Instrument Systems
KONICA MINOLTA Group

CAS 140D

Array spectrometer for high accuracy light measurement

We bring quality to light.

Key features at a glance

- High-end CCD detector, cooled and back-illuminated
- Down to 4 ms integration time
- Spectrograph with minimum stray light and enhanced throughput
- Integrated density filter wheel
- USB, PCIe or Ethernet interface
- “Plug & play” accessory identification

01 \\ CAS 140D – The new reference for spectral measurement

The CAS 140D represents the fourth generation of the worldwide extremely successful series of high-end array spectrometers from Instrument Systems. The previous model CAS 140CT was for many years regarded as the standard for measurement accuracy in spectroradiometry. Now the CAS 140D is establishing a new benchmark. It combines all advantages of the CAS 140CT in terms of measurement accuracy and reliability with sustainable technical optimization for increased repeatability and stability in every environment. As a result, it offers even more versatile applications – from the reference instrument in national calibration laboratories to continuous production. A wide range of accessories complement the spectrometer to create a complete system for a wide range of spectroradiometric and photometric measurement tasks.

Thanks to the modern housing and improved optical and mechanical design, the instrument is even more functional, but smaller and simpler to integrate into existing measurement environments.

Automatic accessory identification of the CAS 140D enables quick and easy changing of a wide range of measurement adapters.

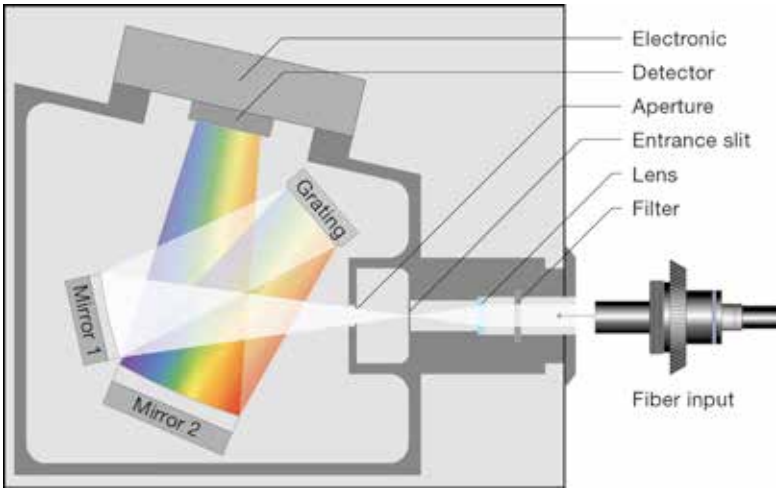
In production environments the new “plug & play” principle ensures high process reliability. The system automatically recognizes the connected accessories and ensures that only currently valid calibrations are used.

Another new feature of the CAS 140D is the interchangeable interface between the spectrometer and control computer. Depending on the measurement task, the interface can be easily replaced via plug-in modules with USB, PCIe or Ethernet interface.

02 \\ Equipment and mode of functioning

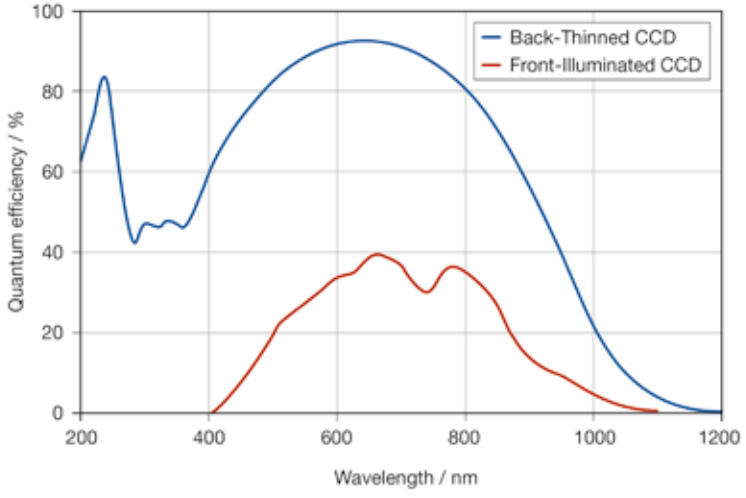
Optimized optical and mechanical design

The proven crossed Czerny-Turner spectrograph has been further optimized for even better stray light suppression and a wide dynamic range. The integrated density filter wheel manages without a mechanical position switch and ensures the exact positioning of the filter with an electronic Hall sensor. The CAS 140D thus extends the intensity measurement range to nine orders of magnitude. The instrument can easily measure both very low and very high light intensities. The filter wheel additionally assumes the function of the mechanical dark current shutter. The use of the shutter can be freely defined by the user and ranges from manual to fully automatic dark current adjustment of the CCD detector.



