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Ocean Optics Inc.
First in Photonics™

A HALMA GROUP COMPANY

LS-1-CAL Series Calibration Light Sources

Installation and Operation Instructions

Description

The LS-1-CAL and the LS-1-CAL-INT are tungsten halogen light sources that you can use to calibrate the absolute spectral response of your system. Each light source emits a spectral intensity that is calibrated by standards that provide traceability to the National Institute of Standards and Technology (NIST).

The bulbs used in the LS-1-CAL and the LS-1-CAL-INT are 900-hour, 3100K bulbs. Each lamp also features a 12 VDC regulated power supply. The lamps are effective in calibrating the absolute spectral response of a system from 300-1050 nm. When the lamps are combined with Ocean Optics OOIIrrad software, you can calculate the absolute spectral intensity of an emissive sample. Furthermore, each light source can be used when calculating absolute irradiance (with OOIIrrad software) or absolute irradiance and emissive color (with OOIIrrad-C software).

LS-1-CAL

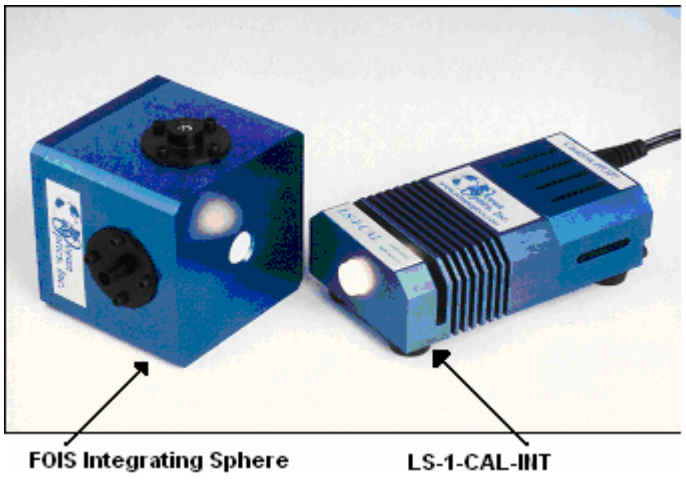
Calibrated for use with a fiber and/or a CC-3 Cosine Corrector

LS-1-CAL-INT

Calibrated for use with the FOIS-1 Integrating Sphere

The LS-1-CAL Series of calibrated light sources are designed for use in the VIS-Shortwave NIR (300–1050 nm). It provides known absolute intensity values at several wavelengths, expressed in $\mu W/cm^2/nm$. Since the spectral intensity of the LS-1-CAL is traceable to the National Institute of Standards and Technology (NIST), it is specifically designed for calibrating the absolute spectral response of your system.

The primary difference between the LS-1-CAL and the LS-1-CAL-INT is the Teflon diffusion disc that is installed in place of the SMA 905 Connector found on the LS-1-CAL. The LS-1-CAL-INT is designed to work with the FOIS-1 Fiber Optic Integrating Sphere. The Teflon disc on the LS-1-CAL-INT fits snugly into the optical aperture on the FOIS-1, providing a uniform light source optimized for the FOIS-1.



The LS-1-CAL-INT can be used with other integrating spheres. However, the optical aperture on the integrating sphere must be large enough to accommodate the Teflon disc on the LS-1-CAL-INT, as the Teflon disc must be fully inserted into the integrating sphere. The LS-1-CAL-INT is not effective when the Teflon disc is placed up against an integrating sphere aperture that is too small to accommodate the disc size.

Note

The LS-1-CAL is NOT designed to operate as an excitation source in your experiments.

Parts Included

The LS-1-CAL Series light source ships with the following items:

- LS-1-CAL or LS-1-CAL-INT Calibrated Light Source
- Switching AC adapter (for power stabilization)
- Power cord for the power supply
- Floppy disk or CD containing calibration lamp report files (.lmp). The LS-1-CAL has two lamp reports; one for using the LS-1-CAL with a bare fiber and one for using the LS-1-CAL with a CC-3 cosine-corrected irradiance probe.
- Allen wrench for securing the inner barrel of the SMA connector

Additional Accessories

The following are additional accessories available from Ocean Optics that you may need, depending on your system set-up:

- Spectrometer
- SMA-terminated optical fiber or CC-3 cosine-corrected irradiance probe
- Ocean Optics OOIIrrad Irradiance Software or OOIIrrad-C Software

WARNING

The light source becomes extremely hot during operation and does not contain a cooling fan. Handle with extreme care during operation.

