

# LI-1500

Light Sensor Logger

Instruction Manual



**LI-COR**<sup>®</sup>

# **LI-1500 Light Sensor Logger Instruction Manual**

**Publication No. 984-14406**

**LI-COR<sup>®</sup>, Inc.  
4647 Superior Street  
P.O. Box 4425  
Lincoln, Nebraska 68504 USA**

**Telephone: (402) 467-3576  
FAX: 402-467-2819  
Toll Free: 1-800-447-3576 (U.S. & Canada)  
envsales@licor.com  
envsupport@licor.com  
www.licor.com**



■ LI-COR, inc.  
4647 Superior Street  
P.O. Box 4425  
Lincoln, Nebraska 68504 USA

■ Phone: 402-467-3576  
FAX: 402-467-2819  
Toll-free: 1-800-447-3576 (U.S. & Canada)  
E-mail: envsales@licor.com

---

## Declaration of Conformity

**Manufacturer's Name:** LI-COR Inc.

**Manufacturer's Address:** 4647 Superior Street  
Lincoln, Nebraska USA 68504

**declares that the product**

**Product Name:** Light Sensor Data Logger

**Model Number(s):** LI-1500

**Product Options:** LI-1500 Light Sensor Data Logger  
LI-1500-GPS Light Sensor Data Logger w/GPS

**conforms to the following Product Specifications:**

**EMC:** FCC 47 CFR Part 15.109 Radiated Emissions, Class A  
EN 55011 Radiated Emissions, Class A  
IEC 61000-4-2 ESD, 4KV/8KV Contact/Air  
IEC 61000-4-3 Radiated RF Immunity, 10/3/1 V/m

**Supplementary Information:**

The product herewith complies with the requirements of the EMC Directive 2004/108/EC.

John Rada  
Director of Engineering

Document #53-14008  
October 8, 2013

Page 1 of 1

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

## NOTICE

The information contained in this document is subject to change without notice.

LI-COR® MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THE THIS MATERIAL, INCLUDING, BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. LI-COR® shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

This document contains proprietary information which is protected by copyright. All rights are reserved. No part of this document may be reproduced or translated into another language with prior written consent of LI-COR®, Inc.

All other trademarks or registered trademarks are property of their respective owners.

© Copyright 2014, LI-COR®, Inc.

LI-COR®, Inc.  
4647 Superior Street  
Lincoln, NE 68504

Phone: 402-467-3576  
Toll Free (U.S. and Canada): 1-800-447-3576

In Germany - LI-COR® GmbH: +49 (0) 6172 17 17 771

[www.licor.com/env](http://www.licor.com/env)  
[envsales@licor.com](mailto:envsales@licor.com)

## Printing History

Publication Number: 984-14406

New editions of this manual will include all updates. An update addendum may be used between editions to provide up-to-date information. Revisions are indicated by the revision number. Minor updates, which do not alter the meaning of the content, will be incorporated without affecting the revision number.

<b>Version Number</b>	<b>Publication Date</b>	<b>Changes</b>
1	May 2014	First Edition

Build Date: Wednesday, May 28, 2014

# Table of Contents

---

## Section 1. Introduction to the LI-1500

---

What's What .....	1-1
Power Sources .....	1-2
Install batteries .....	1-3
Low Battery Indicator .....	1-3
AC Power .....	1-3
Cable Connections .....	1-3
Data Cable Connection .....	1-3
Light Sensor Input Ports .....	1-4
Memory .....	1-4
Precautions .....	1-4
Maintenance .....	1-4
Cleaning .....	1-4
Storage .....	1-4

---

## Section 2. Software Basics

---

Powering On and Off .....	2-1
Keypad .....	2-2
Adjusting Display Brightness .....	2-3
Monitor Mode Navigation .....	2-3
Menu Navigation .....	2-4
Console Settings .....	2-4
Time and Date .....	2-4
Auto Off Timer .....	2-5
Beeper .....	2-5
GPS .....	2-5
Global Positioning System .....	2-5
GPS Tagging .....	2-6
GPS Fix Quality .....	2-6
GPS Variables .....	2-6

---

## Section 3. Configuration

---

Adding a Sensor .....	3-2
-----------------------	-----

Creating a Configuration .....	3-2
Changing the Logging Routine .....	3-3
Changing the Sampling Rate .....	3-4
Standard Modes .....	3-5
Raw Mode .....	3-5
Sampling Rate and Measurement Range .....	3-6
Selecting a Measurement Range .....	3-6
Adding an Output .....	3-7
Configuring a Math Output .....	3-8
Enabling Averaging .....	3-9
Averaging Window .....	3-9
Sampling Rate and Averaging .....	3-10
Measuring Underwater Attenuation .....	3-10
Underwater Attenuation Theory .....	3-11

---

## **Section 4. Logging and Viewing Data**

---

Logging Data .....	4-1
Prompts and Remarks .....	4-2
Underwater Sensor Logging .....	4-2
GPS Tagging .....	4-3
Viewing Logged Data .....	4-3
On the Console .....	4-3
On a Computer .....	4-4
Viewing Real-Time Data .....	4-6

---

## **Section 5. Troubleshooting**

---



---

### **Appendix A. Updating the Firmware**

---



---

### **Appendix B. Specifications**

---



---

### **Appendix C. Replacing the Internal Lithium Battery**

---

---

**Appendix D. Warranty**

---

**Appendix E. Index**

---



# Section 1.

## Introduction to the LI-1500

---

The LI-1500 Light Sensor Logger is a 3-sensor logger that can also function as a handheld meter for displaying real-time data. Three BNC input ports accept LI-COR terrestrial and underwater light sensors.

With Standard Modes sampling, the LI-1500 collects samples at up to 20 Hz, from up to three sensors at once. Math operations and averaging can be applied to the data.

Raw Mode sampling collects samples at up to 500 Hz, from one sensor. Math operations and averaging are not available, but Raw Mode is useful for high frequency applications.

The optional Global Positioning System (GPS) can provide GPS data for viewing or logging.

The weather resistant console is constructed from ABS plastic with a rubber seal between the two halves. The rubber seal also serves as a shock cushion to protect the instrument from impact.



### What's What

If you just received your LI-1500 Light Sensor Logger, check the packaging list to verify that you received everything that was ordered. Each LI-1500 should include the following items:

**Table 1-1.** LI-1500 parts list.

Description	Qty.	Part #
LI-1500 Light Sensor Data Logger	1	9915-003 without GPS 9915-004 with GPS
USB Mini B Dust Cover	1	340-10566
LI-1500 Accessory Kit	1	9915-001
5P A/Mini-B USB Cable 6'	1	392-07872
AC-DC USB Power Supply 5V/1A	1	591-14516
USB Power Supply Prong Kit	1	591-14544
Carabiner Clip	1	610-10456
1.5V Alkaline Size "AA" Batteries	4	442-00854

## Power Sources

The LI-1500 Light Sensor logger uses four "AA" size batteries. AC power (mains) may also be used, but "AA" batteries should be installed to prevent data loss in case AC power is interrupted during logging. An internal lithium cell battery maintains clock settings when "AA" batteries are depleted or absent. The lithium backup battery can last up to seven years. For replacement instructions, see page C-1.

<p><b>Note:</b> The AC to DC power supply adapter will not re-charge batteries.</p>
---

## Install batteries

Use a #1 cross-head (Phillips) screwdriver to remove the two screws that secure the battery cover on the back of the instrument. Push the rubber gasket aside to access hidden screw. Install four "AA" batteries. Observe proper polarity when installing batteries. Reattach the cover.

## Low Battery Indicator

A "Low Battery" message appears when the "AA" battery voltage drops to 4.0V. The power will turn off when the voltage drops to 3.8V. Battery voltage can be viewed in Monitor Mode (see page 2-3).

## AC Power

The LI-1500 can be powered with AC (mains) power. Plug the AC to DC power supply adapter (at right) into a wall outlet supplying AC power. Plug the USB cable into the adapter. Plug the other end of the USB cable into the Mini USB port at the top end of the LI-1500.

## Cable Connections

The mini USB port at the top end of the LI-1500 serves as the data transfer and power connection.

## Data Cable Connection

The LI-1500 communicates with a computer through a USB cable connected to a mini USB port. The computer will identify the LI-1500 as a mass storage device named LI-1500.



Figure 1-1. "AA" batteries installed.



Figure 1-2. AC to DC power supply adapter.

