We bring quality to light.

Optronik Line

Integrating Spheres

Instrument Systems

KONICA MINOLTA Group

Instrument Systems GmbH – Optronik Division

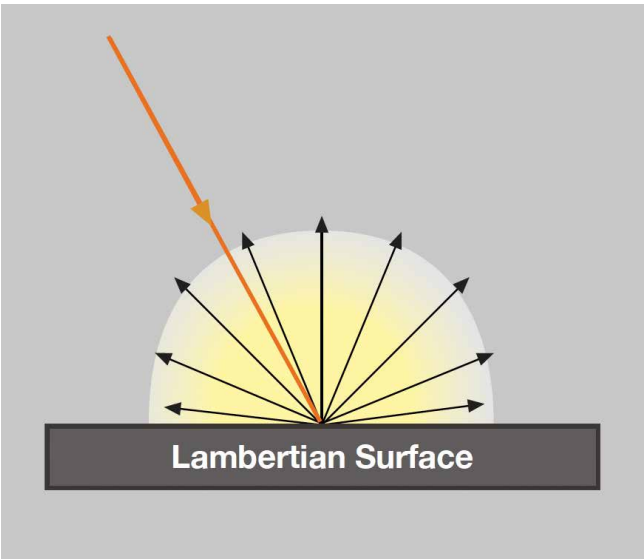
The Optronik Division of Instrument Systems already has a very long track record for its company history. When Optronik GmbH was founded in Berlin back in 1968, development of the world's first digital luxmeter was the focus of attention. In 1972, the first computer-controlled goniophotometer followed for testing automotive lamps.

Today, Optronik Line products are the benchmark for tailor-made solutions in the automotive exterior lighting industries, for product certification and for applications in aerospace and traffic management. The Berlin site is also a center of expertise for goniophotometers and integral light measurement within Instrument Systems GmbH.

Development, production, service and sale of Optronik Line products are all based at the Berlin site. Direct support is provided for our customers in Germany and European countries. A global network of experienced representatives delivers support to international customers.

Diffuse lambertian coating

Lambert's Cosine Law (also known as Lambert's cosine emission law) is the mathematical statement that a radiance of certain idealized optical sources is directly proportional to the cosine of the angle – with respect to the direction of maximum radiance – from which the source is viewed. Lamberts cosine law also applies to certain idealized diffuse reflectors or coatings.

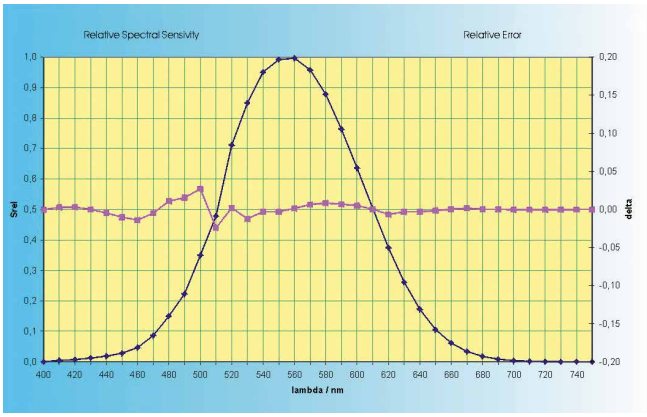


Integrating Sphere – Theory and application

Based upon the principle of multiple diffuse reflection (resulting from the Lambertian coating), the integrating sphere is used to spatially integrate radiant flux, either from an external or an internal source of radiation. The efficiency of an integrating sphere is determined by a number of factors, including the size and number of ports, the size and location of baffles or screens, the number of inclusions in the sphere, and most importantly, the reflectance and diffuse nature of the sphere coating that has to be "Lambertian" (ideally diffuse reflecting).

