xeos
BY SATLINK

Apollo-X User Manual

Submersible Iridium / GNSS / LED Flasher

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Specifics

This manual version is written with respect to Apollo-X firmware build 12893. If you wish to acquire the latest firmware for your device, contact support@xeostech.com

The Apollo-X is the next generation and successor to the Apollo. For the manual of the original Apollo, please see here.

Version History

Version No.	Date	Description
1.0	Aug 2023	Base document
1.1	Jan 2024	Added Mechanical Drawings, new manual links, updated specs.
1.2	Apr 2024	Moved Drawings to drawings.xeostech.com
1.3	Oct 2024	Rebrand to Satlink
1.4	Nov 2024	Added Xeos Connect App. Voltage range adjusted.
1.5	Apr 2025	Ported Nemo-X magnetic switch section with new graphic.
1.6	Jul 2025	Replaced command summary with command index.

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

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Overview

The Apollo-X Submersible Iridium GPS-LED Flasher Mooring Location Beacon continuously monitors for unplanned or accidental release of subsurface instrument moorings.

The Apollo-X makes use of the bi-directional, global, real time Iridium Satellite Short Burst Data (SBD) network in combination with GPS position location and an ultra-bright LED flasher. The Apollo-X's tubular design allows it to be easily retrofitted into existing subsurface flotation configurations, such as syntactic foam.

Inside the Apollo-X is a 9603 Iridium Satellite Short Burst Data core radio transceiver, a specialized low power Xeos digital controller with GPS, ultra-bright LED, and battery package.

The Apollo-X is intended for subsurface deployments up to 11,000 meters below sea level. Xeos by Satlink (Xeos) manufactures other specific products for surface applications as well as sub-surface applications at varying depths.

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

Preliminary Setup

Outside Diagram

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

1	The LED of the Apollo-X is located here. The titanium sections above and below the glass must be shorted to trigger the water sense
2	The magnet switch for turning the Apollo-X on and off is located directly below the glass
3	The meeting point of the electronics head and battery chamber is torqued and should not be opened. A sealing O-ring is installed here.
4	The 15-digit IMEI of the Apollo-X's Iridium modem as well as factory serial number is labelled on the battery tube. On the Apollo-X1, this is on the head.
5	A QR code is available to scan to download the manual. On the X1, this is on the head.
6	The bottom end cap contains a sealing O-ring and allows for battery installation

Setting up an Iridium Account

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

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

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

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

See xeostech.com for more information.

Apollo-X Models

Apollo-X7

The long tube variant of the Apollo-X is the standard model, equipping the largest power supply by capacity and physical size.

While the Apollo-X7 operates in the same manner as the standard long-tube Apollo, this model uses seven size D 1.5V alkaline batteries with a nominal voltage of 10.5V.

The Apollo-X7 has a depth rating of 11,000 meters.

Apollo-X3

The short tube variant of the Apollo, the Apollo-3 offers a shorter, lighter package for easier mooring and has all of the capabilities of the standard version.

While the Apollo-X3 operates in the same manner as the Apollo-X7, this model **requires** three **Saft LSH20** size D 3.6V lithium batteries with a nominal voltage of 10.8V. It also has a different voltage threshold to account for its different battery pack for low battery mode.

Like its larger counterpart, the Apollo-X3 has a depth rating of 11,000 meters.

Apollo-X1

The X1 is a miniature, low voltage version of the Apollo-X beacon. The X1 incorporates all operational functionality of the Apollo-X7, but is certified to a depth of 6000m.

The smaller profile of the X1 **requires** one **Saft LSH20** Size D 3.6V lithium battery.

Apollo-X Remote Head (RH)

The Apollo-X RH is a remote head variant of the Apollo-X line, designed for easier mooring and weight distribution. Apollo-X RHs operate in the same manner as the standard Apollo-X, and can be ordered with long alkaline, or short lithium battery tube.

Since the Apollo-X RH can also be powered externally using its included cable, it can also be powered within the range of 6 to 28VDC.

See the Apollo-X RH Remote Head section for more details.

Apollo-X Operation

Using the On/Off Magnet Switch

The Apollo-X is can be turned on and off with the use of repeated swipes of a magnet against the head. A single swipe will display the on/off state of the Apollo-X in the form of strobe brightness.

To turn the Apollo-X on or off, swipe the magnet against the Apollo-X at the **Swipe Here** label until the Apollo o-X transitions power states. A transition between power states is shown with a **Dim to Bright** LED behaviour (if turning on) or a **Bright to Dim** behaviour (if turning off).

The internal mechanism of the magnet switch relies on repeated opening and closing with interaction from the magnet. Therefore, swipes must be wide enough for the magnet to leave the influencing area of this switch. The graphic below gives a reference for sufficient distance for swiping.