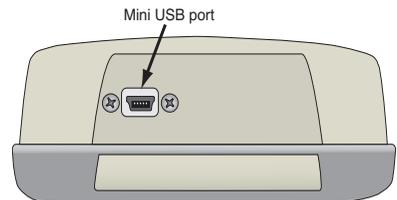


Figure 1-3. Mini-USB port for data transfer and for optional AC power.

## Light Sensor Input Ports

The three BNC bulkhead input ports at the bottom end of the LI-1500 are for connecting LI-COR light sensors with BNC terminations. The input ports are labeled **1**, **2**, and **3**. They are identified as INPUT1, INPUT2, and INPUT3 in the user interface.

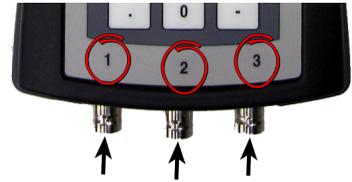


Figure 1-4. Light sensor input ports

## Memory

The LI-1500 is equipped with 1 GB of non-volatile flash memory. The instrument stores data on an internal Secure Digital (SD) card. The format for the SD card is FAT16. Do not modify the card in any way when connected to a computer, and never remove or replace the card unless it is with a card purchased from LI-COR Biosciences (p/n 616-10387). If you need to use a user-supplied SD card for any reason, contact LI-COR for formatting instructions.

## Precautions

The LI-1500 is weather resistant, but the following environmental limitations should be observed:

If the LI-1500 is to be left outdoors and unattended for long periods of time, it should be installed in a protective enclosure or sheltered location. Install the protective plug in the USB port when the port is not in use.

Exposure to direct sun decreases battery life and can cause battery leaks if the internal temperature exceeds the battery manufacturer's specifications. Cold temperatures can also significantly decrease battery life.

## Maintenance

The LI-1500 is designed for low maintenance and generally requires little servicing beyond keeping it clean and replacing the batteries.

### Cleaning

The instrument display and keypad can be cleaned with a moistened non-abrasive cloth when necessary.

### Storage

When storing the LI-1500 for a long period of time, remove the "AA" batteries.

# Section 2.

## Software Basics

---

This section describes how to use the LI-1500 Light Sensor Logger keyboard, navigate the user interface, and change console settings.

### Powering On and Off

Press the power on/off key  to turn on the LI-1500. You will see one of these messages:

- 1. New Config File:** Start at step 2 under "Creating a Configuration" on page 3-2.
- 2. Select Config File:** Scroll up or down   to highlight a configuration. Press **OK** to activate the highlighted configuration and enter monitor mode (see "Monitor Mode Navigation" on page 2-3).

**Note:** You must create and activate a configuration to receive light readings.

Press the power on/off key  to turn off the LI-1500.

## Keypad

The LI-1500 features a 22-button tactile response keypad. The upper block of nine keys are used to navigate through menus, select menu options, and log data. Basic functions of the upper nine keys are described in Figure 2-1.

The lower block of 12 keys are used to enter alphanumeric characters. Each key is used to enter the letters and numbers indicated by the label on the key. The 22nd key is the power on/off key at the top left of the keypad. The period key is also used to initiate remark entries during logging sessions (see page 4-1). Numbered keys (1–9) are also used to record GPS data during logging sessions (see "GPS Tagging " on page 2-6).

When using the alphanumeric keys, each key press cycles through the alphanumeric characters on that key (e.g. pressing the '1' key cycles through a, b, c, and 1 in a continuous loop). The cycle continues until a different button is pressed, or until one second has passed without a key press. Some fields can only accept numeric or alphabetic characters. The right arrow key is used to enter spaces and the left arrow key functions as a backspace key in alphanumeric fields.

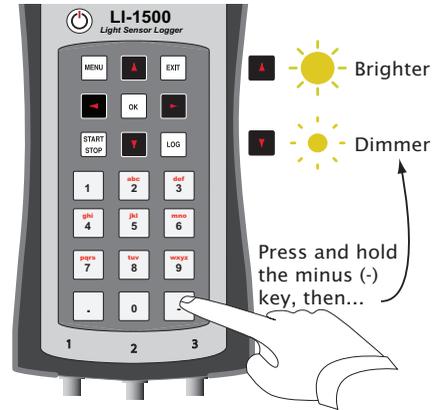


MENU	The <b>MENU</b> key goes to the Main Menu from Monitor Mode or sorts lists of names.
EXIT	The <b>EXIT</b> key returns to the previous screen.
OK	The <b>OK</b> key selects the highlighted menu field. It also saves a setting, file name, or other data.
START/STOP	The <b>START/STOP</b> key initiates or terminates a logging session.
LOG	When in the manual logging mode, the <b>LOG</b> key records a reading of all connected sensors (and GPS if enabled).
Up arrow	The <b>Up</b> arrow and <b>Down</b> arrow keys are used to navigate through menu options or monitor mode lines and increment or decrement values in some fields.
Down arrow	
Right arrow	The <b>Right</b> and <b>Left</b> arrow keys change line variables in monitor mode and scroll through menu sub-levels. If a toggle field is active, they toggle the setting. They also serve as space and backspace keys.
Left arrow	

Figure 2-1. Basic functions of the upper nine keys.

## Adjusting Display Brightness

The LI-1500 display is a 128 x 64 LCD graphics display. It displays alphanumeric characters. To adjust the display contrast, hold the minus (-) key and press the up or down arrow keys.



## Monitor Mode Navigation

After the LI-1500 is powered on and a configuration is chosen or created, the Monitor Mode screen (at right) is displayed. Monitor Mode consists of eight user-selectable lines of real-time information (variables). Each line of the Monitor Mode screen can be set to display any of the variables shown in the table below.

```

2014/3/12      13:55:01
Battery: USB
CONFIG: CONF2
STATUS: Inactive
INPUT2: 9.350
gLAT: 40.856792
gLONG: -96.657667
gALT: 362.3
  
```

Figure 2-2. Monitor Mode screen.

**Table 2-1.** Variables that can be displayed in Monitor Mode.

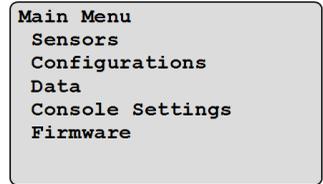
Variable Name	Description
NA	Date (YYYY/MM/DD) and Time (HH/MM/SS)
Battery:	Battery Voltage
CONFIG:	Name of active configuration (or <none> if there is not one active)
STATUS:	Routine status
[Output List]	Any Light or Math outputs each have a line for real-time data display
[Prompt List]	If there are any prompts, each has a line
MULT_[input #]:	If Prompt on Log is enabled, indicates Air or Water multiplier in effect
gLAT:	GPS Latitude
gLONG:	GPS Longitude
gALT:	GPS Altitude
gNSATS:	Number of satellites visible and HDOP (Horizontal Dilution of Precision)
gDATE:	GPS UTC Date (YYYY:MM:DD)
gTIME:	GPS UTC Time (HH:MM:SS)
	Blank line

To change variables on the display, press the up or down arrow key   to select a line. The active line will be highlighted for about one second. Press the right or left arrow keys   to scroll through available variables.

## Menu Navigation

Navigation through menus is accomplished with the upper block of nine keys.

- From monitor mode, Press the **MENU** key to view the main menu.
- Scroll up and down   to highlight a menu option. Press **OK** to select the highlighted menu option.
- Press **OK** after entering file names or other data.
- Press **EXIT** to go back to the previous screen.



```

Main Menu
Sensors
Configurations
Data
Console Settings
Firmware
  
```

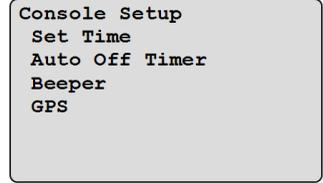
Figure 2-3. Main Menu screen.

## Console Settings

Console settings are global – they take effect no matter what configuration is active.

### Time and Date

The clock is a 24 hour clock (i.e., 6:00 pm = 18:00). The time is entered as HH:MM, where H=hour and M=minute. The date is entered as YYYY/MM/DD, where Y=Year, M=Month, and D=Day.



```

Console Setup
Set Time
Auto Off Timer
Beeper
GPS
  
```

Figure 2-4. Console Setup screen

Select **MENU > Console Settings > Set Time**. Use the right and left arrows   to switch between Hour, Minute, Year, Month, and Day. Use the up and down arrows   to change the numbers in each field.

When the Global Positioning System (GPS) is enabled and a satellite fix is available, **Use GPS** appears as an option under **Set Time**. For this method, enter your offset from UTC in hours. For example: Chicago, IL = -6 hours from UTC during standard time or -5 hours from UTC during daylight saving time.

