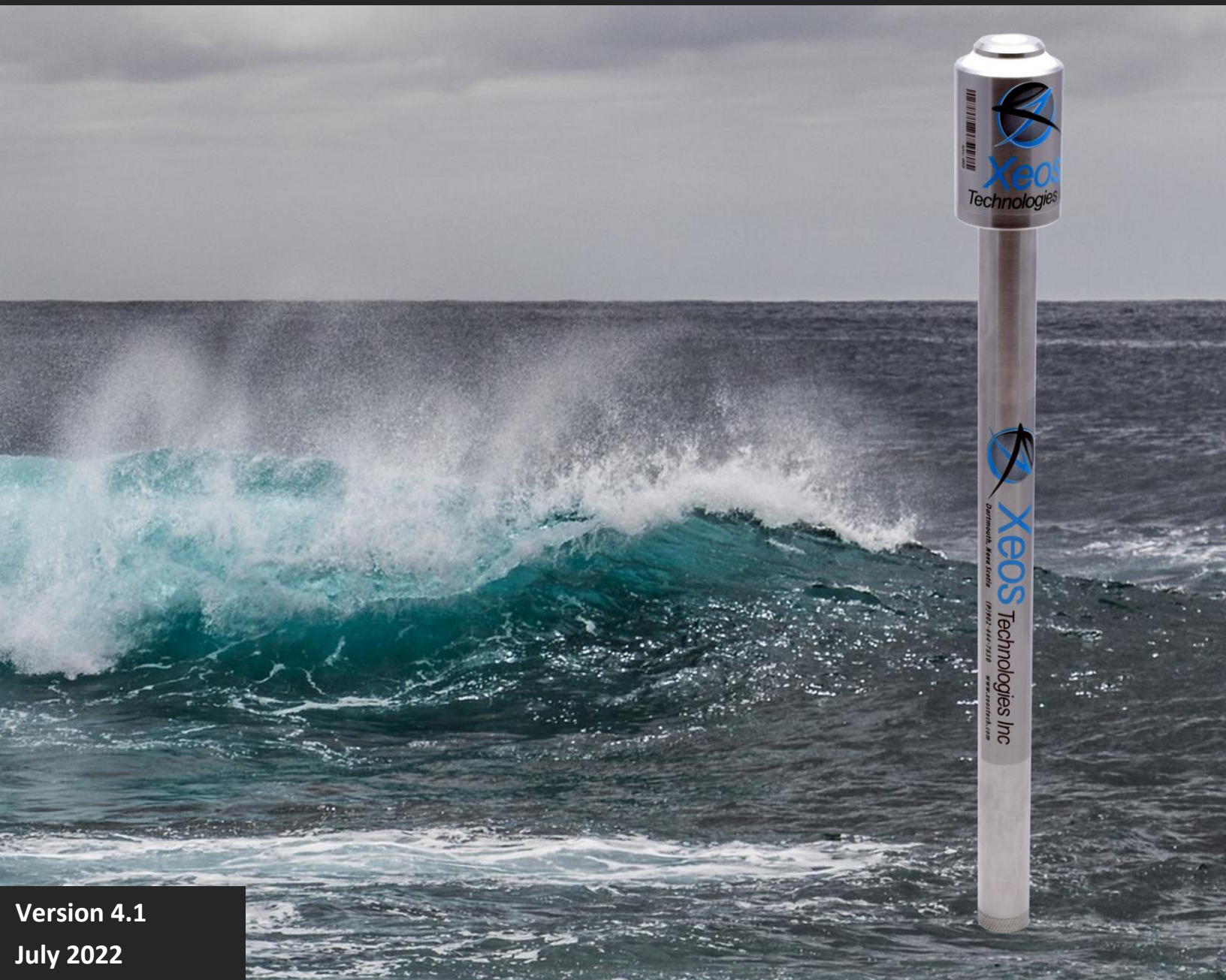
Xeos Technologies Inc.

XMI/XMI-2.0 User Manual

SUBMERSIBLE IRIDIUM SATELLITE BEACON



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Shipped From

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Specifics

This manual version is written with respect to XMI firmware build 7484. If you wish to acquire the latest firmware for your device, contact support@xeostech.com

Version History

Version No.	Date	Description
1.0	Jan 2014	Base document
2.0	Apr 2015	Format revision, appendix additions
2.5	Jan 2018	Added new timer diagram
2.6	Feb 2018	Added Appendix D for Firmware Updates
2.7	Apr 2018	Rewrote Understanding Position Information section
2.8	June 2018	Rewrote Appendix A, added P, I and S Messages
2.9	July 2018	Expanded XMI Remote Head
3.0	Mar 2019	Overhaul; Bluetooth separate doc
3.1	July 2019	Added new Fresh Water deployment details
3.2	Aug 2019	Bluetooth internal details
3.3	Apr 2020	New Bluetooth off operation, settings defaults
4.0	Sept 2021	Added new XMI-2.0
4.1	July 2022	Added Watch Circle Section

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

Overview

The XMI Subsurface Iridium Satellite Mooring Location Beacon regularly monitors for un-planned or accidental release of subsurface instrument moorings. The XMI makes use of the bi-directional, global, real time Iridium Satellite Short Burst Data (SBD) network in combination with GPS position location.

The XMI's tubular design allows it to be easily retrofitted into existing subsurface flotation configurations, such as syntactic foam. Inside the XMI is a 9603 Iridium Satellite Short Burst Data radio transceiver, a specialized low power Xeos digital controller with GPS, Iridium antenna, GPS antenna and battery package. XMI is intended for subsurface deployments and is intended for deployments up to 11,000 m below sea level. Xeos Technologies Inc. (Xeos) manufactures other specific products for surface applications as well as sub-surface applications at varying depths.

The new XMI-2.0 incorporates all of the software features of the previous XMI, with a small change in size and a frosted glass head replacing the ceramic portion of its predecessor. The USB port has also been removed from the battery chamber.

The optional Remote Head version, the XMI-RH, connects the battery pack to the electronics via a 6-foot, 4-Pin undersea cable for more precise weight balancing and installation of antennas on subsea platforms. The XMI-RH is suitable for deployments of up to 7500 meters below sea level.

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

Theory of Operation

The XMI provides notification of planned and unplanned surfacing events as well as location information on high value assets. After being activated, the XMI can be deployed at the depths of up to 11,000 m. The internal solid-state sensor is triggered when the XMI surfaces and immediately begins sending location messages as per the user settings. The internal battery pack provides over 1 1/2 years of subsurface deployment followed by up to 30 days of message transmissions.

Operators can communicate with the XMI once it has surfaced via Iridium using XeosOnline. Optionally, email commands can be sent directly to the XMI. Status information can be obtained, including the health of the GPS system and battery voltage. Timings can be changed, with defaults being one message every 3 hours. If you need to make a change to the settings, the XMI will receive the command on its next Iridium message check.

The XMI will continue to send position messages based on its timings, until it is manually turned off upon retrieval or the battery pack drops below the minimum operating voltage of 7 Volts.

Preliminary Setup

Outside Diagram

The XMI has several items of note to help identify a specific device. Shown below are key sections of the device.

1	The on/off LEDs of the XMI are located here. The titanium sections above and below the ceramic or glass must be shorted to trigger the water sense
2	The magnet switch to turn the XMI on and off is located directly below the ceramic/glass
3	The 15-digit IMEI of the XMI's Iridium modem as well as factory serial number is labelled
4	The head's torqued bottom plate has a sealing O-ring and should never be opened
5	The meeting point of the electronics head and battery chamber is given Loctite to deter opening unless necessary to access USB or change the O-ring installed here
6	A QR code is available to scan to download the manual; another is on the head
7	The bottom end cap contains a sealing O-ring and allows for battery installation

Setting up your Iridium Account

The XMI makes use of the Iridium satellite systems' Short Burst Data (SBD) service for the 9603 transceiver. This service is a global, two-way, real-time, email-based data delivery service that has a maximum outbound (from beacon) message size of 340 bytes and a maximum inbound (to beacon) message size of 270 bytes.

XMI 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 has a unique 15-digit IMEI number 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.

For each IMEI number it is possible to associate up to five (5) unique email addresses. This may vary between service providers. When registering your 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 XMI. Once the SBD account has been activated, please contact your Xeos representative and confirm this.

Quickstart

Before using the XMI

- 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 XMI automatically turns on once all batteries are installed and the endcap connected. The device must be turned off via magnet or battery removal.

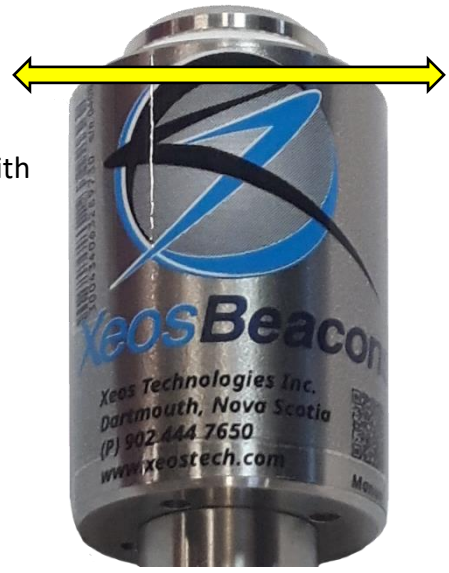
Magnet

- Swipe the magnet **slowly** along the **top of the head** horizontally until the flashing **GREEN LED** (**CYAN** in the XMI-2.0) on the top of the device remains solid. This 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



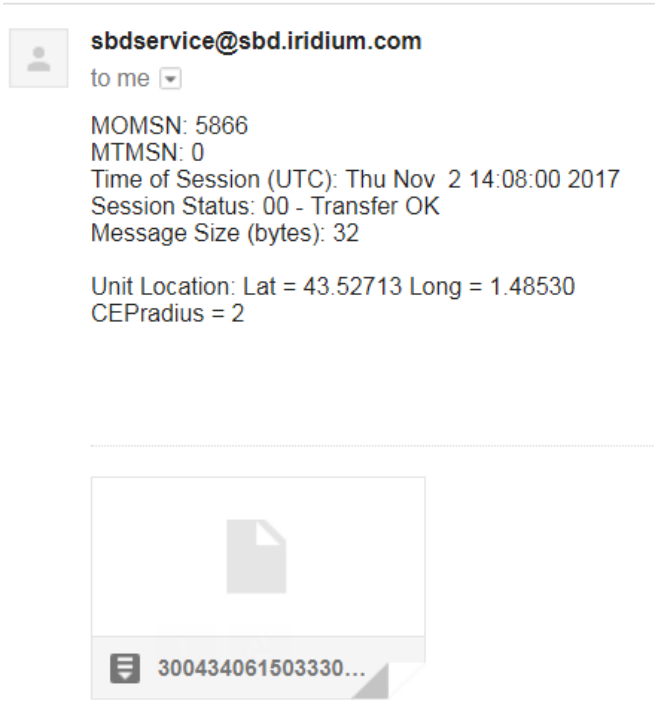
- When deploying the unit, power it up by swiping the magnet.
- Once the unit is confirmed to be on, it is ready to be deployed.
- Turn the XMI **OFF** using the same magnet method as turning **ON**, with the **RED LED** in place of the green/cyan.

