Loaded voltage of the power supply; minimum battery voltage observed during the previous Iridium transmission
44.714406	Latitude of fix, decimal degrees
-63.604947	Longitude of fix, decimal degrees
Vul: 8.16	Unloaded voltage of power supply; battery voltage data from measurement taken just prior to the turning on of the Iridium modem

Timestamp	Latitude	Longitude	Alarm	Bearing	Speed (km/h)	Speed (knots)	Altitude (m)	SNR
Oct 21 2016 01:40:12.001 PM	44.714406	-63.604947	false	0.0	0.0	0.0	0.0	42

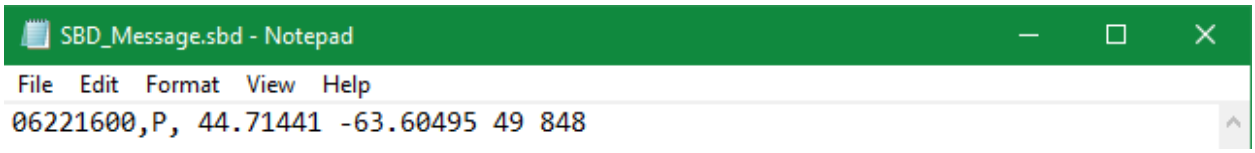
Location Log Readout	
Timestamp	Date and time in UTC of this specific position reading
44.714406	Latitude of fix, decimal degrees
-63.604947	Longitude of fix, decimal degrees
Alarm: False	Indicates if the device has determined if it is in an alarm state
Bearing	Direction of movement determined by device
Speed (km/h)	Speed measurement in kilometers per hour
Speed (knots)	Speed measurement in knots
Altitude	Not used
SNR	SNR (Signal-to-noise ratio) of GPS Fix, higher is better (>37 is good)

Each compressed message is 26 bytes in size, with an additional 11 bytes added for each additional "stacked" position.

ASCII Position (Type P)

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. This message also appears as it is shown below in XeosOnline.

P-type messages are approximately 39 bytes:

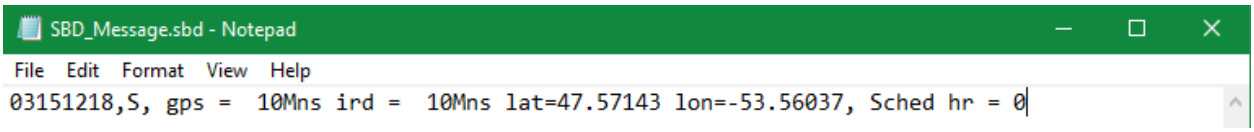


The message type used can be changed using the **$msgenable** command.

Position Readout	
06221600	Timestamp in UTC (Month/Day/Hour)
P	Type of message (Position)
44.71441	Latitude of fix, decimal degrees
-63.60495	Longitude of fix, decimal degrees
49	SNR (Signal-to-noise ratio) of GPS Fix, higher is better
848	Unloaded voltage of device at the time of GPS Fix

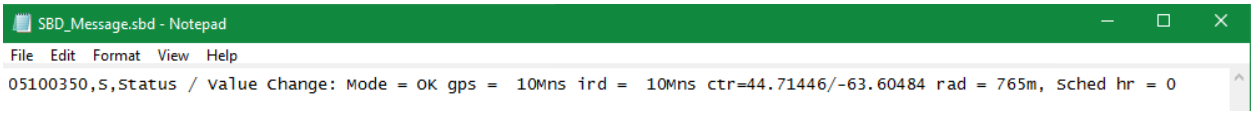
Status Change Message (Type S)

Status messages are sent from the device when there has been a change to the operation of the device, whether a timing change between modes (start-up mode to normal mode, alarm mode to normal mode) or changes to the watch circle details. If watch circle is not enabled, its information is omitted. This message is always sent in ASCII format.



S-Type Message with Watch Circle Disabled

Status Readout – Watch Circle Disabled	
03151218	Timestamp in UTC (Month/Day/Hour)
S	Type of message (Status Change)
Status / Value Change	Indicates that a setting has been changed
gps = 10Mns	Currently used GPS repetition rate
ird = 10Mns	Currently used Iridium repetition rate
lat=47.57143	Latitude of latest fix
lon=-53.56037	Longitude of latest fix
Sched hr = 0	Timing offset of Iridium/GPS sessions from UTC, set via **$reporthour**



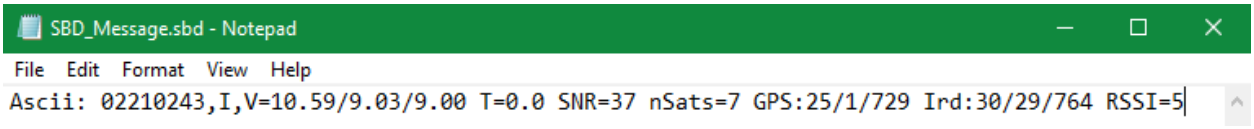
S-Type Message with Watch Circle Enabled

Status Readout – Watch Circle Enabled	
03151218	Timestamp in UTC (Month/Day/Hour)
S	Type of message (Status Change)
Status / Value Change	Indicates that a setting has been changed
gps = 10Mns	Currently used GPS repetition rate
ird = 10Mns	Currently used Iridium repetition rate
ctr	Indicating the lat/long/radius below are the centre of the circle
lat=47.57143	Latitude of installed watch circle
lon=-53.56037	Longitude of installed watch circle
rad=765m	Radius of the watch circle in meters
Sched hr = 0	Timing offset of Iridium/GPS sessions from UTC, set via **$reporthour**

Information Message (Type I)

In situations where the device fails a GPS session through low SNR or other factor, the follow-up Iridium session will send a synopsis of the latest statistics from the device. This message will always be in ASCII format regardless of message format settings and approximately 80 bytes.

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



Information Readout	
02210243	Timestamp in UTC (Month/Day/Hour)
I	Type of message (Information)
V=10.59/9.03/9.00	Battery voltages unloaded/after Iridium session/after GPS session
T=0.0	Most recent temperature measurement, not used in Rover
SNR=37	MaxSNR (Signal-to-Noise ratio) of the last GPS attempt
nSats=7	Number of connected satellites during last GPS attempt
GPS:25/1/729	Quantity of good fixes since powerup, fails/Quantity of failed fixes/ Seconds total GPS has been powered on since power-up
Ird:30/29/764	Quantity of Iridium messages/Quantity of Iridium sessions/ Seconds total on time for Iridium
RSSI=5	Value reported back from the modem. Always a number between zero and five; five being the strongest signal.

Orientation Change Message

The Rover will automatically switch back and forth between the two antenna arrays as the tilt sensor detects shifts in position.

The tilt axis defaults to the horizontal axis; if the Rover is standing upright, it will operate using the custom dual antenna at the top of the enclosure. If the Rover crosses the horizontal axis, i.e. orientated upside down, it will switch to using the dual antenna located at the bottom of the enclosure.