Optical design of the CAS 140D with optimized crossed Czerny-Turner spectrograph.

The improved mechanical and optical design provides significantly increased throughput compared to the previous model CAS 140CT. A new linear variable order sorting filter realizes extremely harmonious spectral behavior.



Comparison of the spectral sensitivity functions of a back-thinned CCD and a front-illuminated CCD. The enhanced sensitivity, particularly in the shortwave spectrum (200 - 400 nm), is clearly visible.

Cooled back-thinned array detector and 24bit electronics

All models feature a cooled, back-thinned CCD area detector with 1024 x 128 pixels. These detectors are far more sensitive to signals in the shortwave spectrum (blue response) than typical front-illuminated CCDs. This is particularly advantageous when measuring white LEDs. CCD chip cooling and binning of the 128 vertical pixels make the CAS 140D detector a trailblazer in all key characteristics. It excels with particularly high measurement sensitivity, excellent signal-to-noise ratio and an enormous dynamic range. The integration time was significantly reduced to as little as 4 ms, which is particularly noticeable in fast production tests.

The new 24bit electronics ensure an even higher degree of accuracy and performance. In addition, the electronic noise was further reduced by optimization of the power feed.

“Plug & play” accessory identification

The CAS 140D features an automatic accessory identification according to the “plug & play” principle. The user merely mounts the desired measurement adapter on the spectrometer. The instrument recognizes which accessory has been mounted and automatically selects the correct calibration files. This feature makes for extremely reliable measurement operation, including the changing of accessories.

Accessory identification ensures reliable use of different measurement adapters. The system automatically recognizes the connected accessories and ensures that only currently valid calibrations are used.

03 \\ Software solutions for analysis and documentation

A broad pallet of software solutions is available for controlling the CAS 140D and analyzing readings. All programs provide highly reliable routines validated by experts for radiometric, photometric and colorimetric calculations.

SpecWin Pro and SpecWin Light with an extended range of functions

The software programs SpecWin Pro and SpecWin Light are available for the diverse laboratory tasks. SpecWin Light includes all basic functions for measurement analysis and documentation. SpecWin Pro additionally offers plug-in modules for a greatly extended range of functions. These include, for example, the integration and control

SpecWin Pro spectral analysis software.

of a source meter or the storage and analysis of a sequence of fast measurements in burst mode.

In addition, the SpecWin Pro and SpecWin Light support measurements according to the IES TM-30-15 method for the improvement of color perception. Besides the two metric values fidelity and gamut index, it also enables graphic evaluations such as Hue Bin tables and color-vector graphics.

Software development kit with DLL and LabVIEW driver

A software development kit (SDK) is available for custom programming or integration into production sequences. In addition to a DLL library, the SDK incorporates valuable sample programs and programming aids. The DLL already contains all colorimetric calculations, so that integration in customized measurement systems and the evaluation of measurement results are easy to implement. In addition, a driver for programming measurement processes in LabVIEW is available for the employment of the CAS 140D in a laboratory.

04 \\ Measurement of LEDs, OLEDs and Solid-State Lighting products

By virtue of its high measurement accuracy and reliability, the CAS series has long since become an internationally recognized reference in LED measurement technology – both in the laboratory and fast tests in production. These many years of expertise have been applied to the extended requirements in the field of Solid-State Lighting.

In combination with our comprehensive range of accessories, the CAS 140D is the ideal solution for the photometric and colorimetric characterization of individual LEDs, OLEDs, LED modules as well as all LED-based lamps and luminaires.

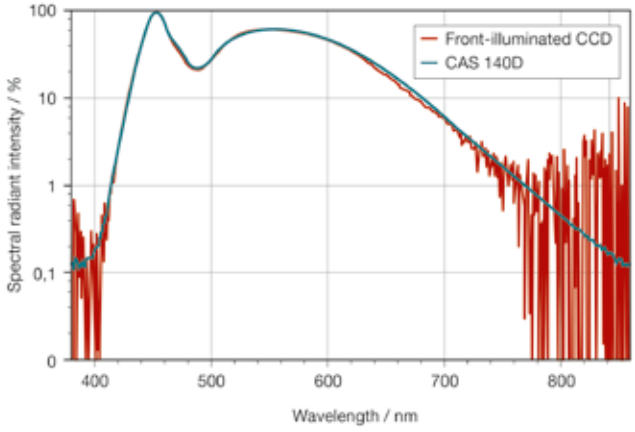
High measurement accuracy of white LEDs

The CAS 140D offers an impressive performance when it comes to the precise measurement of white LEDs. Due to the special distribution of spectral radiation, these make very high demands on measurement accuracy. On this score the CAS 140D is superior in all relevant characteristics such as dynamic range, linearity, stray light suppression and signal-to-noise ratio.

