

ACS & ACU Series

Advanced Calibration Standards
White, RGB, UV and IR



We bring quality to light.



Key features at a glance

- ▲ Advanced Calibration Standards on LED basis available in white, RGB, UV and IR
- ▲ Reference values for radiant or luminous flux, averaged LED intensity and luminance traceable to PTB standards (in conformity with DIN ISO 17025)
- ▲ Specification of color coordinates and dominant wavelength or color temperature if applicable
- ▲ 0.2 % photometric stability over min. 100 operating hours for ACS standards with white LED
- ▲ Maximum operational reliability by use with an ACU control unit

01 \\ Advanced Calibration Standards – from UVC to IR

The LED calibration standards of the ACS series allow you an easy and reliable accuracy proof of the measurement systems from Instrument Systems. If necessary, the photometric or radiometric value can be recalibrated. The ACS calibration standards provide reference values for radiant or luminous flux, averaged LED intensity and luminance according to the CIE 127: 2007 substitution method. The entire spectral range from UVC, UVB and UVA, over blue, green, red and white to IR is covered with the various single species of ACS 570. The high level of accuracy and direct traceability to the national reference standards of the PTB (German National Metrology Institute) are guaranteed by our ISO 17025 accredited test laboratories (registration number D-PL-19052-01-00).

Rapid operational readiness and long service life make the ACS calibration standards ideal for a multitude of laboratory applications, as well as for robust deployment in a production environment. Optimum thermal management is necessary to guarantee the reproducible and permanently stable optical radiant power of the LED calibration standard. The LED and temperature control

system are housed in an enclosure with very low heat conductivity and, therefore, not sensitive to external temperature fluctuations. The compact power and TEC control unit ACU from Instrument Systems ensures rapid temperature control and high stability for the operating current. Alternatively, a Keithley 24xx can be used as a current source and an Arroyo 5305 as a TEC controller.



Figure 1: Single ACS-570-x with different colors.

ACS-570-x – LED calibration standards for luminous flux and luminous intensity

The ACS 570 LED calibration standards for luminous flux and averaged LED intensity ILED-B are available in cool white (ACS-570-1) and the three basic colors blue (-3), green (-5) and red (-7). This covers the entire visible spectral range. Normally, the white ACS-570-1 is used for the calibration of all larger integrating spheres ISP and luminous intensity adapters LED-4xx from Instrument systems. Typical luminous flux values are 20 - 30 lm and the averaged LED intensity is 20 - 30 cd.

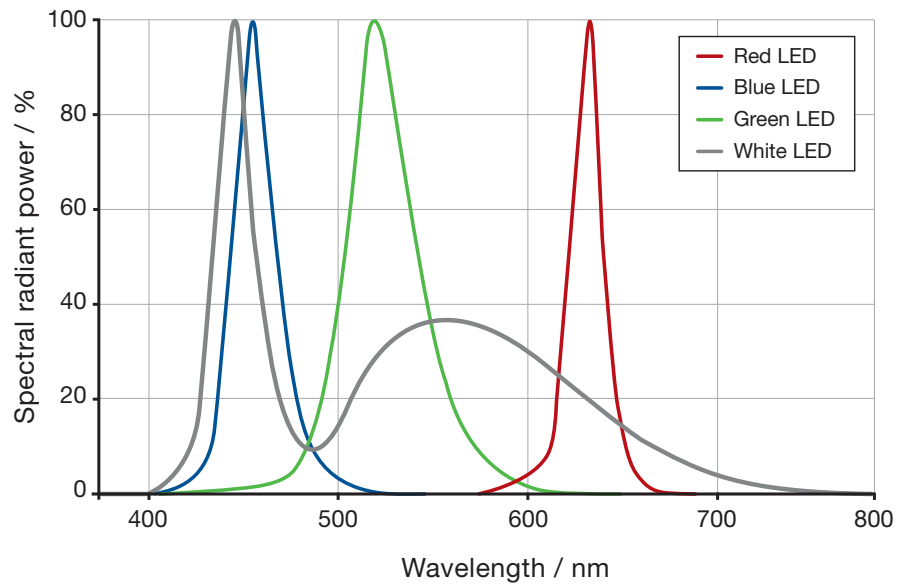


Figure 2: Typical spectral curves for LED calibration standards ACS-570-x

ACS-570-1x/-4x – IR LED calibration standards for radiant flux

The IR LED calibration standards of ACS 570 series from Instrument Systems GmbH are highly stable infrared sources based on LED technology.

