Xeos Technologies Inc.

Kilo User Manual

SUBMERSIBLE IRIDIUM/GPS BEACON

Version 3.0.1

August 2020

Shipped From

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Specifics

This manual version is written with respect to Kilo firmware build 6067. If you wish to acquire the latest firmware for your device, contact support@xeostech.com

Version History

Version No.	Date	Description
1.0	May 2011	Base document
1.1	May 2011	Updated SBD messaging to Kilo
1.2	Feb 2012	Updated specifications including XO information
1.3	May 2012	Updated specifications including warranty
1.4	Aug 2014	Formatting
1.5	Sep 2014	Added watch circle commands
1.6	Feb 2015	Updated watch circle commands and XO instructions
1.7	Jun 2015	Added instructions
2.0	Sep 2017	Document overhaul
2.1	Oct 2017	Corrections to Tilt and Watch Circle Commands
2.2	Mar 2018	Added Specifics Section, higher quality figures
2.3	Apr 2018	Added Understanding Position Information section
2.4	Jun 2018	Updated water sense diagram
3.0	Apr 2020	Document Overhaul
3.0.1	Aug 2020	Fix to Underwater Mode section

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

Table of Contents

General Description

The Kilo Subsurface Iridium Satellite Mooring Location Beacon continuously monitors for unplanned or accidental release of subsurface instrument moorings. The Kilo makes use of the bi-directional, global, real time Iridium Satellite Short Burst Data (SBD) network in combination with GPS position location. The Kilo's sleek tubular design allows it to be easily retrofitted into subsurface flotations such as syntactic foam.

Inside the Kilo is a stainless-steel chamber, 9602 Iridium satellite Short Burst Data core radio transceiver, a specialized low power Xeos digital controller with GPS, Iridium antenna, GPS antenna, and water sense circuitry specially designed to measure changes in capacitance.

Kilo is intended for use in both surface and subsurface deployments and is rated for 2500m below sea level. Xeos Technologies Inc. manufactures other specific products for either surface or subsurface applications, up to 11,000m below sea level.

Theory of Operation

The Kilo is intended for instantly and accurately locating and recovering high value, free drifting surface assets at sea during surface deployments, or sub-surface deployments at the time of surfacing. At default settings, the Kilo will operate for up to 6 months, with 1 year underwater in addition.

The Kilo can establish a watch circle post-deployment and will notify users if it moves outside of the watch circle area. If the Kilo exits its circle or surfaces, it will transmit a position message every 10 minutes for 1 hour. After the first hour, the Kilo will exit this mode and continue to transmit at its user configurable timings.

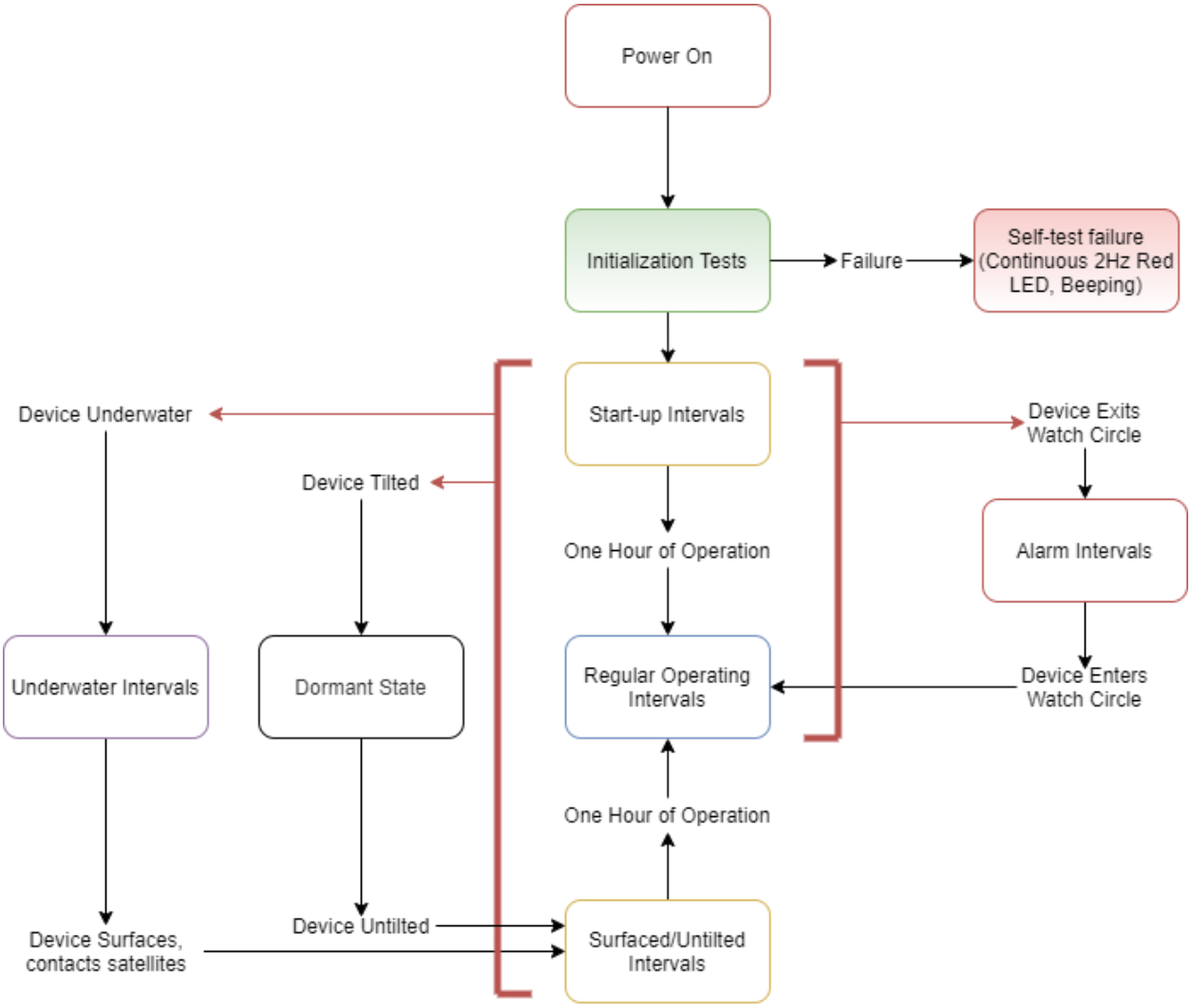
Operators can communicate with the Kilo via Iridium using email commands or XeosOnline™. Through messages from the Kilo, status information can be obtained, including the health of the GPS system and battery voltage.

The Kilo will continue to send position messages while at the surface until it is manually turned off or the battery pack drops below the minimum voltage requirement of 7V.

Transmission Interval Diagram

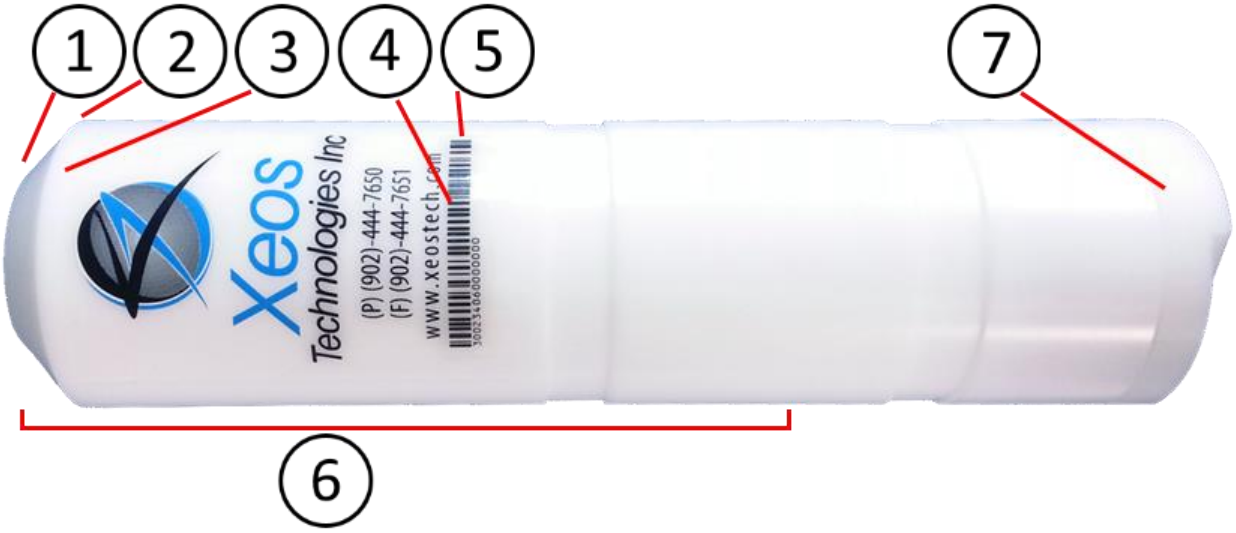
Below is the operating setup of the Kilo in all cases. Note that low power states for underwater and tilted events interrupt other operations, just the same as alarm intervals interrupt in the case of watch circle exits.