## Auto Off Timer

The Auto Off timer turns the LI-1500 off after a pre-set period of time in which no keys are pressed.

1. Select **MENU > Console Setup > Auto Off Timer**.
2. Set the timer as desired using the up and down arrow keys  .
3. Disable the "Auto Off Timer" by pressing the down arrow  until **OFF** appears on the screen.

**Important:** The "Auto Off Timer" should be disabled when the LI-1500 needs to be left on for a long period of time to run a continuous, daily, or one-time logging routine.

## Beeper

If enabled, an audible "beep" accompanies events such as powering on/off, low battery warning, and logging data during a manual logging routine.

Select **MENU > Console Setup > Beeper** and select **On** or **Off**. The default setting is **On**.

## GPS

Enable the Global Positioning System (GPS):

Select **MENU > Console Setup > GPS** and select **Enabled**. If a satellite fix is available, real-time GPS data are now visible in Monitor Mode.

## Global Positioning System

An internal Global Positioning System (GPS) module is an available option for the LI-1500. To enable viewing or logging GPS data:

1. Select **MENU > Console Setup > GPS** and select **Enabled**. It usually takes 5–10 minutes to get a satellite fix with a good view of the sky. When a satellite fix is available, real-time GPS data are visible in Monitor Mode. Continue with Step 2 to enable logging of GPS data.
2. Add the GPS output to a configuration ("Adding an Output" on page 3-7). GPS data is automatically added to each sensor reading logged with this configuration and GPS tagging is available during logging sessions.

**Note:** Batteries will drain faster while GPS is enabled, even when no logging is taking place. The default setting is "Disabled".

## GPS Tagging

With the GPS output added to the active configuration, press a numbered key (1–9) to record current GPS data in a separate record during a logging session.

**Example:** Mark the corners of "Plot 1" by pressing the "1" key at each corner of Plot 1 and then mark the corners of "Plot 2" by pressing the "2" key at each corner of Plot 2 – all during the same logging session.

## GPS Fix Quality

The LI-1500 reports two variables (visible on the "gNSATS:" line in Monitor Mode) indicating the quality of a satellite fix. The first variable is the number of satellites visible to the instrument. The second variable is HDOP (Horizontal Dilution of Precision). HDOP is a measure of the geometric quality of the configuration of satellites in the sky. The lower the number, the better the configuration and the better the fix quality. If all satellites are grouped close together, the triangulation gets worse, and HDOP goes up. An HDOP under 2 is very good. If HDOP is above 5, the GPS may not be seeing enough satellites in the right configuration for a good fix.

## GPS Variables

The following variables can be viewed in Monitor Mode or in logged data files:

**Table 2-2.** GPS Variables.

Name in Monitor Mode	Description
gLAT:	GPS Latitude
gLONG:	GPS Longitude
gALT:	GPS Altitude
gNSATS:	Number of satellites visible and HDOP (Horizontal Dilution of Precision)
gDATE:	GPS UTC Date (YYYY:MM:DD)
gTIME:	GPS UTC Time (HH:MM:SS)

# Section 3.

## Configuration

This section describes how to configure the LI-1500 to display and log data from LI-COR light sensors. The first two steps in the summary below are required in order to get light readings and log data. The remaining steps provide additional functionality.

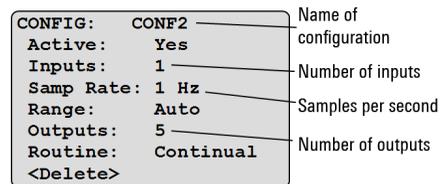


Figure 3-1. Main configuration screen.

### 1. Add a Sensor.

Enter calibration data for each light sensor you will use (see page 3-2).

### 2. Create a Configuration.

Start on page 3-2. Create one or more configurations. This is when you assign a specific sensor to a specific input port (up to 3 sensors). A Light output is automatically created for each sensor in a configuration.

### 3. Change Default Settings in a Configuration.

Change the sampling rate (see page 3-4) and logging routine (see page 3-3) for a configuration.

### 4. Add and Configure Outputs.

Start on page 3-7. Add Math, Prompt, Battery, and GPS outputs to a configuration. Also add more Light outputs to a configuration. You can also enable averaging for outputs (see page 3-9).

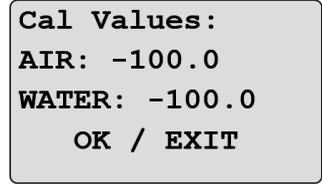
### 5. Select a Measurement Range

If your sampling rate is Raw Mode (or Standard Modes with more than 3 Hz across all three input ports), choose an approximate range of expected light levels or use the default range (see "Selecting a Measurement Range" on page 3-6).

## Adding a Sensor

The LI-1500 Light Sensor Logger is compatible with LI-COR Light Sensors having BNC terminations. Calibration data must be entered for each light sensor. Data for up to 100 sensors can be stored in the memory of the LI-1500.

1. Select **MENU > Sensors > Add New Sensor** and select the model number of your LI-COR light sensor.
2. Enter the sensor's serial number (printed on the sensor). Press **OK** when finished.
3. Select **Mult Val** (terrestrial sensors) or **Mul A/W** (underwater sensors) and enter the sensor's calibration multiplier (use the back arrow  to delete the existing number). Underwater sensors require both **AIR** and **WATER** calibration multipliers (See Figure 3-2 above). Press **OK** when finished.
4. Select **Cal Date:** and use the up and down arrows   to set the date of the sensor's last calibration (Year/Month/Date). Press **OK** when finished.

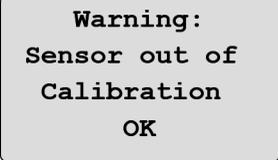


**Cal Values:**  
**AIR: -100.0**  
**WATER: -100.0**  
**OK / EXIT**

Figure 3-2. Calibration Values screen for underwater sensors.

**Note:** Calibration certificates for LI-COR sensors are available at: <http://www.licor.com/env/support/>. Enter your sensor's serial number in the Calibration search box. Certificates include the multiplier and the sensor's last calibration date.

**Important:** A "Sensor out of Calibration" warning appears when opening a logging session if more than two years have passed since the date of the sensor's last calibration as entered in step 4. This is a reminder to send your sensor back to LI-COR for factory calibration. Press **OK** to continue.



**Warning:**  
**Sensor out of**  
**Calibration**  
**OK**

## Creating a Configuration

This section describes how to create and activate a configuration. At least one configuration must be created and made active in order to view and log light readings.

1. Select **MENU > Configurations > Add New Config.**
2. Enter a name for the configuration. Press **OK** when finished.
3. Select **Inputs**, and then select **IN1**, **IN2**, or **IN3**. Attach a LI-COR Light Sensor to the chosen input port.
4. For terrestrial sensors, highlight your sensor's serial number, then **OK > EXIT**. If your sensor is not on the list, select **Add New Sensor** and see "Adding a Sensor" on the previous page.

For underwater sensors, select **Air**, **Water**, or **Prompt On Log**, then press **OK**. This tells the sensor whether to use the **AIR** or **WATER** calibration multiplier. Choose **Prompt On Log** if you want to switch between **AIR** and **WATER** multipliers without changing the configuration, or if you want to use both multipliers at the same time with two or three sensors attached (see "Prompt on Log" on page 4-2).

5. Press **EXIT**. Repeat steps 3–4 to enable a second or third sensor.
6. Select **Active > Yes**. Readings are now visible in Monitor Mode and can be logged.

## Changing the Logging Routine

A logging routine includes settings for *when* the logging session occurs and *how often* a sample is logged (logging rate). Logging routines apply to configurations. A logging routine takes effect when a configuration set for that routine is active and a logging file is opened.

**Important:** Disable the "Auto Off Timer" to prevent interruption of an automatic logging routine if the interval between opening the logging file and the end of the routine will be longer than the time-out interval. Select **MENU > Console Settings > Auto Off Timer**, and press the down arrow  until **OFF** appears on the screen.

**Logging rates for automatic routines:** Each Sample, 100 msec, 200 msec, 500 msec, 1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec, 5 min, 15 min, 30 min, 1 hr, 2 hr, 3 hr, 6 hr, 12 hr, 24 hr

**Note:** The sampling rate must be set at or faster than the desired logging rate. For example, the 1 sec logging rate would *not* be available if the sampling rate is set at 0.1 Hz (one sample every 10 seconds). With the sampling rate set at 0.1 Hz, the shortest time interval you could choose as a logging rate would be every 10 seconds (by choosing **Each Sample**).

