TYPE C TURNING LUMINAIRE GONIOPHOTOMETERS

ALL INCLUSIVE MEASUREMENT SYSTEM

⇒ Spatial luminous intensity distribution (IES / LDT files)

⇒ Luminous flux and efficacy

⇒ Input power and power factor

⇒ Spatial color uniformity (SDCM)

⇒ Total correlated color temperature (CCT), color rendering index (CRI) and spectral radiant flux distribution

⇒ No need for integrating sphere

SAVE TIME, SPACE AND MONEY

⇒ Cost-effective solution

⇒ Laboratory space and construction costs saving solution

⇒ Reliable LDT/IES measurements in standard height rooms

⇒ All needed accessories: laboratory black material, sample holders, computer, installation and training service

⇒ Optimal gonio size for reducing transportation costs

⇒ No over-engineering

Models of Goniophotometer C-1 Product Family

SSL-1-20-10 - LED modules and lamps

SSL-6-70-20 - small-medium sized luminaires

SSL G-900R - small-medium sized luminaires **NEW**

SSL-10-150-30 - medium-long luminaires

SSL-16-100-40 - heavy street and flood lights

SSL-25-200-55 - heavy and large luminaires

Custom model - send a request

SSL RESOURCE

SSL **GONIOPHOTOMETER** for Luminaire manufacturers

OVERVIEW OF SSL GONIOPHOTOMETER C-1 PRODUCT FAMILY

SSL Goniophotometer system has been developed for the measurement of light intensity distributions of SSL lamps, modules, and luminaires. The goniophotometer consists of a goniometer, a photometer (or colorimeter instead as an option), a spectroradiometer (optional) and a power meter. The SSL Goniometers are of C type in C-γ coordinate having its optical axis in horizontal direction. The SSL goniometers are several models for different size luminaires. All gonio models are equipped by the similar gonio controller and power meter. The luminaire under test (LUT) is operated in horizontal axis. The luminous intensity is recorded accurately by combination of a high quality photometer, or colorimeter/spectrometer and power meter with a feature of simultaneous measurement of photometric, spectral, colormetric and electrical parameters of the LUT. The measurement results are reported in standard file formats like IES and EULUMDAT for making possible the reliable 3D lighting simulation. Various lighting application figures like transversal/longitudinal isolux curves or cone diagrams are analyzed and illustrated automatically after measurements in the gonio program GPM.

Fig 1. SSL-10-150-30 goniometer with an alignment laser and stray light tube.

THE GONIOMETER

The goniometer of the SSL goniophotometer system is 2-axis turning device. The goniometer is based on the stepper motors and the mechanical set-up uses aluminum profiles which are separately black-coated. The selected aluminum profiles are screwed together with special adapters to obtain a light weight construction. The photometric center of the LUT to the crossing point of the turning axes is adjusted manually by sliding the vertical arm on the carrier along the stable rail using the alignment laser (Fig. 2).

Each turning includes the acceleration phase, constant-speed phase and the deceleration phase. In this way the turning is wobble-free and enables light-weight and cost-effective goniometer. The angular measurement can be performed in a full 4π sphere.

Fig 2. SSL-6-70-20 Goniometer. The alignment laser helps aligning the Luminaire onto the optical axis and also useful in setuping the gonio and photometer into the same optical axis in a e.g. new lab.

Fig 3. SSL-rack-1. The separate compact device 19" rack forms a easier device arrangement.

Fig 4. The stray light tube and stand for a photodetector.

The new goniometer model G-900R contains an integration of gonio controller and power meter into the goniometer. Other models are equipped by a separate small device rack (Fig. 3) having a extra space (4U) for other devices (e.g. DC / AC power supply).

STRAY LIGHT TUBE

With the attaching the photodetector to a stray light tube (Fig. 4), the laboratory preparation is much easier. The stray light from the side wall, ceiling and floor is eliminated by a stray light tube having a couple of apertures with a knife edge land. The photometer can see reflections only from the back-wall behind the goniometer station, so only it needs to be covered by a special black surface. The stray light tube also allows use of roof lighting in the photometer end of the gonio lab making more more comfortable working area in the lab. The stray light tube is assembled at a fixed photometric distance according to the largest possible test sample. This reduces the risk of erroneous distance setting.

