CAMERA PHOTOMETER

based on the Canon EOS 450D digital reflex camera

Applications

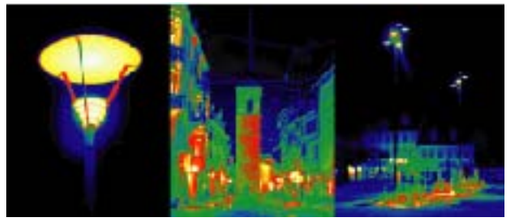
- Indoor measurements, for example in offices and desktop areas in offices.
- Fast and easy determination of luminances in outdoor areas. For example the illumination of public squares and places in the urban surrounding.
- Review the illumination on façades and of street lighting fixtures and other public traffic ways.

Components

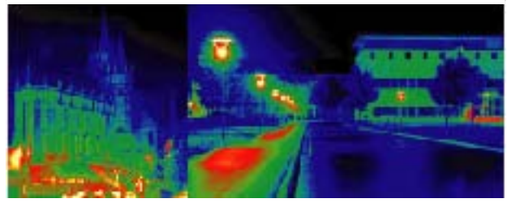
Lens	SIGMA 18-50mm F2.8 EX DC Macro (incl. lens hood and dust cover)
Transport	Mobility case Samsonite + carrying strap
	Transport case TechnoTeam
	Wide strap [EW-100DBII]
Power supply	2 Lithium-Ion accu [LP-E5]
	Battery charger LC-E5 or E5E + power plug
	AC adapter kit [ACK E5]
	Compact mains adapter [CA-PS700]
	+ power cord DC coupler [DR-E5]
Cable/Interface	Video cable [VC-100]
	USB Interface cable [IFC-200U]
Memory card	SDHC card 4GB
Software	EOS Digital Solution (CD ROM)
	LMK 2000
	measuring software (CD ROM)
Manual / Certification	Manual Canon EOS 450D
	Manual LMK mobile advanced
	Manual LMK 2000 Software
	Software manual (PDF)
	Calibration certificate
Optional	additional SDHC card
	Remote control RC-5
	Tripod

camera	Canon 450D (digital / reflex)
lens	Sigma 18-50mm F2.8 EX DC Macro

Obtain the parameters for glare and daylight (luminance, vertical and cylindrical illuminances, UGR, DGI, daylight quotient D, uniformity).



Glare rating on outdoor luminaires (luminance, vertical illuminance, veiling luminance, uniformity).



Evaluate the illumination of streets considering valid standards (luminance, vertical illuminance, lengthwise uniformity, TI-value).

Electronics

Sensor / Resolution	CMOS Canon APS-C with 4272(H) x 2848(V)
File format	14 Bit RAW - data with Bayer structure uncompressed
PC-Interface	USB 2.0
Luminance resolution	2136(H) x 1424(V)
Dynamic resolution	Single measurement: 1:4000
	High-Dyn measurement: 1:32000 (1/1250 s < ti < 8 s)

Configuration

Aperture values	F4 - F11 (calibrated) in 1/3 steps
Focus (measuring distance)	> ca. 130mm (automatic focus/manual focus)
Focal length / Viewing angle	focal length 18mm: 65°(H) x 45°(V)
	focal length 50mm: 28°(H) x 19°(V)

Light sensitivity (typical accuracy rating)

Blende	4	4	11
ISO	100	1600	100
t_i= 0,001 s	20 kcd/m²	1200 cd/m²	140 kcd/m²
t_i= 3,0 s	6 cd/m²	0,36 cd/m²	50 cd/m²

Exposure time	30 sec. - 1/4000 sec.
AEB	+/- 2 EV in 1/3 steps (manual)

Measurement parameter

Selection of measuring range — Selecting aperture, exposure time and und ISO - speed
V(λ)-matching — numerical transformation from R, G, B - sensor data
Calibration uncertainty △L in % — △L = 2,5%
Repeatability △L in %

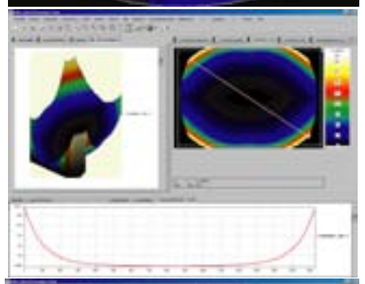
Ti\Av	4	5.6	8	11
0,25 ms	3,1	3,5	3,7	4.3
2,5 ms	1,5	1,8	2,0	2,7
25 ms	1,3	1,7	1,9	2,5
0,25 s	1,3	1,7	1,9	2,5
2,5 s	1,3	1,7	1,9	2,5

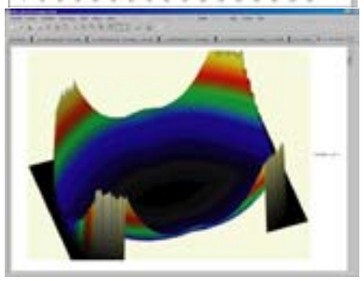
Uniformity △L in %
Measuring uncertainty △L in %
(for standard illuminant A)

△L = 2%

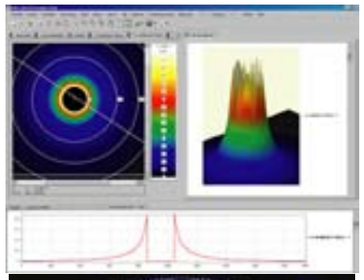
Ti\Av	4	5.6	8	11
0,25 ms	7,6	8,0	8,2	8,8
2,5 ms	6,0	6,3	6,5	7,2
25 ms	5,8	6,2	6,4	7,0
0,25 s	5,8	6,2	6,4	7,0
2,5 s	5,8	6,2	6,4	7,0

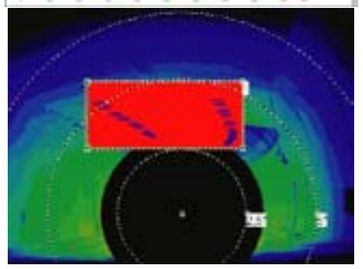
Duties





Glare assessment according UGR standard





Determination of the TI value for lighting fixtures

Operating data

Memory card	SDHC card
Operating system	Windows 2000/XP and Windows Vista
Measuring software	LMK 2000

VIDEO PHOTOMETER

IMAGING LIGHT AND COLOUR MEASURING TECHNIQUE

Introduction

The spatially resolved analysis of light sources and illuminated scenes is getting more and more important. The complex evaluation of those scenes requires to know the luminance distribution within the whole field of view or at least in many selected parts of it.
Solving the necessary measuring tasks by means of measuring devices working point by point either takes an enormous amount of time or is possible only within a coarse raster grid or is not possible at all. Thus, the development of spatially resolved radiation receivers, in particular CCD matrix cameras, has enabled the user to solve measuring problems such as measurements for glare evaluation according to the UGR method, the analysis of visibility conditions in the road traffic at night, immission evaluations of glare sources, the determination of contrasts in illumination situations (workplace) or directly on light sources (e.g. lamps/ luminaires, displays, night design, indicators).

- measuring of luminous and illuminated surfaces
- determination of luminous and background-lit symbols
- data for simulations in the development of lamps, luminaires and headlamps
- capturing of complex illumination and light distribution situations
- cataloguing and presentation

Advantages

- complex evaluation of luminous and illuminated scenes by means of the photograph of an imageresolved luminance distribution
- simultaneous recording of a big number of connected measuring data
- easy data analysis (at a glance)

Result data

- luminance distributions in measuring images L(x,y)
- derived lighting-engineering parameters such as illuminance distribution E(x,y) and luminous intensity distribution I(x,y)
- luminance data in various formats
- statistical data for being used in calculation programs (e.g. EXCEL®, MatLAB®, LabVIEW®)

Technical data

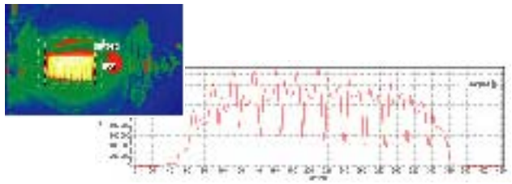
Sensor:	CCD - imaging matrix system	
Standard resolution	1380 x 1030 Pixel	
Higher resolution	2448 x 2050 Pixel	
	4008 x 2672 Pixel	
	4008 x 4008 Pixel	
Resolution (dynamic):	Single picture measurement:	1:1100 (~ 61 dB)
	Multi picture measurement:	1:3600 (~ 71 dB)
	High Dynamic measurement:	1:10000000 (~140 dB)
	A/D conversion:	12/14 Bit
Measurement time:	from 1 to 15 sec. for different luminances, depending on adjusted exposure time	
Measurement accuracy:	△L < 3 % (for standard illuminant A)	
	△x,y < 0.0020 (for standard illuminant A)	
Spectral matching	with full size filter matched to V(l)-function for measuring luminances	
	arranged with X(l)-, V(l)- and Z(l)-filter for measuring colour values; additionally C(l)-, V´(l)-, BLH (blue light hazard) and IR-filter are available	
	(all in all the filter wheel offers 6 positions)	

APPLICATIONS

Measuring luminance distributions

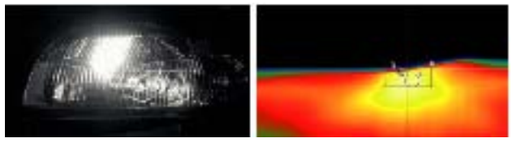
The measurement of luminance distributions L(x,y) allows the complex evaluation of numerous lighting-engineering devices. (lamps, luminaires, projectors and light control systems) as well as the evaluation of illumination scenes. The imaging luminance measuring technology provides the acquisition of both photometric parameters and geometrical data, thus allowing the user to determine further lighting-engineering quantities (luminous intensity, illuminance).
For describing lighting-engineering objects, not only simulation data but also various measuring data are necessary:

- description of luminous and illuminated surfaces of lamps and lighting fixtures by their luminance distributions L(x,y)
- glare assessment (e.g. according to the UGR standard)
- determination of contrasts and spatial contrast distributions
- determination of the illuminance distribution E(x,y) on illuminated surfaces (with diffusely reflecting Lambert characteristic) by means of the luminance distribution



Luminance distribution

Glare weighting on venetian blinds and sun shutters



Illuminace distribution

Measurement of colored LED's

Colorimetric measuring data

The imaging measurement and determination of colour and chromaticity values, for example of lamps and lighting fixtures, is gaining more and more importance. Using the LMK color camera adapted to the colour matching functions of the 2° standard CIE observer (CIE 1931) through a filter wheel, not only luminances can be determined but also tristimulus values. This permits the imaging measurement of chromaticity coordinates, which can be given in different colour spaces.
So it is possible to solve tasks a lot faster compared with classical colour measuring techniques. The following tasks can be cited:

- description of the colour distribution on luminous and illuminated surfaces and symbols by means of the chromaticity coordinates x,y
- determination of the dominant wavelength λ_{dom} and the correlated colour temperature (CCT in Kelvin) of LEDs and lamps

Night design

The cockpit and night design (automobile industry and its supply industry, avionics), offers manifold applications of the spatiallyresolved luminance and colour measuring technology.