The manual logging routine logs a reading when the **LOG** key is pressed. Automatic logging routines are continual, daily, or one time.

Select **MENU > Configurations** and select a configuration from the list. Select **Routine**, then select a routine type:

- **Manual** – then press **EXIT**. Logs a reading each time **LOG** is pressed.
- **Continual** – then set a logging rate and press **EXIT**. Logs automatically while the logging file is open. Close the logging file to stop logging.
- **Daily** – then set a logging rate, start time, stop time, and press **EXIT**. Logs automatically during a set time period every day.
- **One Time** – then set a logging rate, start time/date, stop time/date, and press **EXIT**. Logs automatically during a single set time period.

The appropriate configuration must be active and a logging file open for a routine to be carried out. *Leave the power on* until the logging routine is finished.

## Changing the Sampling Rate

Sampling rates apply to configurations. A specific sampling rate takes effect when a configuration set for that sampling rate is active and a logging file is open.

The sampling rate controls how often a data point is taken. For example, a 10 Hz sampling rate indicates 10 samples are taken every second. If averaging is enabled, the number displayed or logged is the continuous running average of samples taken during the chosen averaging window.

**Example:** If you choose a sampling rate of 1 Hz and an averaging window of 30 seconds, the data point displayed or logged is the average of the instantaneous data points for seconds 1 through 30. For the first 30 seconds only, a data point will not be displayed or logged until 30 seconds have elapsed.

## Standard Modes

**Sampling rates:** 0.01 Hz, 0.1 Hz, 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz.

In the standard sampling modes, up to three input ports can be sampled at once, and averaging is supported.

1. Select **MENU > Configurations** and select a configuration from the list.
2. Select **Samp Rate** and select a sampling rate from the list.

## Raw Mode

**Range of sampling rates:** 1–500 Hz in whole number increments.

Raw Mode sampling permits the user to choose any whole number from 1 through 500 Hz as the sampling rate. Raw Mode sampling is useful for logging rapid changes such as the flicker rate of fluorescent, iridescent, incandescent, and LED light bulbs.

In Raw Mode, the active configuration settings and outputs are disregarded and the following settings are automatically applied:

- **Input:** Only INPUT1 is sampled.
- **Output:** only one output is produced.
- **Logging routine:** **Continual** and every sample is logged.
- **Averaging** is not available.
- **GPS data** cannot be included inside records.
- **Autoranging** is not available (see "Selecting a Measurement Range" on the next page).

These are the steps for Raw Mode sampling:

1. Select **MENU > Configurations** and select a configuration from the list.
2. Select **Samp Rate**.
3. Select **Raw Mode** from the bottom of the list and select **Yes** when asked whether to continue.
4. Enter the desired sampling rate: A whole number from 1 through 500 Hz.

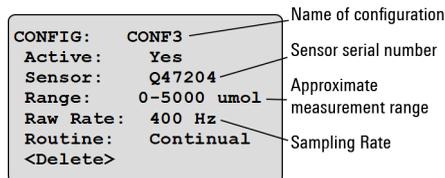


Figure 3-3. Configuration screen for Raw Mode sampling. Only input port 1 is sampled.

5. Select **Sensor** to choose a light sensor for raw mode sampling and make sure this sensor is attached to input 1.
6. In Raw Mode, you can change settings (sensor, range, or sampling rate) by selecting the desired line on the configuration screen (Figure 3-3 on the previous page). To change the Raw Mode sampling rate, select **Raw Rate** > **\*Raw Mode**, then enter a sampling rate and press **OK**. To exit Raw Mode, Select **Raw Rate** and select a standard sampling rate from the list.

## Sampling Rate and Measurement Range

With Standard Modes sampling and a total sampling rate across all three input ports set to 3 Hz or less, the LI-1500 chooses a measurement range automatically based on light levels detected (autoranging). For example, when using one input port the sampling rate needs to be  $\leq 3$  Hz for autoranging to be active. When using two or three input ports at once, the sampling rate needs to be  $\leq 1$  Hz on each port for autoranging to be active.

For Raw Mode sampling or when the total Standard Modes sampling rate is greater than 3 Hz, an approximate measurement range must be selected (or the default range will be in effect). See "Selecting a Measurement Range" below.

## Selecting a Measurement Range

Normally, the LI-1500 automatically selects a measurement range based on light levels detected (autoranging). However, the user must select an approximate measurement range (or use the default) in the following two cases:

1. When using Raw Mode sampling
2. When using Standard Modes sampling, but the total sampling rate for all three input ports is greater than 3 Hz

Approximate measurement ranges available for each sensor type are shown in Table 3-1 on the facing page. When autoranging is not possible, the LI-1500 chooses range 3 (R3) by default. To achieve the highest resolution possible, use Table 3-1 to determine which range is best for your application. Range 4 (R4) is available for applications requiring the largest signal range.

**Table 3-1.** Approximate measurement range choices when autoranging is not available.

Sensor Type	R1	R2	R3 (default)	R4	Units
Terrestrial Quantum	0-50	0-500	0-5000	0-50000	$\mu\text{mol/s/m}^2$
Line Quantum	0-36	0-360	0-3600	0-36000	$\mu\text{mol/s/m}^2$
Underwater Quantum	0-60	0-600	0-6000	0-60000	$\mu\text{mol/s/m}^2$
Spherical Underwater Quantum	0-36	0-360	0-3600	0-36000	$\mu\text{mol/s/m}^2$
Pyranometer	0-3	0-30	0-300	0-3000	$\text{W/m}^2$
Photometric	0-1	0-10	0-100	0-1000	klux

Use the following steps to change the measurement range:

1. Select **MENU > Configurations**.
2. Select a configuration to modify.
3. Select **Range**.
4. For Raw Mode sampling, select a measurement range. For Standard Modes sampling, first select an input port, then select a measurement range for the sensor connected to that input port.

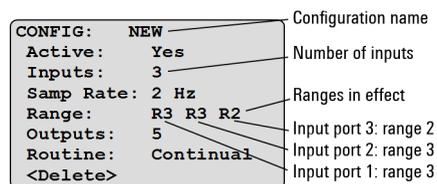


Figure 3-4. Configuration screen with Standard Modes sampling rate greater than 3 Hz total (2 Hz x 3 input ports = 6 Hz total). The "Range:" line displays ranges for input ports 1, 2, and 3 from left to right.

## Adding an Output

An output takes data from light sensors, battery voltage, GPS, prompt entries, or another output and creates a separate data set that can be viewed in monitor mode or logged. The LI-1500 will support up to six Light outputs, 15 Math outputs, and three Prompt outputs in each configuration.

1. Select **MENU > Configurations** and select a configuration from the list.
2. Select **Outputs > Add New Output**. Select an output type:
  - **Light:** Enter a name for the output. Select **Sensor**. Select **Input 1**, **Input 2**, or **Input 3** as the data source. Select **Averaging** to set an averaging window (see "Enabling Averaging" on page 3-9).
  - **Math:** Enter a name for the output. Select **Operation**, then see step 3 under "Configuring a Math Output" on the next page to configure the operation type.

- **Prompt:** Enter name for the output. Select **Type**. Highlight the **Full Alphanumeric** or **Numeric Only** entry type, then press **OK > EXIT**. During manual logging, a Prompt output asks for a different data entry into each record when **LOG** is pressed. For continuous or automatic logging, a prompt output asks for an entry when the logging file is first opened. That same entry is then added into each record (see "Prompts and Remarks" on page 4-2).
- **Battery:** Logs battery voltage in an output named "Battery".
- **GPS:** Logs all of the GPS variables in an output named "GPS".

## Configuring a Math Output

A Math output performs an arithmetic operation on selected data (parameters) and reports the result.

1. Select **MENU > Configurations** and select a configuration from the list.
2. Select **Outputs** and select a math output from the list or see "Adding an Output" on the previous page to add a new Math output.
3. Select **Operation** and select an operation type:
  - **Addition** – Set parameters
  - **Subtraction** – Set parameters
  - **Multiplication** – Set parameters
  - **Division** – Set parameters
  - **Integration** – Select **Param** and select a Light output from the list. Select **Duration** and use the up and down arrow keys to set the length of time in hours and minutes. The integration period starts when the logging file is opened.
  - **Daily Integral** – Select **Param** and select a Light output from the list. Set the start and stop time for the integration period by setting up a Daily routine for the active configuration (see "Changing the Logging Routine" on page 3-3).
  - **Attenuation** – Select **Param A** and select a Light output from the list. Select **Param B** and select another Light output from the list. Select

2014/3/14		14:50:01
CONFIG:	CONF2	
INPUT2:	9.350	Light outputs from ports 2 and 3
INPUT3:	8.125	
DIFF:	1.225	A Math output
gLAT:	40.856792	GPS data
gLONG:	-96.657667	
gALT:	362.3	

Figure 3-5. Viewing outputs in Monitor Mode. The Math output named **DIFF** is displaying the real-time result of subtracting **INPUT3** from **INPUT2**.