When the Rover is inverted, it enters Timer 2 and lets the user know it has inverted by sending a **Stats** message. The Rover does not recognize it has inverted until the device attempts a GPS session and requires the use of the antenna opposite of the one it used during the last session.

Each time an orientation change occurs, the device increments the Orientation Change Count at the top of the Stats message. This occurs both when the device goes inverted, and when it is restored to an upright position.

The ROBY does not use Timer 2, but will transmit this message on power-up since it is deployed in the inverted orientation.

Low Battery Messages

In the event the battery voltage of the device decreases to sufficient levels, the Rover will send warning messages to indicate this event has occurred.

By default, these messages are sent when the Rover registers a tap voltage (one of any group of 3 batteries) less than 3.3 Volts. Below is the ASCII Battery warning message

Ascii: Batt: Tap=3.210 TxMin=9.300 VbNow=10.767

ASCII Battery Message	
Tap = 3.210	The tap voltage recorded that prompted the message
TxMin=9.300	The lowest loaded voltage measured during transmission
VbNow=10.767	The current unloaded voltage of the device

The Rover also sends an event message indicating that a Low Battery Event has occurred (XeosOnline):

BatteryV: 9.27, Tap Voltage Low: 3510, Voltage Unloaded: 10.95

This message is also an indicator that the Rover has entered into Timer 3 (low battery mode)

Note: If the Rover is equipped with a firmware version lower than build 6567 and reaches a low battery mode, the device will operate on Timer 3 until a battery tap voltage of less than 2.7 Volts is detected, at which time the device shuts off. If this is not desired, send the following command to disable this event:

$evtconfig 11 2 n

Communicating with the Rover

There are 3 ways to communicate with the Rover:

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

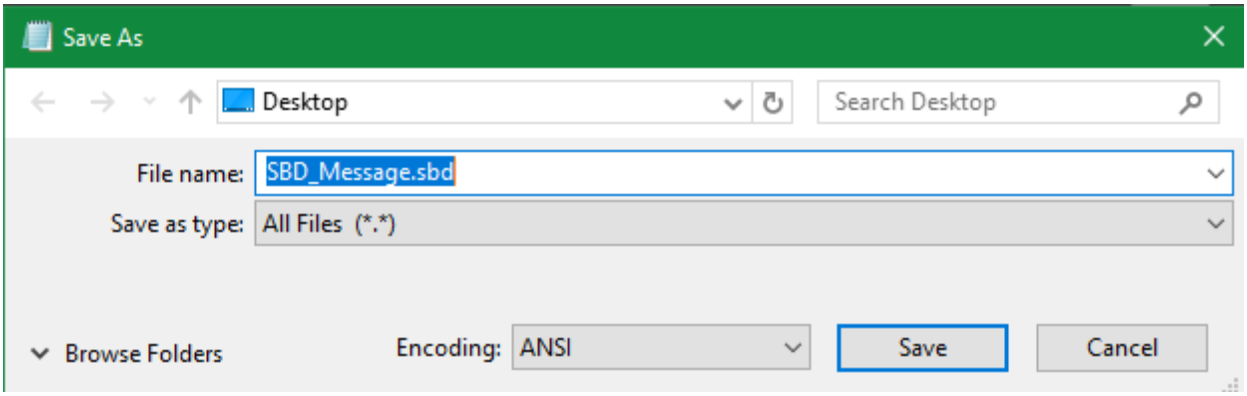
Sending Commands via Email

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

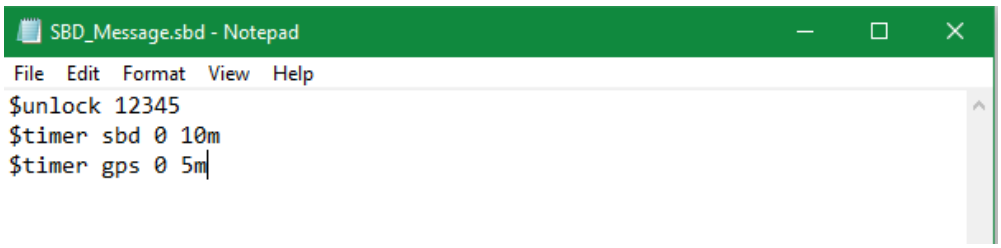
To create an SBD command, open a new file in a text editor (ex. Notepad) and save it using the **.sbd** extension. Make sure the **Save as type** option is set to **All Files** to achieve this.



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.



The Unlock Code

SBD commands without an unlock code will be ignored by devices that require it. These devices include the Apollo, XMI, Onyx, Rover, and OSKER. The unlock code is generated by the device itself and can be retrieved from XeosOnline, or you can query the unit for the unlock code by sending **$unlock** to the device as a command. The device will respond by sharing the 5-digit code with its provisioned destinations.

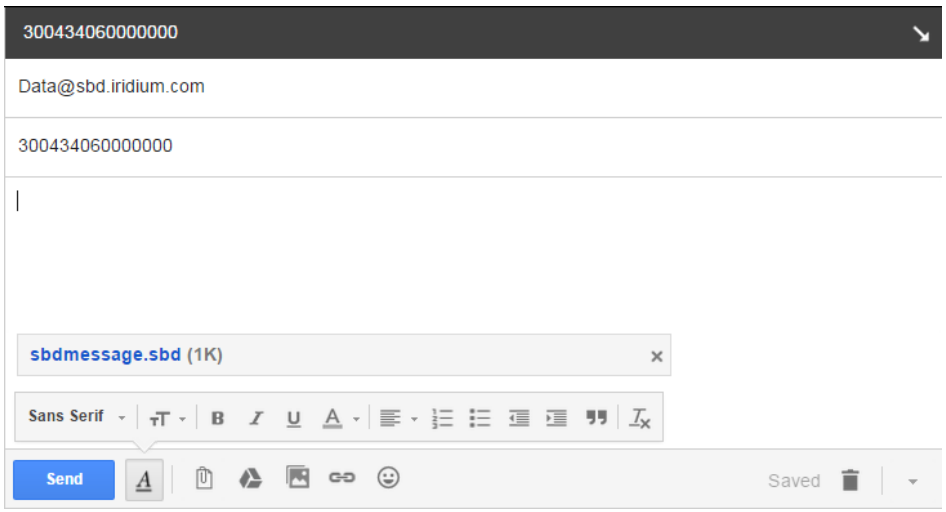
Outgoing	Timestamp: 2019-05-08T19:43:15.936Z, Outgoing SBD Text: $unlock 69294 $statsl

Navigate to your unit and click on the **Message Log** Tab. You will see the unlock code in the most recent outgoing messages.

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**



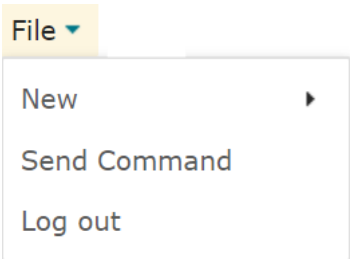
A confirmation will be immediately returned from the Iridium Gateway from the address **sbdservice@sbd.iridium.com** indicating that your message is now in the message queue. It will be delivered to the device during its next Iridium check.