- brightness and uniformity of symbol illuminations
- colour rendering of the functional illumination
- contrast distribution on displays

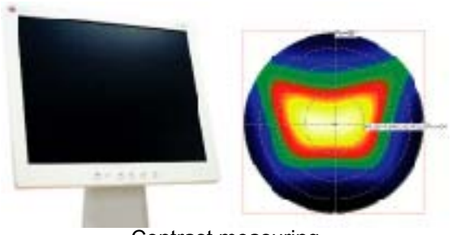
Symbol measuring

For this purpose, the TechnoTeam company has designed special software solutions for recording and evaluating low luminances of smallest symbols, for example with the symbol object for measuring the mean luminance using adaptive algorithms to determine luminance thresholds, thus offering a number of adapted solutions.

Display measuring

The imaging light and color measuring technology is exceptionally well suitable for analysing or also checking the rendering characteristics and quality features of monitors and displays.

- checking of the uniformity of background illumination according to existing standards
- control of the colour rendering characteristics on the basis of existing standards (e.g. EBU Tech. 3273)
- evaluation of the angle-dependent contrast distribution on displays (by means of a conoscopic lens)
- determination of defect pixels

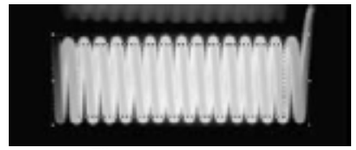


Contrast measuring

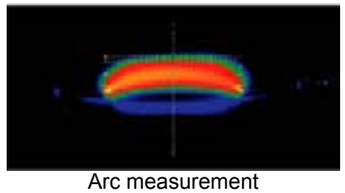
Measuring lamps and lighting fixtures

Regarding the development of lamps and luminaires, the imaging measurement offers a number of advantages.
The TechnoTeam company has designed software solutions which allow the lightingengineering evaluation of the measuring data with respect to characteristic values and guidelines to be simplified drastically.

- simple determination of the mean luminance of filaments and arcs (e.g. using the arc object according to ECE 99)
- imaging evaluation of local luminance maxima
- photographing of large lamps/luminaires by one shot documentation of time depending processes by means of a time-controlled series of shots



Filament measurement

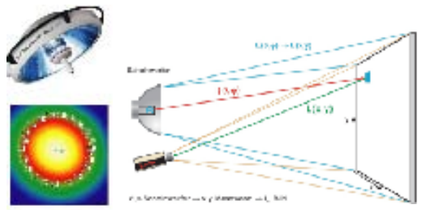


Arc measurement

Measuring headlamps

Being the supplier of measuring equipment for a big number of manufacturers of lighting and illumination devices and maintaining close contacts to its scientific environment, the TechnoTeam company has gained experience in handling both lowest and highest luminances, and is thus in a position to offer solutions adapted to very special applications.

- determination of the illuminance distribution on plane surfaces
- calculation of the luminous intensity distribution of the headlamp
- measurement of the colour scale and colour deviations, e.g. on bright and dark edges in the projected image of a headlamp
- verification and observance of guidelines for car headlamps by means of prescribed measuring points (e.g. HV; AK31; B50L and many more)
- automatic alignment on measurement grids and positioning of measurement spots (ellbow-point detection)



Determination of the LID
(luminous intensity distribution) of a headlamp

Exterior lighting - Streets and tunnels

The LMK measuring system is very well suited to make measurements in an urban environment in public places and streets in order to make data for the lighting design in cities available. Thus, for example, the system allows colour differences on claddings or also the efficiency of lighting installations in public places to be evaluated in a simple way.

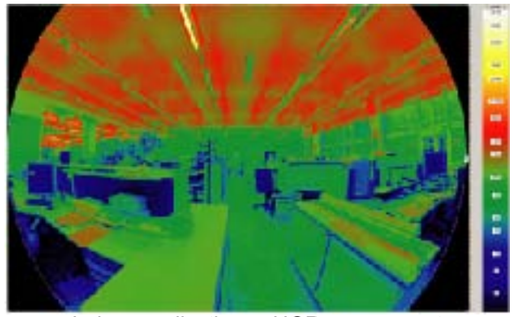
Outdoor applications

- Checking the brightness and colour rendering of large luminous boards and information carriers with regard to their perceptibility (e.g. contrast measurements)
- Glare evaluation, determination of the visibility distance of local lighting installations
- Determination of the luminance distribution according to DIN EN 13201 for streets and tunnels
- Checking the recognizability of roadway markings in varying weather conditions

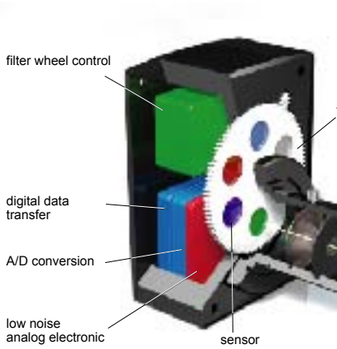
By means of the LMK 98-4 camera, it is possible to make street lighting measurements also out of a car in motion.

Interior lighting

The LMK measuring system allows spatially resolved measurements for verifying existing norms and design projects to be made in a simple and fast way with regard to full illumination, ergonomics and well-being.


Indoor applications - UGR assessment

- Evaluation of brightness distribution and colour of light in lighted rooms
- Determination of contrast and glare evaluation of window surfaces and video workstations located in the vicinity of windows (e.g. CRF measurement, UGR determination)
- Determination of the illuminance distribution with regard to ergonomic and economic aspects of workplaces; evaluation of circadian action potentials of artificial lighting with regard to the health and well-being of humans
- Checking existing norms for emergency and safety lighting



LMK models

The centrepiece of the LMK family is the luminance measuring camera type LMK 98. They use selected CCD sensors made by Sony or Kodak. The current model is the LMK 98-4 and the LMK 98-4 color.

With the release of these cameras both the design just as the electronic system of the LMK have been modified. The measurement system is much more compact. Furthermore, the operation of the LMK with a desktop PC or a notebook is possible, now as before.

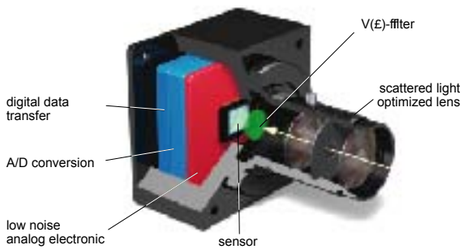
Based on the standard hardware of the LMK 98-4 and LMK 98-4 color the models LMK 98-4 simple and the LMK 98-4 color simple are offered. Their hardware components are similar to the standard systems and achieve the same measurement accuracy.

Further differences concerning the technical features of the LMK 98-4 simple and LMK 98-4 color simple cameras relate to the LMK software (refer to page 14 of the brochure).

For mobile applications, however, the LMK mobile advanced is available. It is based on the high-quality digital cameras of the Canon EOS series, which have been upgraded to suit this application purpose. Thus, the users have at their disposal a luminance measuring system which is easy to operate and which can be applied for solving mobile measuring tasks.

The luminance measuring camera LMK HighRes, equipped with 5, 11 or 16 megapixel sensor resolution, represents a solution for fields of applications which require a high 2D measurement resolution.

Also the LMK HighRes color with 5 megapixel sensor is now available.



MODELS

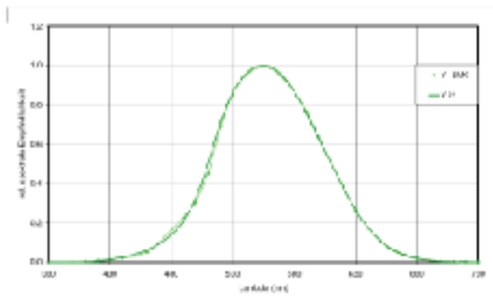
The LMK 98-4 is a high-tech digital CCD camera system equipped with a precise analogue electronic system for signal generation. Each camera is provided with a especially calculated and manufactured full filter in order to achieve a high-quality V(l)-adaptation for determining the luminance.

Additionally the LMK HighRes models with higher imaging resolution are on offer. The metrological specification of the 5 megapixel sensor is similar to the LMK 98-4. The technical details for systems with higher resolution can be found on page 10.


LMK 98-4

LMK 98-4 and LMK HighRes

Sensor	CCD Sony [ICX 285 AL (2/3")] effective Pixel [1380 (H) x 1030 (V)] CCD Sony [ICX 655 AL (2/3")] effective Pixel [2448 (H) x 2050 (V)] [12 Bit digital, progressive scan]
Dynamic range	Single picture measurement (SinglePic) [1:1100 (~61 dB)] Multi picture measurement (MultiPic;10 pics) [1:3600 (~71 dB)] High Dynamic measurement [1:10000000 (~140 dB)]
Data transmission	CameraLink interface (standard: 5m PC connection cable; other lengths can be made available on request)
Metrological specifications	V(l) [f´1 < 3.5%[1]]
Measuring quantities	Luminance [L (cd/m²)] Further measuring quantities can optionally be defined via scaling factors.
Measuring range	Setting the luminance measuring ranges by choosing the integration time from 100 µs...15 s Accuracy rating depending on lens (aperture number = k), e.g.: 1ms ...appr. 1800 cd/m² & 3s ...appr. 0.6 cd/m² (k = min.) 1ms ... 60000 cd/m² & 3s ... appr. 20 cd/m² (k = max.) Higher luminances can be achieved using optional neutral density filters.
Calibration uncertainty[2]	fix focused lenses DL [< 2%] focusable lenses DL [< 2.5%]
Repeatability[3]	ΔL [< 0.1%]
Measuring accuracy	DL [< 3% (for standard illuminant A)]
Uniformity	DL [< 2%]
Fields of application	laboratory measurements, field measurements, industry automation


Spectral matching of the LMK 98-4

1 Measurements according to DIN 5032 Part 6/CIE Pub. 69

2 Calibration according to DIN 5032 Part 6 using a luminance standard led back from the Physical-Technical Federal Institute

3 Measurement performed on a stabilized white LED light source L=100cd/m². Mean value over 100 Pixel; repeatability as variability of the mean value.