In contrast, low-cost spectrometers are less suited to the measurement of white LEDs, as they are usually based on front-illuminated line CCDs which display a limited dynamic range.

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

The consequences of limited dynamic range of front-illuminated CCDs are considerable errors in the determination of the color coordinate and color temperature of white LEDs.



A logarithmic representation of spectra shows what the linear scale hides: Front-illuminated spectrometers yield considerable noise.

Precision test sockets for different LED types.

Measurement adapters for CIE 127-conformant evaluations

All measurement adapters from Instrument Systems permit the CIE 127-conformant evaluation of radiometric and photometric quantities, as well as all relevant colorimetric parameters such as color coordinates, color temperature, color rendering index and dominant wavelength. Thanks to the fiber connector, they can be easily replaced without loss of calibration.

Specially developed test sockets provide electrical power to the LEDs for precise launching of a light beam to the corresponding measurement adapter. Test sockets are available for all standard LED types and ensure the consistent positioning of the LED in the respective measurement adapter and thus a high reproducibility of measurement results.

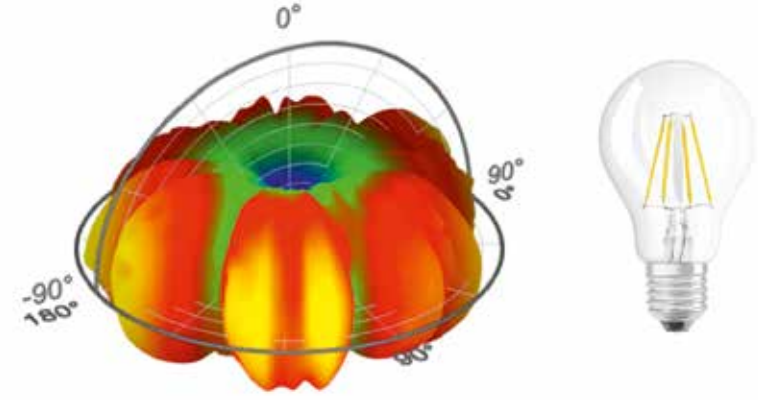
Test sockets with passive and active cooling were developed for high-power LEDs, to permit the setting of predefined temperatures.

Versatile applications in LED production

With its high measurement speed and accuracy, the CAS 140D fulfils the most stringent requirements in LED production, e.g. automated measurements in sorting machines. The CAS 140D offers an extremely short duration between Start-of-Test (SOT) and End-of-Test (EOT) signals in LED production machines, due to an optimization in data handling. On top, Instrument Systems provides the LSM 1000, a sourcemeter optimized for LED production applications, which completes the CAS 140D to an LED tester system.

Angle-dependent characterization with goniophotometers

With the LEDGON 100 or LGS series of goniophotometers the spatial radiation properties of all LED- and SSL-based products can be easily determined with the CAS 140D. In conjunction with the goniophotometer module of the SpecWin Pro software, the measurement system enables not only an analysis of luminous intensity distribution, but also determination of the luminous flux for individual angle ranges and angle-dependent characterization of photometric and colorimetric quantities.



3D luminous intensity distribution of a filament LED bulb measured with a goniophotometer of the LGS series.

High-class determination of luminous flux and color with integrating spheres

The CAS 140D also achieves impressive results in the measurement of photometric and colorimetric quantities such as correlated color temperature (CCT), color rendering index (CRI) and total luminous flux with the aid of integrating spheres. It is thus ideal for use by lamp manufacturers in production and quality control, where the required measurement accuracy is particularly high with regard to color coordinates. Due to the short measurement times of as little as 4 ms, the CAS 140D is also able to analyze the spectral output of a lamp during power-on at much the same speed as with photometers.