While regular and alarm intervals are configurable, start-up and surfaced/untilted intervals are static at 10 minute intervals. The lengths of time these intervals are used are also locked at 1 hour, provided they aren't interrupted.



Preliminary Setup

Outside Diagram



1	The LEDS of the Kilo are located here. LEDs illuminate on magnet contact and power-up.
2	The Iridium/GPS antenna of the Kilo is located here
3	The magnet switch for turning the Kilo on and off is located at the top of the cylinder
4	The 15-digit IMEI of the Kilo's Iridium modem and factory serial number is displayed
5	A QR code is available to scan to download the manual on new devices
6	This area is used for the Kilo's water sensor and must remain unobstructed for subsurface applications
7	Two sealing O-rings are located on the bottom endcap of the Kilo. This is where the device is opened to install batteries and access the micro-USB port

Setting up your Iridium Account

The Kilo makes use of the Iridium satellite system's (www.iridium.com) Short Burst Data (SBD) service for the 9602 transceivers. This service is a global, two-way, real-time, email-based data delivery service that has a maximum out-bound (from beacon) message size of 340 bytes and a maximum inbound (to beacon) message size of 270 bytes.

Kilo 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 that must be registered with the preferred service provider. For a list of service providers in your area please contact Iridium for recommendations.

Xeos Technologies is also able to provide Iridium SBD data service and accounts. Please contact activations@xeostech.com for more information.

Each IMEI number is capable of being associated with up to five (5) unique destinations for messages; 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 Kilo. Once the SBD account has been activated, please contact your Xeos representative and confirm this.

The Kilo makes use of a simple and robust, text-based email protocol. Any email application can be used to send and receive messages to the Kilo, or commands can be sent via Xeos' web service, XeosOnline™.

Quickstart

Before using the Kilo

- Ensure the IMEI of your device is activated through your chosen Iridium provider and intended message recipients are added to its account ahead of deployment.

Power-Up

Battery Installation

The Kilo automatically turns on once all batteries are installed. The device must be turned off via magnet or battery removal.

Magnet

- Swipe the magnet **slowly** along the top of the Kilo's cylindrical area vertically until the flashing **GREEN LED** on the top of the device remains solid. The LEDs will flash again while the device completes power-up.

Confirm Transmission

- Turn the device on and place it outside in view of as much of the sky as possible.
- The unit will transmit a power-up message, and transmit one GPS fix every 10 minutes at default settings within 5 minutes of power-up for one hour.
- Confirm that these messages are being received by your email and/or XeosOnline.

Operation

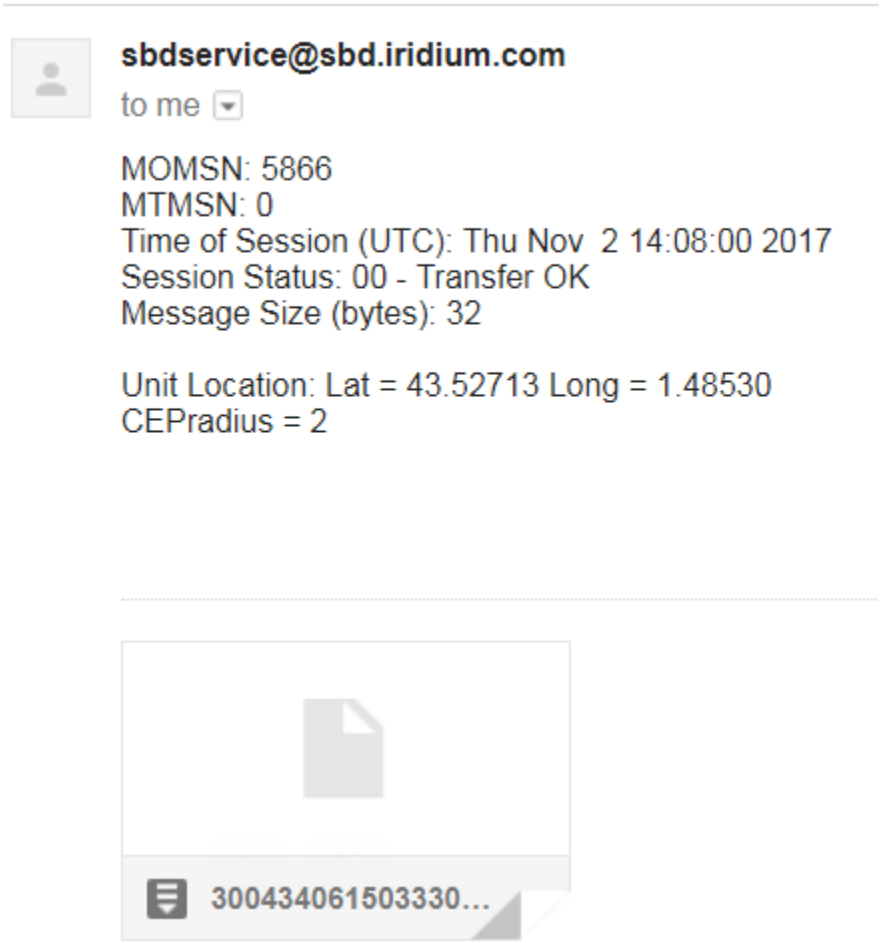
- When deploying the unit, power it up by swiping the magnet.
- Once the unit is confirmed to be on, it is ready to be deployed.
- Turn the Kilo **OFF** using the same magnet method as turning **ON**, with the **RED LED** in place of the green.

Understanding Position Information

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

Iridium Doppler position

The Iridium Gateway calculates the Iridium transceivers' position on earth when it receives a transmission, using Doppler technology. As a result, it is often very inaccurate. This location is only visible to users getting emails directly from the device, as opposed to emails forwarded by XeosOnline. An example of a "raw" Iridium message via email is below and will always have the IMEI of the device in the subject line, regardless of its name on XeosOnline.



sbdservice@sbd.iridium.com	All messages from Iridium devices come from this address.
MOMSN: 5866	Mobile Originating Message Serial Number; each individual message has its own incrementing serial number. A mobile originating message is one that comes **from** the Iridium device.

MTMSN: 0	Mobile Terminating Message Serial Number; like the MOMSN, messages **to** Iridium devices (like commands) also have an incrementing serial number. Since the message in the example is from an Iridium device, the MT number is zero.
Time of Session (UTC)	The time the message arrived at the Iridium Gateway
Session Status	Each message will have a code determined by how well the message was received; codes 00, 01 and 02 are acceptable and will always have their code name (ex. Transfer OK) next to this number.
Message Size (bytes)	The size of the actual message sent by the Iridium device, which is in the attachment in the email.
*Unit Location	The Doppler position of the device as estimated by Iridium's network. It is **NOT** the GPS position measured by the device.
*CEPradius = 2	The numerical value of how accurate the above position is; with a value of 2, This means that using the Lat/Long that the body has supplied, Iridium is 80% confident (always 80%) that the device sending the message is within a circle, 2 kilometers in radius, with the Lat/Long given as the 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 by viewing in a text editor (Notepad). This position information is accurate to within several feet of the true position.

Latitude: 44.714190, Longitude: -63.604930, Timestamp: 2017-12-19T17:35:07.004Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1644, SNR: 48

On/Off Modes

LED Indicators

The top of the Kilo uses red and green LEDs to show its on/off status. It is also to be used as an indicator for when the magnetic switch is used to turn the device on/off. This same LEDs are also used during self-test failure.

Unit Status Indicators	
Action: Turn On	Swipe Magnet back and forth across mag switch until LED is solid green
Action: Turn Off	Swipe magnet back and forth across mag switch until LED is solid red
Check Status	Swipe magnet once across mag switch (red is off, green is on)
Flashing 0.5 Hz **after power-up, beeping**	Self-test failure

Using the Magnet

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

To turn the Kilo on, begin swiping the magnet slowly up and down at the location of the reed switch. The reed switch is located along the top of the cylindrical section of the Kilo.

Note: If the initial color of the LED is Green after a single swipe, the Kilo is already operational.

A flashing green LED indicates the device is in the process of powering up. Continue to swipe the magnet until you see a solid green LED. A solid green LED indicates that the device is powered and operational.

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

At any time, the magnet can be placed against the location of the reed switch **once** to see which mode the beacon is currently in. A red LED indicates the device is turned OFF. A green LED indicates the device is turned ON.

- It is important to wait for all LED's to turn off before initiating another action.
- Cycling power for any reason, for example by using the switch to turn OFF/ON or by removing battery power, will start the startup interval.

NOTE: If after starting up, the red LED continuously flashes and/or beeping occurs for an extended period of time, the device is experiencing a **SELF-TEST FAILURE**. Check the battery orientation first, and if this does not remedy the situation, contact support@xeostech.com

Messages from the Kilo

Messages received from Kilo such as GPS messages or responses to Status requests arrive as email attachments to all the email accounts that the Kilo was setup with, and also appear on XeosOnline. When the unit is first turned on, it will send out three messages (pictured below) and will enter startup mode.

