



XMi User Manual

SUB-SURFACE IRIDIUM SATELLITE BEACON

Version 2.3
July 2015



Shipped From



Contact Us

Email: sales@xeostech.com

Phone: 902 444 7650

Fax: 902 444 7651

Web: www.xeostech.com

Table of Contents

Shipped From	1
Contact Us	1
Table of Contents	2
Version History	6
Overview	6
General Description	6
Theory of Operation	7
Setting up your Iridium Account	7
Quickstart	8
XMi Models	8
XMi-11k	8
XMi-11k RH	8
XMi-7500	9
XMi-7500 RH	9
On/Off Modes	9
Using the Magnets	9
LED Notes	10
Installation and Maintenance	10
Battery Options	10
Opening the Housing	11
O-Rings	12
O-Ring Locations	12
O-Ring Procedures	12
Replacing the Batteries	13

Power Consumption and Battery Life	14
Current Draw	14
Battery Life Estimates	14
Installation	15
Communicating with the XMi	16
Using Xeos Online	16
Adding your device to Xeos Online	16
Tracking your XMi	17
Sending Commands	18
Using E-mail	19
Attaching Email Command Files	19
Received Messages	20
Command Format	20
Using Bluetooth	21
Requirements	21
Downloading and Installing the App	21
Turning on Bluetooth	22
Connecting	22
Status Page	23
Configuration Page	24
Terminal Page	25
Firmware Update Page	26
Using Serial	27
Necessary Equipment	27
Disassembly	27
Connecting to the XMi	28

Understanding Position Information	28
Iridium Doppler Position	29
Global Positioning System Position	29
The XMi's Timers	29
Timer Types	29
SBD	29
GPS	29
WTR	30
XMi Timer Modes	30
Start-up Mode	31
Underwater Mode	31
Alert Mode	31
Normal Mode	31
Default Settings	32
Changing the Timers	32
The XMi's Sensors	33
Water Sensing	33
Additional Settings and Commands	33
Settings	33
Version	34
Timer	35
Lifetime Stats	35
Stats	36
Message Enable	36
Unlock Codes	38
Appendix A: XMi-Relay	39

Summary	39
Basic Functionality	39
Sending Data	39
Receiving Data	39
Settings	40
Appendix B: Technical Specification	41
Mechanical XMi-11k	41
Standard Enclosure	41
Short Enclosure	41
Mechanical XMi-11k RH	42
Standard Enclosure	42
Electrical	43
Power Supply	43
Electronics	43
Environmental	43
Engineering Diagrams	44
XMi-11k with Long Battery Enclosure	44
XMi-11k with Short Battery Enclosure	45
XMi-11k RH with Long Battery Enclosure	46
Warranty, Support, and Limited Liability	47

Version History

Version	Date	Description
1.0	Jan 2014	Base document
1.1	Jan 2014	Grammatical changes and formatting improvements
1.2	Jan 2014	Addition of Remote Head instructions for XMi RH
1.3	Feb 2014	Command changes
1.4	Mar 2014	Updated depth rating
1.5	Aug 2014	O-Ring part update, new sections added
1.6	Sep 2015	Updated material and durometer for O-ring part #
1.7	Feb 2015	Updated timer information
2.0	Apr 2015	Format revision, appendix additions
2.2	Jul 2015	Format revision, setting and timers overhaul
2.3	Aug 2015	Relay functionality added as Appendix A

Overview

General Description

The XMi Sub-Surface Iridium Satellite Mooring Location Beacon continuously monitors for unplanned 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 core 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 optional Remote Head version, the XMi RH, connects the battery pack to the electronics via a 6 foot 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 m 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 [Xeos Online](#). 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 hour. If you need to make a change to the settings, the XMi will receive the command on its next Iridium message check, up to 1 hour after the command is sent.

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.

Setting up your Iridium Account

The XMi makes use of the [Iridium satellite systems'](#) Short Burst Data (SBD) service for the 9602 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 9602 has a unique 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 or use the online form on our website: xeostech.com

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

There are only a few steps required to begin using the XMi:

1. Contact Xeos Technologies to provision your XMi and set-up a Xeos Online account. Make sure to have your XMi's IMEI number on hand.
2. Add your XMi to [Xeos Online](#)
3. [Install batteries](#) by unscrewing the XMi's end-cap
4. Put the XMi in a location with a clear view of the sky, and it will begin transmitting.

XMi Models

XMi-11k



Figure 1: XMi-11k

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

XMi-11k RH



Figure 2: XMi-11k RH

The XMi-11k RH features all the improvements of the XMi-11k, with the added flexibility of a 6' undersea cable for more precise load balancing and installation of antennas on subsea platforms.

XMi-7500

The previous generation XMi-7500 provides all the core features of the XMi-11k, excluding Bluetooth connectivity, for deployments of up to 7,500 meters (24606 feet).

XMi-7500 RH

The XMi-7500 RH is similar to the XMi-7500, with the added flexibility of a 6' undersea cable for more precise load balancing and installation of antennas on subsea platforms.

On/Off Modes

Using the Magnets

The XMi beacon is turned ON and OFF through the use of 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 quickly up and down at the location of the reed switch. The reed switch is located directly behind the Xeos Technologies Logo. A video of the process is available [here](#).

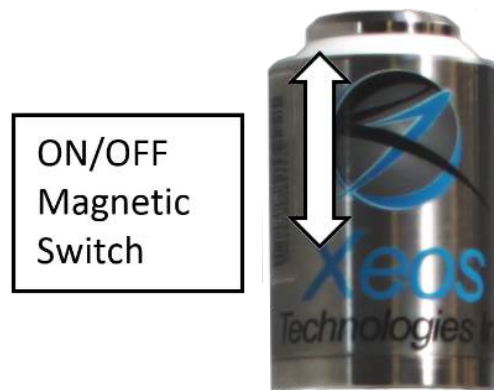


Figure 3: XMi Reed Switch

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.

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, therefore it is necessary that any tests be done outside of a building.

Installation and Maintenance

Battery Options

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



Figure 4: Standard Battery Tube - 16.04"

Standard Enclosure: Can hold 6 x AA alkaline (9V nominal) or lithium batteries.