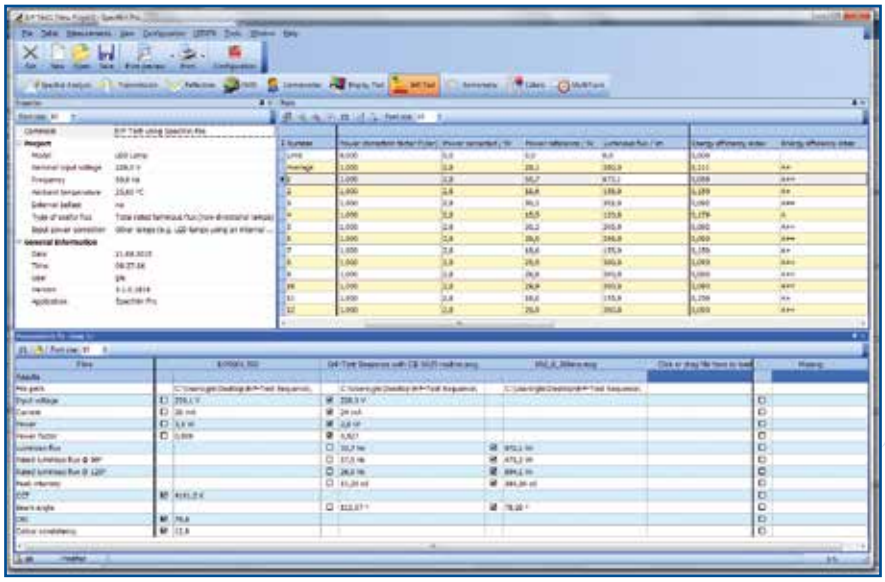
The various ISP series of integrating spheres serve to determine the radiant power and luminous flux of all kinds of light sources. Besides lamps and luminaires in general, these include in particular diverse products for Solid-State Lighting.

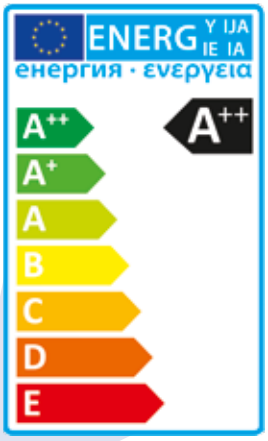
To enable light sources of all sizes to be characterized with the best possible accuracy, Instrument Systems offers integrating spheres with diameters ranging from 75 mm to 2000 mm.

Integrating sphere ISP 2000 (2 m in diameter) for measurement of total luminous flux and colorimetric characteristics of SSL products.

Classification of energy efficiency

On the basis of the CAS 140D Instrument Systems also supplies system solutions for determining the classification of the energy efficiency of lamps and luminaires according to EU regulations. For this purpose the spectrometer is supplemented with the appropriate measurement adapters, integrating spheres and optical probes as well as goniometers, in order to measure the multitude of prescribed parameters. A special module of the SpecWin Pro software enables the evaluation of the energy efficiency measurements of the test sample and calculates key characteristics such as the energy efficiency index and energy class.





ErP test module of SpecWin Pro for evaluating test samples in terms of energy efficiency.

Technical specifications for LED and SSL measurements (preliminary)

Model	UV/VIS	UV/VIS/NIR	VIS	VIS/NIR
Spectral range	200 - 800 nm	220 - 1020 / 300 - 1100 nm	360 - 830 nm	380 - 1040 nm
Stray light				
For LED	$1 \cdot 10^{-4}$			
Sensitivity				
Luminous intensity[1]	0.004 mcd - 20 kcd	0.002 mcd - 8 kcd	0.003 mcd - 15 kcd	0.002 mcd - 8 kcd
Luminous flux[2]	0.1 mlm - 500 klm	0.05 mlm - 250 klm	0.06 mlm - 300 klm	0.05 mlm - 250 klm

Measurement uncertainty	Luminous intensity	Luminous flux
Accuracy[3]	±4 %	±4 %

[1] Applies to a signal-to-noise ratio of 10:1, with LED with 585 nm and LED 436 adapter. Values are higher by a factor of 20 to 100 for white LEDs.
[2] Applies to a signal-to-noise ratio of 10:1, with yellow LED with 585 nm and integrating sphere ISP 250. With white LEDs the values are higher by a factor of 20 to 100.
[3] Immediately after calibration relative to PTB traceable calibration standard. Refers to twofold standard deviation. Applies to the measurement and ambient conditions during calibration (e.g. without density filter, good signal level etc.)

05 \\ Solutions for spectral display measurement

The CAS 140D is coupled with a TOP 200 telescopic optical probe to form the DTS 140D complete system for spectral display measurement. It was developed for the highly precise analysis of radiance and luminance and the color of displays and backlit symbols. No matter which display technology is to be examined – be it an LCD, CRT, OLED or LED display – the display test systems of the DTS 140D series are universally applicable.

In conjunction with a telescopic optical probe, the CAS 140D has a 50% higher throughput than the previous model CAS 140CT, i.e. it can quickly measure extremely weak light sources. Furthermore, the versatile fiber connector of the TOP 200 affords users an opportunity to easily change the measurement adapter and configure the DTS 140D for another application (e.g. LED measurement). This greatly extends its application range – a big advantage compared to spectroradiometers with an integrated lens.

