CAS 140CT
Array Spectrometer

Instrument Systems
light measurement

Te Lintelo Systems bv – Stijn Streuvelsstraat 2 – 6901 KT Zevenaar – The Netherlands – +31 316 340804 – sales@tlsbv.nl – www.tlsbv.nl

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Features at a glance

- Available in several versions from 200 nm to 2150 nm
- High-end back-thinned CCD detector offers utmost measuring sensitivity and dynamic range
- Innovative crossed Czerny-Turner spectrograph minimizes stray light
- Integrated density filter wheel enables an extremely wide intensity measuring range
- Features a USB or PCI interface with extended triggering options

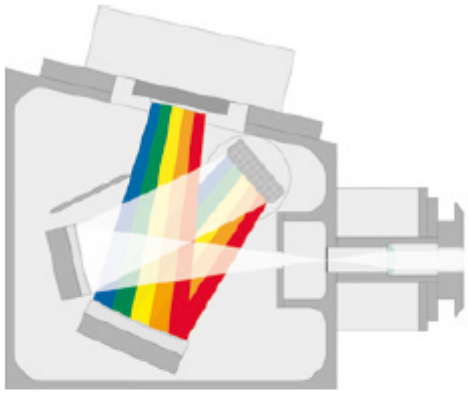
Setting the standard for accuracy and reliability in spectral measurement

The CAS 140CT is the latest of Instrument Systems' high-end array spectrometers, a product line that has achieved extraordinary success around the world. Accurate, robust, and reliable, this instrument offers a peerless combination of attributes. Able to take very accurate measurements, the CAS 140CT is exceptionally stable and durable, even when used continuously in rugged manufacturing environments. All these unique properties make this spectrometer the first choice for many applications ranging from production testing to reference measurements in national laboratories.

Fiber-optic connectors quickly and conveniently join the spectrometer to a comprehensive range of measurement adapters, creating a turnkey system well-suited for the most diverse spectroradiometric and photometric measurement tasks. Factory-equipped with a USB interface, the CAS 140CT may be operated with any notebook. An optionally available PCI interface offers extended triggering possibilities.

Innovations in optical and mechanical design

At the heart of the CAS 140CT is an optimized crossed Czerny-Turner spectrograph featuring highly efficient stray light suppression and a wide dynamic range. The integrated density filter wheel extends the intensity measuring range to nine orders of magnitude. Thus the instrument can measure both very low and very high light intensities without requiring manual adjustments to the measuring setup. Its position recognition method for both the shutter and the density filter wheel make the spectrometer even more mechanically reliable. This feature is particularly valuable for critical measurement tasks and rugged applications in production testing.



Optical design of the CAS 140CT based on an optimized crossed Czerny-Turner spectrograph

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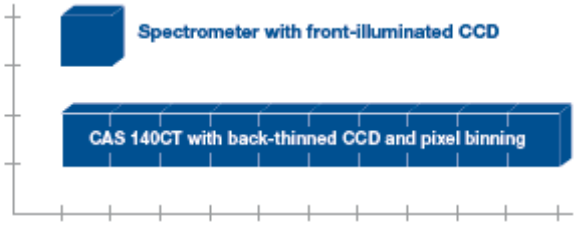
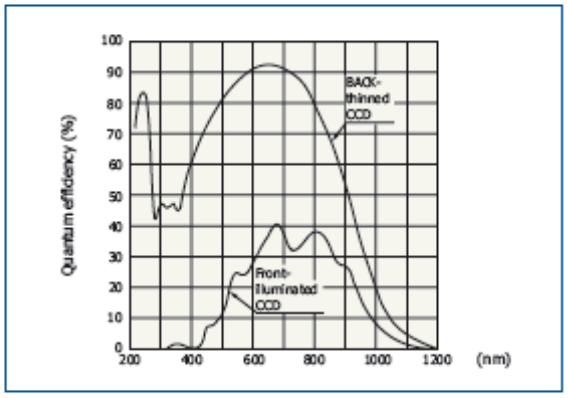
High-end array detectors

All UV, VIS, and NIR models come with a cooled, back-thinned, CCD area detector with 1024 x 128 pixels. Its special design prevents condensation despite a cooling temperature as low as -10°C, and it ensures long service life. This sensor also offers exceptional sensitivity and a tremendous dynamic range. What's more, hardware-based binning of the 128 vertical pixels again improves the signal-to-noise ratio tenfold.



