Instrument Systems KONICA MINOLTA Group	**Wareneingangstest (SRV-302)** ***General instrument check (SRV-302)***	

SP320R5 ☒	**SP320R5D** ☐	**SP320R4** ☐	**SP320R4D** ☐
Model / *model:*	**SP320-114**	**SN : 30932004**	
Kunde/*customer*:	**Universitat Polytechnica de Catalunya**		
mit Zubehör ***with Accessory***	**ISP250-110 & ISP250-211 + OFG464 + PLG420**		
	EOP146 + OFG444 + PLG440		
	LED434B + OFG464 + PLG420		
	TOP100 + OFG313-3MM +60mm Nikon		
	Tra100-210+OFG313-3+PLG310		

Allgemein / general :		
	☒ **JA / *yes*** ☐ **Nein / *no***	**Kommentar / *comment*:**
Beschädigungen Gerät / *damages of the device*	☐	Photo ☐
Starke Verschmutzung / *strong contamination*	☐	Photo ☐
Gerät gereinigt / *device cleaned*	☒	
Chopper-Funktion i.o / *Chopper function ok*	☐	not available
Optical-Port -Funktion (LED leuchtet) /*optical port function(LED works)*	☐	not available
PMT Kühlung vorhanden / *PMT cooling available*	☐	not available
LED der PMT-Kühlung leuchtet / *LED of PMT cooling is working*	☐	not available
LCD Anzeige i.o / *LCD panel ok*	☒	Fehlercode/*error Nr.*
Gerät initialisiert / *device is initialising*	☒	Power-On switch defective

Testmessungen / *test measurements* :				
Dauertest PMT-Empfindlichkeit *endurance test PMT sensitivity*	Dauer *runtime*	Messungen *measurements*		ok
durchgeführt / *done* ☒	180 min	240		☒
Dauertest Mechanik/ *endurance test mechanics*	Dauer *runtime*	Messungen *measurements*		ok
durchgeführt / *done* ☒	180 min	90 (with 14 subranges)		☒
Dunkelstrom komplett und selektiv *dark current complete and selective* ☒		Detektor 1 PMT3 *detector 1*	Wert /*value ok*	☒
		Detektor 2 InGaAs *detector 2*	Wert /*value ok*	☒
Messung mit der Tra100 *measurement with Tra100* ☒	Gitter / *Grating* 1200UV	Detektor 1 PMT3 *detector 1*	Wert /*value ok*	☐
	Gitter / *Grating* 600IR1	Detektor 2 InGaAs *detector 2*	Wert /*value ok*	☒

Durchführung von / *executed by*: UBI
Datum / *date:* 15.Jun. 2020

Instrument Systems KONICA MINOLTA Group	**Wareneingangstest (SRV-302)** ***General instrument check (SRV-302)***	

Messung mit der ACS530 ☒ *measurement with ACS530*	Gitter / *Grating* 1200UV	Detektor 1 *detector 1*	PMT3	Wert /*value ok*	☐
	Gitter / *Grating* 600IR1	Detektor 2 *detector 2*	InGaAs	Wert /*value ok*	☒
Messung mit der LED rot ☒ *measurement with LED red*	Gitter / *Grating* 1200UV	Detektor 1 *detector 1*	PMT3	Wert /*value ok*	☐
	Gitter / *Grating* 600IR1	Detektor 2 *detector 2*	InGaAs	Wert /*value ok*	☒
Wellenlängenüberprüfung mit dazugehörenden Optik (mit Laser) ☒ *Wavelength check with corresponding optic (with Laser)*	Gitter / *Grating* 1200UV	Detektor 1 *detector 1*	PMT3	Wert /*value ok*	☒
	Gitter / *Grating* 600IR1	Detektor 2 *detector 2*	InGaAs	Wert /*value ok*	☒

Kantenfilterfaktoren überprüfen ☒ *check of the order sorting filter factor*		Abweichung i.o ☒ *abreviation o.k*				
Dunkelmessung (nur SP320R4 /gekühlter NVIS) ☐ *dark measurement (only SP320R4/cooled NVIS)*		Offset i.o /*offset ok.* ☐				
PMT-Faktoren mit Tra100 / *PMT factors with Tra100* ☒		Abweichung i.o / *abreviation ok* ☒				
Dauertest PMT-Rauschen HV4 (nur bei gek. PMT ;15 Min.) ☐ *endurance test PMT noise HV4 (only on cool. PMT;15 Min.)*		Drift des Rauschlevels i.o ☐ *drift of noise signal level ok*				
Rauschscanmessung (PMT auf / *on* HV1) ☒ *noise signal measurement*	Detektor 1/*detector 1* PMT3	Gekühlt *cooled*	☐	Bandbreite Rauschen i.o *bandwidth noise ok*	☒	
	Detektor 2/*detector 2* InGaAs	Gekühlt *cooled*	☒	Bandbreite Rauschen i.o *bandwidth noise ok*	☒	

Kontrolle aller mitgelieferter Zubehöre / *checking of all received accessories*				
Einkoppeloptik unbeschädigt *Optical probe not damaged*	Nr. 1 ISP250-110/211	☒		Photo ☐
	Nr. 2 EOP146	☒		Photo ☐
	Nr. 3 LED434B	☒		Photo ☐
	Nr. 4 Tra100-210	☒		Photo ☐
Faser i.o / *fiber ok*	Nr. 1 OFG464 (ISP250)	☒		Photo ☐
	Nr. 2 OFG444 (EOP146)	☒		Photo ☐
	Nr. 3 OFG464 (LED434B)	☒		Photo ☐
	Nr. 4 OFG312-3 (Tra100-210)	☒		Photo ☐
	Nr. 5 OFG313-3 (TOP100)	☐	fiber crushed	Photo ☒

