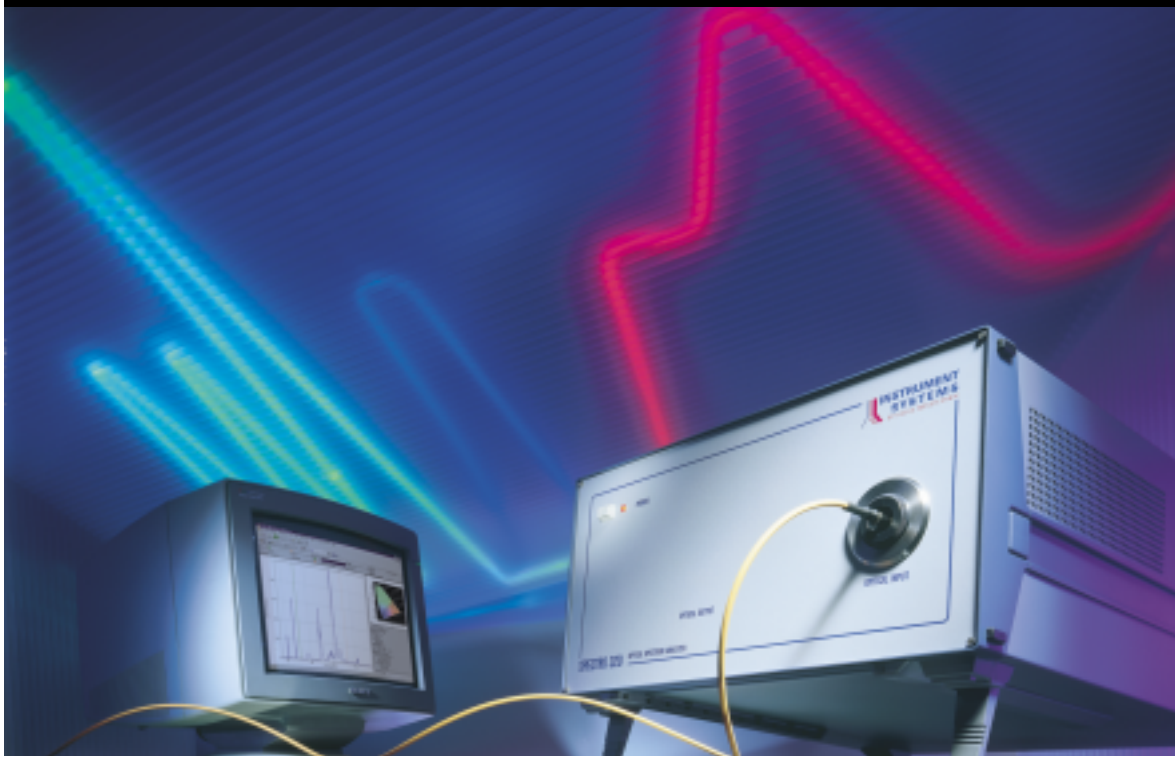
WE BRING QUALITY TO LIGHT.

SPECTRO 320

Scanning Spectrometer

THE ULTIMATE IN ACCURACY AND VERSATILITY



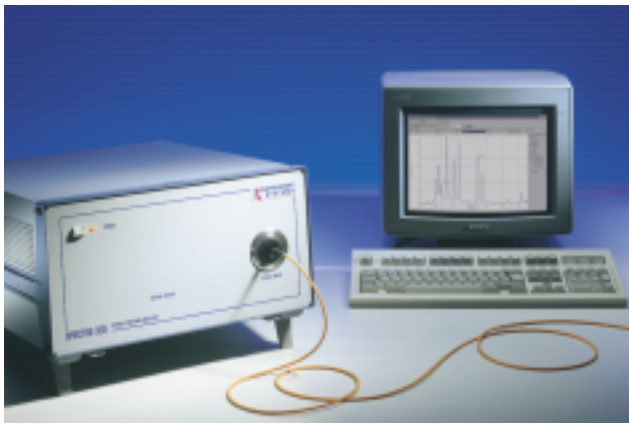
- Unique scanning technology enables short measurement times with superb accuracy and large signal dynamic range
- Broad spectral range from 190 to 5000 nm in a single instrument
- Single and double monochromator versions
- Versatile with comprehensive fiber-optic based accessories

