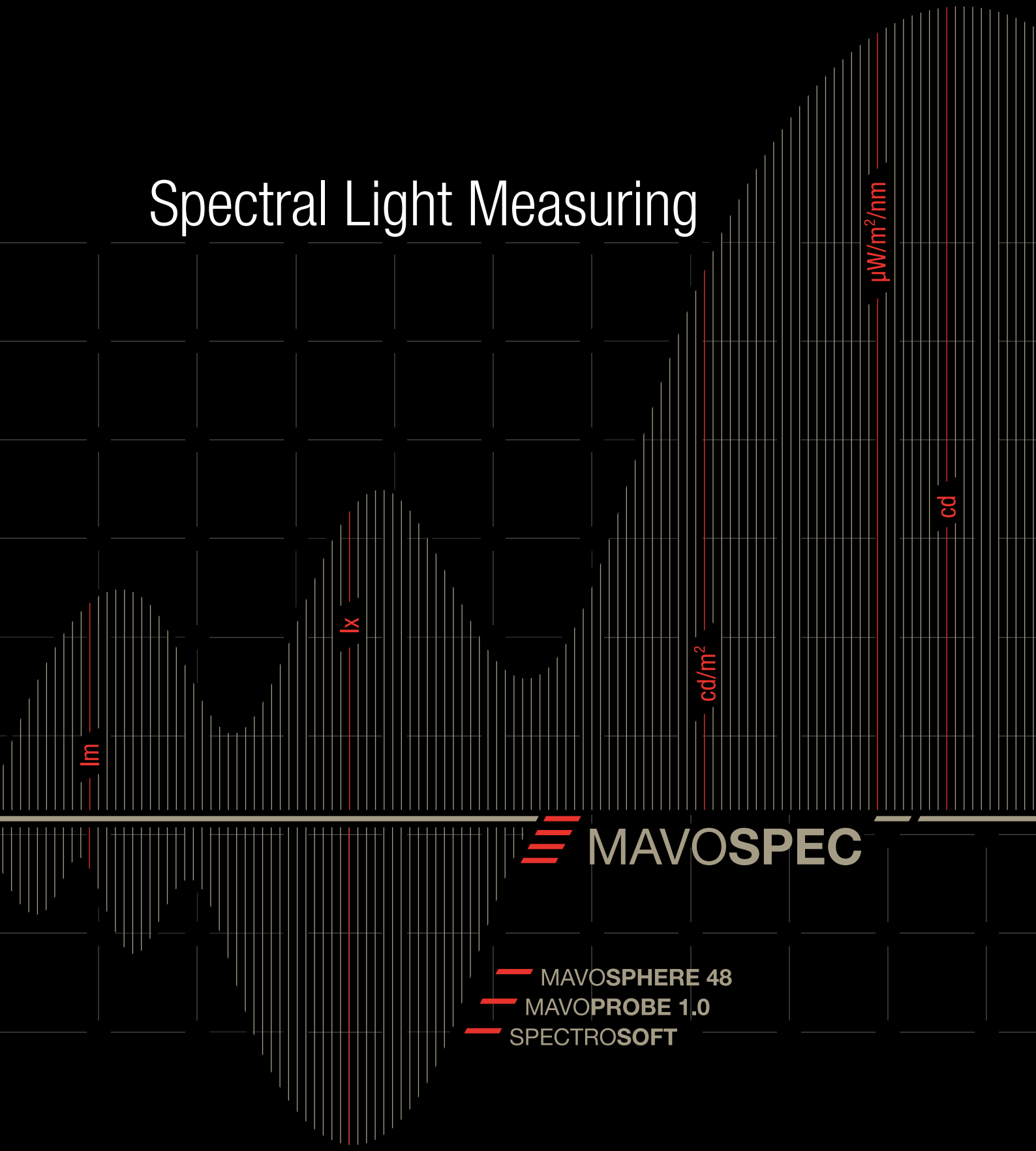
GOSSEN

Spectral Light Measuring



MAVOSPEC

MAVO**SPHERE 48**
MAVO**PROBE 1.0**
SPECTRO**SOFT**

Precision

GOSSEN Foto- und Lichtmesstechnik – Your Guarantee for Precision and Quality

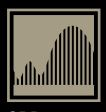
GOSSEN Foto- und Lichtmesstechnik is specialized in the measurement of light, and has decades of experience in its chosen field. Continuous innovation is the answer to rapidly changing technologies, regulations and markets. Outstanding product quality is assured by means of a certified quality management system in accordance with ISO 9001.