Durchführung von / *executed by*: UBI
Datum / *date:* 15.Jun. 2020

Instrument Systems KONICA MINOLTA Group	**Wareneingangstest (SRV-302)** ***General instrument check (SRV-302)***	

TOP Objective vorhanden/ *TOP objective available* ☒	Obj. 1 60mm (SN: 3188989)	Zustand / *condition* cover didn't works properly	Photo ☒
	Obj. 2 (SN:)	Zustand / *condition*	Photo ☐
TOP100 vorhanden / *available* ☒		Zustand / *condition*o.k.	Photo ☐
Blendenumschaltung i.o *aperture switching ok* ☒			
View/Measure Umschaltung i.o *View/Measure switching ok* ☒			
Schielen i.o *peering ok* ☒			
TOP-Magnet i.o / ok ☒			
TOP-Distanzaufkleber vorhanden *TOP-distance label available* ☒	Wenn nein,wurde er nachgerüstet / *if not ,has it been upgraded* ☐		
TOP Transportsicherung vorhanden *TOP transport safety device available* ☒	Wenn nein,wurde es nachgerüstet /*if not ,has it been upgraded* ☐		
TOP200 vorhanden / *available* ☐	SN.	Zustand / *condition*	Photo ☐
Blendenumschaltung i.o *aperture switching ok* ☐			
Blendenrad leichtgängig *aperture wheel free-moving* ☐			
Overlay-Verschiebung getestet *Overlay shift tested* ☐			
Weißabgleich getestet White balance tested ☐			
Vignettierung getestet Vignetting tested ☐			
Blenden sind sauber und unbeschädigt , *apertures not contaminated and damaged*	☐ Blende / *aperture 1*	Zustand / *condition*	Photo ☐
	☐ Blende / *aperture 2*	Zustand / *condition*	Photo ☐
	☐ Blende / *aperture 3*	Zustand / *condition*	Photo ☐
	☐ Blende / *aperture 4*	Zustand / *condition*	Photo ☐
	☐ Blende / *aperture 5*	Zustand / *condition*	Photo ☐
	☐ Blende / *aperture 6*	Zustand / *condition*	Photo ☐
	☐ Offset	Zustand / *condition*	Photo ☐
TOP150 vorhanden / *available* ☐		Zustand / *condition*	Photo ☐
Blende sauber und unbeschädigt *aperture not contaminated or damaged* ☐			

Durchführung von / *executed by*: UBI
Datum / *date:* 15.Jun. 2020

Instrument Systems KONICA MINOLTA Group	**Wareneingangstest (SRV-302)** ***General instrument check (SRV-302)***	

ISP250-110 vorhanden / *available* ☒	SN. 05692007	Zustand / *condition* o.k. Photo ☐
Beschichtung i.o / *coating ok* ☒		
Hilfslichtquelle i.o *auxiliary light source ok* ☒		
Keine Fluoreszenz / *no fluorescence* (ISP75...2000) ☐		

Durchführung von / *executed by*: UBI
Datum / *date:* 15.Jun. 2020

Instrument Systems KONICA MINOLTA Group	**RMA-Abschlußbericht** ***RMA final report***	Rev.: 01 Seite: 1 von 1

RMA: 31885	**SN: 30932004**	**Gerät / *device*: SP320-114**
Wareneingangsdatum / *receipt*: 04.June. 2020		
Kunde / *customer*		
Universitat Polytechnica de Catalunya		
CD6-Centre Desemvolupament de Sensors		
c/ Rambla Sant Nebridi ,10		
08222 Terassa-Barcelona ,Spain		
Grund der Einsendung / *reason for return*		
Repair (Tra100-210→ Lamp not stable) / Recalibration		
Power switch defective		
☐ Garantie / *warranty* | ☐ Kulanz / *goodwill* | ☒ Rechnung / *on charge*		

Fehlfunktion / *malfunction*
1) TOP100: OFG313 fiber damaged →"Aperture 3" image is showing blocked/shadowed light path zone
2) Tra100-210 Lamp: during test with InGaAs (17 hours) → measurement abbreviation (radiometric integral) max. 0,15%
3) Sensitivity of the PMT3 detector decreased about 9 % relating to 2014 →this is normally for the PMT3 detector because it is aging temporally depending of diverse factors
4) Power switch defective → sporadically without function

Durchgeführte Arbeiten / *performed work*
SRV-0302 General instrument check
To 1) replaced the damaged OFG313 fiber
To 2) replaced the lamp (as a precaution →lamp is 16 years old)
To 4) replace the power switch
Calibrations →as ordered

Funktionstest nach der Reparatur / *functional test after repair*
Endurance test of mechanics & electronics
VDE safety test

Empfehlungen zur Fehlervermeidung / *recommendations for error prevention*
To 3) **On the "SP320 user manual "we recommend following calibration Interval:** The calibration interval is normally 1 year. Under difficult operating conditions, i.e. if the SPECTRO 320 (D) is subject to contamination (room air) or severe temperature variations, calibration must be carried out at shorter intervals. Detectors are subject to an aging process if they are used for long periods. This must be taken into account and in the case of UV detectors in particular. Shorter calibration intervals are also recommended here.

Platz für Messergebnisse oder Fotos / *space for measurement results or photos*:

Ausgetauschte Teile werden bei Instrument Systems gelagert und nach einem Monat fachgerecht entsorgt.
Defect parts will be kept at Instrument Systems and disposed of after one month.

