ILT INS250N INTEGRATING SPHERE

OPERATOR'S MANUAL

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INS250N **(FIGURE 1)**

1.0 INTRODUCTION

You have purchased an International Light Technologies' (ILT) Integrating Sphere which has been designed to be a versatile addition to your light measurement equipment and function in a wide variety of applications. The 3 ports have been positioned orthogonally (90 degrees) to each other, to minimize interaction between a light source and the measurement detector, and also between a first “light bounce” and the detector. In addition, a specially designed baffle is mounted inside the sphere to minimize any direct interaction between the three ports.

The sphere diameter and port hole sizes were chosen to be large enough to accept most miniature lamps, up to and including most automotive bulbs, while still being small enough for use in lab and production environments. Three ports are included to allow for: the detector, the built-in calibrated transfer standard lamp, and the test light source. A calibrated transfer lamp is included to allow correction to the calibration which can change with different inputs (and even due to the absorption of the lamp envelope itself). This built-in lamp permits an absolute calibration to be accomplished, even with these variations.

ILT's ILT1700 and ILT1400 Radiometer/Photometers (sold separately) allow programming for direct reading in the appropriate optical units. This is especially useful with the INS250N

as it can be used with numerous detector configurations for both radiometric and photometric applications. For example, the system can be calibrated to read out the mean spherical candle power of miniature lamps and/or light emitting diodes (LEDs) permitting rapid quality control inspection. Then using the same detector and sphere with different filters and calibration factors, you can also obtain the total power in watts. For customers requiring more in depth information such as spectral data, color temperature, CRI, and Chromaticity, the INS250N can also be calibrated with our ILT950 spectroradiometer.

2. PHYSICAL CONFIGURATION

2.1 Size and Weight - The INS250N assembly includes the 10 inch (inside) diameter Integrating Sphere, the mounting fixture/stand, a built in power supply and a calibrated standard transfer lamp. The overall size is approximately 14 ½" wide by 16" high x 10 1/4" deep. The weight is approximately 7 lbs.

2.2 Port Orientation - The system is supplied with three (3) standard 58 mm diameter input/output ports, located in one hemisphere. These ports have been carefully positioned orthogonally (90 degrees) to each other, to minimize the possibility of light traveling directly from one port to the detector.

2.3 Inter-port relationship – One concern when selecting an integrating sphere is proper elimination of "first bounce" or direct measurements. One might assume that if you locate the three ports very close together you would eliminate the possibility of direct exposure from the source at the detector, but depending on the light source, this is not the case. For example, if the source is a collimated beam of light, the first bounce of the beam could bounce back directly to the detector. Another concern when testing lamps is the effect of hot spots. Any "hot spots" should not be in direct view of the detector. Taking this into consideration, the ports of the INS250N are 90 degrees from each other. In addition to optimized port location, the INS250N includes a baffle placed between the detector and each of the other two ports (user and standard lamp) to minimize direct interaction between the three ports. Also included with the INS250N is a detector input cone coated with the same coating as the INS250N. The cone should be used with SED(SEL) detectors to increase the reflective surface area, and restrict the field of view of the detector to +/- 45 degrees to prevent direct view of the test lamp.

2.4 Port Adapter Rings – To accommodate a wide variety of light sources, fixtures, measurement detectors, and transfer standard lamps each of the three INS250N port holes includes an aluminum port adapter ring with thumb screws. Each port adapter ring is capable of securely holding a detector, light source, or other fixture up to 42 mm in diameter. While the port adapter rings allow great flexibility for mounting devices to the sphere for test and measurement, the sides of the port adapter rings can occlude light at wide angles from entering through an open port if the INS250N is used as a cosine receptor. ILT can eliminate one of the port adapter rings to improve cosine performance and install a window to prevent sphere contamination through the open port since the port can no longer accept our standard port plugs with the port adapter ring removed.