The on/off transition will cancel after 3 seconds if an insufficient number of swipes is received.
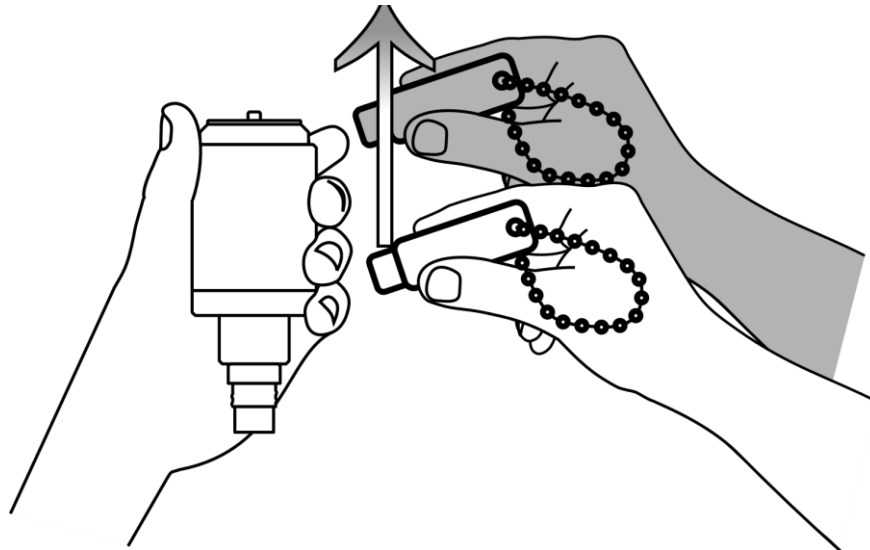
Note: If a new LED sequence begins after turning the Apollo-X **ON**, this indicates a self-test failure. See the section below on failure codes.

Operational Tips

- It is important to let all LEDs stop before initiating another action.
- Cycling power for any reason, such as using the magnetic switch or removing the bottom end cap, will initiate 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, far from potential obstructions.

Installation

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

- The Apollo-X's head must be pointing toward the sky.
- Iridium and especially GPS performance may suffer if large angles of the horizon are blocked, such as if the Apollo-X is next to a wall.
- Do not use conductive material at the top of the Apollo-X around the glass lens; this will cause the water sensor to give improper readings.

Messages from the Apollo-X

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

Version

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

```
Powerup: true, Ascii: Apollo-X7 v1.0-11094. dev:4 Hw:7.1.1 SN=1000
IMEI:300434068303400 Reset Count: 152 Latest Reset Reason: 1
```

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

Unlock

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

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

See below for more details on the Unlock Code.

```
Unlock Code: 19235
```

Position Message

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

Compressed Binary Position (Type GC)

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

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

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

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

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

ASCII Position (Type AG)

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

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

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

Default Message (Type DM)

The default message is transmitted at times when the device has no other data available to send other than its internal sensor states, where applicable. This could be because the GPS is not scheduled to run, or another factor has prevented a fix from being acquired.

```
Timestamp: 2023-06-21T11:02:05.000Z, Voltage Unloaded: 9.59, BatteryV:
7.94, Mode: Low Battery, isAlarm: true, Device Temperature (°C): 0,
Message Type: DM, Status: 33, No GNSS Position Stored: true, Daylight:
true
```

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

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

Surfaced (Type SF)

A specific message that is transmitted when the device, while in Underwater mode, successfully triggers a surfacing event and transmits that it has breached. This marks the beginning of Surfaced mode.

```
Timestamp: 2023-06-19T20:06:29.000Z, Voltage Unloaded: 9.73, BatteryV:
8.9, Mode: Underwater, isAlarm: true, Device Temperature (°C): 21,
Message Type: SUR, Surfaced: true
```

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

Watch Circle Parameters (Type WC)

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

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

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

Communicating with the Apollo-X

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

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

Sending Commands Using XeosOnline

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

Setting up to Send

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

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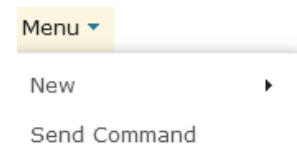
Remember to include the dollar sign (**$**) ahead of each command, and enter each command on a separate line.

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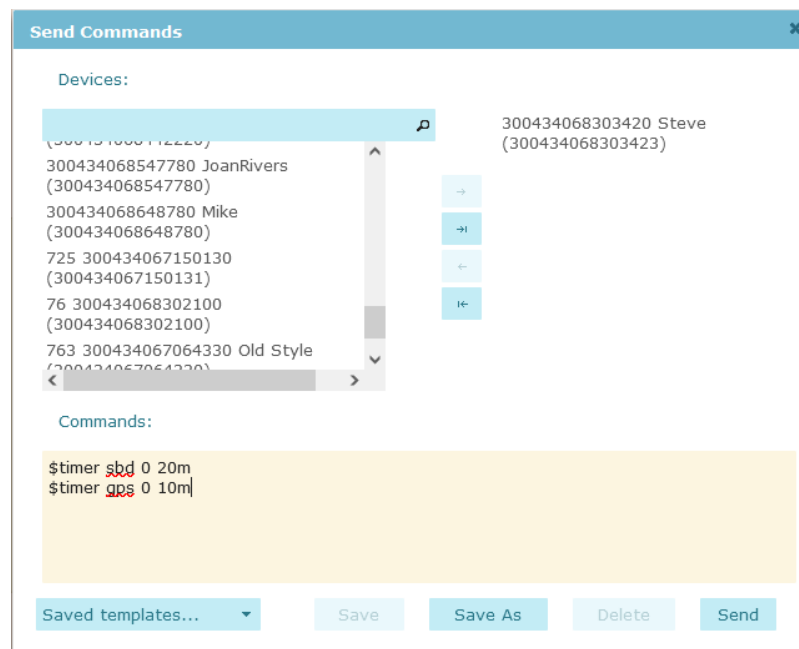
Sending Commands via Email