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 device, 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	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 center 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 **$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

XMI Models

XMI-2.0

The newest model of XMI contains all of the software features of the XMI-11k, including depth rating (11,000 meters/37,089 feet). It continues improvements in antenna design and surface detection, and retains Bluetooth 4.0 connectivity, but not USB. The ceramic portion of the water sensor has been replaced with frosted glass, and the green LED has been replaced with Cyan to differentiate this new iteration.

XMI-11k

The XMI-11k model is fully submersible to 11,000 meters (37,089 feet). It features several improvements over the previous generation XMI, including an improved antenna design, more accurate water sensor, and Bluetooth 4.0 connectivity.

XMI-RH

The XMI-Remote Head features all the improvements of the XMI, with the added flexibility of a 6’ undersea cable for more precise load balancing and installation of antennas on subsea platforms. The XMI-RH can be packaged with the option of a Y-Cable for dual supply (vehicle and battery backup). The XMI-RH has a depth rating of 7500 meters (24,606 feet) with options for 11,000 meters.
Future XMI-Relays will utilize the XMI-2.0 hardware, with a smaller head section.

XMI-Relay

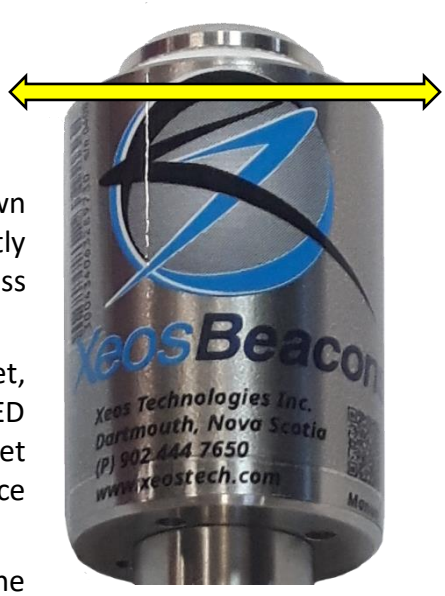
The XMI-Relay, in a remote head package similar to the XMI-RH, features the additional to "Relay" packets of information to and from a connected peripheral device. The XMI-Relay can be packaged with the option of a Y-Cable for dual supply (vehicle and battery backup). As with the XMI-RH, it has a depth rating of 7500 meters (24,606 feet) with options for 11,000 meters. Future XMI-Relays will utilize the XMI-2.0 hardware, with a smaller head section.

XMI-7500

The previous generation XMI-7500 provides all the core features of the XMI-11k, excluding Bluetooth connectivity, for deployments of up to 7500 meters (24,606 feet).

On/Off Modes

Using the Magnets



The XMI 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 XMI.

To turn the XMI ON, begin swiping the magnet slowly up and down at the location of the reed switch. The reed switch is located directly behind the Xeos Technologies Logo. A demonstration of the process is available here.

To turn the XMI 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 the current mode of the beacon. A green LED indicates that the device is turned ON, while a red LED indicates the device is turned OFF.

If after turning the XMI ON, the self-test period causes the XMI to repeatedly flash its red LED for an extended period, this indicates a **SELF-TEST FAILURE**. Contact support@xeostech.com if this occurs.

LED Notes

- It is important to let all LEDs stop illuminating before initiating another action.
- Cycling power for any reason, such as using the switch to the unit OFF/ON or inserting new batteries, will initiate the Start-up 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.

Messages From the XMI

Version (Type V)

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

```
Powerup: true, Firmware Version: XMI-Torch v1.27-6417. dev:4 , Hardware Revision: 2.8-0,
Serial: 351, GPS Version: GSD4e_4.1.2-P1 R+ 11/15/2011 319-Nov 15 ,
Iridium Version: TA16005, Reset Reason(s): Count=12, 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 XMI

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: 2016-10-21T16:40:12.001Z, BatteryV: 5.49, Latitude: 44.714406, Longitude: -63.604947, Vul: 8.16
```

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

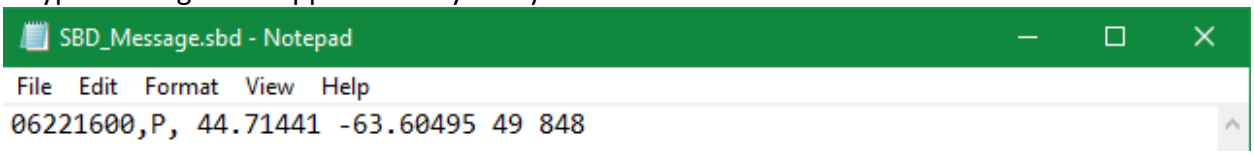
Location Log Readout	
Timestamp	Date and time in UTC of this specific position reading
44.714406	Latitude of fix, decimal degrees
-63.604947	Longitude of fix, decimal degrees
Alarm: False	Indicates if the device has determined if it is in an alarm state
Bearing	Direction of movement determined by device
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:



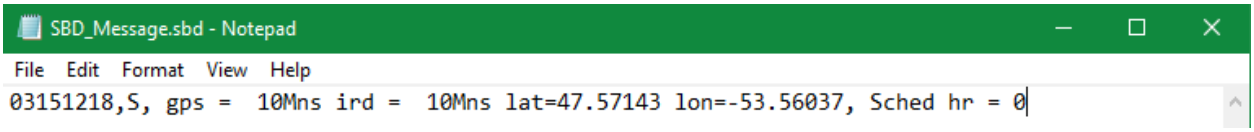
The message type used can be changed using the **$msgenable** command.

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 (>37 is good)
848	Unloaded voltage of device at the time of GPS Fix in mV

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 (underwater to alarm mode, alarm mode to normal mode). This message is always sent in ASCII format.

Note: Since this message is transmitted after surfacing, the fix information could be inaccurate if the mooring drifted while underwater and the last fix was before submergence.

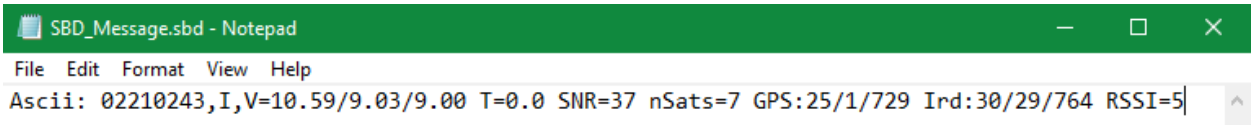


Status Readout	
03151218	Timestamp in UTC (Month/Day/Hour)
S	Type of message (Status Change)
Status / Value Change	Indicates that a setting has been changed
gps = 10Mns	Currently used GPS repetition rate
ird = 10Mns	Currently used Iridium repetition rate
lat=47.57143	Latitude of latest fix
lon=-53.56037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

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 XMI
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.

Communicating with the XMI

There are 4 ways to communicate with the XMI:

1. Over-the-air with E-mail SBD messages
2. Over-the-air with XeosOnline
3. Locally with Bluetooth
4. Locally with a serial-to-USB cable

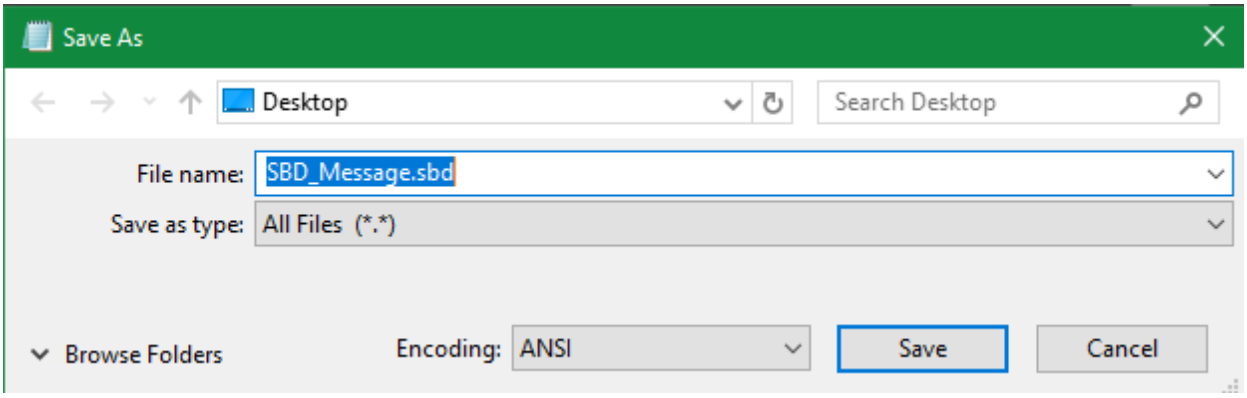
Sending Commands via Email

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

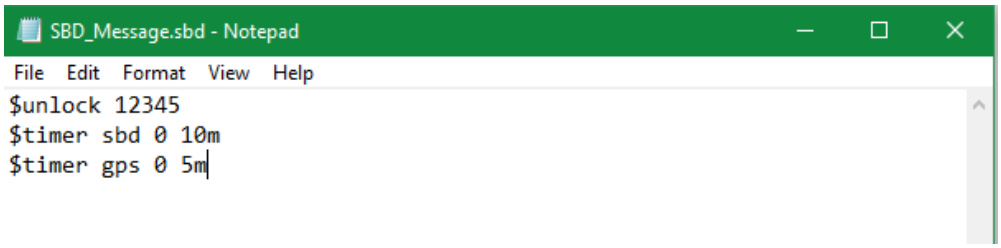
To create an SBD command, open a new file in a text editor (ex. Notepad) and save it using the **.sbd** extension. Make sure the **Save as type** option is set to **All Files** to achieve this.



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 its 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.

