

Wave Glider® SV3 Integrated Sensor User Guide

Xeos Technologies Rover (Resilient Tracker)

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Wave Glider® SV3 Integrated Sensor User Guide: Xeos Technologies Rover (Resilient Tracker)

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The Wave Glider mechanism is patented under US Patent Number 7,371,136 and other patents pending. All aspects of the Wave Glider product have been developed at private expense by Liquid Robotics, Inc.

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Acknowledgements

The Resilient Tracker is a Liquid Robotics-specific implementation of the Xeos Technologies Rover.

Revision History

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Preface

This guide provides information on operating the Xeos Technologies, Inc. Rover installed on each Liquid Robotics, Inc. (LRI) Wave Glider SV3 vehicle. The Rover is referred to as the Resilient Tracker when it is integrated with the Wave Glider SV3.

This guide assumes a working familiarity with the Liquid Robotics Wave Glider SV3 and the Xeos Technologies Rover. The focus is primarily on information specific to the Rover (Resilient Tracker) integration with the Wave Glider SV3.

For more information on the Xeos Technologies Rover, see the *Xeos Technologies Rover User Manual* included on the Liquid Robotics Documentation CD.

For more information on Xeos Technologies go to <https://www.xeostech.com/>.

Liquid Robotics manuals are available on the documentation CD included with each Wave Glider vehicle and by contacting the Liquid Robotics Support Organization at:

- Telephone:

(US) 888-574-4574

(International) 1-408-636-4205

- Email: support@liquidr.com

Before contacting LRI support, please have available the serial number of the vehicle(s) or part(s) that you are contacting LRI Customer Support about.



Warning

The Resilient Tracker includes magnets to keep batteries in place and a magnetic key is used to turn the Resilient Tracker ON and OFF. A magnetic field can be harmful to pacemaker wearers.

Chapter 1. Overview

The Resilient Tracker included with every LRI Wave Glider® SV3 provides WGMS with a secondary source of GPS location data. It consists of a GPS receiver, an Iridium modem, a digital controller, and a battery pack, allowing it to operate entirely independently. It will continue to report location data, even if the Wave Glider SV3 is powered off.

Figure 1.1. Resilient Tracker



The Resilient Tracker contains custom dual GPS/Iridium antennas, one at each end of the enclosure, to maintain Iridium communications even if the Wave Glider SV3 Float is overturned.

Figure 1.2. Resilient Tracker Antennas



The Resilient Tracker makes use of the bi-directional, global, real time Iridium satellite Short Burst Data (SBD) network in combination with GPS position location.

The Resilient Tracker water-tight housing contains:

- A 9603 Iridium satellite Short Burst Data core radio transceiver.

- A specialized low power Xeos digital controller with GPS.
- Two GPS/Iridium antennas.

The Resilient Tracker is intended for surface deployments and should not be deployed below a depth of 10 meters.

The Resilient Tracker internal battery pack is capable of transmitting over 8000 messages during deployments of up to 2 years in duration.

You can issue configuration commands to the Resilient Tracker by email sent over the Iridium satellite network, or from the Web based Xeos Online application. Operators typically use Xeos Online as their primary means of issuing configuration commands, with email over Iridium as a back-up. For more information on the Xeos Online, see the *Xeos Technologies Rover User Manual* included on the Liquid Robotics Documentation CD.

Resilient Tracker GPS location status and battery pack power status is displayed in WGMS and in Xeos Online, however this information can also be received directly by email over the Iridium satellite network.