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

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.

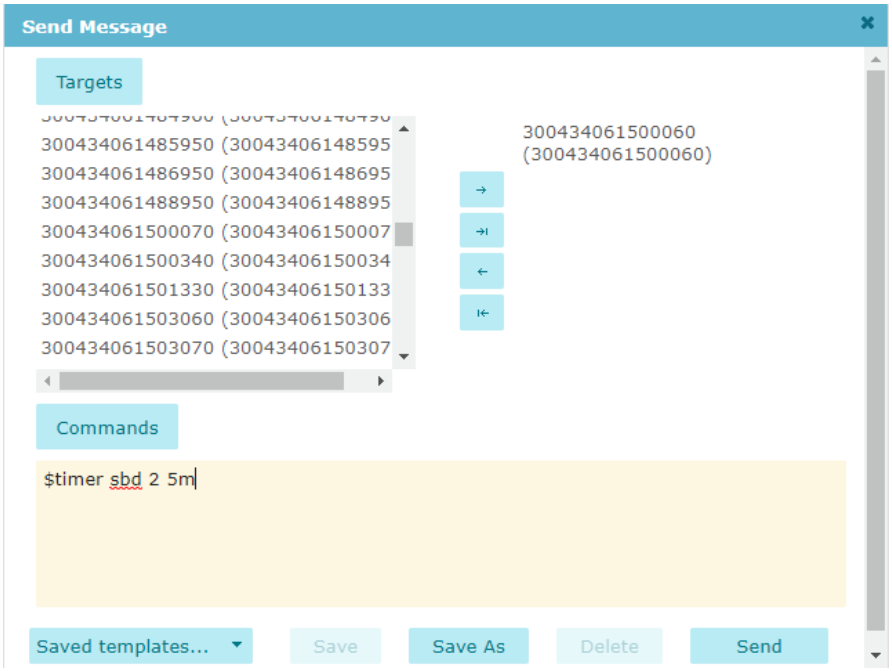
Setting up to Send



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



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.

Messages to the Rover

Settings

The **$settings** command will return a truncated list of important Rover settings aside from timers:

```
Ascii: T/A:Td=0;Ts=15 GPS:MxOn=180;MxPr=90;Tmn=-30;Vmn=9.000;gBlk0=0,0;gBlk1=0,0;gRtyQ=2;gRtyD=20;gFRst=50;wcIC=85;
gBL=24;gFQ=12 Sys:PB=4170;Dsc=;BtP=Y;BtT=5;BtN=NoName2243;LL=0;UC=69294;aes=n;rHr=0;rMn=2 Ird:iBlk0=0,0;iBlk1=0,0;
iRtyQ=2;Smx=8;MxLn=330;iWR=Y;um=3 Tilt:Tt=0;Secs=10;USec=10
```

Name	Default	Description
GPS Settings (GPS)		
MxOn	180	Maximum GPS session length in seconds
MxPr	90	Maximum GPS session length in poor conditions
Tmn	-30	Temperature minimum
Vmn	9.000	Voltage minimum
gBlk0	0,0	GPS Blackout, Unused
gBlk1	0,0	GPS Blackout, Unused
gRtQ	3	GPS retry quantity
gRtyD	8	GPS retry delay in seconds
gFRst	2	Number of GPS failures for GPS reset
wcIC	85	Watch Circle Inner Percent
gBL	24	Maximum saved GPS fixes
gFQ	12	Maximum GPS fixes per message
System Settings (Sys)		
PB	Build	Firmware Build
BtP	Y	Bluetooth on or off
BtT	5	Bluetooth Timeout in minutes
BtN	Name	Bluetooth Name
LL	0	Diagnostic Log detail level
UC	Code	Unlock Code
aes	No	AES Encryption On/Off
rHr	0	Hour on which timings are based (24h UTC)
rMn	2	SBD hour offset in minutes
Iridium Settings (Ird)		
iBlk0	0,0	Iridium Blackout, Unused
iBlk1	0,0	Iridium Blackout, Unused
iRtyQ	2	SBD Retry Quantity
Smx	8	Maximum SBD attempts per session
MxLn	330	Maximum message length (bytes)
iWR	Yes	Wait for registration
um	3	Unsolicited messages allowed

Tilt is not used.

Lifetime Stats

The **$statsl** command will return various performance statistics recorded since the last firmware install as well as current statistics:

```
Message SubType: 0, Orientation Change Count: 0, Timestamp: 2019-05-08T19:47:33.000Z, BatteryV: 11.79, Voltage Unloaded: 12.99, Uptime: 4922,
Power Cycle Count: 6, Watchdog Reset Count: 0, Lowest Battery Voltage: 0, Highest Battery Voltage: 13.11, Iridium Message Count: 22, Iridium Session Count: 23,
Iridium On Time: 16, Iridium Send Failures Non18: 17, Iridium Send Failures Type 18: 6, Bytes TX: 1017, Iridium Messages Received: 4, Bytes RX: 100,
GPS Sessions: 16, GPS On Time: 12, GPS Fix Count: 13, GPS TTFF Average: 10, High Temperature: 0, Low Temperature: 0
```