Durchführung von / *executed by*: UBI
Datum / *date:* 02.07. 2020

Instrument Systems
KONICA MINOLTA Group

TEST CERTIFICATE

Certificate No.	CAL-200-20-015	
Instrument	Spectroradiometer	
Manufacturer	Instrument Systems Optische Messtechnik GmbH Kastenbauerstr. 2 81677 München	
Instrument Type / Serial Number	SP320 -114	SN: 30932004
Accessories / Serial Numbers	LED-434 OFG-464 PLG-420	The serial number of the instrument is provided on the optical fiber to ensure the proper assignment of the external optical probe to the instrument.
Type of Test	Determination of relative spectral irradiance (λ) in the wavelength range from 800 nm to 1700 nm in conformity with CIE63:1984	
Date of Test	26. Jun. 2020	
Customer	Universitat Polytécnica de Catalunya CD6 - Centre de Desemvolupament de Sensors c/ Rambla de Sant Nebridi 10 08222 Terrassa - Barcelona , Spain	
Purchase Order No.	SAR001782	

Instrument Systems Optische Messtechnik GmbH

Date	**Prepared by**	**Approved by**
02.07.2020	U. Binder Test Lab and Service Engineer	M. Steinbach Test Lab and Service Engineer

1. Instrument Description

The above named instrument under test is an optical spectroradiometer. The light, coupled into the spectrometer via an optical fiber, is split into its spectral components by means of a grating and then measured by a suitable detector. The measurement of the irradiance is carried out using an optical probe, which is fixed to the other end of the optical fiber.

2. Test Procedure

a) Wavelength accuracy:
The wavelength scale of the spectrometer is established and verified using emissions of spectral lamps and lasers. These emit one or more spectral lines of known wavelengths listed in the NIST Atomic Spectra Database. Lamps used in the test procedure include Hg, Ar and Xe lines. Other wavelengths are included using HeNe gas lasers. The line wavelengths of the test sources used for the wavelength calibration procedure are physical standards and do not require further traceability. In the infrared wavelength range above 1000 nm Nd based solid state lasers are also used. The wavelength of the lasers is determined using a wavemeter or reference spectrometer.

b) Spectral sensitivity:
The spectral sensitivity of the spectrometer is determined using an appropriate light source with a relative spectral distribution of radiation S(λ) that is known to lie within the spectrometer's wavelength range. For the visible and infrared wavelength range, a halogen lamp is used with a spectral distribution similar to a Planckian radiator with a color temperature of approximately 3100 K.
The measuring area of the optical probe is positioned centrically and perpendicularly to the optical axis of the defined radiation direction of the lamp.

The following configuration files must be installed in the spectrometer and/or the measuring software to ensure proper test results:

309320L1.ini	Configuration file containing information about the wavelength scale, the absolute sensitivity and the hardware parameters of the spectrometer.
309320L1.isc	Calibration file containing the correction of the spectral sensitivity with detector InGaAs.

3. Measurement conditions and traceability

Used reference standards and their traceability:

Working Standard	Internal Calibration Reference	Date of Calibration	Traceable to	External Calibration Reference
1000W halogen lamp BN-9101-618	CEQ-252-20-006	Jan. 2020	Reference standard BN-9101-711	40020-18-PTB

Ambient conditions:

Ambient conditions	
Temperature	23 °C ± 3°C
Humidity	53% ± 5% relative humidity

Spectrometer settings during irradiance measurement:

Detector :	InGaAs	Grating :	600 g/mm IR1
Wavelength range :	800 - 1700	Bandpass :	2 nm
Scan speed:	60 ms / nm	Density filter:	none
Step width:	1 nm	Cut filter :	yes
Averaging:	2		

The warm-up time of the spectrometer was 2 hours. The spectrometer SP320-114 and all accessories listed on page 1 were in good order and condition during the entire calibration process.

4. Measurement results

a) Wavelength

Table of measured lines:

Nominal value [nm]	Measured value [nm]
881.94	881.94
979.97	980.01
1064.27	1064.3
1152.27	1152.28
1531.93	1531.94

The measurement tolerance of the wavelength measurement is +/-0.2 nm for all wavelengths.

b) Relative spectral irradiance

For the testing of the measurement accuracy of the spectroradiometer for relative irradiance the measurement parameters and working standard mentioned in point 3 were used.

Table of measured relative irradiance values:

Wavelength [nm]	Relative irradiance Nominal value	Relative irradiance Measured value
800	0.949613	0.948681
900	0.998345	0.997989
1000	0.981498	0.981285
1100	0.926806	0.926648
1200	0.845145	0.845217
1300	0.757005	0.756981
1400	0.675115	0.674837
1500	0.593055	0.592623
1600	0.517725	0.517466

5. Notes

a) Any mechanical modifications to the tested instrument and the accessories listed on page 1 influence the sensitivity of the instrument.
b) 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.
c) This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.
d) The results indicated in this certificate refer solely to the instruments tested in the laboratory.
e) Strong UV-radiation can cause a significant aging of optical components. The measurement results can be influenced by that aging.
f) For measurements with the largest bandpass (10nm with 600g/mm grating) the spectral sensitivity needs to be corrected. That is done using the calibration files „LED434-B, InGaAs calibrated on Bandpass 10nm " (309320L2.ini /309320L2.isc).