2.5 Baffles – The INS250N includes a specially designed baffle mounted securely in the center position between the three ports. The purpose of the baffle is to prevent direct measurement of light from the test lamp or from a wide-angle source coming through the input port. The baffle has been designed for use with miniature lamps and assumes the source will not be inserted very deeply into the sphere. If this is not the case, a custom baffle may be required to block the test lamp. In order to customize a baffle, we would need to know the

exact dimensions of the test lamp, since the geometry is quite complex for the design of a custom baffle. (Note: the white reflectance coating is very delicate therefor ILT does not recommend customer modifications) Please contact ILT for a quotation.

3. ELECTRICAL CONSIDERATIONS

3.1 Input Power - The standard wiring configuration is set up to accept 115 to 250 VAC, 50-60 Hz input power, and includes a plug for USA 115 VAC. (Plug adapters for other countries can be added by end user) The source input power requirement is less than 10 watts, and if the Power Supply is not used to drive an extra load, the requirement drops to less than 3 watts.

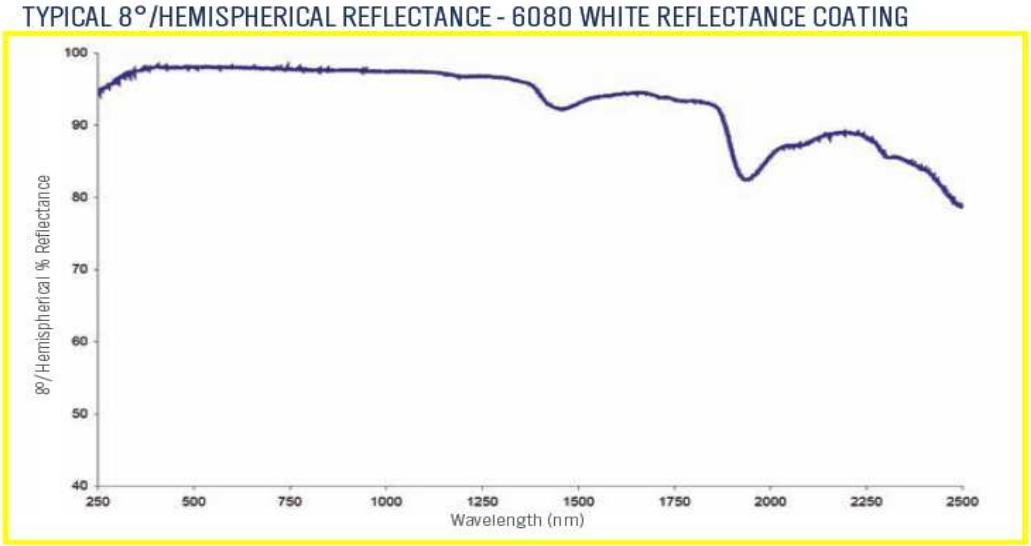
3.2 Standard Source Power - The integrating sphere assembly includes a 5 VDC power supply which supplies current to the transfer standard lamp and can also be used to power the test lamp.

3.3 Available User Power - The 5VDC power supply has a 1.5 amps but only 60 milliamps are needed to power the transfer standard lamp. This leaves more than one (1) amp available to power the test lamp. If LED's are to be tested, an appropriate current limiting resistor can be used to supply the proper bias current.

4.0 OPTICAL PROPERTIES

4.1 White Reflectance Coating- The sphere coating has been chosen for its optical reflectance over a broad spectral range, at the sacrifice of adhesion. This makes the INS250N coating very delicate, therefor it must be handled with extreme care. The coating provides near-perfect diffuse reflectance at levels up to 98% in the 250-2500nm (UV-VIS-NIR)wavelength range with optimal performance provided in the wavelength region from 300 to 1200 nm.

Figure 2



Coating damage has the most effect on stability and prolonged life of the system. Extreme caution should be taken to prevent impact to the sphere and contact with any internal surface. Its is very important to prevent any foreign particles from falling into the sphere including dirt and debris, since a one percent change in reflectance can produce a five percent change in throughput. Sphere re-coating is available, however this type of repair is costly and time consuming as the process requires multiple layers of the specialized coating.