The CAS 140CT is ten times more sensitive than standard spectrometers

Back-thinned CCD sensors are far more sensitive to signals in the shortwave spectrum (higher blue response) than typical front-illuminated CCDs of other spectrometers. This is particularly beneficial when measuring white LEDs. Alongside back-thinned CCDs, the CAS 140CT also comes with cooled InGaAs and extended InGaAs sensors covering the spectral range up to 2150 nm.



Spectral response function of a back-thinned CCD and a front-illuminated CCD

Electronic accessory identification

Integrated for the first time in the CAS 140CT, an Ident key identifies accessories to enable reliable operation with several measurement adapters. The code in the measurement adapter's Ident key is compared with the information in the currently selected calibration file. If they do not match, the software application issues a warning message.

The Ident key identifies measurement adapters

Versatile software solutions

Various software applications are available for controlling the CAS 140CT and analyzing measured results. All programs provide very reliable routines validated by experts and designed to perform radiometric, photometric, and colorimetric calculations.

SpecWin Pro and SpecWin Light

SpecWin Pro and SpecWin Light were developed for diverse tasks in the lab. SpecWin Light comprises all the basic functions necessary for analyzing and reporting measured values. SpecWin Pro adds even more functions to the tool set for enhanced productivity.

DLL and LabVIEW Driver

DLL and LabVIEW drivers are available for creating proprietary programs. Containing all colorimetric calculations, the DLL readily integrates into customer-specific measuring systems.

MultiCAS, MultiTrack and CASPulse

MultiCAS software allows users to combine and synchronize several CAS 140CTs. For example, a cluster of three spectrometers can capture a wavelength range of 200 to 2150 nm in a single measurement.
MultiTrack software was developed to store a sequence of very fast measurements in burst mode.
The CASPulse program synchronizes data acquisition with pulsed power supplies, enabling users to test high-power LEDs.

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LED test & measurement

The CAS 140CT is the perfect instrument for testing all optical parameters of LEDs, OLEDs, and solid-state lighting products. Beyond that, the CAS 140CT's exceptional accuracy and reliability have made it the time-honored, internationally recognized reference in LED test & measurement, both in the lab and on the production floor.

With add-ons such as CIE 127-compliant adapters for measuring luminous intensity and averaged LED intensity (I_{LED-A} and I_{LED-B}), integrating spheres in various sizes for measuring luminous flux, and a compact goniophotometer for analyzing spatial radiation pattern, the CAS 140CT is a turnkey LED measuring system. Thanks to the fiber connection, adapters can easily be changed without sacrificing the calibration. All radiometric, photometric and colorimetric quantities such as color coordinates, color temperature, color rendering index, and dominant wavelength are calculated from each measured spectrum.

LED-436 luminous intensity measurement adapter

Precision test sockets serve to mechanically align the LED and to provide electrical power. Therefore, the LED remains in exactly the same position in the measurement adapter, ensuring reproducible results. Instrument Systems also offers special test sockets with passive and active cooling for operating high-power LEDs. The LED-850 test adapter with active TEC control allows the LED to be set to a specific temperature.

LED-811 test sockets for high-power LEDs

LEDGON goniophotometer

The spatial radiation pattern of individual LEDs, LED arrays, and smaller LED modules are easily determined using the LEDGON 100 goniophotometer. And a special software function provides a convenient and very precise goniometric method of measuring radiant power and total luminous flux.

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LEDGON 100 goniophotometer

LED Tester for the production floor

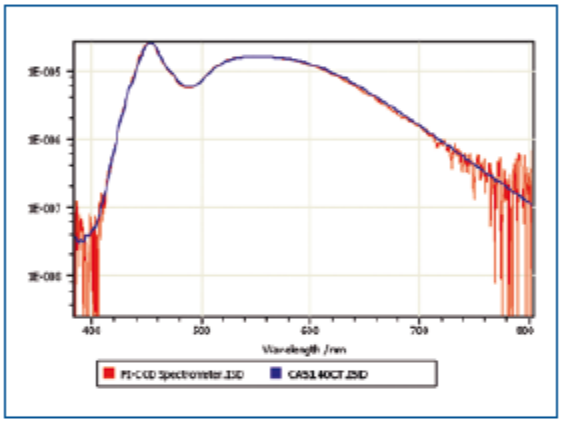
This all-in-one system consists of a compact 19" cabinet with a CAS 140CT array spectrometer, a Keithley 24xx/26xx source meter, and a Windows Workstation PC. The LED Tester was designed specifically for taking automated measurements in production settings, that is, to control mechanical handlers and sorting machines. Within just 50 ms, the LED Tester can measure all radiometric, photometric, and spectral properties of an LED, as well as current and forward voltage.