Connecting the Light Source

The set-up procedure differs slightly, depending on whether you are connecting the LS-1-CAL to a bare fiber or a cosine corrector. The LS-1-CAL-INT connects to an integrating sphere such as the Ocean Optics FOIS-1 Fiber Optics Integrating Sphere.

Connecting the LS-1-CAL

► *Procedure*

1. Use the supplied Allen wrench to loosen the setscrew on the SMA connector of the LS-1-CAL.
2. **If using a bare fiber with the LS-1-CAL:**
    a. Remove the inner barrel from the SMA connector.
    b. Screw this connector barrel onto the end of the fiber until the connection is tight.
    c. Insert the barrel and fiber **completely** into the SMA connector of the LS-1-CAL.

    If using a CC-3 cosine corrector with the LS-1-CAL:
    a. Remove the inner barrel from the SMA connector.
    b. Screw the CC-3 cosine corrector onto the end of the fiber until the connection is tight.
    c. Insert the CC-3 and fiber **completely** into the SMA connector of the LS-1-CAL, replacing the inner barrel of the SMA connector.
3. Use the Allen wrench to tighten the setscrew on the SMA connector or CC-3 of the LS-1-CAL.
4. Screw the other end of the fiber into the SMA connector of the spectrometer.
5. Plug the switching AC adapter (black rectangular box) into the back of the LS-1-CAL. This adapter stabilizes the power coming into the lamp to insure constant spectral intensity
6. Plug the power cord into a standard outlet, then plug the other end of the power cord into the back of the switching AC adapter.

7. Switch the lamp on using the on/off switch on the back of the LS-1-CAL.
8. Allow the lamp to warm up for at least 30 minutes before proceeding.

You have now connected the LS-1-CAL for operation.

Connecting the LS-1-CAL-INT

► ***Procedure***

1. Connect the Teflon disc on the LS-1-CAL-INT into the optical aperture on the FOIS-1.
2. Plug the switching AC adapter (black rectangular box) into the back of the LS-1-CAL-INT. This adapter stabilizes the power coming into the lamp to insure constant spectral intensity
3. Plug the power cord into a standard outlet, then plug the other end of the power cord into the back of the switching AC adapter.
4. Switch the lamp on using the on/off switch on the back of the LS-1-CAL-INT.
5. Allow the lamp to warm up for at least 30 minutes before proceeding.

You have now connected the LS-1-CAL-INT for operation.

Calibrating With the Light Source

► ***Procedure***

Follow the steps below to calibrate the spectral response of your system using the LS-1-CAL or LS-1-CAL-INT:

1. Insert the floppy disk or CD that came with the light source that contains the ASCII file (.lmp) of the Lamp Calibration Report.

   The LS-1-CAL has two lamp reports. One file has the calibration numbers for calibrating the spectral response of your system with the lamp and a bare fiber; the name of this file contains the lamp's serial number followed by FIB.LMP. The other file has the calibration numbers for calibrating the spectral response of your system with the lamp and a CC-3 cosine corrector; the name of this file contains the lamp's serial number followed by CC.LMP.

   The bare fiber calibration is for a bare fiber starting at the Teflon diffuser. When calibrating with the cosine corrector, the distance from the diffuser is important to the calibration.

Calibration File Notes

The calibration files produced at the factory were created by using a NIST-traceable FELS lamp and a NIST-traceable power supply in a black room. The lamp then exhibits the typical back body spectra. The lamp is bright enough to assume a point source, so that the square law could be used to calculate irradiance. This source was then used to calibrate the spectrometer (with or without a cosine corrector). The calibrated spectrometer was then used to calibrate the LS-1-CAL light source.

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2. Copy the ASCII file(s) into the OOIIrrad Irradiance Software directory.
3. Start OOIIrrad Irradiance Software and enter Scope mode.

