

LumiCam 2400B

2D imaging colorimeter with motorized objective lenses



We bring quality to light.



Key features at a glance

- ▲ Motorized objective lenses
- ▲ Up to 30 % shorter measurement time
- ▲ Approx. 20 % smaller footprint
- ▲ Compatible to LumiSuite and LumiCam software
- ▲ Straightforward analysis of photometrical parameters

01 \\ LumiCam 2400B – The new generation of our proven LumiCam imaging colorimeter

Instrument System's mission to continuously fulfil the growing demands of modern light measurement has advanced our industry leading precision colorimeter LumiCam in a new hardware and

software makeover. New motorised objective lenses, a faster filter wheel movement and a more compact design of the LumiCam 2400B in comparison to its predecessor model are only some of the features that

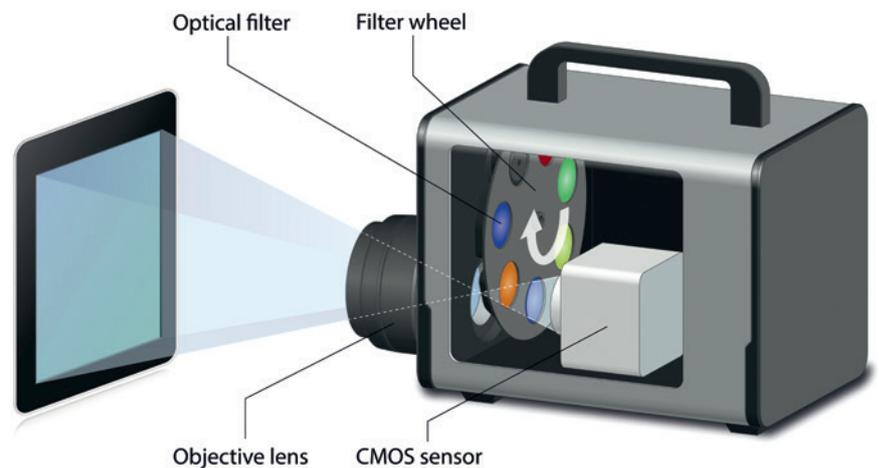
push the measurement experience with the LumiCam 2400B to the next level in regards to accuracy, ease of use and handling.



▲
LumiCam 2400B: 2D imaging colorimeter for quality assurance of displays and dashboards in the automotive interior.

02 \\ LumiCam 2400B functioning principle

Our LumiCam 2400B is a high-resolution 2D luminance and color measurement device based on optical filters. Depending on the variant a sensor-adjusted filter is either permanently mounted between the lens and the sensor or a filter wheel allows for a successive pivoting of multiple individual filters into the detection path. Each pixel of the camera sensor is assigned a calibrated luminance and color value to generate a 2D image of the photometric data. The data exchange between a LumiCam 2400B with its controlling PC works via network cable, whereas both of our two powerful software platforms, the LumiCam software or the LumiSuite software, are able to acquire and analyse the gained photometric information.



Optical design of the LumiCam 2400B with color filter wheel.

03 \\ LumiCam 2400B variants and sensor resolution

The LumiCam 2400B portfolio encompasses three different camera variants in order to address individual user requirements:

LumiCam 2400B Mono



A steady and sensor-calibrated Y' filter allows an exact measurement of luminance and luminous intensity. The Y' filter represents the photopic luminosity function of the human eye $V(\lambda)$ with a precisely defined deviation of $f_1' < 3\%$.



LumiCam 2400B Color

The LumiCam 2400B Color is equipped with a new wheel holding the four color filters Xb' , Xr' , Y' and Z' , jointly resembling the tristimulus functions of the eye receptors. Thus, the camera gives access to a detailed analysis of the color coordinates (x , y and u' , v'), correlated color temperature, dominant wavelength as well as color purity.



LumiCam 2400B Advanced

The LumiCam 2400B Advanced features six color filters (Xb' , Xr' , Y' , Z' plus two correction filters K' , L') and a patented matrix optimization algorithm to achieve optimal measurement results also for narrow-band light sources, such as LEDs or OLEDs.

The five megapixel sensor integrated in the LumiCam 2400B permits a fine spatial 2D resolution of the measured photometric and colorimetric information and is therefore suitable for an investigation of whole instrument clusters or small image details.

