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Overview

General Description

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

The APOLLO 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’s tubular design allows it to be easily retrofitted into existing subsurface flotation configurations, such as syntactic foam.

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

The APOLLO 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 Apollo 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.

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

The APOLLO provides notification of planned and unplanned surfacing events as well as location information on high value assets. After being activated, the APOLLO can be deployed at the depths of up to 11,000 m. The internal solid state sensor is triggered when the APOLLO surfaces from deployment. It will begin to flash and immediately send location messages as per the user settings. The internal battery pack provides over 10 years of subsurface deployment followed by up to 88 days of message transmissions.

Operators can communicate with the APOLLO once it has surfaced via Iridium using Xeos Online. Optionally, email commands can be sent directly to the APOLLO. 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 and the LED-flasher can be turned on or off. If you need to make a change to the settings, the APOLLO will receive the command on its next Iridium message check, up to 1 hour after the command is sent.

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

Setting up your Iridium Account

The APOLLO 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.

APOLLO 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 APOLLO. 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 APOLLO:

1. Contact Xeos Technologies to provision your APOLLO and set-up a Xeos Online account. Make sure to have your APOLLO’s IMEI number on hand.

2. Add your APOLLO to Xeos Online

3. Install batteries by unscrewing the APOLLO’s end-cap

4. Put the APOLLO in a location with a clear view of the sky, and it will begin transmitting.
Addition Models

The ION

The ION is a variant of the Apollo beacon designed for shallow and surface deployments. The titanium battery tube and end-cap of the Apollo are replaced with delrin plastic. The head casing of the ION is made from a Copper-Nickel alloy, which prevents the buildup of biofouling. The ION incorporates all features of the Apollo, but is certified to a depth of 1500m.

Unlike the Apollo, the ION is only available with a short tube, housing three 3.6V Lithium batteries with a nominal voltage of 10.8V.

The MONO

The MONO is a small-package version of the Apollo beacon. The MONO incorporates all features of the Apollo, but is certified to a depth of 6000m.

The smaller profile of the MONO allows for the use of only one 3.6V Lithium battery.

On/Off Modes

Using the Magnets

The APOLLO 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 APOLLO. To turn the APOLLO ON, press the magnet against the glass ring for a 1/2 second and then remove it for a 1/2 second. Do this twice, and the APOLLO will respond by changing its LED from dim to bright.

To turn the APOLLO OFF, repeat the above procedure with the magnet, and watch the LED change from bright to dim.

Using Iridium

In the event you wish to turn off a unit that is at sea, you can send the following command as an SBD message:
$\text{shutdown btpwr}$

The Apollo will turn off as if shut down via magnet when it receives this command on its next Iridium interval. For more information on sending commands to the Apollo, see Communicating with the Apollo.

**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 APOLLO is its internal battery pack. There are two available enclosure sizes for the APOLLO battery pack.

**Figure 2: Standard Battery Tube**

**Standard Enclosure:** Can hold 7 x D-Cell alkaline (10.5V nominal) batteries.

**Figure 3: Short Battery Tube**

**Short Enclosure:** Can hold 3 x D-Cell (10.8V nominal) 3.6V 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 APOLLO are housed in the larger diameter cylinder and the batteries in the narrower, longer cylinder.

![Figure 4: Labelled APOLLO](image)

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

![Figure 5: Unscrewing the end-cap](image)

Make sure that the clear plastic insert is inside the battery enclosure.

![Figure 6: Plastic battery insert](image)

The connection between the APOLLO’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 APOLLO has O-rings at three distinct locations:

O-ring A is located at the connection between the electronics head and the battery tube. It is not recommended that user’s separate the electronics head from the battery tube unless as part of long-term maintenance.

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.

O-Ring Procedures

O-rings are critical to the waterproof nature of the APOLLO. 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.
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 standard internal battery pack in the APOLLO can hold only 1.5 V D-Cell Alkaline batteries (Note: the optional short enclosure only holds 3.6 V D-Cell lithium). 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.**
Once all the batteries have been replaced the enclosure pieces can be reassembled, taking care to inspect and seat the O-ring first.