Figure 5: Short Battery Tube - 13.455"

Short Enclosure: Can hold 7 x CR123A (21V nominal) lithium batteries

Opening the Housing

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

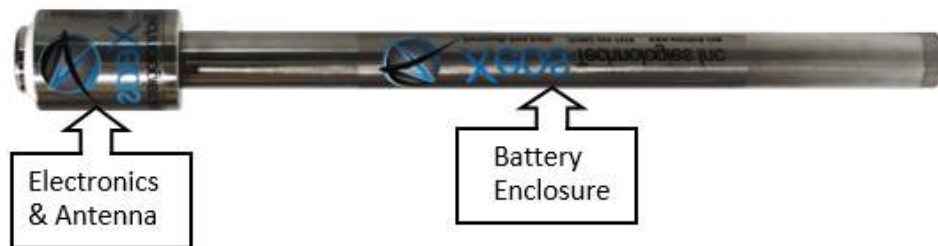


Figure 6: Labelled XMi

First, gently unscrew the end-cap from the battery enclosure.



Figure 7: Unscrewing the end-cap

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.



Figure 8: Plastic battery insert



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 has O-rings at three distinct locations:



Figure 9: Standard XMi O-rings

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.



Figure 10: Electronics board

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.

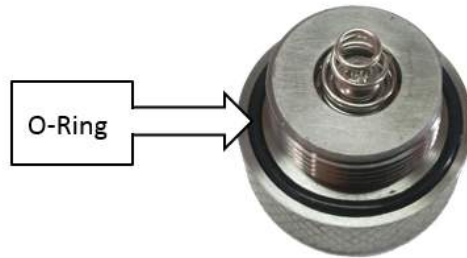


Figure 11: End-cap O-ring

To replace the O-Ring, remove the old O-ring, and 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 lube (Molykote 111 from Dow Corning) to the new O-ring.

To install the new O-ring, gently slide it down over the threads of the electronics section of enclosure and into the O-ring groove, just above the lip of the enclosure.



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 optional short enclosure only holds CR123A). The batteries are configured in a single column. Make sure to only use new batteries.

To replace the batteries, tip the old batteries out of the enclosure once the end-cap has been unscrewed. Make sure to dispose of them appropriately.

To replace the batteries, slide the first battery into the column, ensuring that the positive (+ve) terminal goes into the tube first. Then add the remaining batteries, in the same orientation. Once the enclosure is reassembled, the positive terminal will be pointing towards the electronics/antenna. **DO NOT MIX BATTERY TYPES.**

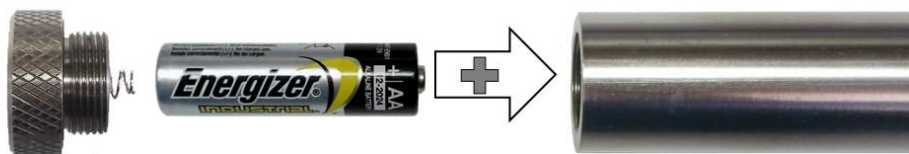


Figure 12: Inserting Batteries

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

The XMi is now ready for testing, and/or deployment.

Power Consumption and Battery Life

The XMi has an internal battery pack. The batteries should be replaced after any deployment exceeding 2 months.

Current Draw

Current draws are as follows (9V nominal):

Sleep current	50uA
Underwater current	25uA
Iridium transmission	60mA (approx. 30s duration)
GPS Acquisition	25mA (approx. 1m duration)

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.

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	952
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

Installation

When installing the XMi there are several factors that can influence performance.

1. The XMi's head should be pointing toward the sky.
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 and clamps to secure the XMi, this will cause erroneous water sense readings.

Communicating with the XMi

There are 4 ways to communicate with the XMi:

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

Using Xeos Online

Before using **Xeos Online** make sure that your account has been setup and your XMi added to your organization. Contact [support](#) for more information.

In a web-browser, navigate to **Xeos Online** and login with your username and password.

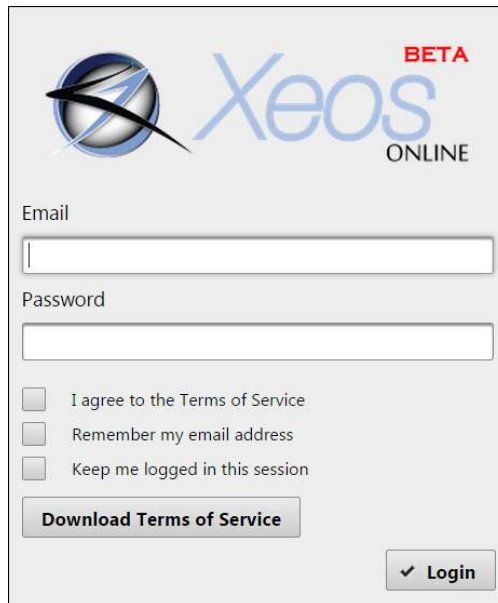


Figure 13: Xeos Online login page

Adding your device to Xeos Online

If you have not already setup your XMi as a device in **Xeos Online**, click on the **Admin tab** and then **Devices** to proceed. Select the New Device button and choose XMi from the device list.

Edit Device

Device: XMI

Organizations: Organizations

Enabled: ☒ Enabled

Name:

Notes:

IMEI:

Incoming SBD: Direct IP SBD

Outgoing SBD: Direct IP SBD

Encryption Key:

Decryption Key:

Cancel Save

Figure 14: XMi Timer Diagram

Name	Description
Device	Device type
Organization	Select any available organizations
Enabled	Enable or disable the device
Name	Give your XMi a descriptive name
Notes	Any additional details related to the XMi
IMEI	Copy and paste your XMi's IMEI
Other	Leave all other options as is

Tracking your XMi

Now that the XMi has been added to [Xeos Online](#), the user can send commands and track location and event data. First, make sure you have the right organization selected from the menu at the top-right of the screen.

Organization: Xeos Technologies

Figure 15: Organization Menu

Click the **Home** button at the top of the screen to get back to the main page of [Xeos Online](#). Select your device from the right-hand device area. Multiple devices may be selected.

Select **Map** to view the current location of your XMi, past GPS fixes and messages can be viewed at the **Location Log**, and **Message Log** tabs. [Xeos Online](#) does not refresh new

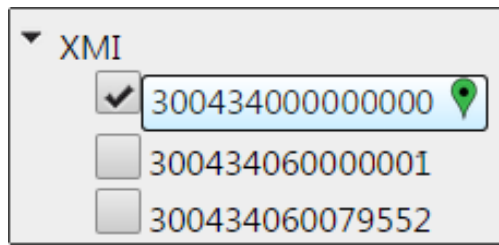


Figure 16: Device Selection

messages and locations automatically, an indicator will appear on the refresh button when new messages are available.