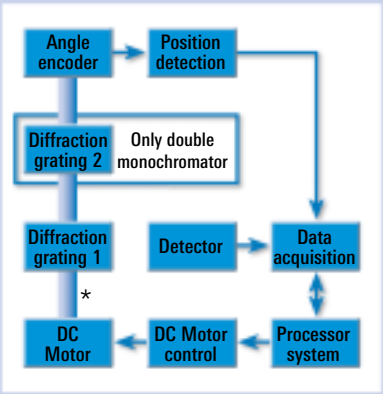
- Spectroradiometry and spectrophotometry in the UV/VIS/IR range
- Complete systems for testing LEDs and displays (including NVIS in conformance with MIL-L-85762A)
- High-resolution spectral measurements, e.g. laser diodes

INSTRUMENT SYSTEMS
OPTISCHE MESSTECHNIK

Expanding the spectrum

The new SPECTRO 320 sets the standard for high performance, high accuracy, and versatile spectrometers in optical test and measurement applications. The SPECTRO 320 can be used as a spectroradiometer with calibrated optical probes, as a spectrophotometer for measuring transmission and reflection, or as an optical spectrum analyzer in fiber-optic metrology and for testing laser diodes. The instrument's innovative and fiber-optic based concept provides flexible solutions for many optical measurement needs.





The innovative spectrometer concept:
Spectra are obtained quickly by using a DC motor to smoothly rotate the diffraction grating. The need for complex mechanical parts is eliminated because a high-precision angle encoder is attached directly to the grating turret. The encoder synchronizes measurement readings while the grating rotates. Users can rely on the SPECTRO 320 for superb absolute wavelength accuracy over the entire spectral range. Year after year.
**mechanical shaft*

The best of both worlds: fast and accurate measurements

This new spectrometer technology permits measurements that combine speed and precision far beyond those of conventional stepper-motor driven monochromators. A spectral range from 380 to 780 nm, for example, can be measured in just a few seconds. The SPECTRO 320 is designed to combine the advantages of the large signal dynamic range and high spectral resolution characteristics of a scanning spectrometer with the short measuring times of array detectors. The SPECTRO 320 also has an enormous spectral range. It is possible to scan from 190 to 5000 nm in the maximum configuration with 3 gratings and 3 detectors. The instrument switches automatically between each grating and detector during the scan.
An RS-232 interface and optional IEEE-488 bus provide the communications link to a PC. Plug-and-go design enables measurements to be taken immediately without the usual time-consuming adjustments. The software allows all the important features to be selectable: scanning speed, gratings, detectors, density filters, cut filters, bandpass (0.07 to 10 nm), and the high-voltage supply level for the photomultiplier. The SPECTRO 320 is available in a single monochromator or double monochromator (SPECTRO 320 D) configuration. The extremely low stray light makes the SPECTRO 320 D ideal for analyzing UV-B radiation and for measuring transmission at high absorption levels.

DFI: Direct-Fiber Input

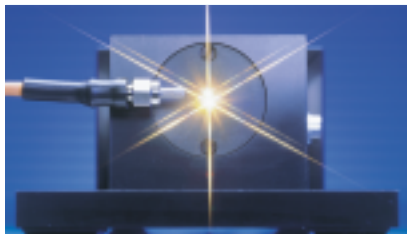
In addition to the available fiber-plug adapters in the PLG-xxx series, fiber bundles with a cross-section converter can also be mated directly to the entrance slit of the SPECTRO 320. This results in a significant increase in sensitivity because a bigger, more effective fiber-optic cross section is used to illuminate the full height of the slit.

Optical Port: optical output and detector input

The optional optical port significantly expands the scope of applications for the SPECTRO 320. The optical output can be used for measuring the spectral sensitivity of detectors, as a fast tunable wavelength filter, or – in combination with a broadband light source – for generating monochromatic radiation. It is also possible to launch light back into the detector input (e.g. using the photometer unit). The optical port accepts all PLG-xxx fiber-optic adapters.