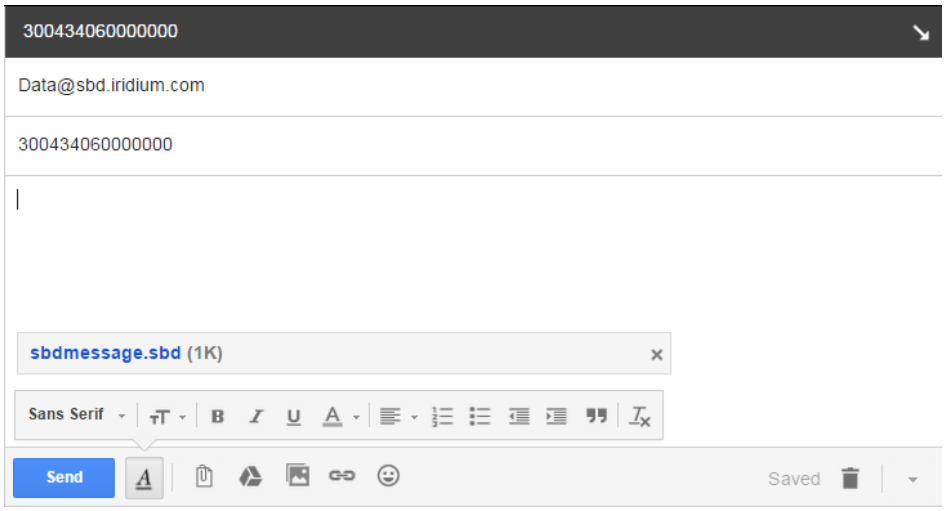
Outgoing	Timestamp: 2019-05-08T19:43:15.936Z, Outgoing SBD Text: $unlock 69294 $statsl

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**



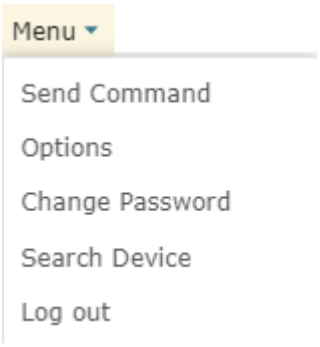
A confirmation will be immediately returned from the Iridium Gateway from the address **sbdservice@sbd.iridium.com** indicating that your message is now in the message queue. It will be delivered to the device during its next Iridium check.

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

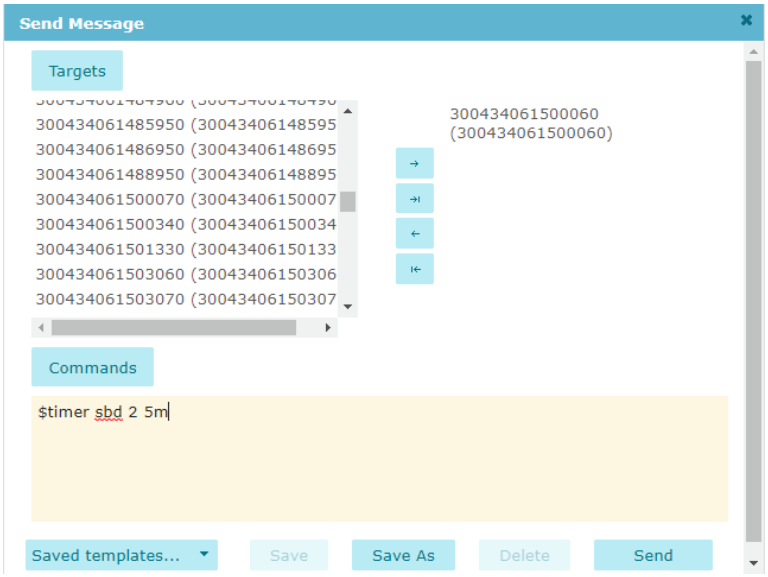


Navigate to the Send Command window.
From the Home Tab, choose
Menu > Send Command

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.



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 XMI.

Using Serial

The XMI can connect directly to a PC over serial. When connected in this way, the user can both send commands locally and update the unit's firmware. While diagnostics will operate, the device's Iridium systems will be inoperable unless externally powered.

Necessary Equipment

A serial connection requires the following equipment and software:

1. An XMI unit
2. A micro-USB cable
3. A PC with a terminal emulator program

The XMI can be powered exclusively by the micro-USB cable. In this configuration, the XMI cannot send or receive GPS or Iridium communications.

Disassembly

Accessing the serial port involves carefully removing the battery tube from the electronics head. The electronics head extends 2.5" into the battery tube, so the XMI must be kept level during disassembly.

1. Start by reading over O-ring Procedures, extreme care must be taken when disassembling the XMI and the O-ring surfaces should be cleaned and inspected.
2. Next, remove the end-cap and slide the batteries out the bottom of the XMI.
3. Once the batteries are removed, the battery tube can be unscrewed from the electronics head.
4. The threads at O-ring B are sealed with Loctite 271 and can be difficult to unscrew. If significant force is required, heat can be applied to weaken the Loctite.
5. Once the electronics head has been removed from the battery tube, threads and O-ring surfaces should be thoroughly cleaned using a lint-free cloth, a wire brush, and cleaning alcohol.
6. The XMI head can now be plugged into a PC using a micro-USB cable.
7. Once the XMI is plugged into the PC, it will begin its boot up sequence. Since there is no power to the Iridium modem, the self-test will fail. After flashing green during the test, the LED will begin flashing red to indicate a failed test.
8. You can now connect to the XMI using a terminal emulator.

Connecting to the XMI

1. Navigate to the Device Manager from Windows Control Panel (or type "Device Manager" in the Windows Start Menu).
2. Note the COM port being used by the XMI's CP210x USB adapter.

3. If the CP210x USB adapter does not appear in your device manager, download and install the CP210x driver.
4. Open your terminal emulator and connect to the XMI using the following settings:

COM Port Setup			
COM Port	See above	DTR/DSR	Off
Baud Rate	57.6k	RTS/CTS	Off
Data Bits	8	XON/XOFF	Off
Stop Bits	1	DTRSET	Off
Parity	None	RTSSET	Off

5. Once connected, initialize the diagnostic port by typing in $ and pressing enter. All commands must be preceded by the $ character
6. The command **$h** will display a list of available commands, while **$settings** will show all relevant settings.

Messages to the XMI

Settings

The **$settings** command will return a truncated list of important XMI settings aside from timers.

```
Ascii: T/A:Td=0;Ts=15 GPS:MxOn=100;MxPr=30;Tmn=-30;Vmn=6.000;gBlk0=0,0;
gBlk1=0,0;gRtyQ=2;gRtyD=20;gFRst=10;gBL=40;gFQ=24
Sys:PB=5384;Dsc=;BtP=n;BtT=5;BtN=XMI999;LL=0;UC=49456;rHr=0;rMn=2
Ird:iBlk0=0,0;iBlk1=0,0;iRtyQ=2;Smx=8;MxLn=330;iWR=Y;um=3
Tilt:Tt=-10;Secs=120;USec=120;tInh=Y
```

Name	Default	Description
GPS Settings (GPS)		
MxOn	100	Maximum GPS session length in seconds
MxPr	30	Maximum GPS session length in poor conditions in seconds
Tmn	-30	Temperature minimum
Vmn	6.000	Voltage minimum
gBlk0	0,0	Unused
gBlk1	0,0	Unused
gRtQ	2	GPS retry quantity
gRtyD	8	GPS retry delay in minutes
gFRst	2	Number of GPS failures for GPS reset
gBL	40	Maximum saved GPS fixes
gFQ	24	Maximum GPS fixes per message
System Settings (Sys)		
PB	Build	Firmware Build
BtP	No	Bluetooth on or off for extended period
BtT	5	Bluetooth Timeout in minutes
BtN	Name	Bluetooth Name
LL	0	Diagnostic Log detail level
UC	Code	Unlock Code
rHr	0	Hour on which timings are based (24h UTC)
rMn	2	SBD 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

Tilt Settings (Tilt)		
Tt	-10	Tilt Threshold
Secs	120	Tilt Seconds
USec	120	Untilt Seconds
tInh	Yes	GPS/Iridium inhibit if tilted

Lifetime Stats

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

```
Message SubType: 0, Timestamp: 2019-04-23T15:12:20.000Z, BatteryV: 6.09, Voltage Unloaded: 8.40, Uptime: 500066,
Power Cycle Count: 9, Watchdog Reset Count: 0, Lowest Battery Voltage: 0, Highest Battery Voltage: 30,
Iridium Message Count: 907, Iridium Session Count: 923, Iridium On Time: 409, Iridium Send Failures Non18: 263,
Iridium Send Failures Type 18: 78, Bytes TX: 34858, Iridium Messages Received: 9, Bytes RX: 311,
GPS Sessions: 861, GPS On Time: 404, GPS Fix Count: 725, GPS TTFF Average: 5, High Temperature: 0, Low Temperature: 0
```

Lifetime Statistics Readout	
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 Type18	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	Average time to fix (Seconds)
High Temperature	Not used with the XMI
Low Temperature	Not used by the XMI

Stats

The **$stats** command will return performance statistics recorded since the last power up. The statistics are like **$statsl**, but exclude **Power Cycle Count** and **Watchdog Reset Count**.

XMI Timers

Timer Types

The XMI's behavior is based on multiple timed events. Understanding how these events interact is necessary to properly using the XMI in the field. There are three major timed events:

SBD

The XMI will attempt to communicate with the Iridium Gateway based on this interval. If the XMI successfully registers with the Iridium Satellite Constellation, it will transmit any messages queued to be sent to the user. Once this is finished it will receive any queued messages from the Iridium Gateway and implement them, provided the proper Unlock Code is received.

GPS

The XMI will search for the GPS network and get a location fix based on this interval. Any successful GPS fixes will be queued for the next Iridium transmission.

The XMI'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.

WTR

The water sensor will measure for a surfacing event based on this timer. This timer is only active once the XMI is in underwater mode.