Figure 17: Home Tabs

Sending Commands

To Send commands through [Xeos Online](#), click on the **Options** button and select **Send Manual SBD**.

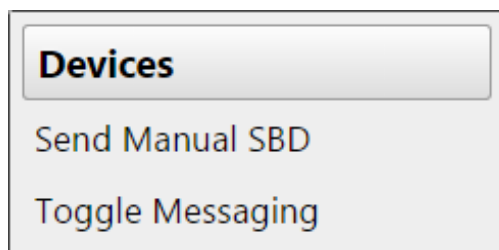


Figure 18: Send Manual SBD

The **Send SBD Dialog** will appear. Select the units you wish to target with commands and move them over to the right-hand target list. Type your command(s) into the command box and press send.

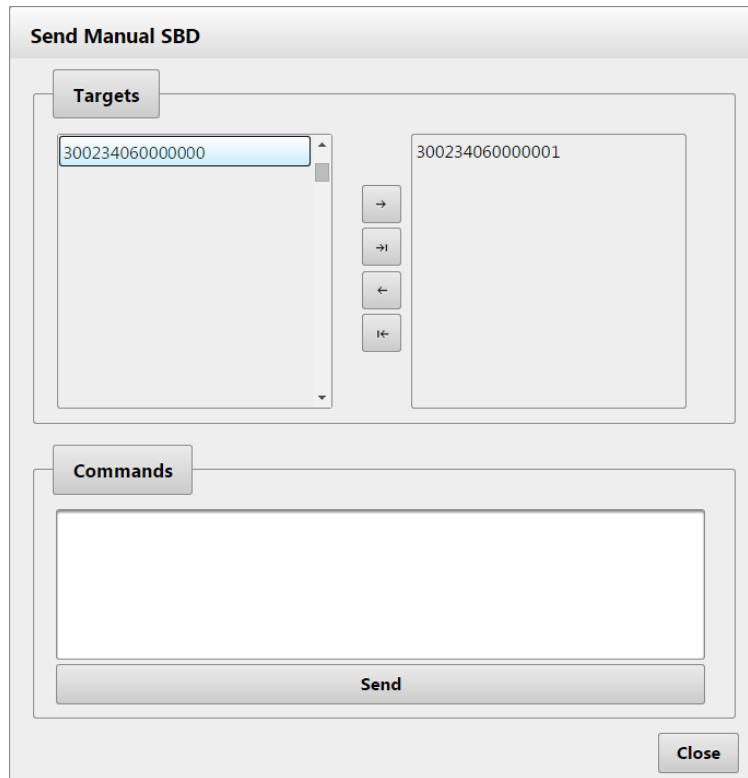


Figure 19: Send SBD Dialog

For more information on available commands, see [Timers and Settings](#)

Using E-mail

E-mail commands can also be used to communicate with the XMi when it is above water. These commands are sent as email attachments. Commands can configure the XMi remotely in the same way as commands sent by [Xeos Online](#). Available XMi commands are covered in [Changing Timers](#) and [Additional Settings and Commands](#).

Attaching Email Command Files

All command messages must be sent to the following email address:
data@sbd.iridium.com

- Messages must have only the unique IMEI number of the XMi in the subject line

- Command files must be sent to XMi as an attachment to a regular email message
- Text in the body of the message will be ignored

Your message is sent to the Iridium Gateway in Arizona, USA

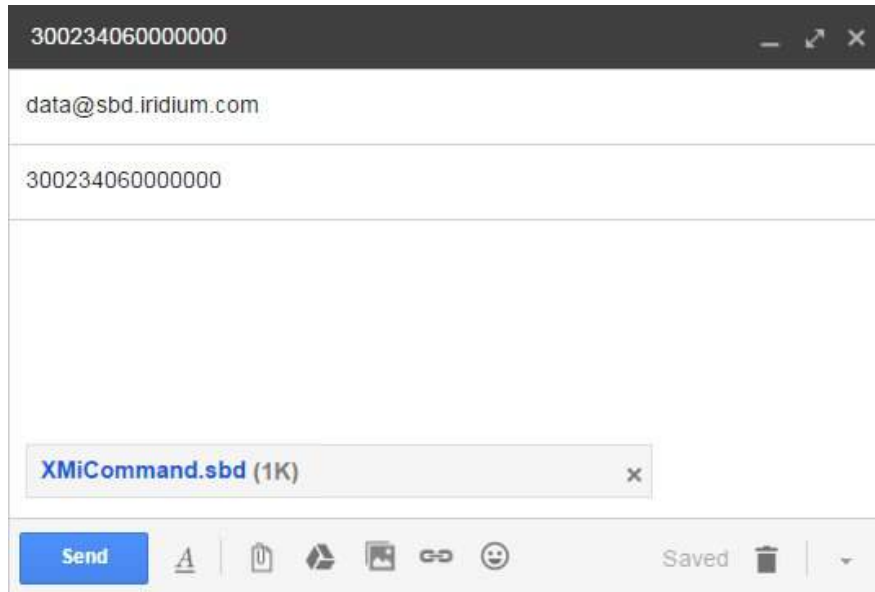


Figure 20: Sample SBD Email

A confirmation is immediately returned from the Gateway to let you know that your message has been received and is in the queue. This message is received from the address: sbdservice@sbd.iridium.com

Note that the Iridium gateway uses separate email address for commands and responses

Received Messages

Messages received from the XMi such as GPS messages or responses to Status requests arrive as email attachments to all of the email accounts that the XMi was provisioned with.

Command Format

Commands sent over E-mail must be formatted in the correct way, or they will be ignored. An unlock code must be included as the first line, see [Unlock Codes](#) for more information. Any number of commands can be included in an SBD file, but each command must be on a separate line.

When creating an SBD command file, the file must be saved with a **.sbd** file extension.