Version

The first message sent from the Kilo indicates the Firmware Version and serial number.

```
Powerup: true, Version: Kilo v1.01-681(6067)~ , Serial: 1240
```

Status

Another message that the Kilo will send will be a Status message. It will display the currently used times and will display differently, depending on whether or not Watch Circle is enabled.

This message also appears when the device moves from regular intervals to alarm intervals, or back. It also is used as a response to a change to these intervals, or changes to the watch circle.

Watch Circle Disabled

```
04151514,S, gps=20Mns ird=20Mns lat=44.71438 lon=-63.60492,Sched hr=0,LNA=n
```

04151514	Date and time of the message (UTC) in MMDDhhmm (M=Month D= Day h= hour m=min). (April 15th at 15:14 UTC)
S	The message is a 'Status' message
gps=20Mns	Shows the GPS acquisition at regular intervals in minutes
ird=20Mns	Shows the Iridium transmission at regular intervals in minutes
44.71438	Latitude of the most recent GPS fix expressed in decimal degrees
-63.60492	Longitude of the most recent GPS fix expressed in decimal degrees
Sched hr=0	Indicates the amount of hours offset from midnight the Iridium interval is set
LNA=N	Indicates if the Low Noise Amplifier is in use

Watch Circle Enabled

```
04140336,S,Status/Value Change: Mode=ALARM gps=15Mns ird=15Mns ctr=44.67037/-63.70031 rad=15000m,Sched hr=0,LNA=n
```

04140336	Date and time of the message (UTC) in MMDDhhmm (M=Month D= Day h= hour m=min). (April 14th at 15:14 UTC)
S	The message is a 'Status' message
Mode=ALARM	Indicates the operating mode the device is in, OK or ALARM
gps=15Mns	Shows the GPS acquisition rate **currently used** in minutes
ird=15Mns	Shows the Iridium transmission rate **currently used** in minutes
44.67037	Latitude of the **watch circle's centre** expressed in decimal degrees
-63.70031	Longitude of the **watch circle's centre** expressed in decimal degrees
Rad=15000m	The radius of the watch circle in metres

Sched hr=0	Indicates the amount of hours offset from midnight the Iridium interval is set
LNA=N	Indicates if the Low Noise Amplifier is in use

Position

The third message is a position message, which has added items if Watch Circle is enabled.

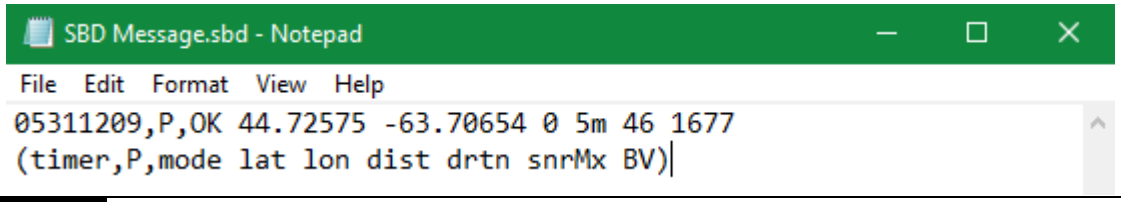
Watch Circle Disabled

Latitude: 44.714370, Longitude: -63.604940, Timestamp: 2020-04-16T14:52:42.319Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1656, SNR: 43

04161452	Date and time of the GPS fix (UTC) in MMDDhhmm (M=Month D= Day h= hour m=min). (April 16th at 14:52 UTC)
P	The message is a 'Position Message'
44.71437	Latitude of the GPS fix expressed in decimal degrees
-63.60494	Longitude of the GPS fix expressed in decimal degrees
43	Maximum SNR (Signal-to-noise ratio) of the GPS fix; higher is better
1656	Battery voltage of the Kilo in millivolts

Watch Circle Enabled

Latitude: 44.725750, Longitude: -63.706540, Timestamp: 2019-05-31T12:09:26.284Z, Mode: Regular, isAlarm: false, DurationInMode: 5, DistanceFromCenter: 0, BatteryV: 1677, SNR: 46



05311209	Date and time of the GPS fix (UTC) in MMDDhhmm (M=Month D= Day h= hour m=min). (May 31st at 12:09 UTC)
P	The message is a 'Position Message'
OK	Indicates that the device is not in alarm (it is inside a set Watch Circle)
44.72575	Latitude of the GPS fix expressed in decimal degrees
-63.70654	Longitude of the GPS fix expressed in decimal degrees
0	Distance from centre of the Watch Circle in meters
5m	Length of time the Kilo has been in the stated mode (OK or ALARM) in minutes
46	Maximum SNR (Signal-to-noise ratio) of the GPS fix; higher is better
1677	Battery voltage of the Kilo in millivolts

Information Message

In the event the Kilo was not able to acquire a GPS fix, a summary of information is transmitted in ASCII.

```
04141708,I,V=16.35/16.41/16.38 T=0 SNR=43 nSats=7 GPS:591/92/21249
Ird:536/787/35408 RSSI=5
```

04141708	Date and time of the message (UTC) in MMDDhhmm (M=Month D= Day h= hour m=min). (April 14th at 17:08 UTC)
I	The message is an 'Information' message
V=A/B/C	Shows the most recent voltages for: A = Unloaded voltage B = Voltage at the end of the last Iridium session C = Voltage at the end of the last GPS session
T=0	Temperature, not used
SNR=43	Highest GPS SNR during the last fix attempt
nSats=7	Maximum number of satellites tracked during the last fix attempt
GPS:D/E/F	GPS Statistics for: D = Number of good fixes since power-up E = Number of failed GPS sessions since power-up F = Total seconds the GPS has been on since power-up
Ird:X/Y/Z	Iridium statistics for: X = Number of Iridium messages sent since power-up Y = Number of Iridium sessions since power-up Z = Total seconds the Iridium has been on since power-up
RSSI=5	Last Iridium signal strength value, max value of 5

Other messages specific to certain events are mentioned below in their respective sections.

Communicating with the Kilo

There are 3 ways to communicate with the Kilo:

1. Over-the-air with E-mail SBD messages
2. Over-the-air with XeosOnline
3. Locally via micro-USB

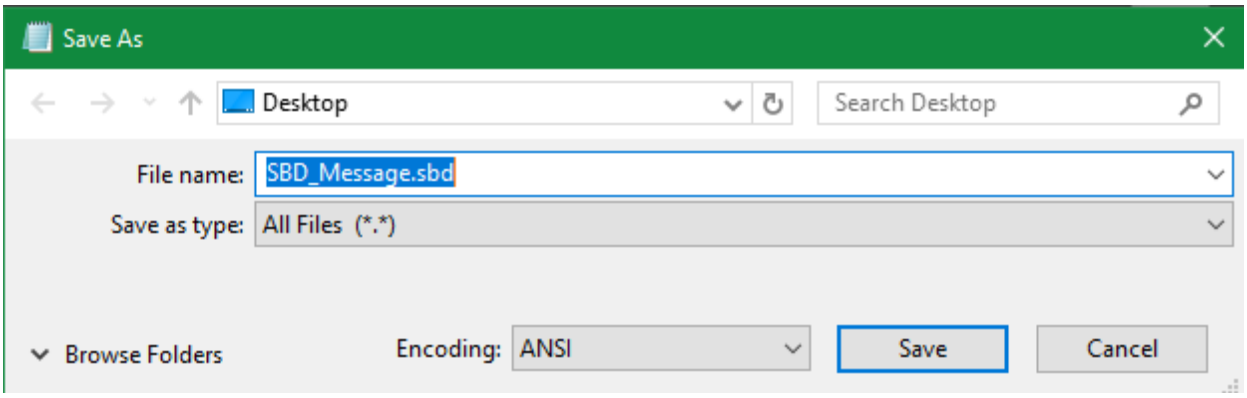
Sending Commands via Email

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

Command Format

Creating the File

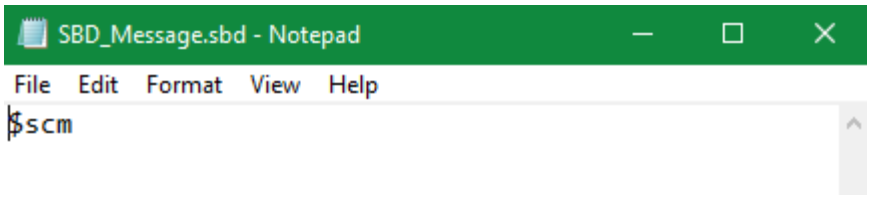
To create an SBD command, open a new file in a text editor (ex. Notepad) and save it using the **.sbd** extension. Make sure the **Save as type** option is set to **All Files** to achieve this.