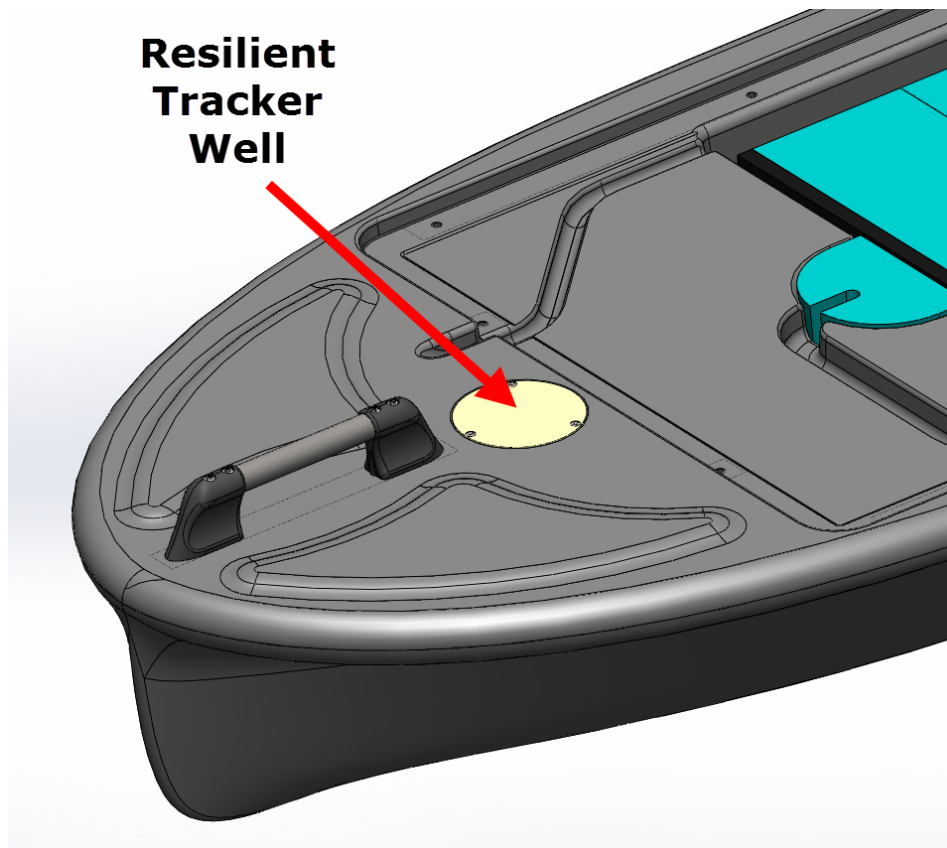
Resilient Tracker GPS and battery status is reported over Iridium at regular pre-configured intervals. The Liquid Robotics factory configured Resilient Tracker reporting frequency is every 720 minutes (12 hours), but you can set the reporting rate from 5 minute intervals to 1440 minute (24 hour) intervals, depending on your mission requirements.

When Liquid Robotics ships a Wave Glider SV3 integrated Resilient Tracker, an Iridium account and Xeos Online access have already been established for that Resilient Tracker. It should begin transmitting data when it is turned on, and WGMS (also Xeos Online) should begin receiving GPS and battery status reports. For more information see [Chapter 2: Getting Started with the Resilient Tracker](#) and [Chapter 3: Configuring the Resilient Tracker](#).

Chapter 2. Getting Started with the Resilient Tracker

The Resilient Tracker is pre-installed in the Wave Glider SV3 Float in the Resilient Tracker Well, a cylindrical receptacle at the forward end of the Float. The Resilient Tracker is held in place by a circular Cover Plate attached to the deck with 3 screws. Shock absorbing foam padding is located at the bottom of the Resilient Tracker Well.

Figure 2.1. Resilient Tracker Location On Wave Glider SV3 Float



Iridium Satellite Communications

The Resilient Tracker uses the Iridium satellite system (www.iridium.com) Short Burst Data (SBD) service for the 9603 transceiver to communicate with on-shore servers that access the internet. The Iridium satellite system is a global (including the polar regions), two-way, real-time data delivery service that has a maximum outbound (from the Resilient Tracker) message size of 340 bytes and a maximum inbound (to the Resilient Tracker) message size of 270 bytes.

Liquid Robotics, Inc. (LRI) establishes an Iridium data delivery account with Xeos Technologies for each Resilient Tracker prior to shipment of the Wave Glider SV3 it is installed in. The Iridium data delivery account is associated with the IMEI number for the Resilient Tracker. Each IMEI number is capable of being associated with up to five (5) unique email addresses.

When a Wave Glider SV3 is purchased, LRI transfers the Iridium data delivery account to the new owner.