LumiCam 2400B variants: Overview

	Mono	Color	Advanced
Luminance	✓	✓	✓
Luminous intensity	✓	✓	✓
Color coordinates ($x, y; u', v'$)		✓	✓
Correlated color temperature		✓	✓
Dominant wavelength		✓	✓
Color purity		✓	✓
Optimized LED color measurement			✓

Accessible optical quantities for different LumiCam 2400B variants.

04 \\ LumiCam 2400B objective lenses – motorised lenses and quickly mounted OD filters

The broad range of electro-mechanically controlled objective lenses that accessorise the LumiCam 2400B reaches from 24 mm, 50 mm to 100 mm and leads to an enhanced data reproducibility due to user-friendly and software controlled motorised focus and aperture setting.

Quick and easy for more accuracy! The external optical equipment for the LumiCam 2400B includes calibrated neutral density filters such as OD2 or OD4, which are compatible with every objective lens. The filters are fixed in position via a magnet mechanism, which allows their fast and reproducible at- and detachment during a measurement series.

The large variety of optical hardware accessories together with the computer controlled lens settings of the LumiCam 2400B generation addresses diverse measurement tasks in quality assurance of dashboards, panel displays, widescreen cockpits or instrument cluster in research, product development as well as production.



LumiCam 2400B equipment encompasses a variety of lenses with quick-mount neutral density filters.



The magnetic quick-change system of the neutral density filters is compatible with all LumiCam 2400B objective lenses.

Overview lenses

	24 mm	50 mm	100 mm
Focal length	24 mm	50 mm	100 mm
Minimum focusing distance (DUT to lens)	12 cm	44 cm	18 cm
Minimum measurement distance (DUT to housing)	21 cm	50 cm	30 cm
Image size at min. measurement distance (h x v)	46 mm x 39 mm	71 mm x 59 mm	12 mm x 10 mm
Pixel size at min. measurement distance	19 µm x 19 µm	29 µm x 29 µm	5 µm x 5 µm
Image size at 1 m distance (h x v)	318 mm x 266 mm	152 mm x 127 mm	73 mm x 61 mm
Pixel size at 1 m distance	128 µm x 128 µm	63 µm x 63 µm	30 µm x 30 µm

Overview of available LumiCam 2400B lenses and their optical properties.

05 \\ LumiCam 2400B hardware – faster measurement and more compact design

Within less than 10 seconds – including data saving time – your color measurement will be on point! For the LumiCam 2400B Color and Advanced we broke ground for an up to 30 % shorter¹⁾ measurement time in comparison to the models of the first LumiCam generation by using an innovative type of filter wheel and its newly optimized actuation.

In addition to the increased measurement speed, the torso of the LumiCam 2400B is now even more compact and has a ca. 20 % shorter housing for the Color and Advanced model, i.e.:

- ▲ 171 mm vs. 225 mm (- 24% without objective lens)
- ▲ 235 mm vs. 278 mm (-16% with 50 mm objective lens)

This new housing of the LumiCam 2400B, together with its removable handle and the decreased amount of connection cables, make the new generation hardware an ideal candidate for a straightforward integration into end-of-line testing systems, climate chambers, “squeak & rattle” test racks or robotic systems.

¹⁾ Dependent on the used light source and computer.

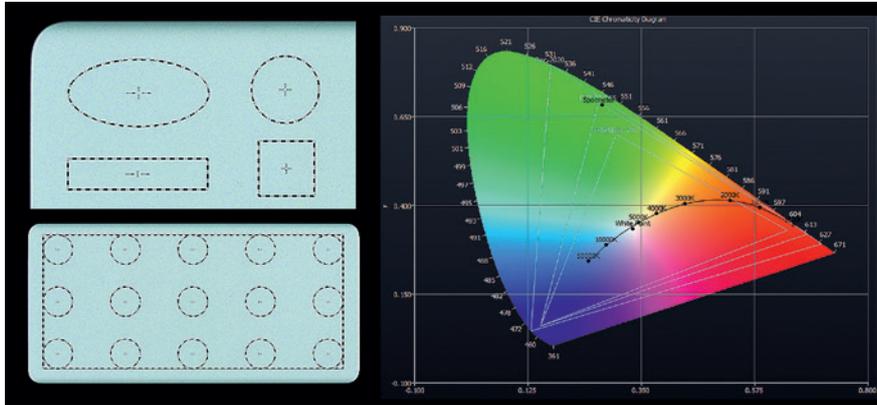


The hardware makeover of the LumiCam 2400B variants Mono, Color and Advanced impresses with compact design.