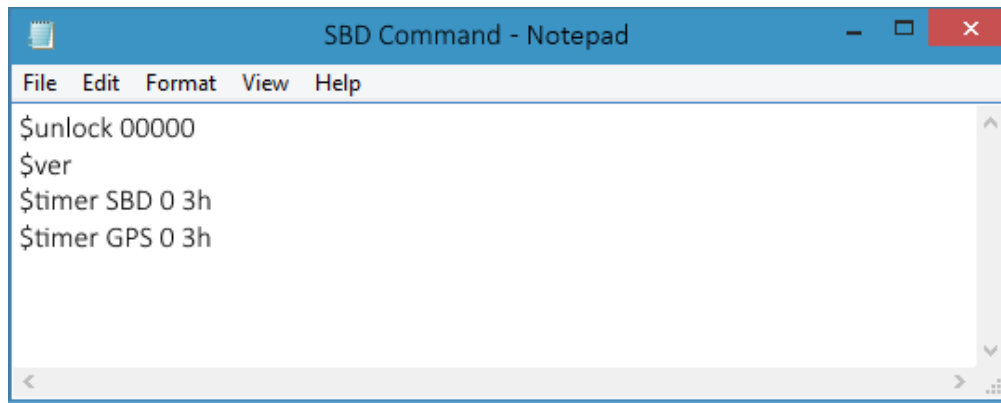


Figure 21: Sample SBD File

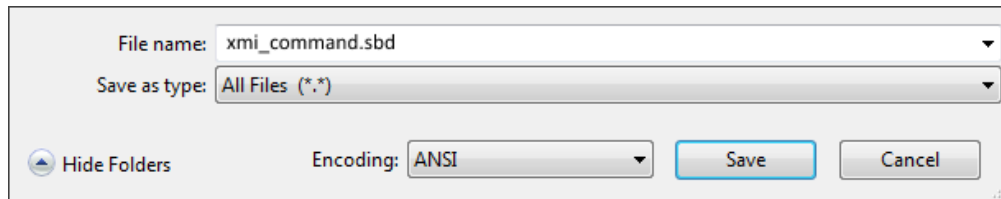


Figure 22: Saving an SBD file

Using Bluetooth

The XMi can also be configured locally using the Xeos Beacon Android App. Configuring your XMi with the App is quick, easy, and requires no disassembly.

Requirements

Using the App with your XMi Beacon requires a few prerequisites:

- An XMi beacon with Bluetooth enabled firmware. If you are unsure about this requirement, please contact with your XMi's serial number.
- An Android Smartphone compatible with Bluetooth Low Energy devices.
- The Xeos Beacon Android App.

Downloading and Installing the App

Not yet available for download.

Turning on Bluetooth

Before attempting to connect to your XMi, make sure it is powered on and Bluetooth functionality is enabled. The latter can be done in one of 2 ways:

1. Turn the XMi off and then on, using a magnet. See On/Off Modes
2. Send the XMi the following command over Iridium: **\$btpwr 1**

Connecting

When the Xeos Beacon App is first opened, the user is presented with the Connection Page.

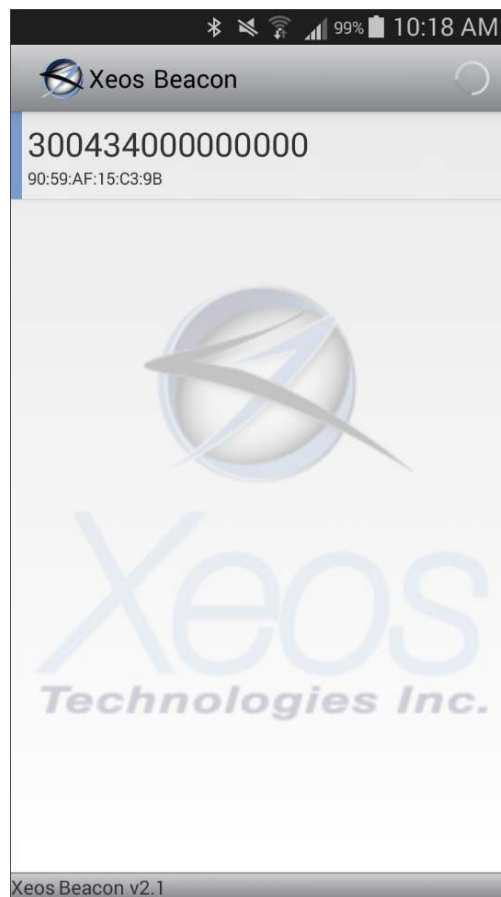


Figure 23: Connection Page

The App will list the name of any Bluetooth enabled device within range. By default the XMi's Bluetooth name will be its IMEI number. Tap your XMi's name to connect.

Status Page

When you first connect to the XMi, the App wil default to the **Status Page**:

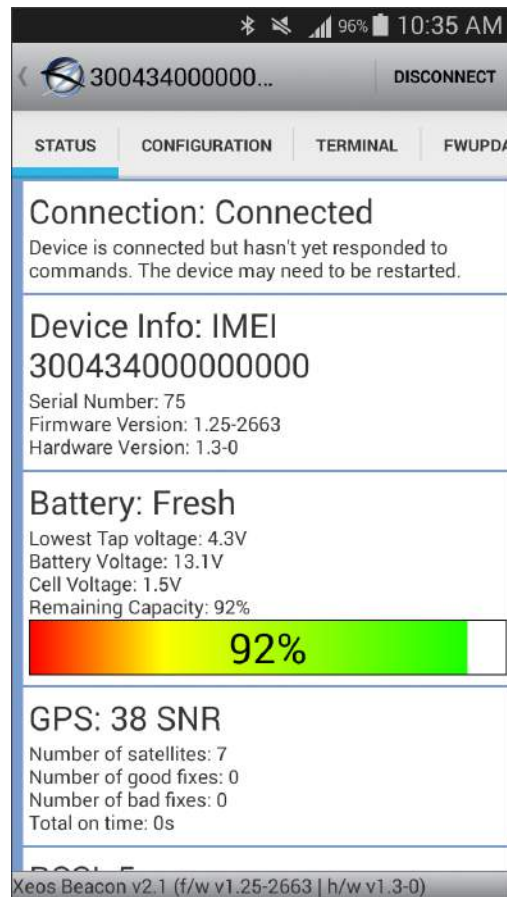


Figure 24: Status Page

The **Status Page** shows all relevant information regarding the current state of your XMi beacon, including:

- Current firmware information
- Detailed battery information
- GPS statistics since the last power-up
- Iridium RSSI strength

Configuration Page

Tapping the **Configuration** tab will bring up the **Configuration Page**:

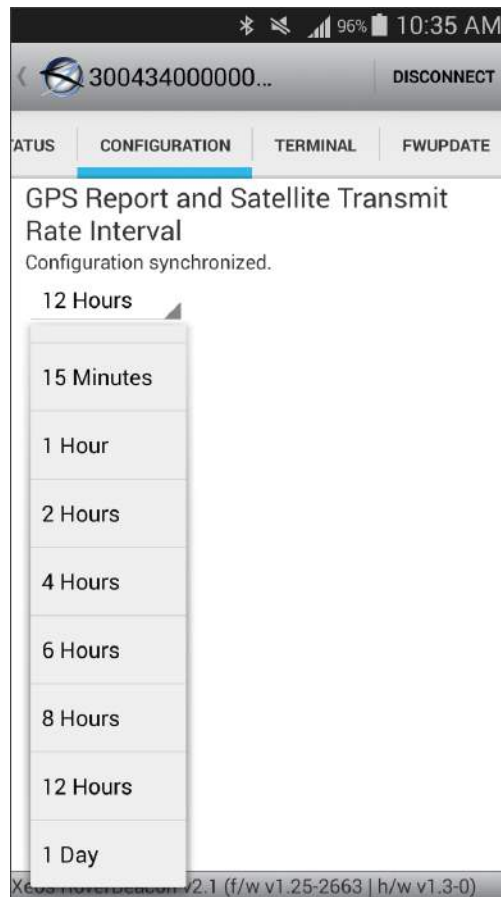


Figure 25: Config Page

Tap the **Interval List** for a drop-down menu of timings. Your selection will set the **Normal mode** timings for the GPS and Iridium reporting. Once you've made your selection, the App will update the XMi and report back with a **Configuration synchronized** message.

Terminal Page

Tapping the **Terminal** tab will bring up the **Terminal Page**:

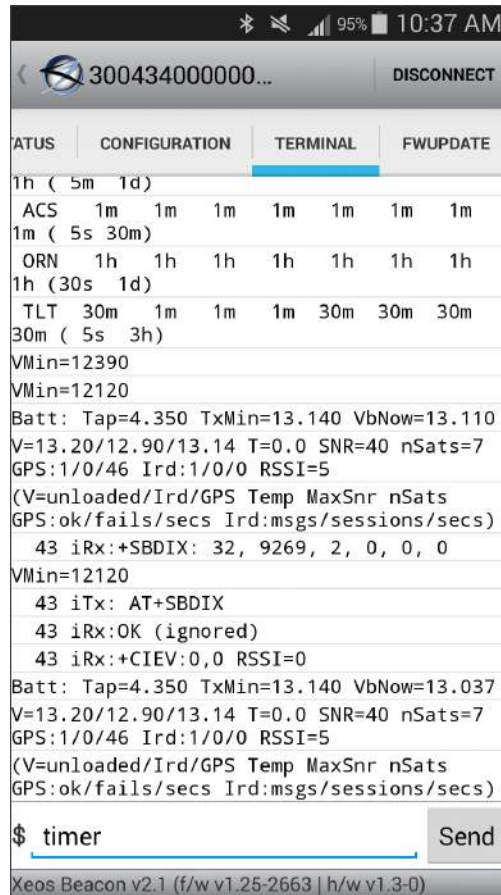


Figure 26: Terminal Page

The **Terminal Page** functions identically to a serial connection to the XMi. Commands can be typed at the bottom of the page. Tap **Send** to transmit the command. Auto-Scroll can be disabled by tapping the **Terminal Page** once.

Firmware Update Page

Tapping the **FWUpdate** tab will bring up the **Firmware Update Page**:

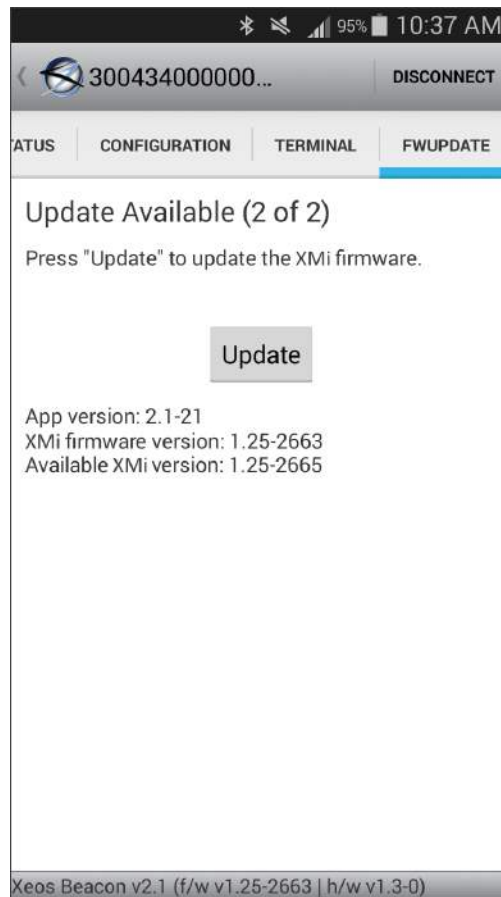


Figure 27: Firmware Update Page

If a firmware update is available for your XMi, you can upgrade your unit by pressing the **Update Button**. The App will upload a new firmware image at 500 bytes per second. Once the upload is complete, the XMi will perform a firmware upgrade on its next power-up. If the update is interrupted for any reason, simply restart the process.

Using Serial

The XMi can connect directly to your PC over serial. When connected in this way, the user can both send commands or update the unit's firmware.

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.
 - 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.
 - 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.
4. The XMi head can now be plugged into a PC using a micro-USB cable.
5. 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.

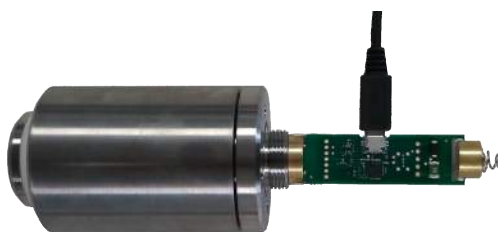


Figure 28: Diagnostic Port

6. 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.

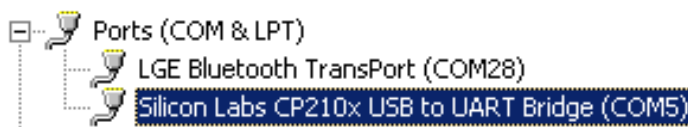


Figure 29: COM Port Entry

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	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.

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 the transmission, using Doppler technology. As a result, it is often very inaccurate. This location is only visible to users getting emails directly from the XMi, as opposed to emails forwarded by Xeos Online.

Global Positioning System Position

The location information is embedded in the SBD attachment sent via the Iridium Gateway. Users of the Xeos Online system will only see this location. The GPS fix is much more accurate than the Doppler position provided by Iridium.

The XMi's 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 receive any queued messages from the Iridium Gateway. Once this is finished and the received messages have been implemented, the XMi will transmit any messages queued for transmission.

GPS

The XMi will try to communicate with 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 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.

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.

XMi 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.