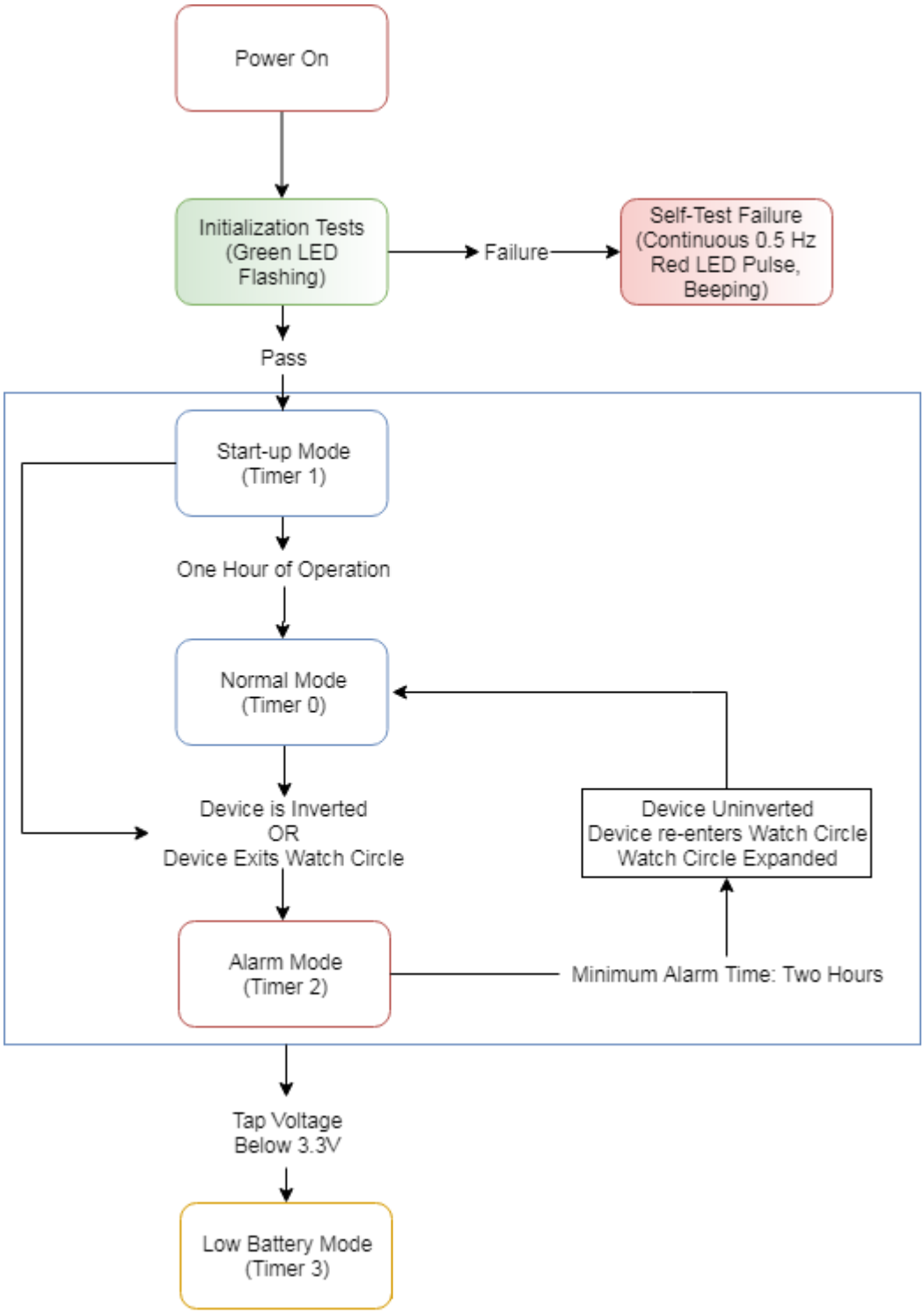
Lifetime Statistics Readout	
Orientation Change Count	Times Orientation has registered as changed
Timestamp	Time of message
BatteryV	Last measured battery voltage (Loaded, Unloaded)
Uptime	Total unit uptime in minutes
Power Cycle Count	Number of power cycles
Watchdog Reset Count	Number of errors
Lowest Battery Voltage	Lowest measured battery voltage
Highest Battery Voltage	Highest measured battery voltage
Iridium Message Count	The number of SBD messages queued for sending
Iridium Session Count	Total successful Iridium connections
Iridium On Time	Total successful Iridium connections on first try
Iridium Send Failures Non18	Iridium failures, excluding RF drop
Iridium Send Failures Type 18	Iridium failures due to RF drop
Bytes TX	Sum of all data sent in Bytes
Iridium Messages Received	Successfully received SBD messages
Bytes RX	Sum of all data received in Bytes
GPS Sessions	Total GPS attempts
GPS On Time	Total successful GPS fixes on first try
GPS Fix Count	Successful GPS fix count
GPS TTFF Average	Time to first fix, in seconds
High Temperature	Not used with the Rover
Low Temperature	Not used by the Rover

Stats

The **$stats** command will return performance statistics recorded since the last power-up. The stats are like **$statsl** but exclude **Power Cycle Count** and **Watchdog Reset Count**. High and low battery voltages using **$stats** will show the values for the last UTC Day.

Timers

The Rover has a combination of preset behaviors and configurable parameters. Here is an outline of its normal/default behavior:



Rover/ROBY Timer Intervals

The following are the parameters for each mode for the Rover and ROBY.

ROVER Timer	T0	T1	T2	T3	T4	Min-Max
SBD	3h	10m	10m	1d	12h	5m – 1d
GPS	3h	10m	5m	1d	12h	5m – 1d

ROBY Timer	T0	T1	T2	T3	T4	Min-Max
SBD	10m	10m	10m	1d	12h	5m – 1d
GPS	10m	10m	10m	1d	12h	5m – 1d

Legend	
SBD	SBD (Iridium) transmission interval
GPS	GPS acquisition interval
T0 – T7	Timer mode number
#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 none of the following modes are triggered
Timer 1	Start-up	Used for the first hour after the unit is powered on
Timer 2	Alarm	Used once the unit is inverted or leaves its watch circle
Timer 3	Low Battery	Used when there is a low battery
Timer 4	No GPS Fix	Used when the GPS module fails to acquire a fix

The default timer settings of the Rover are suitable for most use cases.

Timer Command

The **$timer** command will return the timer intervals all configurable settings. The response will also be returned when timers are changed:

```
Ascii: Tmr:SBD,1h,5m,10m,1d,3h,3h,3h,3h Tmr:GPS,1h,5m,5m,1d,3h,3h,3h,3h
```

The timer string returned includes a summary of all timers. The first five timers (0 – 4) are used.

Changing the Timers

Iridium and GPS intervals can be changed to suit the user's requirements through the use of the $timer command:

$timer SYSTEM TIMER-MODE INTERVAL

The GPS and Iridium interval timers can be set independently of each other, but there are several things to keep in mind. The Rover has by default a limit of 12 GPS fixes per Iridium message and will retain a maximum of 24 unsent fixes (all fixes are saved in internal flash memory). This puts a practical limit on the ratio of GPS fixes to Iridium checks.

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

Example 1	**$timer SBD 2 10m**	Changes the SBD interval of Alarm Mode to 10 minutes
Example 2	**$timer SBD 0 1d**	Changes the SBD interval of Normal Mode to 1 day
Example 3	**$timer GPS 0 6h**	Changes the GPS interval of Normal Mode to 6 hours

After combining the setup of both Example 2 and Example 3, the user would receive 1 message every day containing 4 GPS fixes. These messages would be sent at approx. 00:00 UTC.

As with all other settings aside from watch circle centres, all timers are retained through resets and will be employed at the next power-up.

Watch Circle

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

Recognition of a watch circle exit is tied to the GPS interval of the device in Normal Mode **(Timer 0)**; once a GPS position is logged that shows the device is outside the circle, the device immediately transitions to Alarm Mode **(Timer 2)** and transmits according to Alarm Mode timer intervals.

Enabling the Watch Circle

The watch circle is disabled by default, but can be enabled by the following command:

$WCenable 1

The device will respond with a Switch message in ASCII showing watch circle (component C) is moved to the Y (yes) column.

```
Ascii: Switch: Y = GC, N = MO
```

Once functionality is enabled, the specifics of the user's circle can be implemented.

Setting the Watch Circle

The watch circle parameters can be set by sending the **$setcircle** command using this format:

$setcircle Latitude Longitude Radius

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

Example:

$setcircle 47.56989 -53.55682 100

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

Note:
If a watch circle is not set by command, but functionality is enabled, the Rover will place its centre on the average locations so far acquired (up to positions 48 hours old) and the default radius of 100m.