Highly accurate measurement of white LEDs

The CAS 140CT's superior accuracy is certainly persuasive, especially when it comes to measuring white LEDs. Their special spectral power distribution poses great challenges for measurement equipment, and most spectrometers fall short of the mark. Low-cost spectrometers, especially, are not suitable for measuring white LEDs because they base on front-illuminated line CCDs and have a very limited dynamic range. The CAS 140CT, however, excels in every key benchmark such as dynamic range, linearity, stray light suppression, and signal-to-noise ratio.

	Color coordinate x	Color coordinate y	Color temperature CCT
Reference	0.3236	0.3560	5870 K
	Deviations		
CAS 140CT	0.0005	0.0001	23 K
Spectrometer with FI-CCD	0.0033	0.0009	145 K

The limited dynamic range of front-illuminated CCDs introduces considerable error margins when determining the color coordinates and color temperature of white LEDs.



A logarithmic view of spectra shows what the linear scale hides - low-cost spectrometers yield noisy measurements.

Technical specifications for LED measurement

Model	CAS140CT-152 UV/VIS	CAS140CT-154 UV/VIS/NIR	CAS140CT-156 UV/VIS/NIR	CAS140CT-151 VIS	CAS140CT-153 VIS/NIR
Spectral range	200-800 nm	220-1020 nm	300-1100 nm	360-830 nm	380-1040 nm
Spectral resolution *1	2.7 nm	3.7 nm	3.7 nm	2.2 nm	3.0 nm
Sensitivity					
Luminous intensity *2	0.004 mcd – 20 kcd	0.002 mcd – 8 kcd	0.002 mcd – 8 kcd	0.003 mcd – 15 kcd	0.002 mcd – 8 kcd
Luminous flux *3	0.1 mlm – 500 klm	0.05 mlm – 250 klm	0.05 mlm – 250 klm	0.06 mlm – 300 klm	0.05 mlm – 250 klm
Measurement uncertainty					
Luminous intensity *4	+/-4%	+/-4%	+/-4%	+/-4%	+/-4%
Luminous flux *4	+/-4%	+/-4%	+/-4%	+/-4%	+/-4%
Dominant wavelength	+/-0.5 nm	+/-0.5 nm	+/-0.5 nm	+/-0.5 nm	+/-0.5 nm
Color coordinates (x, y) *5	+/-0.0015	+/-0.002	+/-0.002	+/-0.0015	+/-0.002

*1 Applies to a standard 100 µm slit; other values apply to optional 50 µm and 250 µm slits.
*2 Applies to a signal-to-noise ratio of 10:1 for a yellow LED with 586 nm and with LED-436 adapter; values for white LEDs are higher by a factor of 20 to 100.
*3 Applies to a signal-to-noise ratio of 10:1, for a yellow LED with 586 nm and with ISP250 integrating sphere; values for white LEDs are higher by a factor of 20 to 100.
*4 Immediately after calibration relative to the calibration standard, for diffuse LEDs and without density filters.
*5 Applies to color LEDs, with sufficient dynamic range and after calibration; indicated errors refer to the twofold standard deviation.

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DTS 140 – the full-fledged system for measuring displays

Instrument Systems offers a turnkey system designed to measure the radiance, luminance, and color of displays and panel graphics. Based on the CAS 140CT, DTS 140 series display testing systems are universally applicable regardless of display technology, be it an LCD, CRT, OLED, or LED display.

DTS 140 with manual positioner

The TOP 200 telescopic optical probe, connected to the spectrometer via a fiber-optic light guide, launches the light into the spectrometer. The TOP 200's versatile fiber connector also affords users the opportunity to easily change the measurement adapter and configure the DTS 140 for other measurement tasks. This extends the instrument's application range considerably, providing a benefit that compact spectroradiometers with an integrated lens lack.

Wide range of applications

An extensive selection of lenses is available for the TOP 200 to accommodate different spot sizes and various distances to the test object. The HRL 90 high-resolution lens, for example, serves to analyze tiny graphics and structures with diameters as small as 0.075 mm.