They are available in five versions with typical peak wavelengths of

- » 860 nm (ACS 570-15),
- » 950 nm (ACS 570-17),
- » 1200 nm (ACS 570-42),
- » 1300 nm (ACS 570-44) and
- » 1450 nm (ACS 570-46).

As a service, Instrument Systems provides traceable reference values for radiant flux.

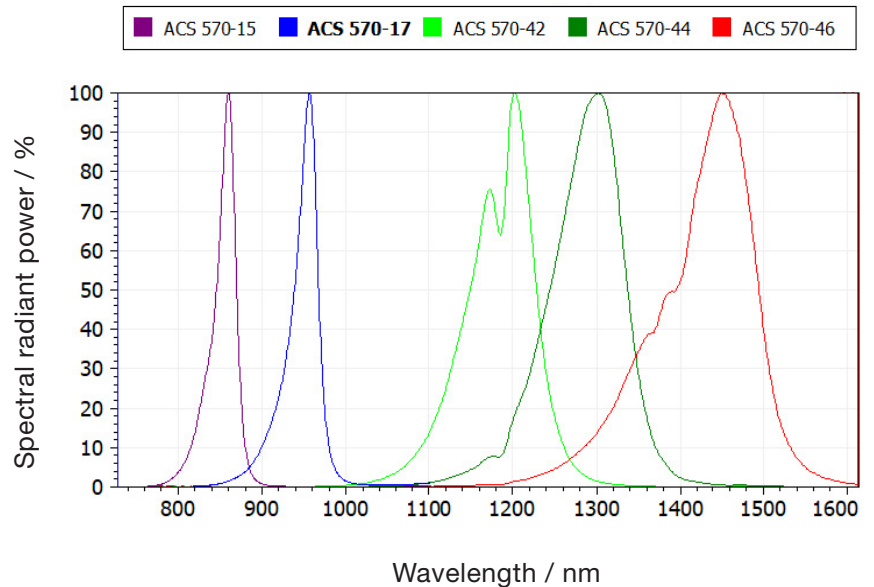


Figure 3: Typical spectral curves for IR LED calibration standards ACS-570-1x

ACS-570-2x – UV LED calibration standards for radiant flux

Instrument Systems is the first provider worldwide to develop UV-LED calibration standards that can be traceably calibrated to the radiant flux. The traceability of the radiant flux has been achieved through the very precise calibration of the spectrometer coupling optics to the irradiance and integrative measurement with a goniospectroradiometer.

The ACS 570 UV LED calibration standards from Instrument Systems are available in three versions with typical peak wavelengths 280 nm for UVC (ACS-570-24), 305 nm for UVB (ACS-570-26), and 365 nm for UVA (ACS-570-28).

The extremely low measurement uncertainties ($k = 2$) of only 4.5% in UVC, 3.5% in UVB and 2% in UVA are comparatively low as in the visible range, which is metrologically less challenging.

UV-LED calibration standards can be used for monitoring and for the absolute calibration of special UV measurement equipment such as integrating spheres of the ISP-PTFE series.