Upon implementing the watch circle, the Rover will return an **S-Type message** (see below):

```
Ascii: 10011801,S,Status / Value Change: Mode = OK gps = 15Mns ird = 15Mns ctr=44.71453/-63.60513 rad = 500m, Sched hr = 0
```

Once the watch circle is set, the unit will operate normally until it approaches the watch circle radius, at which point the device will send a warning message. Once the device exits the watch circle radius, it will begin sending alarm messages with GPS coordinates every 10 minutes **(Timer 2)** until the unit re-enters the watch circle, the radius is expanded via command, or is turned off.

Notes

- A maximum of 24 GPS positions can be included in a single SBD transmission. Unlike other settings, the watch circle's details are erased at each power up.
- Watch circle alert, watch circle warn and inverted mode use the same timer.
- You can adjust the Watch Circle's radius alone by setting the latitude and longitude parameters to 0, followed by the new radius.

Message Enable

The Rover has several message types that can be enabled for GPS and event messages. At factory defaults, the Rover will send compressed binary GPS (not human readable) and plain text event (status) messages. These message formats can be changed using the **$msgenable** command.

The Rover has the following message types available for use:

Message Number	Message Type
0	GPS Plain Text Short
1	GPS Plain Text Long
10	GPS Bin Compressed

At factory defaults, the message format used for positions is GPS Binary Compressed.

The **$msgenable** setting will be applied to each timer. The message format must be as follows:

$msgenable (mode, always zero) (message types separated by commas)

To enable GPS plain text short (Message Type 0) and GPS Binary Compressed (Message Type 10), the following command would be sent:

$msgenable 0 0,10

The Rover will respond to the command by displaying the numerical values for the used message formats.

Any number of message types can be enabled, but for each additional message type the Rover will use additional Iridium data.

Encryption

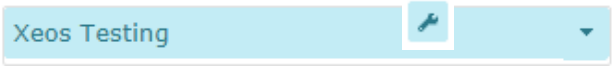
The Rover has some security features enabled by default, such as an unlock codes for receiving commands. As of build 4170, users can also enable end-to-end 256 bit AES encryption between their device and XeosOnline for an additional layer of security. Messages are zero-padded to fill out the 32 byte blocks.

Note: It is advantageous, though not required, to input the encryption key for the Rover into XeosOnline **first**, as the key cannot be retrieved from the Rover once it is installed (though it can be overwritten if unknown/forgotten **locally**). If the device is in the field with an unknown or mismatched encryption key, commands sent to the device will not be properly encrypted when sent over Iridium, and thus improperly decrypted by the Rover, ending with the command not being valid.

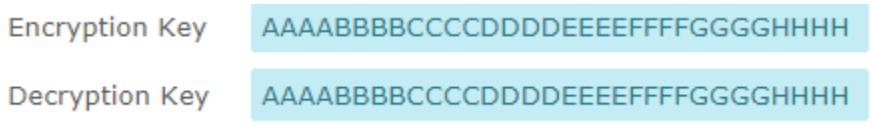
Setting Up Encryption on XeosOnline

1. Log in to XeosOnline and click on the Admin button at the top of the screen.

2. Ensure that your organization is selected in the Organization List



3. Find your device and click the edit device button
4. Enter your passphrase into the appropriate text boxes and press **Save**



Now that the key is saved, it can be referenced when adding it to the Onyx itself.

Generating your Key

Getting the COM Port

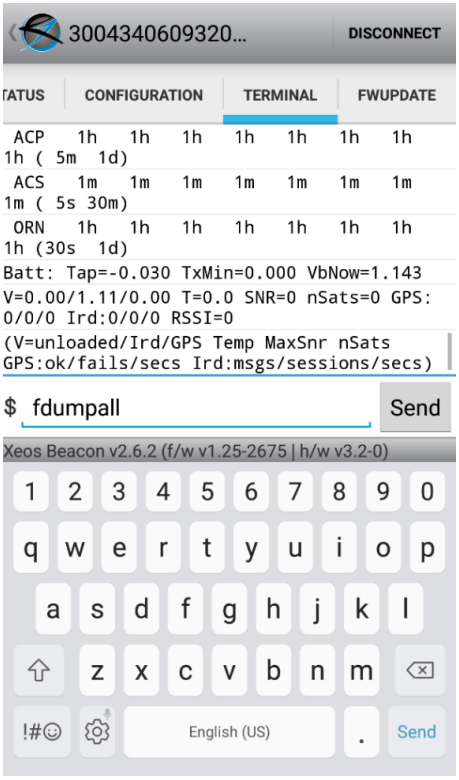
1. Connect to the Rover using the Bluetooth app.
2. Navigate to the Terminal tab on the Bluetooth app to send commands.
3. Enter your encryption passphrase by entering
   $aky PASSPHRASE
   The pass phrase must be exactly 32 characters long.
   Note: This step cannot be done through Iridium.

Enabling Encryption Use

1. Using XeosOnline, SBD email message or Bluetooth, send the command: **$aenbl 1**
2. To disable encryption, send the command: **$aenbl 0**

Flash Memory

The Rover comes equipped with internal flash memory, used to store logged events and GPS positions over the lifetime of the product. This information can be retrieved for data collection or troubleshooting purposes. Since the Rover comes equipped with Bluetooth for configuration with the Xeos Beacon Android App, this method of communication requires no disassembly.



Refer to the Bluetooth App Guide for more information on the app itself.

Dumping the Flash Memory

- Connect to the Rover using the Bluetooth App for Android. If The device does not appear as advertising on the main page do one of the following:
  - Power cycle the device with a magnet or temporary battery removal
  - Send the device the following command over Iridium: **$btpwr 1**
- Navigate to the **terminal page**
- Use the terminal page to send the flash dump command: **$fdumpall**
  - If GPS positions are the only data worth acquiring, the command **$fdump G** can be used.
- The entire memory log of the device will begin outputting into the terminal tab. When the output slows, the dump is complete.
- Output from the Terminal page can be saved to your device in the form of a text file by tapping the diagnostic output, and tapping **Save Output**.
- The saved file will appear in the Android device's Downloads directory.

Deleting the Flash Memory

The Rover's memory does not automatically erase. While the Rover can hold several thousand GPS positions it is prudent to clear the flash memory after extended deployments.

To delete the flash records, send the command: **$flasheraseuserdata**

The deleting process can take up to 30 seconds, after which the device will reset. Current settings in the Rover will not be changed by this process.

Erasing of the flash memory can be done over Iridium if necessary.

Bluetooth

The Rover 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's Bluetooth will advertise after a successful self-test pass using a Bluetooth name set at the factory. By default, advertisement will only run for the **first 5 minutes** after power-up or reset. After this time, the device will need to either be reset, or the Bluetooth power-on command (**$btpwr 1**) must be sent to the device through Iridium for Bluetooth to resume advertising.

If the Bluetooth power-on command is received, the Rover will **always** advertise its name for connection until the Bluetooth power-off (**$btpwr 0**) command is received.

If the Rover is turned off via magnet within the 5 minute advertising window at start-up, the Rover will advertise **even in an off state**. This can be used to turn the Rover on remotely via a Bluetooth-sent **$resetnow** command using the app's terminal tab.