LED – Light of the Future

LED technology has experience rapid growth in recent years thanks to the development of LEDs with very high light efficiency. This is being pushed by the ban on conventional light bulbs with low energy efficiency, as well as an ever increasing energy-saving mentality and environmental awareness. LEDs have long since gone beyond their previous status as effects lighting and are being used for display illumination, LED displays and lamps. Modern means of transportation, signal systems and street lights, as well as indoor and outdoor lighting, are no longer conceivable without them. The brightness and color of LEDs vary due to manufacturing processes, for which reason they have to be tested, classified and characterized during production and in their final applications. As a handy, high-end spectrometer, the MAVOSPEC and its optional accessories meet this measuring challenge brilliantly by ascertaining spectrum, color, color temperature, color rendering index, luminous flux, illuminance, luminance and many other parameters.

The GOSSEN Light Lab

offers calibration services, for our own products, as well as for products from other manufacturers, and issues factory calibration certificates. The optical table used for this purpose is subject to strict test equipment monitoring, and is traced back to the PTB in Braunschweig, Germany (German Federal Institute of Physics and Metrology). Aside from the PTB, our lab is the first in Germany to be accredited for illuminance by DAkkS (German accreditation authority), and is thus authorized to issue internationally recognized DAkkS calibration certificates. This assures that acquired measured values comply with official regulations and, as a rule, stand up to legal argumentation. Longstanding customers from industry, the public authorities and the field of medical engineering hold the products and services offered by GOSSEN Foto- und Lichtmesstechnik in high esteem, are pleased to receive our expert advice and ask us to implement their special requirements.

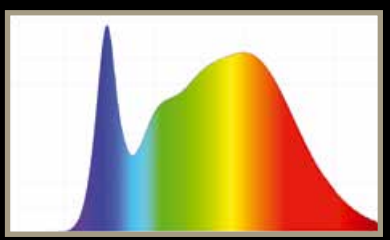


Spectral Power Distribution

(abbreviation: SPD, unit of measure: mW/m²/nm)

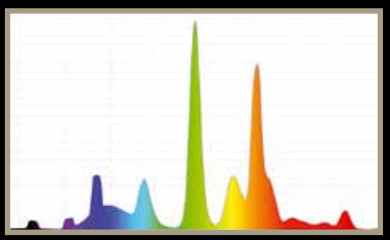
SPD represents the radiant power of a light source for a wavelength or a waveband in the visible range. It provides us with information about the color characteristics of a light source, and can be used to compare the color temperature of different light sources. Information can be inferred from this regarding color rendering properties. The color of an object results from partial reflection of the spectrum emitted by the illuminating light source. If certain ranges are missing from this spectrum, the corresponding color components cannot be reflected or seen. If intensity is not uniform over the entire spectral range, color components with greater intensity are amplified, and those with lower intensity are attenuated.

Afternoon Sunlight



Neutral White LED

Halogen



TL8 840

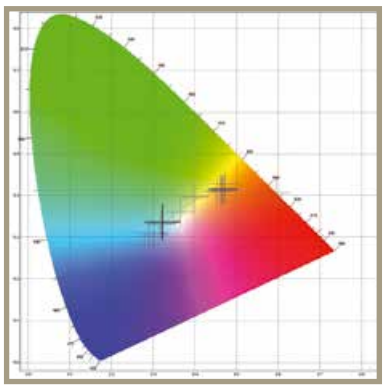
Quality

Color Coordinates

(abbreviation: x, y [CIE 1931] / u, v [CIE 1960] / u', v' [CIE 1976)

Color coordinates are a means of precisely defining a color, i.e. a color's chromaticity as specified by the coordinates of the CIE diagram. The human eye is equipped with sensory cells for the perception of the three primary colors, namely red, green and blue. The photopic curve for the standard observer was ascertained in 1931 by the CIE and indicates sensitivity for the individual wavelength ranges.

On the basis of this spectral value function, the CIE defined the standard XYZ color value system, by means of which each color is described by its standard color components x, y and z. Colors are represented in a two-dimensional diagram via the X and Y coordinates. The third component, Z, can be calculated by means of the relationship z = 1-x-y. Various CIE color systems include CIE 1931 (x,y), CIE 1960 (u,v) and CIE 1976 (u',v').