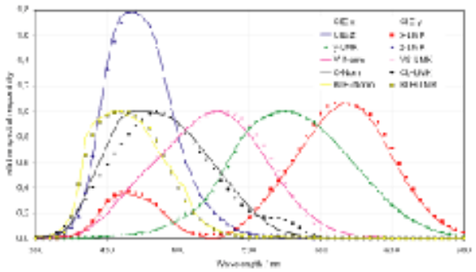
MODELS

The LMK 98-4 color is equipped with a filter wheel for colour measurement, adapted to the CIE colour matching functions of the 2° standard observer (CIE 1931). Thus, luminances and colour coordinates can be measured in a spatially resolved way.

The filter wheel permits a total of 6 filters to be incorporated, with 4 filters being necessary for colour measurement. In addition, the measuring system can also be equipped with filters for the scotopic luminance V´(l), the circadian function of action C(l), an IR-filter (measurements in the NIR range 780-1000 nm), a BLH (blue light hazard), or a clear glass filter.

Additionally the LMK HighRes color equipped with the 5 megapixel for a higher imaging measurement resolution is on offer. The metrological specification of this camera is similar to the LMK 98-4 color type.

LMK HighRes color


Spectral matching of the LMK HighRes color and LMK 98-4 color

LMK 98-4 and LMK HighRes

Sensor
CCD Sony [ICX 285 AL (2/3")]
effective Pixel [1380 (H) x 1030 (V)]
CCD Sony [ICX 655 AL (2/3")]
effective Pixel [2448 (H) x 2050 (V)]
[12 Bit digital, progressive scan]

Dynamic range
Color High Dynamic measurement
[1:10000000 (~140 dB)]
High Dynamic measurement [1:10000000 (~140 dB)]

Data transmission	CameraLink interface (standard: 5m PC connection cable; other lengths can be made available on request)
Metrological specifications	V(λ) [f'_1 < 3.5%[1]]; X(l) [f^*_1 < 4%] Z(λ) [f^*_1 < 6%]; V´(l) [f^*_1 < 6%]
Measuring quantities	Luminance: L (cd/m²), chromaticity coordinates: x,y, Supported colour paces: RGB, XYZ, sRGB, EBU-RGB, User, Lxy, Luv, Lu'v', L*u*v*, C*h*s*uv, L*a*b*, C*h*ab, HIS, HSV, HSL, WST[2] Further measuring quantities can optionally be defined via scaling factors.
Measuring range	Setting the luminance measuring ranges by choosing the integration time from 100 µs...15 s Accuracy rating depending on lens (aperture number = k), e.g.: 1ms ...appr.7500 cd/m² & 3 s ...appr. 2.5 cd/m² (k = min.) 1ms ... 60000 cd/m² & 3 s ...appr. 20 cd/m² (k = max.) Higher luminances can be achieved using optional neutral density filters.
Calibration uncertainty[3]	fix focused lenses ΔL [< 2%] focusable lenses ΔL [< 2.5%]
Repeatability[4]	ΔL [< 0.1%] Δx,y [< 0,0001]
Measuring accuracy	ΔL [< 3% (for standard illuminant A)] Δx,y [< 0.0020 (for standard illuminant A)] Δx,y [< 0.0100 (set of test colours)[5]]
Uniformity	ΔL [< 2%]
Fields of application	laboratory measurements, field measurements, industry automation

1 Measurements according to DIN 5032 Part 6/CIE Pub. 69
2 Dominant wavelength, saturation, correlated color temperature
3 Calibration according to DIN 5032 Part 6 using a luminance standard led back from the Physical-Technical Federal Institute
4 Measurement performed on a stabilized white LED light source L=100cd/m². Mean value over 100 Pixel; repeatability as variability of the mean value.
5 Measured value based on 30 test colors with different spectral distributions based on ROSCO color filters


LMK HighRes with 11 megapixel sensor

MODELS

TThe LMK HighRes 11/16MP are monochromatic luminance measuring cameras equipped either with an 11 or 16 megapixel CCD sensor made by Kodak.
All LMK HighRes systems are adapted to the spectral luminous sensitivity of the human eye by means of a V(l)-filter for the CCD chip.

LMK 98-4 and LMK HighRes

Sensor	CCD Kodak [KAI-11002/16000M, square pixel] active Pixel [4008 (H) x 2672/4008 (V)] [10 Bit digital, progressive scan (1-3 fps)]
Dynamic range	Single picture measurement (SinglePic) [1:1100 (~61 dB)] Multi picture measurement (MultiPic;10 pics) [1:3600 (~71 dB)] High Dynamic measurement [1:10000000 (~140 dB)]
Data transmission	CameraLink or GigE® interface (standard: 5m PC connection cable; other lengths can be made available on request)
Metrological specifications	V(λ) f'_1 < 3.5 %[1]
Measuring quantities	Luminance [L (cd/m²)] Further measuring quantities can optionally be defined via scaling factors.
Measuring range	Setting the luminance measuring ranges by choosing the integration time from 1 ms ... 15 s Accuracy rating depending on lens (aperture number = k), e.g.: [1 ms ...appr. 6000 cd/m² & 3 s ...appr. 2 cd/m²] Higher luminances can be achieved using optional neutral density filters.
Calibration uncertainty[2]	focusable lenses: ΔL [< 2.5%]
Repeatability[3]	ΔL [< 0.1 %]
Measuring accuracy	ΔL [< 3% (for standard illuminant A)]
Uniformity	ΔL [< 2%]
Fields of application	laboratory measurements, field measurements, industry automation

1 Measurements according to DIN 5032 Part 6/CIE Pub. 69
2 Calibration according to DIN 5032 Part 6 using a luminance standard led back from the Physical-Technical Federal Institute
3 Measurement performed on a stabilized white LED light source L=100cd/m². Mean value over 100 Pixel; repeatability as variability of the mean value.

MODELS

The application of high-quality digital cameras in the LMKsystem allows an easy and fast capture of luminance images without depending on your measuring computer. For evaluating the images, the complete functionality of the LMK LabSoft software can also be utilized.

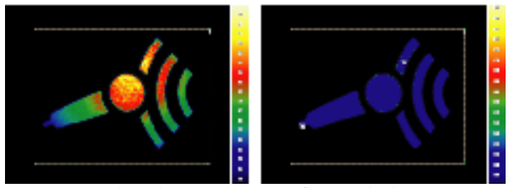
With the already existing systems type LMK mobile and LMK mobile advanced, of which more than 100 have
been sold so far, the TechnoTeam company can rely on excellent know-how and many years of experience in the field of luminance measuring technology. The second generation of mobile luminance measuring cameras represented by the LMK mobile advanced system is based on models of the Canon EOS series.

Ti\Av	4	5.6	8	11
0.25 ms	3.1	3.5	3.7	4.3
2.5 ms	1.5	1.8	2.0	2.7
25 ms	1.3	1.7	1.9	2.5
0.25 s	1.3	1.7	1.9	2.5
2.5 s	1.3	1.7	1.9	2.5
				Repeatability accuracy ΔL in %

Ti\Av	4	5.6	8	11
0.25 ms	7.6	8.0	8.2	8.8
2.5 ms	6.0	6.3	6.5	7.2
25 ms	5.8	6.2	6.4	7.0
0.25 s	5.8	6.2	6.4	7.0
2.5 s	5.8	6.2	6.4	7.0
				Measuring accuracy ΔL in % (for standard illuminant A)

LMK mobile advanced

Sensor	CMOS Canon APS-C 4272(H) x 2848(V) effective pixel (resolution of the luminance image) 2136(H) x 1424(V) 14 Bit RAW - data with Bayer structure, uncompressed
Dynamic range	Single picture measurement (SinglePic) [1:4000 (~60 dB)] High Dynamic measurement [1:32000 (1/1250 sec. < ti < 8 sec.)]
Data transmission	USB 2.0 and/or SD/SDHC memory card
Metrological specification	Spectral matching [numerical weighting of the RGB tristimulus values (multiplying matrices)]
Focal length / Visual field angle	Focal length 18mm: 65°(H) x 45°(V) Focal length 50mm: 28°(H) x 19°(V)
Measuring range	Selecting aperture, exposure time and ISO speed.
Calibration uncertainty	ΔL [2.5%]
Uniformity	ΔL [< 2%]
Fields of application	laboratory measurements field measurements



Luminance image of a symbol

SOFTWARE

LabSoft

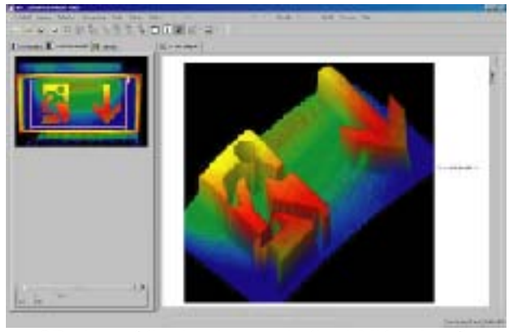
Additionally to all camera systems of the LMK family, the LMK LabSoft is supplied.
The measuring software offers a big number of possible applications when using the luminance measuring systems, as well as for data evaluation and processing.

Ease of operation is guaranteed to the user through the integration of task-specific capture functions.

SinglePic-capture - permits a luminance image to be taken very quickly.
MultiPic-capture - permits the repeated capture of several single images so as to eliminate statistical measuring errors through averaging.
HighDyn-algorithm - permits the capture of a luminance image composed of single images at various integration times so as to realize a higher dynamic range.