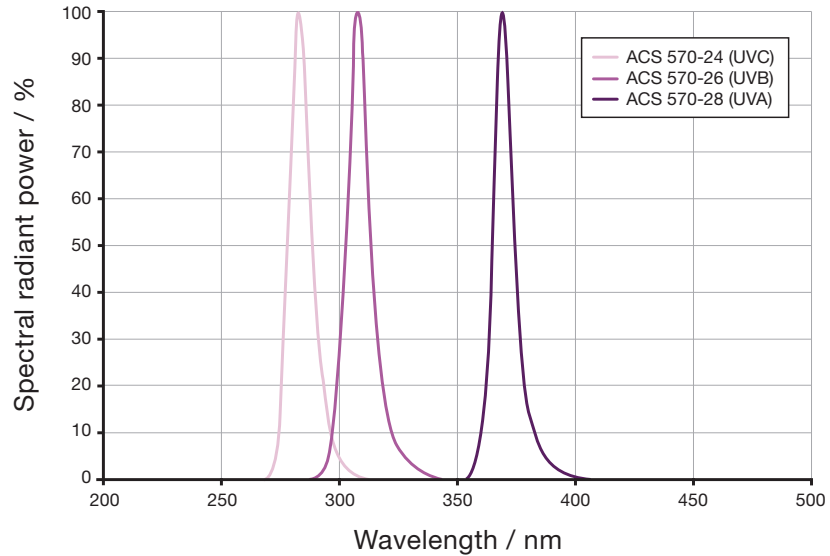


Figure 4: Typical spectral curves for UV LED calibration standards ACS-570-2x

ACS-570-22117 – Broadband LED standard for VIS/NIR

The ACS 570-22117 is a high-performance calibration standard for the visible and near-infrared spectral region. It covers a wide spectral emission range from 400 to 1000 nm. Typical values are about 5 to 10 lm for luminous flux and 35 to 45 mW for radiant power. The emission angle of the device covers approx. $\pm 30^\circ$.

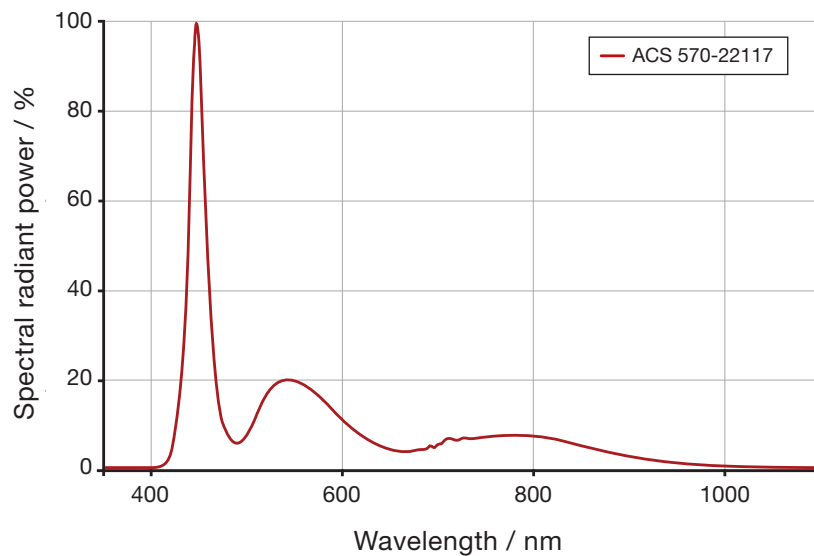


Figure 5: Emission spectrum of ACS-22117.

ACS 586/587 – LED luminance standards

The ACS 586/587 are new, highly stable LED luminance standards. They support testing of all luminance meters on both filter and spectroradiometric basis. The radiation of the high-power LED is emitted into an integrating sphere with an inner diameter of 100 mm

through a diffuser. The inner layer of the integrating sphere homogenizes further the radiation and emits homogeneous luminance through an opening of 25 mm in diameter. This structure ensures that the LED luminance standard has Lambertian radiation characteristics.

The reference values, the spectrum, all relevant operating parameters and the tracked expired operation time are stored in the ACS 586/587.

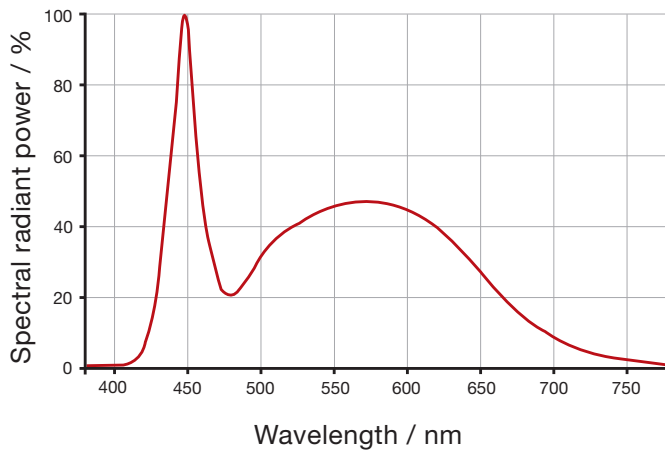


Figure 6: LED luminance standard ACS 587 with a typical spectrum

ACS 150/150B/150C - LED light source for 2D/CAS audit

The ACS 150X is a highly stable LED light source, whose light is homogenized by a 150 mm integrating sphere. It is used to test the image sensor calibration of luminance and color measurement cameras, and to test the measurement accuracy of photometric measuring devices. The ACS-150x was developed exclusively for audit purposes of the standard Lumitops in the near field and is not applicable for Lumitop with wide-angle lenses or Tokina100, Lumicam and TOP.