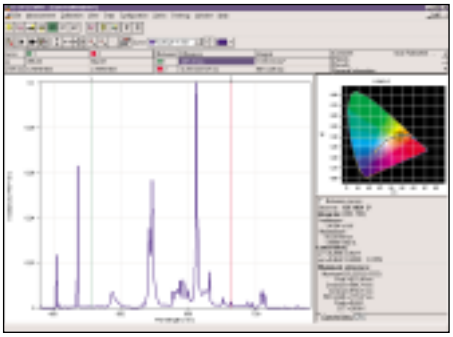
Accessories: flexible and universal

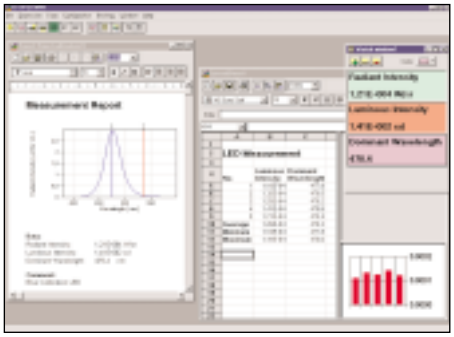
A comprehensive range of accessories facilitates the many uses of the SPECTRO 320. Measurement adapters for a variety of functions can be linked to the spectrometer via fiber-optic cable. Applications include radiation measurements in general spectroradiometry and photometry as well as diffuse and specular transmission/reflection measurements.



SpecWin Software for Windows 95/98/NT/2000

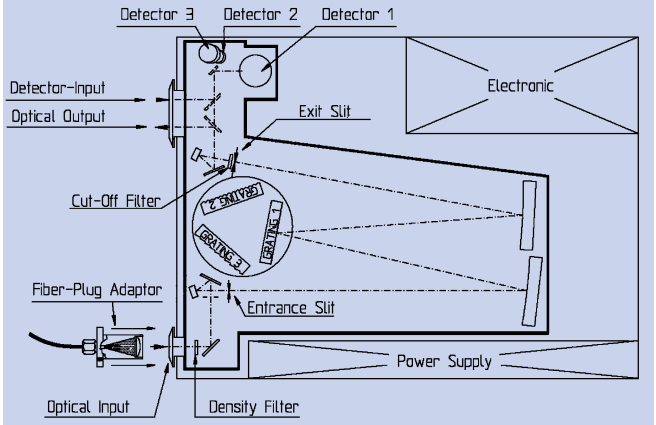
SpecWin software controls all SPECTRO 320 functions and includes an MS-Word®-compatible report generator and an MS-Excel®-compatible spreadsheet. This saves time when taking measurements and provides instant analysis and documentation of results. It also provides a user definable "watch window" with Pass/Fail evaluation and an integrated spectral analysis mode that displays radiometric, photometric, and colorimetric results.





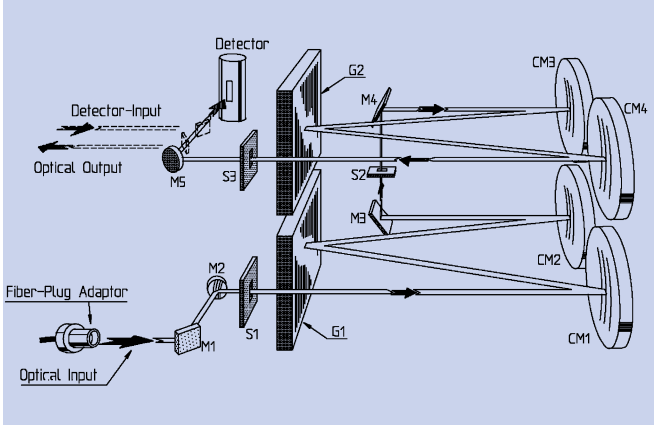
Instrument DLLs

A Windows DLL is available to create customer-specific programs, e.g. for special test sequences. This DLL operates all the SPECTRO 320 functions. It also features comprehensive analysis routines. The DLL gives SPECTRO 320 the capability to be integrated in complex measurement setups with other instruments.