4. Select **Lamp | Select Lamp** and choose the Lamp Calibration Report file that reflects your optical setup.
5. Select **Spectrometer | Configure Fibers** and enter the fiber diameter values for each channel in your setup.
   - If using a bare fiber: Enter the fiber diameter.
   - If using a fiber with a CC-3 cosine corrector: Enter **3,900**.

Note

You must use whatever optical setup you choose for your application when calibrating the spectral response of your system. For example, if you are going to use a 200-µm fiber and a CC-3 for your application, you must use the same components when calibrating the spectral response of your system.

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6. Enter the data acquisition parameters for your setup in the OOIIrrad software, just to the right of the displayed spectrum. The values for **Scans to Average** and **Smoothing Size** must be identical for your reference, dark, and irradiance scans. You can use a different integration period for your reference scan, but you must use the same integration period for your dark and irradiance scans.

OOIIrrad Software Field	Value
Scans to Avg	Enter a value to implement a sample averaging function that averages X number of spectra. Higher values result in better signal-to-noise ratios. This value must remain constant once you have taken your dark and reference scans. If you change this value, you must take a new dark and reference scan.
Smoothing Size	Enter a value to implement a smoothing technique that averages across spectral data. A value of 5, for example, averages each data point with the 5 points to its left and the 5 points to its right. Higher values result in smoother data and higher signal-to-noise ratios. However, if the value is too high, you will experience a loss in spectral resolution. This value must remain constant once you have taken your dark and reference scans. If you change this value, you must take a new dark and reference scan.
Integration Period (ms)	Enter a time (in milliseconds) to regulate the amount of time the detector monitors the incoming photons. If the Scope mode intensity is too low, increase this value. If the Scope mode intensity is too high, decrease this value. While monitoring the graph trace, adjust the integration time until the signal intensity level is approximately 70 – 90% of maximum. You must take a new dark scan if you change this value. Clicking the **Dark** button takes a new dark scan for the sample integration time.

7. Select **Spectrometer | Calibrate** and select the channel that you wish to calibrate. The **Verify lamp was ON for at least 15 minutes for a REFERENCE scan** dialog box appears.

8. Ensure that nothing is blocking the light path to the spectrometer and that the conditions for the reference scan are identical to those you will use for your sample. Then click **OK**. The **Block light path to spectrometer for a DARK scan** dialog box appears.

Note

You must take a reference spectrum before OOIIrrad can calculate absolute irradiance measurements.

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9. Turn the light off and click the **OK** button to take a dark scan. Once you take the dark scan, turn the light back on and allow sufficient time for the lamp temperature to stabilize before proceeding.

   OR

   Remove the filter or CC-3 and fiber from the light source. Ensure that no light is entering the fiber through the SMA 905 Connector at the light source, and then store a dark spectrum. This procedure is useful if calibrating more than one spectrometer channel at once, as you will not need to continuously cycle the lamp when calibrating each channel.

Note

You must take a dark measurement before OOIIrrad can calculate absolute irradiance measure.

You have now calibrated the spectral response of your system.

Viewing and Saving Calibration Results

Once you have calibrated the spectral response of your system, you can view and save the results.

Select **Configure | Spectrometer | Display calibration info when calculating**. The results of the calibration procedure will display in OOIIrrad. The top left graph represents the linear 15th order polynomial regression. The top right graph represents the dark scan. The bottom graph is the calibration curve representing the spectral response of the process.

The calibration procedure automatically saves in files named CH0.cal (master spectrometer channel), CH1.cal (first slave spectrometer channel), CH2.cal (second slave spectrometer channel), etc.