For the visualization of the measuring results, the user can choose, among other things, from a freely scalable pseudocolouring as well as several logarithmic representations. Pre-made and freely scalable point, line, circular and rectangular cursors permit the measuring data to be accessed in a quick and flexible way. The defining of measuring regions by means of geometrical basic shapes facilitates evaluation. In addition, they provide many auxiliary means for the statistical evaluation of the data (tables, sectional diagrams, histograms, and photometric evaluation algorithms). Furthermore, the software offers a function for an automatical detection of regions by means of luminances. This is both useful and advantageous for detecting complex geometrical structures.

The report function for an export of measurement data and evaluation results to MS Word® and MS Excel® is a simple and comfortable possibility for the communication and the sharing of measurement data with others. Furthermore, they offer the advantage of a standard or individual printing template to create a printing report.

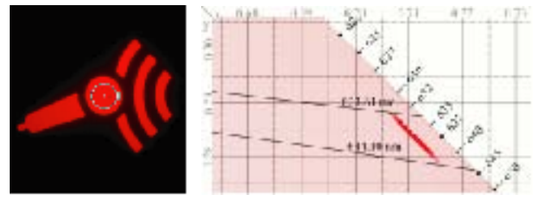


3D view of the luminance in the LMK Labsoft

The LMK LabSoft software provides a big variety of data formats for the export and import of image and measuring data, for example for MatLAB®, LabVIEW® and SPEOS®. The data exchange with Microsoft Office® products and other software programs is enabled by the functions of the Windows® clipboard.

Enhanced software package for colour capture

With the LMK LabSoft color the complete functionality of the luminance measuring software LMK LabSoft is available for the assessment of chromaticity values out of three channel colour images. The measured X,Y,Z colour values can be converted into different colour spaces (e.g. RGB, XYZ, sRGB, EBU-RGB, Lxy, Luv, L*a*b*, HIS, HSV). In case of measuring LEDs or lamps a colour space showing the dominant wavelength, the colour saturation and the correlated colour temperature is available. It is possible to calculate colour distances and colour differences in several colour spaces. Among to the standard graphical forms of showing measured values in graphs and diagrams (in three channels) the chromaticity coordinates can be represented in a colour space diagram (e.g. horse shoe view), which shows the colour gradient and statistical accumulation points.

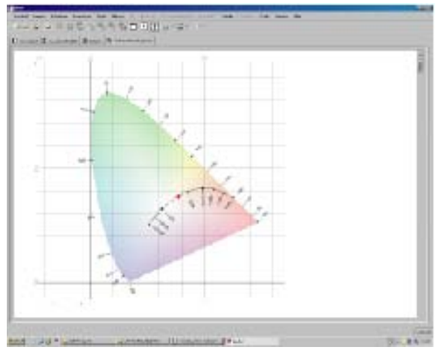


Colour evaluation of a backlit symbol (point density mode)

With the new colour symbol object - chromaticity coordinates can be matched to their luminance levels. So it is easier to detect regions for a colorimetrical evaluation (e.g. backlit symbols) with respect to a luminance threshold.

The user can exert an influence on the calibration data and change the algebra of matrices. So it is possible to adjust the LMK system for an own colour space or for balancing the LMK system with own reference quantities. In this way the spectral matching can be adapted to specific measurement tasks (e.g. LED measurements).

Throughout the measurement in several channels X, Y, Z and V´(λ) and optional C(λ) or BLH (Blue Light Hazard) and the subsequent image processing different radiation measurements for different perception models can be made (e.g. mesopic brightness perception).



Chromaticity diagram in LMK LabSoft color

Display of the colour symbol object

Versions of the LMK LabSoft

LMK LabSoft

With the new measurement and evaluation software LMK LabSoft TechnoTeam provides the consistently ongoing development of the well proven LMK 2000 software. As a result of an intensive exchange of experience with our customers we could enhance our evaluation functionalities. Also the usability is optimised and partly completely overdone. Thus the functionalities for the documentation and the reporting of the measurement results are now totally compatible with MS Office®.
Furthermore the new embedded TCL script language allows the recording and linking of often used functionalities. Thus the automation of complete working procedures is possible.

LMK LabSoft simple

The LMK simple package is offers a measurement system which includes the known camera hardware in combination with only essential software components at a lower price. Therefore, all video photometer systems can be equipped with the LMK LabSoft simple software. This software is reduced to several selected basic functionalities.
Based on the standard hardware of the LMK video photometer systems, one for the application optimized lens is mounted. The package LMK simple comes in principle with only one free configurable standard lens.

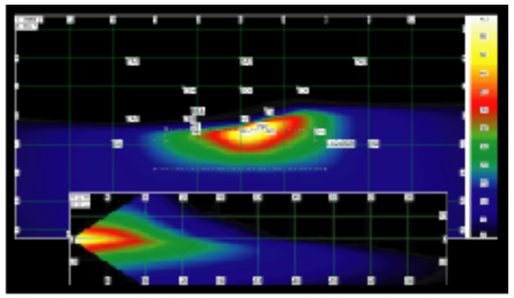
LMK LabSoft extended

With this version of the LMK LabSoft software the possibilities for an interaction and automation of the image processing procedures is rapidly increased. By using an ActiveXÒ Interface the LMK LabSoft and their essential functionalities can be controlled by several other software applications. The assessement of the image and measurement data can be done directly via the host application. Therefore, the integration of the software into an existing workflow is no problem.
Furthermore, a new interface provides the possibility to use over 200 algorithms especially developed by TechnoTeam from the field of industrial machine vision and image processing in the LMK LabSoft software. Thus it is possible to solve complex issues in uncommon and specific fields of action with one specific software solution in one click. Such software solutions will be provided by TechnoTeam on request.

Software functionality	LMK LabSoft simple	LMK LabSoft
Live image	X	X
Exposure adjustment	X	X
Image capture		
'SinglePic'-image	X	X
'MultiPic'-image	X	X
'HighDyn'-image	X	X
Color 'HighDyn'-image	X	X
Capturing modulated light	X	X
Live Luminance and Live HighDyn		X
Capturing measurement series (manual, time controlled, mechanical controlled)		X
Representation of images (Pseudo-colours, ISO colours, scaling)		X
Working with images (load, save, delete, copy, print)		X
Displaying measuring values by means of cursors (standard, rectangle, circle, line, circular ring, cross, zoom)		X
Measurement regions (load, save, copy, paste, group, print)		X
Measuring value indication using inspectors		
Standard statistics (standard evaluation, histogram, sectional view, time statistics, luminance object, integral object, symbol object, arc object, filament object)		X
Report function (create, load, save, print)		X
Evaluation images and image processing		
Additional evaluation images	1	N
Physical parameters and units	X	X
Assigning list of regions		X
Assigning image tab windows		X
Image arithmetics		X
Coordinate transformation		X
Projective rectification - orthophotographs	X	X
ISO lines in luminance images	X	X
Colour images and colour metrics		
Colour space and measuring values	X	X
Calculation of colour differences	X	X
Decomposition of colour images into colour extract images		X
Composition of colour extract images into colour images		X
Test colour images		X
Measurement protocols (create, load, save, comments)	X	X
Automation via TCL-Macro and Active X		
Recording of TCL - Macros		X
Running of TCL - Macros	X	X
Active X programming interface	X	X
Extras		
motor control, photometer control, conoscopic lens, LVK measurement and many more		X

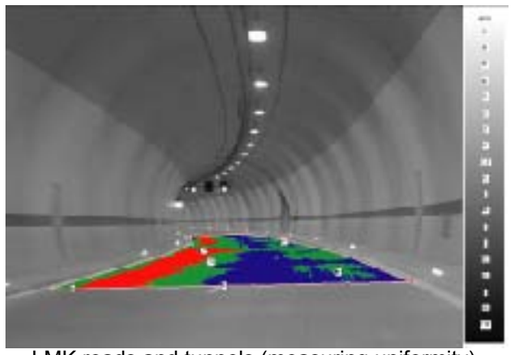
User-related solutions

A number of specific features of the LMK LabSoft software have been developed to satisfy customer wishes. So for specific measuring tasks, a number of various additional modules for the LMK LabSoft software are available.
On the basis of its technical know-how, the TechnoTeam company will provide customerspecific solutions in the future.

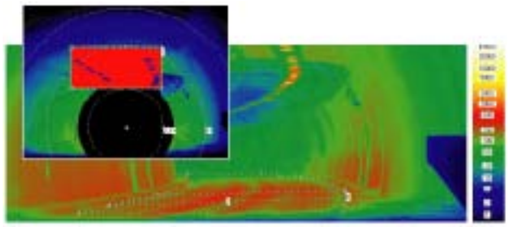


LMK illuminance distribution on road (above) and LiD (below)

- LMK LabSoft Headlamps means an extended version (or additional module) which permits the corresponding illuminance image and also the LiD (luminous intensity distribution curve) to be calculated from the original luminance image captured by means of the LMK camera. Here, the illuminance can be determined either on a plane (e.g. on a projection wall located at a distance of 10 m) or on a hemisphere (e.g. 25 m radius for ECE). Furthermore, the conversion into the illuminances prevailing on the road is provided as an additional option particularly for the automobile sector.
  Headlamps emit light over very large angles, sometimes even over the entire half-space. In most cases, only much smaller angles can be captured in one image. So, several partial images captured at different angular ranges can be put together to form one complete image.



LMK roads and tunnels (measuring uniformity)



LMK glare assessment (Ti und Ls)

- LMK LabSoft Roads and tunnels, is an additional package supplied by means of which street lightings can be measured in a fast and easy way. The user is able to acquire all parameters necessary for the DIN EN 13201 standard by one single capture. The measured luminance values will then be processed by the software for further use.

- LMK LabSoft Glare evaluation contains a data package which allows the fast and easy assessment of some essential glare parameters. Using the software, the user is able to determine important quantities such as the vertical illuminance, the solid angle of the glare source, and the veiling luminance according to common standards.
  These glare quantities are the basis for parameters such as UGR; DGI; TI, etc.

ACCESSOIRES

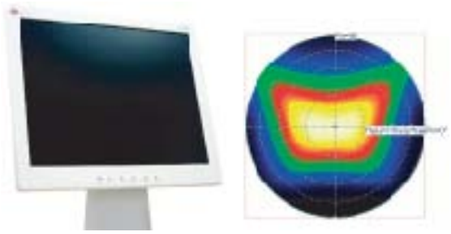
Lenses

Various focusable standard lenses with a fixed aperture for different focal lengths f´= 8 mm, 16 mm, 25 mm, 50 mm and 75 mm are on offer. These lenses are nearly flarefree. They are set and optimized by us for the concrete application. For an integration time of 3 sec., the sensitivity of these lenses is up to 1 cd/m² measurement range end value. Furthermore, all those lenses can be ordered with a fix focus for fixed measurement distances. For small object fields a telecentric macroscopic lens (Macro) is available. Furthermore, this lens can be adapted to the measuring field via various distance rings.