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

## Power Consumption and Battery Life

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

## Current Draw

Current draws are as follows (10.5V nominal):

<table>
<thead>
<tr>
<th>Current Draw</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep current</td>
<td>50uA</td>
</tr>
<tr>
<td>Underwater current</td>
<td>25uA</td>
</tr>
<tr>
<td>Iridium transmission</td>
<td>60mA (approx. 30s duration)</td>
</tr>
<tr>
<td>GPS Acquisition</td>
<td>25mA (approx. 1m duration)</td>
</tr>
<tr>
<td>LED Pulse</td>
<td>444mA (50ms flash duration)</td>
</tr>
</tbody>
</table>

## Installation

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

1. The APOLLO’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 APOLLO is next to a wall.

3. Avoid using metallic fasteners and clamps to secure the APOLLO, this will cause erroneous water sense readings.
Communicating with the APOLLO

There are 4 ways to communicate with the APOLLO:

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

Using Xeos Online

Before using Xeos Online make sure that your account has been setup and your APOLLO added to your organization. Contact for more information.

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

![Xeos Online login page](image)

Figure 11: Xeos Online login page

Adding your device to Xeos Online

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

Now that the APOLLO 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.

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 APOLLO, past GPS fixes and messages can be viewed at the Location Log, and Message Log tabs. Xeos Online does not refresh new
messages and locations automatically, an indicator will appear on the refresh button when new messages are available.

![Device Selection](image1.png)

**Figure 14**: Device Selection

To Send commands through Xeos Online, click on the **Options** button and select **Send Manual SBD**.

![Send Manual SBD](image2.png)

**Figure 16**: 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.

![Send SBD Dialog](image)

**Figure 17:** 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 APOLLO when it is above water. These commands are sent as email attachments. Commands can configure the APOLLO remotely in the same way as commands sent by [Xeos Online](#). Available APOLLO 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 APOLLO in the subject line
• Command files must be sent to APOLLO 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

![Sample SBD Email](image)

**Figure 18:** 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.irdium.com

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

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**Received Messages**

Messages received from the APOLLO such as GPS messages or responses to Status requests arrive as email attachments to all of the email accounts that the APOLLO 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.
The APOLLO can also be configured locally using the Xeos Beacon Android App. Configuring your APOLLO with the App is quick, easy, and requires no disassembly.

Requirements

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

- An APOLLO beacon with Bluetooth enabled firmware. If you are unsure about this requirement, please contact with your APOLLO’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 APOLLO, make sure it is powered on and Bluetooth functionality is enabled. The latter can be done in one of two ways:

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

**Connecting**

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

![Connection Page](Image)

**Figure 21**: Connection Page

The App will list the name of any Bluetooth enabled device within range. By default the APOLLO’s Bluetooth name will be its IMEI number. Tap your APOLLO’s name to connect.
When you first connect to the APOLLO, the App will default to the Status Page:

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

- Current firmware information
- Detailed battery information
- GPS statistics since the last power-up
- Iridium RSSI strength
Tapping the **Configuration** tab will bring up the **Configuration Page**:

![Configuration Page](image)

**Figure 23:** 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 APOLLO and report back with a **Configuration synchronized** message.
Tapping the **Terminal** tab will bring up the **Terminal Page**:

![Terminal Page](image)

**Figure 24**: Terminal Page

The **Terminal Page** functions identically to a serial connection to the APOLLO. 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.
Tapping the **FWUpdate** tab will bring up the **Firmware Update Page**:

![Figure 25: Firmware Update Page](image_url)

If a firmware update is available for your APOLLO, 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 APOLLO will perform a firmware upgrade on its next power-up. If the update is interrupted for any reason, simply restart the process.
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 APOLLO, 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 APOLLO’s Timers**

**Timer Types**

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

**SBD**

The APOLLO will attempt to communicate with the Iridium Gateway based on this interval. If the APOLLO 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 APOLLO will transmit any messages queued for transmission.
**GPS**

The APOLLO 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 APOLLO’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.

**WTR**

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

**LIT**

At default settings the APOLLO’s light sensor will take a measurement every 15 seconds. This timer is not active in underwater mode.

**TLT**

At default settings the APOLLO’s tilt sensor is disabled. When enabled, the tilt sensor takes a reading every 15 seconds, and will only take readings after a GPS fix has been acquired during that power-on session.
APOLLO Timer Modes

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

![APOLLO Timer Diagram](image)

**Start-up Mode**

**Start-up mode** (Timer 1) will begin when the APOLLO is turned on using magnet swipes, if power is applied to the APOLLO such as after a battery change, or if the APOLLO is reset by an SBD command. This mode will last for one hour, after which the APOLLO 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 APOLLO will attempt 4 successful GPS and Iridium transmissions at 15 minute intervals during **Start-up mode**.
**Underwater Mode**

If the APOLLO 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 APOLLO’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 APOLLO has surfaced, an Iridium session will immediately be attempted. If the APOLLO successfully connects to the Iridium network, the APOLLO will exit **Underwater mode**.