Two different coatings are available for integrating spheres, determining the total homogeneity. ACS 150B provides the best spatial non-uniformity at higher luminance. The highest luminance of 25 000 - 35 000 cd/m² can be achieved with ACS 150C.



Figure 7: Measurement setup and LED light source for 2D / CAS audit.

02 \\ Advanced Technology behind Advanced Standards

ACU

The ACU is a new compact control unit for ACS calibration standards from Instrument Systems. It contains a high-precision constant current source in a compact desktop housing in addition to a TEC controller for accurate temperature stabilization. The ACU has been developed for both laboratory and production use. The ACU is controlled by means of a computer via USB using the ACS-Control software. Both, Windows 10 and OS X operating systems are supported.

Moreover, the relevant program libraries (.dll and .dylib) are available for direct access for both operating systems Windows and OS X.



▲ Figure 8: ACU – ACS Control Unit

System functionality

The ACS calibration standards are equipped with a high-power LED. A glass window provides protection against dust and dirt. The connection for operation of the LED is designed in four-wire technology in order to create higher measuring accuracy. Electricity is supplied to the LED through one conductor pair and the other pair is used to measure the forward voltage of the LED.

The temperature is stabilized by the TEC controller of the ACU through feedback with a Pt100 sensor near the cooling surface of the high-power

LED. The operating temperature of the LED is actively stabilized with a Peltier element. The heat generated is dissipated to the surrounding environment by a heat sink. An additionally installed fan accelerates the process of dissipating heat.

The calibration values and all necessary operating parameters are stored in the ACS. The ACS-Control software supplied with the standards controls the system. The lapsed operating time is recorded and stored in the unit.

Instead of the ACU a Keithley 24xx can also be used as a current source

in combination with an Arroyo 5305 as a TEC controller. In this case, a connection cable ACS-570-9 will be necessary. Control is possible via the software LED Control 2, but the internal memory for calibration values and the operating time cannot be read out.

Stabilization time

The stabilization time is an important criterion for simple application of the ACS series in the laboratory and in production settings. A specific set of PID control parameters for each LED type is forwarded by the software to the control electronics.

After completion of the short stabilization phase, the forward voltage and the temperature remain constant. The radiant power of the LED therefore remains constant over a long service life and the fast operational readiness saves valuable time.

ACS 570 in application

ACS 570 can be applied to monitor various systems. For luminous flux measurements with ACS 570 there are adapters available for all spheres manufactured by Instrument Systems. The adapters

are universally applicable with all our LED test sockets. For averaged LED intensity measurements, the ACS 570 can be connected directly to the corresponding ILED-B measurement probe to ensure fast and repeatable positioning.



Figure 9: Use of an ACS 570 on an ILED-B measurement probe (luminous intensity measurement)

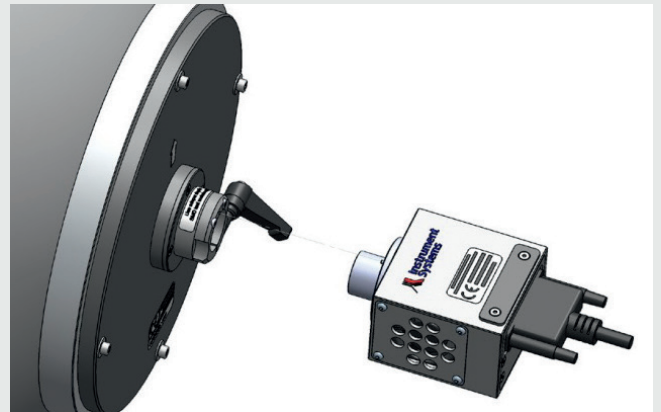


Figure 10: Use of an ACS 570 on an integrating sphere (luminous flux measurement)

03 \\ Our test laboratories – accredited quality

As a leading manufacturer of light measurement equipment, we strive to ensure that you are able to place the greatest possible trust in our instruments. Our customers enjoy significantly greater certainty and guaranteed comparability of readings with the accreditation of our test labs according to DIN EN ISO / IEC 17025 with flexible

scope of application of category III. This enables our customers to demonstrate the quality of measurements to any third party and ensures a long-term investment. Within the accredited scope test results for radiometric, photometric as well as colorimetric quantities can be provided in accordance with international standards.