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

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

Command Format

Creating the file

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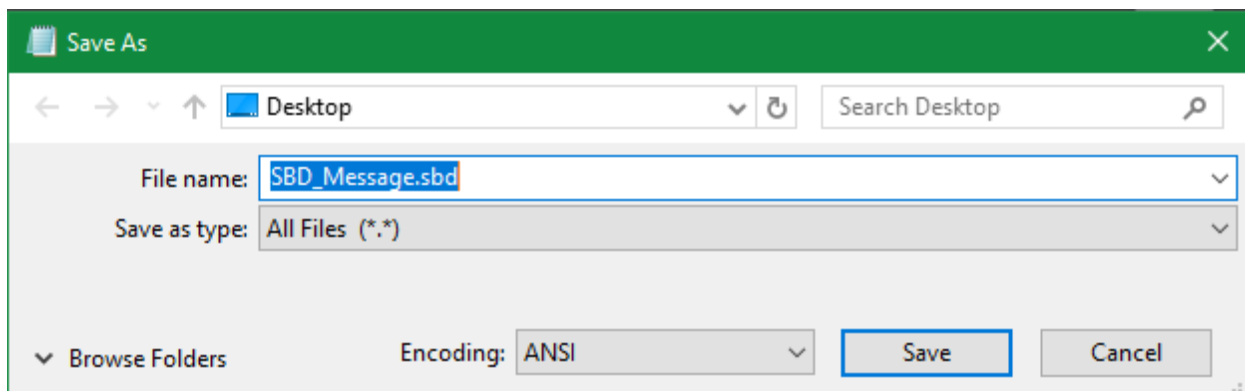
Command Structure

Commands must be structured in the following way:

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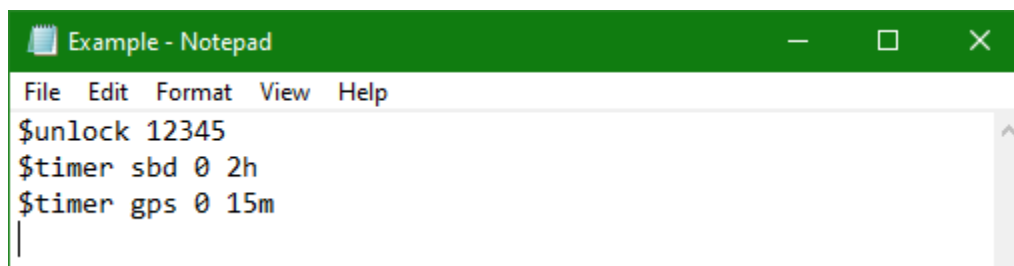
The Unlock Code

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

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

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

Sending the Command

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

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

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

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

Xeos Beacon Bluetooth App

Select Xeos products can be configured locally using the Xeos Connect 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 Apollo-X.