TLT

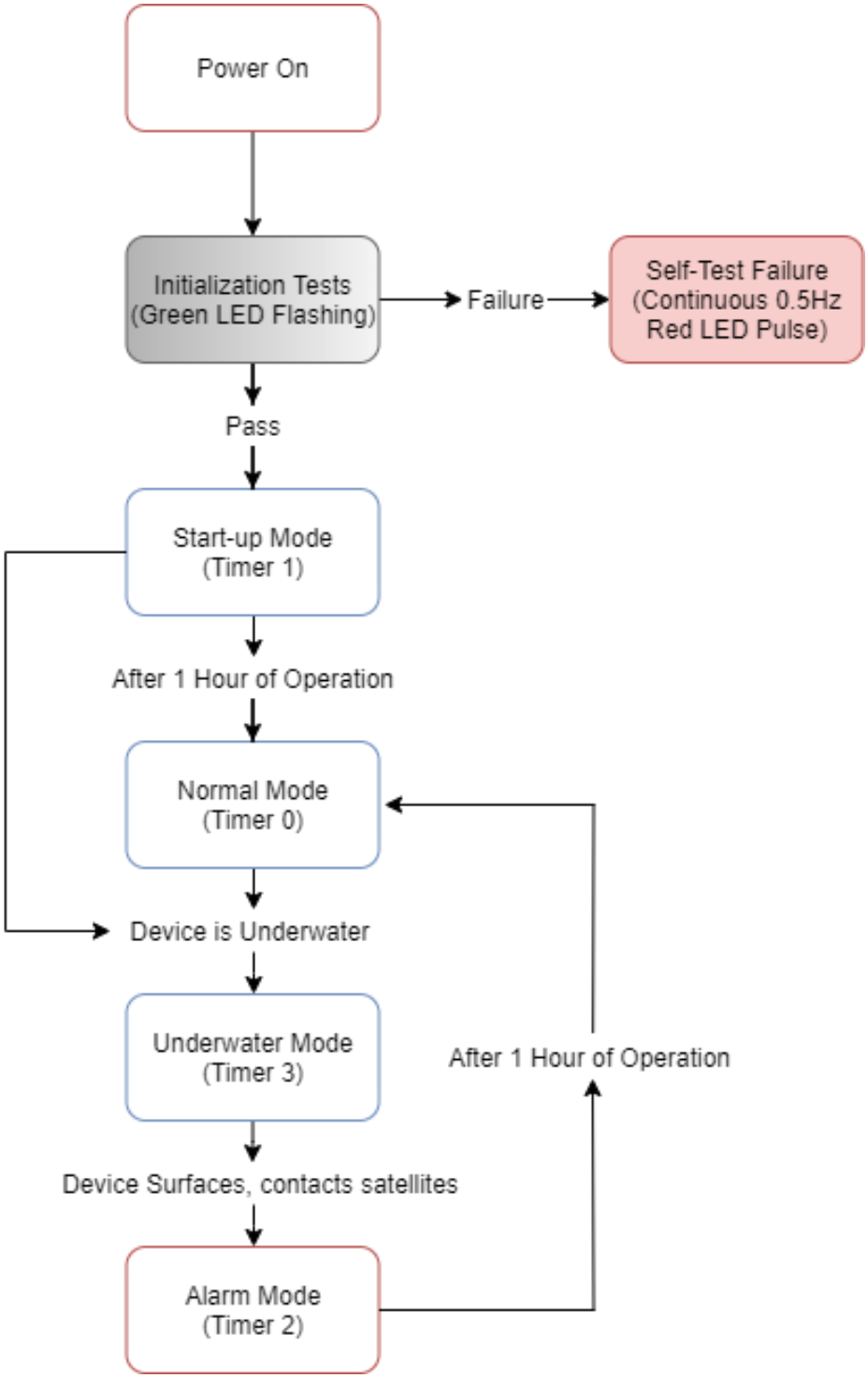
At default settings the XMI's tilt sensor is disabled. When enabled, the tilt sensor will take continuous readings to determine the orientation of the XMI, and will only take readings after one GPS fix has been acquired during that power-on session.

After a set time of inversion beyond the threshold (TltSecs) the XMI will not transmit if the Tilt Inhibit feature is enabled.

Once the device has registered that it is un-tilted, it will enter Alarm Mode as though surfacing.

Timer Modes

The interval at which each timer is executed depends on the XMI's current mode. Each mode corresponds to external conditions interpreted by the XMI's logic. The following diagram shows when each mode is invoked.



Normal Mode – Timer 0

Timer zero is the default timer mode of the XMI and will be used if no other modes apply. At default settings, the XMI will transmit 1 GPS fix every 3 hours. If no other modes are engaged, the XMI will continue in normal mode until its batteries are depleted or the unit powered off.

Start-up Mode – Timer 1

Start-up mode will begin when the XMI is turned on using magnet swipes, if power is applied to the XMI such as after a battery change, or if the XMI is reset by an SBD command ($resetnow). This mode will last for a maximum of one hour, but can be interrupted by another mode (ex. underwater or alarm).

While the maximum time of Timer 1 cannot be changed, GPS and SBD intervals can be set by the user as with all other timers.

Alarm Mode – Timer 2

Alarm mode will always begin after the XMI has exited underwater mode, or if the device returns upright from a tilted state, if tilt sensing is enabled. In alarm mode, the XMI immediately sends an SBD message to the Iridium Gateway indicating that it has surfaced, then the XMI will transmit 1 GPS position every 10 minutes for 1 hour. Once this alarm mode has finished, the XMI will enter normal mode.

Underwater Mode – Timer 3

If the XMI is unable to transmit successfully and fails to connect to the Iridium network after 3 attempts, it will enter underwater mode (Timer 3). Once in underwater mode, the XMI's GPS is disabled, and the Iridium transmit interval is set to attempt a connection once per day at midnight UTC. The water sense will also take a reading at 1-minute intervals.

While in underwater mode, if the water sense detects that the XMI has surfaced, an Iridium session will be queued and attempted. If the XMI successfully connects to the Iridium network, the XMI will exit underwater mode and enter Alarm Mode.

The XMI will always exit underwater mode if it successfully connects to the Iridium network. Since the XMI will only enter underwater mode after 3 consecutive failed Iridium transmissions, it can take several hours depending on the XMI's Iridium transmission rate.

Low Battery Mode (Timer 4)

Since various voltages can power the XMI, this mode is disabled by default. Contact Xeos if you wish to utilize a slower timer interval in the event of a low battery event.

No-GPS Mode (Timer 5)

The XMI will change its GPS and Iridium rates if it fails 5 consecutive GPS sessions through obstruction or timeout. Timers will be restored to normal mode if conditions return to normal.

Timer Intervals

Below are the default parameters for each mode. Symbols are shown on diagnostics only.

Timer	<T0>	T1	T2	T3	T4	T5	T6	T7	Min-Max
SBD	3h	10m	10m	1d	6h	1h	3h	3h	5m-2d
GPS	3h	10m	10m	1d	6h	2h	3h	3h	1m-1d
WTR	1m	20s	1m	1m	1m	1m	1m	1m	10s-1h

Legend	
SBD	SBD (Iridium) transmission interval
GPS	GPS acquisition interval
ACS	Acceleration Sample Rate
T0 – T7	Timer 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 none of the following modes are triggered
Timer 1	Start-up	Used for one hour from the time of power-up or reset
Timer 2	Alarm	Used for one hour from the time of surfacing
Timer 3	Underwater	Used while the device is submerged
Timer 4	Low Battery	Used when the voltage is consistently lower than user's preference
Timer 5	No-GPS	Used when consistent failures of GPS acquisition occur

The default timer settings of the XMI are suitable for most use cases.
Note: Timers 6 and 7 are not used in the XMI.

Timer

The **$timer** command will return the timer intervals of the current mode. This response will also be returned when timers are changed.

```
Ascii: Tmr:SBD,10m,10m,10m,1d,6h,1h,3h,3h
Tmr:GPS,10m,10m,10m,1d,6h,2h,3h,3h
Tmr:WTR,1m,1m,1m,1m,1m,1m,1m,1m
Tmr:TLT,1m,20s,1h,1h,1m,1m,1m,1m
```

The timer string returned includes a summary of all timers. The first six timers 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 XMI has a limit of 24 GPS fixes per Iridium message and will retain a maximum of 40 unsent fixes. This puts a practical limit on the ratio of GPS fixes to Iridium checks.

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

Example 1	**$timer GPS 0 1h**	Changes GPS interval of **Normal Mode** to 1 hour
Example 2	**$timer GPS 2 5m**	Changes GPS interval of **Alarm Mode** to 5 minutes
Example 3	**$timer SBD 3 6h**	Changes SBD interval of **Underwater Mode** to 6 hours