All working standards used are directly traceable to the reference standard of the national laboratories PTB (Germany) or NIST (USA). The test certificates included with our measuring instruments depict details of the traceability chain.

04 \\ Technical specifications

VIS LED calibration standards	ACS-570-1	ACS-570-3	ACS-570-5	ACS-570-7
LED color	cool white	blue	green	red
Typical luminous flux [lm]	20 – 30	5 – 10	15 – 20	8 – 12
Typical averaged LED intensity I-LED-B [cd]	20 – 30	5 – 10	15 – 20	8 – 12
Typical dominant wavelength / Correlated color temp. CCT	5000 – 6200 K	480 nm	530 nm	622 nm
Operating current and accuracy	300 mA ± 0,1 mA	250 mA ± 0,1 mA		
Operating temperature at the control point and accuracy	35°C ± 0.05°C			
Ambient conditions	15 – 35°C; max. rel. air humidity 70 %, not condensing			
Temporal stability of the luminous flux and luminous intensity	0.2 % / 100 h; 0.5 % / 300 h	0.2 % / 12 h and 0.5 % / 100 h		
Temporal stability of the color coordinates x and y	0.0002 / 100 h; 0.0005 / 300 h	0.0002 / 12 h and 0.0005 / 100 h		
Time to operational readiness	< 240 seconds			
Recommended recalibration interval	After 300 operating hours or one year	After 100 operating hours or one year after last calibration		
Temperature dependence of the luminous flux / intensity	< 0.15 % / 10 K			< 0.25 % / 10 K
Temperature dependence of the color coordinates x and y	< 0.0001 / 10 K	< 0.0002 / 10 K		< 0.0001 / 10 K
Connections	Sub-D, 25-pole (ACS to control unit); USB (control unit to PC) Alternative with ACS-570-9 to the combination Keithley / Arroyo			

IR calibration standard ACS 570 series	ACS 570-15	ACS 570-17	ACS 570-42	ACS 570-44	ACS 570-46
Typical radiant flux [mW]	25 - 40	45 - 70	55 - 70	45 - 60	30 - 40
Typical peak wavelength	860 nm	950 nm	1200 nm	1300 nm	1450 nm
Typical full width at half maximum	25 nm	30 nm	80 nm	90 nm	95 nm
Operating current and accuracy	250 mA ± 0.1 mA		1000 mA ± 0.1 mA		
Operating temperature at control point and accuracy	35 °C ± 0.05 °C				
Temporal stability of radiant flux	< 0.2 % / 12 h and 0.5 % / 100 h				
Temperature dependency of radiant flux	< 0.15 % / 10 K	< 0.25 % / 10 K			
Turn-on stabilization time	< 240 s				
Recommended recalibration interval	After 100 operating hours or one year after last calibration				
Connections	D-sub, 25-pin (ACS 570 to ACU); USB (ACU to PC) Alternative with adapter cable ACS 570-9 to Keithley / Arroyo				

UV LED calibration standards	ACS-570-24	ACS-570-26	ACS-570-28
Typical irradiance @ 300 mm distance [mW/m ²]	180 – 200	280 – 300	670 – 690
Typical radiant flux [mW]	40 - 60	65 - 70	54 – 56
Expanded measurement uncertainty (k=2)	4.5 %	3.5 %	2 %
Typical peak wavelength	278 nm ± 3 nm	306 nm ± 3 nm	367 nm ± 3 nm
Typical centroid wavelength	280 nm ± 3 nm	308 nm ± 3 nm	369 nm ± 3 nm
Operating current and accuracy	250 mA ± 0.1 mA		
Operating temperature at control point and accuracy	35°C ± 0.05°C		
Maximum relative change over the ON time	< 0.2 % / 12 h and 1 % / 100 h		
Temperature dependency of the calibration value	< 0.3 % / 10 K	< 0.2 % / 10 K	< 0.2 % / 10 K
Turn-on stabilization time	< 240 s		
Recommended recalibration interval	One year after last calibration		
Connections	Sub-D, 25-pole (ACS to control unit); USB (control unit to PC) Alternative with ACS-570-9 to the combination Keithley / Arroyo		