Applications

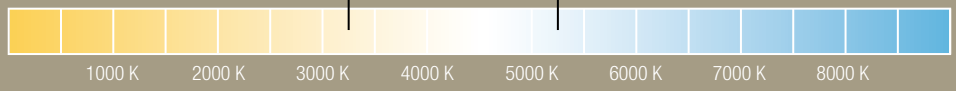
Color Temperature

(abbreviation: CCT, unit of measure: Kelvin [K])

CCT is used to quantitatively specify the respective color impression of a light source. It's defined as the temperature of a black object, the so-called planckian radiator, which belongs to a certain color of the light which is emitted by the source of radiation. In concrete terms, it's the temperature whose light effect is most similar to the color to be described at uniform brightness under specified observation conditions.

The light color of sources of artificial light is categorized into three groups in accordance with DIN EN 12464, parts 1 and 2.
Depending on the predominant spectral color components, differentiation is made amongst:

Light Color	CCT [K] Correlated Color Temperature	Color Component	Lamp Examples
Warm white (ww)	< 3300	Primarily red	Incandescent lamps, fluorescent lamps, LEDs
Neutral white (nw)	3300 … 5300	Balanced / red, green, blue	Halogen metal vapor lamps, fluorescent lamps, LEDs
Daylight white (dw)	> 5300	Primarily blue	High pressure mercury lamps, fluorescent lamps, LEDs



Color Rendering Index

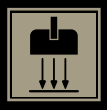
(abbreviation: Ra)

Ra is a measure of the color rendering properties of lamps and has a theoretical maximum value of 100. The higher the color rendering index, the better the color rendering properties of the lamp. Color rendering which is as natural as possible is achieved through the use of lamps with an Ra value of greater than 90. Ra is the arithmetic mean value of der color deviation demonstrated by test colors 1 through 8 in accordance with DIN 6169. DIN EN 12464 specifies the color rendering properties of lamps used to illuminate various types of rooms and activities.

Ra	Color Rendering	Lamp Examples	Applications
> 90	Excellent	Halogen metal vapor lamps Deluxe fluorescent lamps Tungsten halogen lamps, LED	Graphics trades, museums, showrooms for textiles and leather goods, hair styling and cosmetics salons, dental treatment facilities
80 … 89	Good	Halogen metal vapor lamps Fluorescent lamps LED	Administration buildings, schools, industrial and sports facilities
70 … 79	Medium	LED	
60 … 69	Medium	Halogen metal vapor lamps for street lighting	Street lighting
40 … 59	Inadequate	High pressure mercury lamps	Rough industrial work
20 … 39	Inadequate	High pressure sodium vapor lamps	Indoor areas in exceptional cases only

Depending on the manufacturer, the color rendering properties of lamps are defined together with color temperature by means of a 3 digit code.
The first digit identifies color rendering. The second and third digits identify light color via color temperature in Kelvin.

Digit	Ra Range	Digit	Color Temperature
9	90 ... 100	27	2700 K
8	80 ... 89	30	3000 K
7	70 ... 79	40	4000 K
6	60 ... 69	50	5000 K
5	50 ... 59	60	6000 K
4	40 ... 49	65	6500 K



Illuminance

(abbreviation: E, unit of measure: lux)

Illuminance indicates with how much intensity a surface is illuminated. It amounts to one lux when a luminous flux of one lumen illuminates a surface of one square meter. Illuminance is measured at horizontal and vertical surfaces. Since, as a rule, uniform light distribution is not achieved with normal lighting, specifications in the standards usually make reference to mean illuminance which is calculated from the weighted arithmetic mean of all illuminance values in the room.

Applications

The MAVOSPEC with standard diffuser measures the illuminance of lamps, light fixtures and lighting systems in a great variety of applications.

– Monitoring of workstations and public buildings
– Planning, production, repair and maintenance of lighting systems
– Quality assurance for manufacturers of lamps and light fixtures
– Research and development at light engineering facilities

Luminous Flux

(abbreviation: Φ, unit of measure: lumen [lm])

Luminous flux is the total amount of light emitted from a light source in all directions and indicates the light power of a lamp. It's measured with the help of an optional MAVOSPHERE, which is available in diameters ranging from 48 mm for LEDs, all the way up to 2000 mm for entire light fixtures. MAVOSPHEREs are hollow, Ulbricht integrating spheres with a reflective coating on the inside. They uniformly distribute incident light over the entire surface of the sphere by means of diffuse reflection, thus functioning as integrators. The MAVOSPEC is connected to a detector port, and as a rule it measures illuminance which is converted to luminous flux or spectral power via the sphere constant. Light sources which only radiate into the front half-space over 180° are measured with 2π configuration, i.e. they emit light through an opening into the sphere's interior. Light sources which radiate in all directions over 360° are measured with 4π configuration, i.e. the light source is mounted at the center of the sphere, thus necessitating a larger sphere diameter.