Depending on port position, baffling, and to an extent, sphere size, integrating spheres can be configured for a number of applications, including:

- Light collection from internal or external source (lamp measurement photometry)
- Uniform light sources
- Laser power measurement
- LED spectral and flux measurement
- Reflectance of either specular or scattering samples
- Total or diffuse only transmittance measurement
- Cosine receptors



Highest accuracy-superior spectral response of our silicon detectors

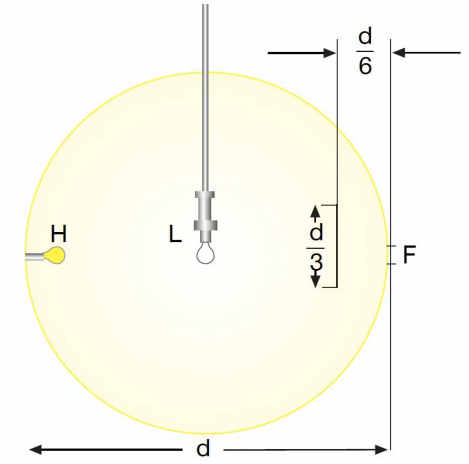
Lamp measurement systems

The oldest application for the integrating sphere is the measurement of total geometric luminous flux from electric lamps. The technique originated at the turn of the 20th century (by Richard Ulbricht in Germany, which is why it is also called an Ulbricht sphere) as a simple and fast method of comparing the lumen output of different lamp types. It is still widely used in the lamp industry for quality control during manufacture. The alternative method is a goniophotometer which would need to rotate a photodetector in a complete sphere around the lamp (or rotate the sample in relation to a detector). Each discrete intensity point (lm/sr) is then integrated over 4π steradians.

ITS 1000

In contrast to the absolute measuring method using a goniophotometer that scans the complete intensity distribution of the lamp and integrates the flux, the integrating sphere is the relative measuring method requiring calibration of the sphere with a calibrated flux (or spectral distribution) bulb that should be traceable to a national standard (PTB or NIST).

In a sphere photometer, the lamp to be measured is mounted at the center of the integrating sphere and baffled from a viewing port equipped with a diffuser and photopic response detector. The baffle is usually positioned at 2/3 of the radius from the sphere center. Its size should be as small as possible yet large enough to screen the maximum dimension of the lamp.



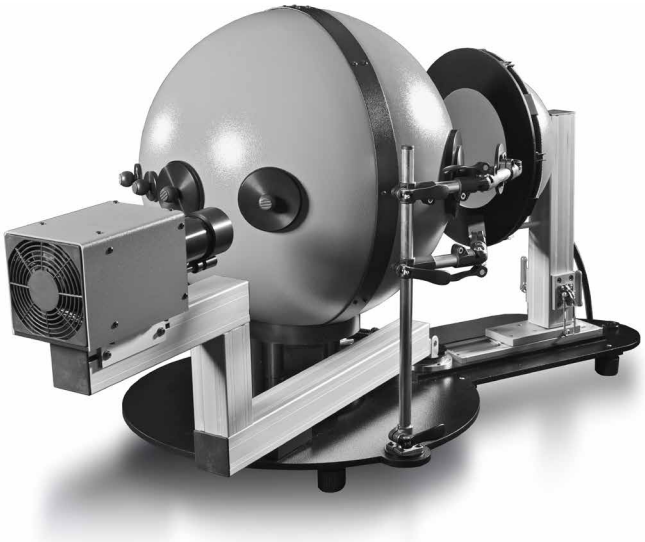
Sphere construction according to DIN 5032 and CIE 84 for lamp flux measurement

Classic application: flux measurement of bulbs

The lumen output from the test lamp is determined by first calibrating the photodetector signal using a lamp standard of known luminous flux. The lamps are alternately substituted into the integrating sphere. An auxiliary lamp can be permanently mounted inside the sphere to compensate for the substitution error caused by different self-absorption from the test and standard lamps.

Reflectance and transmittance measurement

Another application for integrating spheres is the measurement of the reflectance and transmittance of diffuse or scattering materials.