Command Structure

Commands must be structured in the following way:

1. Each command **MUST** have a dollar sign (**$**) before each command.
2. A list of commands, one command per line.

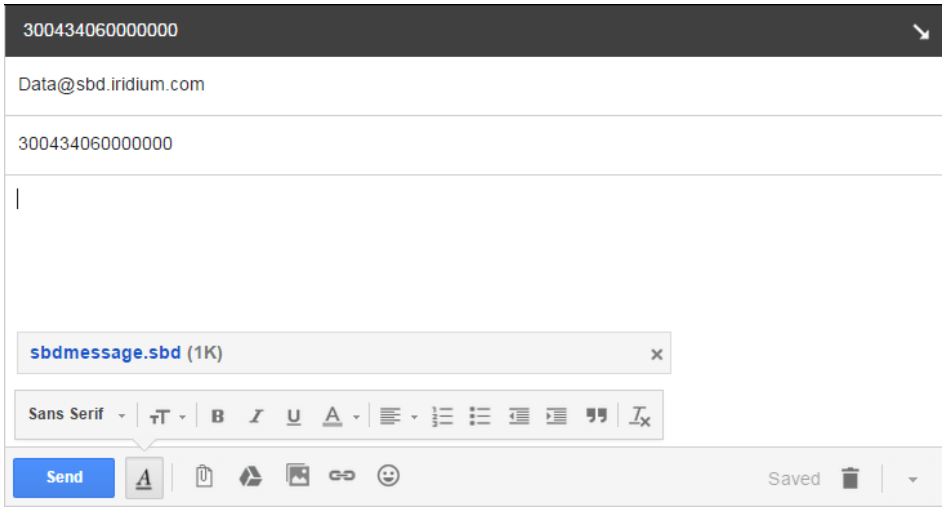


Special email commands are used to communicate with the Kilo when it is above water. These commands are sent as email attachments. Commands can configure the Kilo before deployment and can also be used to remotely reconfigure or update status with Kilo. The Kilo must have a good view of the sky to receive these commands.

Sending the Command

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

To	**data@sbd.iridium.com**
Subject	**The 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.

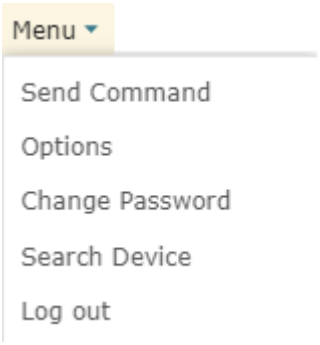
Commands can be sent from any email address, but responses will be returned **only** to email addresses on the unit's forwarding list.

Note: The Iridium gateway uses separate email addresses for commands and responses.

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

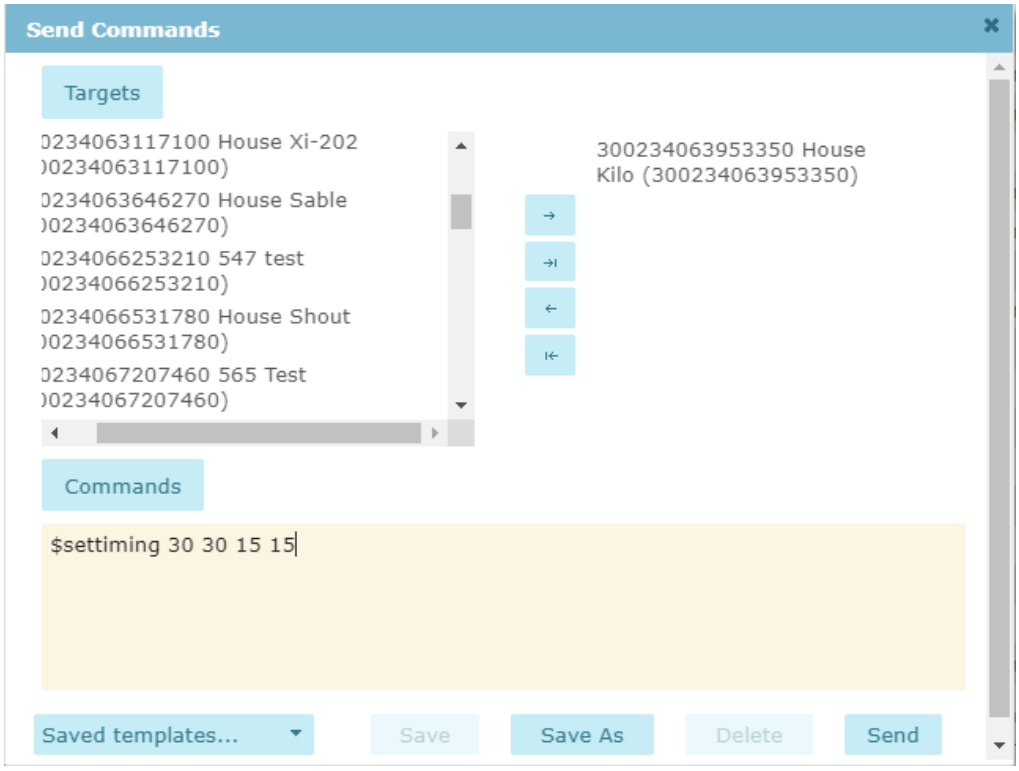


Navigate to the Send Command window.
From the Home Tab, choose
Menu > Send Command

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, one on each line, 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.



Communicating over USB

The Micro-USB connection at the top of the battery core is used for flash memory dumps and firmware upgrades through the use of a terminal emulator. Port settings are as follows:

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

When interfacing with the Kilo over USB, batteries should not be installed. As a consequence, the device will fail its initial self-test. Sending any character to the device will abort the self-test and end any beeping.

For information on firmware upgrades, see here.

For more information on flash memory dumps, see here.

Messages to the Kilo

There are six commands that are sent to the Kilo over the Iridium network via email or XeosOnline:

1. Set Timing
2. Status
3. Enable Watch Circle Functionality
4. Set Watch Circle
5. Reset
6. Restore Factory Defaults

Set Timing

The **$settiming** command is used to set the Iridium check and GPS acquisition intervals for the Kilo, after the 1-hour startup period has concluded. These interval values are set and stored in minutes. The set timing file command is as follows:

$settiming RegularGPS RegularIridium AlarmGPS AlarmIridium

$settiming 60 60 15 15

Details:

- The default timer is 180 minutes (3 hours)
- The minimum/maximum intervals are 5/1440 minutes (1 day)
- Values beyond the minimum/maximum will be set to the minimum/maximum
- Set intervals will persist between power cycles and resets
- Intervals are relative to 00:00 UTC

Once an SBD command has been sent to the Iridium gateway and queued for delivery, the Kilo will receive the command on its next scheduled Iridium check. Upon receiving and processing a **$settiming** command, the Kilo will send back a status message containing its new timings.

Status Request

The **Status Request** command is used to retrieve Kilo's current settings and beacon status.

$scm

The Kilo will respond to the command with the Status message.

Enabling the Watch Circle

The following command is used to initially enable watch circle functionality.

$switch c 1

After Watch Circle Functionality has been enabled, functionality will remain enabled until commanded OFF, including through resets using the **$resetnow** command. Specifics on Latitude, Longitude and Radius will **NOT** survive resets.

If the Kilo being commanded is using a firmware version lower than build 6067, see below.

The Kilo will return a listing of which features are on (Y) and off (N) in response:

`Switch:U=Y;G=Y;C=Y;T=N`

The Switch Watch Circle command uses the following syntax and can be used to turn Watch Circle Functionality ON and OFF after its initial set-up which was laid out above:

$switch c 1	Turns ON Kilo's Watch Circle Functionality
$switch c 0	Turns OFF Kilo's Watch Circle Functionality

Set Watch Circle

The **$setcircle** command is used to set the location and radius of the watch circle. If a watch circle is not set by command, but functionality is enabled, the Kilo will place its centre on the average locations so far acquired. The device will create a Watch Circle using the 48-hour average as its centre and the default radius of 100m.

The Kilo will discard the settings to the watch circle if powered off or reset.

A watch circle is set using the following convention:

$setcircle latitude longitude radius

$setcircle 44.72636 -63.70753 500

The longitude and latitude values are used to manually specify the centre of the watch circle. The radius (specified in meters) value is used to set the radius of the watch circle.

- The default Watch Circle Radius is **100** meters.
- The maximum radius for the watch circle is **15000** meters.
- The minimum radius for the watch circle is **50** meters.
- Values above or below the limits will be ignored.
- To adjust the watch circle's radius without changing the Lat/Long, replace Lat/Long values with 0's:

$setcircle 0 0 250

If the Kilo exits the programmed Watch Circle, the unit will enter an Alarm Mode and send a Status change message, followed by a GPS position. The Kilo will then transmit a position message according to the alarm rate until the device returns to the circle, the circle is expanded

sufficiently, or watch circle functionality is turned off. The Kilo will also continue to display its distance from the centre of the programmed circle.

Reset

The **Reset** command does a full software reset of the Kilo. This will effectively power the beacon OFF and then ON. The Kilo's timers and settings will **not** be reset but watch circle specifics **will be erased**. This command should only be used on the advice of Xeos Technologies Inc. The reset command is as follows:

$resetnow

Restore Factory Defaults

To reset the device back to the settings it was originally programmed with on manufacture, send the following command:

$factorydefaults

The device will reconfigure, and reset on receiving this command.