PRACTICAL NEED FOR GONIOPHOTOMETERS

SSL Goniophotometer from SSL Resource Oy provides effective measurements of LED-based luminaires. Goniometric data is crucial for the full characterization of luminaires particularly for the measurement of luminous distribution curves or polar diagrams which present light intensity depending on angle. This information is key in preparing lighting simulation and light design or when we need to know what is the spatial distribution of light. Also the luminous flux, luminous efficacy, and correlated color temperature and color rendering index of luminaire - that are important marketing and lighting design information as well - are measured at the same time. Therefore the separate luminous flux measurement setup like integrating spheres are not necessarily needed. Additionally, the goniophotometers do not cause the sphere geometry induced measurement errors.

GONIOMETRIC MEASUREMENT PRINCIPLE

The luminaire is rotated around the horizontal and vertical axis and at each position the photometric signal is measured at a fixed photometer location in the far field of radiation.

The C-plane is controlled by the horizontal axis. In each C-plane, the angular luminous intensity distribution of the LUT is measured as a function of γangle by turning the LUT with the vertical axis.

The horizontal and vertical axes are moved with a sufficient angular step and range to reliably measure the angular luminous intensity distribution of LUT. The luminous flux can be reliably calculated by summing up all the luminous intensities from each measurement direction.

The SSL goniophotometers follows the CIE S 025 and IES LM-79-08 standards.

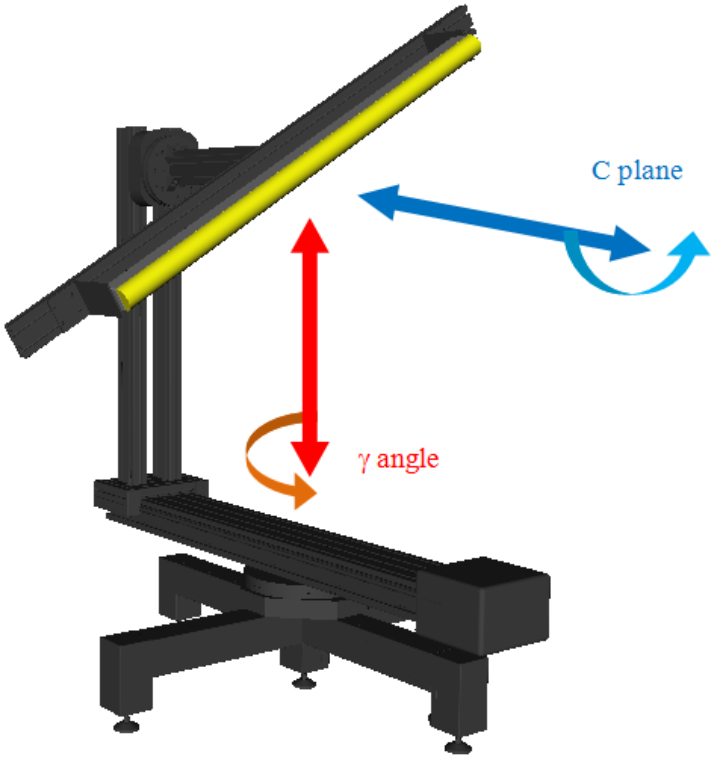


Fig 6. Goniometer setup for linear light source with upwards radiation.

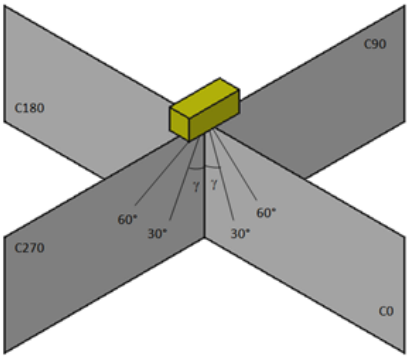


Fig 5. Determination of planes C0–180, C90–270 and the γ-angle.
The luminous intensity values as a function of γ angle are provided on plane C, at angles in e.g. 22.5°/5° steps or other intervals.