End of certificate

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-19052-01-00

Instrument Systems
KONICA MINOLTA Group

TEST CERTIFICATE

Certificate No.	CAL-203-20-014	
Instrument	Spectroradiometer	
Manufacturer	Instrument Systems Optische Messtechnik GmbH Kastenbauerstr. 2 81677 München	
Instrument Type / Serial Number	SP320 -114	SN: 30932004
Accessories / Serial Numbers	EOP-146 OFG-444 PLG-440	The serial number of the instrument is provided on the optical fiber to ensure the proper assignment of the external optical probe to the instrument.
Type of Test	Determination of spectral irradiance E_e (λ) in the wavelength range from 280 nm to 1700 nm in conformity with CIE63:1984	
Date of Test	25. Jun. 2020	
Customer	Universitat Polytécnica de Catalunya CD6 - Centre de Desemvolupament de Sensors c/ Rambla de Sant Nebridi, 10 08222 Terrassa - Barcelona Spain	
Purchase Order No.	SAR001782	

Instrument Systems Optische Messtechnik GmbH

Date	**Prepared by**	**Approved by**
02.07.2020	U. Binder Test Lab and Service Engineer	M. Steinbach Test Lab and Service Engineer

1. Instrument Description

The above named instrument under test is an optical spectroradiometer. The light, coupled into the spectrometer via an optical fiber, is split into its spectral components by means of a grating and then measured by a suitable detector. The measurement of the irradiance is carried out using an optical probe, which is fixed to the other end of the optical fiber.

2. Test Procedure

a) Wavelength accuracy:
The wavelength scale of the spectrometer is established and verified using emissions of spectral lamps and lasers. These emit one or more spectral lines of known wavelengths listed in the NIST Atomic Spectra Database. Lamps used in the test procedure include Hg, Ar and Xe lines. Other wavelengths are included using HeNe gas lasers. The line wavelengths of the test sources used for the wavelength calibration procedure are physical standards and do not require further traceability. In the infrared wavelength range above 1000 nm Nd based solid state lasers are also used. The wavelength of the lasers is determined using a wavemeter or reference spectrometer.

b) Spectral sensitivity:
The spectral sensitivity of the spectrometer is determined using an appropriate light source with a relative spectral distribution of radiation S(λ) that is known to lie within the spectrometer's wavelength range. For the visible and infrared wavelength range, a halogen lamp is used with a spectral distribution similar to a Planckian radiator with a color temperature of approximately 3100 K. For the ultraviolet part of the spectrum, a deuterium lamp is applied.
The measuring area of the optical probe is positioned centrically and perpendicularly to the optical axis of the defined radiation direction of the lamp.

c) Irradiance measurement:
The test procedure is based on the following standard: CIE Commission Internationale de L`Eclairage, ""The spectroradiometric measurement of light sources", Publication CIE 63:1984.
The irradiance measurement is carried out using an appropriate light source with a known spectral irradiance E(λ) for a specified radiation direction and a predefined distance. This light source homogenously radiates light onto the optical probe. The distance between the front face of the optical probe and the reference plane of the lamp relevant for the measured spectral irradiance is 70 cm.

The following configuration files must be installed in the spectrometer and/or the measuring software to ensure proper test results:

309320E1.ini	Configuration file containing information about the wavelength scale, the absolute sensitivity and the hardware parameters of the spectrometer.
309320E1.isc	Calibration file containing the correction of the spectral sensitivity with detector PMT3 and detector InGaAs.

3. Measurement conditions and traceability

Used reference standards and their traceability:

Working Standard	Internal Calibration Reference	Date of Calibration	Traceable to	External Calibration Reference
1000W halogen lamp BN-9101-618	CEQ-252-20-006	Jan. 2020	Reference standard BN-9101-711	40020-18-PTB
Deuterium lamp AN5083	CEQ-262-19-005	Nov. 2019	Reference standard DLS-IS-L#01	40022-19-PTB

Ambient conditions:

Ambient conditions	
Temperature	23 °C ± 3°C
Humidity	55% ± 5% relative humidity

Spectrometer settings during irradiance measurement:

Detector 1 :	PMT3	Grating 1 :	1200 g/mm UV
Detector 2 :	InGaAs	Grating 2 :	600 g/mm IR1
Wavelength range 1:	280 – 930 nm	Bandpass 1 :	2.5 nm
Wavelength range 2:	800 - 1700	Bandpass 2 :	5 nm
Scan speed:	60 ms / nm	Density filter:	none
Step width:	1 nm	Cut filter :	yes
Averaging:	2		
PMT high voltage:	3	PMT cooling:	none

The warm-up time of the spectrometer was 2 hours. The spectrometer SP320-114 and all accessories listed on page 1 were in good order and condition during the entire calibration process.

4. Measurement results

a) Wavelength

Table of measured lines:

Nominal value [nm]	Measured value [nm]
435.83	435.88
546.08	546.13
632.82	632.88
881.94	881.91
979.97	979.98
1064.27	1064.3
1152.27	1152.37
1309.68	1309.69
1531.93	1531.91

The measurement tolerance of the wavelength measurement is +/-0.2 nm for all wavelengths.

b) Irradiance

For the testing of the measurement accuracy of the spectroradiometer for irradiance the measurement parameters and working standard mentioned in point 3 were used.

Table of measured irradiance values

Wavelength [nm]	Irradiance Nominal value [W/(m² nm)]	Irradiance Measured value [W/(m² nm)]
400	9.300E-03	9.263E-03
500	3.186E-02	3.177E-02
600	6.110E-02	6.115E-02
700	8.576E-02	8.576E-02
800	1.007E-01	1.007E-01
900	1.059E-01	1.061E-01
1000	1.041E-01	1.042E-01
1200	8.964E-02	8.966E-02
1400	7.161E-02	7.165E-02
1600	5.443E-02	5.495E-02

The measurement uncertainty of the spectral irradiance depends on the wavelength:

Wavelength λ in [nm]	Relative expanded uncertainty
280 ≤ λ < 300	9%
300 ≤ λ < 360	7%
360 ≤ λ < 400	4%
400 ≤ λ < 800	3.5%
800 ≤ λ < 850	4%
850 ≤ λ < 950	5%
950 ≤ λ < 1650	4.5%
1650 ≤ λ < 1700	6%

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.

