Halogen Calibrated Light Sources
Installation and Operation Manual

For Products: HL-3-CAL, HL-3-CAL-EXT, HL-3-INT-CAL, HL-3-INT-CAL-EXT, HL-3 plus-CAL, HL-3 plus -CAL-EXT, HL-3 plus -CAL-INT, and HL-3 plus -CAL-INT-EXT

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Important Safety Notices

1. Do not remove or modify any installed safety device on this equipment. Doing so will void your warranty and create an unsafe operating environment.
2. Dangerous voltages are present in this device. There are NO user serviceable parts inside.
3. Only allow qualified personnel to service this unit.
4. Inspect this unit and its power supply before using it for the first time. Do not use the unit if it is damaged in any way. Contact your dealer for repair or replacement information.

Table of Contents

About This Manual

Document Purpose and Intended Audience

This document provides you with an installation section to get your system up and running, basic information about the calibration light source, and a log to save the time of the light source's use.

What's New in this Document

This version of the *Halogen Calibrated Light Sources Installation and Operation Manual* adss information about bulb replacment.

Document Summary

Chapter	Description
Chapter 1: *Setup*	Contains a list of package contents and unpacking instructions. Also contains procedures for connecting to a spectrometer.
Chapter 2: *HL-3 Specifications*	Contains operating environment specifications, as well as other physical details of the product.
Appendix A: *Calibration Basics*	Provides an overview of the physics for radiometrically calibrated systems.
Appendix B: *HL-3 Use Log*	Provides a sample log for recording lamp use.

Product-Related Documentation

You can access documentation for Ocean Optics products by visiting our website at **http://www.oceanoptics.com**. Select *Technical Operating Instructions*, then choose the appropriate document from the available drop-down lists.

Upgrades

Occasionally, you may find that you need Ocean Optics to make a change or an upgrade to your system. To facilitate these changes, you must first contact Customer Support and obtain a Return Merchandise Authorization (RMA) number. Please contact an Ocean Optics Application Scientist for specific instructions when returning a product.

Note

You cannot change the bulb in this light source, as a recalibration is required when the bulb is replaced. Contact Ocean Optics for information on bulb replacement.

Chapter 1

Setup

Overview

The HL-3 Series of Halogen Calibrated Light Sources for the VIS-Shortwave NIR (350 nm-1100 nm) is a tungsten-halogen light source that provides known absolute intensity values at several wavelengths, expressed in µW/cm²/nm and in a radiant flux in µW/nm for the INT models. Since the spectral intensity of the HL-3 Series can be traced to an intensity standard traceable to the National Institute of Standards and Technology (NIST), it is specifically designed for calibrating the absolute spectral response of your system.

Note

If you have a spectrometer setup that is highly sensitive, you may oversaturate it.

HL-3 *plus*-CAL Calibrated Light Source

Models Available

HL-3 Series light source models are available in regular (350 – 1100 nm or 350 – 1050 nm) and extended (EXT models) (350 – 2400 nm) wavelength ranges. The INT models are used with an integrating sphere (rather than a CC-3 cosine-corrected irradiance probe). The following models are available in the HL-3 Series:

Model	Calibrated Wavelength Range	Maximum Uncertainty Level	Shutter?
HL-3-CAL	350 – 1100 nm	10%	No
HL-3-CAL-EXT	350 – 2400 nm	10%	No
HL-3-INT-CAL	350 – 1100 nm	15%	No
HL-3-INT-CAL-EXT	350 – 2400 nm	15%	No

In addition the following *plus* versions are available which reduce the percentage of uncertainty to 3% and offer a shutter:

Model	Calibrated Wavelength Range	Maximum Uncertainty Level	Shutter?
HL-3 *plus*-CAL	350 – 1050 nm	3%	Yes
HL-3 *plus*-CAL-EXT	350 – 2400 nm	3%	Yes
HL-3 *plus*-INT-CAL	350 – 1050 nm	7%	Yes
HL-3 *plus*-INT-CAL-EXT	350 – 2400 nm	7%	Yes

The following sections provide instructions on unpacking and setting up your HL-3 Series Light Source.

Unpacking the HL-3 Series Light Source

► ***Procedure***

1. Unpack your lamp assembly and power supply carefully. Although the lamp is rigidly mounted, dropping this instrument can cause permanent damage.
2. Inspect the outside of the instrument and make sure that there is no damage. Do not use the instrument if damage is present.
3. Use this instrument in a clean laboratory environment (see *Operating Environment*).

Contents

Your HL-3 Series Light Source package should contain the following:

- HL-3 light source unit
- 1 AC adapter for stabilizing power
- Power cord
- Lamp Calibration Report for using the HL-3 light source with a CC-3 cosine-corrected irradiance probe or integrating sphere (INT models)
- 1 CD that holds files for both lamp calibration reports
- 1 Allen wrench for adjusting the inner barrel of the SMA connector and CC-3 cosine corrector

Connecting a Spectrometer to the HL-3

Before using an HL-3 Series light source for the first time, check for transport damage. Be sure to adhere to all warnings on the unit and in this operational manual. Make sure you have your HL-3 light source, your spectrometer, a CC-3 cosine-corrected irradiance probe or integrating sphere, and Ocean Optics spectrometer operating software.