After combining the setup of both **Example 1** and **Example 3**, the user would receive 1 message every 6 hours containing 6 GPS fixes. These messages would be sent at approx. 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 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 =
```

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

The XMI 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 XMI 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 XMI will use additional Iridium data.

Bluetooth

The XMI 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 XMI'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 XMI will **always** advertise its name for connection (except when in underwater mode) until the Bluetooth power-off (**$btpwr 0**) command is received. **If the Bluetooth was commanded on, Bluetooth will also advertise while the device is off.**

Since the Bluetooth in the XMI shares the same antenna as GPS and Iridium, connection can be interrupted by these systems if they are in session.

Other Commands

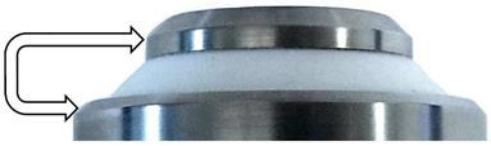
Below is a list of other commands that can be sent via Iridium or Bluetooth to acquire additional information, or configure the XMI. Remember to add the $ symbol ahead of any commands.

Command	Parameters	Description
ver	---	Show hardware and firmware versions (V-Type message)
Status	---	Show operating status
sysInf	---	GPS/Ird summary (Prompts I-Type message)
FactoryDefaults	---	Reset all to defaults and reset.
btPwr	0/1	Bluetooth power On/Off
btName	X	Set Bluetooth name for the XMI (implement with $btpcycle)
btpcycle	---	Power cycle Bluetooth, initiate new name with this cmd
batt	---	Show battery status
settings	---	Show all settings.
stats	---	Show statistics (since last powerup/reset)
statsL	---	Show Lifetime Statistics
switch	X 0/1	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	Minute	Minutes offset past the hour for GPS/Iridium
ResetNow	---	Restarts the system. The effect is the same as restarting via the magnet

XMI Operation - Sensors

Water Sensing

The XMI's water sensor is used to detect a change from underwater to surface. The sensor measures capacitance between the antenna and electronics head, based on the dielectric constant of either air or water.



When the XMI is not underwater, the water sensor is not used. The water sensor will only begin measuring once the unit enters underwater mode. Once in underwater mode, the XMI takes water measurements every minute.

Once the water sensor measures that the XMI is above water, it will immediately attempt an Iridium connection. If the Iridium connection is successful, the XMI will immediately transmit a 'surfaced message' and enter alarm mode for 1 hour.

2017-01-24T21:21:41.000Z, Ascii: Surfaced

The XMI's water sense mechanism is programmatically set to operate optimally in salt water environments. To operate the device in fresh water, the water sense threshold value must be **increased** to trigger a water sense surfacing event.

To change the water sense threshold, use the following commands in order:

$engmode 2009
$wsthresh X

Where **X** is the new value of the threshold.

The water sense reading has to be **lower** than the threshold number when submerged, and **higher** than the threshold number when surfaced for surfacing to take place. Fresh water environments can vary in the reading given, therefore testing should be done ahead of fresh water deployments to ensure proper operation.

The water sense reading can be interrogated via a Bluetooth connection via the **$wsr** command.

Tilt Sensing

If the XMI's tilt sensor is enabled, the XMI will continuously take internal orientation readings.

To turn the tilt sensor on, issue the command:

$switch t 1

When the device has reached beyond the tilt threshold for the time indicated by Tilt-seconds, the device will become inactive.

When the device reaches above the threshold for the time indicated by Tilt-unseconds, the device will return to an active state. By default, this will be according to Timer 2.

If the user wishes the device to continue to transmit while tilted, disable the Tilt-Inhibit feature by issuing the command:

$tltinh 0

Tilt seconds and unseconds are configured using the same command at the same time:

$tltsecs X Y

Where:

X is tilt seconds, time until the XMI enters inactive mode
Y is untilt seconds, time until the XMI enters active mode

Tilt features like tilt-inhibit cannot be manipulated until the tilt system is enabled via the **$switch** command.

Installation

When installing the XMI there are several factors that can influence performance:

1. The XMI's head should be pointing upward at the sky with as much of the sky visible as possible.
2. Iridium and especially GPS performance may suffer if large angles of the horizon are blocked, such as if the XMI is next to a wall.
3. Avoid using metallic fasteners at the top of the XMI, this will cause erroneous water sense readings if the top disk and head are shorted. It can also interfere with Iridium and GPS sessions.

Maintenance

Battery Options

The power source for the XMI is its internal battery pack. There are two available enclosure sizes for the XMI battery pack:

Standard Enclosure: Holds 6 x AA alkaline or Lithium (9V nominal) or 9 x CR123A lithium batteries (27 V nominal).

Short Enclosure: Holds 7 x CR123A (21V nominal) Lithium batteries.

Opening the Housing

The mechanism for installing the batteries is the same regardless of which enclosure is used. The electronics and antennas for the XMI are housed in the larger diameter cylinder and the batteries in the narrower, longer cylinder.

If installing batteries, only install them from the bottom endcap. Only open the top if accessing the USB port or changing the o-ring in that section.

Electronics Battery Enclosure Endcap

- Gently unscrew the end-cap from the battery enclosure.