5. Notes

a) Any mechanical modifications to the tested instrument and the accessories listed on page 1 influence the sensitivity of the instrument.
b) 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.
c) This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.
d) The results indicated in this certificate refer solely to the instruments tested in the laboratory.
e) Strong UV-radiation can cause a significant aging of optical components. The measurement results can be influenced by that aging.
f) For measurements with the largest bandpass (10nm with 600g/mm grating) the spectral sensitivity needs to be corrected. That is done using the calibration files „EOP146, InGaAs calibrated on Bandpass 10nm“ (309320E2.ini /309320E2.isc).

End of certificate

DAkkS Deutsche Akkreditierungsstelle D-PL-19052-01-00

Instrument Systems
KONICA MINOLTA Group

TEST CERTIFICATE

Certificate No.	CAL-221-20-002	
Instrument	Spectroradiometer	
Manufacturer	Instrument Systems Optische Messtechnik GmbH Kastenbauerstr. 2 81677 München	
Instrument Type / Serial Number	SP320 -114	SN: 30932004
Accessories / Serial Numbers	LED-434 with LED-439 OFG-464 PLG-420	The serial number of the instrument is provided on the optical fiber to ensure the proper assignment of the external optical probe to the instrument.
Type of Test	Test of averaged LED intensity $I_{LED,B}$ [cd] of LEDs in conformity with CIE127:2007.	
Date of Test	26. Jun. 2020	
Customer	Universitat Polytécnica de Catalunya CD6 - Centre de Desemvolupament de Sensors c/ Rambla de Sant Nebridi 10 08222 Terrassa - Barcelona , Spain	
Purchase Order No.	SAR001782	

Instrument Systems Optische Messtechnik GmbH

Date	**Prepared by**	**Approved by**
02.07.2020	U. Binder Test Lab and Service Engineer	M. Steinbach Test Lab and Service Engineer

1. Instrument Description

The above named instrument under test is an optical spectroradiometer. The light, coupled into the spectrometer via an optical fiber, is split into its spectral components by means of a grating and then measured by a suitable detector. The measurement of the Averaged LED intensity of LEDs is carried out using a detector head which is fixed to the other end of the optical fiber.
The detector head comprises a plane, circular diffuser with an area of 100 mm². A spacer tube placed in front of the diffuser and a suitable LED test socket are used to ensure the correct positioning of the LED, centrally and perpendicularly to the diffuser and with a distance of 100 mm ($I_{LED,B}$) and 316 mm ($I_{LED,A}$), respectively, to the LED's light emitting area.

2. Test Procedure

a) Wavelength accuracy:
The wavelength scale of the spectrometer is established and verified using emissions of spectral lamps and lasers. These emit one or more spectral lines of known wavelengths listed in the NIST Atomic Spectra Database. Lamps used in the test procedure include Hg, Ar and Xe lines. Other wavelengths are included using HeNe gas lasers. The line wavelengths of the test sources used for the wavelength calibration procedure are physical standards and do not require further traceability. In the infrared wavelength range above 1000 nm Nd based solid state lasers are also used. The wavelength of the lasers is determined using a wavemeter or reference spectrometer.

b) Spectral sensitivity:
The spectral sensitivity of the spectrometer is determined using one or more appropriate light sources with a relative spectral distribution of radiation S(λ) that is known to lie within the spectrometer's wavelength range. A halogen lamp with a spectral distribution similar to a Planckian radiator with a colour temperature of approximately 3100 K is used for the visible (and infrared) wavelength range between 360nm and 930nm. For the ultraviolet part of the spectrum, a deuterium lamp is used in the wavelength range between 200nm and 360nm.
The radiation of the lamp is coupled into the detector head, centrally and perpendicularly to the diffuser. The spacer tube for the positioning of the LED is removed during this procedure.

c) Averaged LED intensity of LEDs:
The test procedure is based on the following standard: CIE Commission Internationale de L`Eclairage, "Measurement of LEDs", Publication CIE 127:2007 2nd edition.
The measurement is carried out using high-power LED calibration standards with calibrated averaged LED intensity values. The LED calibration standards are operated with a constant current and at a stabilized temperature. The light of the LED is emitted from the front face of a metal tube with a diameter of 25 mm that is mounted on the top of the housing. The LED calibration standards are mounted to an appropriate test socket and positioned in the required distance to the detector head according to CIE127:2007 $I_{LED,B}$.

The following configuration files must be installed in the spectrometer and/or the measuring software to ensure proper test results:

309320L1.ini	Configuration file containing information about the wavelength scale, the absolute sensitivity and the hardware parameters of the spectrometer.
309320L1.isc	Calibration file containing the correction of the spectral sensitivity with detector PMT3.