Equipped with an aperture mirror with a very slight 15° incline, the optimized Pritchard-style optical design delivers perfectly sharp and round measurement spots. The TOP 200 features an integrated viewfinder camera that captures the targeted field of view for presentation on the computer screen, making it so much easier to pinpoint the measurement spot on the test sample.

The viewfinder camera also provides good visibility even at low brightness levels.

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Patented precision for the best results

Developed specifically for the TOP 200, a special multi-mode fiber connection with a patented mode mixer ensures the spectrometer captures all the light launched into the optical fiber. The mode mixer also eliminates transmission fluctuations caused by fiber movements, and reduces polarization sensitivity to a very low level.

DTS 140 NVIS for testing night-vision compatible displays

Instrument Systems developed the DTS 140 NVIS specifically to test military displays and panel graphics according to MIL-L-85762A and MIL-STD-3009. Based on the robust CAS 140CT array spectrometer technology, this system is an excellent choice for rugged manufacturing and quality assurance applications where toughness, reliability, and ease of use matter.

The pass/fail test functions available in the SpecWin Pro software facilitate fully automated measurements.

One of the biggest challenges in taking NVIS measurements is correctly capturing the huge differences in intensity between the visible (380 to 650 nm) spectral range and the near infrared (650 to 930 nm) spectral range. This is why the DTS 140 NVIS is based on a modified version of the CAS 140CT with even more powerful stray light suppression and a mechanism that automatically adjusts measurement sensitivity to cope with varying signal intensities.

Consequently, the measured results – even for filtered incandescent panels – correlate exceedingly well with reference scanning spectroradiometers.

Technical specifications for display measurement

Model		DTS140-131		DTS140-133		DTS140-231	DTS140-233	DTS140-235
Spectral range		360 - 830 nm		380 - 1040 nm		360 - 830 nm	380 - 1040 nm	380-1040 nm
Spectral resolution *1		2.2 nm		3.0 nm		2.2 nm	3.0 nm	7.0 nm
Data point interval		0.5 nm		0.65 nm		0.5 nm	0.65 nm	0.65 nm
TOP 200 Telescopic Optical Probe								
Lens type		60 mm		60 mm		HRL 90	HRL 90	HRL 90
Lens veiling glare *3		1%		1%		0.1 %	0.1 %	0.1 %
Working distance *2		**18 cm**	**50 cm**	**18 cm**	**50 cm**	**23 cm**	**23 cm**	**23 cm**
Measurement spot sizes *4	Aperture 1	0.15 mm	0.9 mm	0.15 mm	0.9 mm	0.075 mm	0.075 mm	0.075 mm
	Aperture 2	0.3 mm	1.7 mm	0.3 mm	1.7 mm	0.15 mm	0.15 mm	0.15 mm
	Aperture 3	0.6 mm	3.5 mm	0.6 mm	3.5 mm	0.3 mm	0.3 mm	0.3 mm
	Aperture 4	1.2 mm	6.9 mm	1.2 mm	6.9 mm	0.6 mm	0.6 mm	0.6 mm
Measurement sensitivity range *5	Aperture 1	0.2 - 1·10E9 cd/m²		0.1 - 1·10E9 cd/m²		0.6 - 4·10E9 cd/m²	0.4 - 3·10E9 cd/m²	0.1 - 1·10E9 cd/m²
	Aperture 2	0.06 - 4·10E8 cd/m²		0.04 - 3·10E8 cd/m²		0.2 - 1·10E9 cd/m²	0.1 – 1·10E9 cd/m²	0.03 – 3·10E8 cd/m²
	Aperture 3	0.02 - 1·10E8 cd/m²		0.01 - 1·10E8 cd/m²		0.06 – 4·10E8 cd/m²	0.04 – 3·10E8 cd/m²	0.01 – 1·10E8 cd/m²
	Aperture 4	0.006 - 4·10E7 cd/m²		0.004 – 3·10E7 cd/m²		0.02 – 1·10E8 cd/m²	0.01 – 1·10E8 cd/m²	0.003 – 3·10E7 cd/m²
Measurement uncertainty								
Luminance *6		± 3 %						
Radiance *6		± 4 %						
Color coordinates (x,y) *7		± 0.0015						
Dominant wavelength		± 0.5 nm						
Polarization sensitivity		< 1 %						

*1 Applies to a standard 100 µm slit; other values apply to optional 50 µm and 250 µm slits.
*2 Distance from the test sample to the TOP 200's front panel; for models with the 60 mm lens, basic calibration is done at a working distance of 50 cm.
*3 Measured at aperture 2 and according to MIL-L-85672A.
*4 For the 60 mm lens, the measurement spot diameter depends on the working distance.
*5 Applies to a signal-to-noise ratio of 10:1 in the spectrum, measured with standard illuminant A without density filters; measuring sensitivity improves tenfold with narrowband LED spectra.
*6 Immediately after calibration relative to the calibration standard.
*7 With sufficient dynamic range and after calibration; indicated errors refer to the twofold standard deviation.