- Make sure that the clear plastic insert is inside the battery enclosure.
    - Make sure to use the appropriate insert for your battery type. AA batteries require the thicker insert, to account for their smaller diameter.

The connection between the XMI's head and battery tube is sealed with Loctite. Users should not attempt to unscrew the head when changing batteries, as the amount of force required could damage the electronics.

O-Rings

O-Ring Locations

The Standard XMI and XMI-2.0 have O-rings at three distinct locations:

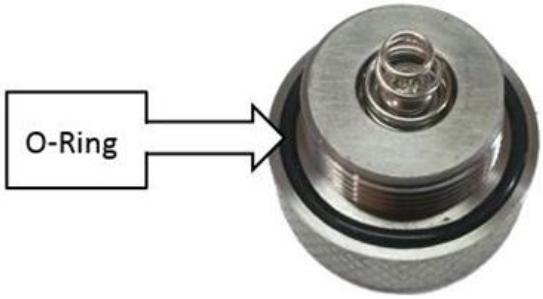
O-ring A is part of the XMI's electronics head and is installed as part of the manufacturing process. The two separate parts of the head are torqued to 80 pounds. It is **not** recommended that users disassemble the XMI's head as part of routine maintenance.

O-ring B is installed at the connection between the electronics head and the battery enclosure. To prevent any possibility of leakage, Loctite 271 is used to lock the threads, therefore extreme care must be taken if removing the battery enclosure, as the electronics board extends into the battery tube.

O-ring C is installed at the connection between the battery enclosure and the end-cap. When changing batteries, the end-cap should always be un-screwed.

O-Ring Procedures

O-rings are critical to the waterproof nature of the XMI. The O-ring should be visually inspected to make sure it is properly seated in the groove at the base of the threads and to ensure there is no visible damage to the O-ring.



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

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

To replace the 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 it 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.
- Gently slide the new O-ring down over the threads and into the O-ring groove.
- Push the O-ring level into the groove.

It is very important to be aware of where the O-ring is sitting on the end-cap. If the O-ring is not sitting perfectly in its groove, there will not be a perfect seal which could cause fatal damage to the unit.

Replacing the Batteries

The internal battery pack in the XMI can hold either AA or CR123A batteries (**Note:** the short enclosure only holds 7 CR123As).

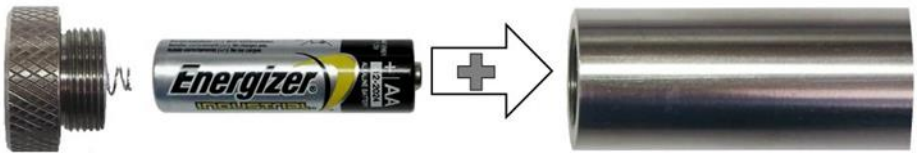
The batteries are configured in a single column. Make sure to only use new batteries. The battery supply should be replaced after any deployment exceeding 2 months.

To replace the batteries:

- Remove the bottom endcap
- Tip the old batteries out of the enclosure. Make sure to dispose of them appropriately.
- Slide the replacement batteries into the column, ensuring that the positive (+) terminal goes into the tube first.
- Restore the bottom endcap to the XMI when all batteries are inserted.

Note: The XMI will automatically turn on when the endcap is installed with batteries installed. Make sure to turn off the XMI with a magnet if not using right away.

DO NOT MIX BATTERY TYPES.



Power Consumption and Battery Life

Battery Life Estimates

The following tables give battery life estimates for a range of use cases. These are calculated lifespans and not testing results. Environmental factors including temperature will affect these calculations.

See Appendix C for current measurements.

1 Year Subsurface Battery Type	GPS/Iridium	Transmit Life	Total Messages
9V (6xAA Alkaline)	3h/3h	96 days	768
9V (6xAA Lithium)	3h/3h	186 days	1488
21V (7xCR123A)	3h/3h	119 days	852
9V (6xAA Alkaline)	10m/10m	5 days 9 hours	774
9V (6xAA Lithium)	10m/10m	10 days 8.5 hours	1491
21v (7xCR123A)	10m/10m	6 days 4 hours	950

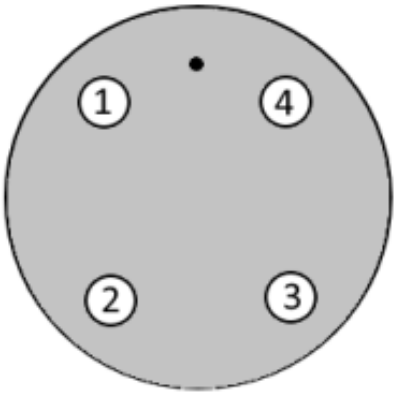
Surface Deployment (0 Days Subsurface) Battery Type	GPS/Iridium	Transmit Life	Total Messages
9V (6xAA Alkaline)	3h/3h	202 days	1616
9V (6xAA Lithium)	3h/3h	292 days	2336
21V (7xCR123A)	3h/3h	215 days	1720
9V (6xAA Alkaline)	10m/10m	11 days 5 hours	1614
9V (6xAA Lithium)	10m/10m	16 days 5 hours	2334
21v (7xCR123A)	10m/10m	12 days	1728

Appendix A: XMI Remote Head

The XMI has a remote head option to allow for better load balancing by separating the locations of the electronics package from the battery pack. The XMI Remote Head features all of the capabilities of the standard XMI and is supplied power via a waterproof cable to a 4-Pin SubConn connector.

The Y-Cable version of the XMI Remote Head is supplied with steering diodes to allow for battery back-up, should the connected vehicle lose power.

Connector Pinout



4-Pin, MCBH-4-FS-TI, External View	
Pin Number	Name
1	Ground
2	No Connection
3	+V Battery (7VDC – 30VDC)
4	No Connection
Guide pin for proper orientation is shown as black dot.	

Appendix B: XMI-Relay

Summary

The XMI Relay allows for serial relay functionality and requires different firmware. Units with the proper firmware can send data to and from a connected serial device over Iridium. Operation of other items, such as timers and sensors, operate the same as a typical XMI.

Basic Functionality

The XMI has a single serial line which must be switched between relay and diagnostics mode. By default, the XMI-Relay will be in Relay Mode and will not accept most commands. Diagnostics can be enabled by issuing the command **$diag 1** and disabled with **$diag 0** over the serial line (this also applies when communicating via Bluetooth).

The XMI will always accept commands over Iridium.

Serial Relay

To send data to or from a connected serial device, connect to the serial port on the Apollo Relay. By default, the Apollo Relay will use these connection settings:

Baud Rate	57.6k
Parity	None
Data Bits	8
Stop Bits	1

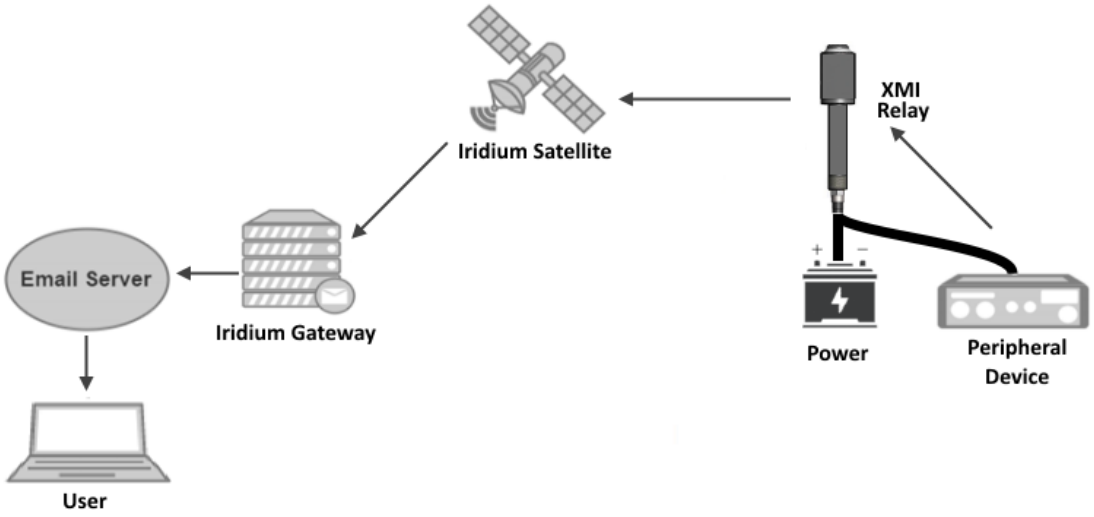
In the event the peripheral device has a different baud rate, the Apollo Relay can be changed to match for communication purposes using:

$baudrate XXXXX Y

XXXXX	Baud Rate