Telescopic optical probe for a wide range of applications

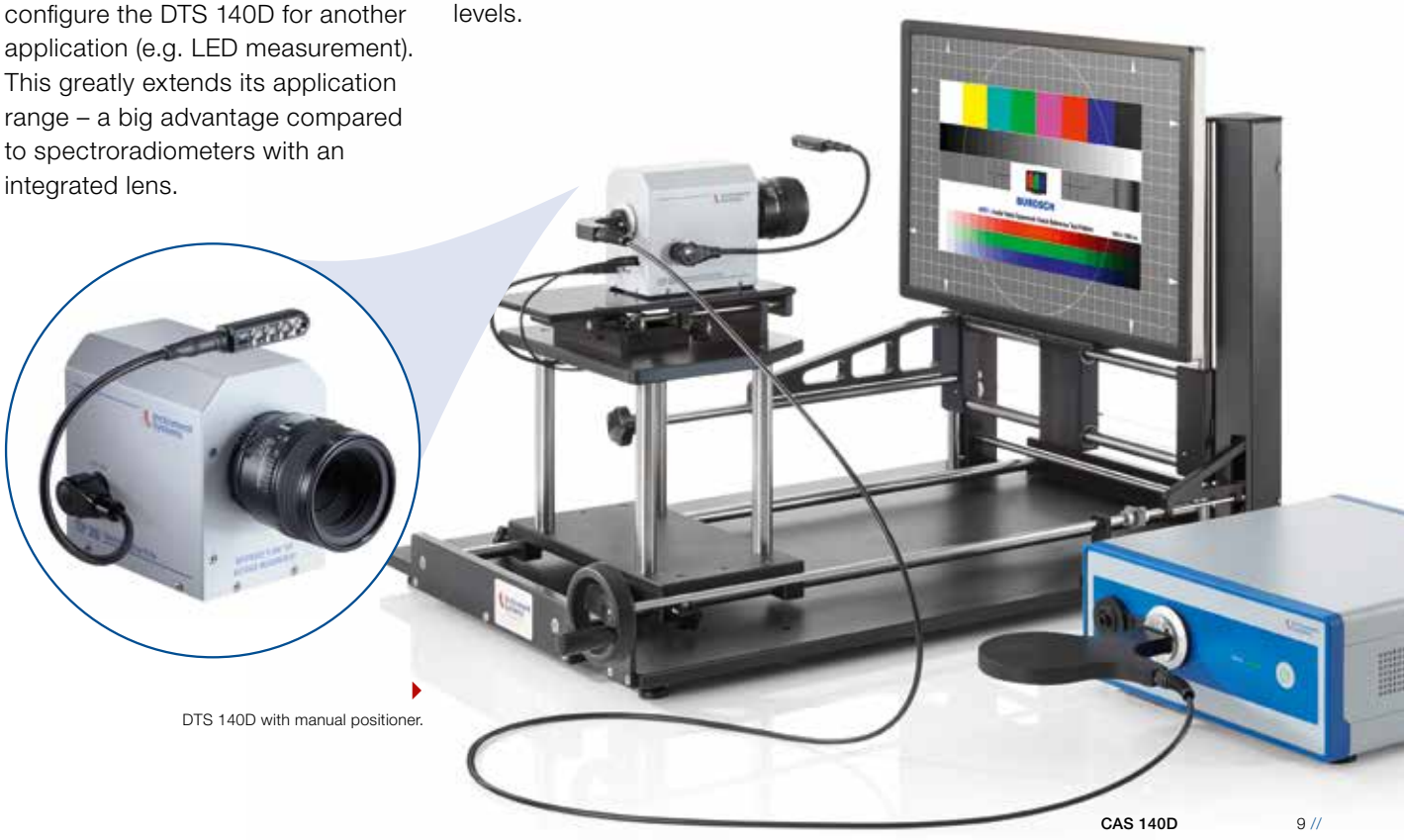
A wide range of lenses is available for the TOP 200 for realizing different spot sizes and distances to the test object. The high-resolution HRL 90 lens, for example, can be used for analyzing the smallest symbols and structures with diameters as small as 0.075 mm.

The optimized Pritchard-style optical design of the TOP 200 equipped with a 15° slightly inclined aperture mirror delivers perfectly sharp and round measurement spots. For convenient positioning of the exact measuring range on the test sample, the TOP 200 features an integrated CMOS viewfinder camera. The measurement spot is captured on the computer screen, ensuring good visibility even at low brightness levels.

With its automated aperture wheel, the TOP 200 telescopic probe is best suited for flexible setups in the laboratory. Developed for applications in a production environment, the TOP 150 features a fixed single aperture and is therefore even more robust and cost-efficient.

Patented light launch with mode mixer

The multimode fiber connector with patented mode mixer developed for the TOP 200 and TOP 150 ensures that the spectrometer measures all light launched into the fiber. The mode mixer also eliminates transmission fluctuations caused by fiber movements, and ensures extremely low polarization sensitivity.



DTS 140D with manual positioner.