The procedure will differ, depending on whether you are using a cosine corrector or an integrating sphere (INT models).

Connecting a Spectrometer to the HL-3-CAL Models When Using a Cosine Corrector

► *Procedure*

Use the following procedure to connect your HL-3 light source to a spectrometer when using a cosine corrector:

1. Loosen the set screw on the HL-3's SMA barrel and the CC-3 cosine corrector adapter slot.
2. Screw the CC-3 cosine corrector onto the end of the fiber. The connection should be tight. Insert the CC-3 all the way into the HL-3's adapter slot, taking the place of the SMA's inner barrel.
3. Tighten the setscrew on the SMA adapter slot of the HL-3 with an Allen wrench. Connect the other end of the fiber into the SMA connector of the spectrometer.
4. Plug the switching AC adapter into the back of the HL-3. The adapter stabilizes power coming into the lamp to ensure constant spectral intensity.
5. Plug the wall mount AC adapter into a standard outlet..
6. Turn the lamp on. Allow the lamp to warm up for at least 15 minutes before using it. Place the HL-3 horizontally.
7. Insert the calibration disk that came with your light source into your computer. This disk contains one ASCII file with the same information as the Lamp Calibration Reports that came with your HL-3. The file name contains the lamp's serial number, followed by **.LMP.** Copy these files to the desired directory on your computer.
8. Start your spectrometer operating software. See your spectrometer manual for instructions on calibrating the spectrometer with the HL-3.

Connecting a Spectrometer to the HL-3-INT-CAL Models When Using an Integrating Sphere

► *Procedure*

Use the following procedure to connect your HL-3 light source to a spectrometer when using an integrating sphere (INT models):

1. The HL-3-CAL-INT and HL-3-CAL-INT-EXT have a diffusor for light output. Place the HL-3-CAL-INT output diffusor at the aperture of your integrating sphere. The minimum aperture diameter of your integrating sphere should be 6 mm. The HL-3-CAL-INT is validated for any larger Aperture diameters up to 30 mm. The HL-3-CAL-INT has to be placed in a vertical orientation.
2. Plug the switching AC adapter into the back of the HL-3. The adapter stabilizes power coming into the lamp to ensure constant spectral intensity.
3. Plug the wall mount AC adapter into a standard outlet.
4. Turn the lamp on. Allow the lamp to warm up for at least 15 minutes before using it.
5. Insert the calibration disk that came with your light source into your computer. This disk contains one ASCII file with the same information as the Lamp Calibration Reports that came with your HL-3. The file name contains the lamp's serial number, followed by **.LMP.** Copy these files to the desired directory on your computer.
6. Start your spectrometer operating software. See your spectrometer manual for instructions on calibrating the spectrometer with the HL-3.

Tips

When you perform measurements with the calibrated spectrometer system, record a new dark spectrum before each measurement. This minimizes the influence of a shifted dark spectrum.

Use a log to monitor the operation time of the light source. Recalibration of the light source after 50 hours of operation is recommended. A sample log is provided in Appendix B: *HL-3 Use Log*.

Chapter 2

HL-3 Specifications

This section provides information on the operating environment and specifications of the HL-3 Series light sources.

Operating Environment

The following table provides information on optimizing the operating environment of your HL-3.

Operating Environment	The HL-3 Unit . . .
Moisture	Is designed for operation in dry rooms only.
Ventilation	Should be placed so that its location or position does not interfere with proper ventilation.
Heat	Should be placed away from any device that emits excessive heat.
Object and Liquid Entry	Should be positioned so that objects do not fall on top of the unit. Additionally, ensure that no liquids are spilled into the enclosure through openings.

Specifications

Specification	Value
Spectral Range (calibrated): Regular Models Regular *plus* Models EXT Models	 350 – 1100 nm 350 – 1050 nm 350 – 2400 nm
Dimensions (LWH): HL-3-CAL and HL-3-CAL-EXT HL-3-INT-CAL and HL-3-INT-CAL-EXT HL-3 *plus*-CAL and HL-3 *plus*-CAL-EXT HL-3 *plus*-INT-CAL and HL-3 *plus*-INT-CAL-EXT	 13.5 cm x 5.8 cm x 5.9 cm; 5.3" x 2.3" x 2.3" 12.8 cm x 5.8 cm x 5.9 cm; 5.0" x 2.3" x 2.3" 14.5 cm x 6.3 cm x 6.1 cm; 5.7" x 2.5" x 2.4" 13.8 cm x 6.3 cm x 6.1 cm; 5.4" x 2.5" x 2.4"
Power Input	12 VDC/800 mA – 1100 mA (regulated)
Bulb Life	10,000 hours (recalibrate after 50 hours of use)
Output to Bulb	5 V / 1.0 A
Time to Stabilized Output	15 minutes

Specification	Value
Connector: Regular Models INT Models	 CC-3 cosine corrector Integrating Sphere
Shutter: Regular Models *plus* Models	 No Yes

Appendix A

Calibration Basics

Overview

Calibrated systems, independent of the particular calibrated unit, are always traceable to national standards. A calibrated item is comparable to all calibrated items which are calibrated for the same calibrated unit.