Maintenance

LS-1-CAL and LS-1-CAL-INT maintenance must be done at the Ocean Optics factory:

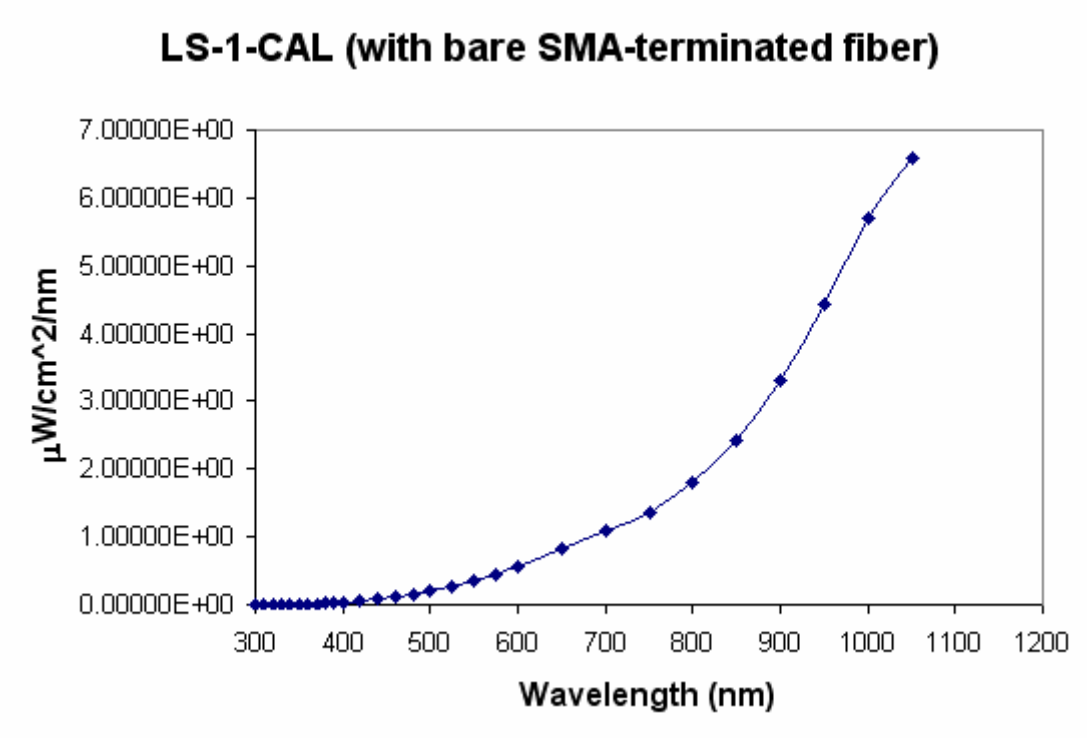
- Recalibration: You should have the LS-1-CAL and LS-1-CAL-INT recalibrated after every 50 hours of use. Contact an Ocean Optics Application Sales Engineer for information on lamp recalibration.
- Bulb replacement: You cannot change the bulb in the LS-1-CAL and LS-1-CAL-INT, as a recalibration is required when the bulb is replaced. Contact an Ocean Optics Application Sales Engineer for information on bulb replacement.