Summary of the features

- ⇒ C type goniophotometer in C-γ coordinate
- ⇒ Optical axis in horizontal direction
- ⇒ Angular luminous intensity measurements
- ⇒ Luminous flux and efficacy measurements
- ⇒ EULUMDAT/IES file generation
- ⇒ Angular spectral and color measurements
- ⇒ Spectrometric and colorimetric measurements

HOW TO MEASURE OMNIDIRECTIONAL RADIATION?

The goniometer needs to be adjustable to position the photometric center of luminaires with varying thicknesses (distance from its back surface to the photometric center) to the turning axes. For measurement of luminaires with an moderate upward radiation, the maximum γ angle of the goniometer and luminaire mounting should be such that the dead angle is minimized and the total radiation angular range is covered. The photometric center positioning should be large enough for linear lights with moderate upwards radiation (Fig. 6 & Fig. 7 left). For measurement of up and down light luminaire (Fig. 7 right), the range of the photometric center positioning can be smaller, because up and down radiation part of such a luminaire is measured separately and the measurement software combines these two measurement results into one single measurement file.

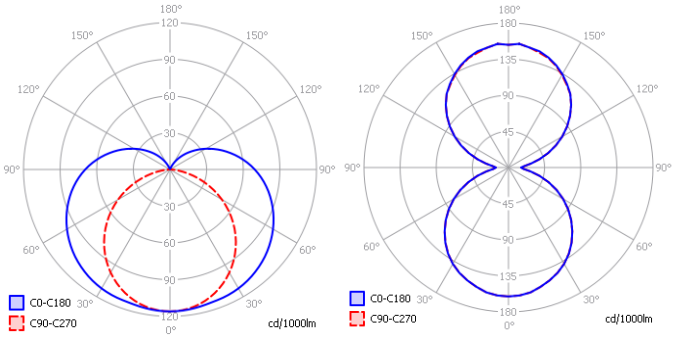


Fig 7. Polar curve of intensity distribution of two examples (left, asymmetric luminaire with moderate upwards radiation - right, symmetric luminaire with remarkable down and up light) on two planes. (Fig. 5)

- Plane C90–C270: parallel to the longitudinal axis of the fixture
- Plane C0–C180: perpendicular to the fixture's longitudinal axis

WHAT IS SUFFICIENT SIZE FOR GONIOMETER LABORATORY ROOM?

The large and heavy C type mirror Goniophotometers require extremely large room sizes. Our largest Goniophotometer SSL-25-200 -55 can be located into a standard height room for a cheaper laboratory arrangement and for a easier transportation in the customer premises. The measurement distance between the luminaire under test (LUT) and the photodetector set a limit for the minimum laboratory size. The angular luminous intensity distribution needs to be measured at such a distance (= photometric distance) where the LUT can be considered as a point light source. The minimum photometric distance is dependent on the size and the beam width of the LUT. The ratio between the minimum photometric distance and the maximum extent of the LUT varies from 5 to 15 depending on the angular beam pattern and the required accuracy for the point source approximation.

WHAT IS A SUITABLE PHOTOMETER?

The photometer needs to have a good match with the CIE1924 photopic spectral sensitivity V(λ) of standard human eye as described by the spectral quality factor f_1'. The photometers with $f_1' < 6\%$ are generally considered as sufficient for precise goniophotometric measurements of white light sources. The f_1' value does not provide the actual luminous intensity measurement errors caused by a spectral mismatch, because it depends on the combined effect between the source spectrum and the photometer spectral mismatch. Our photometer is ideal for LED measurements because its mismatch at LED wavelengths (430-680nm) is small relative to its f_1'. Also, its spectral mismatch to V(λ) is calibrated through the spectral responsivity measurements of the photometer and the spectral measurement of LED lights. Additional specific requirement for the measurement with a goniophotometer is a wide dynamic illuminance range. Our new photometer SSL L-200 is fast and works reliably in a large dynamic range taking into account the flicker effects (Fig.8).

Fig 8. High precision photometer SSL L-200 for large dynamic illuminance range of 0.5 mlx - 100klx.

WHEN USE A COLORIMETER / SPECTROMETER?