Each measurement result has an uncertainty, and the level of uncertainty is given either for one single standard deviation (k = 1) or for two standard deviations (k = 2), which is often named as expanded uncertainty.

A calibrated device should give trusted results; therefore, the calibration has to be done by the metrologist following a previously defined and proven calibration procedure. Clear documentation of the calibration setup and of the calibrated devices used is an indispensable requirement.

Calibration for Absolute Irradiance: Models HL-3 plus-CAL, HL-3 plus-CAL-EXT, HL-3-CAL and HL-3-CAL-EXT

Absolute irradiance has the physical unit µW/nm/cm^2. The interpretation is as follows: This is the wavelength resolved electromagnetic radiation which is emitted through an area [cm^2].

More detailed information can be found at:
http://oceanopticsfaq.com/category/calibrations/radiometric_calibrations/

Calibration for Radiant Flux

Radiant flux has the physical unit µW/nm. It reflects the total amount of emitted electromagnetic radiation from a light source and is typically realized by placing a light source inside an integrating sphere. The HL-3 *plus*-INT models are used to calibrate the integrating sphere with an attached spectrometer.

Uncertainty Level Calculation for HL-3 *plus* Family

Each realistic measurement has an uncertainty and therefore, a calibration has an uncertainty. The uncertainty should be validated seriously since this reflects how reliable the calibration is. The following international standards define the uncertainty and are describing how the uncertainty should be derived:

- IEC Guide 115 Application of uncertainty of measurement to conformity assessment activities in the electrotechnical sector.
- JCGM100:2008: GUM 1995 with minor corrections

Ocean Optics calibrations are done in relation to these international standards.

Ocean Optics provides a calibration of the HL-3 *plus*-CAL on an absolute irradiance scale in µW/nm/cm^2. The sources of uncertainties taken into account are listed below in the example. The actual values are listed in the individual calibration certificate for your light source. The calibration certificate contains more detailed information.

Sources of Uncertainties

	Variable	Source of uncertainty
1.	R	Uncertainty in reproducibility [R], caused by switching on/off
_1.1	S	Stability[S] within 50 hours of operation
2.	T and F	Influence of temperature [T] and humidity [F] in the air. The temperatures during calibration have a temperature range of 19 °C to 25 °C. The humidity might influence the calibration in the NIR for wavelength larger than 1100 nm.
3.	d	Uncertainty in mounting distance [d] of the used Cosine Corrector. 1.8 % per 0.1 mm deviation from aperture plane.
4.	ROT	Uncertainty from rotating [ROT] the Cosine Corrector.
5.	D_Lambda	Uncertainty caused by wavelength calibration of the spectrometer which was used to calibrate the Light source. [D_Lamba[QE]=0,3 nm, D_Lambda[NirQ512]= 1 nm]
6.	D_AbsIrrad	Uncertainty of the calibration light source used. This is in most cases the Ocean Optics working standard. See calibration certificate for details.
7.	StrayL	Influence from spectrometers internal stray light which was used to calibrate the light source.
8.	T_TEC_	Influence of the sensor temperature [TEC] of the spectrometer which was used to calibrate the light source.
9.	Dark	Influence from uncertainties of the measured dark level of the spectrometer used to calibrate the light source.
10.	Rep	Reproducibility of the used spectrometer system for calibration.
11.	SP_Lin	Linearity of the spectrometer system which was used to calibrate the light source.
12.	Bend	Uncertainty caused by bending [Bend] of the fibers.

These factors are taken into account for deriving the wavelength for resolved levels of uncertainty (listed below).

Standard Uncertainties and Uncertainty Budgets in % at Wavelength (Example)

		400	500	600	800	1000	1200	1600	1800	2000	2400
	Standard uncertainty k = 1	5,09	3,64	3,01	3,00	3,04	3,04	3,05	3,04	10,86	10,86
	Expanded uncertainty k = 2	10,18	7,28	6,01	6,00	6,08	6,08	6,10	6,08	21,71	21,71

Place the light source horizontally. A value of 6 % of expanded uncertainty must be taken into account for vertical placement.

Appendix B

HL-3 Use Log

HL-3 Series Use Log

Use Log No.:_____ Page No.: _____ ID No.: _____

Lamp S/N: Date Calibrated:

Reference Standard: _____ Working Standard: _____

Note: Do not exceed 50 hours of total "ON" time without recalibration.

Date Used	Start Time	Stop Time	Printed Initials	Signature	Running Total for "on" Time	Comments

Date Used	Start Time	Stop Time	Printed Initials	Signature	Running Total for "on" Time	Comments

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