Fisheye lens and half space image

Special imaging systems

The semi spherical lens allows the capture of an object field at a field angle of ±92°. This lens can be used for capturing complex illumination situations, for example in the case of the evaluation of interiors. For determining the radiation characteristics of small fields, for example for determining the angle-dependent contrast of displays, a conoscopic lens is offered which can be used to record the luminance within an angular range of ± 60°.



Conoscopic lens and conoscopic image

Neutral density filters

ND-filters with different transmissions ranging from 0.5 ... 0.00001 enhance the measurement range of the CCD camera to be increased for the measurement of very high luminances.

aperture (f=mm)	min. measuring distance[1] (mm)	least field of view (circa)	least field of view (mm x mm)	field of view with a distance of 500 mm	field of view with a distance of 1000 mm
8	500	60°(H) x 56°(V)	520 x 390	520 x 390	1125 x 845
16	185	30°(H) x 22°(V)	85 x 64	270 x 203	540 x 407
25	220	20°(H) x 15°(V)	58 x 44	160 x 120	360 x 275
50	280	10°(H) x 7°(V)	32 x 23	75 x 56	160 x 120
75	565	6°(H) x 5°(V)	52 x 39	-	105 x 78

telecentric macro lens with distance ring	measuring distance[1] (mm)	field of view (mm x mm)	depth of focus (mm)
0 mm	160	14 x 10	± 0.3
+ 10mm	160	10 x 8	± 0.2
+ 20mm	160	7 x 6	± 0.15
+ 30mm	164	6,5 x 5	± 0.15
+ 40mm	169	5 x 4	± 0.1

Further lens solutions with other viewing types can be realized on request.

1 measuring distance = lens - leasing edge of camera

ACCESSOIRES

LED normal

With the LED normal the TechnoTeam company offers coloured luminance standards based on LED. The stability of the luminance is realized through the controlled constantcurrent operation of selected 5 mm LEDs. Here, the closed-loop system is controlled by a spectrally matched photodiode, with the LEDs being thermally stabilized by a Peltier device.

- high stability of the luminance (< 1%/100h)
- high stability of the dominant wavelength / colour (<1nm/100h)
- stable function irrespective of the room temperature (10°C bis 30°C)
- homogeneous luminance over the emergence surface (<2% inhomogenity)
- standard equipment in (red, green, blue, yellow, orange, white)

In addition to the standard colours, also other colours can be supplied on customer's request. For this, the customer shall select, in cooperation with the TechnoTeam company, the type of LED of an equivalent 5mm-LED. For each LED normal TechnoTeam provides a certification for the factory calibration. For the traceability of the photometric data of the LED luminance standards it is possible to calibrate the devices at a national metrology institute (e.g. PTB (D) or METAS (CH)). For each LED normal the following data will be certified: luminance L and chromaticity coordinates x,y.

Evaluation computer

For operating the LMK LabSoft software, the minimum hardware requirements are:

- Intel Pentium III min. 1.3 GHz 1 GB RAM
- CD-ROM, >100 GB E-IDE hard disc
- available PCI expansion slot for LMKframegrabber (Notebook with PCMCIA or PCI Express Interface)) or Ethernet adapter for GigE Vision™
- WINDOWS 2000 or higher

TechnoTeam recommends sufficient testing of the PCs to be used. If necessary, the customer may obtain from TechnoTeam advice on the currently available makes.

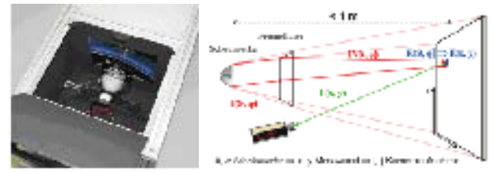
LED normal with different colours

Principle of the LED normal

AUTOMATION

Compact measuring box

The KMP is a mobile solution for the indirect measurement of light without a specially adapted laboratory room. The KMP has 2 chambers. A reflective wall and an aperture are fixed in the measuring chamber. In the object chamber (archetype chamber) there is a fixed mounting for head-lights as well as the fixed positioned measuring camera.
The LiD (luminous intensity distribution) of the headlight will be imaged on the reflective wall placed in the focal plane of the imaging system of the KMP .
Between the two chambers an optical system is located. This optical system (lens) cuts the measuring distance to a shorter distance (e.g. outer dimension L x W x D: 95cm x 50cm x 43cm). According to the path of rays on the imaging side of the optical system the light source to be measured is virtually placed at an infinite distance. Therefore, the system works in compliance with the photometrical border distance.
The luminance image is measured with an LMK. Thus with the illuminance the luminous intensity distribution can be calculated.



KMP (compact measuring box)

Symbolchecker

The Symbolchecker is a semi-automatic stand-alone system for quality management in the production of backlit symbols (e.g.switches and dashboard instruments).

- Average of luminance as an average value for the automatically detected complete backlit symbol
- Uniformity: is calculated with the minimum, average value and maximum of the luminance within the symbol, determined with a measuring spot of 3 x 3 pixel size.
- Position: as the average of the segment centroids, calculated out of the contour of the segment. The determination of the contour is sub pixel exact.
- Structure width: means a geometrical measurement of symbol segments with parallel outer lines. With the calculated distances over an iterative calculated average value (eliminating the values with the largest difference from the current average value) the structure width of the symbol is determined.
- Symbol quality: means the percentage matching of the symbol with the pattern recognized.

Symbolchecker

SOFTWARE

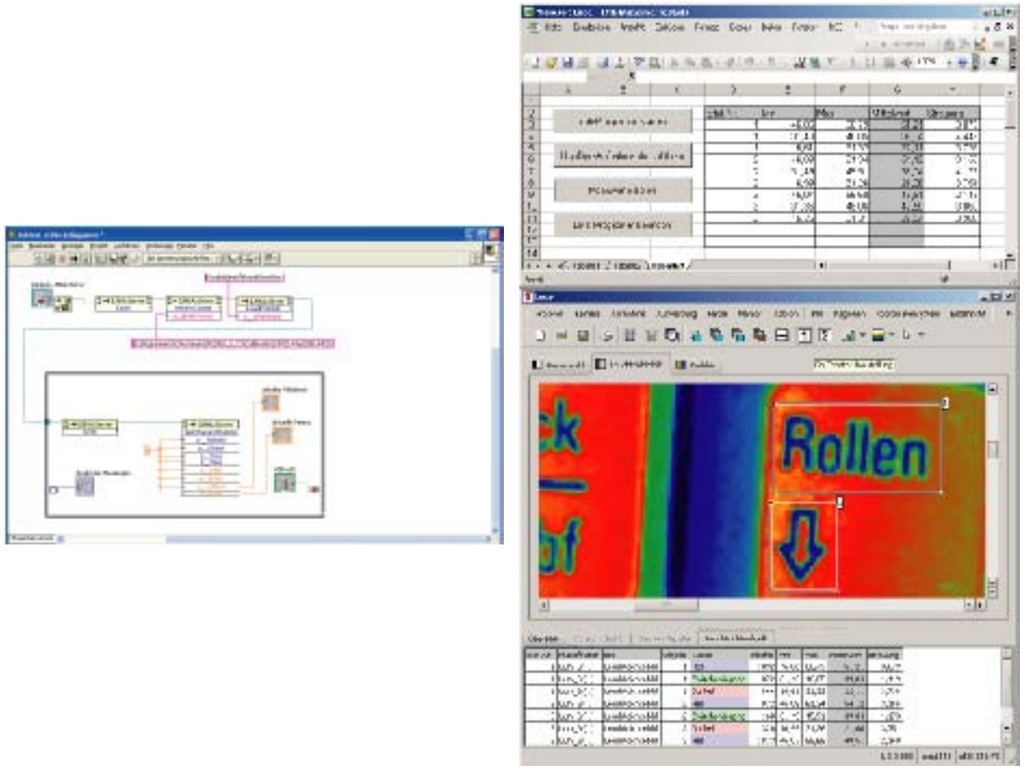
Programming interface LMK LabSoft extended

The LMK LabSoft extended has an ActiveXÒ-interface available and can be controlled by a host application with ActiveXÒ capability (e.g. MS ExcelÒ, LabViewÒ). In this way it is possible to use the functionality of the LMK LabSoft as a server for other applications.

All capturing modes will be provided: capturing Live camera images; SinglePic-, Multi-Pic- and HighDyn-algorithm for the capturing and calculation of luminance images; Color-HighDyn-algorithm for calculation of colour values by using a TechnoTeam colour filter camera.

By using the interface all statistical operators (e.g. luminance, integral and symbol object) are available. So directly after the image capturing the currently measured data can be imported into the host application (e.g. Excel spread sheet analysis). In addition it is possible to open and save already prepared protocol files with parameterised statistic objects via ActiveX®.

Furthermore it is possible to run self-made TCL script macros, which are prepared and saved with the LMK LabSoft beforehand, via ActiveXÒ from the host application.
On customer request it is possible to extend the interface to all functions of the functionality provided in the interactive use of the LMK LabSoft.



