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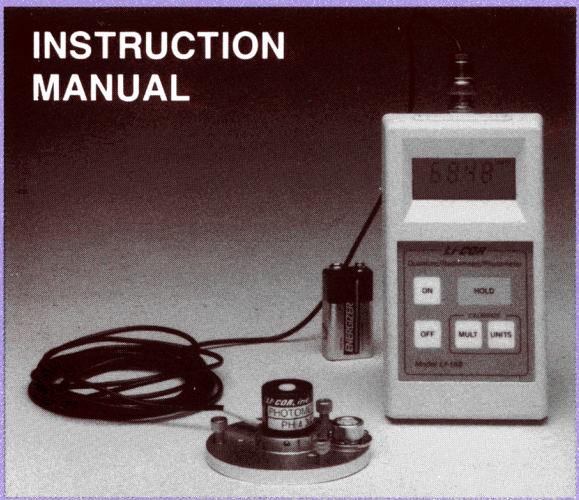
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LI-189

Quantum/Radiometer/Photometer



LI-COR®

LI-189

Quantum/Radiometer/Photometer

Operating Manual

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How to Use this Manual

This manual contains the operation and maintenance information for the LI-189 Quantum/Radiometer/Photometer. Read both the general information and the operating instructions before using the LI-189.

Information on type 'SA' sensors used with the LI-189 can be found in the LI-COR Radiation Sensors instruction manual for type SA sensors.

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1 General Information

1.1 Instrument Function

The LI-189 is compatible with all LI-COR type 'SA' radiation sensors. With these sensors the LI-189 can make instantaneous measurements of Photosynthetically Active Radiation (PAR) in air or water, illuminance in units of lux or footcandles, and solar irradiance (W m^{-2}).

1.2 Sensors

The LI-189 is compatible with all LI-COR type 'SA' radiation sensors, which utilize a BNC connector.

LI-COR type 'SB' radiation sensors are also compatible if the Calconnector (Calibration connector) is detached from the BNC connector.

LI-COR type 'SZ' radiation sensors are not compatible with the LI-189; they may, however, be fitted with a BNC connector. Contact LI-COR for further information.

Recalibration of all LI-COR radiation sensors is recommended every two years.

Complete information concerning the sensors that can be used with the LI-189 is found in the type 'SA' LI-COR Radiation Sensors instruction manuals. In addition, several technical reports on LI-COR sensors are available. These include a report entitled "Radiation Measurements", which summarizes the types of measurements that can be made with each LI-COR sensor and contains conversion factors for commonly used measurement units. A report concerning the immersion effect and cosine collecting properties of underwater sensors is also available (Roemer, Hoagland report).

1.3 Accessories

The following accessories are available for the LI-189. Contact LI-COR for current information.

189-01 Carrying Case: A soft-sided case for the LI-189 and terrestrial type radiation sensors. Size: 20.3 L x 10.2 W x 9 cm D (8" x 4" x 3.5"). Weight: 98 g (0.216 lbs).

LI-COR Radiation Sensors: Type 'SA' (e.g. LI-190SA) with BNC connectors.

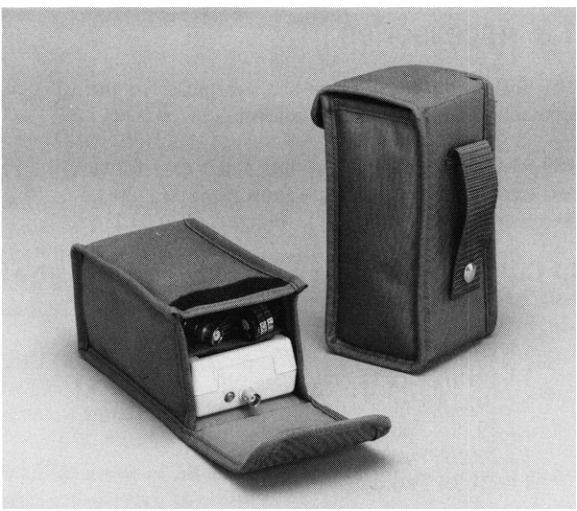
LI-190SA Quantum Sensor
LI-191SA Line Quantum Sensor
LI-192SA Underwater Quantum Sensor*
LI-193SA Spherical Quantum Sensor*
LI-200SA Pyranometer Sensor
LI-210SA Photometric Sensor

* Requires 2222UWB cable.

2003S Mounting and Leveling Fixture: The 2003S is for use with all LI-COR terrestrial type sensors.

2222SB Extension Cable – For use with all LI-COR terrestrial type sensors. Available in 15.2 m (50 ft), 30.4 m (100 ft), or custom lengths to 304 m (1000 ft).