Applications

The MAVOSPEC–MAVOSPHERE combination measures luminous flux, which is the basis for calculating light efficiency. And this serves as a measure for the economic and energy efficiency of lamps and light fixtures.

Light efficiency η [lm/W] = luminous flux [lm] / electrical power P [W]

– Receiving inspection and quality control of LEDs, lamps and light fixtures
– Development and specification of lamps and light fixtures
– Color and brightness groups for LEDs (binning) with optional software GL SpectroSoft
– Measurement of all types of fiber-optic sources, for example endoscopes
– Calibration of lamps with several LEDs
– Testing of diffusers and optics for LEDs
– Monitoring of spectrum, color and luminous flux

Luminance

(abbreviation: L, unit of measurement: cd/m²)

L indicates the brightness impression perceived by the eye when positioned in front of a luminescent or illuminated surface. It describes the physiological effect of light on the eye and is used as a planning factor for outdoor lighting. Luminance can be measured with the optional MAVOPROBE 1.0 accessory by means of contact, as well as distance measurement. A counterweight is included for mounting in the case of contact measurement on displays, and in the case of distance measurement the measuring spot can be projected and aligned by means of the included laser pointer.

Applications

Combined with the MAVOPROBE 1.0, the MAVOSPEC measures the luminance of illuminated and self-luminous surfaces, and is suitable for universal use.

– Measurement of CRTs, LCDs, LEDs, OLEDs and plasma displays
– Testing for uniform illumination of projection screens
– Measurement of lighting installations, light tables and outdoor advertising
– Calibration of displays

Binning of LEDs

Binning is the classification of LEDs based on finely graduated color temperatures and brightness values into bins of like characteristics. Due to the utilized manufacturing processes, small deviations occur in the characteristic values of the LEDs during production, which become conspicuous when compared directly with each other. During further processing into lamps or large-format monitor screens, LEDs from the same bins are used together. Optional software GL SpectroSoft is equipped with a bin editor and can assign LEDs to defined bins during measurement.

