

TEST CERTIFICATE

Instrument Systems GmbH

Certificate No. CAL-425-23-003

Instrument Imaging Photometer and Colorimeter

Manufacturer Instrument Systems GmbH
Kastenbauerstr. 2
81677 Munich

Instrument Type / Serial No. LC 2400B - 300 SN: 11081451

Accessories /Serial No. ▶ Lens: Sigma AF 24mm SN: 55602745
▶ Density filter: OD-2 SN: 11081451-201

Type of Test ▶ Accredited scope
Test of luminance L_v in $[cd/m^2]$ with standard illuminant A according to ISO 23539:2005 and DIN EN 13032-1:2012.
▶ Not accredited scope
Test of tristimulus values for the CIE 1931 2° Standard Observer according to DIN EN ISO 11664-1:2011
Test of measurement accuracy of chromaticity coordinates with a sample set of colored and white LEDs

Date of Test 26. Jan. 2023

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Purchase Order No. KA019076

Date of Issue

26. Jan. 2023

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1 INSTRUMENT DESCRIPTION

The LumiCam LC 2400B-300 is a luminance and colorimetry camera. All CIE tristimulus filters as well as two additional filters are mounted on a motor-driven filter wheel and moved sequentially into the path of the beam during the measurement. The instrument is equipped with a Sigma AF 24mm objective lens, which is labeled with a serial number.

2 TEST PROCEDURE

The following configuration files must be installed in the LumiCam software to ensure the proper use of the camera:

LumiCam 11081451.xml checksum: 8171e1adaeeeda36d5b8358013496431	Configuration file containing information about the hardware parameters of the camera and the relative and absolute sensitivity.
LumiCam 11081451.ini (26.01.2023)	Configuration file containing information about the hardware parameters of the camera.
Sigma 24mm.ini (26.01.2023)	Configuration file containing information about the relative and absolute sensitivity.
Sigma 24mm +OD2.ini (26.01.2023)	Configuration file containing information about the relative and absolute sensitivity with neutral density filter OD2.

2.1 4-FILTER-MODE

The LumiCam LC 2400B-300 is mounted in horizontal position on an optical bench opposite to a calibrated luminance standard. The distance between the reference plane of the luminance standard and the camera is 500 mm. Focusing onto the reference plane with the given distance is done using the objective lens.

To test the measurement accuracy of the chromaticity coordinates of the camera, the color coordinates of the luminance standard and three additional color filters with known tristimulus values are measured.

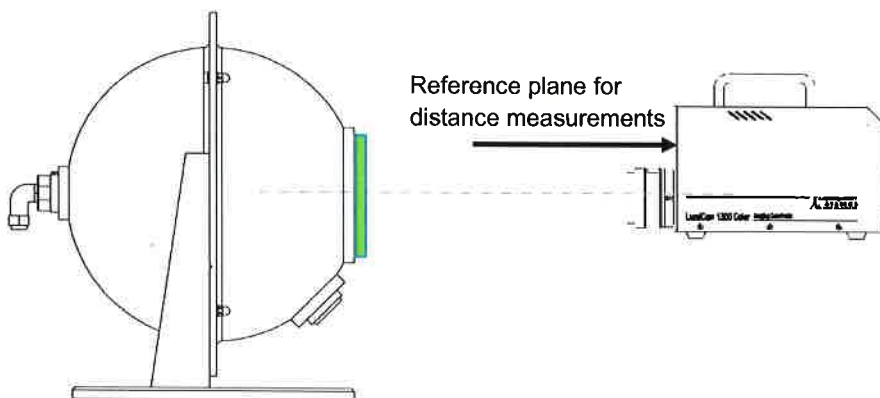


Figure 1: Test setup – luminance standard with color glass filter and LumiCam 1300

To test the luminance and the color coordinates a spotmeter with a radius of 11 mm located in the center of the luminous area of the luminance standard is used.