216 Replacement Battery - 9 Volt transistor type. The LI-189 requires one for replacement.

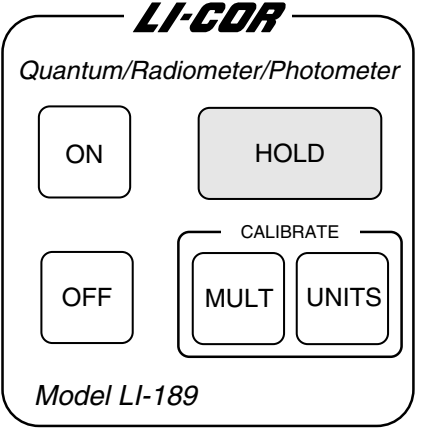


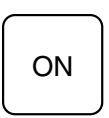
189-01 Carrying Case

2 Operation

2.1 Using the Keypad

The LI-189 utilizes a 5-key keypad (below), which functions as follows:





Power ON.



Power OFF. The LI-189 must be turned off manually. There is no time-delayed automatic shut-off on the LI-189.



Retains the current reading on the display until the **HOLD** key is pressed again.



Used to enter the sensor calibration multiplier. When **MULT** is pressed, the prompt **CAL** is displayed to indicate that the LI-189 is in calibration mode rather than measurement mode.



Press this key in calibration mode (while **CAL** is displayed) to change the Units Label on the display to match the calibrated units of the sensor.

2.2 Sensor Calibration

All LI-COR radiation sensors produce a current that is proportional to the radiation intensity. During the factory calibration, the sensor output (in microamps) is measured while the sensor is exposed to a standard lamp of known intensity. The sensor output at this intensity has the general units of microamps per radiation unit and is called the **Calibration Constant** (Calconstant). Each sensor has a slightly different output for a given radiation intensity and will therefore have a unique Calconstant.

The LI-189 measures the current output of the sensor, and converts the measured current to units of radiation. In order to make this conversion, the LI-189 uses the sensor **Calibration Multiplier**. The Calibration Multiplier is the negative reciprocal of the Calconstant.

$$\text{Multiplier} = \frac{-1}{\text{Calconstant}}$$

The Calibration Multiplier is always a negative number because the shield (ground) in the coaxial cable is positive instead of negative.

Since the Calibration Multiplier is unique for each sensor, it must be entered into the LI-189 each time the sensor is changed or recalibrated (see Section 2.3).

NOTE: When using the LI-189, always enter the Calibration Multiplier, **not** the Calconstant. If the Calconstant is entered any data collected will be erroneous.

For type 'SA' sensors purchased after September, 1985, the calibration multiplier is given on the certificate of calibration, and is also attached to the sensor. The calibration label attached to a quantum sensor appears as follows, and contains the value of the multiplier, as well as the serial number of the sensor, and the date of its most recent calibration.

MULT:

tcoff: 0.0036
Units: µmol s^{-1} m^{-2} per µA
SERIAL NO.
CAL DATE: DD/MM/YR LI-COR®

For the LI-192SA and LI-193SA Underwater Quantum Sensors there are two calibration multipliers; one for "in air" operation and one for "in water" operation. Use the multiplier that is appropriate for your application.

If the calibration constant for your sensor has been lost or misplaced, it can be obtained from LI-COR by providing the serial number of the sensor.

Converting Calconstants to Multipliers

For LI-COR sensors that are not type 'SA' (i.e, type 'SB', etc.), the calibration multiplier must be calculated from the calibration constant given on the certificate of calibration.

EXAMPLE: Calculate the multiplier for a LI-190SB Quantum sensor with a calibration constant of 8.0 µAmps/1000 µmol s^{-1} m^{-2}.

$$\textbf{Multiplier} = \frac{(-1)\left(1000\ \mu\text{mol}\ s^{-1}\ m^{-2}\right)}{8\ \mu\text{Amps}}$$

$$= \frac{-125.0\ \mu\text{mol}\ s^{-1}\ m^{-2}}{1\ \mu\text{Amp}}$$

EXAMPLE: Convert a calibration multiplier of 3.6 Klux/mAmp to footcandles (see Appendix B for conversion factors).

$$\textbf{Multiplier}\ (\text{fc}) = \frac{3.6\ \text{Klux}}{\mu\text{Amp}} \times \frac{1000\ \text{lux}}{1\ \text{Klux}} \times \frac{0.0929\ \text{fc}}{1\ \text{lux}}$$

$$= \frac{334.44\ \text{fc}}{\mu\text{Amp}}$$

2.3 Configuring the LI-189

IMPORTANT: After changing sensors, the LI-189 **must** be configured to the new sensor.