The removable handle allows an easy integration of the LumiCam 2400B hardware into test and measurement setups.

06 \\ Software upgrade for the LumiCam 2400B – powerful, user-friendly and compatible



▲ Spotmeter in rectangular or elliptic form, grid of spotmeter, line profile and CIE color chart (Lv xy, Lv uv and Lv u'v') are examples for the multiple LumiSuite color image analysis tools.

The operation of the LumiCam 2400B including data capture and analysis is now compatible to both of our powerful image analysis software platforms, the LumiCam software and the LumiSuite software. Up upon your special light measurement requirements in lab or production application, the LumiCam software or the LumiSuite promise a comprehensive determination of numerous photometrical properties such as luminance and color distributions.

LumiSuite Software

At Instrument Systems, we are eager to develop our LumiSuite software solutions continuously to be able to evaluate photometrical information according to latest international standards set by the display and automotive industry. Some examples of our large and steadily growing LumiSuite software analysis features are:

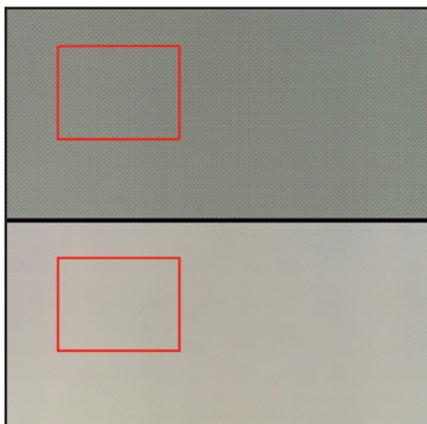
- ▲ Comprehensive 2D color image analysis
- ▲ Testing of German OEM analysis requirements, such as color, gamma or dot defects according

to the standards of the OEM Working Group of the German Flat Panel Display Forum DFF

- ▲ Homogeneity / Black Mura audits according to OEM standards
- ▲ Intelligent pre-processing (auto display recognition, perspective correction, cropping and refill, Moiré correction, etc.)
- ▲ Blob and line defects examination
- ▲ MultiPoint Correction tool for the generation of spectral reference images

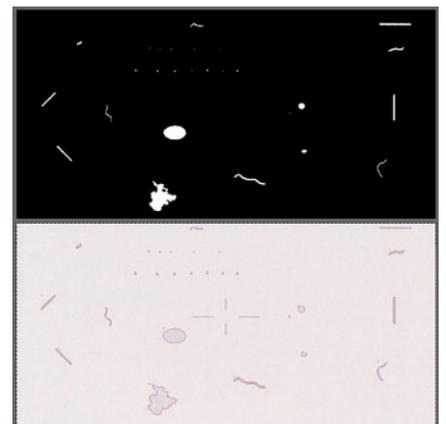
NEW: LumiSuite SDK

In addition to the multiple features, the LumiSuite software offers an industry-proven software development kit (SDK) which is perfectly suitable for a further integration into automated production systems²⁾!



▲ Pre-processing tool Moiré correction in LumiSuite. Upper panel: before correction of Moiré artifacts. Lower panel: with Moiré correction applied. The red square is a zoom in of the blue shaded area.

▲ LumiSuite defects detection tool. Top picture: threshold image. Lower picture: results image.



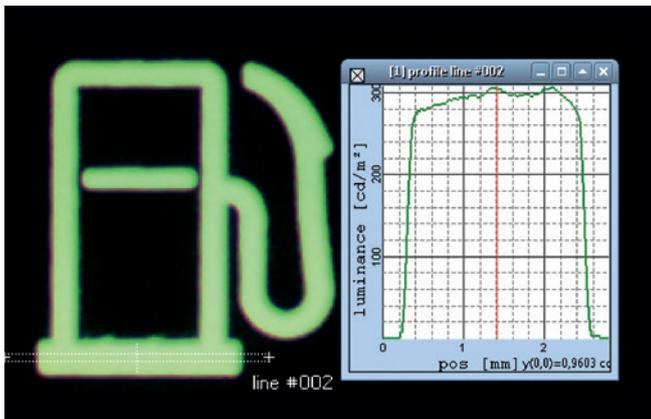
²⁾ For further information on our LumiSuite software please also have a look at our website: <https://www.instrumentsystems.com/en/products/software/lumisuite/>

LumiCam Software

Our well-established LumiCam software offers an extensive, user-friendly graphical user interface (GUI) containing a wide range of photometrical data evaluation tools for example:

- ▲ Spotmeter of variable sizes
- ▲ Line profiles
- ▲ Polygons generated by individually set anchor points or
- ▲ Polygons for flexible regions of interests

For the LumiCam 2400B a switch from the LumiCam software to the LumiSuite software platform is possible at any time!