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Versatility in spectral measurement

The CAS 140CT is well-equipped to meet all the demands of spectral measurements and photometry. Armed with a versatile fiber connector, a wide range of accessories, and powerful software functions, it masters all prevailing measurement challenges. System solutions are also available for photovoltaic applications as well as for analyzing fast combustion processes and special-effect finishes.

Spectroradiometry and photometry

Various EOP series optical probes connect via optical fiber to the CAS 140CT to measure irradiance and illuminance.

EOP series of optical probes

Instrument Systems offers optical probes with primarily directional response characteristics and high light throughput or with excellent cosine correction and the resultant greater loss of light. Additionally, the ISP 40 integrating sphere was developed to offer both a broad spectral range and very good cosine correction.

Quality in light and color

The CAS 140CT's robustness and excellent spectral measuring accuracy has prompted renowned lamp manufacturers to use it to test their discharge lamps on the production floor. Measuring photometric and colorimetric quantities such as total luminous flux, correlated color temperature (TN) and color rendering index (CRI) with an integrating sphere is a key component of ongoing quality control. This demands very accurate measurements, especially when determining color coordinates, and in the past only precision scanning spectrometers were able to meet this demand.

Furthermore, the CAS 140CT takes measurements very quickly, and is able to analyze the spectral output of a lamp during power-on at much the same speed as a photometer.

The various ISP series integrating spheres serve to determine the radiant power and total luminous flux of all kinds of light sources ranging from lamps and luminaires in general to diverse solid-state lighting products in particular.

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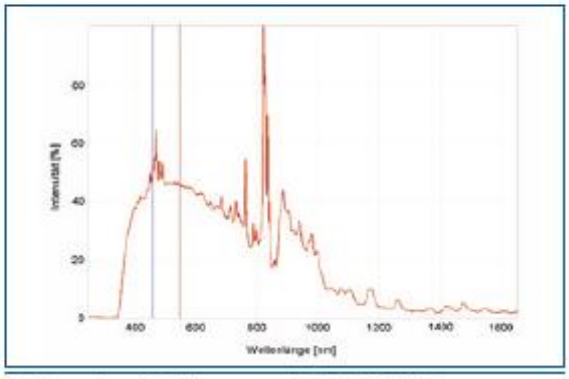
The ISP 1000 integrating sphere with 1 m diameter

Precision in UV measurements

The CAS 140CT's excellent stray light properties and a special calibration method also ensure that light sources are measured accurately in the ultra-violet spectral region. In combination with the TOP 200 telescopic optical probe, it measures radiance to ascertain lamps' eye safety (according to CIE-ISO S009). Various software-based weighting functions are easily applied to the measured spectrum.

Lightning-fast for flash lamps

An optical probe equipped with a fast shutter for capturing short light pulses (no shorter than 4.5 ms) complements the CAS 140CT to create the perfect measuring setup for flash lamps.



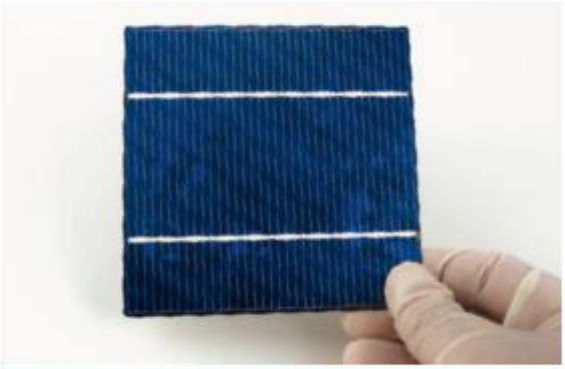
Emission spectrum of a flash lamp measured with two CAS 140CTs

With this shutter, the spectrometer is able to analyze a small section of the flash's temporal intensity profile. This ability is critical when using flash lamps for testing solar cells.