Other Commands

Below is a list of other commands that can be sent via Iridium or Bluetooth to acquire additional information, or configure the Rover. Remember to add the $ symbol ahead of any commands.

Iridium or Bluetooth Command	Parameters	Description
ver	---	Show hardware and firmware versions (V-Type message)
Status	---	Show uptime/current timer mode/volts/orientation
startmsg	---	Combination Ver/Timer/Short Settings message
sysInf	---	GPS/Ird summary (I-Type message)
scm	---	Status Change Message (S-Type message)
FactoryDefaults	---	Set all configuration to defaults and reset device
btPwr	1/0	Bluetooth power On/Off
batt	---	Show battery status
taprv	---	Show individual battery tap voltages and full string voltages
settings	---	Show all settings
stats	---	Show statistics (since last powerup/reset)
statsL	---	Show Lifetime Statistics
switch	X 1/0	Switch component X On/Off. No parameter lists components
MsgEnable	timer# m1,m2,etc	Set & Show which messages are enabled for each Timer
ReportHour	Hour (0 – 23)	Set/Show Daily Reporting Hour offset from UTC
RepMinute	X (Minutes)	Minutes offset past the hour for GPS/Iridium
WCEnable	1/0	Watch Circle Enable/Disable
WCInner	X	Watch Circle percent of radius for elevated GPS monitoring
ResetNow	---	Restarts the system. The effect is the same as restarting via the magnet
Bluetooth		
btpcycle	---	Power cycle Bluetooth
btName	Insert Name	Set Bluetooth name for the Rover, changes after $btpcycle
fdumpall	---	Print out Flash Memory of the Rover (Bluetooth Only)

Testing the Rover

Before testing

The following should be confirmed ahead of testing:

1) The Rover should be confirmed **activated** on the Iridium network to ensure that any messages transmitted are able to be received, and directed to send messages to the intended destinations.
2) Each battery used during the test should be examined with a voltmeter to ensure none of the cells are defective or discharged. Individual cells with a voltage measuring less than 1.5 V should not be used, **but new batteries should be used during deployments.**
3) Xeos recommends the **Energizer EN91 AA alkaline battery**, or the **Energizer L91 lithium Battery. Duracell batteries should not be used as they are prone to leaking under some conditions.**

Testing

Power-up and Batteries

1) Insert the batteries into the device in the proper orientation. Labels on the battery core indicate the direction to add the cells.
2) As the last batteries are added, the Rover will turn on automatically.
    - If there are still cells missing during the battery self-test, the Rover will beep and flash its red LED. This should cease when all batteries are added, so long as they are of good health.
    - If the red LED continuously flashes, and/or beeping is heard when all batteries are added, a self-test failure has occurred. Recheck the batteries and their orientation first, and if this persists, contact Xeos.
3) Once all LED action has ceased, use a magnet to find the magnetic on/off switch on the device (the green LED will illuminate on detection). Use this opportunity to turn the device off by swiping the magnet repeatedly at this location (OFF is indicated by a solid RED LED) to confirm proper operation of the magnetic switch. Use the same method to turn the device on (ON is indicated by a solid GREEN LED).

Transmission

1) Place the device upright in a location outside that has as much of the sky visible as possible; buildings and other tall objects can impede a beacon's ability to transmit.
2) The following messages are to be expected from the Rover after turning on within five minutes:
    a. A power-up message displaying the firmware version and serial number:

```
Powerup: true, Firmware Version: Rover v1.27-6593. dev:4 , Hardware Revision: 5.1-0, Serial: 1114,
GPS Version: 5xp__5.7.12-P3_SDK.GCC_N96-012400+5xpt_5.7.12-P3.KCC, Iridium Version: TA19002,
Reset Reason(s): Count=10, Current=(S), Prev=(cleared)
```

b. A GPS Position, the SNR strength of which should consistently be greater than or equal to 40. The Position will appear in both the message and location logs, and the SNR will appear in the location log only.

```
BatteryV: 11.88, Latitude: 44.714394, Longitude: -63.604902, Voltage Unloaded: 12.96
```

Latitude	Longitude	SNR
44.714195	-63.604902	41

The device will then send one GPS message every 10 minutes until its start-up period has expired (a period of one hour). The SNR value for each GPS position should be a value no less than 38.

After this point, transmission intervals are tied to the rates laid out by Timer Zero if upright, or Timer Two if inverted.

Response to commands

During testing, commands can be sent to the device to change configuration or request statistics. These commands are read in during Iridium sessions and prompt responses from the Rover, confirming that said commands were acted upon.

1) Send the **$scm** command, which will prompt the Rover to report its current timer intervals and last GPS fix. This message also is automatically sent when one Timer Mode takes over for another (example: Start-up to Normal Mode after 1 hour of operation).

Response to $scm

```
Ascii: 05092049,S, gps = 3Hrs ird = 3Hrs lat=44.71433 lon=-63.60498, Sched hr = 0
```

Inverted Messaging

At any time while the device is on, invert the device to sit it on its top white section. On the next GPS session, the Rover will begin utilizing its bottom antenna for GPS and Iridium sessions.

The Rover will send an Orientation Change Message (a variant of the **Stats** message) on the first Iridium session after inversion. The beginning of this message is below:

```
Message SubType: 0, Capsized Event: true, Orientation Change Count: 2,
```
etc…

The Rover should be left in this orientation to allow the Rover to send several GPS fixes with its bottom antenna. The same expectations in quality should be expected from the bottom antenna as with the top. If the Rover has been on for greater than one hour, inversion will trigger Timer 2.

Example

Below is XeosOnline output from a Rover that utilized its default timers and transmitted appropriately. During the first hour of testing, the **$scm** command was sent, after which the device was inverted. After inversion an Orientation Change message was sent on the next transmission interval.

All GPS SNRs from the top and bottom of the Rover were at or above 38 as expected for successful test in the Location Log.