▲ LumiCam analysis tool: line profile.

▲ LumiCam analysis tool: polygon.

07 \\ LumiCam 2400B – BSDF analysis setup

In combination with the LumiCam software, the second generation LumiCam 2400B also supports the sophisticated LumiCam BSDF (bidirectional scattering distribution function) analysis kit.

The BSDF setup permits a time-effective identification and

separation of (non-) specular components and thus an evaluation of appearance characteristics like haze or distinctness of a surface. One major application of the BSDF setup can be, for example, OLED display characterization after latest standards in the automotive

interior sector. For detailed information on the BSDF analysis kit, please have a look at our BSDF application note and data sheet or at our website under <https://www.instrumentsystems.com/en/systems/lumicam-display-measurement/>.

08 \\ Accredited quality

As a leading manufacturer of light measurement equipment Instrument Systems strives to ensure that you can put greatest possible trust in our instruments. Thanks to the accreditation of our test laboratories according to DIN EN ISO/IEC 17025, our customers enjoy reliable and

traceable measurement results and guaranteed comparability between different measurement instruments. This enables our customers to demonstrate the quality of measurements to any third party and ensures excellent accountability. Besides the DIN EN 13032-1 test

procedure for photometric quantities, we follow DIN EN ISO 11664 for the measurement of colorimetric quantities. All standards used are directly traceable to reference standards of the national laboratories PTB (Germany) or NIST (USA).

09 \\ Service and support

At Instrument Systems, we set a benchmark with our products and our services. We secure the long-term value of your investment and guarantee optimum productivity over the entire period of use with industry leading support.

Our service offerings include the following:

- ▲ Engineering services
- ▲ Technical advice, also post-sales
- ▲ Test certificate and factory calibration
- ▲ Instrument repair and hardware upgrade
- ▲ Software updates

10 \\ Technical specifications

LumiCam 2400B	Mono	Color	Advanced
Quantities			
Photometric quantities	Luminance (cd/m ²), luminous intensity (cd), contrast		
Colorimetric quantities	-	Color coordinates (x,y), color coordinates (u',v'), tristimulus values (X, Y, Z), dominant wavelength (nm), color saturation, correlated color temperature CCT (K)	
Camera data			
Sensor	Sony IMX264LLR CMOS Sensor		
Sensor size	2/3", 11.1 mm diagonal		
Effective number of pixels (h x v)	2428 x 2028 (5 MP)		
Pixel size	3.45 μm x 3.45 μm		
AD converter	12 bit		
Exposure time	40 μs to 30 s		
Luminance measurement			
Measurement range ¹⁾	0.3 mcd/m ² – 2.5 Mcd/m ²		
Extended measurement range ²⁾	2.5 x 10 ¹⁰ cd/m ²		
Measurement time incl. data saving time (at 10 cd/m ²) ³⁾	1.9 s		
Measurement time incl. data saving time (at 100 cd/m ²) ³⁾	1.8 s		
Accuracy for std. illuminant A ⁴⁾	±3 %	±3 %	±3 %
Accuracy for LED color light ⁸⁾	-	-	±2 %
Repeatability ⁵⁾	±0.03 %		
Uniformity ⁶⁾	±0.5 %		
Filter match ⁷⁾	f ₁ ' < 3 %		

Color measurement			
Measurement time incl. data saving time (at 10 cd/m ²) ³⁾	-	10 s	16 s
Measurement time incl. data saving time (at 100 cd/m ²) ³⁾	-	8 s	12 s
Accuracy (x, y) for std. illuminant A ⁴⁾	-	±0.003	±0.003
Accuracy (x, y) for color light ⁸⁾	-	±0.010	±0.010
Accuracy (x, y) for LED color light ⁹⁾	-	-	±0.005
Repeatability (x, y) ⁵⁾	-	±0.0001	±0.0003
Uniformity (x, y) ⁶⁾	-	±0.001	±0.001
Filter match	f _t ' (Y) < 3 %	f _t ' (Xb) < 6 % f _t ' (Xr) < 6 % f _t ' (Y) < 3 % f _t ' (Z) < 4 %	f _t ' (Xb) < 6 % f _t ' (Xr) < 6 % f _t ' (Y) < 3 % f _t ' (Z) < 4 %
General			
Interface	Gigabit Ethernet		
Operating system	Windows 7 (32/64 bit), Windows 10 (64 bit)		
Dimensions (L x W x H) (incl. 50 mm objective lens, no handle)	210 mm x 105 mm x 100 mm	235 mm x 119 mm x 133 mm	
Weight	1.5 kg	3 kg	
Power supply	24 V external		
Operating conditions	10 to 40 °C, max. 70 % relative humidity (non-condensing)		