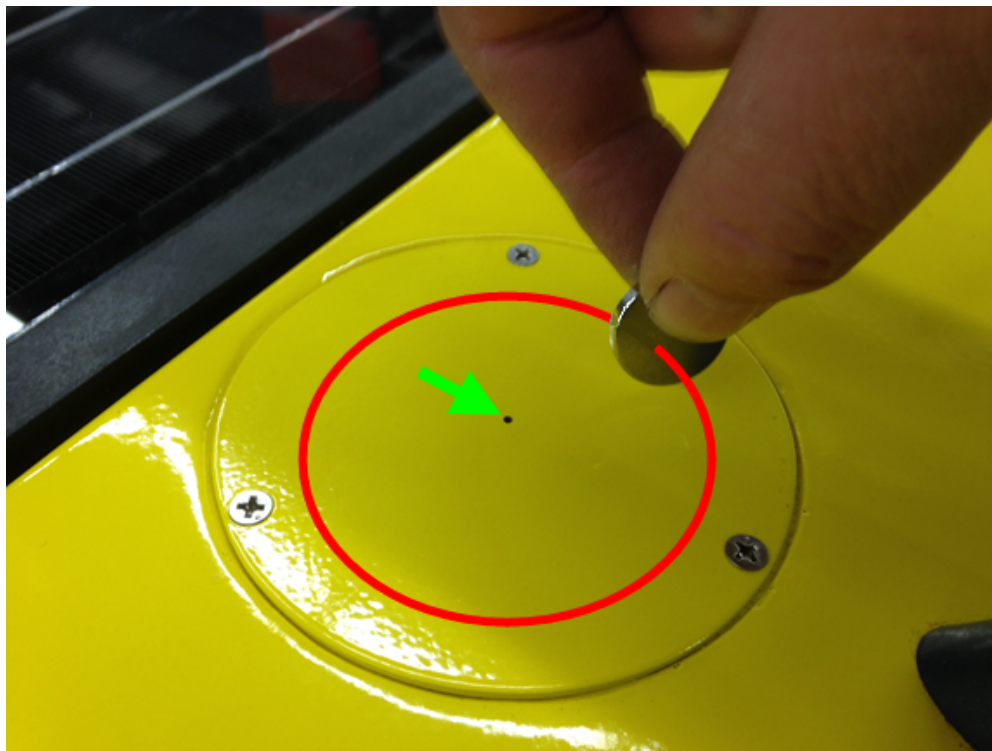
Note

You have the option to establish an Iridium data delivery account with a different service provider after you take delivery of the Wave Glider SV3, for more information see the *Xeos Technologies Rover User Manual* included on the Wave Glider Documentation CD.

Turn the Resilient Tracker ON or OFF

The Resilient Tracker is turned ON or OFF by moving a magnetic key in close proximity to a Hall-Effect switch. When the Resilient Tracker is installed in the Wave Glider SV3 Float, you can turn it ON or OFF by moving the magnetic key in a circular motion approximately 1/4 inch above the Resilient Tracker Well Cover Plate as illustrated in [Figure 2.2](#). There is a small viewing hole in the center of the Resilient Tracker Well Cover Plate (see the green arrow in [Figure 2.2](#)) where you can see the LED lights that indicate the status of the Resilient Tracker.

Figure 2.2. Using the Magnetic Key



Note

If you are outside, you may need to create a shadow over the Resilient Tracker Well Cover Plate to view the LED lights through the viewing hole.

To verify if the Resilient Tracker is ON or OFF, move the magnetic key in a single circular motion (clockwise or counterclockwise) over the Resilient Tracker Well Cover Plate:

- If a **steady red** LED appears, the Resilient Tracker is turned OFF.

If you want to turn the Resilient Tracker ON, continue to move the magnetic key in a circular motion over the Resilient Tracker Well Cover Plate. The LED will begin to **flash green** indicating that it is powering up. Keep moving the magnetic key in a circular motion, until the LED is a **steady green** indicating the Resilient Tracker is turned ON, then remove the magnetic key.

- If a **steady green** LED appears, the Resilient Tracker is turned ON.

If you want to turn the Resilient Tracker OFF, continue to move the magnetic key in a circular motion over the Resilient Tracker Well Cover Plate. The LED will begin to **flash red** indicating that it is powering down. Keep moving the magnetic key in a circular motion, until the LED is a **steady red** indicating the Resilient Tracker is turned OFF, then remove the magnetic key.