Automation and control of the LMK LabSoft via ActiveX®

IPED LED checker (OLED checker)

Production-accompanying measuring technique for LED and LED assembly groups

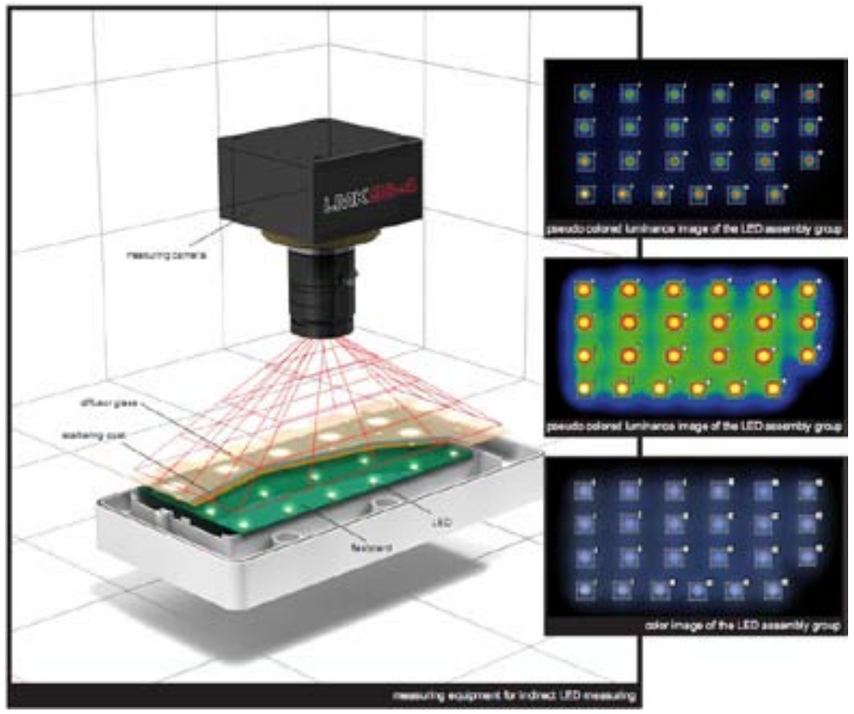
LEDs are becoming increasingly important in different fields of architectural illumination, for lighting fixtures and for the automotive industry. Because they are small and easy to combine, LED assembly groups are used very often. There are practically no restrictions concerning their design, so many different arrangements are possible. Nearly the same applies to OLEDs.

To get photometric data of the (O-)LEDs, a well adaptable measuring system is necessary. It must be able to capture high dynamic images for different areas of color spaces as well as for different light intensities/ luminances. Moreover it must be able to determine intensity gradients and also the uniformity of light sources for both assemblies and single LED symbols.

All this information can be determined by means of an imaging photometer or imaging colorimeter within fractions of a second. In addition, there are image-processing operations specially adapted to these problems. For example (O-)LEDs in the picture can be detected and separated automatically.

Measuring principle

Depending on the specific application, (O-)LEDs can be measured either directly or indirectly. The measuring principle for the indirect measurement is shown in the following figure.



Here, a diffusing screen is mounted at a suitable distance to the LED assembly. The luminance and chromaticity coordinates can then be measured on this screen.

There are applications just as emergency lights, where especially the single results of each LED compared with one another are of interest. So, it has to be checked whether all LEDs have a minimum of intensity (luminance) and also that the color distance between the LEDs is within a predefined tolerance.

The luminance distribution of the single LEDs contains some important information:

- The luminance and the size of the light spot provides information about the partial luminous flux.
- From the coordinates of the “light spot”, both the position of the LED or also a certain “squint” of the LED can be concluded.

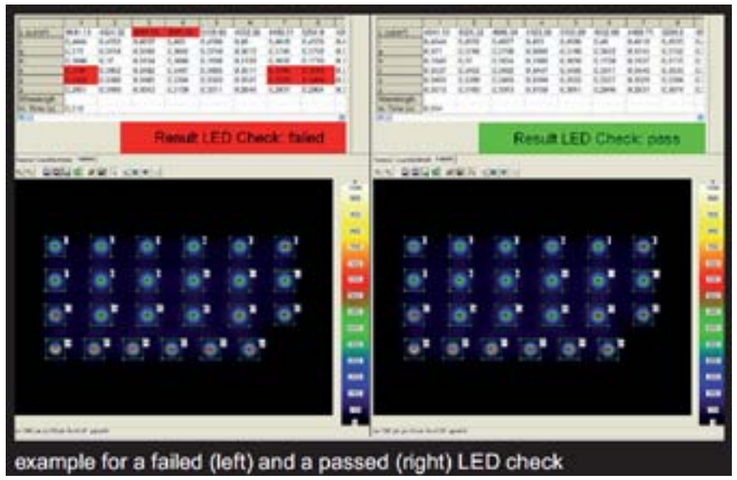
The use of a color camera does not only permit the brightness to be measured, but also the color in an imaging manner:

- color differences occurring within the radiation of a single LED can be detected (e.g. in the case of white LEDs).

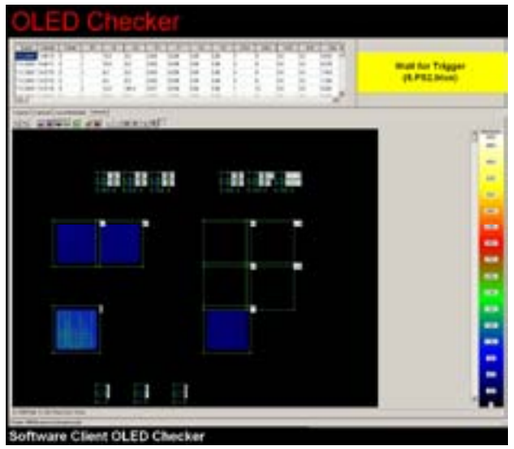
TSC
www.toptical.com.tw 02-2346-1510 toptical@ms17.hinet.net

Software client

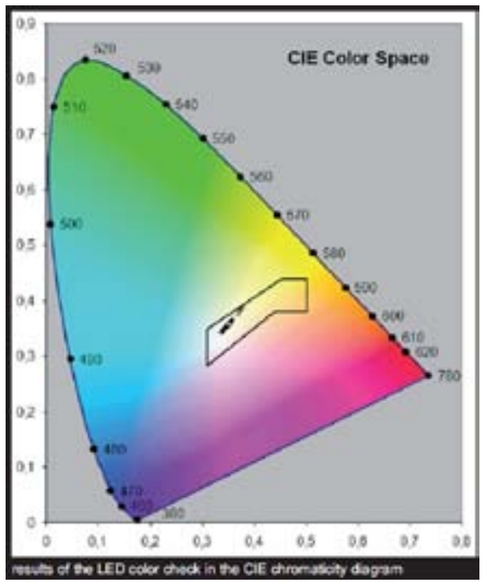
The LED Checker package contains also several interfaces for the communication with a process control system.
Results represented in the software user interface or the data can be optionally transferred to external protocol files and programs.



example for a failed (left) and a passed (right) LED check



Software Client OLED Checker



results of the LED color check in the CIE chromaticity diagram

NEAR-FIELD GONIOPHOTOM ETER

RIGO 801

The full determination of the data of luminaires and lamps becomes more and more important:

- Primary prerequisite of a correct illumination planning
- Simulation, development of luminaires and lamps
- Cataloging and presentation

The goniophotometer type RIGO 801 utilizes a new image-resolving CCD measuring technique for determining ray data and luminous intensity distributions. The correct determination of the luminous intensity distributions (LVK) of lamps and luminaires is performed far within their photometric limiting distance on the basis of image-resolved measurements of luminous intensity distributions. A CCD-camera is moved by a goniometer around the measuring object at rest on a spherical surface, with the radius of this sphere being fixed only by the field angle of the camera. Thus, the goniometer can also be installed in small laboratories. Anordnung zur Messung der Lichtstärkeverteilungen von Leuchten und Lampen Gebrauchsmuster DE 297 06 488.6 v. 11.04.1997

Poschmann, R.; Riemann, M.; Schmidt, F.; Verfahren und Anordnung zur Messung der Lichtstärkeverteilung von Leuchten und Lampen; Patent DE 41 10 574 v. 30.3.1991

Advantages

Full description of the light emission by ray data
Small dimensions of the set-up
Measuring in normal position

Result data

Luminous intensity distributions (LID)
Ray data available in various formats (e.g. ASAP, SPEOS, RWR, Lucid- Shape, LightTools, Zemax)
Processing and archiving of the LVK data in a photometric database (LumCAT)

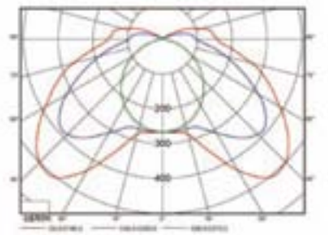
Technical data

Type of the goniophotometer
Image-resolving according to Prof.
Riemann
Dimensions
Appr. 3L*3L*3L
L: max. luminaire/lamp dimension
Min. distance between the C-layers 0.1°
Min. distance between the radiation angles 0.1°
Measuring time
Appr. 25 min. for 2.5° x 2.5°
Camera
CCD – digital camera (Kappa) LMK98-2, 13bits, V(λ) - filter
Illuminance meter
Digital 18Bit, V(λ) – adapted

Measurement of photometric objects

The measurement of photometric objects turns out to be necessary for various tasks:

- With respect to developmental aspects, the influence of modifications must be determined. The aim is to optimize the photometric parameters.
- Luminaires and lamps themselves are only components of a complete illumination system or of devices. For calculating such devices or systems, data are required which describe the luminaires/ lamps.
- Descriptive data must be made available for marketing the products.

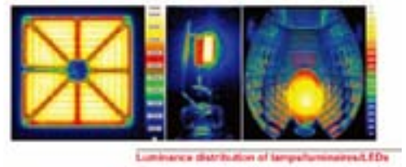


LID – point characterization

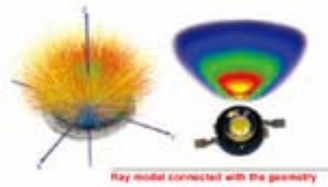
Photometric measuring data

For describing photometric objects, not only simulation data but also various measuring data are necessary:

- Light-emitting characteristic data of luminaires/lamps (LIDs, spectral characterization; object assumed to be a point)
- Description of the luminous surfaces of luminaires/lamps (luminance distributions)
- Light-emitting characteristic data of geometrically expanded luminaires/ lamps (4D-luminance distribution, ray distribution in the space)
- Energetic description of the luminaires/ lamps (efficiency ratio, power input, temperature behavior)



Luminance distribution of lamps/luminaires/LEDs



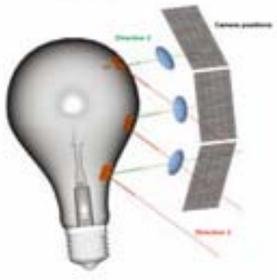
Ray model connected with the geometry

Its place in photometry

The photometric data of luminaires/lamps are measured by different types of measuring devices. In doing so, the radiation of light of luminaries is recorded on the basis of an evaluation from different observation directions.