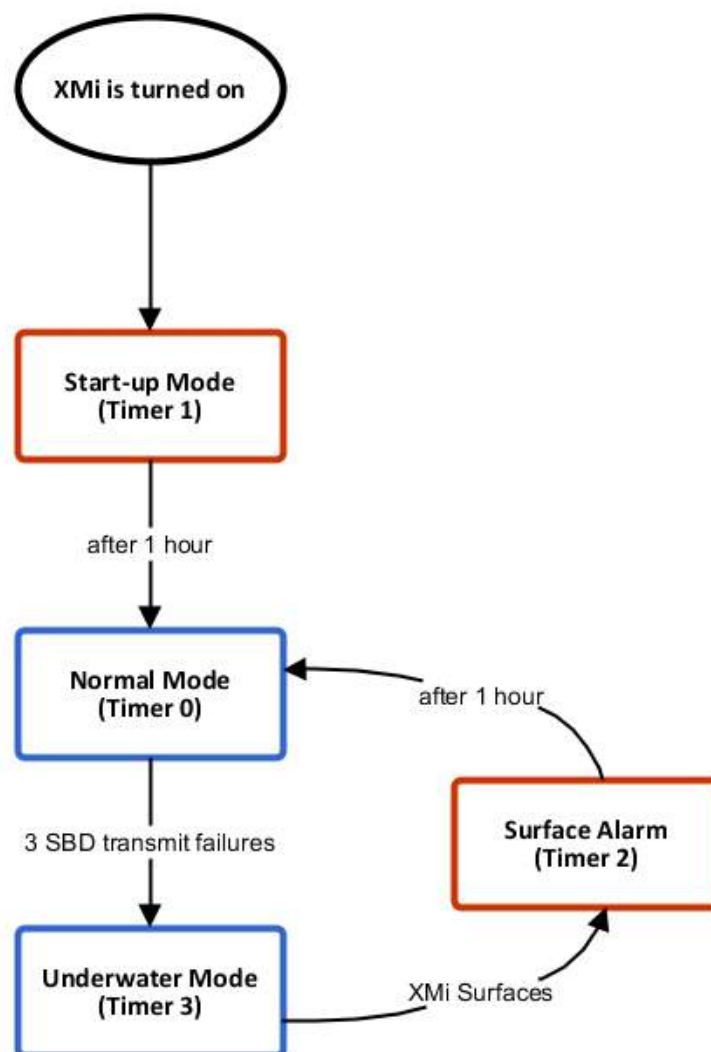


Figure 30: XMi Timer Diagram

Start-up Mode

Start-up mode (Timer 1) 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. This mode will last for one hour, after which the XMi will enter either **Normal mode** or **Underwater mode**.

Start-up mode will always last for 1 hour. This duration cannot be changed, however the GPS and SBD intervals can be set by the user. With default settings, the XMi will attempt 6 successful GPS and Iridium transmissions at 10 minute intervals during **Start-up mode**.

Underwater Mode

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 00:00 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 immediately be attempted. If the XMi successfully connects to the Iridium network, the XMi will exit **Underwater mode**.

The XMi will always exit **Underwater mode** if it successfully connects to the Iridium network. Once the XMi has exited underwater mode, **Alert mode** will begin. Since the XMi will only enter **Underwater mode** after a failed Iridium transmission, it can take several hours depending on the XMi's Iridium transmission rate.

Alert Mode

Alert mode will always begin after the XMi has exited **Underwater mode**. When it enters **Alert 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 **Alert mode** has finished, the XMi will enter **Normal mode**.

Normal Mode

Once Start-up mode has finished, the XMi will enter **Normal mode** if it is not underwater. This 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.

Default Settings

Mode	Timer 0	Timer 1	Timer 2	Timer 3
SBD	3h	10m	10m	1d
GPS	3h	10m	10m	1d
WTR	1m	1m	1m	1m

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

Changing the Timers

The length of the XMi's various modes cannot be altered. **Alert mode** and **Start-up mode** are fixed at 1 hour. However, the Iridium and GPS intervals can be changed to suit the user's requirements.

The GPS and Iridium interval timers can be set independantly 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:

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

Example 1 would change the GPS interval of Normal mode to every hour, while **Example 3** would change the SBD message interval to 6 hours. After sending the commands from 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.

The XMi's Sensors

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.



Figure 31: Sensor Measurement

Water Sensing

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 **Alert mode** for 1 hour.

```
Timestamp: 2015-07-15T19:11:36.000Z, Ascii: Surfaced
```

Figure 32: Xeos Online Surfaced Message

Additional Settings and Commands

There are a number of commands that can be sent to the XMi, in addition to changing timers. These commands can be sent locally or remotely. However, the response from remote commands is often less detailed in order to save bandwidth. Modifying these settings **will** affect the performance of the XMi. The following is a summary of remote commands:

Settings

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

```

Ascii: T/A:Td=0;Ts=100 GPS:MxOn=100;MxPr=30;Tmn=-30;Vmn=6.000;gBlk0=0,0;gBlk1=0,0;gRtyQ=2;gRtyD=20;gFRst=50;gBL=40;gFQ=24 ...
Sys:PB=2788;BtP=n;BtT=5;BtN=;LL=0;UC=0;aes=n;rHr=0;rMn=2 Ird:iBlk0=0,0;iBlk1=0,0;iRtyQ=2;Smx=8;MxLn=330;iWR=Y Tilt:Tt=5;Secs=120;Usec=120

```

Figure 33: Xeos Online Settings Response

System Settings

MxOn	Maximum GPS session length in seconds
MxPr	Maximum GPS session length in poor conditions
Tmn	Temperature minimum
Vmn	Voltage minimum
gBlk0	Unused
gBlk1	Unused
gRtyQ	GPS retry quantity
gRtyD	GPS retry delay in seconds
gFRst	Number of GPS failures for GPS reset
gBL	Maximum saved GPS fixes
gFQ	Maximum GPS fixes per message

System Settings

PB	Firmware Build
BtP	Bluetooth on or off
BtT	Bluetooth Timeout in minutes
BtN	Bluetooth Name
LL	Diagnostic Log detail level
UC	Unlock Code
aes	Unused by the XMi
Hr	Hour on which timings are based(24h UTC)
rMn	SBD hour offset in minutes

Iridium Settings:

iBlk0	Iridium Blackout, Unused
iBlk1	Iridium Blackout, Unused
iRtyQ	SBD Retry Quantity
Smx	Maximum SBD attempts per session
MxLn	Maximum message length (bytes)
iWR	Wait for registration

Tilt functionality is not used by the XMi.