Specifications

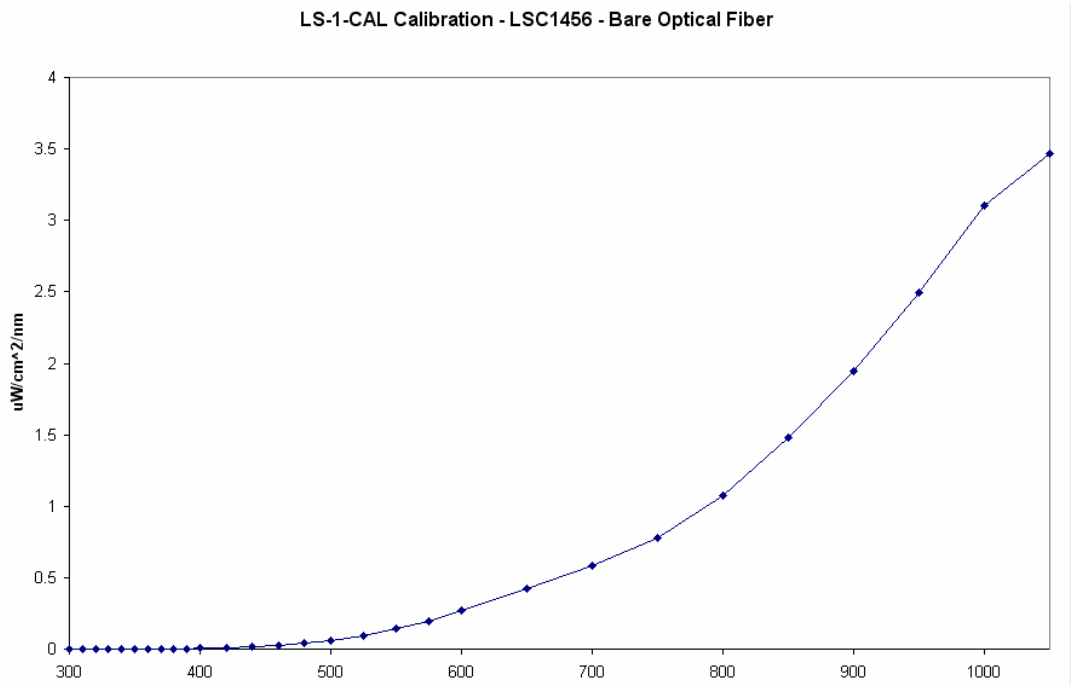
Lamp Specifications

Specification	Value
Dimensions (mm) LxWxH	90 x 50 x 32 mm
Weight	370 g
Power consumption	12 VDC/800 mA (regulated)
Power output	6.5 watts
Spectral range	300–1050 nm (calibrated)
Connector LS-1-CAL LS-1-CAL-INT	 SMA 905 for fiber; 6.35 mm barrel for cosine corrector PTFE for integrating sphere
Bulb life (hours)	900 hours (recalibrate after every 50 hours of use)
Output to bulb	5 volts/1.3 amps
Bulb color temperature	3100 K
Time to stabilized output	~30 minutes
Output regulation	0.2% voltage