The Apollo-X's Scheduler

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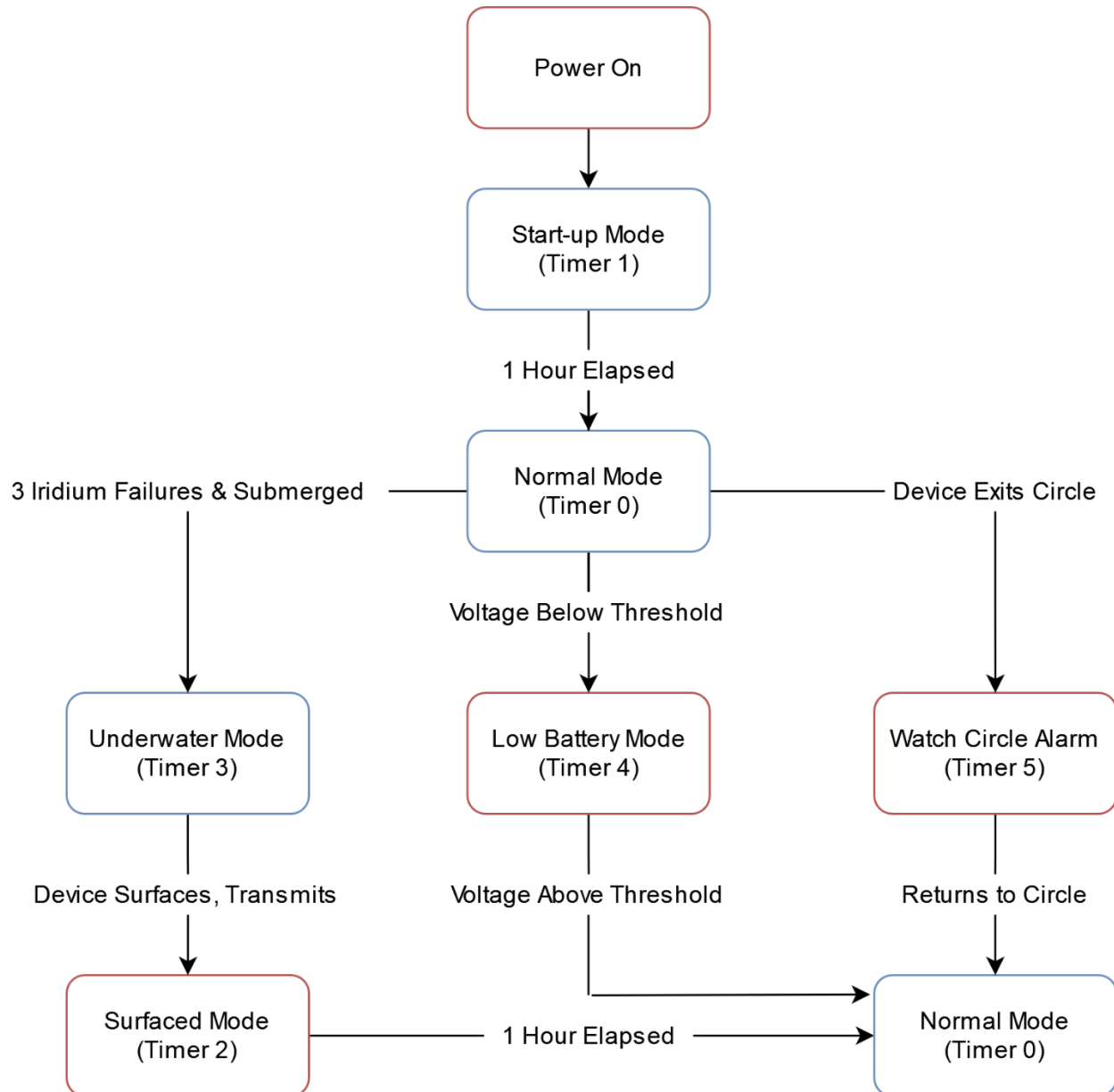
Apollo-X Tasks

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

GPS

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

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

SBD (Iridium)

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

Iridium also employs a retry scheme, in the event queued messages are not successfully transmitted. For each scheduled Iridium task, two retries are possible if necessary:

- Two minutes after the scheduled Iridium task ends, if a message was not sent
- Five minutes after the first retry task ends, if a message still has not been sent.
- If a message still has not been sent after both retries, it is queued for the next regularly scheduled Iridium task.
- Retries do not occur if the Apollo-X is in Underwater Mode.

WTR

The water sensor will regularly check to determine if the device is above or below the surface based on this timer. This is used for both entering and exiting Underwater Mode, as well as determining if it is an appropriate environment to run the strobe LED, under default configuration. Only one submerged/surfaced reading is required to disable/enable strobe flashing, respectively.

LIT

The Apollo-X's light sensor will take regular measurements to determine if it is appropriate to run the strobe LED. Only one light/dark reading is required to disable/enable strobe flashing, respectively.

This timer is not active in underwater mode.

TLT

At default settings the Apollo-X's tilt sensor is disabled. When enabled, the tilt sensor will take regular readings to determine the orientation of the Apollo-X.

After three consecutive inverted readings, the strobe LED will be disabled, in the same way water or light sense readings act on the strobe.

STB

The strobe LED will flash at the rate set for the timer mode that the Apollo-X is currently operating in, provided readings from other sensors do not prevent the operation, or a blocking task. These would be:

- The device detects that it is submerged via the water sensor
- Detection of sufficient light via the light sensor
- The Apollo-X finds itself to be inverted with the tilt sensor
- The Iridium task is currently running
- The device is in Low Battery mode

While the strobe's repetition rate can be changed for most timers using the **$strobe** command, the repetition rate can also be changed **for a specific timer** using the **$timer** command; a departure in operation from the original Apollo.

As noted above, the strobe is disabled during Low Battery mode. In this instance the **$timer** command must be used to prompt the strobe to run in this state. The number of flashes is consistent between all timer modes and would also be implemented here.

Apollo-X Timer Modes

Normal Mode (Timer 0)

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

Start-up Mode (Timer 1)

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

Surfaced Mode (Timer 2)

Surfaced mode begins after the Apollo-X has exited Underwater mode, sending a message indicating that it has surfaced. The Apollo-X then transmits one position every ten minutes for one hour. Once this mode has finished, the device will enter Normal mode unless another event is queued (ex. Low Battery).

Underwater Mode (Timer 3)

If the Apollo-X is unable to transmit successfully and fails to connect to the Iridium network after three attempts (tasks), **and** has detected with its water sensor that it is submerged, it will enter Underwater mode.

Once in underwater mode, the Apollo-X's GPS does not run, 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 every minute to detect a surfacing event. The light sensor does not run in Underwater mode.

While in Underwater mode, if the water sense detects that the Apollo-X has surfaced, an Iridium session will be queued and attempted. If the Apollo-X successfully connects to the Iridium network, the Apollo-X will exit Underwater mode and enter Surfaced mode.