Message Log

Message
Timestamp: 2019-06-19T14:40:09.001Z, BatteryV: 11.88, Latitude: 44.714214, Longitude: -63.604915, Voltage Unloaded: 13.14
Message SubType: 0, Capsized Event: true, Orientation Change Count: 2, Timestamp: 2019-06-19T14:40:40.000Z, BatteryV: 11.82, Voltage Unloaded: 13.14, Uptime: 4136, Lo
Timestamp: 2019-06-19T14:30:08.001Z, BatteryV: 11.85, Latitude: 44.714170, Longitude: -63.604832, Voltage Unloaded: 13.14
Timestamp: 2019-06-19T14:20:08.001Z, BatteryV: 11.85, Latitude: 44.714221, Longitude: -63.604941, Voltage Unloaded: 13.17
Timestamp: 2019-06-19T14:10:08.001Z, BatteryV: 11.82, Latitude: 44.714310, Longitude: -63.604877, Voltage Unloaded: 13.17
Timestamp: 2019-06-19T14:00:08.001Z, BatteryV: 11.82, Latitude: 44.714266, Longitude: -63.604922, Voltage Unloaded: 13.17
Timestamp: 2019-06-19T14:00:46.000Z, BatteryV: 11.82, Voltage Unloaded: 13.17
Message SubType: 0, Capsized Event: true, Orientation Change Count: 1, Timestamp: 2019-06-19T14:00:37.000Z, BatteryV: 11.79, Voltage Unloaded: 13.17, Uptime: 1735, Lo
Timestamp: 2019-06-19T13:50:45.000Z, Ascii: 06191350,S, gps = 10Mns ird = 10Mns lat=44.71423 lon=-63.60489, Sched hr = 0
Timestamp: 2019-06-19T13:50:08.001Z, BatteryV: 11.79, Latitude: 44.714227, Longitude: -63.604890, Voltage Unloaded: 13.20
Timestamp: 2019-06-19T13:44:15.561Z, Outgoing SBD Text: $unlock 69294 $scm
Timestamp: 2019-06-19T13:40:08.001Z, BatteryV: 11.79, Latitude: 44.714227, Longitude: -63.604902, Voltage Unloaded: 13.20
Timestamp: 2019-06-19T13:33:34.001Z, BatteryV: 11.79, Latitude: 44.714246, Longitude: -63.604934, Voltage Unloaded: 13.26
Timestamp: 2019-06-19T13:35:17.000Z, Ascii: 06191334,V,Rover v1.26-4170. dev:4 Hw:3.2-0 SN=214188 GPS: IRD:TA13001 Reset: Count=17, Current=(S), Prev=(cleared)

Location Log

Timestamp	Latitude	Longitude	SNR
Jun 19 2019 02:40:09.001 PM	44.714214	-63.604915	43
Jun 19 2019 02:35:07.001 PM	44.714195	-63.604909	41
Jun 19 2019 02:30:08.001 PM	44.714170	-63.604832	42
Jun 19 2019 02:20:08.001 PM	44.714221	-63.604941	42
Jun 19 2019 02:10:08.001 PM	44.714310	-63.604877	38
Jun 19 2019 02:00:08.001 PM	44.714266	-63.604922	43
Jun 19 2019 01:50:08.001 PM	44.714227	-63.604890	45
Jun 19 2019 01:40:08.001 PM	44.714227	-63.604902	43
Jun 19 2019 01:33:34.001 PM	44.714246	-63.604934	44

Deployment of the Rover

Below are installation tips for the Rover:

- Ensure that the Rover is moored with the white end of the enclosure facing up.
- The top of the Rover 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 should not be deployed near (less than 1 metre) other transmitters.

Troubleshooting

Red LED/blinking
Indicative of a self-test failure. As of build 6058 Bluetooth turns on during a self-test failure.
Using the **$status** command will show what failure code is present.
i - Iridium - Modem cannot communicate with CPU of Rover; contact Xeos
f - Flash - Flash error is showing as a full chip; erasing the chip may resolve this issue
t - Battery taps - Batteries are either oriented incorrectly, or a tap is too low.

- Using the **$taprv** command shows voltages of all 6 taps. Taps lower than 3.6 Volts show as a failure.

TapRV response:
Battery taps (averages=4 delay=1000 uS limit=3.60)
Str0: T0=12.03(4.08) T1=7.95(4.02) T2=3.93(3.93) OK
Str1: T0=12.15(4.02) T1=8.13(4.08) T2=4.05(4.05) OK

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 to use the bottom Iridium antenna to check the RSSI level (greater than zero). The Status page of Bluetooth app shows most recent occurrence of these stats.
  - Change the location of the device; place the device in an area with as much total view of the sky as possible.
- Dumping the flash memory will display all Iridium sessions that occurred, regardless of success.

Messages are not readable (in binary)
Messages are in compressed binary format by default; use the **$msgenable** command to change the format to ASCII.

No GPS/poor GPS

- The Rover's start-up message lists the firmware version of the GPS chip. If the GPS version is not displayed, the CPU is unable to communicate with the GPS chip.
- Change the location of the device; place the device in an area with as much total view of the sky as possible.
- Dumping the flash memory will display all GPS sessions that occurred, regardless of success.
  - Check the number of satellites seen (greater than 4), SNR level (greater than 38), time the GPS session was on (less than 60 seconds for first fix, less than 20 for other fixes). The status page of the Bluetooth app shows most recent occurrence of these stats.
- Flip the Rover 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 **$timer** command
- Check timer currently being used with the **$status** command (Returns TMde=1)
- 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
    - Watch circle warn can also be triggered if location is too close to the radius (default 85% of the way to the boundary)
- Inversion triggered when the device has overturned and is using a different antenna than the last time that it transmitted.
    - While the Rover will send an Orientation Change message whenever this happens, Timer 2 will not be used if the inverted event is turned off with **$evtconfig 2 2 n**

Maintenance

Batteries

The internal battery pack in the Rover 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 should not be used** since the seal is more apt to fail and cause leakage in higher temperature conditions.

1. Xeos recommends the **Energizer EN91 AA alkaline** battery, or the **Energizer L91 Lithium** 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 should not have batteries installed.

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 the correct way as the columns alternate direction. Incorrect battery installation will activate the self-test failure mechanism.

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

The Rover may beep to indicate changes in the battery voltage as it can start as final batteries are installed.

Once all the batteries have been replaced, the Rover will stop beeping. 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. 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'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:

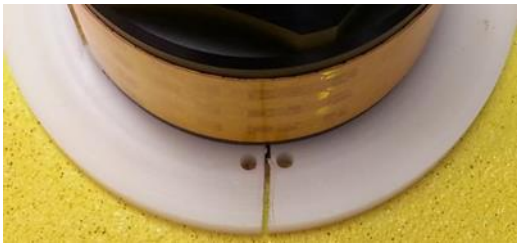
- Remove the old O-ring using a soft tool (toothpick) to avoid scratching the o-ring groove.
- Clean all dirt away from the threads and grooves where the old O-ring was seated using a lint-free cloth, cleaning alcohol, and a soft brush.
- Apply a thin layer of O-ring lubricant (Molykote 111 from Dow 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.

Removing the ROBY float

Xeos does not recommend removing the ROBY's float unless it is necessary. The unit can be used and disassembled while the float remains on.

1. Using a pair of internal snap ring pliers, stretch the top ABS brace until it can be slid off the ROBY's top cylinder.



2. Repeat step one for the bottom brace.
3. After both braces have been removed, the float can be slid off the ROBY.

Recovery and Storage

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

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

Appendix A: Part Sourcing Summary

Battery Compartment

Source:	Repair or replacement must be done by Xeos Technologies Inc. 1-902-444-7650 or support@xeostech.com
	Only use new, approved batteries for deployments. In the event used batteries are for short term testing, batteries must have equivalent battery voltages to prevent reverse charge forming and subsequent battery leakage. Visual inspection of the battery compartment should be done after each deployment to ensure there has been no leakage. Signs of corrosion, leakage or water ingress should be reported to Xeos immediately.

O-Rings

Part Number:	568-138 90D DURO BUNA (White Section) 568-137 90D DURO BUNA (Black Section)
Source:	O-rings may be purchased through Xeos Technologies Inc. or from a variety of vendors. Please call for assistance if required.
Maintenance:	O-rings should be visually inspected prior to each deployment, no matter how short. Any evidence of wear or stretching requires that they be replaced. O-rings should always be replaced after a deployment of 2 months or more. O-rings should also be replaced after a series of short deployments adding up to 2 months.