When combining the broadband tristimulus colorimeter with a goniometer (called as goniocolorimeter), the spatial color uniformity (SDCM) and total color parameters of the LUT can be measured. The advantages of the goniocolorimeter over the goniophotometer are the self-color correction and the simulatenous meaurement of the luminous intensity distribution and spatial color uniformity. Its self-color correction improves the accuracy of the luminous intensity measurement compared to a single photometer detector. With a comparison to the goniospectrometer, the goniocolorimeter is a faster and more reliable for measuring spatial luminous intensity and color distribution. Its signal-to-noise ratio is much better while making possible to measure quickly the color parameters even at low light levels. The goniocolorimeter is needed particularly for the spatial color measurement of long LED tube lamps to meet the photometric distance condition. The goniocolorimeter needs only one single photodetector to measure fast and reliably all photometric and colorimetric parameters of white light sources.

The spectrometer is needed for measurement of CRI and spectral distribution. It needs to be append to the goniophotometer system also for measurement photometric and colorimetric parameters of single color LED and multi color LED sources such as plant growth lights. This is because the spectrometer is used to correct the spectral mismatch of a photometer that causes a bit larger error for single color LEDs with a narrow wavelength band. When using a spectrometer, the angular dependent parameters of CRI and spectral distribution can be measured in addition to the measurement features obtained with the goniocolorimeter.

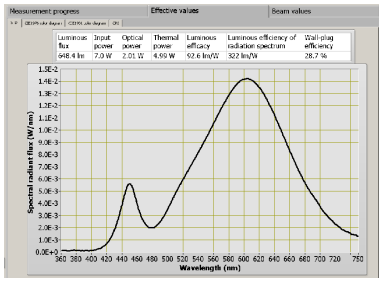


Fig 9. Goniospectrometer software.

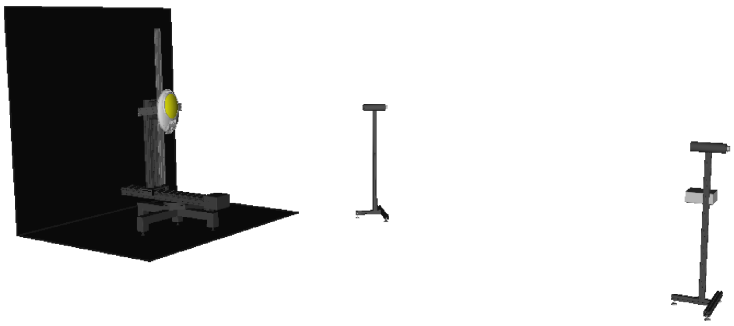


Fig 10. Goniospectrophotometer setup. Spectrometer is located at a shorter distance and photometer beyond the photometric distance.

ADDITIONAL MEASUREMENT INFORMATION

The standard light distribution figures like polar curves in EULUMDAT/IES files can be measured by the basic gonio setup. In addition to this, the measurement system has also a feature to simultaneously measure the electrical power, power factor and supply voltage during the angular light measurements. This enables automatic luminous efficacy measurements of the SSL luminaires. Goniospectrometric measurement setup conforms to goniospectrometric measurements on four C planes at γangles in 10° steps according to IES LM-79-08 standard including also option to measure with more dense angular steps. The spatial color measurements produces information of the color coordinates (x,y; u'v'), CCT and CRI as a function of observation angle. The spatial uniformity is indicated by SDCM value (or MacAdam ellipse) within which the color coordinates from different directions are located. SSL-GSM software supports accurate determination of total spectral radiant flux and luminous flux by numerical integration of angular spectral radiant intensity and luminous intensity. The spectral radiant intensity at all positions are recorded by the software. Then the effective color parameters are analyzed providing total CCT, CRI and total spectral radiant flux . The goniospectrophotometer is arranged i.e. the spectrometer is positioned in its own stray light tube making possible to a simultaneous measurement with the spectrometer and photometer (Fig. 10). Then, CCT and CRI values are automatically recorded into IES/LDT files during the spatial light distribution measuremen by photometer.

ABSOLUTE LUMEN INTEGRATOR

The largest goniophotometer SSL-25-200-55 can be equipped by an Absolute Lumen Integrator (ALI). Using the ALI, the absolute luminous flux and the spatial luminous intensity distribution of the small LUTs (<22cm) can be measured directly in the nominal burning position. The ALI makes possible fast luminous measurements.