The Apollo-X will always exit underwater mode if it successfully connects to the Iridium network. Since the Apollo-X requires three consecutive failed Iridium transmissions to enter this mode, it can take several hours depending on the Apollo-X's Iridium transmission rate.

If Tilt is enabled, the criteria above is still true, but inversion replaces the submerged state.

Low Battery Mode (Timer 4)

The Apollo-X will enter Low Battery mode if the device's voltage drops below the set threshold. This is triggered by two consecutive Iridium sessions with a minimum **loaded** battery voltage less than the threshold. This threshold depends on the product type, but can also be adjusted:

Apollo-X7	7.5 VDC
Apollo-X3	8 VDC
Apollo-X1	2.4 VDC

Watch Circle Alarm Mode (Timer 5)

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

Default Timer Settings

Timer	<T0>	T1	T2	T3	T4	T5	T6	T7	Min-Max
GPS	1h	15m	10m	n/a	2h	10m	n/a	1h	30s-7d
SBD	1h	15m	10m	1d	1h	10m	n/a	1h	30s-7d
WTR	1m	15s	1m	1m	1m	1m	n/a	1m	5s-1d
LIT	1m	15s	1m	1m	1m	1m	n/a	1m	5s-1d
TLT	1m	15s	1m	1m	1m	5m	n/a	1m	5s-1h
STB	15s	15s	15s	n/a	n/a	15s	n/a	20s	1s – 1m

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

Timers		
Timer 0	Normal	Used if no other modes are triggered
Timer 1	Start-up	Used immediately after power-up or reset (one hour duration)
Timer 2	Surfaced	Used when the device has surfaced (one hour duration)
Timer 3	Underwater	Used when the device determines it is underwater or inverted.
Timer 4	Low Battery	Used when the device consistently detects low voltage according to the set threshold
Timer 5	Watch Circle Alarm	Used when the device has exited its Watch Circle

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

Timer Command

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

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

Changing the Timers

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

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

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

$timer SYSTEM TIMER-MODE INTERVAL

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

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

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

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 one message every six hours containing six GPS fixes. These messages would be sent at approximately 00:00 UTC, 06:00 UTC, 12:00 UTC and 18:00 UTC.

Strobe LED

Strobe Number and Interval

There are two parameters available for configuring the Apollo-X's flasher; the interval and the pulse count. At default settings, the Apollo-X's LED will flash twice every fifteen seconds, each LED pulse lasts for 50 milliseconds.

Note: The strobe command will impact LED operation for all timer modes simultaneously, **except low battery mode**. To configure the strobe to run while in that mode, the **$timer** command with the **STB** task must be used.

The interval setting determines the number of seconds between flashes, while the pulse count determines the number of pulses with each flash. Both parameters are set using the following command:

<p align="center">$strobe [number of pulses] [interval in seconds]</p>

The number of pulses can be up to 4, while the period is limited to a maximum 60 seconds. The number of flashes is consistent between all timer modes and would also be implemented for Low Battery mode. This command is written as:

<p align="center">$strobe X Y</p>

Example	Command	Pulse Number	Strobe Interval
1	$strobe	1	20
2	$strobe	2	50

Sending the commands in Example 1 would set the flasher to pulse once every twenty seconds. Example 2 would set the flasher to pulse two times every fifty seconds. The device responds with the new setting when commanded.

Strobe Disabling

Some users may prefer to disable the Apollo-X's strobe regardless of environment. To disable the regular operation of the strobe, issue the following command:

<p align="center">$switch B 0</p>

To re-enable the strobe, issue:

<p align="center">$switch B 1</p>

With this feature, the strobe will not pulse according to its settings according to the **$strobe** command. The strobe will only illuminate if the magnetic reed switch is acted upon, as the LED is the visual aid used to indicate the Apollo's power status.

Using the **$switch** method to disable the strobe is saved in memory. This means the strobe will remain in a disabled state through resets unless commanded otherwise. Self-test failure codes and start-up/shutdown sequences will run regardless of environment.

Other Strobe Features

By default, the Apollo-X's strobe discontinues flashing once the device is submerged, or inverted (if Tilt is enabled). This can be changed to flash continuously regardless of submergence by issuing the command:

$StrFlshUw 1

The opposite setting is restored by sending:

$StrFlshUw 0

Watch Circle

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

Setting the Watch Circle

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

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

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

Example:

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

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

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

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

Additional Watch Circle Information

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

The Apollo-X's Sensors

Water Sensing

The Apollo-X'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.

The Apollo-X will use the current state of the sensor (submerged or surfaced) to make a final determination of whether or not the Strobe will run. It will also be utilized in conjunction with successful or failed Iridium transmissions to begin Underwater mode, or begin Surfaced mode, depending on the state change.

Once the water sensor measures that the Apollo-X is above water, it will immediately attempt to collect a position and transmit. If the Iridium task is successful, the Apollo-X will immediately transmit a 'surfaced message' and enter surfaced mode for 1 hour. After the hour has elapsed, the Apollo-X will return to normal mode, under normal circumstances.