Water Submergence and Surfacing

The Kilo employs a water sensor, used to detect when the device returns to the surface after a submergence session.

There are two conditions which must be met before the Kilo will detect that it is submerged:

1. The Kilo must be fully submerged underwater
2. Iridium transmission must fail 3 consecutive sessions

After both conditions are met, the Kilo will enter Underwater Mode, and continuously take water sense readings in anticipation of surfacing. The time the device takes to enter Underwater Mode strongly depends on the Iridium interval it is operating under at the time, and how long a time until the next transmission time; a Kilo that won't attempt to transmit until 5 hours after physically submerging will take longer to go into Underwater Mode than one that will attempt to transmit 1 hour after submerging, for example.

Surfacing Alert

If the Kilo detects a transition from underwater to surface it will send an SBD message indicating that event. Following surfacing, the Kilo will transmit once every 10 minutes for 1 hour, followed by a return to its Normal Operating Mode.

```
Surfaced: true
```

There are two conditions which must be met before the Kilo will initiate a Surfaced event:

1. A change in the internal water sense reading of the Kilo, where the latest reading is at least 10% lower than the rolling average of previous readings. This event queues the Iridium check-in.
2. An Iridium check-in session (containing the above Surfaced message) is attempted. If this message is not successfully sent, the device re-enters underwater mode. Due to this, it is imperative that the top of the Kilo is not obscured from sending messages.

A back-up 24-hour timer is present during Underwater Mode to decrease events of un-noticed surfacing.

Tilt Sensor

The Kilo comes equipped with a tilt sensor which, when enabled, puts the Kilo into a hibernation state when the device is tilted and does not make any attempts to collect a position or transmit over Iridium.

The tilt axis defaults to the horizontal axis, meaning if the Kilo is standing upright it will operate normally, and will go into hibernation when orientated upside down.

The tilt sensor is not enabled by default. To enable the tilt sensor, a command must be sent to the Kilo in the following format:

$switch t 1

The Kilo will return a listing of which features are on (Y) and off (N) in response:

```
Switch:U=Y;G=Y;C=N;T=Y
```

Enabling the tilt sensor will survive the **$resetnow** command.

The Switch tilt sensor command uses the following syntax:

$switch t 1	Enables the Kilo's tilt sensor
$switch t 0	Disables the tilt sensor

When the device detects that it is no longer tilted, it will send an ASCII text message reporting the new state, followed by a single fix.

```
Not Tilted
```

Following this, the device will transmit once every 10 minutes for a period of one hour, before returning to regular intervals.

It is possible to use the tilt sensor on other axis (Y,Z). For more information please contact Xeos Technologies at support@xeostech.com

Flash Memory

The Kilo comes equipped with internal flash memory, used to store logged events and GPS positions over the lifetime of the product. This information can be retrieved for data collection or troubleshooting purposes. The retrieval of this information is done through the Micro-USB port at the top of the battery core.

Hardware Required

- A micro-USB programming cable
- The Kilo unit **with batteries removed**
- A Windows PC

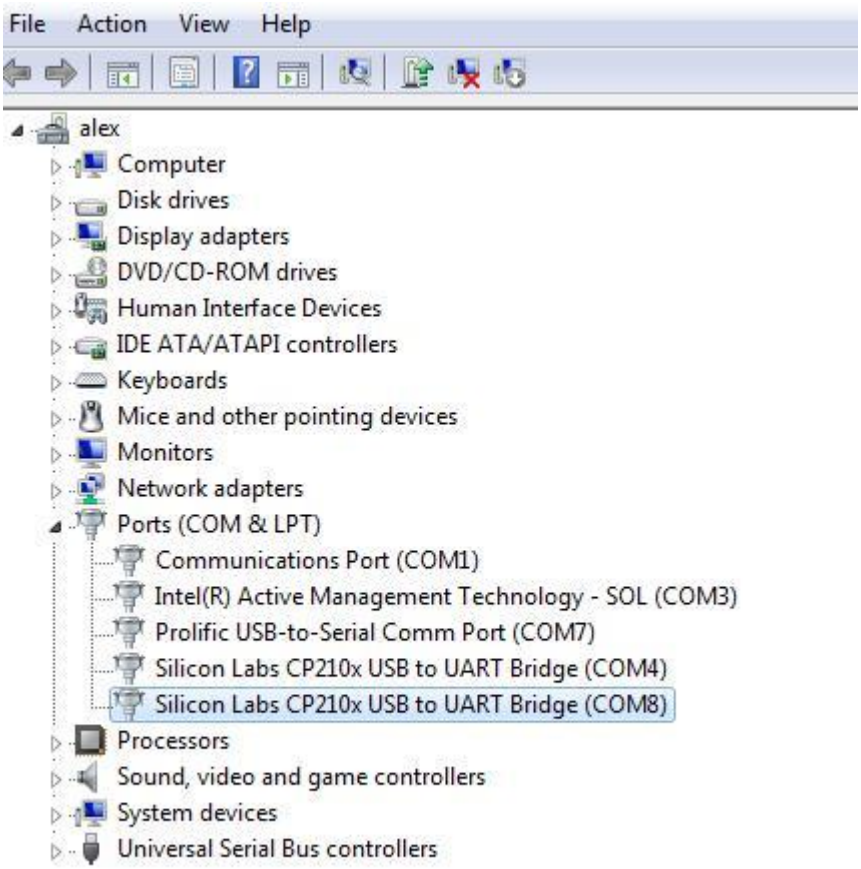
Software Required

- Terminal Emulator
- Silicon Labs CP210x USB to UART driver

Kilo Connection

1. Unscrew the battery end-cap from the Kilo and set aside
2. Remove all batteries from the Kilo. **Warning: Failure to remove batteries may cause electrical damage to the Kilo**
3. **Carefully** plug the micro-USB cable into the Kilo's connector and plug the USB into the PC

Navigate to the computer's device manager to check if the Silicon Labs CP210x chipset is recognized by the computer.



If the driver is not present, download and install the Silicon Labs CP210x Device driver.

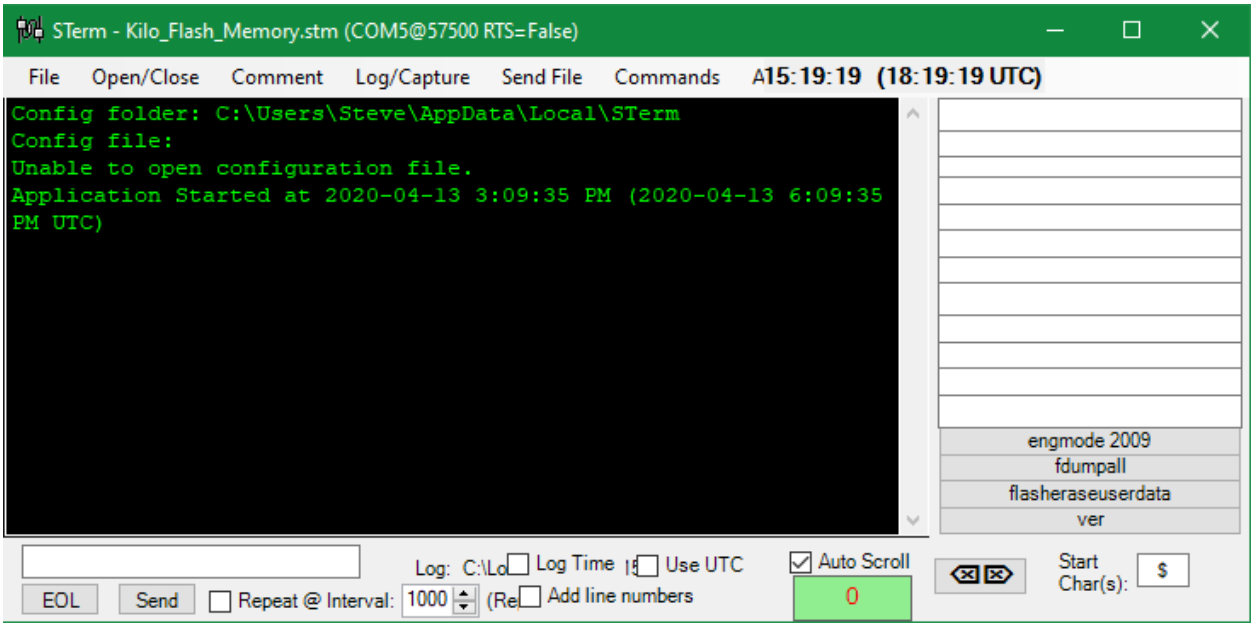
Downloading the Flash Memory

Note: While this section discusses use of STerm, any terminal emulator can be used. STerm can be downloaded from here.