3. Measurement conditions and traceability

Used reference standards and their traceability:

Working Standard	Internal Calibration Reference	Date of Calibration	Traceable to	External Calibration Reference
1000W halogen lamp BN-9101-618	CEQ-252-20-006	Jan. 2020	Reference standard BN-9101-711	40020-18-PTB
Deuterium lamp AN5083	CEQ-262-19-005	Nov. 2019	Reference standard DLS-IS-L#01	40022-19-PTB
LED calibration standard white, ACS-570-1 SN: 007357018	LED-19-017	Sep. 2019	Reference standards: - ACS570-1 SN:10008751 - ACS570-1 SN:10008851	 47237 PTB 17 47233 PTB 17
LED calibration standard blue, ACS-570-3 SN: 008457018	LED-19-019	Sep. 2019	Reference standards: - ACS570-3 SN:10051551 - ACS570-3 SN:10051651	 47238 PTB 17 47234 PTB 17
LED calibration standard green, ACS-570-5 SN: 007557018	LED-19-021	Sep. 2019	Reference standards: - ACS570-5 SN:000457017 - ACS570-5 SN:10052051	 47239 PTB 17 47235 PTB 17
LED calibration standard red, ACS-570-7 SN: 007757018	LED-19-023	Sep. 2019	Reference standards: - ACS570-7 SN:000957017 - ACS570-7 SN:10061451	 47240 PTB 17 47236 PTB 17

Ambient conditions:

Temperature	23 °C +/- 3 °C
Humidity	54 % relative humidity

Spectrometer settings during averaged LED intensity measurement:

Detector:	PMT3	Averaging:	2
Grating:	1200 g/mm UV	Step width:	1 nm
Wavelength range:	200 – 930 nm	Density filter:	none
Bandpass:	1 nm	Cut filter :	yes
Scan speed:	60 ms / nm	PMT high voltage:	3
PMT cooling:	none		

The warm-up time of the spectrometer was 2 hours. The spectrometer SP320-114 and all accessories listed on page 1 were in good order and condition during the entire calibration process.

4. Measurement results

a) Wavelength

Table of measured lines:

Nominal value [nm]	Measured value [nm]
253.65	253.66
435.84	435.85
546.08	546.09
632.82	632.84
881.94	881.94

The measurement tolerance of the wavelength measurement is 0.2 nm for all wavelengths.

b) Averaged LED intensity of LEDs

For the testing of the measurement accuracy of the spectroradiometer for averaged LED intensity the measurement parameters and working standards mentioned in point 3 were used.

Table of results:

LED Serial number	Dominant wavelength [nm] / correlated color temperature [K]	Averaged LED intensity [cd] Nominal value	Averaged LED intensity [cd] Measured value
ACS570-1_007357018	5905	18.83	18.83
ACS570-3_008457018	481.34	8.647	8.797
ACS570-5_007557018	528.31	18.58	18.54
ACS570-7_007757018	622.34	9.701	9.702

The values of dominant wavelength and correlated color temperature are not subject to the test procedure and specified for information only.

The measurement uncertainty of the averaged LED intensity depends on the color of the LED:

Color	relative expanded uncertainty
Blue	4.5%
White	3%
Green	3%
Red	4.5%

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.

5. Notes

a) Any mechanical modifications to the tested instrument and the accessories listed on page 1 influence the sensitivity of the instrument.
b) 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.
c) This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.
d) The results indicated in this certificate refer solely to the instruments tested in the laboratory.
e) The accessory LED-439 which is used for this testing is not the property of the customer and will not be delivered with this purchase order.

End of certificate

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-19052-01-00

Instrument Systems
KONICA MINOLTA Group

TEST CERTIFICATE

Certificate No.	CAL-230-20-013	
Instrument	Spectroradiometer	
Manufacturer	Instrument Systems Optische Messtechnik GmbH Kastenbauerstr. 2 81677 München	
Instrument Type / Serial Number	SP320 -114	SN: 30932004
Accessories / Serial Numbers	TOP100-100	SN: --
	Nikon AF 60mm lens	SN: 3188989
	TOP100-101	The serial number of the instrument is provided on the optical fiber to ensure the proper assignment of the external optical probe to the instrument.
Type of Test	Determination of luminance L_v and spectral radiance L_e (λ) in the wavelength range from 380 nm to 930 nm in conformity with CIE63:1984, ISO 23539:2005 und DIN 13032-1:2012.	
Date of Test	30. Jun. 2020	
Customer	Universitat Polytécnica de Catalunya CD6 - Centre de Desemvolupament de Sensors c/ Rambla de Sant Nebridi 10 08222 Terrassa - Barcelona , Spain	
Purchase Order No.	SAR001782	

Instrument Systems Optische Messtechnik GmbH

Date	**Prepared by**	**Approved by**
02.07.2020	U. Binder Test Lab and Service Engineer	M. Steinbach Test Lab and Service Engineer

1. Instrument Description

The above named instrument under test is an optical spectroradiometer. The light, coupled into the spectrometer via an optical fiber, is split into its spectral components by means of a grating and then measured by a suitable detector. The measurement of the radiance is carried out using an optical probe, which is fixed to the other end of the optical fiber.

2. Test Procedure

a) Wavelength accuracy:
The wavelength scale of the spectrometer is established and verified using emissions of spectral lamps and lasers. These emit one or more spectral lines of known wavelengths listed in the NIST Atomic Spectra Database. Lamps used in the test procedure include Hg, Ar and Xe lines. Other wavelengths are included using HeNe gas lasers. The line wavelengths of the test sources used for the wavelength calibration procedure are physical standards and do not require further traceability. In the infrared wavelength range above 1000 nm Nd based solid state lasers are also used. The wavelength of the lasers is determined using a wavemeter or reference spectrometer.

b) Spectral sensitivity:
The spectral sensitivity of the spectrometer is determined using a standard lamp for radiance with a relative spectral distribution of radiation S(λ) that is known to lie within the spectrometer's wavelength range. The spectral distribution is similar to a Planckian radiator with a color temperature of approximately 2856 K. The optical axis of the telescopic optical probe lies perpendicular to the luminous area of the radiance standard. This area is in the focus of the objective lens.

c) Luminance and radiance:
The test procedure is based on the following standards: CIE Commission Internationale de L`Eclairage, "The spectroradiometric measurement of light sources", Publication CIE 63:1984, and "Photometry — The CIE system of physical photometry", Publication ISO 23539:2005 (CIE S010:2004).
The luminance is determined focusing the objective lens of the optical probe onto the luminous area of a working standard with known average luminance and radiance values. The distance between the front plane of the housing of the telescopic optical probe and the luminous area of the standard lamp is 500mm.