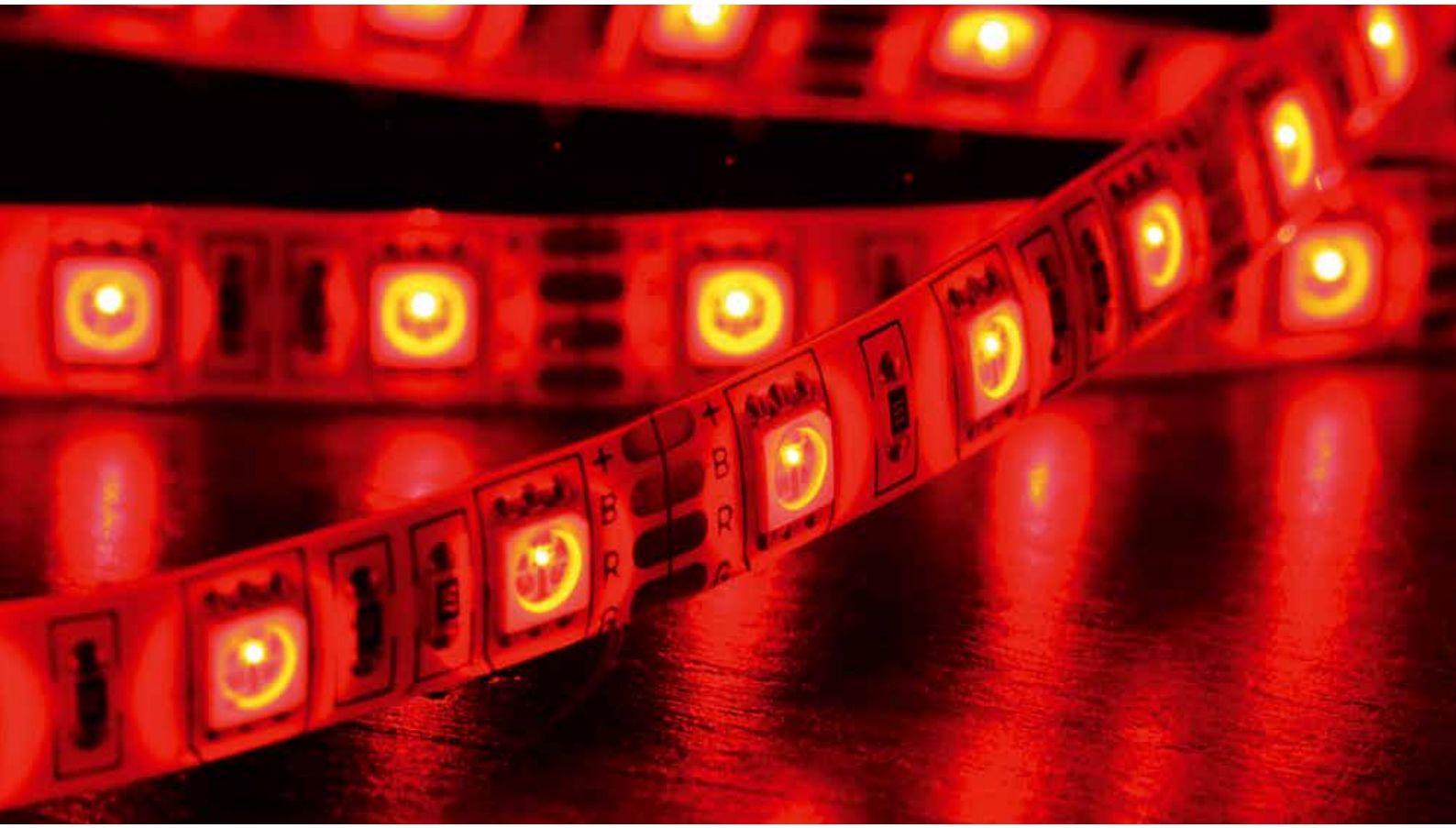
Metamerism

This term designates the effect which allows two colors to appear identical under one light source and different under another type of light. This is due to the fact that the human eye perceives variously combined light spectra as identical color information. The various spectral reflectance curves occur as the result of different pigments or materials. The color impression is caused by reflection of the spectrum emitted by the light source. If the spectral composition of the light changes, individual spectral lines may be missing which would otherwise be reflected by the illuminated object and perceived by the eye.

MAVOSPEC

The Handy Light Lab

integrates the performance of a high-end spectrometer into a portable meter with intuitive touch-screen operation and a high resolution color display in a unique fashion. Light measurement data are acquired quickly and accurately, and are visualized by the meter's internal software in a manner which is equally understandable for experts and laypersons. The miniaturized spectrometer is exceptionally well laid out for portable and stationary measurement of LEDs, OLEDs and all other light sources within the visible range.



For the first time ever, the MAVOSPEC unites a top quality photonic measuring system with and Android operating system and an intuitive user interface which is typical for portable devices. Diverse communication capabilities via USB and WiFi support data transmission and control with external software, as well as integration into stationary measuring systems. The outstanding optical system generates minimal spurious light within a range of 340 to 750 nm, and consists of miniaturized collimator lenses with nano-printed diffraction lines as well as a high-quality CMOS image sensor.

The MAVOSPEC reads out spectral power distribution, peak wavelength, various color coordinates in accordance with CIE standards, correlated color temperature, color rendering indices and illuminance. Measuring functions can be expanded through the use of optional accessories and software.
This results in an extensive range of possible applications and a broad spectrum of uses in planning, installation and maintenance of illumination systems, R&D, production and quality assurance for lamps and light fixtures, as well as certification of light sources, e.g. LED retrofits for incandescent light bulbs.


CIE Chart - m140225-155342
16:00
1931(xy)
x=0.3508 y=0.3548
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1 0.2 0.3 0.4 0.5 0.6 0.7
Back
Measure
Config
MAVOSPEC
GOSSEN

MAVOSPEC


16:05
Spectrum - m140225-155342
Y=339.04lx CCT=4799 Ra=97.3
4
2
0
400
500
600
700
Back
Measure
Config
MAVOSPEC
GOSSEN
USB 2.0
WiFi
miniSD

Specifications

Illuminance – The standard probe with diffuser measures illuminance in accordance with the standards based on Lambert's cosine law with cosine correction accuracy per class B.

Large dynamic range – With a resolution of 0.01 lx, the meter is capable of measuring values from 1 to 200 000 lx, thus covering a broad range of applications.