Additionally, up to three CAS 140CTs may be clustered and synchronized. With this technology, it is possible to capture a broad spectral range of 200 to 2150 nm in just one measurement and within a few milliseconds.

Transmission and reflection measurements

With its exceptional stability and low stray light, the CAS 140CT is also well-suited for taking transmission and reflection measurements. Its versatile fiber connector accepts various measurement adapters, each optimized for a specific application.
For example, the CAS 140CT, in combination with the ISP 150 integrating sphere, is able to determine the diffuse transmission and reflection of scattering samples and solar cells in compliance with the DIN 5036 standard.



Measuring the diffuse reflection of solar cells

Instrument Systems developed the GON 360 goniometer to measure optical components as well as the specular transmission and reflection of coatings. Available in a manual and a motorized version, this goniometer serves to examine samples at variable illumination and observation angles. Compact measurement adapters are also available for measuring reflection and transmission with fixed geometries.

GON 360 for transmission and reflection measurements at variable angles

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Technical specifications

Model	UV/VIS	UV/VIS/NIR	VIS	VIS/NIR	NIR	IR1	IR2
Spectral range	200-800 nm	220-1020 / 300-1100 nm	360-830 nm	380-1040 nm	750-1050 nm	780-1650 nm	1500-2150 nm
Detector	BT-CCD	BT-CCD	BT-CCD	BT-CCD	BT-CCD	InGaAs	ext. InGaAs
Number of pixels	1024 x 128	1024 x 128	1024 x 128	1024 x 128	1024 x 128	512	256
Spectral resolution *1	2.7 nm	3.7 nm	2.2 nm	3.0 nm	2.0 nm	9 nm	15 nm
Data point interval	0.6 nm	0.8 nm	0.5 nm	0.65 nm	0.3 nm	2.1 nm	3 nm
Wavelength accuracy	+/-0.3 nm	+/-0.3 nm	+/-0.3 nm	+/-0.3 nm	+/-0.3 nm	+/-0.5 nm	+/-1.5 nm
Stray light (broadband for illuminant A) *2	5-10E-4	5-10E-4	5-10E-4	5-10E-4	5-10E-4	1-10E-3	1-10E-3
Stray light for LEDs *3	1-10E-4	1-10E-4	1-10E-4	1-10E-4	1-10E-4	1-10E-3	-
Integration time	10 msec - 65 sec	10 msec - 65 sec	10 msec - 65 sec	10 msec - 65 sec	10 msec - 65 sec	10 msec - 65 sec *8	10 msec - 200 msec
Linearity	0.5%	0.5%	0.5%	0.5%	0.5%	1%	1%
Cooling	-10°C	-10°C	-10°C	-10°C	-10°C	-10°C	-20°C
Spectroradiometry							
Irradiance sensitivity range *4	5-10E-8 – 500 W/m²nm	2-10E-8 – 200 W/m²nm	3-10E-8 – 300 W/m²nm	2-10E-8 – 200 W/m²nm	5-10E-8 – 500 W/m²nm	3-10E-6 – 3-10E+4 W/m²nm	3-10E-5 – 0.6 W/m²nm
Signal sensitivity at 1s integration time *4	1-10E-6 W/m²nm	4-10E-7 W/m²nm	6-10E-7 W/m²nm	4-10E-7 W/m²nm	1-10E-6 W/m²nm	2-10E-4 W/m²nm	3-10E-4 W/m²nm
Spectroradiometric accuracy *5	+/-3.5%	+/-3.5%	+/-3.5%	+/-3.5%	+/-3.5%	+/-5%	+/-8%
Spectrophotometry							
Baseline noise *6	+/-60 counts, or +/-0.4%					+/-25 counts or +/-0.2%	
Transmission measuring accuracy	+/-0.5% T or +/-0.02A at 1A					+/-1% T or +/- 0.05A at 1A	
Baseline drift *7	0.15%/h or +/- 0.006A/h					0.15%/h or +/- 0.006 A/h	
Spectrograph							
Focal length, grating	Approx. 120 mm f/3.5 / plane ruled grating						
Slit	Standard: 100 µm, optional 50 µm or 250 µm; 250 µm standard at IR2						
Filter wheel	Density filter OD 1 to OD 4; UV/VIS and UV/VIS/NIR with UV density filters						
Electrical data							
AD converter	15 Bit resolution						
PC interface	USB 2.0 standard; optional: PCI bus plug-in card in place of USB 2.0						
Triggering	1 TTL input with an ascending slope; 2 software-controlled TTL outputs; 1 TTL output with flash pulse						
Other							
Dimensions (H, W, D)	192 x 330 x 348 mm³						
Power consumption	50 VA max.						
Ambient temperature	15 - 35°C; relative humidity 0 - 70%, non-condensing						
Weight	Approx. 10 kg						
Applicable standards	Meets EN 60721-4-7 Class 7M2, EN 60721-4-7 Class 2M2, EN 61326:2004-05 and EN 61010-2002-08						

