

1800-02RA Radiance Calibration Accessory

Installation and Operation Instructions

The 1800-02RA Spectral Radiance Accessory attaches to the LI-COR 1800-02 Optical Radiation Calibrator to provide a source of spectral radiance for calibrating the 1800-06 Telescope/Microscope Receptor. The 1800-02RA contains a specially prepared diffuser, which is mounted in the end of the device, and is directly illuminated by the calibration lamp in the 1800-02. The characteristics of the diffuser and its distance from the lamp were chosen to provide for easy calculation of spectral radiance values for calibration.

Mounting the 1800-02RA

Before mounting the 1800-02RA, observe the interior of the tube and the surface of the white diffuser; both should be free of dust and lint. Any accumulated dust and/or lint can be removed by blowing dry, oil-free air or dusting gas across the surface. Remove the instrument mounting port (or sensor mounting port) from the 1800-02 and install the radiance accessory with the two 4-40 x 1/2" flat head screws provided.

Generating a Spectral Radiance Calibration File

Each 1800-02L Calibration Lamp is supplied with calibration data which gives the spectral irradiance of the lamp in $\text{W m}^{-2} \text{ nm}^{-1}$, at 10 nm intervals over the 300-1100 nm wavelength range. To convert this spectral *irradiance* lamp data to spectral *radiance* data, multiply by 0.10. For example, if the calibration lamp has an output of $0.035 \text{ W m}^{-2} \text{ nm}^{-1}$ at 400 nm, the value used with the 1800-02RA spectral radiance accessory should be $0.035 \times 0.1 = 0.0035 \text{ W m}^{-2} \text{ nm}^{-1} \text{ steradian}^{-1}$. The spectral radiance data calculated in this manner are only valid for the calibration lamp whose serial number matches the calibration data, and only when used with the 1800-02RA using the procedure described in the following operational instructions.

The LI-1800 Portable Spectroradiometer can be used to generate the spectral radiance lamp file for use with the 1800-06. Continuing the example above, assume that the spectral *irradiance* lamp data have already been entered in the LI-1800 as a file name L101. A spectral *radiance* lamp file is generated by using the LI-1800's transform (XF) command (Section 4.5, LI-1800 Instruction Manual) and specifying L101 as both File A and File B, and then specifying the constant A as 0.1 and constants B and C as zero. If we named the resulting file R101, then we would use the R101 file as the lamp file when performing the calibrate (CA) function (Section 4.2, LI-1800 Instruction Manual) to generate a new calibration file for the 1800-06 Telescope/Microscope Receptor. When using the 1800-06 receptor, any scan files that are divided by this new radiance calibration file will have units of $\text{W m}^{-2} \text{ nm}^{-1} \text{ steradian}^{-1}$.

Configuring The LI-1800 and 1800-06 Telescope/Microscope Accessory

Install the desired objective lens combination onto the 1800-06 body, and connect the body to the LI-1800 with the 1800-10 Quartz Fiber Optic Probe. Insert the tip (notch upward) of the fiber optic bundle completely into the adapter on the output port of the 1800-06 body and tighten the two set screws with a small hex key. Attach the 1800-10 Quartz Fiber Optic Probe to the LI-1800 as follows:

1. Remove the 2 retaining screws (phillips head) from the standard cosine receptor and pull the receptor straight up and off of the LI-1800 optical input port.
2. Install the fiber probe housing on the optical input port, making sure that the guide hole on the fiber probe is aligned with the guide pin on the optical port. To maintain accurate optical alignment, it is necessary for the probe

housing to be screwed down with the two 4-40 x 3/8" flat head screws provided. This is the same size screw that is used with the standard cosine head. Make certain the fiber probe housing is securely fastened to the LI-1800, as slight movements can cause large errors.

Although any lens/aperture combination can be calibrated directly with the 1800-02 and 1800-02RA, a single calibration file will generally suffice for use with objective lens options A, B, or the Quartz Microscope configuration. Section 12.4 in the LI-1800 manual contains further information on generating calibration files for each of the lens options.

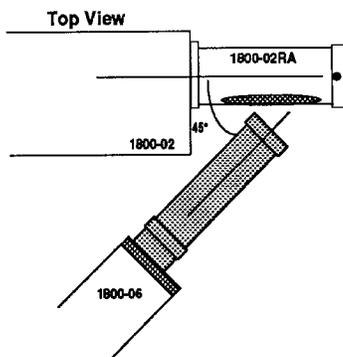
The accuracy of the calibration is dependent upon the proper positioning of the 1800-06 in relation to the diffuser in the 1800-02RA. Follow these four steps to correctly position the 1800-06:

NOTE: Visual alignment in each of these four steps will provide sufficient accuracy; precise measurements are not required.

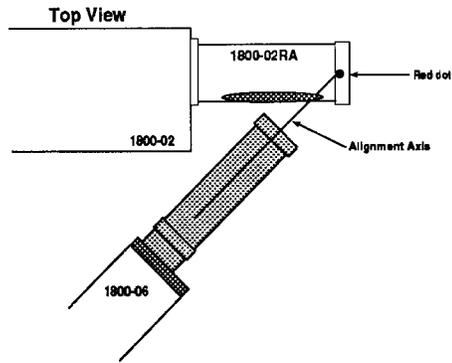
1. Support the telescope (i.e., with a tripod, etc.) so that the objective lens is level (within $\pm 2^\circ$) and so that the center line of the objective lens is at the same height as the center line of the 1800-02RA.