KMS 500

The measurements are performed photopically or spectrally, as a function of wavelength. The measurement of luminous reflectance or transmittance is performed using a photopic response detector. A transmittance measurement places a material sample at the entrance port to the sphere.

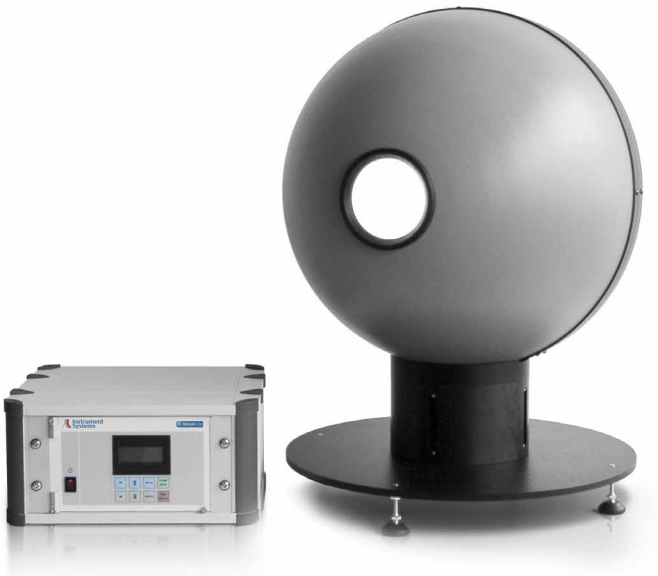
In reflectance measurements, the sample can be placed at a port opening opposite the entrance port. The incident flux is reflected by the sample. The total hemispherical reflectance, both the diffuse and specular components, is collected by the integrating sphere. There are special applications such as ECE R46 that also require a specific sphere design (see picture on the right).

Uniform light source: luminance standard

Integrating spheres provide the ideal means for creating a uniform light source. Light collected by a sphere is diffusely reflected many times, so that any spatial characteristics are integrated for light leaving the sphere exit port plane.

The emitted light is nearly perfectly Lambertian. Our uniform source sphere LDN 500 is internally coated with a special photometer paint, a proprietary diffuse white coating that produces excellent diffuse reflectance over the VIS-NIR wavelength region.

The functional principle is that a lamp or several lamps are placed inside the integrating sphere around the perimeter of the viewing port. The lamps are baffled from the port. The radiance of the sphere is a function of the wattage rating of the lamp.



LDN 500

Tungsten halogen lamps are most commonly used with integrating sphere sources. These lamps provide a continuous spectrum free of emission lines or temporal instability when operated from a regulated current power supply. The spectral radiance of the sphere source can be estimated by combining the sphere radiance equation with blackbody equations for the spectral radiant flux.

ITS 500 and ITS 1000 Integrating Sphere Photometric Lamp Measurement Systems

Our integrating sphere photometer systems are designed to measure the total luminous flux, luminous color, and spectral distribution of lamps according to DIN 5032 and CIE No. 84. The systems accommodate most lamp types, including arc, fluorescent, incandescent, HID, and LED.

Each lamp measurement system features an integrating sphere, optionally calibrated lamp standard, precision power supply, photopic response detector, and display unit. The Digilumen 9500 luminous flux meter used in conjunction with the sphere features the highest photometer accuracy classes L and A according to DIN 5032 and CIE No. 69 with excellent spectral matching of the high precision photopic Si-detectors to the sensitivity for brightness of the human eye.

Optional software is available for enhanced operation of the ITS 1000 lamp measurement system.

We manufacture spheres with diameters of 50 cm and 100 cm.

Internal view: three burning positions, up-side, down-side (vertical), front-side (horizontal)

ITS 1000

Applications

High performance precision photometer for lamp flux measurement used in laboratory environments.

