LMK 5 & LMK 5 color

Sensor

[14 Bit digital, progressive scan]

LMK 5-1 luminance / color
CCD Sony [ICX 285 AL (2/3")]
effective Pixel [1380 (H) x 1030 (V)]

LMK 5-5 luminance / color
CCD Sony [ICX 655 AL (2/3")]
effective Pixel [2448 (H) x 2050 (V)]

Dynamic range

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

Data transmission

Gigabit Ethernet Interface (GigE®)

Metrological specifications

$V(\lambda)$ [f'_1 < 3.5%[1]]; $X(\lambda)$ [f'_1 < 4%]
$Z(\lambda)$ [f'_1 < 6%]; $V'(\lambda)$ [f'_1 < 6%]

Measuring quantities

Luminance: L (cd/m²)
Chromaticity coordinates: (x,y)
Supported color spaces:
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 100µs…15s (aperture number = k), e.g.:
100 µs … appr. 75000 cd/m² &
15 s … appr. 0.5 cd/m² (kmin = 4)
100 µs … appr. 600000 cd/m² &
15 s … appr. 4.0 cd/m² (kmin = 11)
The values above representing the highest measurement values for the selected measurement ranges. The limit of detection ($f_{3,0}$) in all measurement ranges is about 0,04 % relative to the highest measurement value in the range.
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%]
$\Delta x,y$ [< 0.0001]

Measuring accuracy

ΔL [< 3% (for standard illuminant A)]
$\Delta x,y$ [< 0.0020 (for standard illuminant A)]
$\Delta x,y$ [< 0.0100 (set of test colors)[5]]

Uniformity

ΔL [< 2%]

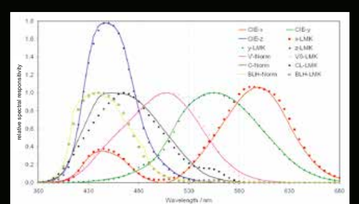
Fields of application

laboratory measurements, field measurements, industry automation

The **LMK** 5 color is equipped with a filter wheel for color measurements, adapted to the color matching functions of the 2° CIE standard observer (CIE 1931).
Thus, luminances and additional color or chromaticity data can be measured. The filter wheel allows a total of 6 full glass filters to be incorporated, with 4 filters needed for the color measurement.

In addtion, the measuring system can also be equipped with filter glasses for the scotopic range $V'(\lambda)$, the melanopic action function $s_{mel(\lambda)}$, an infra-red filter (in the NIR range of 780 - 1100nm), the blue light hazard function (BLH) or a clear glass.

LMK 5 luminance / color



Spectral matching of the **LMK** 5 color

1 Measurements according to DIN 5032 Part 6 / ISO/CIE 19476:2014 (CIE S 023/E:2013) | 2 Dominant wavelength, saturation, correlated color temperature | 3 Calibration according to DIN 5032 Part 6 / ISO/CIE 19476:2014 (CIE S 023/E:2013) using luminance standards traceable to the PTB (Physikalisch-Technische Bundesanstalt, the National Metrology Institute of Germany) | 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 Maximum difference of the measured value to the reference measurements using 12 LED based luminance / color standards.

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Display test and measurement software AddOn
for **LMK** photometer / colorimeter

LMK
display

LMK Display

The characterization of different display types - small mobile phone displays up to large TV displays or also head-up displays - is an important topic in various R&D applications and the quality management for production accompanying processes.
For example automotive displays and their very strict performance, quality and safety requirements or the measurement of virtual displays (VR/AR, ocular systems) are becoming more and more important.

Imaging Luminance and Color measuring devices (ILMD/ICMD) can be used to analyse a various range of performance and quality benchmarks for the different display types.

The image measuring technology can be used to evaluate uniformity parameters like black-level gradients in a few seconds measurement time.
Using special lenses (e.g. hyper-centric lens (Conoscope) or Macroscopic lenses) the user can perform angular luminance and color characterization for small parts of the display or for single pixel / subpixel structures.

Additionally parameters like the Gamma-curve can be measured with one shot within seconds. In addition, the evaluation of sticking images is possible with the same measuring device.

The **LMK** Luminance/Color System can be equipped with three different lens types for display analysis

- 50mm focusable lens (whole screen analysis like uniformity measurement)
- Conoscopic lens (angular dependent luminance and color measurements)
- Macroscopic lens (single-/subpixel structure analysis e.g. for Pixel-Crosstalk analysis or the evaluation anti-glare and anti-reflection coatings)

The **LMK** display software package is available for the current **LMK** 5 systems and the future **LMK** 6 generation based on CMOS sensor.