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

**Alert Mode**

**Alert mode** will always begin after the APOLLO has exited **Underwater mode**. When it enters **Alert mode** the APOLLO immediately sends an SBD message to the Iridium Gateway indicating that it has surfaced, then the APOLLO will transmit 1 GPS position every 10 minutes for 1 hour. Once **Alert mode** has finished, the APOLLO will enter **Normal mode**.

**Normal Mode**

Once Start-up mode has finished, the APOLLO will enter **Normal mode** if it is not underwater. This is the default timer mode of the APOLLO and will be used if no other modes apply. At default settings, the APOLLO will transmit 1 GPS fix every hour. If no other modes are engaged, the APOLLO will continue in **Normal mode** until its batteries are depleted or the unit powered off.

**Default Settings**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Timer 0</th>
<th>Timer 1</th>
<th>Timer 2</th>
<th>Timer 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBD</td>
<td>1h</td>
<td>15m</td>
<td>10m</td>
<td>1d</td>
</tr>
<tr>
<td>GPS</td>
<td>1h</td>
<td>15m</td>
<td>10m</td>
<td>1d</td>
</tr>
<tr>
<td>WTR</td>
<td>1m</td>
<td>1m</td>
<td>1m</td>
<td>1m</td>
</tr>
</tbody>
</table>

The default timer settings of the APOLLO are suitable for most use cases.
Changing the Timers

The length of the APOLLO’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 independently of each other, but there are several things to keep in mind. The APOLLO 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 APOLLO, timer commands are always the same format:

<table>
<thead>
<tr>
<th>Command</th>
<th>Timer</th>
<th>Mode</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1: $timer GPS 0 1h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Example 2: $timer GPS 2 5m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Example 3: $timer SBD 0 6h</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.
Configuring the Flasher

There are two parameters available for configuring the APOLLO’s flasher, the period and the pulse count. At default settings, the APOLLO’s LED will flash twice every ten seconds, each LED pulse lasts for 50 milliseconds.

The period 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: `strobe "number of pulses" "period in seconds"`. The number of pulses can be up to 4, while the period is limited to 60 seconds.

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameter 1</th>
<th>Parameter 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1: $strobe</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Example 2: $strobe</td>
<td>4</td>
<td>50</td>
</tr>
</tbody>
</table>

Sending the commands in Example 1 would set the flasher to pulse once for 50 ms every 20 seconds. While Example 2 would set the flasher to pulse 4 times every 50 seconds.
The APOLLO’s Sensors

The APOLLO’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 27: Sensor Measurement**

Water Sensing

When the APOLLO 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 APOLLO takes water measurements every minute.

Once the water sensor measures that the APOLLO is above water, it will immediately attempt an Iridium connection. If the Iridium connection is successful, the APOLLO will immediately transmit a ‘surfaced message’ and enter **Alert mode** for 1 hour.

**Figure 28: Xeos Online Surfed Message**

Light Sensing

The APOLLO’s light sensor measures illuminance every 15 seconds. If the light level is below the set threshold, the Flasher will begin flashing according to its **Strobe settings**.

To change the threshold of the light sensor, you must use the following commands:

$engmode 2009$: Used to unlock the light sense threshold command.

$lslvl x$: Set the light sense threshold to a specific value. The lower the number, the less light is required to disable the strobe (Max = 4000, Default = 600, Min = 40).

It is important to note that the APOLLO’s light sensor threshold is set according to outside illuminance. Indoor light sources can be more than ten times less powerful than the sun over a given area and may not trigger the flasher off as expected.
Tilt Sensing

The APOLLO’s tilt sensor, when enabled, takes an accelerometer reading every 15 seconds. If the APOLLO is tilted beyond its tilt threshold, the APOLLO will not attempt to transmit, and will not flash until it returns to an upright position. The timer for the tilt sensor is not activated until the APOLLO acquires at least one GPS fix.