Timestamp: 2023-06-19T20:06:29.000Z, Voltage Unloaded: 9.73, BatteryV: 8.9, Mode: Underwater, isAlarm: true, Device Temperature (°C): 21, Message Type: SUR, Surfaced: true

The Apollo'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.

The water sense reading taken by the device has to be **lower** than the threshold number when submerged, and **higher** than the threshold number when surfaced for a surfacing event to be triggered. Fresh water environments can vary in the reading given; testing should be done ahead of fresh water deployments to ensure proper operation.

To change the water sense threshold, use the command:

$wsthresh X

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

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

Light Sensing

The Apollo-X's light sensor regularly measures illuminance. If the light level is below the set threshold, the strobe will begin flashing according to its Strobe settings.

The light sensor can be disabled so the Apollo-X treats the environment as permanently dark using the following command:

$switch L 0

Tilt Sensing

The Apollo-X's tilt sensor, if enabled, regularly checks the orientation of the device. If the Apollo-X is tilted beyond its threshold, the Apollo-X will **not** strobe until returning to an upright position.

The Apollo-X can use the Tilt ability to enter Timer 3, instead of utilizing water sense. If the Apollo-X fails to transmit messages in three consecutive Iridium tasks, *and* the device is inverted, Timer 3 is initialized until the device returns to an upright position.

To activate the Apollo-X's tilt capability, use the command:

$switch T 1

The opposite value can be used to disable this feature.

Bluetooth

The Apollo-X has integrated Bluetooth hardware to facilitate local communication with the user for configuration and firmware upgrades via the Xeos Connect Android App.

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

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

In any of the above situations, Bluetooth will only run for **two minutes** after power-up or other power-on methods, plus any additional time that the user is connected with a paired device. When the user disconnects from the device, Bluetooth will run for an additional **one minute** to allow for reconnections, before turning off.

Since the Bluetooth in the Apollo-X shares the same antenna as GPS and Iridium, these other tasks will not run until Bluetooth has been disconnected from a paired device.

Command Index

The below is not an exhaustive list of the entire command set; presented are the settings and commands most likely to be utilized via Iridium or Bluetooth. Remember to add the **$** symbol ahead of any commands. Commands and arguments are **not** case-sensitive and are only given different cases for easier readability in this document.

Arguments below as **<#>** indicates a valid range of values. Arguments below in **[ARG]** indicates separate, required arguments after the command. Commands that do not take any arguments are shown as **n/a**

Enable/disable commands use a **TRUE**/**FALSE** setup arguments in the form of **1** or **0**.

Time-based commands use a numerical value followed by an appropriate time measurement:

s	Seconds
m	Minutes
h	Hours
d	Days

Command	Arguments	Description	Example
$timer	Ex. 1, **n/a** Ex. 2, [SYSTEM] [MODE] [VALUE**s**/**m**/**h**/**d**]	Display the entire configuration of all intervals of all systems (ex. 1), or change an interval (ex. 2) Systems SBD (Iridium Transmission) GPS (Position Collection) WTR (Water Sense) LIT (Light Sense) TLT (Tilt Sense) STB (Strobe) Modes 0 – Normal 1 – Start-up 2 – Surfaced	1 - $timer 2 - $timer SBD 0 1h

		3 – Underwater 4 – Low Battery 5 – Watch Circle Alarm	
$switch	Ex. 1, n/a Ex. 2, [COMPONENT] **1**/**0**	Display on/off states of components (ex. 1) or switch component on/off (ex. 2) Components: G – GPS L – Light Sense B – Strobe W – Underwater Mode T - Tilt	1 - $switch 2 - $switch L 0
$settings	n/a	Show all settings and thresholds	$settings
$status	n/a	Returns the timer mode in use	$status
$unlock	Ex. 1, n/a Ex. 2, [OLD_CODE] [NEW_CODE] <10000 – 99999>	Display the unlock code of the device (ex. 1), or change the unlock code of the device (ex. 2)	1 - $unlock 2 - $unlock 12345 67890
$sysInf	n/a	GPS and Iridium pass/fail summary, outputs "I" message	$sysInf
$iss	n/a	Display Iridium performance metrics	$iss
$viewsensor	n/a	Display latest sensor readings	$viewsensor
$setcircle	[LAT] [LONG] [RADIUS] Radius <50 – 15000>	Set the watch circle and enable	$setcircle 44.1841 -63.1886 700
$getcircle	n/a	Request the watch circle installed	$getcircle
$clearcircle	n/a	Empty watch circle settings and disable	$clearcircle
$strobe	[Number Flashes] [Interval] Strobe <1 – 4> Interval <1 – 60>	Set the number of flashes that occur in each strobing event, and set the interval for how often events occur. The strobe command impacts all timer modes where the STB rate is **not** set to n/a in the timer table (Underwater, Low battery by default)	$strobe 3 15
$StrFlshUW	**1**/**0**	Enable strobe flashing while underwater (1 = Flash Underwater)	$StrFlshUW 1