The various measuring devices differ from each other in the following points:

- Either the measuring object is moved in order to set a defined radiation direction with regard to the photometric receiver, or the photometric receiver is moved in order to set a defined observation direction.
- Either only one photometric receiver is utilized which is positioned at a sufficiently large measuring distance (beyond the photometric limiting distance), or space-resolving or direction- resolving receivers are utilized which are positioned at a short measur ing distance.



The following conventional types of measuring devices for determining photometric parameters can be classified:
A Goniophotometer with rotating mirror
B Goniophotometer based on luminance measuring cameras
C Goniophotometer with long measuring arm
D Luminaire rotator
Only type B, goniophotometer based on luminance measuring cameras, is able to generate measuring data for the radiation characteristics of geometrically expanded measuring objects for the calculation in the near field just as for the evaluation of luminance distributions on objects.
The measuring data of the luminous intensity distributions (LIDs) can be saved in all common file formats (EULUM-DAT, TM14, IES, Calculux) using the photometric database LumCAT. Ray data are made available in the formats of the simulation tools ASAP, SPEOS, LightTools, Lucid- Shape and Zemax. In addition, also customer- specific formats can be realized

Ray model basic data of the RIGO 801

For luminaire simulations (e.g. calculation of reflectors in headlamps), for the planning of illumination systems or for raytracing methods (computer simulation of living spaces and things like that), the data of the radiating/ luminous objects are necessary. The full description of the radiation conditions of a surface requires to indicate the luminance distribution $L_{x,y,z,\lambda}$ (ϑ, ϕ) in all surface points $(x,y,z)_{Surface}$ of the object. (Differing spectral distributions on the surface itself are not considered here.) As a surface can be described by two parameters z=f(x,y) - a 4D-data field results L(ϑ, ϕ, x, y).

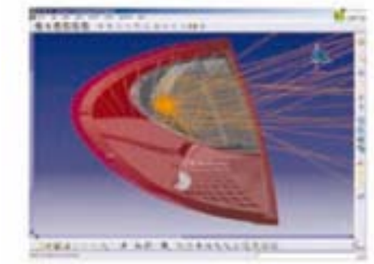
The data records thus obtained permit the user to describe objects using ray models. Ray models are already used in many simulation programs. However, they are often based on synthetic, mathematically defined models for the luminous objects (e.g. description of a filament).

In some cases, model data may describe the actually used lamps and luminaires only insufficiently. Therefore, there is a high demand for measured data. If the luminance conditions on the surface (ray data) are to be determined, individual sensors which perform integral measurements cannot be employed. The required data can, in principle, be measured by means of an imageresolving luminance measuring camera (LMK)* on a positioning unit (goniometer). This kind of measuring device is offered by the TechnoTeam company as RIGO 801 device in different versions. It has already stood its test in a big variety of different applications.

Application of the measuring data

The measurement of the 4D-luminance distribution of measuring objects opens up new possibilities of describing photometric objects, integrating them into simulation programs, and obtaining data for documentation and planning. On the basis of the ray model, a big number of photometric param eters of luminaires/ lamps can be determined using the RIGO 801 device.

- Conventional planning data (LID) for light planning
- Data for near-field applications (Nearfield LID)
- Luminance distributions
- Data for programs for the computerassisted simulation of complex photometric assemblies

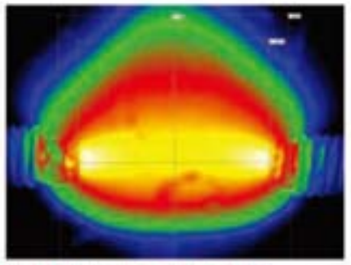


Simulation with measured ray data

Planning of illumination systems

The near-field goniophotometer type RIGO 801 makes conventional luminous intensity distribution fittings (LID) of luminaires/ lamps available.

At present, standard programs for the planning of illumination systems mostly use the luminous intensity fittings (LID) of luminaires as starting data. However, in the evaluation using LID, the luminaires/lamps are regarded only as point measuring objects, which is fully sufficient for many cases of application.



Evaluation of a luminance distribution on an arc (LMK – arc object, logarithmic representation

Evaluation of luminance distributions

The internal database is the 4D-luminance data field, which resulted from 2D-luminance data measured at the respective observation positions (camera positions through goniometer control). Thus, also these original luminance images are available and can be evaluated using the LMK-functions.
The image-resolving measuring devices cannot only be combined with certain modules of image processing, but also with options for the recording and measurement of geometrical relations (lengths, angles, solid angles), thus permitting a big number of derived parameters to be obtained, too.

Evaluation of a luminance distribution of a filament (LMK - filament, logarithmic representation)

Full description of the luminous objects

For all those tasks where the data obtained as mentioned above are not sufficient, the complete measuring data can be used. This concerns, for example, the raytracing methods for reflector calculations on downlights or headlamps, the ray calculation of complex illumination systems (e.g. projec tors) and others. The data records available after measurement can be converted into those formats used by the following simulation or evaluation programs.

Technical data

The goniometers used for moving the image-resolving luminance measuring devices are realized according to the desired range of the measuring objects and also according to the available laboratory space.

Applications

Goniophotometer for LED and small lamps
Size of measuring object [6 x 6 x 6 mm³ - 50 x 50 x 50 mm³]
Space required [600 x 600 x 800 mm³]

Goniophotometer for lamps and small luminaires
Size of measuring object [20 x 20 x 20 mm³ - 300 x 300 x 300 mm³]
Space required [1300 x 1300 x 1900 mm³]

Goniophotometer for luminaires (according to customer's wishes)
Size of measuring object [≤ 2000 x 2000 x 2000 mm³]
Space required [≤ 4000 x 4000 x 4900 mm³

Relation between possible sizes of the measuring object and the space required by the measuring systems

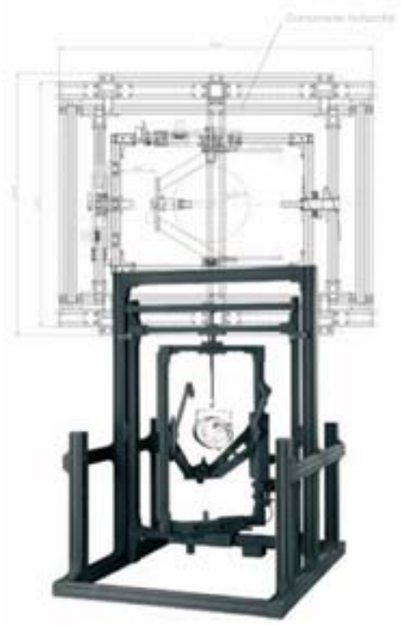
GONIOM ETERM ODELS

Goniometer for LEDs and small lamps

Size of measuring object
[6 x 6 x 6 mm³ - 50 x 50 x 50 mm³]
Space required:
[600 x 600 x 800 mm³]
Movement:
The measuring camera and the illuminance meter are moved on a circular path around the lamp (horizontal ϑ−axis). The lamp itself is turned around a vertical ϕ-axis.
Travel path:
[ϕ = 0° ... 360°, ϑ = -140° ... 140°]
Measuring position of the luminaire:
Normal position, standing
Measuring width:
[100 mm]
Positioning accuracy:
[ϕ < 0,02°, ϑ < 0,05°]
Repetitive accuracy:
[ϕ < 0,01°, ϑ < 0,02°]

Goniometer for lamps and small luminaires swivelling

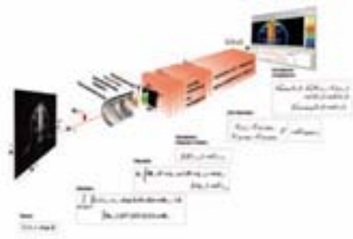
Size of measuring object:
[20 x 20 x 20 mm³ - 300 x 300 x 300 mm³]
Space required:
[1300 x 1300 x 1900 mm³]
Movement:
The measuring camera and the illuminance meter are moved on a sphere around the lamp (two independent axes arranged vertically to each other (ϑ, ϕ)).
Travel path:
[ϕ = -2° - 362°, ϑ = 0° - 360]
Measuring position of the luminaire:
Normal position, no movement of the measuring object. The whole goniometer can be swivelled, which permits different measuring positions to be realized.
Measuring width:
[270 mm]
Positioning accuracy:
[ϕ < 0,02°, ϑ < 0,05°]
Repetitive accuracy:
[ϕ < 0,01°, ϑ < 0,02°]



GONIOM ETERM ODELS
Goniometer for luminaires

Size of measuring object:
[≤ 2000 x 2000 x 2000 mm³]
Space required:
[≤ 4000 x 4000 x 4900 mm³]
Movement:
The measuring camera and the illuminance meter are moved on a sphere around the lamp (two independent axes arranged vertically to each other (ϑ, ϕ)). mounted to a fixed upper point.
Travel path:
[ϕ = -2° - 362°, ϑ = 0° - 360°] (upper lamp suspension)
Measuring position of the luminaire:
Normal position, no movement of the measuring object; lamp suspension possible at5the top and at the bottom.
Measuring width:
[500 - 2000 mm]
Positioning accuracy:
[ϕ < 0,02°, ϑ < 0,05°]
Repetitive accuracy:
[ϕ < 0,01°, ϑ < 0,02°]

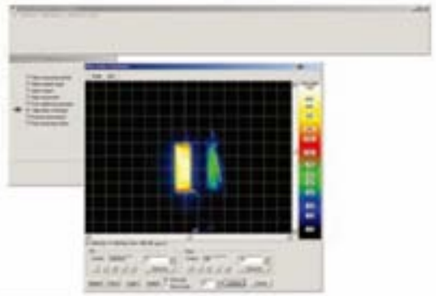
Sensors
Image-resolving measuring camera
- CCD – digital camera (Kappa), LMK98-3, V(λ) – full filter-adapted
- Digital framegrabber, 12/13 Bit
- Changeable lenses, photometrically corrected, distortion-corrected



Illuminance meter
- V(λ)-calibrated, cosine - adaptation
- Temperature-stabilised
- Digital signal output via RS422/232
- 18-bit resolution, 8 measuring ranges
- Usage of external photodiodes possible (e.g. UV measuring cells)