Follow these steps to enter the Calibration Multiplier for a sensor:

1. Press the **MULT** key. The **CAL** prompt is displayed.

2. Press the **UNITS** key until the Units Label on the display matches the sensor type. Readings will be incorrect if the Units Label does not match the sensor type. *No units conversions are performed (see Section 2.4 below).*

Sensor Type	Units Label	Readout Units
Quantum	µmol	µmol s^{-1} m^{-2}
Pyranometer	W m^{-2}	Watts m^{-2}
Photometric	lux or Klux	lux or Kilolux
Photometric	fc	footcandles

3. Turn the small calibration screw on the top end of the LI-189 (Figure 2-1) until the display reads the value of the calibration multiplier. Press the **MULT** key again, and the LI-189 is calibrated for the attached sensor.

It may be difficult to match the last digit of the multiplier on the display, so just get as close as possible. Errors will be very small if the last digit is off by one. For example, if the sensor multiplier is -100.0 mmol s^{-1} m^{-2}/mA, and the entered value is -100.1, the resulting error will be 0.1%.

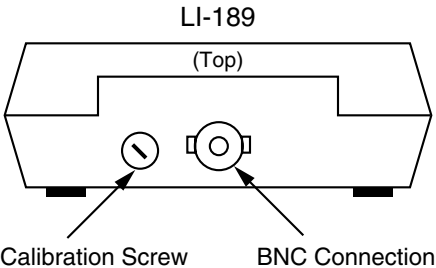


Figure 2-1. Location of calibration screw for setting calibration multiplier.

NOTE: If a single LI-COR radiation sensor is purchased with the LI-189, the calibration multiplier will be entered at the factory, allowing for immediate use of the sensor. If more than one sensor is purchased, verify that the multiplier entered into the LI-189 matches the multiplier of the sensor you intend to use.

2.4 Converting Units

The LI-189 with an attached Photometric sensor can display in units of lux (Klux) or footcandles. However, no units conversions are performed. The Calibration Multiplier ***must*** be entered in the same units as those you wish to display. To convert lux to footcandles, or vice versa, use the following conversion factors:

1 lux = 0.0929 fc, or
1 fc = 10.764 lux
= 0.0107 Klux

Example: Assume that the sensor multiplier is 3.6 Klux. To convert this multiplier to footcandles:

$$\text{Multiplier(fc)} = \frac{3.6\ \text{Klux}}{\mu\text{Amp}} \times \frac{1000\ \text{lux}}{1\ \text{Klux}} \times \frac{0.0929\ \text{fc}}{1\ \text{lux}}$$

$$= \frac{334.44\ \text{fc}}{\mu\text{Amp}}$$

2.5 Changing Default Power-Up Units

The units label displayed when the LI-189 is powered ON is determined by two jumpers inside the LI-189. The default Units Label corresponds to the sensor whose multiplier was originally entered at the factory (μmol s^{-1} m^{-2} if no sensor was purchased). To change the default power-up units, follow these steps:

1. Remove the 4 screws from the corners of the LI-189 back panel.

2. Locate the two units jumpers on the circuit board (see Figure 2-2).

3. Carefully remove one or both of these jumpers by pulling straight up with a small pair of pliers. Be careful not to bend or break the jumper pins.

4. Re-insert the jumper(s) as shown in Figure 2-3 to correspond to the Units Label desired.

5. Replace the back panel, being careful not to pinch any of the wires between the two halves of the case.

6. Replace the screws. Don't overtighten the screws, as the threads in the plastic case may be damaged.

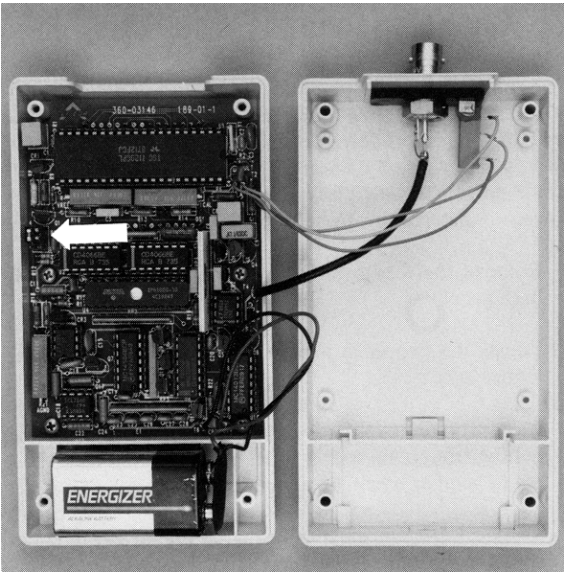
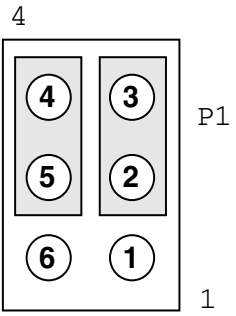
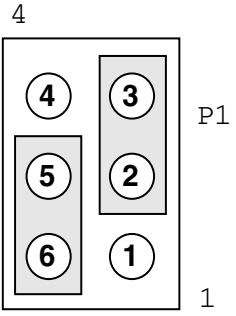