ITS 500 / ITS 1000

General characteristics

- Equipment for luminous flux measurement of light sources by comparison with a standard lamp
- Construction according to DIN 5032 Section 1 and CIE Publication No. 84 “The Measurement of Luminous Flux”
- Metal frame construction with swiveling mechanism to open the sphere
- Light-tight mechanical lock
- Flexible adjustment bar to connect our lamp holders
- 3 burning positions (2 vertical, 1 horizontal), clamping device for fixing holders in pendent, upright, and horizontal position
- Coated inside with our $BaSO_4$ photometer paint with Lambertian white diffusing surface, reflectance 80% with variation of reflectance < 1.5% in wavelength range 400 to 700 nm
- Diameter: 0.50 meter (ITS 500), 1 meter (ITS 1000)
- Sphere material: Aluminium
- Thermometer: Digital, resolution 0.1°C
- Universal flange prepared to install several photometer heads for V (λ) (Digilumen 9500) and tristimulus colorimeter head CM 10
- Baffle to be shifted
- Auxiliary lamp

Scope of supply

- Sphere ITS 500 or ITS 1000
- Stable stand
- Auxiliary lamp
- Baffle
- Thermometer
- Adjustment bar for positioning sample
- Instruction manual

ITS 1000

ITS 1000 open

Photometer Digilumen 9500

- Precision photometer head with Si-photopic detector
- Diameter of light sensitive area: 12 mm
- Superior V(λ)-approximation, class L (highest accuracy) or A (high accuracy) according to DIN 5032 Section 7, DIN-EN 13032-1
- Thermostatic stabilization of photometer head to approx. 35°C ± 0.1°C
- Diffuser built-in flush with inner surface of sphere
- Electronic, microprocessor-controlled display unit Digilumen 9500
- $4^1/_2$-digit LED seven segment display
- Ranging auto/manual or remote programmable
- Fixed lux calibration, freely selectable lumens calibration
- Attenuator: Adjustable factor 0.001…99.99
- Approx. 5 readings/s, automatic average creation for alternating light
- Interface: Serial RS 232
- Power supply: International wide range power supply 80…270 V, 40…400 Hz
- Power consumption: Max. 20 W
- Dimensions: (W x H x D) 291 x 88 x 199 mm
- Weight: 2 kg
- Display range: 10^{-3} lm (last digit) to 2 x 10^5 lm

Options

- Range extension
- CM 10 colorimeter for luminous color measurements
- SNT 10 DC power sources and voltage / current stabilizer
- AC power supplies / multimeters
- Spectral measurement with CAS 140CT (Instrument Systems)
- System integration with 19-inch electronic rack
- Software LightCon sphere program package for integrating spheres
- Lamp holders (automotive bulbs, general lighting lamps)
- Flux and spectral calibration bulbs
- Special photometer paint

Digilux / Digilumen 9500

CM 10 - Tristimulus colorimeter for luminous color and correlated color measurement according to DIN 5033

Product selection chart

Part No.	Sphere diameter	Max. lamp length	Lamp ratings		Spectral range	Lamp standard		Application software
			Min.	Max.		Power	Flux	
ITS 500	500 mm	250 mm	0.4 lms	400 W	Photopic	35 W	450 lms	Available
ITS 1000	1000 mm	600 mm	0.5 lms	1500 W	Photopic	75 W	1400 lms	Available

Sphere accessories

Lamp sockets for integrating spheres
Precision measuring sockets are special quadri-pole lamp holders with two separate galvanic connections, each of which has a point of contact with the lamp, one for the supply of the lamp and the other for the voltage / current measurement.

Electrical data of measuring sockets for vehicle lamps
U_{nom} 24 V DC, I_{max} 20 A, Test voltage U_{test} 50 V DC.

Electrical data of measuring sockets for general purpose lamps
U_{nom} 250 V AC/300 V DC, I_{max} 10 A, Test voltage U_{max} 2000 V_{eff}. Other high voltage sockets on request.