TV displays

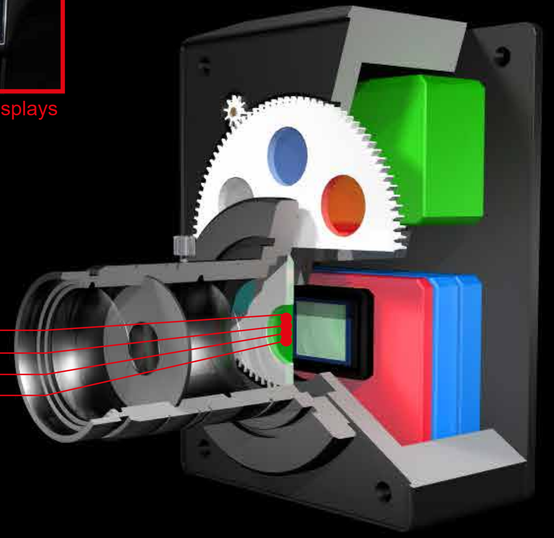
Automotive displays

Computer displays

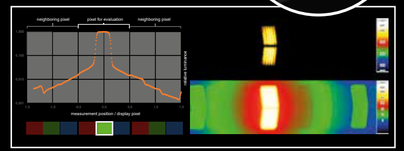
Mobile phone displays

LMK 5 [CCD based]
1386 (H) × 1035 (V) (1MP)
2448 (H) x 2050 (V) (5MP)

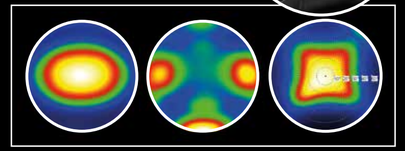
LMK 6 [CMOS based]
1936 (H) × 1216 (V) (2MP)
2448 (H) x 2048 (V) (5MP)
4112 (H) x 2176 (V) (8MP)



LMK Pixel Crosstalk method developed by Dr. Fink characterizes the loss of image clarity caused by anti-glare coatings. The method uses high-resolution imaging with a Macroscopic lens, giving a distribution and evaluation of scattered light.

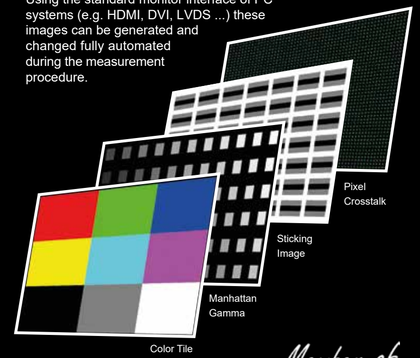


LMK CCM (Conoscopic contrast measurement)
The software package allows the user to perform angular contrast determination of displays in an easy way. It provides the capability of H/V angular coordinates conversion as well as the definition of measurement regions and points in the ϑ,ϕ and ϑ_H, ϑ_V angular coordinate system.



Test Image Generator

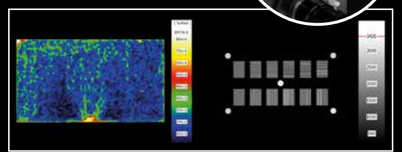
Using the standard monitor interface of PC systems (e.g. HDMI, DVI, LVDS ...) these images can be generated and changed fully automated during the measurement procedure.

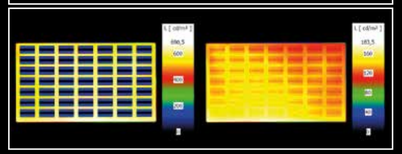


Member of DFF German Flat Panel Display Forum

LMK BlackMURA supplies the analysis of display screen quality according to the black-level uniformity. Thus the package is providing an extension to the functions of the **LMK** LabSoft for realising a gradient filter detection of particular non-uniformity on the display screen.

LMK Sticking Image supplies the analysis of display screen quality according to the three-level burn-in method developed by Dr. Lauer.





Target applications

- Various topics in the application of display evaluation (human machine interface (HMI) displays, HeadUpDisplays (HUD), AR/VR Displays) such as luminance level, color settings, luminance/color uniformity and angular dependence of luminance/color
- Material evaluation (e.g. Brightness enhancement foils, Combiner windows for HUD)
- Evaluation of display screen surfaces (anti reflection / anti glare coatings)

Research & Development (R&D)

- BlackMURA analysis according to DFF Standard „Uniformity Measurement Standard for Displays V1.2"
- Sticking Image determination according to the "three-level burn-in Method" of Dr. Lauer (Visteon). The evaluation according to the current Daimler specification is in process.
- Pixel Crosstalk analysis according to the method of Dr. Fink (Porsche)
- Angular contrast measurements with the Conoscopic lens

Production control

- Luminance and Color evaluation
- BlackMURA
- Sticking Image (available soon)