DTS 140D NVIS for testing night-vision compatible displays

The DTS 140D NVIS was specially developed by Instrument Systems for testing displays and panels according to MIL-L-85762A and MIL-STD-3009. Based on robust array spectrometer technology, the system is an excellent choice for applications in production and quality assurance, where toughness and simple operation are required.

Automated measurements are enabled by the pass/fail test functions of the SpecWin Pro software.

One of the biggest challenges in taking NVIS measurements is correctly capturing the extreme differences in intensity between the visible spectral range from 380 to 620 nm and the near infrared range from 620 to 930 nm. The DTS 140D NVIS is thus based on a modified version of the CAS 140D, in which the spectrometer stray light was further reduced and measurement sensitivity automatically adjusted to cope with the various intensity ranges. Even for panels with an incandescent backlight unit, the measured results correlate exceedingly well with those of traditional scanning spectroradiometers.

Technical specifications for display measurements (preliminary)

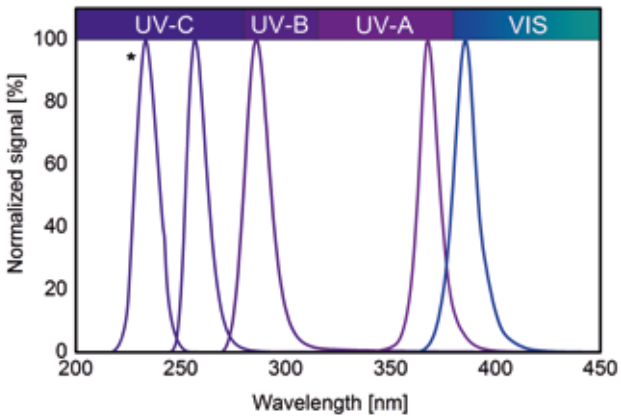
Model		**DTS140D-131 VIS**		**DTS140D-133 VIS/NIR**		**DTS140D-235 VIS/NIR (NVIS)**
Spectral range		360 - 830 nm		380 - 1040 nm		380 - 1040 nm
Spectral resolution[1]		2.2 nm		3.0 nm		7.0 nm
TOP 200 Telescopic Optical Probe						
Lens type		60 mm		60 mm		HRL 90
Lens veiling glare (approx.)[2]		1%		1%		0.1%
Polarization sensitivity		<1%		<1%		<1%
Working distance[3]		**18 cm**	**50 cm**	**18 cm**	**50 cm**	**23 cm**
Measurement spot sizes	Aperture 1 (Ø 0.125 mm)	0.16 mm	0.90 mm	0.16 mm	0.90 mm	0.075 mm
	Aperture 2 (Ø 0.25 mm)	0.34 mm	1.9 mm	0.34 mm	1.9 mm	0.15 mm
	Aperture 3 (Ø 0.5 mm)	0.66 mm	3.7 mm	0.66 mm	3.7 mm	0.3 mm
	Aperture 4 (Ø 0.8 mm)	1.0 mm	5.8 mm	1.0 mm	5.8 mm	0.5 mm
Mesurement sensitivity range[4]	Aperture 1 (Ø 0.125 mm)	0.2 - $1 \cdot 10^9$ cd/m²		0.1 - $1 \cdot 10^9$ cd/m²		0.1 - $1 \cdot 10^9$ cd/m²
	Aperture 2 (Ø 0.25 mm)	0.06 - $4 \cdot 10^8$ cd/m²		0.04 - $3 \cdot 10^8$ cd/m²		0.03 - $3 \cdot 10^8$ cd/m²
	Aperture 3 (Ø 0.5 mm)	0.02 - $1 \cdot 10^8$ cd/m²		0.01 - $1 \cdot 10^8$ cd/m²		0.01 - $1 \cdot 10^8$ cd/m²
	Aperture 4 (Ø 0.8 mm)	0.006 - $4 \cdot 10^7$ cd/m²		0.004 - $3 \cdot 10^7$ cd/m²		0.003 - $3 \cdot 10^7$ cd/m²

Measurement uncertainty	**Luminance**	**Radiance**
Accuracy[5]	±3 %	±4 %

[1] Applies to a 100 µm slit.
[2] Measured with aperture 2 according to MIL-L-85672A.
[3] Distance measured between test sample and TOP 200 front plate. In models with 60 mm lens, basic calibration takes place with a working distance of 50 cm.
[4] Applies to a signal-to-noise ratio in the spectrum of 10:1, measured with standard illuminant A, without density filter. Measuring sensitivity increases tenfold with narrow-band spectra (e.g. LED displays).
[5] Immediately after calibration relative to PTB traceable calibration standard. Refers to twofold standard deviation. Applies to the measurement and ambient conditions during calibration (e.g. without density filter, good signal level etc.)