Confirm Data Transmission

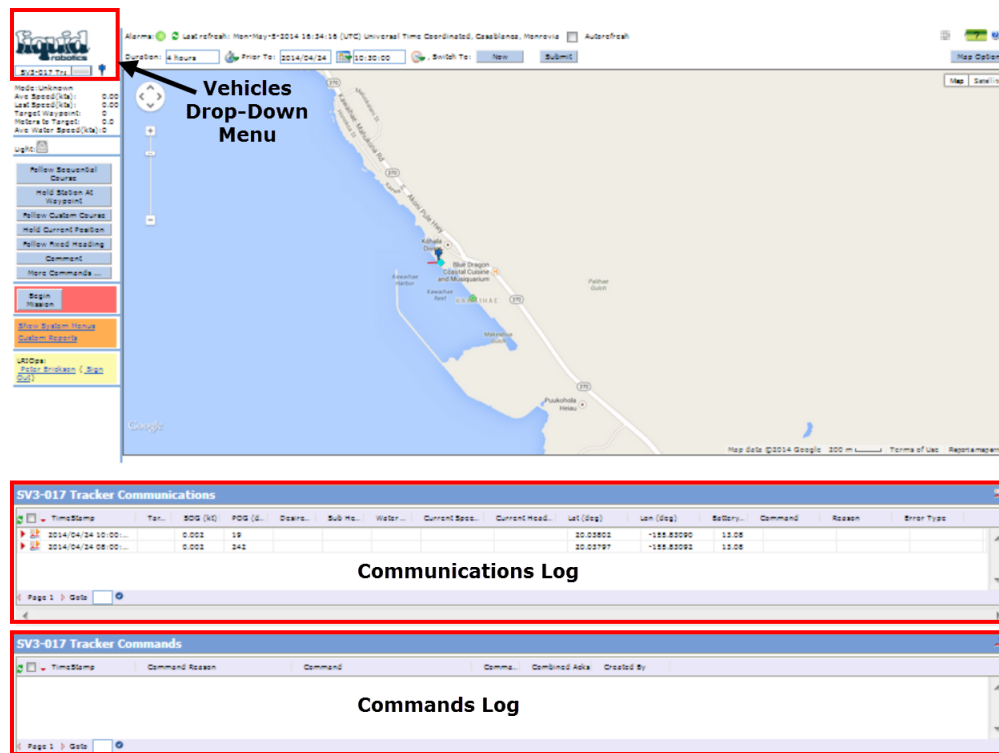
Prior to shipment, LRI will provision your Wave Glider SV3 and its Resilient Tracker in WGMS.

LRI will provide you with WGMS login credentials and the name assigned to your Resilient Tracker.

To confirm the Resilient Tracker is transmitting data properly:

1. Confirm that the Resilient Tracker is turned ON.
2. Move the Wave Glider SV3 to a location where the installed Resilient Tracker has a clear view of the sky.
3. Log in to the WGMS Dashboard.

Figure 2.3. WGMS Dashboard



4. In the Dashboard sidebar, select the name assigned to the Resilient Tracker you want to test in the Vehicles drop-down menu.

Figure 2.4. Tracker Selected in Vehicles Drop-Down Menu



5. Scroll down to view the Communications Log for the Resilient Tracker.

Figure 2.5. Resilient Tracker Communications Log

The screenshot shows the 'SV3-017 Tracker Communications' log. Red arrows point to specific columns with labels: 'Time Stamp' points to the 'Timestamp' column, 'Speed Over Ground (knots)' points to the 'SOG (kt)' column, 'Heading Over Ground (degrees)' points to the 'POG (deg)' column, 'Location Coordinates' points to the 'Lat (deg)' and 'Lon (deg)' columns, and 'Battery Level (volts)' points to the 'Battery' column.

Time Stamp	Target	SOG (kt)	POG (deg)	Desired	Sub Hea...	Water S...	Current Speed	Current Headin...	Lat (deg)	Lon (deg)	Battery
2014/04/24 10:00:26	0.01	223							20.03761	-155.83096	13.05
2014/04/24 08:28:36	0.006	141							20.03779	-155.83078	13.05
2014/04/24 06:00:36	0.001	352							20.03797	-155.83094	13.11
2014/04/24 04:00:09	0.001	235							20.03793	-155.83093	13.08
2014/04/24 02:00:38	0.002	189							20.03794	-155.83091	13.08
2014/04/24 00:00:38	0.002	19							20.03802	-155.83090	13.08

The Resilient Tracker is configured with a 12 hour reporting rate before shipment from Liquid Robotics, but it will operate at a 10 minute reporting rate for the first 60 minutes after it is turned on to make communications verification more convenient.