SPECTRO 320: Single monochromator

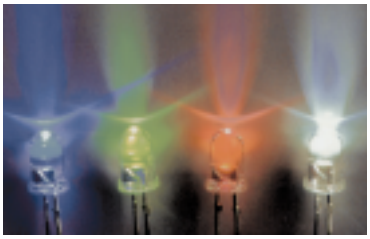
All optical elements of the asymmetric Czerny-Turner monochromator are reflective and have a broadband coating from 190 to 5000 nm. The direct fiber input is positioned in front of the entrance slit to replace the focusing optics. Downstream from the exit slit, reflecting mirrors direct the radiation onto the specified detector. The optical output and detector input make up the optical port.



SPECTRO 320 D: Double monochromator

Superimposing the two single monochromators creates a compact spectrometer in a subtractive configuration. The two gratings are positioned on the same shaft, which eliminates the difficult problem of synchronizing the first and second monochromator. No other double monochromator compares to the SPECTRO 320 D for fast scans with extremely high wavelength accuracy and stability.

LED Measurement: ultimate accuracy



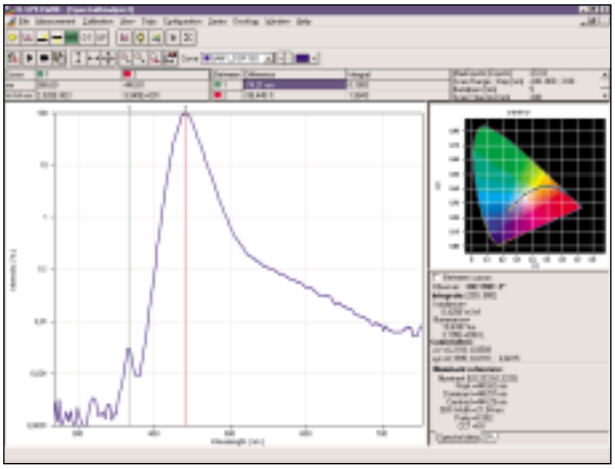
Luminous intensity, luminous flux, and all spectral characteristics can be determined quickly and accurately in a single measurement using the appropriate adapter with the SPECTRO 320. The geometries of the measuring adapters from INSTRUMENT SYSTEMS are in exact conformity with CIE (International Commission on Illumination) specifications. Measurement results therefore correlate precisely with CIE recommendations. A complete LED test station includes a SPECTRO 320 with PMT3 photomultiplier, an LED optical probe, a selection of LED test sockets, and a constant-current source. The universal fiber-optic interface is engineered to allow adapters to be changed quickly and easily without invalidating the calibration. This saves time and greatly extends the range of applications.

LED optical probes from INSTRUMENT SYSTEMS are in exact conformity with CIE recommendations

The following characteristics of an LED are calculated from the measured spectral data: luminous intensity or luminous flux, radiant intensity or radiant power, color coordinates and color rendering index, FWHM, as well as dominant, centroid, and peak wavelength.

Logarithmic representation showing the spectrum of a blue LED

The dynamic measuring range of the SPECTRO 320 D is up to 7 decades (without the use of density filters). This exceptionally large dynamic range permits precise analysis of the weak UV peak for this special LED at 367 nm. The minimum between the main peak and the UV peak is 5 orders of magnitude below maximum intensity.



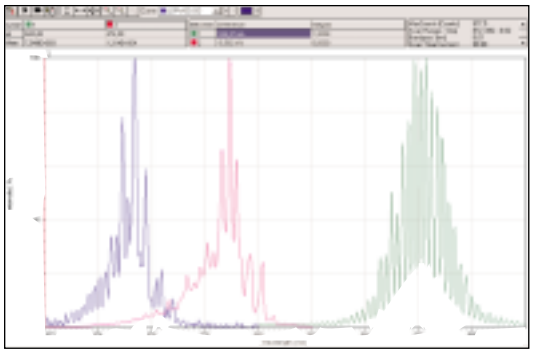
TECHNICAL SPECIFICATIONS FOR LED MEASUREMENTS		
SPECTRO 320 Model	**UV**	**VIS**
Measuring range *1		
Luminous intensity*2	0.04 mcd-8000 cd	0.01 mcd-2000 cd
Luminous flux *3	0.08 mlm-16000 lm	0.02 mlm-4000 lm
Accuracy		
Luminous intensity*4	± 4 %	
Luminous flux *4	± 5 %	
Dominant wavelength *5	± 0.3 nm	
Color coordinates*5	(x,y) ± 0.0015	