Standard lamps for integrating spheres and goniophotometers
Luminous flux standard lamps with calibration certificates to calibrate luminous flux test equipment with integrating spheres or for use the goniophotometers.

Universal fixture plate for sphere

Standard flux lamps for general lighting
Standard lamps for calibration of luminous flux test equipment with certificate issued by an accredited testing laboratory. The test certificate includes the relevant electrical values and the luminous flux.

Spectral calibration bulbs
Set of spectrally calibrated bulbs with calibration certificate.

Standard flux lamps for vehicle lights
Standard lamps for testing vehicle lights according to ECE Regulation No. 37 with certificate issued by an accredited testing laboratory. The test certificate includes the relevant geometrical, electrical, and photometrical values.

Precision lamp holders for different lamp types

Photometer paint for integrating spheres

Our photometer paint for integrating spheres acc. to CIE Publication No. 84 (1989), characterized by Lambertian diffuse and selective reflectance and composed of highly purified $BaSO_4$.

Characteristics

- Lambertian white diffusing surface
- Reflectance 80% (DIN 5036 Section 3)
- Variation of reflectance < 1.5% in wavelength range 400 to 700 nm
- Particularly suitable for coating integrating spheres according to CIE Publ. No. 84 (1989) "The measurement of luminous flux"
- Recommended quantity approx. 1.25 kg/m^2
- Individual test report for reflectance, spectral reflectance, and sphere factor
- Option: photometer paint with 98% reflectance on request

Sphere diameter	Quantity
0.5 m	1 kg
1.0 m	4 kg
1.5 m	9 kg
2.0 m	16 kg
2.5 m	25 kg
3.0 m	35 kg

Photometers paint quantity needed

DC Power Supplies

We manufacture a range of laboratory DC power supplies, SNT 10, developed mainly to meet theneeds of the automotive lighting and neighboring industries. For additional information, please askfor the DC Power Supplies SNT 10 brochure.

Standard versions available:
SNT 10 - 50V/12A (20 A for U <18V)
SNT 10 - 50V/10A
SNT 10 - 32V/20A
SNT 10 - 32V/12
ASNT 10 - 32V/3.2A

Standard setting resolution:
0.001 V / 0.001A

Optional setting resolution:
0.2 mA or 0.1 mA

LDN 500 Luminance Standard (uniform light source)

Features and applications

The LDN 500 is an integrating sphere uniform light source with color temperature regulation. Each model includes a sphere photometer and control unit. The LDN 500 luminance standard creates on its light emitting surface a luminance which is accurately defined. Alternatively, you can control constant luminance or color temperature. The LDN 500 is therefore an excellent tool for testing and calibrating a variety of photometers, such as:

- Luminance meters
- Retroreflectometers
- Photo receivers
- Colorimeters and video cameras

The LDN 500 model has a diameter of 500 mm. The light emitting area has a diameter of 100 mm. The power supply is integrated into a separate control unit. A keyboard on the control device's front plate serves to control the following functions:

- Automatic maintainance of constant luminance
- Automatic maintainance of constant color temperature
- Continuous adjustment of luminance and/or color temperature
- Storage of frequently used values

The measured values are indicated on a separate display and control unit or on an integrated display. An RS 232 serial interface allows for control of the LDN 500 via PC; e.g. if the device is used for automated measuring applications.