2. Orient the telescope lens tube at an angle of $45^\circ (\pm 2^\circ)$ from the 1800-02RA accessory tube, when viewed from directly above the equipment. In the absence of a protractor or a square, a 45° angle can be made by folding a piece of paper across opposite corners.

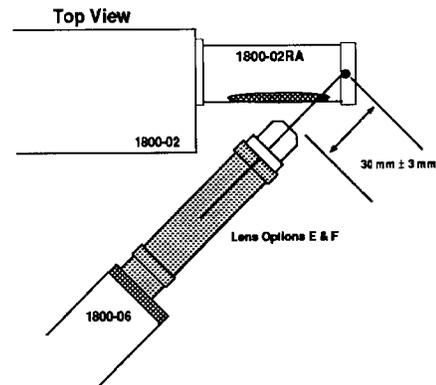
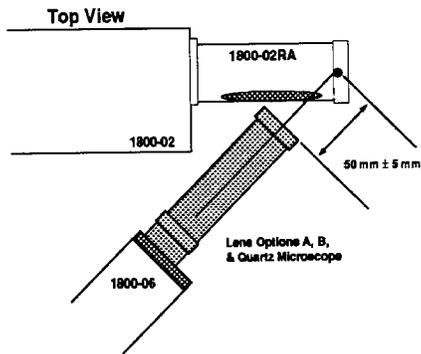


3. Aim the axis of the 1800-06 lens tube straight toward the red dot on the top of the 1800-02RA mounting tube (within ± 2 mm).



4. Adjust the distance between the end of the lens and the red dot to be:

50 mm \pm 5 mm for 1800-06 lens options A, B, or the Quartz Microscope option, or
 30 mm \pm 3 mm for lens options E and F.



After completing step 4, recheck the alignment of the 1800-06 described in the steps above to make sure that the position of the Telescope/Microscope Receptor satisfies each of the 4 alignment requirements simultaneously. Secure the 1800-06 against accidental movement, and begin the calibration procedure as described in this manual, or in Section XIII of the LI-1800 instruction manual.

NOTE: Calibrations should be performed in a room with the lights turned off and the window shades closed to prevent measuring radiation from sources other than the calibration lamp.

After calibration, remove the 1800-02RA from the 1800-02 and store it in a dust proof, clean plastic bag, away from direct sunlight.

Theory of Operation

The 1800-02RA converts incident irradiance to radiance according to the properties of a characterized, stable diffusive material made from lightly compressed and sintered TFE resin. This choice of resin and processing method yields a material of widely recognized utility due to its spectral and spatial uniformity, repeatability, and high reflectance. High-temperature sintering adds durability and longevity at no significant loss in characteristics for this application. Surface finish is important in maintaining the bidirectional reflectance values assumed in this application. Since

control of the manufacturing parameters results in reproducible standards, individual calibration is not required. A verification procedure after manufacture ensures that each diffuser meets the specified standards.

The diffuser is located so that it receives normal illumination by the calibration lamp direct beam, so that it can be viewed by the 1800-06 receptor at an angle 45° from normal. When the 1800-02RA was designed, the length of the mounting tube was chosen so that the characteristics of the diffuser in this geometric configuration would result in the irradiance data of the lamp being multiplied by a simple constant (0.1) in order to obtain radiance data for the diffuser. The total reflectance of the diffuser is 0.99 ± 0.01 from 350 to 1100 nm; reflectance at 300 nm is about 0.97. The surface finish of the diffuser maintains the expected reflectance at a 45° viewing angle.

The suggested viewing conditions limit the viewing area of the 1800-06 Telescope/Microscope Receptor to the central 25 mm diameter or less to limit the edge effects of the diffuser. For any given optical receptor, the 1800-06 must have a viewing diameter less than 25 mm. Verification of the viewing diameter size can be accomplished by placing the 1800-06 in View mode and shining a pen light through the viewing port so that it shines through the objective lens and onto the diffuser. The spot of light on the diffuser will be oval in shape and should be less than 25 mm in diameter if the 1800-06 is placed properly.

The radiance of the 1800-02RA under the prescribed viewing conditions and with the prescribed surface finish is 0.10 x lamp irradiance, $\pm 3\%$ from 350 to 1100 nm, or $\pm 5\%$ at 300 nm.

Maintenance

The 1800-02RA requires no periodic maintenance provided it is kept clean, dry, and stored out of direct sunlight. If necessary, dust and lint can be removed by blowing dry, oil-free air or dusting gas across the surface. Dust can cause excessive stray light which can affect calibration values.

To remove particles that stick to the diffuser surface and will not blow off with dusting gas, the diffuser can be rinsed with distilled water. However, solvents should never be used on the diffuser and the surface of the diffuser should never be rubbed or touched unless the surface is to be refinished. If the surface of the diffuser does get damaged, it can be refinished without returning the diffuser to LI-COR. Contact LI-COR for details on the refinishing procedure.

To remove the diffuser from the 1800-02RA, follow these steps:

1. If necessary, remove the 1800-02RA from the 1800-02.
2. Remove the 2 screws retaining the protective cap which holds the diffuser onto the 1800-02RA mounting tube.
3. Hold the mounting tube upright with the mounting tube in one hand and the end cap in the palm of the other hand. Pull the end cap downward, being careful not to scrape the surface of the diffuser or to let it fall out of the end cap.
4. Remove the diffuser from the tube and take note of which side was facing outward (toward the accessory tube and calibration lamp). Since only one side of the diffuser is characterized for use, it must have the same face outward when it is reassembled.

While the diffuser is removed, the mounting tube can also be cleaned, if necessary.



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