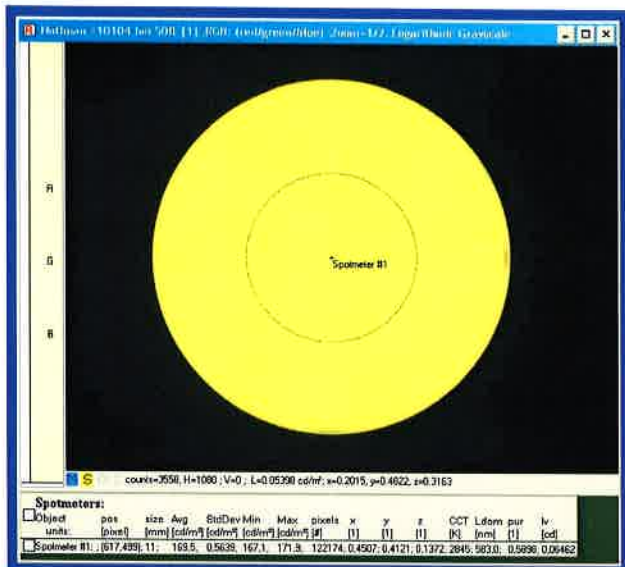


Figure 2: Image of the luminance standard with spotmeter $r=11$ mm

2.2 6-FILTER-MODE

To test the measurement accuracy of the chromaticity coordinates of the imaging photometer and colorimeter camera in the 6-Filter-Mode the color coordinates of the luminance standard and three additional color filters with known tristimulus values are measured.

In addition a homogeneous light source is used, which is fitted with a test set of colored and white LEDs (listed in 4.3). The luminance and the chromaticity value of the light source with the individual LEDs are measured with a reference Spectroradiometer CAS140CT SN: 528314214 and are used as a reference for the testing of the accuracy of the chromaticity coordinates of the imaging photometer and colorimeter camera in the 6-Filter-Mode.

To test the luminance and the color coordinates a spotmeter with a radius of 6.9 mm located in the center of the luminous area of the luminance standard is used.

3 MEASUREMENT CONDITIONS AND TRACEABILITY

Measurements were taken under conditions in conformity with DIN EN 13032-1:2012.

Used reference standards and their traceability:

Working standards	Internal calibration reference	Date of calibration	Traceable to	External calibration reference
Luminance and radiance standard Gigahertz-Optik #0599	CEQ-274-22-021	Dec. 2022	- Reference standard FEL-1000W BN-9101-624 - Reflectance standard SRS-99-020 no. 6836 - Luminance standard LN3 SN: 03B202	40028-21-PTB NIST O-0000000905 41225 PTB 21
Luminance Standard LMT Type LN3 SN: 069131 with color filters - blue #069131-BG28-02 - green #069131-VG9-01 - red #069131-OG590-01	CEQ-272-22-006	Mar. 2022	- Reference standard FEL-1000W BN-9101-711 - Reflectance standard SRS-99-020 no. 6836 - Luminance standard LN3 SN: 03B202	40012-20-PTB NIST O-0000000905 41225 PTB 21

Ambient conditions	
Temperature	(23 ± 3) °C
Humidity	(44 ± 10) % relative humidity

The warm-up time of the luminance standards was 20 minutes; the camera warm-up time was 30 minutes, before the measurements were performed.

The LumiCam LC 2400B-300 and all accessories listed on page 1 were in good order and condition during the entire test process.

4 MEASUREMENT RESULTS

Measurement results given in this section apply solely to the specific test object at the time of the test and under the conditions specified in this certificate.

4.1 TEST OF LUMINANCE IN THE 4-FILTER-MODE

4.1.1 Measurements without density filter

Measurements with different luminance values and distances relative to the luminance standard are carried out during the test of the luminance camera.

These measurements are performed in the auto integration mode, with aperture 4 and 3 averages.

Measured average luminance for the reference standard used:

Nominal value [cd/m ²]	Measured value [cd/m ²]	Deviation	Relative expanded uncertainty
49.87	50.11	0.5%	4 %
499.7	499.7	0.0%	4 %

The measurements with various distances are carried out with a fixed luminance value set to 499.7 cd/m²:

Distance [cm]	Measured value [cd/m ²]	Deviation	Relative expanded uncertainty
25	499.6	0.0%	4 %
50	499.7	0.0%	4 %
75	500.2	0.1%	4 %
100	499.2	-0.1%	4 %

The specified relative expanded uncertainty of measurement corresponds to twice the standard deviation (k=2). For a normal distribution, this means that 95 per cent of the measured values lie within the indicated measurement uncertainty interval.

4.1.2 Measurements with density filter OD2

Measurements with different luminance values are carried out during the testing: These measurements are performed in the auto integration mode, with aperture 4 and 3 averages.

Measured average luminance for the reference standard used:

Nominal value [cd/m ²]	Measured value [cd/m ²]	Deviation	Relative expanded uncertainty
5996	5995	0.0%	4 %

The specified relative expanded uncertainty of measurement corresponds to twice the standard deviation (k=2). For a normal distribution, this means that 95 per cent of the measured values lie within the indicated measurement uncertainty interval.

4.2 TEST OF TRISTIMULUS VALUES IN THE 4-FILTER-MODE (NOT ACCREDITED SCOPE)

The measurements are performed in the auto integration mode, with aperture 4 and 3 averages.