STRAIGHTFORWARD BURNING POSITION CORRECTION

The extremely large size and very expensive mirror goniometers maintain the burning position of the luminaire that is critical in case of the traditional light sources. Such sources like fluorescent tubes or sodium lamps had a significant change in their luminous flux when their position regarding the gravity is changed.

Anyway, a large portion of SSL luminaires do not cause such a significant burning position effect. One example is 1D heat sink based luminaires with deep fins that causes a noticeable burning position effect on the luminous flux. Its thermal management may be changed a bit due to the luminaire turning goniometer. The Type (C,γ) Goniometer system with horizontal optical axis (called as "horizontal C gonio") is the best solution for cost effective measurement of any size of LED based lighting fixtures. The horizontal C type gonio changes less the burning position of e.g. symmetric LED fixture than A/B type goniometer and also the horizontal optical path enables cost-effective and lab-space saving goniometer system.

For complying the newest standard CIE S 025, the burning position effect of the test luminaire can be characterized by the SSL-BPC software and an additional burning position corrector setup. When measuring the luminous intensity distribution, the luminous flux value can be quite straightforwardly corrected to the nominal burning position by knowing that the luminous intensity is measured at the normal direction (at γ=0°) of the lighting fixture in all tested C planes (different burning positions). Then the final correction for the nominal burning position is straightforwardly done by the burning position corrector setup (Fig. 11).

Fig 11. Measurement setup of burning position effect in case of SSL G-900R goniometer.

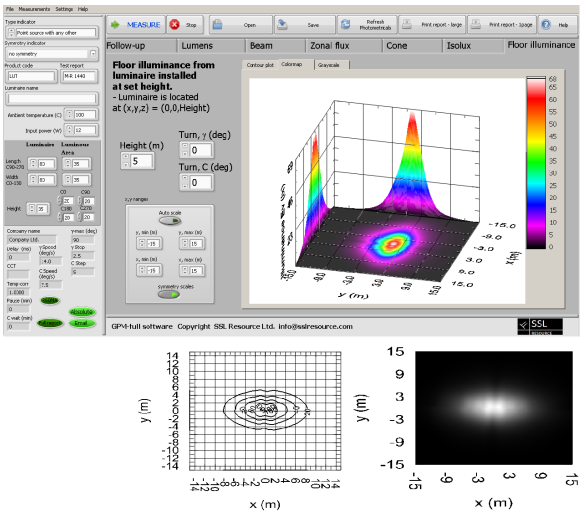
SSL Goniophotometer – MEASUREMENT SOFTWARE

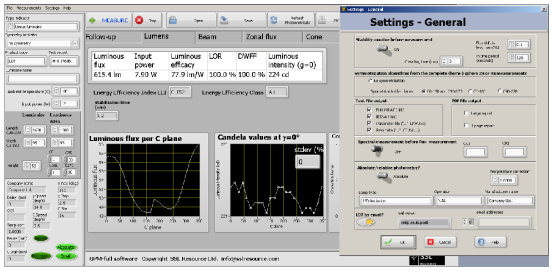
MEASURED PARAMETERS

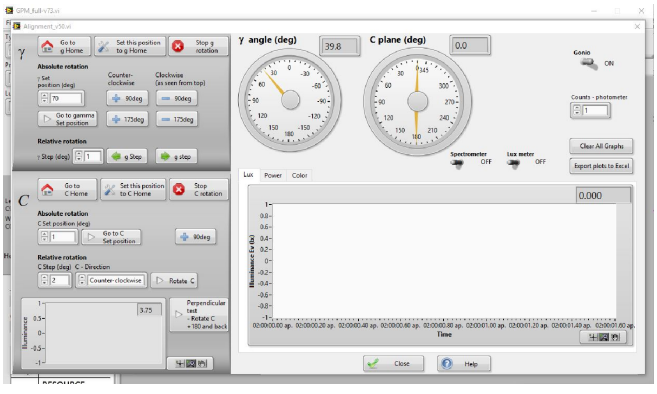
- Luminous intensity distribution $I_V(\gamma,C)$ (cd, cd/klm)
- Luminous flux Φ_V, (lm)
- Luminous efficacy η_V, (lm/W)
- Input power P_{IN}, (W)
- Beam angles (50% and 10% from the maximum) at two perpendicular C planes (C0° – 180° and C90° – 270°)
- Light output ratio LOR (%)
- Down-wards flux fraction, DWFF (%)
- Cumulative flux, $\Phi_V(\gamma)$ (%)
- Polar curve / Linear curve
- Cone angle presentation at different distances (beam width in angle and in meters, illuminance in the center and edge of the cone)
- Luminance and CU/CCEC/WEC tables
- Isolux curves (longitudinal)
- Floor illuminance distribution
- Color coordinates x,y and u'v' as a function of angle
- CCT and CRI as a function of angle
- Spectral power distribution as a function of angle
- Total (effective over the total angle) color coordinates, CCT, CRI and spectral radiant flux, optical power (W)
- Spatial color uniformity with a SDCM value corresponding MacAdam ellipse within it the color coordinates are located in different angles
- Wall-plug efficiency
- Efficacy of radiation spectrum, LER
- Scotopic - Photopic ratio, S/P ratio
- PAR values; µmol/s values as a function of angle and total