LED luminance standard ACS-586-1	
Diameter of the light emitting aperture	25 mm
Typical luminance ¹⁾	400-660 cd/m ²
Temporal stability of luminance	Within ±0.5% in 300 h
Temporal stability of color coordinates x and y	Within ±0.0005 in 300 h
Spatial uniformity ²⁾	< ±0.5% deviation from photometric average value in reference to the center
Typical correlated color temperature (CCT)	5000-6000 K
Turn-on stabilization time	< 240 s
Recommended recalibration interval	After 300 operating hours
Typical sensitivity to ambient temperature variation (luminance)	< 0.15% / 10 K
Typical sensitivity to ambient temperature variation (color coordinates x, y)	< 0.0001 / 10 K

¹⁾ Exact value determined with DTS 140 with following uncertainties: luminance: ±3.5%; color coordinates: ±0.0015; CCT ±10K

²⁾ Determined with LumiTop 2700, distance 50 cm, FOV 15 mm, max. translation from center ±10 mm

ACS 150X LED light source for 2D/CAS audit	ACS 150	ACS 150B	ACS 150C
Coating	84% BaSO ₄	97% BaSO ₄	97% BaSO ₄
Mechanical Data			
Diameter of the light-emitting aperture	50 mm	50 mm	50 mm
External dimensions (L x W x H)	262 mm x 181 mm x 167 mm	262 mm x 181 mm x 167 mm	262 mm x 181 mm x 172 mm
Weight	1.1 kg	1.1 kg	1.2 kg
Photometric / Colorimetric Data			
Luminance ¹⁾	Typically 300 – 500 cd/m ²	Typically 400 – 600 cd/m ²	Typically 25 000 – 35 000 cd/m ²
Correlated color temperature (CCT) ¹⁾	Typically 5000 – 6000 K	Typically 5000 – 6000 K	Typically 5000 – 6000 K
Spatial non-uniformity (RNU) ²⁾ in luminance ³⁾	< 1.0%	< 0.6%	< 1.0%
Spatial non-uniformity (RNU) ²⁾ in chromaticity coordinates	< 0.0004 in x and y	< 0.0004 in x and y	< 0.0004 in x and y
Recommended recalibration interval	100 h / 1 year	100 h / 1 year	100 h / 1 year
Long-term stability			
Long-term stability of luminance ¹⁾	Within 0.3 % / 12 h and 0.5 % / 100 h	n/a	Within 0.3 % / 12 h and 0.5 % / 100 h
Long-term stability of chromaticity coordinates ¹⁾	Within 0.0002 / 12 h and 0.0005 / 100 h	n/a	Within 0.0002 / 12 h and 0.0005 / 100 h
Long-term stability of spatial non-uniformity in L _v	Within 0.01 % / 100 h	Within 0.01 % / 100 h	Within 0.01 % / 100 h
Long-term stability of spatial non-uniformity in x, y	Within 0.00002 / 100 h in x and y	Within 0.00004 / 100 h in x and y	Within 0.00002 / 100 h in x and y
Turn-on stabilization time	< 200 s	< 200 s	< 200 s
Sensitivity to ambient conditions (variation of temperature and relative humidity)			
Sensitivity of luminance ¹⁾	< 1.0 % / 10 K and < 0.2 % / 35 % RH	n/a	< 1.0 % / 10 K and < 0.2 % / 35 % RH
Sensitivity of chromaticity coordinates ¹⁾	< 0.0002 / 10 K and < 0.0001 / 35 % RH	n/a	< 0.0002 / 10 K and < 0.0001 / 35 % RH
Sensitivity of spatial non-uniformity in L _v	< 0.02 % / 10 K and < 0.02 % / 35 % RH	< 0.02 % / 10 K and < 0.01 % / 35 % RH	< 0.02 % / 10 K and < 0.02 % / 35 % RH
Sensitivity of spatial non-uniformity in x, y	< 0.0001 / 10 K and < 0.0001 / 35 % RH	< 0.0001 / 10 K and < 0.0001 / 35 % RH	< 0.0001 / 10 K and < 0.0001 / 35 % RH
Operating temperature range	15 - 35°C	15 - 35°C	15 - 35°C

¹⁾ Exact value determined with DTS 140 with following uncertainties: luminance: ±3.5%; chromaticity coordinates: ±0.0015; CCT: ±10 K

²⁾ The response non uniformity (RNU) is calculated for an image with 16 pixels cropped at each edge and 10 by 10 pixel binning (34 averages). The RNU is defined as the 95% percentile of the deviation of all bins from the mean image value.