**Separation** and enter the separation distance – the distance between the two underwater light sensors (see "Measuring Underwater Attenuation" on the next page).

- **Logarithm** – Natural Logarithm, Ln() – Set a parameter

Select **Param** to set parameters. A parameter is a numeric constant or a pre-existing output to which the operation is applied.

4. Press **EXIT** to return to the "Outputs" screen.

**Example:** Select the **Addition** operation type and the **Output** parameter type. Choose **INPUT1** and **INPUT2** as parameters. Readings generated by **INPUT1** and **INPUT2** will be added together in the new output.

## Enabling Averaging

Averaging is applied to outputs. A specific averaging window takes effect for a particular output.

The averaging function is useful for applications where the signal to be measured is very small, or where the maximum possible resolution is desired. Setting the average to a high value increases resolution since more samples are used to compute the average. The averaging function is often used when light measurements are taken under water or with changing cloud cover.

1. Select **MENU > Configurations** and select a configuration from the list.
2. Select **Outputs** and select a Light output from the list or add a new Light output (see "Adding an Output" on page 3-7).
3. Select **Averaging** and select an averaging window from the list.
4. Select **Min/Max > Yes** to include minimum and maximum values in the output. The minimum and maximum values are taken from the sampled values – not from the logged values. Press **EXIT** twice.

## Averaging Window

The averaging window is the time period over which sampled numbers are averaged. The sampling rate affects what averaging windows are available (see Table 3-2 on page 3-10).

**Table 3-2.** Averaging windows by sampling rate.

Sampling Rate	Averaging Windows Available
0.01 Hz	5 min, 15 min, 30 min, 1 hr, 2 hr, 3 hr, 6 hr, 12 hr, 24 hr
0.1 Hz	15 sec, 30 sec, 60 sec, 100 sec, 5 min, 15 min, 30 min, 1 hr, 2 hr, 3 hr
1 Hz	5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec, 5 min, 15 min
2 Hz	1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec, 5 min
5 Hz	500 msec, 1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec
10 Hz	200 msec, 500 msec, 1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec
20 Hz	100 msec, 200 msec, 500 msec, 1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec
Raw Mode	No averaging

## Sampling Rate and Averaging

The sampling rate controls how often a data point is taken. For example, a 10 Hz sampling rate indicates 10 samples are taken every second. If averaging is enabled, the number displayed or logged is the continuous running average of samples taken during the chosen averaging window.

**Example:** If you choose a sampling rate of 1 Hz and an averaging window of 30 seconds, the data point displayed or logged is the average of the instantaneous data points for seconds 1 through 30. For the first 30 seconds only, a data point will not be displayed or logged until 30 seconds have elapsed.

## Measuring Underwater Attenuation

With two LI-192 Underwater Quantum Sensors connected to the LI-1500 – each placed at different depths – you can measure the vertical attenuation of light underwater. Set up the LI-1500 using the following steps:

1. Create a configuration including the two LI-192 sensors and make this configuration active (see "Creating a Configuration" on page 3-2).
2. Add a **Math** output (see "Adding an Output" on page 3-7).
3. Select **Attenuation** as the operation type (see "Configuring a Math Output" on page 3-8).
4. Select the LI-192 sensor outputs as the two parameters.

5. For separation distance, use the vertical distance between the two sensors in meters.

The Math output reports the vertical attenuation coefficient in  $m^{-1}$ .

**Note:** The LI-COR 2009S Lowering Frame can hold only one LI-192 sensor for measuring downwelling radiation.

## Underwater Attenuation Theory

The Attenuation operation type uses the following equation:

$$K_d = \frac{1}{z} \ln \frac{E_1}{E_2} \quad 3-1$$

Where:

$K_d$  is the vertical attenuation coefficient in  $m^{-1}$ .

1 and 2 are the sensors (1 is the upper sensor).

$z$  is the physical separation between sensors (meters).

$E_1$  and  $E_2$  are the readings from the sensors (units do not matter as long as they are the same).



# Section 4.

## Logging and Viewing Data

This section describes how to log light or GPS data with the LI-1500 Light Sensor Logger and how to view logged data on the console or on a computer. This section also describes how to view real-time data in Monitor Mode.

### Logging Data

1. From the Monitor Mode screen, press the **START|STOP** key on the keypad.
2. Select **New File** (enter a name) or **Existing File** (select from the list).
3. Enter a session remark or press **OK**. The logging file is now open.
4. The trigger for logging depends on the logging routine chosen (see "Changing the Logging Routine" on page 3-3):

Manual: press **LOG** to record the current data for all outputs.

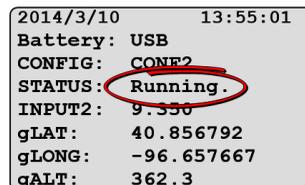
Continual

Daily

One Time

The **STATUS** line in Monitor Mode indicates **Running** when a logging routine is active. A dot (.) flashes at the end of the **STATUS** line while data are being recorded (see Figure 4-1).

5. Press **START|STOP** to close the logging file.



```
2014/3/10      13:55:01
Battery: USB
CONFIG: CONF2
STATUS: Running.
INPUT2: 9.350
gLAT: 40.856792
gLONG: -96.657667
gALT: 362.3
```

Figure 4-1. Monitor Mode with a logging routine running and data being recorded.

**Important:** Leave the power on and the logging file open until the logging routine is finished. The LI-1500 will not turn itself on for Daily or One Time routines. Also disable the Auto off Timer to prevent the early termination of Continual, Daily, or One Time logging routines (see "Auto Off Timer" on page 2-5).

## Prompts and Remarks

The user is given the option to enter a session remark each time a logging file is opened to begin a logging session. Press the period key (.) to enter additional remarks while the logging file is open. These remarks are time-stamped when you press **OK**. Automatic logging continues uninterrupted.

Prompts are enabled by adding a Prompt output to the active configuration see "Adding an Output" on page 3-7). During manual logging, a Prompt output asks for a different data entry into each record when **LOG** is pressed. For continuous or automatic logging, a prompt output asks for an entry when the logging file is first opened. That same entry is then added into each record.

With a prompt, data are inserted into the same record as the sensor data. Prompt data and sensor data appear on the same line in a spreadsheet. A remark, on the other hand, is inserted into its own record and appears as its own line in a spreadsheet. Prompts allow data to be added by the user, while remarks are a way of annotating data if needed.

## Underwater Sensor Logging

When logging data from an underwater sensor, the configuration can be set for **Air**, **Water**, or **Prompt On Log** (see "Creating a Configuration" on page 3-2).

With **Air**, the "in-air" calibration multiplier is used. With **Water**, the "in water" calibration multiplier is used. These multipliers are entered when you add a sensor to the memory of the LI-1500 (see "Adding a Sensor" on page 3-2).

### Prompt on Log

**Prompt on Log** allows you to switch between "in air" and "in water" measurements without changing the configuration. It also allows both "in air" and "in water" measurements at the same time with two or three underwater sensors attached to the LI-1500.

With **Prompt on Log** enabled, you will be asked to choose between the **Air** or **Water** multiplier for each attached underwater sensor. Press **OK** after highlighting your choice. This request is made at the following times:

1. Each time you begin a logging session
2. Each time you press the zero (0) key during a logging session
3. Each time you press the **LOG** key during a manual logging session

**Important:** Your choice of **Air** or **Water** will always be applied to the *next* reading, *not* the reading that happened the moment you pressed **LOG**.

With one or more underwater sensors attached, a variable available in Monitor Mode (see "Monitor Mode Navigation" on page 2-3) indicates which multiplier is currently in effect (**Air** or **Water**). The variable is labelled **MULT\_1**, **MULT\_2**, or **MULT\_3**, corresponding to the input port number. See Figure 4-2 for an example with two underwater sensors attached.

```

2014/3/15      13:55:01
Battery: USB
CONFIG: CONF2
STATUS: Inactive
INPUT2: 9.250
MULT_1: Water
MULT_2: Air
gALT: 362.3

```

Figure 4-2. Monitor Mode indicating "Water" multiplier in effect for the sensor attached to input 1 and "Air" for the sensor attached to input 2.