Spectral power distribution – Measurement of spectral power distribution over a large spectral range of 340 to 750 nm with determination of the peak wavelength. Portions of the UV A range are covered.

Chromaticity, color coordinates – Measurement of color coordinates in accordance with CIE 1931 [x,y], CIE 1960 [u,v] and CIE 1976 [u', v'], and display of the CIE standard color table.

Light quality – Measurement of the correlated color temperature CCT and color rendering index Ra, as well as individual indices R1 through R14.

Outstanding measured value stability – The integrated temperature sensor and automatic temperature compensation of the dark stream assure outstanding measurement results over a large temperature range.

Individual calibration – Before shipment, each spectrometer is photometrically and radiometrically calibrated together with any optional accessories.

Simple functions expansion – Luminance, luminous flux and other measured quantities can be measured with optional measuring accessories or calculated from the spectrum with the help of analysis software.

Intelligent accessories detection – Coded measuring accessories are detected automatically in order to avoid measuring errors, associated calibration data are taken into consideration and the correct measured quantity is displayed.

Convenient daily use – Intuitive operation via touch-screen, easily legible color display with high resolution, compact design, protected transport in a high-quality aluminum case

Automatic measured value storage – Thousands of light measurements are automatically sorted into directories according to date and saved to files named with date and time on an interchangeable 4 GB micro SD card. Directories and files can be individually named or deleted.

Easy data transfer – Data saved to the interchangeable 4 GB micro SD card in XML format can be easily transferred to a PC via a reader and imported to any desired programs.

Universal interfaces – The integrated USB and WiFi interfaces allow for a flexible system structure and convenient data exchange with the PC, or optional GL SpectroSoft application software.

Synchronization with measuring systems – The trigger input/output is used to synchronize measurement with external system setups.

Stationary measurement setups – The ¼" tripod thread on the back allows for mounting to a tripod, to an optical table in the light lab or in production.

Complete Solutions

Interchangeable Probe

The meter recognizes the coded probe, takes the associated calibration data into account and automatically displays the correct measured quantity.

Intuitive Operation

The meter is operated with the touch-screen and a key at the side. Measured values and graphics are displayed in a clear-cut, concise fashion at a high-resolution color display.

High-Performance Basic Unit

The basic unit is equipped with a standard diffuser for measuring illuminance and numerous colorimetric quantities.

MAVOSPHERE 48

The optional MAVOSPHERE 48 replaces the standard probe and allows for the measurement of luminous flux for individual LEDs. Depending on the application, the MAVOSPHERE is also available in larger diameters as an accessory.

GL SPECTROSOFT

Optional software GL SpectroSoft is included on the product CD. Different versions can be enabled via USB dongle.

MAVOPROBE 1.0

The optional MAVOPROBE 1.0 replaces the standard probe and allows for the measurement of luminance. A counterweight is also included for contact measurement, as well as a laser pointer for projecting and aligning the measuring spot for distance measurements.

QM

Certification

Reliable Measured Values through Calibration at Regular Intervals

The MAVOSPEC with intuitive user interface is one of the most accurate and reliable spectrometers in its class, and reflects the most up-to-date technology available on the market. Like all other precision light meters, this product also requires regular maintenance, recalibration and software updates in order to continuously fulfill performance capabilities within the tolerances and specifications stipulated by the manufacturer. GOSSEN recommends a calibration interval of once every 12 months.

When do measuring instruments have to be calibrated?

As a standard for quality management systems, DIN EN ISO 9001:2008 stipulates essential requirements for monitoring measuring instruments in section 7.6, insofar as they are used to assure valid results, and thus uniform product quality as well. Measuring instruments must be retraced to national standards at regular intervals by means of calibration, and if necessary adjusted, and plainly labeled with their calibration status. If it's determined during calibration that the measuring instrument does not fulfill the specified requirements, the operating company must evaluate the validity of previously obtained measurement results and implement appropriate measures with regard to the measuring instrument itself, as well as all affected products. Consequently, calibration at regular intervals assures the quality of the respective product or service on the basis of internationally comparable measurement results. This provides for legal security with respect to product liability, as well as for approval tests and audits.