³⁾ Within central 63% of the light emitting aperture, i.e. 32 mm in diameter (lateral positioning accuracy: ±2 mm from center; tilt tolerance: ±0.5° from perpendicular).

Please note: Audit limits for usage of ACS in production lines depend on device tested, ACS model, environmental conditions and process maturity. For support please contact your Instrument Systems sales engineer.

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05 \ Ordering information

Order number	Description
LED calibration standards	
ACS-570-1	White high-power LED calibration standard in socket with 25 mm Ø
ACS-570-3	Blue high-power LED calibration standard in socket with 25 mm Ø
ACS-570-5	Green high-power LED calibration standard in socket with 25 mm Ø
ACS-570-7	Red high-power LED calibration standard in socket with 25 mm Ø
ACS-570-15	IR-LED calibration standard for radiant flux (860 nm) in socket with 25 mm Ø
ACS-570-17	IR-LED calibration standard for radiant flux (950 nm) in socket with 25 mm Ø
ACS-570-42	IR-LED calibration standard (~1200 nm) in socket with 25 mm Ø
ACS-570-44	IR-LED calibration standard (~1300 nm) in socket with 25 mm Ø
ACS-570-46	IR-LED calibration standard (~1450 nm) in socket with 25 mm Ø
ACS-570-24	UVC-LED calibration standard (~280 nm) in socket with 25 mm Ø
ACS-570-26	UVB-LED calibration standard (~305 nm) in socket with 25 mm Ø
ACS-570-28	UVA-LED calibration standard (~365 nm) in socket with 25 mm Ø
ACS-586-1	Calibration standard for luminance with cold white high-power LED and 100 mm integrating sphere with 25 mm measurement port; cable connector backwards
ACS-587-1	Calibration standard for luminance with cold white high-power LED and 100 mm integrating sphere with 25 mm measurement port; cable connector sideways
ACS-150	2-in-1 audit set for LumiTop 2700 for inline verification of measurement accuracy of the spectroradiometer (L, x, y) and uniformity of camera measurement (L, x, y)
Power sources and temperature controllers	
ACU-100	Combined control unit for the operation of LED calibration standards of ACS-series (power supply 0-15 V, 0-1000 mA and TEC controller +/-21 V, +/-4 A); incl. connector cables and control software
W-110	Keithley 2400 sourcemeter
W-210	Arroyo Instruments TECSource temperature controller, model 5305
ACS-570-9	Adapter cable for connecting ACS-570-x series of high-power LED calibration standards to a current source and TEC control unit (Keithley/Arroyo)
Determination of reference values	
CAL-502	Factory calibration of luminance standard ACS-150 with final test of luminance and test certificate according to DIN EN ISO 17025; including specifications for color coordinates (x, y) and CCT as well as uniformity test; CAL-502 enables ACS-150 to be used as an audit source for CAS 140D.
CAL-511	Factory calibration of Averaged LED Intensity ILED-B of LEDs with final test and test certificate according to DIN EN ISO 17025
CAL-513	Factory calibration of total luminous flux of LEDs with final test and test certificate according to DIN EN ISO 17025
CAL-517	Factory calibration of radiant flux of IR-LED calibration standards ACS 570-15/17 in an integrating sphere; with test certificate according to DIN EN ISO 17025
CAL-523	Factory calibration of radiant flux of UV- or IR-LED calibration standards with a goniometer; with test certificate according to DIN EN ISO 17025
CAL-581	Factory calibration of luminance standard ACS-586/-587 with final test of luminance, color coordinates (x, y) and CCT; with test certificate according to DIN EN ISO 17025. CAL-581 enables ACS-586/-587 to be used as an audit source for CAS 140D.



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