4.2 Transfer Standard Lamp- The 5V, 42 lumen Halogen Transfer Lamp was chosen due to its low output in a range similar to that of many common miniature lamps and sources of beam power. The proximity of the standard lamp output to the commonly used ranges reduces the chance of a non-linearity creating unwanted error. This is not to say that our detectors are non linear, in fact, they are more linear than most methods of measurement. However it is a good technical precaution to stay in the same "ball park". This lamp is not meant to be a calibration standard in its own right. It was selected to have a long life and provide a good indication of the condition of the sphere. Its primary use is to allow correction to the spheres initial calibration. (see section 6. for details)

4.3 Source/User Port— Other miniature lamps may be mounted in a similar fashion to that of the Transfer Standard Lamp. The standard baffle provides proper blocking of direct radiation from reaching the detector, as long as the lamp is located close to opening of the port plug. If a large lamp is used, which projects considerably into the sphere, the direct path to the detector may not be properly blocked. In this case it would be necessary to redesign the baffle, or make a new one specifically for that application. If your application requires a custom baffle please contact ILT for a quote. (Please note: The white reflectance coating is very delicate therefor ILT does not recommend customer modifications.

4.4 Detector Input Cone - The INS250N includes a detector input cone with 1¼" x 24 threads for use with ILT1400 and ILT1700 SED(SEL) detectors. If your sensor includes a W or TD wide eye diffuser, the "Cone Plug" should be used in place of the diffuser. To make the detector have the correct acceptance angle,the cone is mounted on the front of the detector to improving the gain and also restricting the field of view to +/-45 degrees. This field restriction is required when a beam measurement is being made.

5. TYPICAL APPLICATIONS

5.1 Mean Spherical Candle Power(MSCP)— Isotropic intensity of a light source is also refered to as the MSCP rating of a lamp. It is measured at the design voltage and is the total amount of light emitted from a light source in ALL directions. One MSCP is equivalent to all the light emitted from all directions of one standard spermaceti candle. 1 MSCP equals 12.57 (4 pi) lumens (photometric) or Watts/Steridian (radiometric).

Isotropic intensity, also referred to as mean spherical candela, requires an integrating sphere for measurement and should not be confused with Beam Intensity, often classified as beam candela. If the output of the source emits in all directions, then the MSCP measurement is a better indication of performance. On the other hand, if the output from the source is emitted one direction, then Beam Intensity measurements would be more appropriate and a sphere would not be required.

5.2 Flux Measurements Determining the the total radiant power (Watts) or luminous flux (lumens) of light sources is one of the most common uses of integrating spheres. To properly measure the total Flux of a source, one must "capture"all of the radiation in every direction.

5.2.1 Laser Measurements— Total flux measurements can be performed with the source located outside the sphere (directional sources) or inside (omni-directional sources). If your requirements are to determine the flux output from a source which is in the form of a beam, such as a laser, the integrating sphere makes a very nice receiving system, since the large Input Port forms a uniformly sensitive detector- with a large receiving-diameter (37.6mm).

In the case of laser applications, the final absolute answers are in Optical Power (Watts or Lumens).

5.2.2 Wide-Beam Flux Measurements— Wide beam sources are also very accurately measured simply by catching all the light in the input port. For diverging beams, it is necessary to be close enough to insure that the outer edges of the beam diameter are still smaller than the input port diameter. The uniform sensitivity of the port properly measures the total flux entering the hole. In addition the Sphere acts as an attenuator and provides a uniform signal to the detector. Large solid angles can be accommodated. In fact one steradian of flux can be measured, by establishing the source at 34.7 millimeters distance away from the user port. This makes it very easy to make beam candela (lumen/steradian) measurements, since you would be measuring with a solid angle of one steradian. The receiving cone for other solid angles can also be measured with a great deal of accuracy, since the distances are large, and uncertainties are minimized. If the distance to the input port is large with respect to the port diameter (37.6mm), then the calculation reduces approximately to the area of the Input Port (11.10 sq. cm.), divided by the distance squared. In other words, if you were 10 centimeters away from the rim of the port, you would divide 11.10 by 10 squared and find the solid angle to be 0.111 steradians.