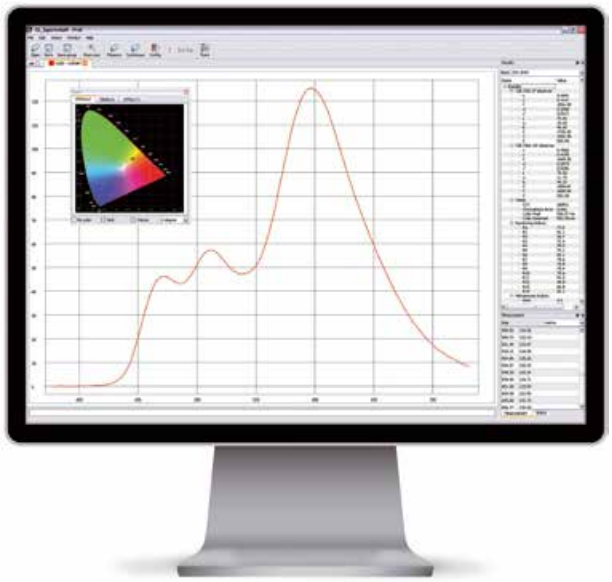
Strictest Standards for the GOSSEN Light Lab

The GOSSEN Light Lab is equipped with a tested and monitored optical table, whose traceability to the national standard maintained by the PTB (German Federal Institute of Physics and Metrology) is assured by means of a Wi41G standard lamp. The lab is subject to test equipment monitoring in accordance with DIN EN ISO 9001-9004, and is additionally accredited for illuminance by DAkkS in accordance with DIN EN ISO/IEC 17025 under registration number D-K-15080-01-01. And thus you can count on product quality, the competence of our employees, continuous external monitoring and international recognition of our calibration services. In addition to factory calibration, GOSSEN also offers DAkkS calibration for illuminance.

GL SPECTROSOFT

GL SpectroSoft

GL SpectroSoft is optional evaluation software with an intuitive user interface and extensive measuring functions for the spectral analysis of light sources, as well as transmission and reflection measurements. Spectral values measured with the MAVOSPEC and the respectively required accessories, as well as externally generated spectra, can be evaluated in accordance with current CIE standards. The software calculates colorimetric magnitudes such as chromaticity in accordance with various CIE standards, correlated color temperature, chromaticity error, peak wavelength, dominant wavelength, color rendering index and index of metamerism. Extensions such as scotopic and photopic values, PAR and PPFD values and MacAdam ellipses can be implemented upon request.
The software is extremely well suited for general light assessments, for laboratory applications and for quality assurance in production. The configurable desktop can be adapted to the respective measuring task, and displays only the required information in a clear-cut fashion. Various program versions are available to match different requirements.



GL SpectroSoft Basic, Specifications

Spectral power distribution – graphic display of the spectrum with scaling function and assignment of colors to wavelengths

Tabular measured value display – table with spectral data in native or calculated step sizes of 1, 2 or 5 nm

Evaluation of the spectra – calculation of photometric and colorimetric quantities, chromaticity (XYZ; x,y; u',v'; CIELab), correlated color temperature, chromaticity error, peak wavelength and value, dominant wavelength, color rendering index Ra and individual indices R1 through R14

Chromaticity display – in in the CIE standard color table, CIE 1931 [x,y], CIE 1960 [u,v] or CIE 1976 [u', v'] with a selectable standard observer of 2° or 10°

Basic photometric quantities – depending on utilized accessories, illuminance, luminance or luminous flux is calculated from the spectrum.

Personalized measurement reports – can be generated in HTML format for the momentarily displayed measurement for the purpose of documentation.

Remote control of and data transfer – for the MAVOSPEC via USB or WiFi interface. Individual, continuous and interval controlled measurements are supported.

Universal exchange of spectra – externally generated spectra can be imported from TXT files and subsequently evaluated. Internal data can be exported via TXT files or the clipboard and processed with other applications.

Individually configurable desktop – individual windows can be arranged and scaled as desired, and saved as a configuration.

International use – selectable user interface language: German, English, French, Italian or Polish

GL SpectroSoft Pro, Enhanced Specifications

LED binning – brightness and color bins can be set up with the integrated editor. LEDs are assigned to the predefined classes during measurement.

Indices of metamerism – are ascertained for the UV and visible ranges.

Approval of color matching stations – measured quantities required in accordance with ISO 3664 are ascertained during the course of a test run and an approval report is generated.

Candle power (cd) – calculation of candle power via the illuminance measurement with standard diffuser and specified distance.

Transmission and reflection – of optical components can be implemented with an external light source and optical measuring accessories.

Measured values at a glance – selectable measured quantities can be displayed in a special window.

Clear-cut comparison – selectable measured quantities from various measurements can be summarized in a table and displayed in a special window.