## GPS Tagging

1. Add the **GPS** output to the active configuration see "Adding an Output" on page 3-7).
2. press a numbered key (1–9) to record current GPS data in a separate record during a logging session.

**Example:** Mark the corners of "Plot 1" by pressing the "1" key at each corner of Plot 1 and then mark the corners of "Plot 2" by pressing the "2" key at each corner of Plot 2 – all during the same logging session.

## Viewing Logged Data

Logged data are stored in files that can be opened on the LI-1500 console or on a computer. Data from multiple logging sessions may be stored in a single file.

### On the Console

1. Select **MENU > Data > Files**. Select a logging file from the list.
2. Select **View** and select a logging session from the list.
3. Select **Session Info** to view session metadata such as the configuration name, software version, any remarks, number of records, and the time/date when the logging file was opened for this session.

4. Select **Records** and select an individual record to view date and time, any prompt entries, the light level for each output, computed values, battery voltage, and GPS data (if enabled).

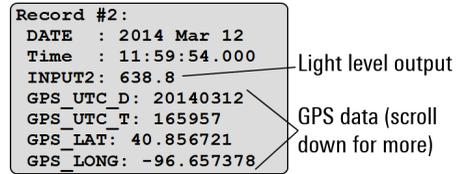


Figure 4-3. Logged data screen for a single record.

### On a Computer

1. Connect the LI-1500 to your computer with the USB cable. It will appear as a mass storage drive named LI-1500.
2. Open the DATA folder in the LI-1500 drive, locate the desired logging file, and drag or copy it to a directory on your computer.
3. Open the logging file in a spreadsheet application on your computer. Logging files are tab delimited, ASCII text files with the ".txt" ending. Some column widths may need to be adjusted for a full view of the data (see Figure 4-4 below).

**Note:** Hours may not be visible in the Time column for data sampled at a rate of 2 Hz or higher. Change the format of the Time column in your spreadsheet application in order to make hours visible.

File Header	Model:	LI-1500 Light Sensor Logger										
	Config:	GPS1										
	Session Remark:	GPSON										
	Software Version:	0.0.26										
	Timestamp:	20140312 11:59:50										
Data headers	DATAGPSH	Record	Date	Time	GTag	GUtcD	GUtcT	GLat	GLong	GElev	GNumSa	GHDOP
	DATAH	Record	Date	Time	INPUT2	GPS_UTC_D	GPS_UTC_T	GPS_LAT	GPS_LONG	GPS_ELEV	GPS_NS	GPS_HDOP
Data records	DATA	0	3/12/2014	59:52.0	664.5	20140312	165955	40.8567	-96.657	376.1	9	0.91
	DATA	1	3/12/2014	59:53.0	632.4	20140312	165956	40.8567	-96.657	375.9	10	0.91
	DATA	2	3/12/2014	59:54.0	638.8	20140312	165957	40.8567	-96.657	375.8	10	0.91
	DATA	3	3/12/2014	59:55.0	686.4	20140312	165958	40.8567	-96.657	375.8	10	0.91
	DATA	4	3/12/2014	59:56.0	681.7	20140312	165959	40.8567	-96.657	375.9	10	0.91
GPS tagging record	DATAGPS	5	3/12/2014	11:59:54	G1	20140312	165959	40.8567	-96.657	375.9	10	0.91

GPS tag number. Indicates "1" key pressed for record 5

Sensor data

Latitude and Longitude

HDOP=Horizontal Dilution of Precision

Figure 4-4. Sensor and GPS data viewed on a computer with a spreadsheet application.

## Raw Mode Data

Data logged with Raw Mode sampling can be viewed with a spreadsheet (as described above) or with LI-COR's FV7x00 software for Windows. This software was designed for high speed gas analyzers, but also works well for graphing large data sets taken at high sampling rates with the LI-1500.

### Viewing Raw Mode Data with the File Viewer:

1. Download the FV7x00 software at:  
<http://www.licor.com/env/support/>  
Click on **LI-1500** and then **Software**. Click on **File Viewer Software FV7x00** to install the file viewer software on your computer.
2. Drag and drop your data file onto the FV7x00 window or click the "+" at the bottom left corner of the FV7x00 screen.
3. Click on the **Variables** tab, then click on a record.
4. Hold down your left mouse key and draw a box around a portion of the graph to zoom in on a graph (Figure 4-5 below). Hover the cursor over the graph to see individual readings and time.

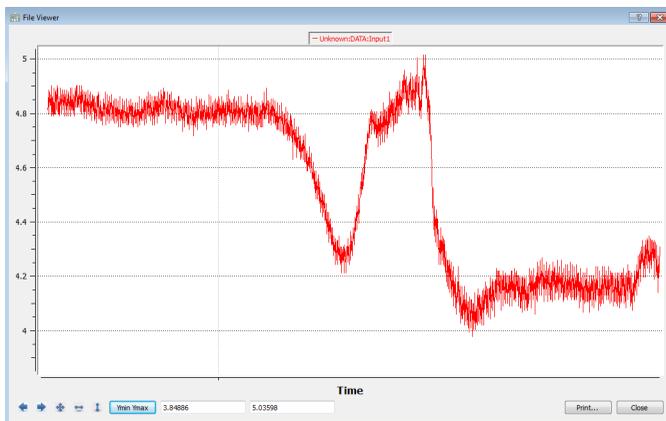


Figure 4-5. Viewing Raw Mode data with the Fv7x00 software.

## Viewing Real-Time Data

In Monitor Mode (see page 2-3), the LI-1500 can be used as a handheld meter for viewing real-time light level data. If the Global Positioning System (GPS) is enabled and a satellite connection is available (see page 2-5), GPS data can also be viewed in Monitor Mode.

1. Make sure a configuration is active and sensors are attached to the correct input ports.
2. Use the up and down arrows to highlight any line in monitor mode.
3. Use the left and right arrows to toggle between any available variables, including any active outputs showing real-time light or GPS readings.

2014/3/14		14:50:01	
CONFIG:	CONF2		
INPUT2:	9.350		Light outputs from ports 2 and 3
INPUT3:	8.125		
DIFF:	1.225		A Math output
gLAT:	40.856792		GPS data
gLONG:	-96.657667		
gALT:	362.3		

Figure 4-6. Viewing real-time data in Monitor Mode. The Math output named `DIFF` is displaying the result of subtracting `INPUT3` from `INPUT2`.

# Section 5.

## Troubleshooting

---

### Console will not power up:

- The "AA" batteries could be exhausted and in need of replacement (see "Install batteries" on page 1-3).
- Make sure batteries are installed with the proper polarity.
- This could also be caused by a locked processor. Try removing the batteries for a few seconds, and then replacing them.

### Instrument will not turn off:

The LI-1500 will not power off if a data file is open or if it is reading data from the internal memory. Wait a few moments for the data transfer to finish and close any open data files, then try again. If the control unit continues to be unresponsive, press and hold the power button for five seconds. Open data files may be lost. If the LI-1500 continues to be unresponsive, remove the "AA" batteries for a few seconds. Replace the batteries. Stored data will not be at risk, but open data files may be lost.

### Instrument locks up:

Remove and re-install the batteries. Stored data will not be at risk, but open data files may be lost.

### GPS readings are absent or the fix quality is poor:

Make sure Global Positioning System is set to "enabled". Select **MENU** > "**Console Setup**" > "**GPS**" and select "**Enabled**". In addition, the GPS output must be added to the active configuration in order to log GPS data (see "Adding an Output" on page 3-7).

**Note:** Indoors, connection to satellites is usually not possible. Outdoors, connection to satellites may be blocked by obstructions such as buildings.

**Fix Quality:** HDOP (visible on the "gNSATS:" line in Monitor Mode) stands for "Horizontal Dilution of Precision". It is a measure of the geometric quality of the configuration of satellites in the sky. The lower the number, the better the configuration and the better the fix quality. If all satellites are grouped close together, the triangulation gets worse, and HDOP goes up. An HDOP under two is very good. If HDOP is above five, the GPS may not be seeing enough satellites in the right configuration for a good fix.

**Sensor readings are absent or incorrect:**

- Make sure a configuration is created using your sensor's calibration multiplier and make sure this configuration is made active (see "Creating a Configuration" on page 3-2).
- Check the sensor cable for damage, including nicks, cuts, or sharp bends.
- Check the BNC connector.
- Check the date of your sensor's last calibration. Calibration certificates are available at:

<http://www.licor.com/env/support/>.