Y	Stop Bits (0 or 1)

The XMI Relay will immediately use the commanded baud rate, **but this setting does not survive resets.**

Mobile Originated SBD (From Device)



To send a payload of data from your connected serial device via the XMI Relay to the user, the device will send the payload in the following format:

$sendSBD
payload line 1
payload line 2
payload line 3
$finished

All lines are terminated with either a carriage return, line feed, or both.

For example, using a carriage return as the line terminator for the same content as the previous example (represented with "\R"):

$sendSBD\R payload line 1\R payload line 2\R payload line 3\R $finished\R

$sendSBD\R The payload of the message can be single-lined as well\R $finished\R

The **$sendSBD** and **$finished** commands **must** be immediately preceded and followed by a line terminator character. The payload can be data of any type and is not limited to ASCII characters.

Any data that exceeds the 330 byte SBD message limit will be split into several chunks and sent according to the Iridium device's SBD interval. Each Iridium transmission can send up to 8 SBD messages of 330 bytes each.

At default settings, the maximum sized message that can be queued for transmission is 4 kilobytes; this limit can be increased to 24 kilobytes, but this can cause loss of data and other issues if transmission conditions are not ideal. Contact Xeos Technologies if your requirements exceed default settings.

Mobile-originated messages will be transmitted over the Iridium satellite network from the Iridium device and arrive as an e-mail attachment. The first line in the e-mail attachment will have the following format:

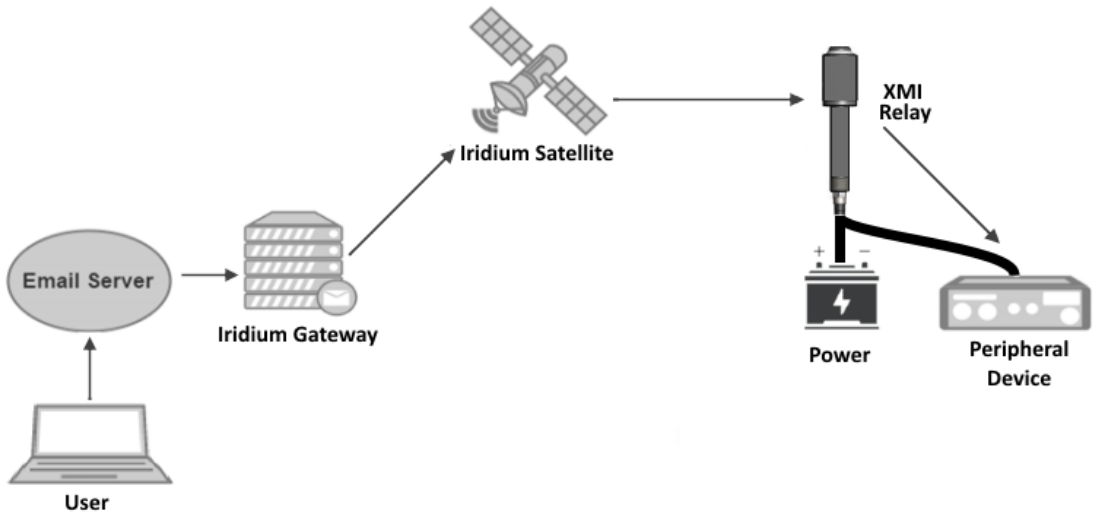
devData X,S,Y,Z PAYLOAD

devData a,1,1,1 The payload of the message can be single-lined as well

X	The alphabetic representation of the port the device is connected to
S	The sequence number of the incremented with each new $sendSBD command
Y	The message part number
Z	The total number of parts to the complete message

Following the "devData" line will be all or part of the payload, depending on the size of the payload.

Mobile Terminated SBD (To Device)



To send a payload of data to your connected serial device via the XMI, create a file with the extension ".sbd" with its contents adhering to the following format:

$unlock 12345
$outPort X (where 'X' is the alphabetic port number of the connected device)
payload line 1
payload line 2
payload line 3

Again, all lines are terminated with either a carriage return, line feed, or both. The unlock line will be a 5 digit numerical code, unique to each device. Its purpose is to prevent accidental or malicious commands from being processed by either the XMI, or your connected device.

When the data to be sent is compiled, normal methods of sending commands to Iridium devices can be implemented, either through email or a web service such as XeosOnline.

All lines after the **"$outPort"** line will be delivered to the connected serial device the next time the XMI-Relay is scheduled to contact the Iridium network. The total message, cannot exceed 270 bytes. Upon reception of the **$outPort** command, the XMI would output the following data to the connected serial device, according to the above example:

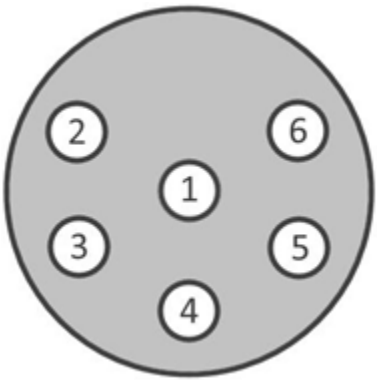
payload line 1
payload line 2
payload line 3

Settings

At default settings the XMI's serial settings are identical to what is detailed at Connecting to the XMI. It is recommended that relay functionality be tested over a USB connection before deployment.

The Y-Cable version of the XMI Relay is supplied with steering diodes to allow for battery back-up, should the connected vehicle lose power.

Connector Pinout



6-Pin, MCBH-6F-TI, External View	
Pin Number	Name
1	No Connection
2	TXD RS-232
3	RXD RS-232
4	+V Battery (Pack)
5	+V External (Vehicle Power)
6	Ground

Appendix C: Technical Specifications

Electrical

Power Supply	
Supply Range	7V to 30VDC (XMI) 7V to 28VDC (XMI-2.0)
Batteries	6 x AA - Standard Enclosure (Energizer Lithium L91 or Alkaline EN91 recommended) 7 x Panasonic CR123A - Optional Short Enclosure 9 x Panasonic CR123A – Standard Enclosure
Battery Capacity	2.4 Amp Hours (AA Alkaline) 3.0 Amp Hours (AA Lithium) 1.5 Amp Hours (CR123A Lithium)
Voltage	9 Volts nominal (Standard enclosure 6 AA batteries) 21 Volts nominal (Short enclosure 7 x CR123A batteries) 27 Volts nominal (Long enclosure 9 x CR123A batteries)
Idle Current (9V) **Bluetooth on/off**	110µA 50µA
OFF Current (9V) **Bluetooth on/off**	80µA 20µA
Underwater Current (9V)	25µA
Iridium Transmit (9V)	70mA (approx. 30s duration)
GPS Acquisition (9V)	15mA (approx. 30s duration)
Bluetooth Connected Current (9V)	3.3mA

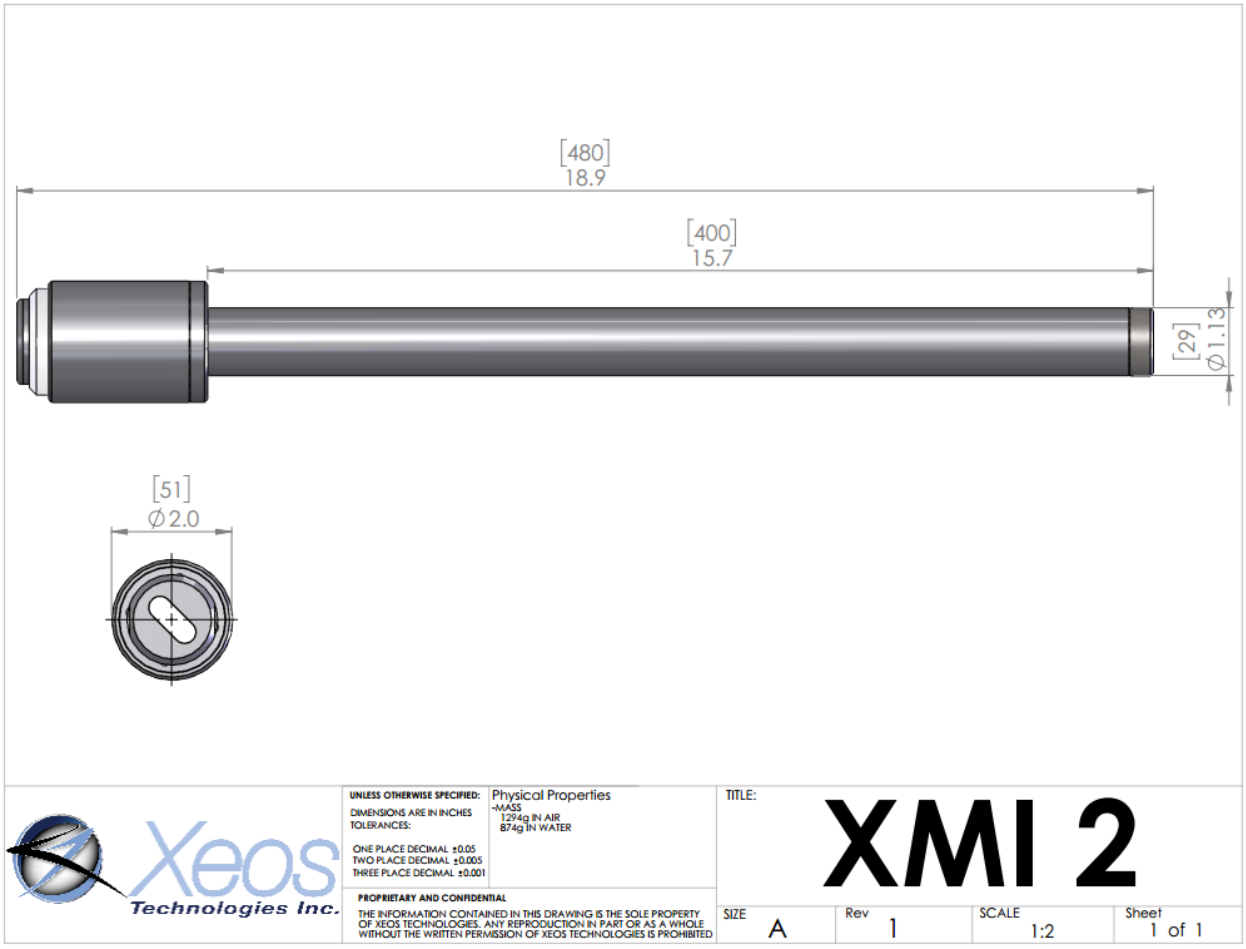
Electronics	
Digital Controller	Xeos XMI Controller (XMI) Xeos Apollo Controller (XMI-2.0)
GPS Receiver	48 channel SiRFstarIV GSD4e GPS chip (XMI) 48 channel SiRFstarV GSD5e GPS chip (XMI-2.0)
Iridium Modem	Iridium 9603 modem
Antenna	Xeos proprietary antenna designed to withstand high pressure environments

O-Rings

O-Ring Type	2-020 70 DURO BUNA-N
O-Ring Lubricant	Molykote 111, Dow Corning compound
Material	Buna-N Nitrile Rubber
Dimensions	0.875 X 1.000 x 0.070"

Appendix D: Engineering Diagrams

XMI-2.0 with Long Battery Enclosure



Material	All titanium with a non-permeable ceramic component

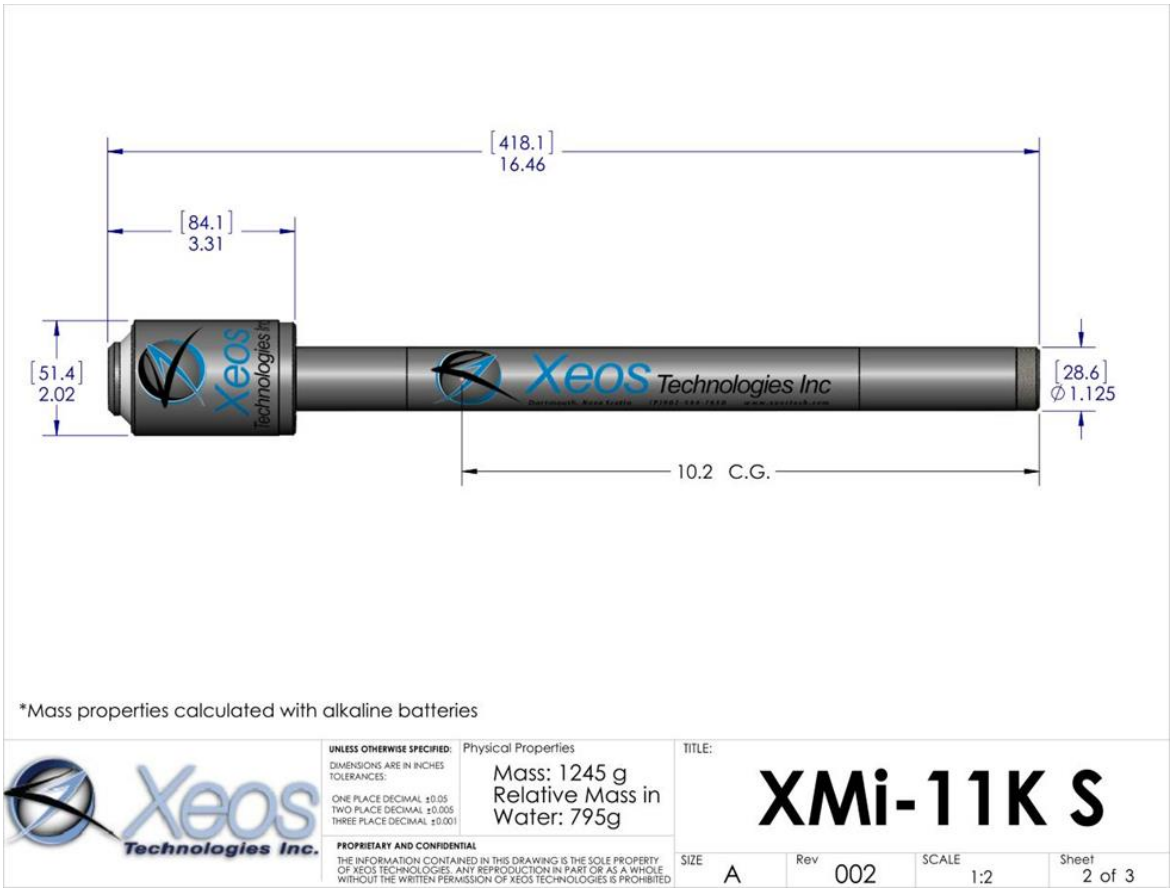
Standard Enclosure – XMI-2.0	
Dimensions	48.00 cm L – Total 2.90 cm D – Tube 5.10cm D - Head
Mass	874 g - in water 1294 g - out of water (Alkaline Batteries)
Operating Temperature	-40° C to +60° C (-40° F to 140° F)
Depth Rating	Submersible to 11,000m (36,089 ft)

XMI-11k with Long Battery Enclosure

Material	All titanium with a non-permeable ceramic component

Standard Enclosure – XMI-11k	
Dimensions	48.39 cm L – Total 2.86 cm D – Tube 5.14cm D - Head