If the Sphere is calibrated to read optical watts, it is easy to convert to irradiance. The input port is 11.10 square centimeters; therefore if you overfill the port with light, dividing the number of watts measured, by the input area, converts the reading to watt per square centimeter. If it is calibrated in Lumens, then by dividing by the input area in square feet (1.195e-2) you can convert to Lumens per square foot (Foot-Candles).

5.3 Diffuse Source (Radiance/Luminance) — In order to calibrate a luminance (brightness) meter, it is necessary to have a uniform diffuse source of luminance. Such a source is difficult to generate while maintaining both the properties of uniformity across the surface and still have a diffuse lambertian spatial emission pattern. An Integrating Sphere is ideal for solving both requirements. The internal transfer standard lamp will produce a low level luminance source; however a brighter source can be used. We can provide a luminance calibration and special lamp installation if this is a requirement.

5.4 Cosine Receiver—Not only does the Input Port of an Integrating Sphere have a uniform sensitivity across the face of the hole, it also provides a very good spatial sensitivity to match the Lambertain response (Cosine). In the design of the INS250N we include 3 Input Port Adapters which obstruct the light at wide angles, thus altering the Cosine Response to oblique angles. However, we can manufacture a sphere without a port adapter, and can install a window for environmental protection. Contact the factory for these custom modifications.

5.5 Flat Response Attenuator— The special White Reflectance Coating has a very flat Spectral Response, making it an excellent attenuator from the UV through the Infra-red portion of the spectrum (see figure 2). UV light is especially difficult to measure and still maintain detection, having a cosine response. This is one of the strong features of the INS250N.

6. USING THE TRANSFER STANDARD LAMP

The transfer standard lamp has been included in the INS250N to eliminate as much of the error produced by variations in the configuration of the Sphere as possible. Adjusting the calibration factor is recommended when you remove the port plug to measure a laser, insert a special fixture for holding a lamp, or even inserting the test lamp (remember the lamp base

itself may absorb a great deal of light). Any changes to the input port can affect the overall accuracy of the calibration. By following the steps below, the transfer lamp can be used to compensate for changes made when removing the port adapter to apply your light source.

(Note: You may want to have your calibration certificate and instrument instruction manual handy)

The first step is to verify the calibration factor is properly stored/entered into your ILT1400 or ILT1700 system for the exact system configuration used during calibration.

Once you are set up correctly, turn on the transfer standard lamp and take a reading using the initial calibration factor. (Always be sure to perform a proper zero when using the ILT1400/ILT1700) Record this as reading 1. _____(lumens or watts)

Enter reading 1 into your ILT1400 or ILT1700 system using the same procedure as entering a calibration factor. (ie: your ILT1400 reads 3.46 mW, enter 3.46 e-3 as the new cal factor)

Remove the plug and set up the sphere as if to take a reading of your source, keeping the source turned off. This could be an open port(laser), custom holder, lamp, or standard holder and lamp. Take a new reading and record this as reading 2. _____ (a/W or a/lm)

Shut off your transfer standard lamp.

Reading 2 is your adjusted calibration factor. Enter reading 2 into your ILT1400 or ILT1700 system.

You may now proceed with taking measurements using your adjusted calibration factor.

7. MAINTENANCE

The most vulnerable part of the INS250N is the White Reflectance Coating ("Paint"). Any foreign vapors or particles can change its reflection quality and thereby change the calibration of the system. For this reason, it is extremely important to keep the unused ports closed with a port plug, detector, or some other type of cover(even tape) to prevent dust from getting inside. Since there are no moving parts, and because the white paint cannot be cleaned, there really are no maintainable parts. Damage to the sphere would require service at the factory including repair and re-coating as needed. The sphere should also be returned to the factory for calibration of the transfer standard lamp once a year. ILT recommends calibration of all equipment annually. (Or sooner if you are seeing a change in the standard lamp output). Please contact a customer service rep at ILT for a return authorization prior to shipment. We can be reached at 978-818-6180 or by email: ilservice@intl-lighttech.com.