Enter your sensor's serial number in the Calibration search box. Certificates include the multiplier and the sensor's last calibration date. LI-COR recommends factory calibration for LI-COR light sensors every two years.

**Data are not logged correctly:**

- Make sure the clock is set to the correct time (see page 2-4).
- Make sure a configuration is created and made active (see page 3-2).
- Make sure the logging routine start/stop times are set correctly (see page 3-3).
- Disable the "Auto Off Timer" during automatic logging sessions to prevent interruptions. Select **MENU > Console Settings > Auto Off Timer**, and press the down arrow  until **OFF** appears on the screen.

**Time settings are not retained when changing the "AA" batteries:**

Change the lithium backup battery inside the console (see page C-1). The backup battery can last up to seven years, but will need to be changed eventually.

**Data will not read to memory or transfer to a computer:**

In rare cases, such as after a fall, the SD memory card can slip out of place. Open the instrument case and push the card back into place. See "Replacing the Internal Lithium Battery" on page C-1 for instructions on opening the case.



# Appendix A.

## Updating the Firmware

---

Check your firmware (embedded software) version by navigating to **MENU > Firmware > Info > Version**.

The latest firmware is available for download at:

<http://www.licor.com/env/support/>.

Click on **LI-1500 > Software**, then click on the embedded software link and save the firmware file to a directory on your computer. Next follow these steps:

- 1.** Connect the LI-1500 to your computer with the USB cable. It will appear as a mass storage drive named LI-1500.
- 2.** Copy the new firmware file to the LI-1500 root directory. The file will have an ".img" ending.
- 3.** Next, "eject" the LI-1500 mass storage drive as you would for any USB mass storage device. Disconnect the LI-1500 from your computer.
- 4.** On the LI-1500, navigate to **MENU > Firmware > Upgrade**. Select the new firmware file and press **OK**. The new firmware file will take several minutes to install. Press **OK** when the firmware update is complete.

**Optional:** Delete the older ".img" file versions to avoid the risk of downgrading to an older firmware version by mistake.



# Appendix B.

## Specifications

---

**Current Inputs:** 3 BNC connectors (used to connect LI-COR sensors)

**Output Channels:**

Light

Math Channels: 8 math channels (addition, subtraction, multiplication, division, natural logarithm, integration, daily integration, attenuation)

GPS (optional)

Prompt

Battery Voltage

**Input Channel Specifications:**

Frequency Rejection: >70dB at 50 or 60 Hz (1 input channel @ sampling rates of 1, 2, 5, 10, 20 Hz)

Current Accuracy:  $\pm 0.3\%$  of full scale reading @25°C

Signal Ranges:

**Table B-1.** Signal Ranges.

Range #	Current Range	Resolution (Typical)
1	0 – 0.250 $\mu$ A (micro-amps)	0.0305 nA (nano-amps)
2	0 – 2.50 $\mu$ A (micro-amps)	0.1525 nA (nano-amps)
3	0 – 25 $\mu$ A (micro-amps)	1.525 nA (nano-amps)
4	0 – 250 $\mu$ A (micro-amps)	15.25 nA (nano-amps)

Raw Mode (1 – 500 Hz): Selectable Range

Standard Modes (Continual, Manual, Daily, One Time):

Auto range for total sampling rate  $\leq 3$  Hz (e.g. 1 Hz sampling on 3 input channels)

Fixed range (selectable) for total sampling rates  $> 3$  Hz (e.g. 2 Hz sampling on 2 input channels)

**Sampling Rates:**

Standard Modes: 0.01 Hz, 0.1 Hz, 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz

Raw Mode: 1–500 Hz (1 Hz through 500 Hz in whole number increments)

**Logging Rates:**

Standard Modes Sampling: Every Sample, 100 msec, 200 msec, 500 msec, 1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec, 5 min, 15 min, 30 min, 1 hr, 2 hr, 3 hr, 6 hr, 12 hr, 24 hr

Raw Mode Sampling: Every sample (1–500 Hz)

**Averaging:**

Standard Modes Sampling: averaging windows depend on sampling rate (see table below)

**Table B-2.** Averaging windows by sampling rate.

Sampling Rate	Averaging Windows Available
0.01 Hz	5 min, 15 min, 30 min, 1 hr, 2 hr, 3 hr, 6 hr, 12 hr, 24 hr
0.1 Hz	15 sec, 30 sec, 60 sec, 100 sec, 5 min, 15 min, 30 min, 1 hr, 2 hr, 3 hr
1 Hz	5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec, 5 min, 15 min
2 Hz	1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec, 5 min
5 Hz	500 msec, 1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec
10 Hz	200 msec, 500 msec, 1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec, 100 sec
20 Hz	100 msec, 200 msec, 500 msec, 1 sec, 5 sec, 10 sec, 15 sec, 30 sec, 60 sec

Raw Mode Sampling: No averaging

**Display:** 128 x 64 graphics display

**Real-Time Clock:**

Year, Month, Day, Hour, Minute, Seconds

Accuracy of ±3 minutes per month

**Data Storage Capacity:** 1 GB (FAT16 file system)

**Communications:** USB (as mass storage device)

**Global Positioning System (Option) – GPS RADIONOVA® RF Antenna Module:**

Horizontal position accuracy: 2.5 m CEP (50% Circular Error Probability,

Open-Sky, 24hr Static, good view of the sky).

Maximum position update rate: 1 Hz.

GPS receiver sensitivity, autonomous acquisition: -148dBm.

Time to first fix (TTFF), hot start: 1 second.

TTFF, warm start: 6 seconds (typical).

TTFF, cold start (with good view of the sky): 37 seconds at 90% probability.

**Power Supply Options:**

4 “AA” size batteries

USB, AC–DC power adapter

USB, external battery power pack (customer supplied)

**Battery Life:**

80 hours life (typical usage of 1 Hz sampling rate and logging rate)

40 hours life (typical usage with GPS option on)

**Environmental Conditions:**

Operating Temperature Range: -20 to 50°C

Humidity Range: 0 to 95% RH (non-condensing conditions)

Storage Temperature Range: -40 to 65°C

**Size:** 20.9 x 9.8 x 3.5 cm (8.2" x 3.9" x 1.4")

**Weight:** 0.454 kg (1.0 lb) with batteries



# Appendix C.

## Replacing the Internal Lithium Battery

---

The following steps describe how to replace the internal lithium battery. The battery should last up to seven years. Always use a BR1225 watch battery (p/n 442-08614).

- 1.** Using a #1 cross-head (Phillips) screwdriver, loosen the four screws that secure the top and bottom of the control unit. The four screws are located in the corners of the back of the control unit, under the gray protective rubber. Nudge the rubber out of the way of the screws.
- 2.** Gently separate the two halves.
- 3.** The battery is in a round coin-cell battery holder (Figure C-1 on the next page). Lift the silver tab slightly and slide the battery out. It may be necessary to lift the battery slightly with the blade of a standard screwdriver.

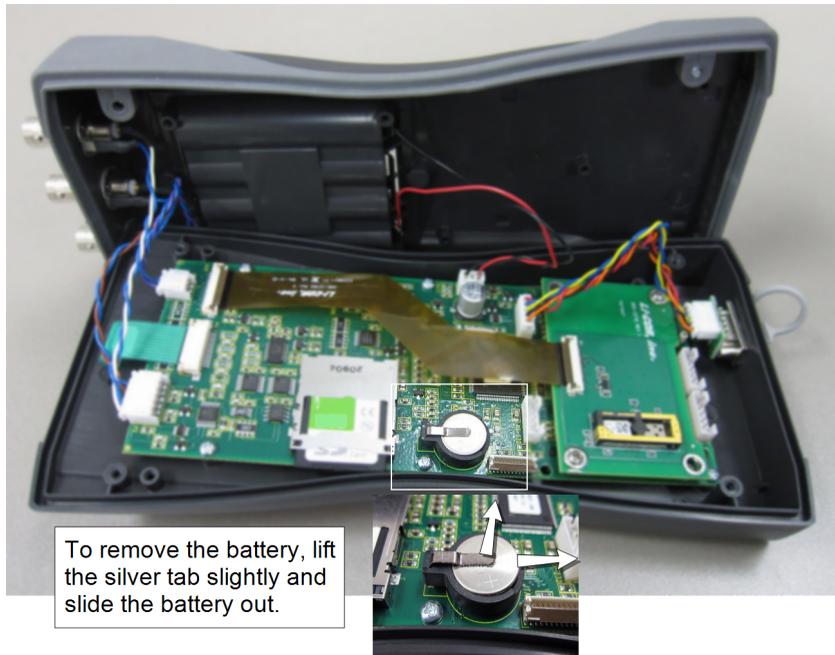


Figure C-1. Replacing the Internal lithium backup battery.