1. Open STerm.exe application. The screen should appear as shown below:
2. Change the **COM Port** to what was seen in the device manager
3. Use the following settings:

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

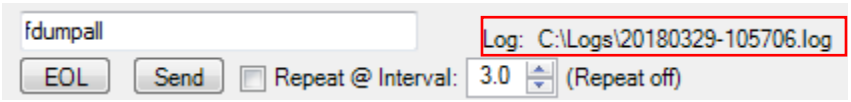
4. Press **Open Port**



5. Type **ver** into the command box and press **Send.** The Kilo will print its current firmware version to the screen.
6. Once this is finished, type **engmode 2009** into the command box and press Send. **"Eng mode ON"** should appear.
7. Type **fdumpall** and press Send; the unit will begin printing out all records saved in flash. This could take several minutes if the unit has been in service for a while.

Saving the Output

Output from the Kilo will be automatically logged in a **.log** file in the "C:\Logs" folder once STerm is closed. The exact name of the log can be seen here:



Deleting the Flash Memory

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

To delete the flash records, use the previously discussed interface steps, unlock engineering mode and send the command: **$flasheraseuserdata**

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

Erasing of the flash memory can be done over Iridium if necessary, but note that this also resets the device.

Testing the Kilo

Before testing

The following should be confirmed ahead of testing:

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

Power-up and Batteries

1. Insert the batteries into the device in the proper orientation.
2. Add the battery spring board to the battery stack, and screw in the Kilo's endcap. The device will immediately turn on. Ensure at this point that both the green and red LEDs have the ability to illuminate; they will do so on power-up.
   If at this point the red LED continuously flashes, and/or beeping is heard, a self-test failure has occurred. Recheck the batteries and their orientation first, and if this persists, contact Xeos.
3. Once all LED action has ceased, use a magnet to find the magnetic on/off switch on the device (the green LED will illuminate on detection). Use this opportunity to turn the device off by swiping the magnet repeatedly at this location (OFF is indicated by a solid RED LED) to confirm proper operation of the magnetic switch. Use the same method to turn the device on (ON is indicated by a solid GREEN LED).

Transmission

1. Place the device upright in a location outside that has as much of the sky visible as possible; buildings and other tall objects can impede a beacon's ability to transmit.
2. The following messages are to be expected from the Kilo after turning on within five minutes:
   a. A power-up message displaying the firmware version and serial number
   b. A GPS Position, the SNR strength of which should consistently be greater than or equal to 38.
3. The device will then send one GPS message every 10 minutes until its start-up period has expired (a period of one hour). The SNR value for each GPS position should be a value no less than 38.

After this point, transmission intervals are tied to the rates laid out by the **$settiming** command.

Response to commands

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

- Send the **$scm** command, which will prompt the Kilo to report its set regular intervals and last GPS fix.

Underwater Mode

Underwater Check

While the device is in start-up mode (within the first hour after power-up) fully submerge the device in a bucket of water with a tablespoon of salt added, **upside down**. The bucket can be inside or outside, so long as when the device is made to surface, it can be placed outside immediately. This is to simulate two points:

1. The device upside down simulates the Kilo's inability to find Iridium satellites to transmit information. The Kilo requires three consecutive Iridium failures for it to enter Underwater Mode and begin utilizing its water sensor.
2. Once the water sensor is in use, the device will begin to calculate a rolling average to determine its submergence.

It is suggested for the testing that the device remain in a submerged state, upside down, for at least **one hour.**

Surfacing

After one hour has elapsed, surface the device and place it in an open area, upright. The Kilo will register the change in submergence based on its calculated average, and queue an Iridium “Surfaced” message.

If the Kilo successfully sends this message, it will exit Underwater Mode, and again transmit one position once every 10 minutes for one hour, before returning to Normal Mode. If the device does not transmit this message, either:

1. The change in the water sense reading was not large enough to queue the Surfaced Iridium message
2. The device is not able to view satellites sufficiently to send the "Surfaced" message.

In the event this message fails to transmit, the Kilo will not reattempt an Iridium session until Midnight UTC as per the Underwater Mode timing interval. Contact Xeos if the Kilo does not surface.

Example

Below is XeosOnline output from a Kilo that utilized its default timers and transmitted appropriately. During the first hour of testing, the **$scm** command was sent, after which a response was returned. The device then went silent upon submergence, and transmitted consistently after surfacing as expected. All GPS SNRs were well above 40 as expected for successful test.

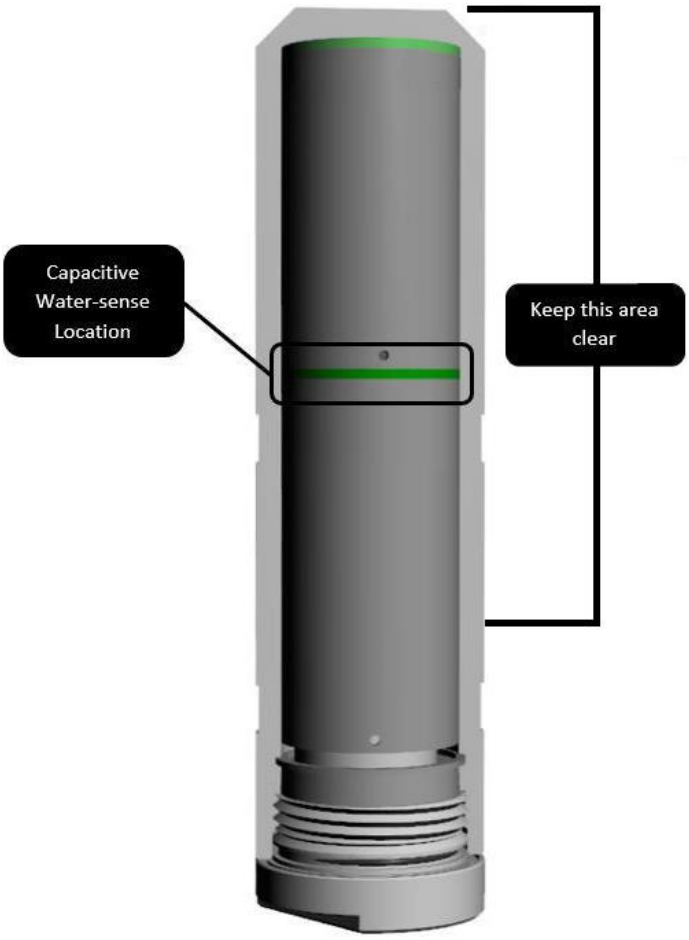
Message
Latitude: 44.714210, Longitude: -63.604850, Timestamp: 2019-01-28T14:49:55.101Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1725, SNR: 47
Latitude: 44.714220, Longitude: -63.604870, Timestamp: 2019-01-28T14:39:54.777Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1731, SNR: 46
Latitude: 44.714200, Longitude: -63.604940, Timestamp: 2019-01-28T14:28:21.701Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1722, SNR: 47
Surfaced: true
Latitude: 44.714260, Longitude: -63.604960, Timestamp: 2019-01-24T15:40:53.417Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1734, SNR: 47
Latitude: 44.714260, Longitude: -63.604930, Timestamp: 2019-01-24T15:30:24.569Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1722, SNR: 48
Latitude: 44.714180, Longitude: -63.604770, Timestamp: 2019-01-24T15:20:00.319Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1719, SNR: 47
Timestamp: 2019-01-24T15:20:52.147Z, Ascii: 01241511,S, gps=3Hrs ird=3Hrs lat=44.71418 lon=-63.60477,Sched hr=0,LNA=n
Latitude: 44.714240, Longitude: -63.604880, Timestamp: 2019-01-24T15:10:16.829Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1734, SNR: 49
Timestamp: 2019-01-24T15:03:03.566Z, Outgoing SBD Text: $scm
Latitude: 44.714250, Longitude: -63.604900, Timestamp: 2019-01-24T15:00:57.867Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1737, SNR: 46
Latitude: 44.714330, Longitude: -63.605040, Timestamp: 2019-01-24T14:49:37.460Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1734, SNR: 46
Latitude: 44.714190, Longitude: -63.604920, Timestamp: 2019-01-24T14:39:16.579Z, Mode: Regular, isAlarm: false, DurationInMode: 0, DistanceFromCenter: 0, BatteryV: 1734, SNR: 48
Powerup: true, Version: Kilo v1.01-681(3967)~ , Serial: 1466

Deployment of the Kilo

The Kilo is intended for use on marine flotation devices. It is important that the top of the Kilo is located as high above the surface of the water as possible. Both the Iridium and GPS antennas are located at the top of the unit. It is recommended that users install Kilo on a mast or superstructure at the top of their surface buoy or flotation device.

Care should be taken when installing to avoid putting metal bands close to the top of the unit where the antennas are located.

- Alongside a wall or tall obstruction will cause coverage to suffer.
- Kilo should not be deployed near (less than 1 metre) other transmitters.



Maintenance

Batteries

The housing of the Kilo holds 12 AA batteries. There is no provision for external power.

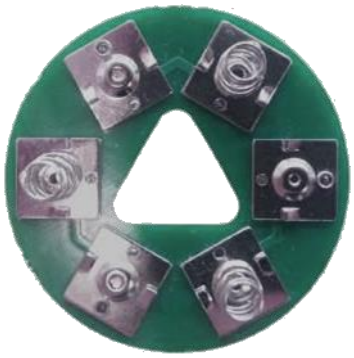
Choosing Batteries

The Kilo battery pack can hold and operate with any AA alkaline or lithium battery, however, only industrial grade batteries designed for harsh environments should be used.