Options

- Additional calibration certificate for luminous intensity
- Measured color filter with specification of chromaticity coordinates
- Filter for conversion to other illuminants
- Power supply for 115 V, 50-60 Hz

Technical data

Luminance standard LDN 500

- Integrating sphere, 500 mm
- Sphere material: Aluminum
- Special sphere coating diffuse (Lambertian) reflecting, 80% reflectance, spectral characteristics according to DIN 5032
- Halogen incandescent bulb 12 V / 100 W
- Baffle to shield the light exit port against direct light
- 3 Si-photo detectors to regulate luminance and correlated color temperature
- Light exit port with diffuse cover, 100 mm
- Luminance at standard illuminant A approx. 1100 cd/m^2
- Luminance range approx. 200...2200 cd/m^2
- Uniformity of luminance > 98% on a center circle of 90 mm
- Total dimension with stand: 500 mm x 700 mm (height)
- Weight: Approx. 15 kg

Display and control unit

Lamp power supply

- Table housing, optionally to be integrated in19“ configuration
- Lamp power supply for halogen bulb 100 W
- Microprocessor-controlled electronic regulation unit, regulation of either voltage, luminance, or correlated color temperature
- Regulation range of correlated color temperature: 2500 K...3000 K
- Digital display of lamp voltage, luminance, and correlated color temperature on graphic LC display with background illumination
- Integrated lamp burning time and switching cycle counter
- Serial interface (RS 232) for remote control and readout of measured values
- Mains supply: 230 V / 50 Hz, max. 130 W
- Power cable with Euro plug
- Calibration traceable to PTB standard with our calibration certificate

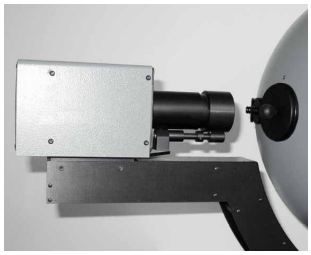
Reflectance and transmittance measurement KMS 500

KMS 500 transmittance and reflectance measurement instrument

Applications

The KMS 500 is a specialized measuring instrument used for various applications to measure luminous reflectance and transmittance of different materials.

- Its design is based upon the properties of an integrating sphere.
- Its design follows the guidelines defined by DIN 5036 Section 3 and CIE Publication No. 38 (1987) (Measurement of transmittance and reflectance)
- In addition, it is suitable for measurements according to ECE-R46, ISO 5740–1982 (Measurement of the reflectance of flat and convex rear mirrors)
- Many additional applications are possible wherever information on reflectance and transmittance is needed. Relative measuring method: Reflectance and/or transmittance standards with defined reflectance properties required.



Left: Display and control of color temperature
Right: Directional light sorce, color temperature regulated to standard illuminant A

Options

- Working standards to calibrate the measuring equipment, with calibration certificate: Regular reflecting standard (surface reflecting mirror), diffuse reflecting standard
- τ_{dif} -illuminant source for connection to integrating sphere for measurements of τ_{dif}

Equipment for measurement of

- Reflectance ρ
- Diffuse reflectance ρ_d
- Transmittance τ
- Diffuse transmittance τ_d
- Reflectance of flat and convex surface rearview mirrors
- Transmittance τ_{dif} at diffuse light incidence (optional)

Measurement according to the following standards:

- CIE Publication No. 38
- DIN 5036 Section 3
- ECE Regulation R 46
- ISO 5740 – 1982

- Integrating sphere 500 mm diameter mounted on base plate with sample holders. Sphere construction according to DIN 5036 section 3 and ISO 5740–1982 with integrated photometer head, 30 mm diameter of light sensitive surface, superior V(λ)-approximation
- Moveable ρ and τ -Illuminant source for connection to integrating sphere, for measurements of p and p_d with a color temperature acc. to standard illuminant A, with color temperature control system via several Si-photo elements
- Power supply and control circuit for illuminant source, connection cables, power supply for 230 V, 50-60 Hz, power cable with Euro plug
- Digital display unit Digilux 9500 with amplifier and 4½-digit display of measuring value, attenuator for adjusting the display value to the calibration standard value, RS 232 serial interface; power supply: international wide range power supply 80...270 V, 40...400 Hz, Euro plug.

Instrument Systems is continually working on the further development of its products.
Technical changes, errors and misprints do not justify claims for damages.
For all other purposes, our Terms and Conditions of Business shall be applicable.

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