$btPwr	1/0	Bluetooth power on, for two minutes, or turn off Bluetooth immediately.	$btPwr 1
$btName	NAME	Set the Bluetooth name for the device. No spaces allowed, maximum 15 characters.	$btname MY_NEW_NAME
$ver	n/a	Show firmware/hardware version, product type, IMEI etc. Equal to the initial message after a reset.	$ver
$FactoryDefaults	n/a	Reset all to settings to defaults. The device does **not** reset.	$FactoryDefaults
$ResetNow	n/a	Restarts the system. The effect is the same as restarting via the magnet	$ResetNow
Inadvisable to change unless absolutely necessary.			
$lightthresh	<0 - 65535>	Set the threshold where the environment is dark (higher # = more likely to read dark)	$lightthresh
$wsthresh	<0 - 65535>	Set the threshold where the device shows as submerged (higher # = more likely to read submerged)	$wsthresh
$batterythresh	<200 - 28000>	Set the value the loaded voltage has to be lower than to trigger Low Battery mode, in **millivolts**	$batterythresh

Maintenance

Battery Options

The power source for the Apollo-X is its internal battery pack. There are three available enclosure sizes for the Apollo-X:

Product	Battery Type	Quantity
Standard Enclosure (X7)	Energizer Industrial LR20 alkaline	7
Short Enclosure (X3)	Saft LSH20 3.6V lithium	3
Apollo-X1	Saft LSH20 3.6V lithium	1

For lithium models, only the Saft LSH20 has the ability to source enough current to supply peaks in Iridium transmissions, therefore the Saft LSH20 is required for use with lithium Apollos.

Opening the Housing

The mechanism for opening the Apollo-X is the same regardless of which enclosure is provided. A plastic insert is vacuum-sealed on the X7 and X3 models to the full length of the inside of the battery chamber to prevent shorts with longer tubes. The X1's insert is removable, but should be present at all times.

The head for the Apollo-X7 and Apollo-X3 is torqued to the battery tube at the factory. Users should not attempt to unscrew the head when changing batteries, as the amount of force required could damage the electronics.

Battery Replacement

All Apollo-X batteries are oriented 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
- Slide the first battery into the column, ensuring that the positive (+) terminal faces the head of the Apollo-X
- Add the remaining batteries in the same orientation
- Restore the endcap to its place on the device, taking care to inspect the O-ring first.

DO NOT MIX BATTERY TYPES.

O-Rings

The Apollo-X7 and X3 models have O-rings at two distinct locations:

O-ring A is located at the connection between the electronics head and the battery tube. It is not recommended that users separate the electronics head from the battery tube unless as part of long-term maintenance and is torqued at the factory to deter opening.

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

Meanwhile, the Apollo-X1's singular O-ring is located at the centre joint.

All user-replaceable Apollo-X O-rings are the same part: **2-031/N70**

O-Ring Replacement

O-rings are critical to the waterproof nature of the Apollo-X. 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 Apollo-X.
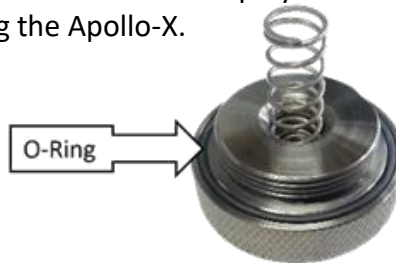
To replace the O-Ring:
- Remove the old O-ring with a non-metallic pick (toothpick), and clean all dirt away from the threads and grooves where it was seated using a lint-free cloth, cleaning alcohol, and a soft-brush.
- Apply a thin layer of seal lubricant (**Molykote 111 from Dow Corning**) to the new O-ring.
- Slide the new O-ring down over the threads of the endcap and into the O-ring 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; this could cause fatal damage to the unit.

Recovery and Storage

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

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

The Apollo-X should be cleaned and inspected for corrosion or water ingress inside the endcap. The endcap O-ring should be visually inspected.

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

The Apollo-X should be stored as follows:
- Dry location
- Assembled, **without batteries** but with O-rings in place
- Ambient temperature of -40° C to +85° C
- Either horizontal or vertical storage is permitted

Troubleshooting

LED extended blinking on start-up
Indicative of a self-test failure. The LED failure code will indicate the source of the detected failure.

No Iridium messages (assuming no self-test failure)
- Determine the nature of the issue (antenna-related, system related or location-related)
  - o Ensure the device's Iridium IMEI is active on the Iridium network with your service provider.
  - o Ensure the device is provisioned to send messages where intended.
  - o Change the location of the device; place the device in an area with as much total view of the sky as possible.
- Ensure correct batteries are being used; Apollo-X3's and X1's will still strobe even if outfit with alkaline batteries, though they cannot source the current to transmit.
- Ensure fresh batteries are being used.

Messages are not readable (in binary)
Messages are in compressed binary format by default; use the **$gpstype 2** command to change the format to ASCII.

No GPS/poor GPS (assuming no self-test failure)
- Change the location of the device; place the device in an area with as much total view of the sky as possible.
- Check the timing interval of the GPS system with the **$timer** command
- If the device is transmitting **DM** type messages, inspect the GPS status information, which can provide a reason for why the latest position failed, if this is the case.