The following configuration files must be installed in the spectrometer and/or the measuring software to ensure proper test results:

309320T1.ini	Configuration file containing information about the wavelength scale, the absolute sensitivity and the hardware parameters of the spectrometer.
309320T1.isc	Calibration file containing the correction of the spectral sensitivity with detector PMT3.

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 Hoffman Engineering LS-65-8E #HEC7936	CEQ-274-20-011	19.06.2020	- Reference standard FEL-1000W BN-9101-712 - Reflectance standard SRS-99-020 no. 4029 - Luminance standard LN3 SN: 03B202	40021-18-PTB PTB 44190/17 40059 PTB 12

Ambient conditions:

Temperature	23 °C +/- 3 °C
Humidity	57 % relative humidity

Spectrometer settings during radiance measurement:

Detector:	PMT3	Averaging:	2
Grating:	1200 l/mm UV	Step width:	1 nm
Wavelength range:	380 – 930 nm	Density filter:	none
Bandpass:	5 nm	Cut filter :	yes
Scan speed:	60 ms / nm	TOP100 aperture size:	2
PMT high voltage:	3	" f number of lens:	2.8
PMT cooling:	none	" focal length of lens:	60 mm

The warm-up time of the spectrometer was 3 hours.

4. Measurement results

a) Wavelength

Table of measured lines:

Nominal value [nm]	Measured value [nm]
435.84	435.88
546.08	546.14
632.82	632.90
881.94	881.90

The measurement tolerance of the wavelength measurement is 0.2 nm for all wavelengths.

b) Luminance and radiance

For the testing of the measurement accuracy of the spectroradiometer for spectral radiance and luminance the measurement parameters and working standard mentioned in point 3 were used.

Table of results:

Wavelength [nm]	Radiance L_e Nominal value [W/(cm² sr nm)]	Radiance L_e Measured value [W/(cm² sr nm)]
400	7.939E-08	7.968E-08
500	4.003E-07	4.004E-07
600	8.638E-07	8.645E-07
700	1.288E-06	1.285E-06
800	1.589E-06	1.592E-06
900	1.751E-06	1.754E-06
Luminance L_v	**Nominal value** [cd/m²]	**Measured value** [cd/m²]
	494.5	494.6

The measurement uncertainty of the spectral radiance depends on the wavelength:

Wavelength λ in [nm]	Relative expanded uncertainty
380 ≤ λ < 400	5%
400 ≤ λ < 500	4%
500 ≤ λ < 850	3.5%
850 ≤ λ < 930	4.5%

The measurement uncertainty for luminance L_v relates to the spectra of halogen lamps with a color temperature of approximately 2856 K and amounts to:

Luminance Lv	Relative expanded uncertainty
	3.5%

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.

5. Notes

a) Any mechanical modifications to the tested instrument and the accessories listed on page 1 influence the sensitivity of the instrument.
b) 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.
c) This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.
d) The results indicated in this certificate refer solely to the instruments tested in the laboratory.

End of certificate

DAkkS Deutsche Akkreditierungsstelle D-PL-19052-01-00

Instrument Systems
KONICA MINOLTA Group

TEST CERTIFICATE

Certificate No.	CAL-241-20-001	
Instrument	Spectroradiometer	
Manufacturer	Instrument Systems Optische Messtechnik GmbH Kastenbauerstr. 2 81677 München	
Instrument Type / Serial Number	SP320 -114	SN: 30932004
Accessories / Serial Numbers	ISP-250	SN: 05692007
	OFG-464	The serial number of the instrument is provided on the optical fiber to ensure the proper assignment of the external optical probe to the instrument.
	PLG-420	
Type of Test	Test of luminous flux [lm] of LEDs in conformity with CIE127 - 2007	
Date of Test	29. Jun. 2020	
Customer	Universitat Polytécnica de Catalunya CD6 - Centre de Desemvolupament de Sensors c/ Rambla de Sant Nebridi 10 08222 Terrassa - Barcelona , Spain	
Purchase Order No.	SAR001782	

Instrument Systems Optische Messtechnik GmbH

Date	**Prepared by**	**Approved by**
02.07.2020	U. Binder Test Lab and Service Engineer	M. Steinbach Test Lab and Service Engineer

1. Instrument Description

The above named instrument under test is an optical spectroradiometer. The light, coupled into the spectrometer via an optical fiber, is split into its spectral components with a diffraction grating and then measured by a suitable detector. The measurement of the luminous flux of LEDs is carried out using an integrating sphere which is fixed to the other end of the optical fiber.