*1 Approximate value for a 100 µm (IR2 model 250 µm) standard slit. Other values for optional 50 µm and 250 µm slits.
*2 Measured with an OG 455 cut-off filter at 400 nm and a silicon filter (1200 nm cut-off wavelength) at 1000 nm, relative to the peak intensity of unweighted spectral data.
*3 Measured at 150 nm distance to the left of the peak wavelength, relative to the peak intensity of unweighted spectral data.
*4 Measured with the EOP-120 optical probe and OFG-414 fiber bundle at 600 nm (and at 1200 nm for the IR1 model and at 1600 nm for the IR2 model), a signal-to-noise ratio of 10:1, and without averaging.
*5 Immediately after calibration relative to the calibration standard, and without density filter.
*6 At shortest integration time, without averaging and at 15.000 counts signal level. When averaged, this value improves (e.g. averaged over 9 times equals a threefold noise reduction).
*7 Applies to a LS100-130 light source after 1 hour warm-up time.
*8 Applies to IR1 model in low-gain mode only; maximum integration time in high-gain mode is 15 sec.

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Ordering information

Order number	Description				
Spectrometer	**Model**	**Detector**	**Spectral range**	**Spectral resolution**	**Data point interval**
CAS140CT-151	VIS	CCD (back-thinned)	360 – 830 nm	2.2 nm	0.5 nm
CAS140CT-152	UV-VIS	CCD (back-thinned)	200 – 800 nm	2.7 nm	0.6 nm
CAS140CT-153	VIS-NIR	CCD (back-thinned)	380 – 1040 nm	3.0 nm	0.65 nm
CAS140CT-154	UV-VIS-NIR	CCD (back-thinned)	220 – 1020 nm	3.7 nm	0.8 nm
CAS140CT-155	NIR	CCD (back-thinned)	750 – 1050 nm	2 nm	0.3 nm
CAS140CT-156	UV-VIS-NIR	CCD (back-thinned)	300 – 1100 nm	3.7 nm	0.8 nm
CAS140CT-171	IR1	InGaAs Diode Array	780 – 1650 nm	9 nm	2.1 nm
CAS140CT-175	IR2	Extended InGaAs Diode Array	1500 – 2150 nm	15 nm	3 nm
Options					
CAS140CT-330	50 µm slit (instead of the standard 100 µm slit)				
CAS140CT-332	250 µm slit (instead of the standard 100 µm slit); this slit is standard on the IR2 model				
CAS140CT-333	500 µm slit (instead of the standard 100 µm slit)				
CAS140CT-400	PCI bus plug-in card in place of USB 2.0 interface				
ACS-010	Accessory identification (ident key)				
Software					
SW-120	SpecWin Light spectral software for Windows OS. Supports emission, transmission, reflection and LED/display measurement				
SW-130	SpecWin Pro spectral software for Windows OS. Same as SpecWin Light plus extended functions for LEDGON, DTS500, NVIS, etc.				
SW-140	SpecWin Light/Pro plug-in for Keithley 24xx/26xx source meter				
SW-231	DLL driver software for custom programs				
SW-233	LabVIEW driver software; also requires SW-231				
DTS140 models (complete for display measurements)					
DTS140-131	360 - 830 nm; 60 mm lens; working distance 18 cm to infinite				
DTS140-133	380 - 1040 nm; 60 mm lens; working distance 18 cm to infinite				
DTS140-231	360 - 830 nm; HRL 90 lens; working distance 23 cm fixed				
DTS140-233	380 - 1040 nm; HRL 90 lens; working distance 23 cm fixed				
DTS140-235	Specifically for NVIS measurements according to MIL-L-85762A and MIL-STD-3009				

Instrument Systems constantly endeavors to develop products further. Any technical changes, errors, or misprints do not constitute grounds for claims to compensation.
Our General Terms and Conditions apply in all other respects.

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