- Xeos recommends the **Energizer EN91 AA alkaline battery**, or the **Energizer L91 lithium Battery.**
- New batteries should be used for each new deployment
- Each battery should be tested with a battery tester or voltmeter to ensure none of the cells are defective or discharged. Individual cells with a voltage measuring less than 1.5 V should be discarded.

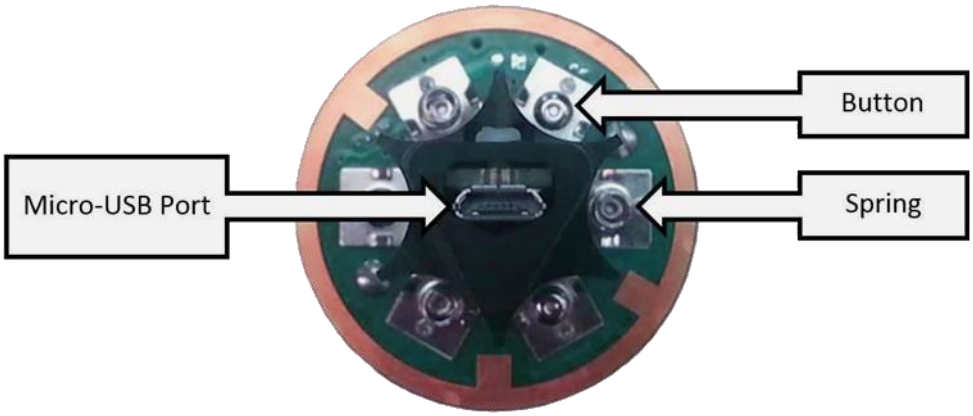
Adding/Replacing Batteries

After removing the screw-cap, the loose battery board can be removed by turning the Kilo right side up and letting the board fall onto a table or your hand.



KILO BATTERY BOARD

After the Circuit board is removed, the black battery core is revealed, with 6 slots that will hold 2 AA batteries each (12 batteries in total).



Drop the batteries into the main body of the Kilo. At the bottom of each slot, there is either a ‘spring’ or a ‘button’.

- For slots with buttons, drop the batteries with the negative end facing up.
- For slots with springs, drop the batteries with the positive end facing up.

KILO BATTERY ORIENTATION

Restore the loose battery board to the top of the batteries. The board is constructed such that all 3 possible orientations are valid.

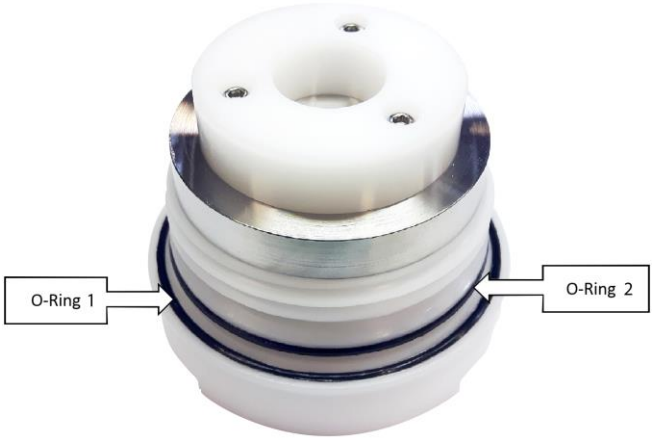
After inspecting the O-rings and seating surfaces, screw on the Kilo’s endcap. The device will power up immediately. If the batteries are low, or have been inserted incorrectly, the Kilo will sound a quick repeating beep and flash the red LED at the top for 5 minutes or until the batteries have been corrected or replaced.

O-Rings

O-rings are critical to the waterproof nature of the Kilo. The O-rings should be visually inspected to make sure that it is properly seated in the groove and to ensure there is no visible damage to the O-ring. If the O-ring fails visual inspection or the Kilo has been deployed for longer than 2 months, the O-ring should be replaced prior to the next deployment.

At the bottom of the Kilo's acetyl housing is a screw-cap with two O-Rings;

- A0-2038N7 2-5/8x2-3/4 (O-ring 1)
- 568-137 70A DURO BUNA (O-ring 2)



To replace an O-ring:

- Remove the old O-ring and clean all dirt away from the screw-cap and inner housing using a lint free cloth, cleaning alcohol, and a soft-brush
- Thoroughly inspect the O-ring groove as well as the point of contact on the inside of the Kilo enclosure, any scratches or dirt could compromise the O-ring seal
- Apply a thin layer of O-ring lubrication (Molykote 111 from Dow Corning) to the new O-ring and gently slide the new O-Ring down over the threads of the screw-cap and into the O-ring groove

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

Recovery and Storage

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

As soon as possible after the Kilo is recovered, all batteries should be removed and discarded. The Kilo should be cleaned and inspected for corrosion or water ingress. O-rings should be visually inspected. Any concerns should be discussed with Xeos support (+1-902-444-7650 or support@xeostech.com) prior to storage.

The Kilo should be stored as follows:

- Dry location
- Assembled, **without batteries** but with O-rings in place
- Ambient temperature of -40° C to +85° C
- Either horizontal or vertical storage is permitted

Appendix A: Updating Firmware

1. Retrieve the unit from the field
2. Remove the Kilo's Batteries
3. Update Kilo Firmware
4. Test the Kilo's ability to transmit
5. Check the device's O-rings
6. Redeploy the device

Hardware Required

- A micro-USB programming cable
- The Kilo unit **with batteries removed**
- A Windows PC

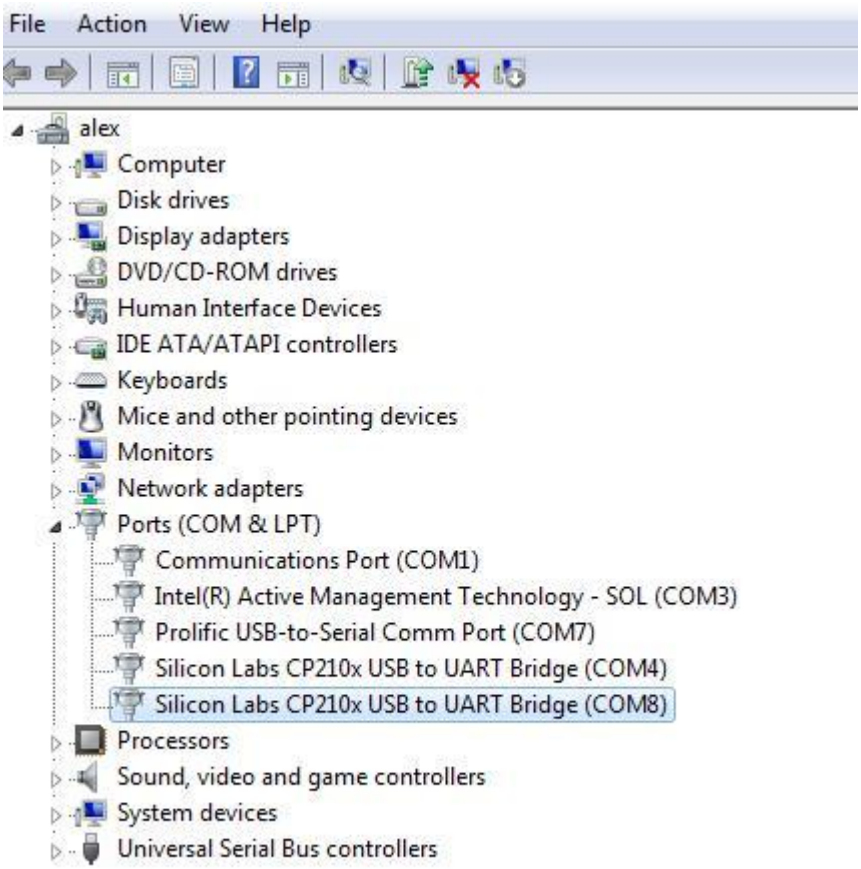
Software Required

- Terminal Emulator
- Silicon Labs CP210x Device driver
- Kilo Firmware Update Package
    - AVRdude.exe
    - AVRdude.conf
    - Kilo Command (.cmd) file
    - Kilo Firmware (.hex) file

Kilo Connection

1. Unscrew the battery end-cap from the Kilo and set aside
2. Remove all batteries from the Kilo. **Warning: Failure to remove batteries may cause electrical damage to the Kilo**
3. **Carefully** plug the micro-USB cable into the Kilo's connector and plug the
4. USB into the PC
5. Once it is plugged in, the Kilo may begin beeping. This is no cause for alarm; this warning is given when the Kilo detects incorrect battery orientation and can be ignored
6. The Kilo's LED will also flash red, indicating a self-test fail due to a lack of batteries

Navigate to the computer's device manager to check if the Silicon Labs CP210x chipset is recognized by the computer.