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¹⁾ The lower limit corresponds to the maximal exposure time and smallest f-number at SNR 10:1 and vice versa.

²⁾ Valid for OD4 filter.

³⁾ Value calculated from 100 repetitions taking data saving time into account.

⁴⁾ Calculated from 100 repetitions; refers to the deviation of the mean from the reference value.

⁵⁾ Calculated from 50 repetitions. Refers to the double standard deviation of the measured values.

⁶⁾ Refers to the maximum deviation from the mean value calculated from flat-field verification image.

⁷⁾ Deviation of the filter transmission from the V(λ) curve integrated over the entire visible spectrum.

⁸⁾ Maximum deviation from the reference source (illuminant A with set of color glass filters).

⁹⁾ Derived from 20 repetitions for R, G, and B – LEDs with optimized signal level. Refers to the double standard deviation.

11 \ Ordering information

Order number	Description
LumiCam 2400B variant	
LC2400B-100	LumiCam 2400B Mono Imaging photometer with 2430 x 2030 pixels, without PC, without software
LC2400B-110	LumiCam 2400B Mono Imaging photometer with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>German</i> configuration
LC2400B-120	LumiCam 2400B Mono Imaging photometer with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>English</i> configuration
LC2400B-200	LumiCam 2400B Color Imaging photometer and colorimeter with 2430 x 2030 pixels, without PC, without software
LC2400B-210	LumiCam 2400B Color Imaging photometer and colorimeter with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>German</i> configuration
LC2400B-220	LumiCam 2400B Color Imaging photometer and colorimeter with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>English</i> configuration
LC2400B-300	LumiCam 2400B Advanced Imaging photometer and colorimeter with 2430 x 2030 pixels, without PC, without software
LC2400B-310	LumiCam 2400B Advanced Imaging photometer and colorimeter with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>German</i> configuration
LC2400B-320	LumiCam 2400B Advanced Imaging photometer and colorimeter with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>English</i> configuration
Objective lenses and accessories	
LC-323-1	24 mm lens for LumiCam 2400B, article includes firmly mounted adapter ring for OD filter
LC-324	50 mm lens for LumiCam 2400B, article includes firmly mounted adapter ring for OD filter
LC-326	100 mm lens for LumiCam 2400B, article includes firmly mounted adapter ring for OD filter
LC-372	OD 2 filter for LumiCam 2400B
LC-374	OD 4 filter for LumiCam 2400B
DTS400	Manual XYZ positioning system
Computer and Software	
PC-211	Laptop, incl. Windows 10, German configuration
PC-212	Laptop, incl. Windows 10, English configuration
PC-201	Desktop computer, incl. Windows 10, German configuration
PC-202	Desktop computer, incl. Windows 10, English configuration
SW-501	Basic LumiCam software (license for single device)
SW-501-BM	Black Mura Plug-in for LumiCam software
SW-530	LumiSuite Smart Analysis SDK, contains only SDK (software development kit)
SW-540	LumiSuite Smart Analysis GUI, contains only GUI (graphical user interface)
SW-550	LumiSuite Smart Analysis, contains GUI (graphical user interface) and SDK (software development kit)
SW-550-BM	Black Mura Plug-In for LumiSuite SW, contains GUI (graphical user interface) and SDK (software development kit)
SW-550-MPC	MultipointCorrection Plug-In for LumiSuite SW, contains GUI (graphical user interface) and SDK (software development kit)
Others	
LC-BSDF-100	BSDF analysis kit for LumiCam 2400B for the measurement of the „bidirectional reflectance/transmittance distribution function“
LC-BSDF-110	Optical bench for transmissive or reflective measurements with the BSDF analysis kit for the LumiCam 2400B
LC-BSDF-115	DUT holder for the BSDF setup in reflective configuration



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