MacAdam ellipse – in preparation

Technical Data

Model MAVOSPEC

Article number	M600A

Photometry

Application	Daylight, LEDs, halogen and more
Illuminance [lux]	1 lx … 200 000 lx
Illuminance class	Class B – DIN 5032-7 Class AA – JIS C 1609-1:2006
Error limit – cos like rating (f2')	1.9%
Distance, diffuser to surface to be measured	29 mm
Luminance [cd/m²]	1 cd/m² ... 10 000 cd/m², optionally with MAVOPROBE 1.0
Luminance measuring method	Distance / contact
Lumen – luminous flux	Optionally with MAVOSPHERE
mWatt – spectral power value	Optionally with MAVOSPHERE
CRI – color rendering index per CIE	Ra, R1 ... R14
CCT – correlated color temperature per CIE 13.3	■
Peak wavelength	■
Dominant wavelength	Optionally with GL SpectroSoft
Chromaticity coordinates [x,y] per CIE 1931	■
Chromaticity coordinates [u',v'] per CIE 1976	■
Chromaticity coordinates [u, v] per CIE 1960	■
Chromaticity error	Optionally with GL SpectroSoft
Index of metamerism	Optionally with GL SpectroSoft
Binning	Optionally with GL SpectroSoft
Evaluation per ISO3664	Optionally with GL SpectroSoft

Technical Data

Spectral range	340 ... 750 nm (UV ... VIS)
Spectral range optional	640 ... 1100 nm (VIS ... NIR)
Sensor	CMOS image sensor
Number of pixels	256
Physical resolution	~ 1.7 nm / ~ 1.8 nm
Wavelength reproducibility	0.5 mm
Integration time	5 ms ... 100 s
A-D converter	16 bit
Signal-to-noise ratio	1000:1
Spurious light	2*10 E-3
Full width at half maximum (FWHM)	12 nm
Radiometric accuracy	4%
Flicker compensation	■
Temperature sensor and automatic zero-point correction	■
Chromaticity measuring uncertainty	0.0015
Tripod mount	■
Automatic detection of respective accessories	■

Interfaces and Memory

USB	USB 2.0
WiFi	802.11b/g
Bluetooth	In preparation
SD card slot	Micro SD
Measured value memory	Automatic / 4 GB micro SD
Data format	XML
Plug for fiber-optic cable	Optional SMA905D

Operation

Display	3.5" color LCD, 240 x 320
Operation	Touch-screen, also PC / notebook

CD

Software	Optional GL SpectroSoft Basic / Pro

Miscellaneous

Operating system	Android
Power supply via USB port	< 640 mA
Power pack	Mains power pack, 100 … 240 V (50/60 Hz) 0.15 A
Battery / rechargeable battery	Rechargeable Li-ion battery, 1400 mAh
Rechargeable battery life	< 6 h
Charging time with charger / USB	2 h
Operating temperature	5° ... 35° C
Dimensions [H x W x D]	146 x 74 x 24 mm
Weight	315 g
Scope of delivery	Case, battery, USB cable, power pack, carrying strap, display protector, 4 GB micro SD card

Photo also shows optional accessories including MAVOSPHERE 48, MAVOPROBE 1.0 and SpectroSoft with dongle.

Accessories

MAVOSPHERE 48

Article Number M601A

Inside diameter	48 mm
Entrance aperture	9 mm
Weight	0.15 kg

MAVOPROBE 1.0

Article Number M602A

Adapter for measuring luminance, for contact and distance measurements, including laser and counterweight

GL SPECTROSOFT BASIC

Article Number M603A

Operating and evaluation software

GL SPECTROSOFT PRO

Article Number M603B

Operating and evaluation software with enhanced range of functions

MAVOSPHERE 205

Article Number M601C

Inside diameter	205 mm
Entrance aperture	50 mm
Auxiliary light source	White LED
Weight	3.3 kg

MAVOSPHERE 500

Article Number M601D

Inside diameter	500 mm
Entrance aperture	80 mm
Auxiliary light source	White LED
Weight	17.5 kg

MAVOSPHERE 1100

Article Number M601E

Inside diameter	1100 mm
Entrance aperture	150 mm
Auxiliary light source	White LED
Weight	60 kg

MAVOSPHERE 2000

Article Number M601F

Inside diameter	2000 mm
Entrance aperture	700 mm
Auxiliary light source	White LED
Weight	190 kg

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