Type of filter	Nominal values Color coordinates		Measured values Color coordinates		Deviation		Relative expanded uncertainty
	x	y	x	y	x	y	
None	0.4540	0.4102	0.4534	0.4107	-0.0006	0.0005	+/- 0.0030
Blue	0.1426	0.1326	0.1437	0.1327	0.0011	0.0001	+/- 0.0100
Green	0.2859	0.5820	0.2870	0.5836	0.0011	0.0016	+/- 0.0100
Red	0.6652	0.3348	0.6643	0.3355	-0.0009	0.0007	+/- 0.0100

The specified relative expanded uncertainty of measurement corresponds to twice the standard deviation (k=2). For a normal distribution, this means that 95 per cent of the measured values lie within the indicated measurement uncertainty interval.

All measurement results relate only to the devices indicated above.

4.3 TEST OF TRISTIMULUS VALUES AND LUMINANCE IN THE 6-FILTER-MODE (NOT ACCREDITED SCOPE)

The measurements are performed in the auto integration mode, with aperture 4 and 3 averages.

Table of the verification measurement of the colored and white LEDs:

Source	Nominal value			Measured value LumiCam			Deviation		
	L _v [cd/m ²]	x	y	L _v [cd/m ²]	x	y	dL _v [%]	dx	dy
LED 470nm	2.604	0.141	0.047	2.611	0.142	0.047	0.3	0.0003	0.0005
LED 615nm	26.534	0.675	0.325	26.234	0.675	0.323	-1.1	0.0009	-0.0016
LED 505nm	10.167	0.087	0.548	10.274	0.087	0.547	1.1	-0.0004	-0.0006
LED 528nm	9.134	0.166	0.684	9.091	0.165	0.686	-0.5	-0.0007	0.0012
LED 555nm	27.565	0.280	0.596	27.411	0.281	0.594	-0.6	0.0009	-0.0020
LED 588nm	5.108	0.594	0.406	5.131	0.593	0.406	0.4	-0.0010	0.0009
LED 465nm	24.463	0.153	0.027	24.395	0.153	0.027	-0.3	0.0005	-0.0005
LED 485nm	48.842	0.131	0.067	48.459	0.130	0.066	-0.8	-0.0003	-0.0002
LED 5000K	8.722	0.341	0.342	8.706	0.341	0.342	-0.2	0.0003	0.0004
LED 3000K	145.615	0.447	0.419	145.295	0.448	0.420	-0.2	0.0011	0.0012
LED 574nm	1.908	0.445	0.554	1.925	0.445	0.555	0.9	-0.0001	0.0012
LED 637nm	2.526	0.706	0.294	2.531	0.705	0.295	0.2	-0.0005	0.0011
LED 565nm	3.561	0.477	0.520	3.565	0.478	0.519	0.1	0.0010	-0.0011
LED RGB	101.578	0.334	0.351	100.987	0.331	0.351	-0.6	-0.0022	-0.0001
LED 535nm	104.107	0.256	0.707	102.533	0.253	0.706	-1.5	-0.0024	-0.0011
LED 525nm	16.061	0.181	0.718	15.928	0.181	0.719	-0.8	-0.0004	0.0008
LED 595nm	138.625	0.575	0.424	138.968	0.575	0.424	0.2	0.0001	0.0003
LED 515nm	50.955	0.136	0.711	50.924	0.139	0.712	-0.1	0.0026	0.0004
LED 605nm	22.314	0.660	0.340	22.116	0.660	0.339	-0.9	0.0000	-0.0009
LED 3500K	139.650	0.423	0.396	139.080	0.423	0.396	-0.4	0.0000	0.0003

All measurement results relate only to the devices indicated above.

5 NOTES

- a) This certificate also applies for order no. CAL-425(-10) and CAL-421 of the price list.
- b) Any mechanical modifications to the tested instrument and the accessories listed on page 1 influence the sensitivity of the instrument.
- c) Instrument Systems certifies that all reference standards and measuring devices have been used within the valid scope of application during the entire test process. The test objects described on page 1 were in good order and condition during the test procedure.
- d) This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.
- e) The results indicated in this certificate refer solely to the instruments tested in the laboratory.
- f) The device is designed, specified and tested for operation in horizontal position. If you like to use it in a different position, we highly recommend to make all lens settings in horizontal position. Particularly, changing the lenses or setting distance and aperture parameters should be made only with the device placed in horizontal position; otherwise, the number of measurement errors may increase considerably.
- g) Attention: The configuration files of the device under test are only valid when using LumiCam software version 5.1 (and above).

End of certificate