Mass	910 g - in water 1400 g - out of water (Alkaline Batteries)
Operating Temperature	-40° C to +60° C (-40° F to 140° F)
Depth Rating	Submersible to 11,000m (36,089 ft)

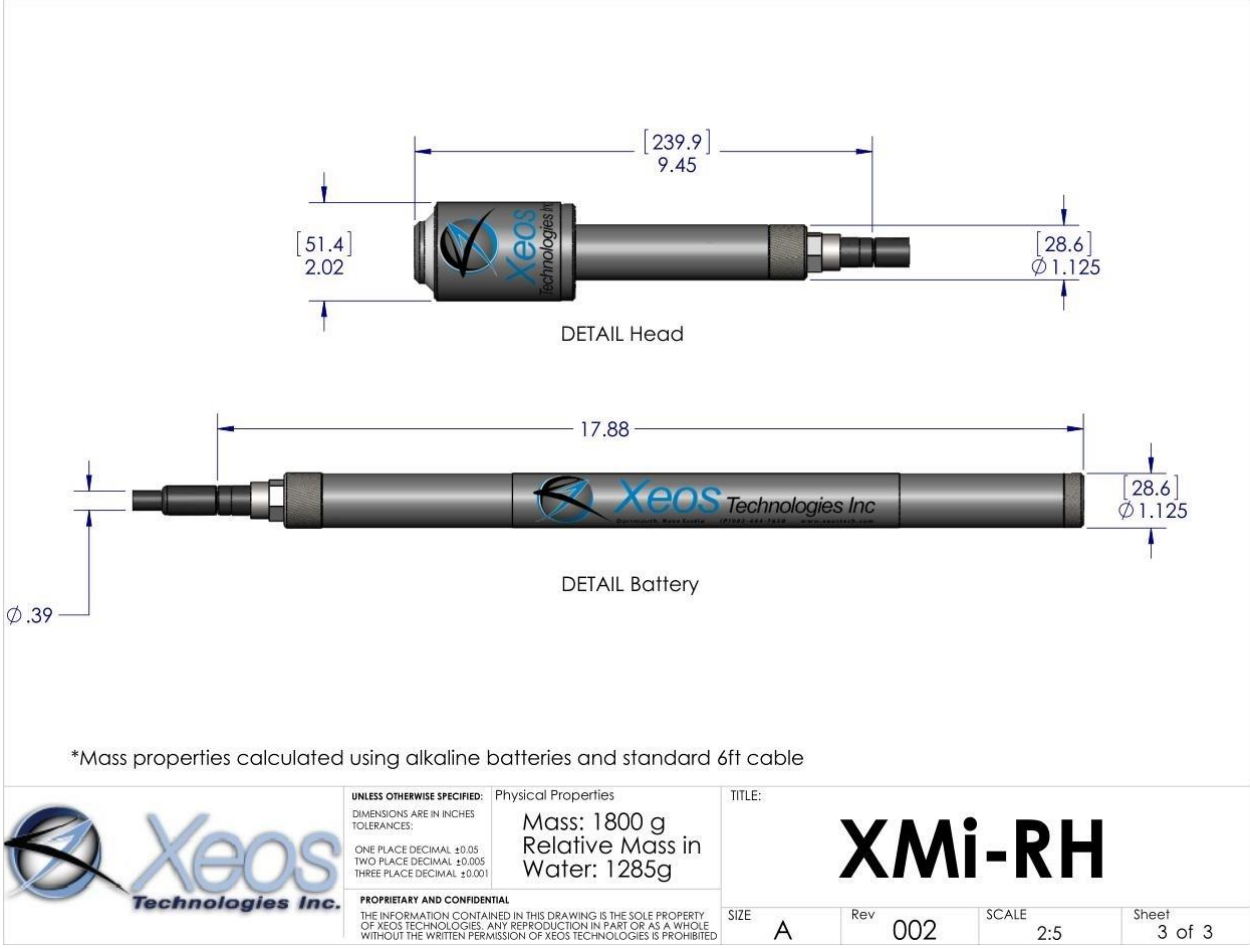
XMI-11k with Short Battery Enclosure:



Material	All titanium with a non-permeable ceramic component

Short Enclosure	
Dimensions	41.81 cm L x 2.86 cm D (16.46” L x 1.125” D)
Mass	795 g - in water 1245 g - out of water (Alkaline Batteries)
Operating Temperature	-40° C to +60° C (-40° F to 140° F)
Depth Rating	Submersible to 11,000m (36,089 ft)

XMI-RH with Long Battery Enclosure



Material	All titanium with a non-permeable ceramic component

Remote Head Enclosure	
Dimensions	24 cm L x 5.13 cm D (9.45” L x 2.02” D) – Head 45.41 cm L x 2.86 cm D (17.88” L x 1.125” D)- Battery Pack 172.88 cm L (6’ L)- Cable
Mass	1285 g - in water 1800 g - out of water
Operating Temperature	-40° C to +60° C (-40° F to 140° F)
Depth Rating	Submersible to 7500m (24606 ft)

Appendix E: Firmware Updates

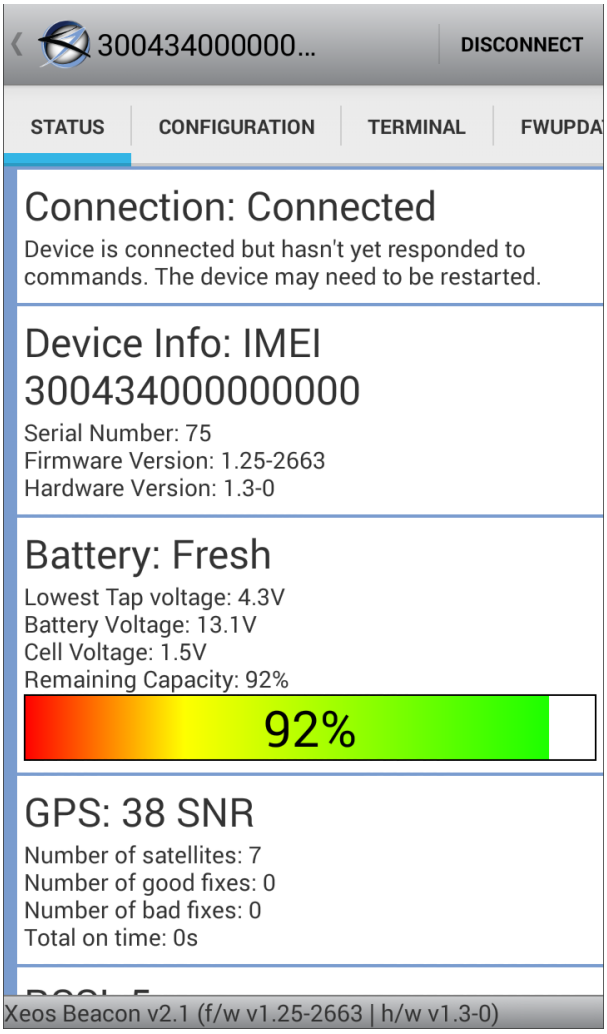
XMIs can be updated via two methods:

- Xeos Beacon Bluetooth App
- Serial Connection

Updating Firmware via Bluetooth

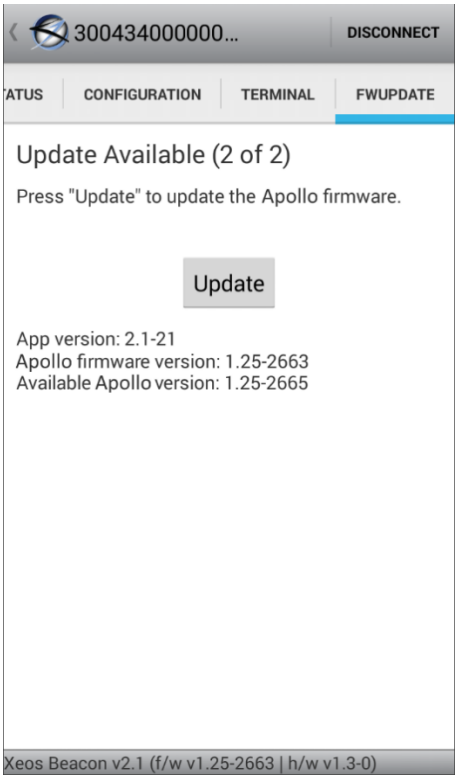
Download the Xeos Beacon App. This application requires an Android device to operate.

Connect to the device using the Bluetooth App while the XMI is on by selecting its name from the menu when it appears. You will be brought to the Status Page.



Navigate to the FWUpdate Page. Here, the build version of your device will be compared with that offered by the Application. If they differ, an update can be chosen.

Press **Update** to begin the process.



The App will upload a new firmware image at 500 bytes per second, showing a progress bar. Once the upload is complete, reset the device. The device will perform a firmware upgrade on its next power-up. If the update is interrupted for any reason, simply restart the process.

Updating Firmware via Serial

Using the Micro-USB port on the XMI, firmware can be updated. **The XMI-2.0 does not use USB.**

Materials

- Use of a computer running some version of Windows OS
- XMI to USB cable (Micro-USB)
- Device driver for the USB port
- XMI firmware package
    - AVRdude.exe
    - AVRdude.conf
    - XMI Firmware Hex File
    - XMI Firmware Command File
- Tools for disassembly

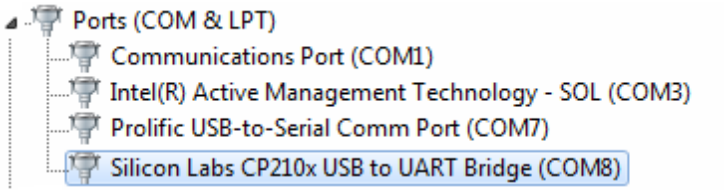
Process

1. Remove the XMI Head from the battery tube
2. Set the XMI upside down, so the circuit board faces up
3. Plug the Micro-USB connector into the connector in the XMI.

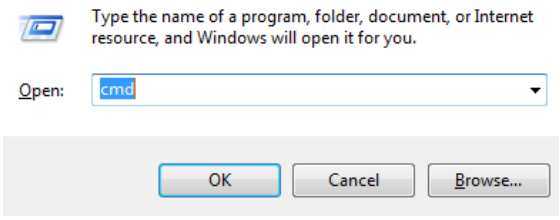
a. For the XMI-Relay, the device will have to be plugged into an RS232 cable at the SubConn connector for the update. An alternative is to use the Bluetooth App to update the device.

4. Connect the other end of the USB programmer to your computer. LEDs flashing once the XMI is connected to the computer are no cause for alarm; the XMI is drawing on the USB port's available power for the firmware update.
6. Connect the XMI to your PC via the XMI to USB cable.
7. Take note of the COM port number in Control Panel → Device Manager

In this case: COM8

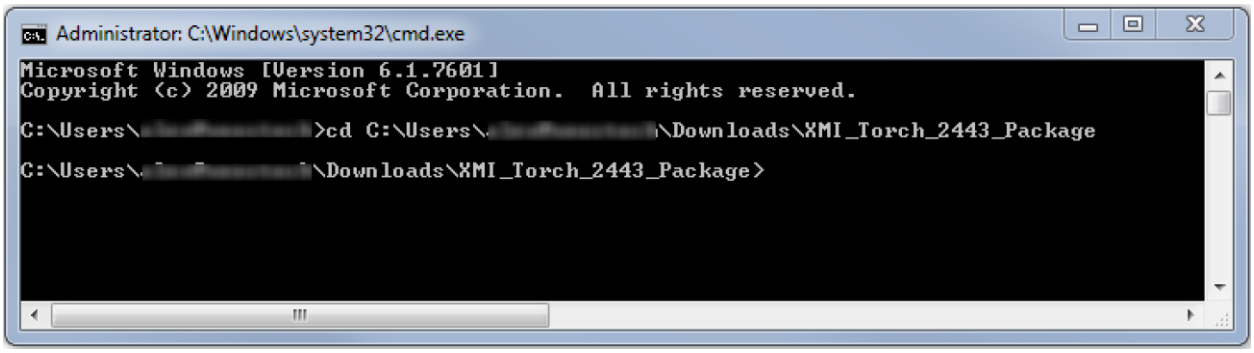


8. If the Silicon Labs CP210x does not appear in the device manager under Ports, see the end of this section.
9. Extract the zipped folder from the Xeos website containing the firmware update to your desktop.
10. Press **Windows Key + R** to open the run window:
11. Type **cmd** and press enter to open a command prompt.

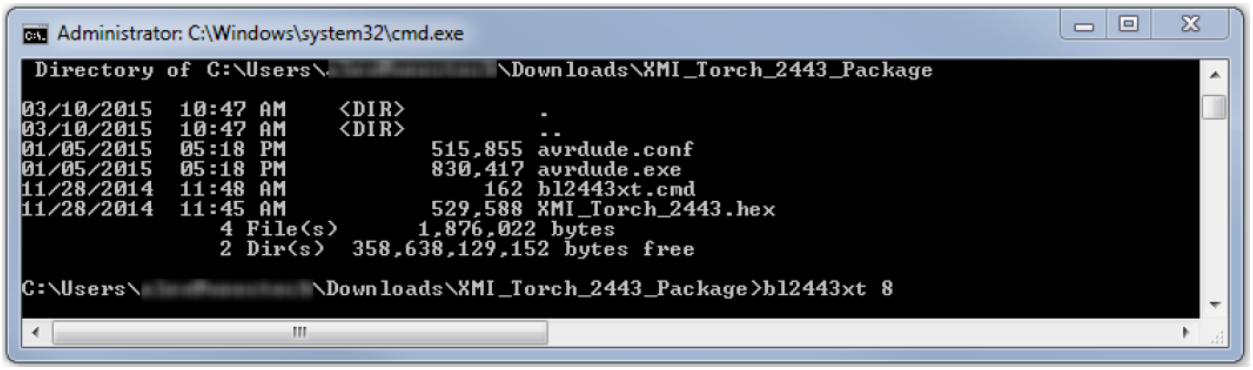


12. Navigate to the location of the XMI. For example:

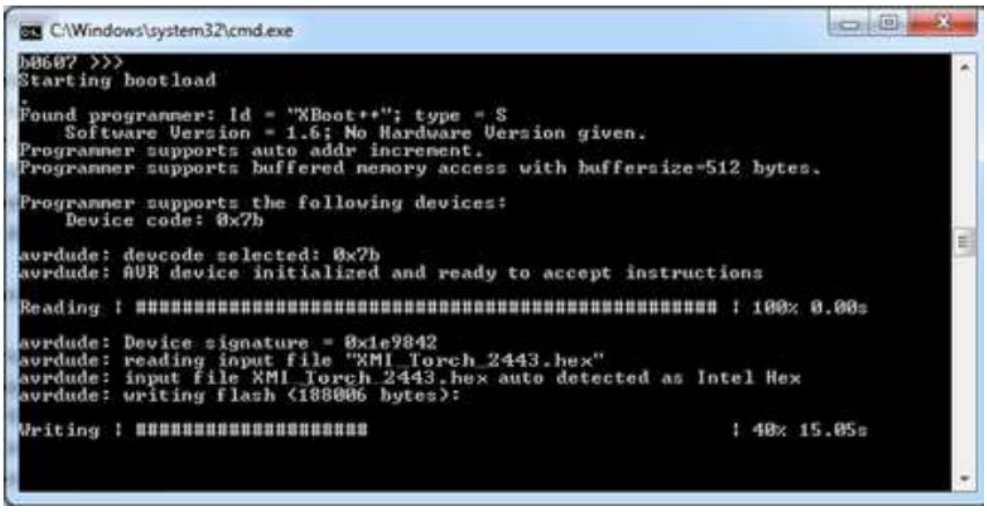
13. Type **dir** and press **Enter** to see the contents of the folder.



14. Drag the .cmd file into command prompt, and type in the COM port previously noted, and press **Enter**.



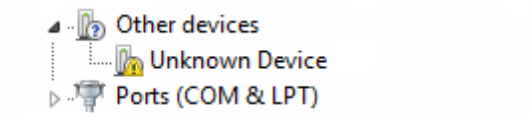
15. The firmware will begin updating right away. Firmware update should take approximately 90 seconds. If the window closes immediately upon executing the file, the firmware update has failed.



16. The XMi update progress will be shown in the command prompt window. When it has completed successfully it will say: **"avr dude done. Thank You."**

Installing the Serial to USB Driver

1. Navigate to: **Control Panel** → **Device Manager**
2. The Serial to USB device should be present as an unknown device:



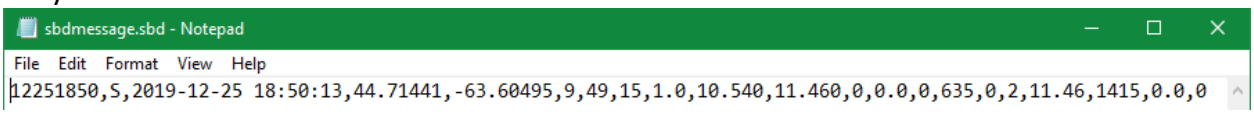
3. Right click the **Unknown Device**, select **Update Driver Software**.
4. In the new window, click **Browse my computer for driver software**.
5. Click on the **Browse** button and navigate to folder containing the Silicon Labs device driver.
6. Click **Next** and the driver should install.

Appendix F: GPS Text Long

GPS Text Long can be used for a more detailed summary of GPS information. This form is only presented in ASCII format and due to its length is a larger file, at around 110 bytes depending on the information sent.

Like GPS Text Short, only the most recent GPS position is sent, therefore this message format cannot be stacked.

Greyed out fields are not used in the XMI



GPS Text Long Readout	
12251850	Date and Time, MMDDHHMM
P	Position Type message
2019-12-25 18:50:13	Date and time, adds year and second of fix
44.71441	Latitude
-63.60495	Longitude
9	Number of satellites seen
49	Maximum SNR of fix
15	Time to fix
1.0	HDOP (Horizontal Dilution of Precision)
10.540	Loaded Voltage
11.460	Unloaded Voltage
0	Temperature
0.0	Speed
0	Heading
635	GPS Horizontal Error
0	Watch Circle Set 1 (Yes) 0 (No)
2	RSSI (Iridium signal strength)
11.46	Battery Voltage
1415	On-seconds, seconds since power-up/last reset
0.0	Degrees Celsius
0	Movement counter

Warranty, Support and Limited Liability

Xeos Technologies Inc. warranties the XMI 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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