Version

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

```
Powerup: true, Firmware Version: XMI-Torch v1.22-2443, dev:4, Hardware Revision: 2.5-0, Serial: 175, GPS Version: GSD4e_4.1.2-P1 R+ 11/15/2011 319-Nov 15, ...
Iridium Version: TA13001, Reset Data: Count = 15, Current = (S), Prev = (cleared)
```

Figure 34: Xeos Online Version Response

Powerup	Not applicable to \$ver
Firmware Version	Major, minor, build of current 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 chip
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

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,5m,3m,1m,1m,1h,2h,1h,1h Tmr:GPS,5m,3m,20s,20s,2h,2h,1h,1h
```

Figure 35: Xeos Online Timer Response

The timer string returned includes a summary of GPS and SBD timers. The first four timers are used by the XMi:

Timer 0 (Normal mode), Timer 1 (Start-up mode), Timer 2 (Alert mode), Timer 3 (Underwater mode).

The last 4 timers are unused by the XMi and can be ignored.

Lifetime Stats

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

```

BatteryV: 11.15, Uptime: 10872, Power Cycle Count: 3, Watchdog Reset Count: 0, Lowest Battery Voltage: 0, ...
Highest Battery Voltage: 13.290000000000001, Iridium Message Count: 14, Iridium Session Count: 12, ...
Iridium On Time: 11, Iridium Send Failures Non18: 18, Iridium Send Failures Type 18: 7, Bytes TX: 962, ...
Iridium Messages Received: 5, Bytes RX: 162, GPS Sessions: 14, GPS On Time: 6, GPS Fix Count: 10, ...
GPS TTFF Average: 9, High Temperature: 0, Low Temperature: 0

```

Figure 36: Xeos Online Lifetime Stats Response

BatteryV	Last measured battery voltage
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
Irdium 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	Average time to fix, in 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 particular statistics are similar to **\$statsl**, but exclude **Power Cycle Count** and **Watchdog Reset Count**.

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:

Message Number	Message Type
0	GPS Plain Text Short
1	GPS Plain Text Long
5	Argos PDR, unused by the XMi
6	Sensor Binary, unused by the XMi
7	Event Data, unused by the XMi
8	Water Sense Hist, water sense event data
10	GPS Bin Compressed
11	Motion Binary, unused by the XMi

At factory defaults, the following message types are enabled for each mode:

Timer Mode	Message Types
0	8, 10
1	8, 10
2	8, 10
3	8, 10
4	8, 10

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

\$msgenable timer message types

So to enable GPS plain text short, GPS Binary Compressed, and Water Sense data on Timer 0 (**Normal mode**) you would send the following command:

\$msgenable 0 0,10,8

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

Unlock Codes

The XMi uses unlock codes as a security measure to prevent unauthorized commands. The unlock code is generated on power-up after a successful firmware upgrade, or it can be changed manually through the diagnostic port. The unlock code is sent out to all provisioned addresses associated with the XMi's IMEI in a plain text message exactly 18 bytes in size.

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

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

Appendix A: XMi-Relay

Summary

Some custom versions of the XMi allow for serial relay functionality. At present this capability is only available over serial and not Bluetooth. XMi units with the proper firmware can send data to and from a connected serial device over the Iridium Satellite Network.

Basic Functionality

The XMi has a single serial line, it 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 enable by issuing the command **\$diag 1** and disabled with **\$diag 0** over the serial line. The XMi will always accept commands over Iridium.

Sending Data

Data sent by the remote device to the XMi for relay must be framed with specific characters:

\$sendSBD