Checking the Battery Level

The Battery level should be at least 13.4 volts before launching a mission. You can confirm the battery level from the WGMS Communications Log (see above), on Xeos Online, or by email.

For information on battery replacement see [Chapter 5: Changing the Batteries](#).

Resilient Tracker Power Consumption

The default Resilient Tracker reporting interval for both GPS and Iridium is once every 12 hours. Resilient Tracker power consumption depends on the reporting interval. Battery life depends on the type of batteries installed in the Resilient Tracker. For more information see [Figure 2.6](#).

Figure 2.6. Estimated Battery Life

GPS POSITION INTERVAL	IRIDIUM CALL INTERVAL	CONSUMPTION PER CYCLE	DURATION (ALKALINE BATTERIES)	DURATION (LITHIUM BATTERIES)
10 min (default)	10 min (default)	0.6913 mA	723.27 hours 30.13 days	1398.33 hours 58.26 days
30 min	30 min	0.7396 mA	2027.99 hours 84.50 days 2.82 months	3920.77 hours 163.37 days 5.45 months
60 min	60 min	0.7896 mA	3799.39 hours 158.31 days 5.29 months	7345.49 hours 306.06 days 10.20 months
3 hours	3 hours	0.9896 mA	9094.22 hours 378.93 days 12.63 months	17,582.15 hours 732.60 days 24.42 months
6 hours	6 hours	1.2896 mA	581.58 days 19.39 months 1.615 years	1,124.40 days 37.48 months 3.12 years
12 hours	12 hours	1.8851 mA	795.67 days 26.52 months 2.21 years	1538.29 days 51.28 months 4.27 years
24 hours	24 hours	3.0888 mA	971.25 days 32.38 months 2.70 years	1699.83 days 56.66 months 4.72 years

**Default GPS and Iridium
Reporting Interval**

Chapter 3. Configuring the Resilient Tracker

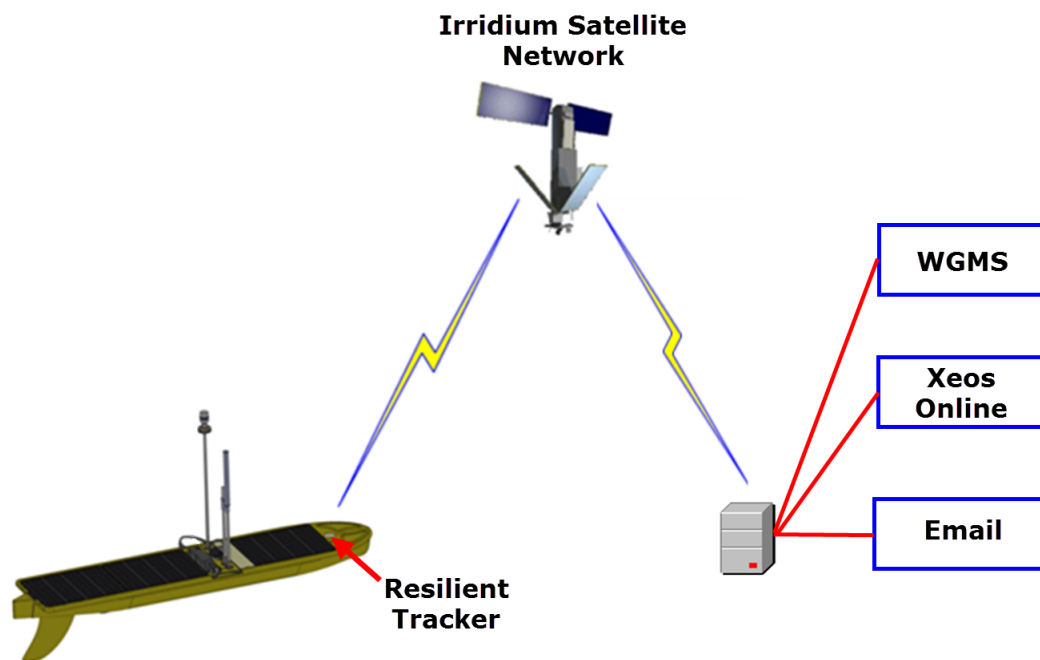
The Resilient Tracker reporting frequency is pre-configured to a 12 hour interval. The following sections explain how you can change the Resilient Tracker reporting frequency using Xeos Online or email.