06 \\ Solutions for further spectral measurement tasks

The CAS 140D is ideally suited for all requirements in spectral measurement and photometry. The versatile fiber connector, a broad range of accessories and the balanced software functions enable a wide range of system solutions that cover all regular measurement tasks.



Normalized spectra of different UV-LEDs with peak wavelengths at 235, 255, 285, 365 and 385 nm measured with CAS 140CT and PTFE integrating spheres at Instrument Systems.

* UV-LED spectra (220-260 nm) used with kind permission from TU Berlin and Ferdinand-Braun-Institut Berlin.

Spectroradiometry and photometry

The optical probes of the EOP series are exceptionally well-suited to the precise measurement of spectroradiometric and photometric magnitudes. They can be easily connected via optical fiber to the CAS 140D for reliable determination of irradiance or illuminance. Instrument Systems offers optical probes with primarily directional response characteristics and high light throughput or models with excellent cosine correction but lower light throughput.

UV measurements

The CAS 140D's excellent stray light properties, combined with a special calibration method, ensure that light sources in the ultraviolet spectral range can be measured accurately. Together with a measurement adapter, for example, measurements can be taken to determine photobiological safety (according to CIE-ISO S009 / EN 62471). Various software-based weighting functions are easily applied to the measured spectrum.

A broad range of UV-compatible integrating spheres is available for the measurement of the radiant flux of UV LEDs. A special stray light correction of the spectrograph of the CAS 140D can be carried out to improve the measurement characteristics of the overall system. Stray light correction improves measurement accuracy in particular in the UV spectral range and is thus particularly suitable for the measurement of UV LEDs. Instrument Systems is currently the only commercial vendor of this method that was developed by leading national laboratories.

EOP optical probes with different light throughput and angular response characteristic.

Transmission and reflection measurements

Due to high stability and stray light suppression, the CAS 140D is also optimally suited to transmission and reflection measurements. Combined with the appropriate measurement adapter, the CAS 140D is the ideal measurement system for the respective application. In addition to measurement tasks in the range of directional transmission, such as the examination of optical filters and lenses, it permits the examination of the diffuse transmission and reflection of scattering samples and solar cells.

Calibration equipment

Instrument Systems offers a broad range of calibration equipment – ranging from single LED calibration standards, up to complete calibration laboratories. Calibration equipment ensures that the measurement devices can be monitored and audited in a simple manner. If required, a special calibration module in SpecWin Pro performs a re-calibration of the measurement setup. Our ISO 17025 accredited test laboratories ensure highest accuracy and direct traceability to the reference standards of national institutes.

ACS-570 series of LED calibration standards. The compact power supply and TEC-control unit PSU 10 ensures a fast temperature regulation, as well as a high stability of the supply current.

07 \\ 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. This enables our customers to demonstrate the quality of measurements to any third party.

All 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.

08 \\ Service and support

We at Instrument Systems are setting a benchmark not only with our products. Our services secure the long-term value of your investment and guarantee optimum productivity over the entire period of use.

Our service offerings include the following:

- Engineering services
- Technical advice, also post-sales
- Re-calibration with certificate
- Instrument repair and hardware upgrade
- Software updates

09 \\ Technical specifications*

*preliminary

Model	UV/VIS	UV/VIS/NIR	VIS	VIS/NIR
Spectral range	200 - 800 nm	220 - 1020 / 300 - 1100 nm	360 - 830 nm	380 - 1040 nm
Detector	Back-thinned CCD			
Number of pixels (vertically binned)	1024 x 128			
Spectral resolution[1]	2.7 nm	3.7 nm	2.2 nm	3.0 nm
Datapoint interval	0.6 nm	0.8 nm	0.5 nm	0.65 nm
Wavelength accuracy	<±0.3 nm			
Integration time	4 msec - 65 sec			
Shortest duration SOT to EOT[2]	6 ms			
Sensor dynamic range[3]	37,000:1			
Non-Linearity	±0.5 %			
Cooling	-10 °C			
Stray light				
Broadband for Illuminant A[4]	$5 \cdot 10^{-4}$			
With laser[5]	$5 \cdot 10^{-5}$			
Sensitivity				
Irradiance[6] [W/m² nm]	$5 \cdot 10^{-8}$ - 500	$2 \cdot 10^{-8}$ - 200	$3 \cdot 10^{-8}$ - 300	$2 \cdot 10^{-8}$ - 200
Measurement uncertainty[7] (dom. wavelength / color coordinates)				
Accuracy	±0.5 nm / ±0.0015	±0.5 nm / ±0.002	±0.5 nm / ±0.0015	±0.5 nm / ±0.002