Seal Lubrication

Part Number:	Molykote 111
Source:	Lubrication may be purchased through Xeos Technologies Inc. or from a variety of vendors. Please call for assistance if required
Maintenance:	Lubrication should be used each time the O-Ring is removed and reseated
Procedure:	Squeeze a thin layer of lube onto the O-Ring. Gently spread the lube around the O-Ring until it is completely coated. Follow instructions for seating the O-Ring

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.

Firmware Updates

Source:	Firmware updates are published to the Google Play Store. For backup USB, firmware is on the Xeos Firmware Repository. Validated users may log in and download the most up to date version as needed
Maintenance:	Prior to each deployment, the firmware version should be checked, and updates applied, if needed. Email support@xeostech.com if you need assistance determining if you should apply a firmware update. Firmware updates can be uploaded via Bluetooth. Alternative method using Micro-USB on device (requires disassembly)
Procedure:	A detailed instruction and procedure will accompany each firmware release.

Appendix B: 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
GPS Receiver	48 Channel SiRFstarIV, GSD4e GPS chip, SiRFstar V (hardware dependent)
Iridium Hardware	9603 Modem

Electrical	
Battery Compliment	18 AA batteries (lithium or alkaline)
Operating Voltage	9 – 32V
Nominal Voltage	13.5V
Battery Capacity	3.0 Amp Hours (alkaline) 5.8 Amp Hours (lithium)
Iridium Transmission	70mA
GPS Acquisition	13mA
Bluetooth Connected	3.6mA
Idle Current Bluetooth On, Off	90µA 30µA
Off Current Bluetooth On, Off	80µA 15µA

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.*

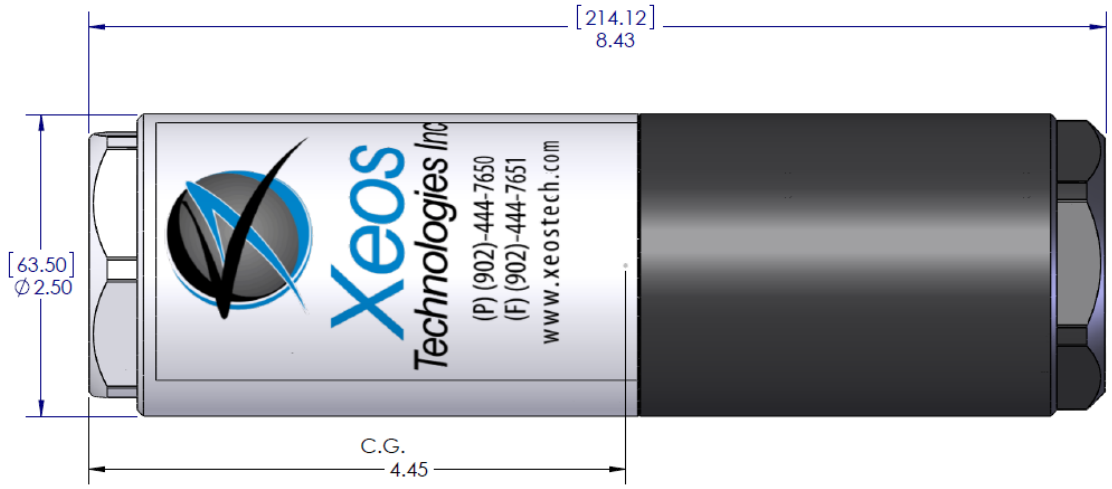
Appendix C: Sample Power Consumption Patterns

Note: These are calculated lifespans and not testing results; environmental factors including temperature will affect these calculations.

GPS Interval	Iridium Interval	EN91 Alkaline	L91 Lithium
10 min	10 min	38 days 1.24 mths	47 days 1.54 mths
30 min	30 min	110 days 3.61 mths	136 days 4.47 mths
1 hour	1 hour	207 days 6.8 mths	255 days 8.38 mths
3 hours (default)	3 hours (default)	498 days 1 year, 4.3 mths	612 days 1 year, 8.12 mths
6 hours	6 hours	767 days 2 years, 1.21 mths	942 days 2 years, 6.96 mths
12 hours	12 hours	1049 days 2 years 10.48 mths	1289 days 3 years, 6.37 mths
1 day	1 day	1287 days 3 years, 6.31 mths	1580 days 4 years, 3.94 mths

Calculations subject to change without notice. Xeos conducts ongoing battery life and power consumption tests to provide more accurate information to customers.

Appendix D: 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

Xeos Technologies Inc.

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
ONE PLACE DECIMAL ±0.05
TWO PLACE DECIMAL ±0.005
THREE PLACE DECIMAL ±0.001

Physical Properties
See Mass Table

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TITLE:
Rover

SIZE	Rev	SCALE	Sheet
A	003	1:4	1 of 1

Appendix E: GPS Text Long

GPS Text Long (Type 1) messages allow for greater detail in ASCII format. These messages are approximately 185 bytes in length.

Greyed out fields are unused.

Ascii: 05101540,S,2019-05-10 15:40:11,44.71441,-63.60494,6,43,11,1.2,13.170,12.120,0,0.0,0,635,Y,2,1190,5,13.18,71458,0.0,0

GPS Text Long Readout	
05101540	Date and time, MMDDHHmm
S	Status type message
2019-05-10 15:40:11	Date and time, adds year and second of fix
44.71441	Latitude
-63.60494	Longitude
6	Number of satellites seen
43	Maximum SNR of fix
11	Time to fix
1.2	HDOP (Horizontal Dilution of Precision)
13.170	Loaded Voltage
12.120	Unloaded Voltage
0	Temperature
0.0	Speed
0	Heading
635	GPS Horizontal Error
Y	Watch circle set, Yes/No
2	Distance device is from centre of set circle (meters)
1190	Number of seconds device has been in this mode (In-circle or out of circle, whatever the status is at this time)
5	RSSI (Iridium signal strength)
13018	Battery Voltage
71458	On-second, seconds since power-up/last reset
0.0	Temperature, Degrees C
0	Movement Counter

Warranty, Support and Limited Liability

Xeos Technologies Inc. warranties the Rover 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.

NO OTHER WARRANTIES: Xeos Technologies Inc. disclaims all other warranties, either express or implied, including but not limited to implied warranties of merchantability and fitness for a purpose, with respect to the product or the accompanying written materials. This limited warranty gives you specific legal rights. You may have others, which vary from state to state.

NO LIABILITY FOR CONSEQUENTIAL DAMAGES: In no event shall Xeos Technologies Inc. or its suppliers be liable for any damages whatsoever (including, without limitation, damages for loss of equipment, for loss of business profits, business interruption, loss of business information, or other pecuniary loss) arising out of the use of or inability to use this Xeos Technologies Inc. product, even if Xeos Technologies Inc. has been advised of the possibility of such damages.