SOFTWARE FEATURES

- Automatic measurement of angular dependence of luminous intensity, spectral and colormetric parameters
- Beam symmetrization with symmetry of C0-180 and C90-270, or C0-180 planes, or C90-270 planes.
- Symmetric measurement (three options)
- Spectral mismatch measurement for high accuracy luminous intensity and luminous flux measurement with combination of spectrometer and photometer
- Up-wards / down-wards combination.
- Compensation method for burning position using luminous intensity values at γ=0° in different C-planes.
- Opening of data from an existing EULUMDAT file (analyses the parameters in the list above)
- User defined parameters for Floor illuminance, isolux, cone diagrams like turning angle, distance or isolux values
- Custom Test report (pdf)







SSL Goniophotometer – TECHNICAL DATASHEET




PRODUCT	SSL-1-20-10	SSL-6-70-20	SSL G-900R NEW	SSL-10-150-30	SSL-16-100-40	SSL-25-200-55
Application area	Small luminaires (e.g. LED modules, lamps E14, E27,etc)	up to small-medium sized SSL luminaires	up to small-medium sized SSL luminaires (e.g. LED panels / downlights)	up to medium-long luminaires (e.g. Linear luminaires, small street lights)	Up to heavy street lights and thick luminaires e.g. Flood lights	up to large and heavy luminaires (e.g. street lights and other heavier exterior lighting fixtures)
Goniometer type	C type with horizontal optical axis					
Gonio driver and controller	2 axis Stepper motor controller with RS-232 interface, Worm gear drive system with deep groove ball bearings					
Goniometer arrangement	Portable goniometer with separate device		Integrated goniometer and device rack	Goniometer with separate device rack		
Height, Width, Length, Weight	0.3 m, 0.3 m, 0.3 m, 8kg	0.7 m, 0.7 m, 0.7 m, 25kg	1.230m, 0.582m, 0.508m, 50kg	1 m, 1 m, 1 m, 70kg	1 m, 1 m, 1 m, 80kg	1.3 m, 1.3 m, 1.3 m, 110kg
Approx. Height of optical axis		0.7 m	1.1 m	1.2 m	1 m	1.4 m
LUT Photometric center positioning (vertical axis)	0–10 cm	0–20 cm	0–25 cm	0–30 cm	0-40 cm	0–55 cm
Max dimension of the LUT	20 cm	70 cm	90 cm	150 cm	100 cm	200 cm
Max mass of the LUT (installed status)	1 kg	6 kg	6 kg	10 kg	16 kg	25 kg
Installation Minimum space for laboratory room (WxHxL)	Table installation, 0.4 m x 0.4 m x 1.2 m	Table or floor, 1m x 1m x 5m	Floor installation 1.5m x 2m x 5m	Floor installation, 2.5m x 2.5m x 8.5 m	Floor installation, 2.5m x 2.2m x 8.5 m	Floor installation, 3 m x 2.6m x 12 m
Angular range	±175° (γ and C axes)					
Resolution	<0.006° (γ and C axes)					
Reproducibility / Accuracy	<0.1° (γ and C axes)					
Pre-set angular steps	7 steps selectable between 0.1–10° (γ axis) / 9 steps selectable between 2.0–90° (C axis)					
Angular speed (γ axis)	5 speeds selectable from 2 - 20 °/s	5 speeds selectable from 2 - 10 °/s		5 speeds selectable from 2 - 10 °/s		
Angular speed (C axis)	5 speeds selectable from 3 - 20 °/s			5 speeds selectable from 2 - 10 °/s		
Detector	USB/ RS-232 interface, Measurement range 0.0005 – 100 000 lx, f1'< 5%, Clear entrance aperture					
Spectrometer	USB interface, optical bandwidth: 12 nm / 3 nm, wavelength range: 340-750 nm / 200-900 nm					