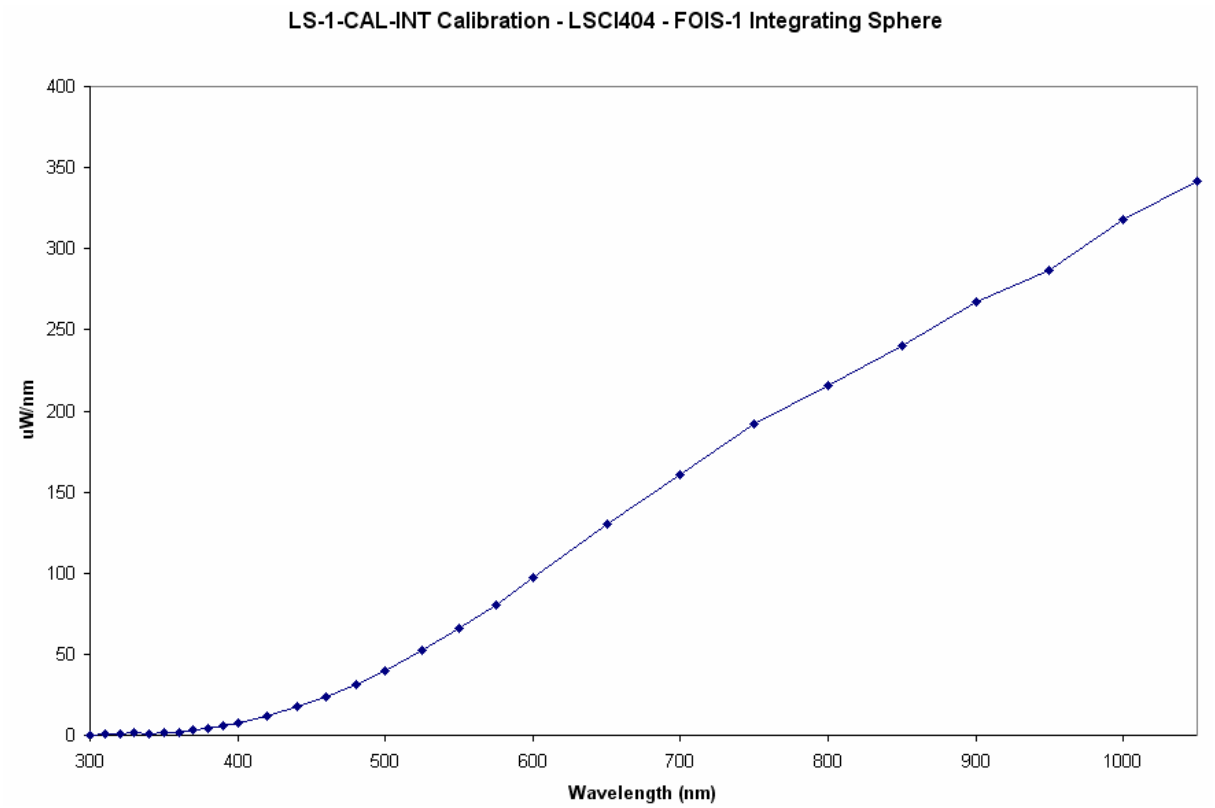
Spectral Output



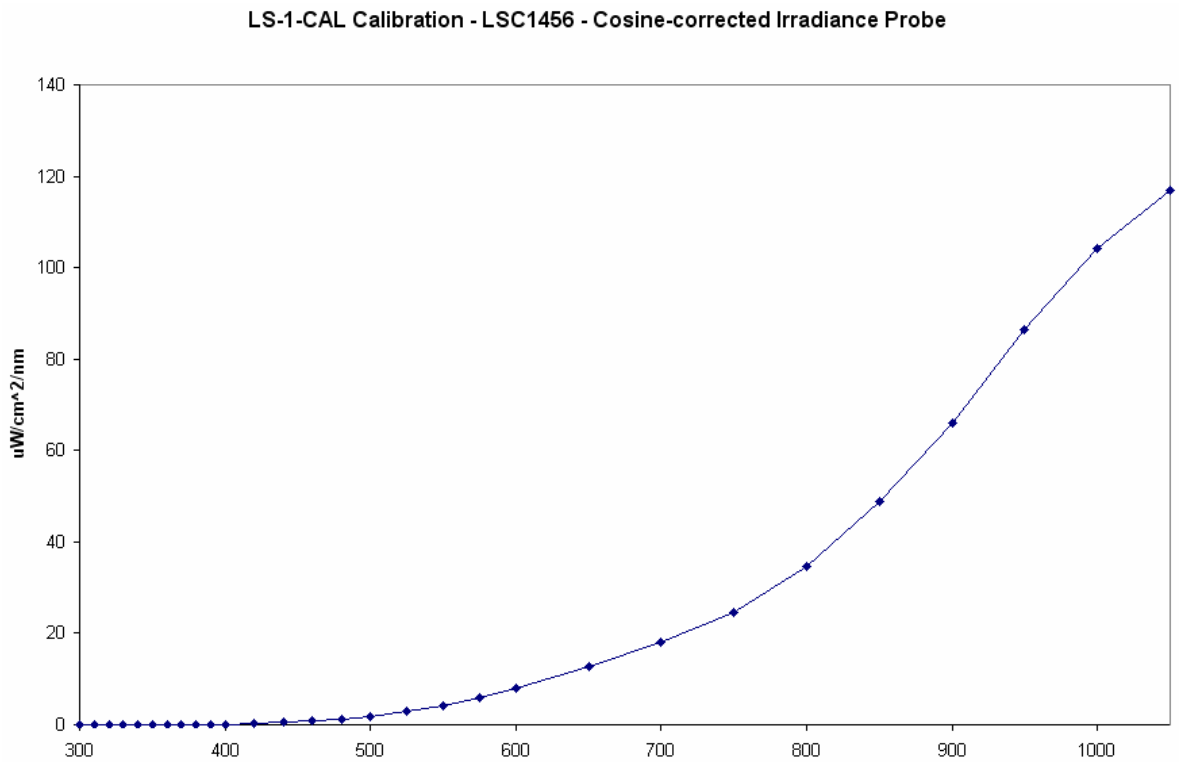
Spectral Output of the LS-1-CAL Using a Bare SMA-terminated Fiber



Spectral Output of the LS-1-CAL Using the CC3 Cosine Corrector



Spectral Output of the LS-1-CAL-INT When Connected to a FOIS-1 Integrating Sphere



Spectral Output of the LS-1-CAL with a Cosine-corrected Irradiance Probe