If the driver is not present, download and install the Silicon Labs CP210x Device driver.

Uploading Firmware

1. Note the COM port being used by the Kilo's CP210x USB adapter
2. Create a new folder called AVRDude in the **C Drive**
3. Download and extract the Kilo firmware update package into the new AVRDude folder.
4. Open Command Prompt.
5. Type in **cd\,** and hit **Enter** to bring you to the line **C:\>**
6. Type **cd AVRdude** to direct command prompt to the **AVRdude** folder in the C drive that you have just created. You'll now see the next line read **C:\AVRdude**
7. Drag and drop the .cmd from your **AVRdude** folder into **command prompt**. Then type in the COM port number previously noted (in our case, **8**), and hit **Enter.**

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

KILO UPDATER SCREEN

9. The Kilo's update progress will be shown in the command prompt window. When it has completed successfully it will say**: 'avr dude done. Thank You.'**
10. After programming has successfully completed, unplug the Micro-USB cable from the Kilo
11. Install batteries and reassemble the Kilo

Appendix B: Technical Specifications

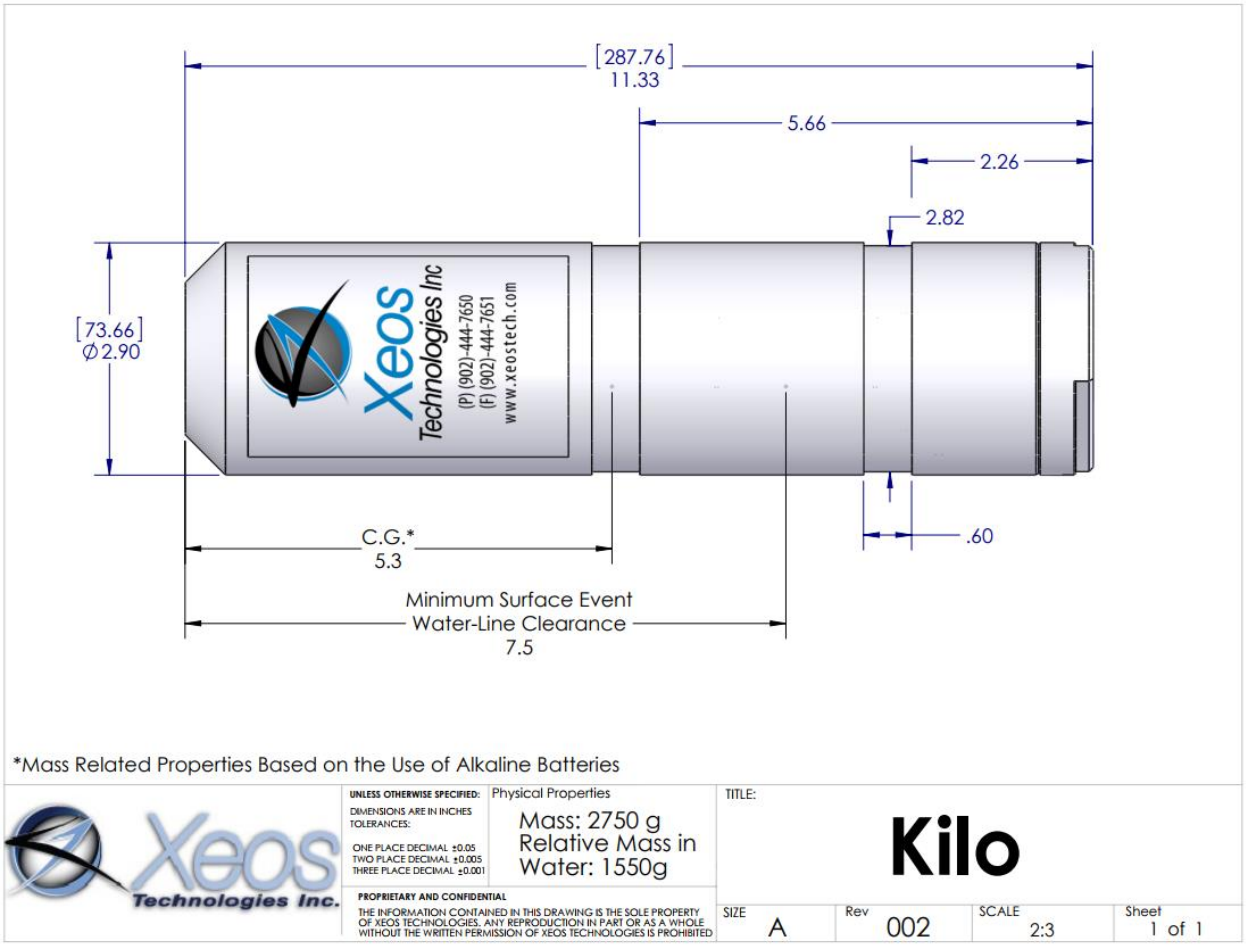
Mechanical	
Material	Outside Housing: Delrin Inside Casing: Stainless Steel
Dimensions	28.78 cm L x 7.37 cm D (11.33” L x 2.90” D)
Mass (Alkaline)	2.75 kg (Air) 1.55 kg (Water)
O-Rings	Inner O-ring: 568-137 70A DURO BUNA Outer O-ring: A0-2038N7 2-5/8x2-3/4
Seal Lubrication	Molykote 111 from Dow Corning

Electrical	
Battery Compliment	12 AA Batteries (Lithium or Alkaline)
Operating Voltage	7 – 25V
Nominal Voltage	18V
Capacity	2.0 Amp Hours (Alkaline) 3.0 Amp Hours (Lithium)
Iridium Transmission	70mA
GPS Acquisition	15mA
Idle Current	<100µA
Underwater Current	<25µA
Off Current	<20µA
Life Expectancy	1 Year Subsurface followed by 6 months of outbound/inbound surface messages

Electronics	
Iridium Hardware	9602 Iridium Transceiver
Digital Controller	Xeos IRDC3
GPS Receiver	48 Channel SiRFstarIV GSD4e GPS chip

Environmental	
Depth Rating	2500 metres
Operating Temperature	-30°C to +60°C (-22°F to +140°F)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)

Appendix C: Engineering Diagram



Appendix D: Troubleshooting

Red LED/blinking

Indicative of a self-test failure. A flash memory dump will print self-test failure codes at the bottom of its memory:

i - Iridium - Modem cannot communicate with CPU of Kilo; contact Xeos

f - Flash - Flash error is showing as a full chip; erasing the chip may resolve this issue. It should be noted that if the error is flash, a dump of the flash will show no information.

t - Battery taps - Batteries are either oriented incorrectly, or a tap is too low.

No Iridium messages (assuming no self-test failure)

- Determine the nature of the issue (antenna-related, system related or location-related)
  - Ensure the device's Iridium IMEI is active on the Iridium network with your service provider.
  - Ensure the device is provisioned to send messages where intended.
  - Change the location of the device; place the device in an area with as much total view of the sky as possible.
- Dumping the flash memory will display all Iridium sessions that occurred, regardless of success.

No GPS/poor GPS

- Change the location of the device; place the device in an area with as much total view of the sky as possible.
- Dumping the flash memory will display all GPS sessions that occurred, regardless of success.
  - Check the number of satellites seen (greater than 4), SNR level (greater than 38), time the GPS session was on (less than 60 seconds for first fix, less than 20 for other fixes).

Device is transmitting too frequently/not enough

- Check intervals with **$scm** command
- Change timer interval as required

Device is going into alarm when it should not (Watch Circle)

- Watch circle centre is in the wrong location or an unsatisfactory radius
  - **$setcircle X Y Z** to change circle and radius
  - **$setcircle 0 0 Z** to change radius only

Device is not surfacing when it should

- Device is connected to material that is interfering with the water sensor (metal)
- Device was not submerged enough to create a high enough rolling average for change
- Device registered surfacing, but obstruction prevented Iridium message transmission
  - Dumping flash memory will show all water sense and Iridium events for investigation.

Appendix E: Legacy Features

Enable Watch Circle Functionality (Pre-Build 6067)

The following commands are used to initially enable watch circle functionality **in the following order.**

$engmode 2009	Unlocks the enable table
$enable c 1	Enables the Watch Circle Switch command
$switch c 1	Turns on Watch Circle Ability
$engmode off	Re-locks the enable table

Initial Enable Watch Circle Functionality Command Block

The Kilo will return a listing of which features are on (Y) and off (N) in response:

```
Switch:U=Y;G=Y;C=Y;T=N
```

After Watch Circle Functionality has been enabled, functionality will remain enabled until commanded OFF, including through resets using the **$resetnow** command. Specifics on Latitude, Longitude and Radius will **NOT** survive resets.

The Switch Watch Circle command uses the following syntax and can be used to turn Watch Circle Functionality ON and OFF after its initial set-up which was laid out above:

$switch c 1	Turns ON Kilo's Watch Circle Functionality
$switch c 0	Turns OFF Kilo's Watch Circle Functionality

Warranty, Support and Limited Liability

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

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

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

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

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