SSL Goniophotometer — ORDERING INFORMATION

Goniometers	
SSL-1-20-10 SSL-6-70-20 SSL G-900R	Goniometer, Colorimeter C-400, colorimeter head CH-400 (USB interface), GPM-sw-full, Stray light tube chamber and stand, Alignment laser for C and γ axis alignment, laser distance meter
SSL-10-150-30 SSL-16-100-40 SSL-25-200-55	Goniometer, Photometer L-200, photometer head LH-200 (RS-232 interface), GPM-sw-full, Stray light tube chamber and stand, Alignment laser for C and γ axis alignment, laser distance meter
Sample holders	
SSL-SH-20	Sample holder of linear LUT for SSL-1-20-10 and SSL-6-70-20 goniometers attaching by screwing the LUT using square nuts (M4/M6) in the grooves
SSL-SH-900 SSL-SH-150 SSL-SH-100 SSL-SH-200	Sample holder of linear LUT for SSL G-900R, SSL-10-150-30, SSL-16-100-40, SSL-25-200-55 goniometer stations two alternatives attaching mechanisms: (1) by squeezeing the LUT with four angle brackets (2) by screwing the LUT using square nuts (M4/M6/M8) in the grooves (angle brackets are removed)
SSL-SH-park	Sample holder of park lights for SSL-16-100-40, SSL-25-200-55 goniometers: Mounting by squeezing a park light from its edges, max. Ø70 cm, a top of the park light can be located into center hole diameter 12 cm
SSL-SH-panel	Sample holder of panel lights and down lights for SSL G-900R, SSL-10-150-30, SSL-16-100-40, SSL-25-200-55 goniometer stations: Mounting by squeezing a LED panel from its edges, compatible for different sizes LED panels with thicknesses of >7.5 mm
SSL-SH-down-light	Sample holder of recessed down lights for SSL-6-70-20, SSL G-900R, SSL-10-150-30, SSL-16-100-40, SSL-25-200-55 goniometers: A closed wooden box with wooden perforated plates for a spring fixation of a down light, max. Ø40cm, thickness 30 cm
SSL-SH-street	Sample holder of street luminaires with pole mounting system for SSL-16-100-40, SSL-25-200-55 goniometer stations: 60mm tube, fixation by two screws in radial orientation, max. distance between mounting hole and the roof of the LUT 13cm
Options	
SSL-black	Special low reflectance black material for a back wall and floor of gonio laboratory room
SSL-computer	Measurement computer with needed communication cards and installation work (drivers and software)
SSL-GSM	Goniospectrometer measurement system: Spectrometer (data 1.5nm steps, in 340-750nm) with Tripod and mechanics adapters, GSM sw measures all the total and angular dependent spectral and colormetric quantities
Power meter and power sources	
SSL-pow-2	Automatic input power measurement, Chroma 66201 and AC plug measuring adapter, software integration into GPM software
SSL-AC	Chroma 61601, 500W: a stable AC power & automatic control of LUT powering through the GPM software
SSL-DC	TDK, GEN 750W, automatic control of input current together with the light output measurement
SSL-rack-1	small 19" equipment rack for gonio controller and power meter, free space of 4U for other equipment such as DC / AC power supply
SSL-ALI	Absolute lumen integrator for SSL-25-200-55 goniometer station: Sample holder and stand not included
SSL-BPC	Setup for burning position corrector including a related software tool
SSL-service	Goniophotometer system first installation and basic training including 2-3 example measurements on customer site (1-2 days)

SSL RESOURCE

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