- 4.** Slide the new battery into the holder with the positive (+) terminal facing up.
- 5.** Join the top and bottom halves of the control unit. Be sure the rubber seal is seated properly.
- 6.** Gently tighten the four screws that hold the two halves of the case together. Be very careful not to over tighten the screws, as they may strip the plastic. If a torque screwdriver is available, torque the screws to 4 in.-lbs. (0.5 newton meters).

# Appendix D.

## Warranty

---

Each LI-COR, Inc. instrument is warranted by LI-COR, Inc. to be free from defects in material and workmanship; however, LI-COR, Inc.'s sole obligation under this warranty shall be to repair or replace any part of the instrument which LI-COR, Inc.'s examination discloses to have been defective in material or workmanship without charge and only under the following conditions, which are:

- 1.** The defects are called to the attention of LI-COR, Inc. in Lincoln, Nebraska, in writing within one year after the shipping date of the instrument.
- 2.** The instrument has not been maintained, repaired or altered by anyone who was not approved by LI-COR, Inc.
- 3.** The instrument was used in the normal, proper and ordinary manner and has not been abused, altered, misused, neglected, involved in an accident or damaged by act of God or other casualty.
- 4.** The purchaser, whether it is a DISTRIBUTOR or direct customer of LI-COR or a DISTRIBUTOR'S customer, packs and ships or delivers the instrument to LI-COR, Inc. at LI-COR Inc.'s factory in Lincoln, Nebraska, U.S.A. within 30 days after LI-COR, Inc. has received written notice of the defect. Unless other arrangements have been made in writing, transportation to LI-COR, Inc. (by air unless otherwise authorized by LI-COR, Inc.) is at customer expense.
- 5.** No-charge repair parts may be sent at LI-COR, Inc.'s sole discretion to the purchaser for installation by purchaser.
- 6.** LI-COR, Inc.'s liability is limited to repair or replace any part of the instrument without charge if LI-COR, Inc.'s examination disclosed that part to have been defective in material or workmanship.

**There are no warranties, express or implied, including but not limited to any implied warranty of merchantability of fitness for a particular purpose**

**on underwater cables or on expendables such as batteries, lamps, thermocouples, and calibrations.**

**Other than the obligation of LI-COR, Inc. expressly set forth herein, LI-COR, Inc. disclaims all warranties of merchantability or fitness for a particular purpose. The foregoing constitutes LI-COR, Inc.'s sole obligation and liability with respect to damages resulting from the use or performance of the instrument and in no event shall LI-COR, Inc. or its representatives be liable for damages beyond the price paid for the instrument, or for direct, incidental or consequential damages.**

The laws of some locations may not allow the exclusion or limitation on implied warranties or on incidental or consequential damaged, so the limitations herein may not apply directly. This warranty gives you specific legal rights, and you may already have other rights which vary from state to state. All warranties that apply, whether included by this contract or by law, are limited to the time period of this warranty which is a twelve-month period commencing from the date the instrument is shipped to a user who is a customer or eighteen months from the date of shipment to LI-COR, Inc.'s authorized distributor, whichever is earlier.

This warranty supersedes all warranties for products purchased prior to June 1, 1984, unless this warranty is later superseded. To the extent not superseded by the terms of any extended warranty, the terms and conditions of LI-COR's Warranty still apply.

DISTRIBUTOR or the DISTRIBUTOR's customers may ship the instruments directly to LI-COR if they are unable to repair the instrument themselves even though the DISTRIBUTOR has been approved for making such repairs and has agreed with the customer to make such repairs as covered by this limited warranty.

Further information concerning this warranty may be obtained by writing or telephoning Warranty manager at LI-COR, Inc.

# Index

---

## A

- AC Power 1-3
- Add a Sensor 3-2
- Addition 3-8
- Adjust Display Brightness 2-3
- Attenuation 3-8, 3-10
  - theory 3-11
- Auto-Off Timer 2-5
- Averaging 3-9
- Averaging Windows 3-9, 3-10, B-1, B-2

## B

- Backup Battery C-1
- Batteries 1-3
  - backup C-1
  - low battery indicator 1-3
- Battery Life B-3
- Battery Output 3-8
- Beeper 2-5
- BNC Input Ports 1-4

## C

- Cable Connections 1-3
- Changing Monitor Mode Variables 2-4
- Cleaning 1-4
- Configuration 3-1
  - activating 3-3
  - creating 3-2
- Console 1-1
- Console Settings 2-4

## D

- Daily Integral 3-8
- Data
  - viewing logged data 4-3
  - viewing real-time data 4-6
- Data Cable Connection 1-3
- Data Storage Capacity B-2
- Date and Time 2-4
- Display 2-3
- Division 3-8

## E

- Environmental Conditions B-3

## F

- Firmware A-1
- Frequency Rejection B-1

## G

- Global Positioning System 2-5
  - fix quality 2-6
  - tagging 2-6
  - variables reported 2-6
- GPS Output 3-8

## I

- Instrument Software A-1
- Integration 3-8

## K

- Keypad 2-2

## **L**

- Light Output 3-7
- Light Sensors
  - adding 3-2
  - calibration date 3-2
  - calibration multipliers 3-2
  - input ports 1-4
  - serial numbers 3-2
- Lithium Battery C-1
- Logarithm 3-8
- Logging Data 4-1
- Logging Rate 3-3
- Logging Routines 3-3

## **M**

- Maintenance 1-4
- Math Outputs 3-8
- Memory 1-4
- Menu Navigation 2-4
- Monitor Mode 2-3
- Multiplication 3-8

## **N**

- Natural Log 3-8
- Noise Filtering B-1

## **O**

- Operations 3-8
- Outdoor Use 1-4
- Output Channels 3-7
- Outputs 3-7
  - battery 3-8
  - GPS 3-8
  - light 3-7
  - math 3-8
  - prompt 3-8

## **P**

- Parameter 3-9
- Parts List 1-1
- Power On and Off 2-1
- Power Sources 1-2

- Prompt on Log 4-2
- Prompt Output 3-8
- Prompts 4-2
- Prompts and Remarks 4-2

## **R**

- Raw Mode Data
  - viewing 4-5
- Raw Mode Sampling 3-5
- Real-Time Data 2-3
- Remarks 4-2

## **S**

- Sampling
  - raw mode 3-5
- Sampling Rate 3-4
  - standard modes 3-5
- Sensors 3-2
- Specifications B-1
- Standard Modes Sampling 3-5
- Storage 1-4
- Subtraction 3-8

## **T**

- Time and Date 2-4
- Troubleshooting 5-1

## **U**

- Underwater Attenuation 3-10
  - theory 3-11
- Underwater Sensors 3-2, 4-2
- USB Port 1-3
- User Interface 2-1

## **V**

- Vertical Attenuation 3-10
  - theory 3-11
- Viewing Logged Data 4-3
- Viewing Real-time Data 4-6



## **LI-COR Biosciences**

### ***Global Headquarters***

4647 Superior Street  
Lincoln, Nebraska 68504  
Phone: +1-402-467-3576  
Toll free: 800-447-3576  
Fax: +1-402-467-2819  
envsales@licor.com • envsupport@licor.com • www.licor.com/env

### ***Regional Offices***

#### **LI-COR GmbH, Germany**

Serving Andorra, Albania, Belarus, Cyprus, Estonia, Germany,  
Iceland, Latvia, Lithuania, Liechtenstein, Malta, Moldova, Monaco,  
San Marino, Ukraine, and Vatican City.  
LI-COR Biosciences GmbH  
Siemensstraße 25A  
61352 Bad Homburg  
Germany  
Phone: +49 (0) 6172 17 17 771  
Fax: +49 (0) 6172 17 17 799  
envsales-gmbh@licor.com • envsupport-gmbh@licor.com

#### **LI-COR Ltd., United Kingdom**

Serving Denmark, Finland, Ireland, Norway, Sweden, and UK.  
LI-COR Biosciences UK Ltd.  
St. John's Innovation Centre  
Cowley Road  
Cambridge  
CB4 0WS  
United Kingdom  
Phone: +44 (0) 1223 422102  
Fax: +44 (0) 1223 422105  
envsales-UK@licor.com • envsupport-UK@licor.com

LI-COR Distributor Network: [www.licor.com/env/distributors](http://www.licor.com/env/distributors)

5/14 984-14406

**LI-COR®**