2. Test Procedure

a) Wavelength accuracy:

The wavelength scale of the spectrometer is established and verified using emissions of spectral lamps and lasers. These emit one or more spectral lines of known wavelengths listed in the NIST Atomic Spectra Database. Lamps used in the test procedure include Hg, Ar and Xe lines. Other wavelengths are included using HeNe gas lasers. The line wavelengths of the test sources used for the wavelength calibration procedure are physical standards and do not require further traceability. In the infrared wavelength range above 1000 nm Nd based solid state lasers are also used. The wavelength of the lasers is determined using a wavemeter or reference spectrometer.

b) Spectral sensitivity:

The spectral sensitivity of the spectrometer is determined using one or more appropriate light sources with a relative spectral distribution of radiation S(λ) that is known to lie within the spectrometer's wavelength range. A halogen lamp with a spectral distribution similar to a Planckian radiator with a colour temperature of approximately 3100 K is used for the visible (and infrared) wavelength range between 360nm and 930nm. For the ultraviolet part of the spectrum, a deuterium lamp is used in the wavelength range between 240nm and 360nm.
The radiation of the lamp is coupled in via the side port of the integrating sphere. Apart from the auxiliary lamp and the detector including the corresponding shutters, there are no further accessories inside the sphere.

c) Luminous flux of LEDs:

The test procedure is based on the following standard: CIE Commission Internationale de L`Eclairage, "Measurement of LEDs", Publication CIE 127:2007 2nd edition.
The measurement is carried out using high-power LED calibration standards with calibrated luminous flux values. The LED calibration standards are operated with a constant current and at a stabilized temperature. The light of the LED is emitted from the front face of a metal tube with a diameter of 25 mm that is mounted on the top of the housing. The luminous flux is measured using an integrating sphere. The LED is positioned at the edge of the integrating sphere, with the light emitting area extending approximately 2 mm into the sphere. The diameter of the aperture of the side port is 10 mm. The mechanical design of the LED prevents any backward-directed radiation.
For calibration the adapter plate ISP250-211 is mounted at the port of the integrating sphere to insert the LED test socket.

The following configuration files must be installed in the spectrometer and/or the measuring software to ensure proper test results:

30932012.ini	Configuration file containing information about the wavelength scale, the absolute sensitivity and the hardware parameters of the spectrometer.
30932012.isc	Calibration file containing the correction of the spectral sensitivity with detector PMT3.

3. Measurement conditions and traceability

Used reference standards and their traceability:

Working Standard	Internal Calibration Reference	Date of Calibration	Traceable to	External Calibration Reference
1000W halogen lamp BN-9101-618	CEQ-252-20-006	Jan. 2020	Reference standard BN-9101-711	40020-18-PTB
Deuterium lamp AN5083	CEQ-262-19-005	Nov. 2019	Reference standard DLS-IS-L#01	40022-19-PTB
LED calibration standard white, ACS-570-1 SN: 007357018	LED-19-017	Sep. 2019	Reference standards: - ACS570-1 SN:10008751 - ACS570-1 SN:10008851	 47237 PTB 17 47233 PTB 17
LED calibration standard blue, ACS-570-3 SN: 008457018	LED-19-019	Sep. 2019	Reference standards: - ACS570-3 SN:10051551 - ACS570-3 SN:10051651	 47238 PTB 17 47234 PTB 17
LED calibration standard green, ACS-570-5 SN: 007557018	LED-19-021	Sep. 2019	Reference standards: - ACS570-5 SN:000457017 - ACS570-5 SN:10052051	 47239 PTB 17 47235 PTB 17
LED calibration standard red, ACS-570-7 SN: 007757018	LED-19-023	Sep. 2019	Reference standards: - ACS570-7 SN:000957017 - ACS570-7 SN:10061451	 47240 PTB 17 47236 PTB 17

Ambient conditions:

Ambient conditions	
Temperature	23 °C ± 3 °C
Humidity	56% ± 5% relative humidity

Spectrometer settings during luminous flux measurement:

Detector:	PMT3	Averaging:	2
Grating:	1200 g/mm UV	Step width:	1 nm
Wavelength range:	240 – 930 nm	Density filter:	none
Bandpass:	2.5 nm	Cut filter :	yes
Scan speed:	60 ms / nm	PMT high voltage:	3
PMT cooling:	none		

The warm-up time of the spectrometer was 3 hours. The spectrometer SP320-114 and all accessories listed on page 1 were in good order and condition during the entire calibration process.

4. Measurement results

a) Wavelength

Table of measured lines:

Nominal value [nm]	Measured value [nm]
253.65	253.65
435.84	435.96
546.08	546.18
632.82	632.93
881.94	881.94

The measurement tolerance of the wavelength measurement is +/-0.2 nm for all wavelengths.

b) Luminous flux of LEDs

For the testing of the measurement accuracy of the spectroradiometer for luminous flux of LEDs the measurement parameters and working standards mentioned in point 3 were used.

Table of results:

LED Serial number	Dominant wavelength [nm] / correlated color temperature [K]	Luminous flux [lm] Nominal value	Luminous flux [lm] Measured value
ACS570-1_007357018	5782	17.72	17.72
ACS570-3_008457018	481.23	7.670	7.849
ACS570-5_007557018	528.10	16.67	16.72
ACS570-7_007757018	622.37	9.485	9.476

The values of dominant wavelength and correlated color temperature are not subject to the test procedure and specified for information only.

The measurement uncertainty of the luminous flux depends on the color of the LED:

Color	relative expanded uncertainty
Blue	4.5%
White	3.5%
Green	3.5%
Red	5%

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.

5. Notes

a) Any mechanical modifications to the tested instrument and the accessories listed on page 1 influence the sensitivity of the instrument.
b) 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.
c) This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.
d) The results indicated in this certificate refer solely to the instruments tested in the laboratory.
e) The BaSO4 coating of the sphere can fatigue due to external influences like dirt, UV-radiation, heat and humidity. These processes can change the reflection of the sphere wall and therefore influence the measurement results.

End of certificate