Model	UV/VIS	UV/VIS/NIR	VIS	VIS/NIR
Measurement uncertainty[7] (irradiance and illuminance)				
Accuracy	±3.5 %			
Spectrophotometry				
Baseline noise[8]	±0.4 %			
Transmission measuring accuracy[9]	±0.5 % T			
Baseline drift[10]	0.15 %/h			
Spectrograph				
Focal length, grating	Approx. 120 mm f/3.5 / plane ruled grating			
Slit	50 µm, 100 µm or 250 µm			
Filter wheel / Shutter	Max. 7 slots for density filters OD 0.5 to OD 4; UV/VIS and UV/VIS/NIR with UV density filters; position monitoring with encoder			
Electrical data				
AD converter	24 Bit resolution, Chip 16 Bit			
PC interface	USB 2.0, PCIe, Ethernet			
Triggering	1 TTL input with ascending slope; 2 software-controlled TTL outputs; 1 TTL output with flash pulse			
Other				
Dimensions (H, W, D)	144 x 341 x 359 mm³			
Power supply	Wide-range input 100 - 240 VAC 50/60 Hz			
Power consumption	Max. 70 VA			
Ambient temperature	15 - 35 °C; relative humidity 0 - 70 % max., non-condensing			
Weight	Approx. 9 kg			
Valid standards	In conformity with EN 60721-4-7 Class 7M2, EN 60721-4-7 Class 2M2, EN 61326:2004-05 and EN 61010-2002-08			

[1] Applies to a 100 µm slit.
[2] With USB interface.
[3] For a single acquisition with 4 ms integration time.
[4] Measured with edge filter OG455 at 400 nm, relative to peak intensity of unweighted spectral data.
[5] Measured 150 nm to left of the peak wavelength, relative to peak intensity of unweighted spectral data.
[6] Measured with optical probe EOP-120 and OFG-414 fiber bundle at 600 nm and signal/noise ratio of 10:1, without averaging.
[7] Immediately after calibration relative to PTB traceable calibration standard. Refers to twofold standard deviation. Applies to the measurement and ambient conditions during calibration (e.g. without density filter, good signal level etc.).
[8] With shortest integration time, without averaging and with 50% modulation. This value improves with appropriate averaging (e.g. 9x averaging results in a 3x reduction of noise).
[9] Applies to optimum spectral range; with 10% transmission and immediately after recording an averaged baseline.
[10] Typical value. Applies with LS100-130 light source after 1 hour warm-up.

10 \\ Ordering information

Order number	Description			
Spectrometer	**Model**	**Interface**	**Slit**	**Filter wheel**
CAS140D[Model][Interface][Slit][Filter wheel]	[151] VIS [152] UV/VIS [153] VIS/NIR [154] UV/VIS/NIR (220 - 1020 nm) [156] UV/VIS/NIR (300 - 1100 nm)	[U] USB [P] PCIe [E] Ethernet	[1] 100 µm [2] 50 µm [3] 250 µm	[A] : [J] (OD 0.5 to OD 4; max. 7 filters)
Options				
CAS140D-422	Active USB extension			
Spare parts				
SPR-03-10	PCIe plug-in for PC			
SPR-03-11	PCIe plug-in modul			
SPR-03-12	3 m PCIe cable			
SPR-03-13	5 m PCIe cable			
SPR-03-20	USB plug-in modul			
SPR-03-30	Ethernet plug-in modul			
Software				
SW-120	SpecWin Light spectral software for Windows. Features emission-, transmission-, reflexion- and LED/display-measurements			
SW-130	SpecWin Pro spectral software for Windows. Including all modules and measurement modes			
SW-135	SpecWin Pro/Light language pack for Chinese (traditional und simplified) and Japanese			
SW-136	Calaris calibration software for array spectrometers; plug-in for SpecWin Pro			
SW-140	SpecWin Pro plug-in for Keithley 24xx/26xx sourcemeter			
SW-141	SpecWin Light plug-in for Keithley 24xx/26xx sourcemeter			
SW-150	SpecWin Pro plug-in for AC-sources and powermeter			
SW-160	SpecWin Pro MultiTrack plug-in for fast acquisition of spectra			
SW-231	Software development kit (SDK); DLL software for customized programs			
SW-233	LabVIEW driver software; requires SW-231			
DTS 140D models (complete for display measurements)				
DTS140D-131	360 - 830 nm; 60 mm lens; working distance 18 cm to infinity			
DTS140D-133	380 - 1040 nm; 60 mm lens; working distance 18 cm to infinity			
DTS140D-235	380 - 1040 nm; high-resolution lens HRL90; working distance 23 cm fix; for NVIS measurements according to MIL-L-85762A and MIL-STD-3009			

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We bring quality to light.