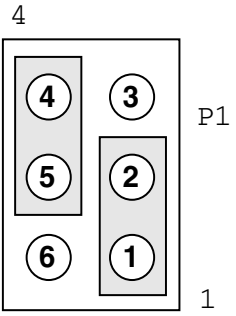
Figure 2-2. Location of jumpers for changing default power-up units.



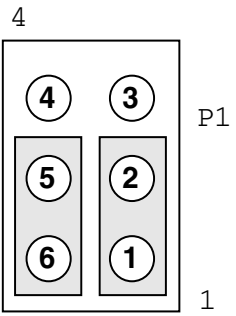
µmol s^{-1} m^{-2} (Quantum)



W m^{-2} (Pyranometer)



lux (Photometric)



footcandles (Photometric)

Figure 2-3. Position of jumpers to change default power-up units.

2.6 Power Requirements

Power is supplied by one 9 volt transistor battery. Eveready alkaline #522 (LI-COR part #216) or equivalent may be used. Battery life is in excess of 200 hours. A **LO BAT** message is displayed when there is less than 20 hours of battery life remaining. The battery should be replaced immediately after the **LO BAT** message is displayed to ensure reliable operation.

The battery compartment is accessed through a slide-out panel on the back of the instrument case.

Although typical battery life is more than 200 hours of continuous operation, it is dependent upon the storage temperature. Do not store the LI-189 at high temperatures.

Appendix A. Specifications

Current Accuracy: 25 °C: ± 0.3% of reading ±1 digit on the least significant digit displayed (all ranges).
0-55 °C: ±0.4% of reading ± 3 digits on the least significant digit displayed (all ranges).
Range Selection: Autoranging (3 ranges).
Linearity: ± 0.05%.
Operating Conditions: 0 to 55 °C, 0 to 90% RH (non-condensing).
Storage Conditions: -55 to 60 °C, 0 to 90% RH (non-condensing).
Display: 4 1/2 digit custom LCD display. Updated every 0.6 seconds.
Keypad: Sealed, 5-key tactile response keypad.
Battery Life: 200 hours (minimum) continuous operation.
Power Requirement: One 9V Eveready Alkaline #522 or equivalent.
Low Battery Detection: Low battery indicator displayed with approximately 20 hours battery life remaining.
Size: 14 L × 7.7 W × 3.8 cm D (5.5" × 3" × 1.5").
Weight: 0.26 kg (0.57 lbs).
Sensors: Any LI-COR sensor with BNC connector; Quantum, Pyranometer, or Photometric.
Warranty: 1 year parts and labor.

LI-189 Range and Resolution:

Sensor Type	Range	Resolution
Quantum	0-199 µmol s^{-1} m^{-2} -1999 -19999	0.01 µmol s^{-1} m^{-2} 0.1 1
Radiometric	0-19 W m^{-2} -199 -1999	0.001 W m^{-2} 0.01 0.1
Photometric	0-1999 lux -19999 lux 0-199 klux 0-199 fc -1999 -19999	0.1 lux 1 lux 0.01 klux 0.01 fc 0.1 1

Appendix B. Conversion Table

Type of Measurement	Instantaneous Measurements
Quantum	1.0 μm s^{-1} m^{-2} = 1 μE s^{-1} m^{-2} = 6.022 • 10^{17} photons $s^{-1}m^{-2}$ = 6.022 • 10^{17} quanta s^{-1} m^{-2} = 6.022 • 10^{13} quanta s^{-1} cm^{-2}
Radiometric	1 W m^{-2} = 1.433 • 10^{-3} cal cm^{-2} min^{-1} = 1.433 • 10^{-3} langley min^{-1} = 0.100 mW cm^{-2} = 100 μW cm^{-2} = 1.0 J s^{-1} m^{-2} = 1000 erg s^{-1} cm^{-2} = 0.317 BTU ft^{-2} h^{-1} = 5.283 • 10^{-3} BTU ft^{-2} min^{-1}
Photometric	1 lux = 1 lm m^{-2} = 0.0929 lm ft^{-2} = 0.0929 fc = 0.001 klux

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