Device is transmitting too frequently/not enough
- Check all intervals with **$timer** command
- Inspect the timer mode currently being used in transmitted messages
- Change timer interval as required

Self-Test Failure Codes

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

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

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

Appendix A: Apollo-X Remote Head (RH)

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

The Apollo-X RH is equipped with steering diodes for its input supply pins to allow for powering from two sources via a Y-cable. The Apollo-X RH would then be powered by the source that has the higher voltage. If only a single supply is utilized, the other pin is simply not utilized.

Note: While the pins are labelled with different names below, the Apollo-X RH treats both power sources the same. Xeos' standard battery pack pinout utilizes Pins 1 and 4 for V- and V+, respectively.

Connector Pinout
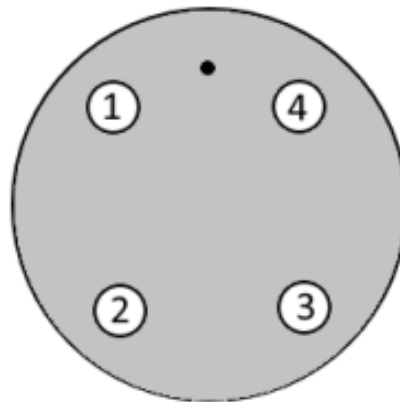
Connector: MCBH-4-FS-TI, External View

Pin Number	Name
1	Ground
2	No Connection
3	+V Battery (6VDC – 28VDC)
4	+V External (6VDC – 28VDC)
Guide pin for proper orientation is shown as black dot.	

Appendix B: Technical Specifications

Electrical				
	X7	X3	X1	X RH
Supply Range (VDC)	6 – 28	6 - 28	2.2 - 5	6 - 28
Batteries	Energizer Industrial LR20 D-Cell (7)	Saft LSH20 D-Cell (3)	Saft LSH20 D-Cell (1)	User Defined, Standard packs avail.
Battery Capacity (Amp hours)	18.5	13	13	User Defined
Voltage Input (VDC)	10.5 Nominal	10.8 Nominal	3.6 Nominal	User Defined
Idle (Surfaced, µW)	950	950	720	1050
Dormant (Underwater, µW)	270	270	270	375
Strobe Flash (mW/Flash, 50ms)	3600	3600	3100	3600
GPS Current (30s average, mW)	204	204	180	204
Iridium Tx (30s average, mW)	800	800	1200	800
Iridium Tx Peak (A)	1.5	1.5	1.5	1.5
Bluetooth Connected (mW)	40	40	36	40

Only the Saft LSH20 has the ability to source enough current to supply peaks in Iridium transmissions in lithium models, and is therefore required in these applications.

Batteries are strongly recommended to be removed if device is entering storage.

Electronics	
Digital Controller	Xeos Apollo-X
Antenna	Xeos proprietary antenna, designed to withstand high pressure environments
Iridium Transceiver	Iridium 9603
GNSS Receiver	Revision dependent Xeos 48 channel GPS (SiRFStarV) uBlox MAX-8C0
GNSS Datum	WGS84

Sealing	
Seal Lubricant	Molykote 111
O-ring Size	2-031/N70
O-ring Dimensions	1.75" x 1.875" x 0.070"

Mechanical Specifications

All Xeos Drawings are hosted in STEP and PDF format on drawings.xeostech.com

Appendix D: Supplemental Messages

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

System Information Message

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

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

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

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

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

Switch Response

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

```
Ascii: SWITCH: Y = ULGCB N = T
User Enable / Disable Settings:
(Switch)
e.....UnderwaterMode(U): YES
e..............Light(L): YES
e................GPS(G): YES
e.......Watch Circle(C): YES
e......Tilt Activate(T): NO
e............Strobe(B): YES
```
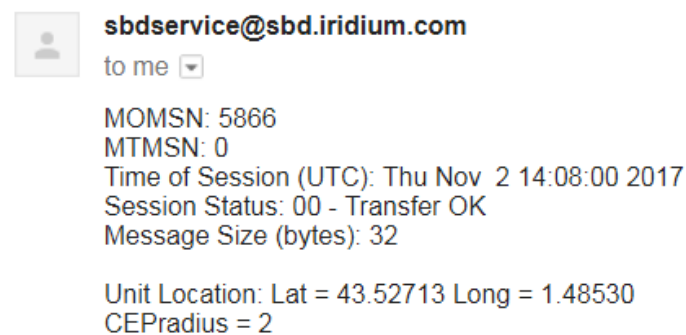
When any of the states of these systems is changed, the same message is sent in response.

Appendix E: Raw Iridium 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 Apollo-X, as opposed to emails forwarded by XeosOnline. An example of a "raw" Iridium message via email is below and will always have the IMEI of the device in the subject line, regardless of its name on XeosOnline.

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

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

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

Global Positioning System

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

Warranty, Support and Limited Liability

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

LIMITED WARRANTY: Xeos by Satlink 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 by Satlink entire liability and your exclusive remedy shall be at Xeos' option, either (a) return of the price paid or (b) repair or replacement of the product that does not meet Xeos' Limited Warranty and that is returned to Xeos 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 by Satlink 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 by Satlink 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, even if Xeos has been advised of the possibility of such damages.