Note

The email method is not typically used as the primary means of managing the Resilient Tracker.

Figure 3.1. Resilient Tracker Communications

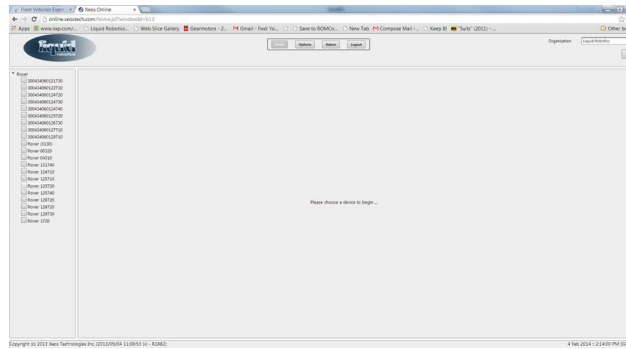


Using Xeos Online to Change the Reporting Rate

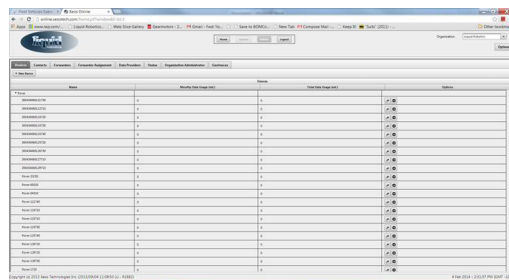
The following procedure is an example of how you can change the Resilient Tracker reporting interval using the Xeos Online application. For more information on Xeos Online, refer to the *Xeos Technologies Rover User Manual* included on the Liquid Robotics Documentation CD

1. Go to **online.xeostech.com** and sign in with the credentials provided by Liquid Robotics.
2. The Xeos Online home page will open:

Configuring the Resilient Tracker



3. Click on the **Admin** button and the **Device** tab on the **Admin** page will open by default:

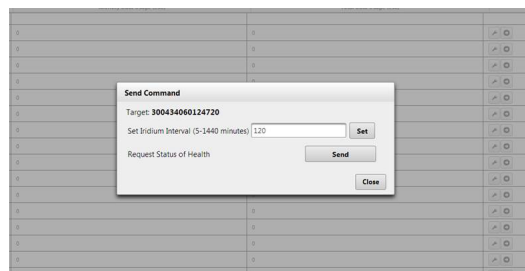


4. In the **Device** tab, find the row that contains the IMEI number for the Resilient Tracker you want to change the reporting rate on, then click on the arrow icon in the **Options** column.

Name
300434060121730
300434060122710
300434060124720
300434060124730
300434060124740

Options

5. Enter the new reporting interval in the **Set Iridium Interval (5-1440 minutes)** field, then click **Set**.



You can also use Xeos Online to set up multiple message forwarders to send specific messages (or all messages) to a group of email addresses. For more information see the *Xeos Technologies Rover User Manual* included on the Liquid Robotics Documentation CD.

Using Email to Change the Reporting Rate

The Resilient Tracker makes use of a simple and robust, binary email protocol. Any email application can be used to send and receive messages to the Resilient Tracker.

You can issue commands to the Resilient Tracker by sending an e-mail message to **data@sbd.iridium.com** with the Resilient Tracker's **15 digit IMEI number** as the subject. You must attach a text file to the email containing the command syntax, but you must edit the file extension to **.sbd** (instead of .txt).