To activate the APOLLO’s tilt capability, use the command:

$switch t 1

Additional Settings and Commands

There are a number of commands that can be sent to the APOLLO, 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 APOLLO. The following is a summary of remote commands:

Settings

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

```
Ascii:T/A:Td=0:Tc=100:GpsOn=100:MxOn=30;Mxm=30;Vmn=6.000;gBlk0=0.000;gBlk1=0.000;gRtyQ=2;gRtyD=20;gRts=50;gBL=40;gFQ=24  ...
SysP=2786;Bp=5;Bn=1;C=0;Uc=0;A=0;Rr=0;Mn=2;Hr=0;Blk=0;0;Hr=0;Rts=5;FQ=8;MxLn=330;Wys=5;Ttl=5;Sect=120;USec=120
```

Figure 29: 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
- **gRtQ**: 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 APOLLO
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 Settings:

tlThresh  Tilt Threshold
tlSecs  Tilt Seconds
tlSecs  Untilt Seconds

Version

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

Figure 30: 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 APOLLO
**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 31: Xeos Online Timer Response*

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

- **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 APOLLO 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 32: Xeos Online Lifetime Stats Response*
<table>
<thead>
<tr>
<th>Stat</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BatteryV</td>
<td>Last measured battery voltage</td>
</tr>
<tr>
<td>Uptime</td>
<td>Total unit uptime in minutes</td>
</tr>
<tr>
<td>Power Cycle Count</td>
<td>Number of power cycles</td>
</tr>
<tr>
<td>Watchdog Reset Count</td>
<td>Number of errors</td>
</tr>
<tr>
<td>Lowest Battery Voltage</td>
<td>Lowest measured battery voltage</td>
</tr>
<tr>
<td>Highest Battery Voltage</td>
<td>Highest measured battery voltage</td>
</tr>
<tr>
<td>Iridium Message Count</td>
<td>The number of SBD messages queued for sending</td>
</tr>
<tr>
<td>Iridium Session Count</td>
<td>Total successful Iridium connections</td>
</tr>
<tr>
<td>Iridium On Time</td>
<td>Total successful Iridium connections on first try</td>
</tr>
<tr>
<td>Iridium Send Failures non18</td>
<td>Iridium failures, excluding RF drop</td>
</tr>
<tr>
<td>Iridium Send Failures Type 18</td>
<td>Iridium failures due to RF drop</td>
</tr>
<tr>
<td>Bytes TX</td>
<td>Sum of all data sent in Bytes</td>
</tr>
<tr>
<td>Iridium Messages Received</td>
<td>Successfully received SBD messages</td>
</tr>
<tr>
<td>Bytes RX</td>
<td>Sum of all data received in Bytes</td>
</tr>
<tr>
<td>GPS Sessions</td>
<td>Total GPS attempts</td>
</tr>
<tr>
<td>GPS On Time</td>
<td>Total successful GPS fixes on first try</td>
</tr>
<tr>
<td>GPS Fix Count</td>
<td>Successful GPS fix count</td>
</tr>
<tr>
<td>GPS TTFF Average</td>
<td>Average time to fix, in seconds</td>
</tr>
<tr>
<td>High Temperature</td>
<td>Not used with the APOLLO</td>
</tr>
<tr>
<td>Low Temperature</td>
<td>Not used by the APOLLO</td>
</tr>
</tbody>
</table>

**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 APOLLO has several message types that can be enabled for GPS and event messages. At factory defaults, the APOLLO 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 APOLLO has the following message types available:
<table>
<thead>
<tr>
<th>Message Number</th>
<th>Message Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>GPS Plain Text Short</td>
</tr>
<tr>
<td>1</td>
<td>GPS Plain Text Long</td>
</tr>
<tr>
<td>5</td>
<td>Argos PDR, unused by the APOLLO</td>
</tr>
<tr>
<td>6</td>
<td>Sensor Binary, unused by the APOLLO</td>
</tr>
<tr>
<td>7</td>
<td>Event Data, unused by the APOLLO</td>
</tr>
<tr>
<td>8</td>
<td>Water Sense Hist, water sense event data</td>
</tr>
<tr>
<td>10</td>
<td>GPS Bin Compressed</td>
</tr>
<tr>
<td>11</td>
<td>Motion Binary, unused by the APOLLO</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Timer Mode</th>
<th>Message Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>8, 10</td>
</tr>
<tr>
<td>1</td>
<td>8, 10</td>
</tr>
<tr>
<td>2</td>
<td>8, 10</td>
</tr>
<tr>
<td>3</td>
<td>8, 10</td>
</tr>
<tr>
<td>4</td>
<td>8, 10</td>
</tr>
</tbody>
</table>

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 APOLLO will use additional Iridium data.
Unlock Codes

The APOLLO 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 APOLLO’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 APOLLO, 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: APOLLO-Relay

Summary

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

Relay functionality is only available with the APOLLO Remote Head.