Drives, control systems
Servomotors and Harmonic Drive gears

Evaluation computer
- Intel Pentium at least 2,6 GHz P4 CPU 1 GB RAM
- CD-ROM-drive
- >40 GB E-IDE hard disk
- 19" Monitor
- WINDOWS 2000
- Digitaler Framegrabber
- Interface card (RS422)



RIGO 801 - Measuring software

Software
RIGO 801
Basic software for operating the goniometer

- Capture of LIDs using the camera or illuminance meter, saving in the TechnoTeam – format, conversion into different standard formats using the software package LumCAT
- Angular step widths 0.1°... 2.5° (camera), 0.1°... 180° (illuminance meter)
- High measuring speed (e.g. 25 minutes for a 2.5° x 2.5° measurement).
- Capture of ray data, saving in the TechnoTeam format. Conversion using the program converter type 801 into various standard format

Converter 801 – Conversion into ray data formats

Converter type 801
Program for the conversion of the TechnoTeam – ray data format into various standard formats
- Presently available formats: ASAP, SPEOS, RWR, LucidShape, LightTools and Zemax.
- Presently available enveloping geometries: sphere, cylinder and cuboid.
- API for programming own raytracing - DLLs
- The output in custom-made formats is possibl

Software

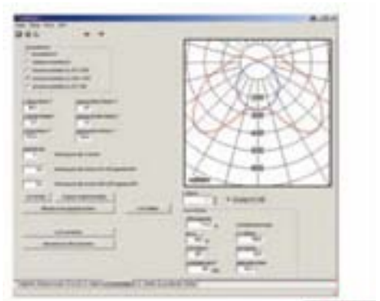
LMK 2000
Luminance measuring software LMK 2000*.

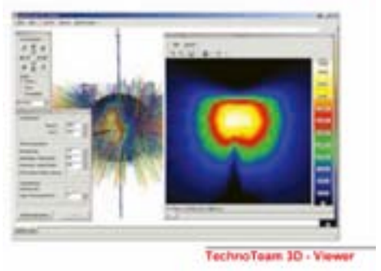
- Task-specific capture functions
- A variety of visualization functions
- Extensive statistical evaluations
- User-defined evaluation and drawing up of print reports
- Component for controlling the goniometer mechanics
- Special evaluation objects, e.g. spiral and arc object (ECE 99)

LumCAT

- Conversion of the LVK-data from the TechnoTeam format into other formats (EULUM-DAT, TM14, IES, Calculux, ...)
- System for managing and processing luminaire data (database)
- Modification of all product information
- Drawing up of measuring protocol

TechnoTeam 3D – Viewer
Program for the 3D visualization of luminous intensity and ray distributions.





Power supply and metrological equipment

Zentro SX1H-X20S
A.C. voltage stabilizer 200–254 V; 2,42kVA
SSP 500-52 KA344A
DC-laboratory power supply 0...40V, 0...25A (Gossen-Metrawatt)
Digital wattmeter type WT200
Yokogawa WT200, single-phase digital wattmeter, max. 600V, 20A, 0...50kHz
Power Analyser NORMA 3000
LEM NORMA GmbH, 1 to 3 phases,max. 1000V, 10A, 0.1...110kHz
Control panel
Control panel for the easy connection of power supplies, the multipurpose meter and the luminaire/lamp.
Luminous flux general-lighting service lamp (LMT)
Incandescent lamp 24V/100W, matt socket E27
Measuring lampholder for luminous flux general-lighting service lamp (LMT)
E27 socket with hard gold-plated contacts, additional measuring contacts

The components mentioned in this document such as a.c. voltage stabilizer, laboratory power supply, multipurpose meter and control panel can be installed in the goniometer switch cubicle and cabled upon customer's request.

LEDnormal
LED-luminance standard

stabilized color LED based standards

Properties

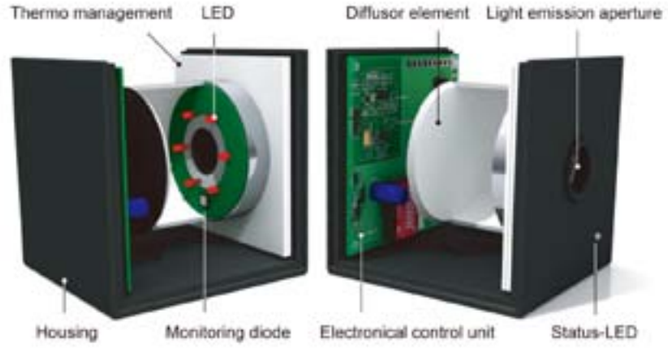
- High stability of luminance (< 1% / 100 h)
- High stability of dominant wavelength/colour (<1 nm / 100 h)
- Low power up time (<5 min)
- Stable operation at 10°C - 30°C temperature
- High uniformity of luminance at emission surface (<2% inhomogeneity)
- Exact emission surface (diameter: 20.0 mm with fit H7)
- Compact housing 120 mm x 110 mm x 120 mm (H x W x D)
- Available standard colours (white, blue, green, yellow, amber, red)
- Custom made colours on demand

Working principle

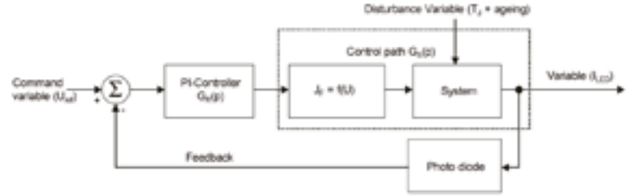
The stability of the luminance is realized through a temperature control with a Peltierelement and a intensity control with a spectral matched photo element. Only selected LED's in 5 mm housings are applied.

Calibration @ TechnoTeam

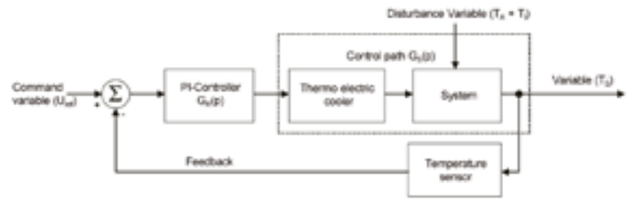
For each LED standard TechnoTeam provides the following data: Luminance L, chromaticity coordinates: x, y, dominant wavelength ldom and spectral power distribution S(l). The traceability for this data to any national standard organisation is at the moment not possible. @ PTB (Physikalisch-Technische Bundesanstalt) For the traceability of the photometric data of the LED standards it is necessary to calibrate the devices at a national metrology institute. In further times it is planned that the PTB will calibrate the luminance L and the chromaticity coordinates x and y.
The PTB is the German national metrology institute providing scientific and technical services.



PI-controller of intensity I_{LED}



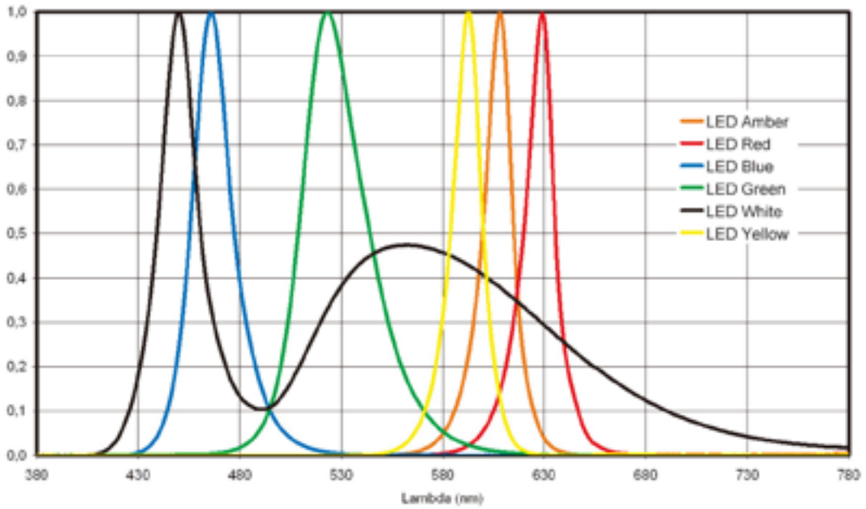
PI-controller of temperature



Available LED standards[1]

	LED White	LED Blue	LED Blue	LED Yellow	LED Amber	LED Red
L (cd/m²)	440	80	500	210	300	240
x	0.3300	0.1300	0.2000	0.5700	0.6400	0.6900
y	0.3200	0.0600	0.7200	0.4200	0.3600	0.3100
ldom (nm)		470	533	590	603	620
CCT (K)	6300					

Spectral power distribution of the LED standards



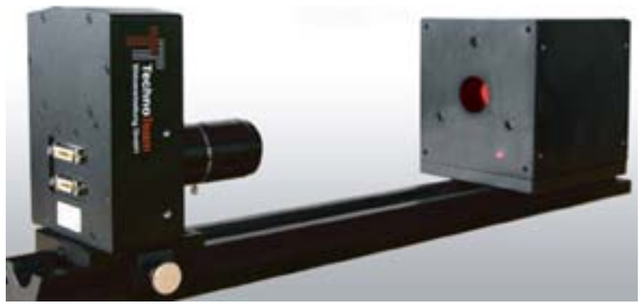
Furthermore other colours can be realized on customers demand.
Therefore the customer has to choose in partnership with TechnoTeam the LED type of a conforming (or relating) 5 mm LED. Thus the LED type must be according necessary stability properties and furthermore must be chosen from a larger charge (appr. 100 LED's) of LED's with similar attributes (luminous intensity, colour, light spread characteristic).

Fields of application

CCF measurements
For the determination of a colour correction factor (CCF) for a specific spectral power distribution (SPD) you have to measure at a known luminance L for this SPD. The quotient of the measured luminance value and the known luminance value of the LED light source is called CCF and can be used as a correction factor for all further measurements at this and similar SPD's.

Maintenance at customers side
For the maintenance of luminance and colour measuring cameras it is often better to calibrate the device at the customer facilities. For this purpose the calibration measurement can be done with the mobile and calibrated LED light sources. Therefore a dismount of the camera for example from a machine is often not necessary.

System adjustment and calibration
Capturing of 10 - 15 different LED light sources with a colour camera.
Calculating a transformation matrix for the colour camera with the help of a balanced calculation (e.g. GLS) and using the measured data and the calibrated data of the LED light sources.



Stability tests
With regular measurements of the LED light sources it is possible to assure the stability of a measurement device.