Acquire unlock code:

After each power cycle, the Resilient Tracker generates a random “unlock code” that is sent by email to the addresses that it has been configured with. If you cannot find the email from the Resilient Tracker that contains the unlock code, send an email message to **data@sbd.iridium.com** that has the correct IMEI number in the subject line, and attach a an empty text file with the file name: **unlock.sbd**. The Resilient Tracker will respond at its next scheduled transmission interval with a plain text message containing the correct unlock code, for example: **unlockcode=2468101** (where **2468101** is the unlock code for that Resilient Tracker) Once you have the correct unlock code for the Resilient Tracker, you can begin sending commands by email.

Commands:

There are **timer** commands that change the Resilient Tracker SBD and GPS reporting rate, and there is a **resetnow** command that resets the Resilient Tracker to its factory default configuration.



Note

It is possible to set the GPS reporting rate to a different interval than the SBD reporting rate. Typically the GPS and SBD reporting rates are the same when the Resilient Tracker is integrated with a Wave Glider. The default reporting rate is 12 hours for both GPS and SBD. For information on setting the GPS and SBD reporting rates to different intervals, contact the Liquid Robotics Support Organization.

Each command message must begin with \$unlock <unlock code> in the first line and the last line in the .sbd file must be followed by a carriage return (empty line).

The syntax for the timer command is:

```
$unlock <unlock code>
$timer sbd 0 1h
$timer gps 0 1h
```

The **0** is the timer mode. There are several timer modes:

0 = Normal Mode

1 = Startup - The first hour after the unit is turned on.

2 = Inverted - When the unit is inverted.

4 = No GPS Fix - This is triggered after 6 consecutive GPS acquisition failures. The Rover will revert back to timer 0 after a successful GPS acquisition.

The **h** represents hours. You can also set the reporting rate in minutes by replacing the **h** with an **m**.

The syntax for the resetnow command is:

```
$unlock <unlock code>
$resetnow
```

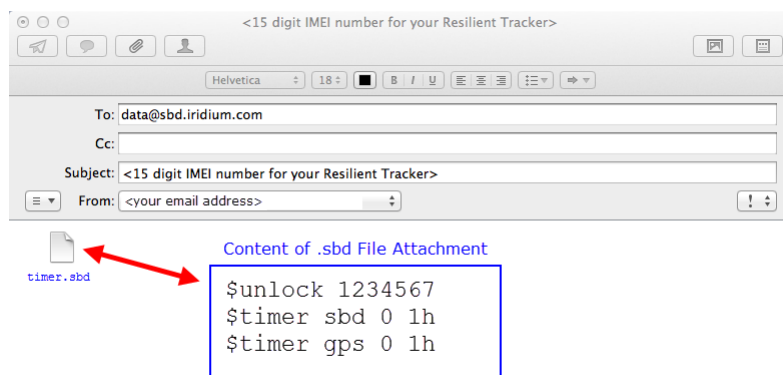
For example, to change the report rate in the normal timer mode to 24 hours for both SBD and GPS, the command syntax in the .sbd file attached to the email message would be:

```
$unlock 1234567
$timer sbd 0 24h
$timer gps 0 24h
```

To set the report rate in minutes, rather than hours, follow the numeral with a lower case m. For example, 150 minutes would be: 150m

In the following example, a command is being sent to set the sbd and gps report rate to 1 hour.

Figure 3.2. Example: Send Command by Email



Note

Another way to get the unlock code is to send a .sbd file with an incorrect unlock code, for example, **\$unlock 1234567** in the first line of the .sbd file (followed by a carriage return). The Resilient Tracker will respond at its next scheduled transmission interval with a plain text message containing the correct unlock code.

Chapter 4. Removing or Installing the Resilient Tracker

The Resilient Tracker is pre-installed in the Wave Glider SV3 Float in the Resilient Tracker Well, a cylindrical receptacle at the forward end of the Float. The Resilient Tracker is held in place by a circular Cover Plate attached to the fiberglass deck with 3 screws. Shock absorbing foam padding is located at the bottom of the Resilient Tracker Well.

To uninstall the Resilient Tracker: Remove the 3 screws from the Resilient Tracker Well cover plate and pull the Resilient Tracker out of the well.

Figure 4.1. Resilient Tracker Uninstalled



To Install the Resilient Tracker: Make sure the foam shock absorber is in place at the bottom of the Resilient Tracker Well, then slide the Resilient Tracker into the well with the white half of the housing up. Place the cover plate over the top of the Resilient Tracker and install the three screws that hold it in place. **It's important that the cover plate is firmly secured to the**

Wave Glider Float, but be careful not to over-tighten the screws, they are threaded into fiberglass.