Basic Functionality

The APOLLO has a single serial line, it must be switched between relay and diagnostics mode. By default the APOLLO-Relay will be in relay mode and will not accept most commands. Diagnostics can be enabled by issuing the command `$diag 1`, and disabled with `$diag 0` over the serial line. The APOLLO will always accept commands over Iridium.

Sending Data

Data sent by the remote device to the APOLLO 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 APOLLO’s SBD interval. Each Iridium transmission can send up to 8 sbd messages of 330 bytes each, including SBD header info.

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 APOLLO’s serial line is very simple. Using **Xeos Online** messages must be sent in the following format:

```plaintext
$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 APOLLO’s serial settings are identical to what is detailed at Connecting to the APOLLO. It is recommended that relay functionality be tested over a USB connection before deployment.
Appendix B: Hades

Description

The Hades variant of the Apollo provides continuous GPS updates to any connected devices. GPS updates include both NMEA sentences and a connection to the GPS circuit’s PPS pin. GPS will run continuously while the Apollo is not underwater, outputting a GGA sentence once per second.

Enabled NMEA Strings include:

- **GGA**: Fix information
- **GLL**: Lat/Lon data
- **GSA**: Satellite Data
- **GSV**: Detailed Satellite Data
- **RMC**: Recommended Minimum Specific GNSS Data
- **VTG**: Course Over Ground & Ground Speed

Connector Pinout

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PPS RS-232</td>
</tr>
<tr>
<td>2</td>
<td>TXD RS-232</td>
</tr>
<tr>
<td>3</td>
<td>RXD RS-232</td>
</tr>
<tr>
<td>4</td>
<td>+V Battery</td>
</tr>
<tr>
<td>5</td>
<td>+V External</td>
</tr>
<tr>
<td>6</td>
<td>Ground</td>
</tr>
</tbody>
</table>
## Appendix C: Technical Specification

### Mechanical APOLLO

**Material**  
All titanium with a non-permeable ceramic antenna component

### Standard Enclosure

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>20.83” L x 2.00” diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
<td>2562 g - in water, 3637 g - out of water (Alkaline Batteries)</td>
</tr>
</tbody>
</table>

### Short Enclosure

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>11.15” L x 2.00” diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
<td>1264g - in water, 1839g - out of water (Lithium Batteries)</td>
</tr>
</tbody>
</table>

### MONO

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>5.77” L x 2.00” diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
<td>280g - in water, 590g - out of water (Lithium Battery)</td>
</tr>
</tbody>
</table>

### ION

<table>
<thead>
<tr>
<th>Material</th>
<th>Copper Nickel head casing with a non-permeable ceramic antenna component. Delrin battery enclosure and end-cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions</strong></td>
<td>11.875” L x 2.00” diameter</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>1760g - in water, 1149g - out of water (Lithium Batteries)</td>
</tr>
</tbody>
</table>
## Electrical

### Power Supply

**Supply**
- 7 x D-Cell 1.5V Alkaline Batteries - Standard Enclosure
- 3 x 3.6V D-Cell Lithium Batteries - Optional Short Enclosure & ION model
- 1 x 3.6V D-Cell Lithium Battery - Mono

**Supply Range**
- +7V to +30V - Standard and Short Apollo, ION
- +3.6V - Mono

**Sleep Current (10.5V)**
- 50uA

**Iridium Transmit (10.5V)**
- 60mA

**Sleep Current (3.6V)**
- 250uA

**Iridium Transmit (3.6V)**
- 120mA

**GPS Acquisition**
- 25mA

**Voltage**
- +10.5 Volts Nominal (Standard 7 D-Cell Alkaline Batteries)
- +10.8 Volts Nominal (Short Enclosure 3 D-Cell Lithium Batteries)
- +3.6 Volts Nominal (Apollo Mono 1 D-Cell Lithium Battery)

**Battery Capacity**
- 18.5 Amp Hours (D-Cell Alkaline)
- 13.0 Amp Hours (D-Cell Lithium)

### 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)
Not yet available
Physical Properties

Mass: 590g
Mass in Water: 280g
Warranty, Support, and Limited Liability

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

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

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

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