Data to be sent

\$finished

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 in to several chunks and sent according to the XMI'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 is can cause loss of data and other issues if transmission conditions are not ideal. Contact [Xeos Technologies](#) if your requirements exceed default settings.

Receiving Data

Sending data to your connected device over the XMi's serial line is very simple. Using [Xeos](#)

Online messages must be sent in the following format:

\$outport a

Data to be sent

The **\$outport a** command must be immediately followed by a line terminator character. The rest of the message will be relayed to your connected device. The total message, cannot exceed 270 bytes.

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.

Appendix B: Technical Specification

Mechanical XMi-11k

Material All titanium with a non-permeable ceramic antenna component

Standard Enclosure

Dimensions 19.05" L x 2.02" diameter)

Weight 910 g - in water, 1400 g - out of water (Alkaline Batteries)

Short Enclosure

Dimensions 16.46" L x 2.02" diameter

Weight 795g - in water, 1245g - out of water (Alkaline Batteries)

Mechanical XMi-11k RH

Material All titanium with a non-permeable ceramic antenna component

Cable 1.846 m (6') long 20 AWG stranded (26x34) high-conductivity tinned copper conductors, EPDM rubber insulation & EPDM rubber jacket

Standard Enclosure

Dimensions (Head) 9.45" L x 2.02" diameter)

Dimensions (Battery Pack) 17.88" L x 1.125" diameter

Weight 1285 g - in water, 1800 g - out of water (Alkaline Batteries)

Electrical

Power Supply

Supply	6 AA batteries (Lithium or alkaline) - Standard Enclosure 7 x CR123A - Optional Short Enclosure
Sleep Current (9V)	50uA
Iridium Transmit (9V)	60mA
GPS Acquisition	25mA
Voltage	+9 Volts nominal (Standard enclosure 6 AA batteries) +21 Volts nominal (Short enclosure 7 x CR123A batteries)
Battery Capacity	2.4 Amp Hours (AA Alkaline) 3.0 Amp Hours (AA Lithium) 1.5 Amp Hours (CR123A Lithium)
Life Expectancy	1.5 Year sub-surface deployment with 30 days transmission at surface

Electronics

Digital Controller	Xeos IRDC-3
GPS Receiver	48 channel SiRFstarIV, GSD4e GPS chip
Iridium Modem	Iridium 9603 modem
Antenna	Xeos proprietary antenna, designed to withstand high pressure environments

Environmental

Operating Temperature	-40° c to +60° c
Depth Rating	Submersible to 36,089 feet (11,000m)

Engineering Diagrams

XMi-11k with Long Battery Enclosure



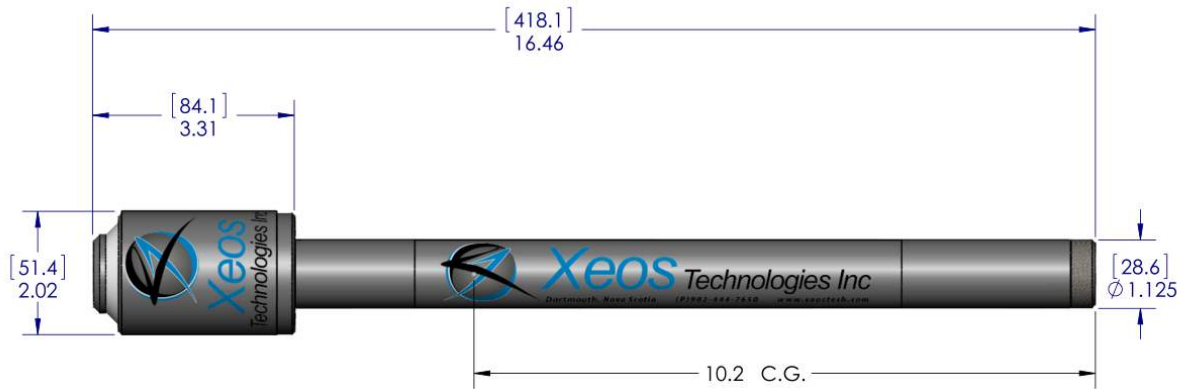
*Mass properties calculated with alkaline batteries



UNLESS OTHERWISE SPECIFIED:	Physical Properties
DIMENSIONS ARE IN INCHES TOLERANCES: ONE PLACE DECIMAL ± 0.05 TWO PLACE DECIMAL ± 0.005 THREE PLACE DECIMAL ± 0.001	Mass: 1400 g Relative Mass in Water: 910 g
PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF XEOS TECHNOLOGIES. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF XEOS TECHNOLOGIES IS PROHIBITED	

TITLE:			
XMi-11K			
SIZE	Rev	SCALE	Sheet
A	002	2:5	1 of 3

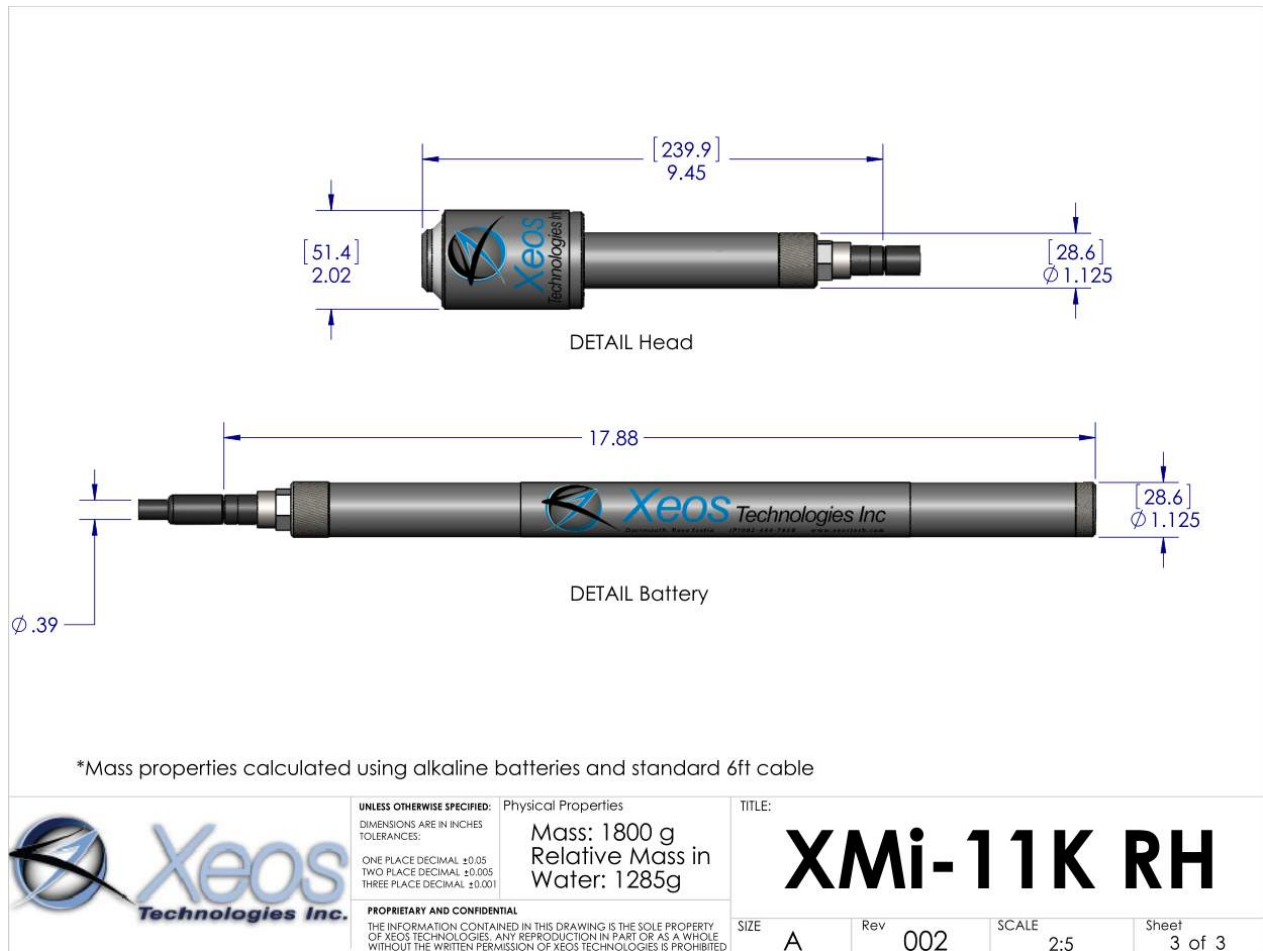
XMi-11k with Short Battery Enclosure



*Mass properties calculated with alkaline batteries

	UNLESS OTHERWISE SPECIFIED: Physical Properties		TITLE:	
	DIMENSIONS ARE IN INCHES TOLERANCES: ONE PLACE DECIMAL ± 0.05 TWO PLACE DECIMAL ± 0.005 THREE PLACE DECIMAL ± 0.001		Mass: 1245 g Relative Mass in Water: 795g	
	PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF XEOS TECHNOLOGIES. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF XEOS TECHNOLOGIES IS PROHIBITED.		XMi-11K S	
SIZE: A		Rev: 002	SCALE: 1:2	Sheet 2 of 3

XMt-11k RH with Long Battery Enclosure



Warranty, Support, and Limited Liability

Xeos Technologies Inc. warrants 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.

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 particular 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.