Chapter 5. Changing the Batteries

The cylindrical acetyl Resilient Tracker housing consists of two halves. The black lower half threads into the white upper half. There are two O-rings that create a water-tight seal.

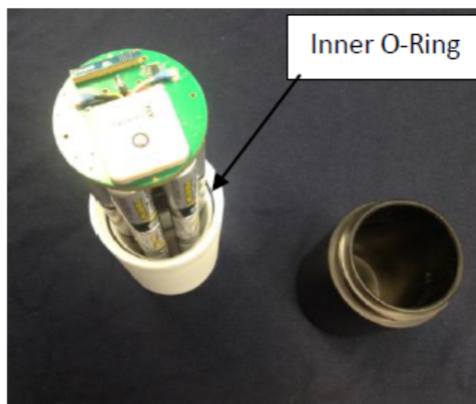
To change the Resilient Tracker batteries:

1. With your hands, carefully unscrew the black bottom half of the housing from the white upper half.

Figure 5.1. Unscrew Resilient Tracker Housing



2. There is an O-ring just below the threads on the black lower half, and another O-ring just above the threads on the upper half. Inspect the O-rings, they are critical to keeping the Resilient Tracker electronics dry. The O-rings should be visually inspected to make sure they are properly seated and to ensure there is no visible damage. If the O-rings pass visual inspection and have been deployed for 2 months or less, the O-rings do not need to be replaced. If the O-rings fail visual inspection or have been deployed for longer than 2 months, the O-rings should be replaced prior to re-deploying the Resilient Tracker. For more information see [“Replacing the O-Ring Seals”](#) (page 16).



3. The Resilient Tracker battery pack holds 18 AA batteries. The batteries and all of the electronics are attached to the white upper half of the Resilient Tracker housing. The batteries are configured in 6 columns of 3 batteries each. The center of the battery pack column is magnetized to ensure the batteries stay in place.

Figure 5.2. Battery Columns



To remove the old batteries, remove one of the easier to access batteries from each column, then gently shake the Resilient Tracker with the battery pack column pointing downward to get the remaining batteries to slide to a position where they are easier to reach. Remove the remaining batteries.

To replace the batteries, slide the first battery into each column in the correct orientation as indicated by the label in each column. The positive/negative orientation of the batteries is not the same in every column. Add the second and third batteries. The may beep while batteries are being added to indicate changes in the battery voltage. Once all of the batteries have been replaced, the Resilient Tracker will stop beeping. Reassemble the Resilient Tracker housing taking care to inspect & seat the O-Rings first. The Resilient Tracker is now ready for testing and deployment.

 Note

If the batteries are low, or if some of the batteries have been inserted incorrectly, the Resilient Tracker will sound a quick intermittent beep and flash the red LED at the top for 5 minutes, or until the batteries have been correctly installed, or replaced.

Replacing the O-Ring Seals

The O-rings are:

- White upper half of the Resilient Tracker body - **Parker 2-138 (90 duro)**
- Black lower half of the Resilient Tracker body - **Parker 2-137 (90 duro)**

To replace them, remove the old O-rings, and clean all dirt away from the threads on each half of the Resilient Tracker housing. Also clean the grooves where the O-rings seat. Apply a thin layer of O-ring lube (Parker Super 'O') to the new O-ring.

For the white upper half of the Resilient Tracker housing, gently slide the new O-Ring past the threads inside the housing until it is seated in the O- Ring groove.

For the black lower half of the Resilient Tracker housing, gently slide the new O-Ring down over the threads and into the O-ring groove, just above the lip of the enclosure.



Important

The O-Rings must be properly seated in their grooves to ensure that water will not get into the Resilient Tracker housing after it is reassembled.

Chapter 6. Pre-Launch Checklist

Before sending the Wave Glider SV3 on a mission, you should verify that the Resilient Tracker is working properly:

1. Turn the Resilient Tracker On.
2. Confirm that the Resilient Tracker GPS and battery status reports are being received by WGMS.
3. Confirm that the Resilient Tracker battery pack power level is at least 13.4 volts.