**1 Applies to single monochromator with PMT3 at maximum slit width. Other values apply to smaller slits. The lower sensitivity limit applies to a signal-to-noise ratio of 10:1, measured at a yellow LED.*
**2 With LED430 adapter.*
**3 With ISP80 adapter.*
**4 Immediately after calibration relative to the calibration standard, for diffuse LEDs and without density filter*
**5 At adequate signal dynamic range and after calibration. The specified errors apply a twofold standard deviation.*

Fiber-optic metrology

Interchangeable adapter plugs for FC/PC, ST, DIN, Radiall, and SMA provide easy connections for applications in fiber-optic metrology

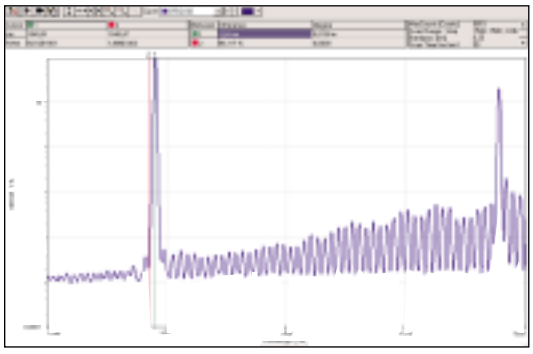
High spectral resolution as narrow as 0.07 nm combined with a wide spectral range from UV to IR and short measuring times make the SPECTRO 320 ideal for numerous applications in fiber-optic metrology and for testing laser diodes. The instrument's flexibility facilitates measurements that are often impossible with conventional optical spectrum analyzers or spectrometers. Determining the absorption of single-mode fibers in the UV range is just one example. Only the UV-optimized SPECTRO 320 with cooled photomultiplier provides the necessary signal sensitivity and dynamic measuring range.



Testing laser diodes

Multimode laser diode in pulsed and CW operation

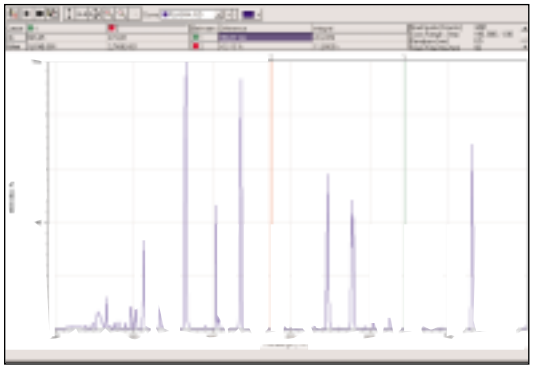
Laser diodes are present in many different technologies. Multimode laser diodes have many modes that are separated by 0.2 to 1.5 nm. These secondary modes are suppressed in single mode laser diodes or DFB lasers. Knowledge of the mode structure and side mode suppression ratio is very important for many applications. Only extremely precise measurements with very high spectral resolution, wavelength accuracy, and dynamic measuring range can deliver the desired results. The SPECTRO 320 is fully compliant with these requirements and also offers superior flexibility.



High spectral resolution with any fiber input

DFB laser diode with measured side mode suppression ratio of 45 dB at a distance of 0.8 nm and a strong secondary mode at 29 nm distance to the main peak. The radiation was launched via a fiber bundle.

The SPECTRO 320 has a software selectable entrance slit. This means that users can launch free space radiation or connect fibers with a large core diameter and still achieve a high spectral resolution. In conventional spectrum analyzers for optical communications, however, the end of the optical fiber generally substitutes for the entrance slit of the monochromator. The specified spectral resolution in these instruments can only be obtained using single mode fibers. Fibers with large core diameters drastically diminish spectral resolution and wavelength accuracy.



Precise determination of plasma and fluorescence lines

Measuring plasma and fluorescence lines often requires high spectral resolution, short scan times and a broad spectral range. This is where the different models of the SPECTRO 320 spanning UV to IR provide significant benefits. The versatility and wide range of optical probes also meets diverse requirements for launching radiation.

Display measurement in the automotive and aerospace industries

The DTS320 Display Test System includes a SPECTRO 320 with PMT3 photomultiplier and the TOP 100 telescope optical probe. The integrated system is supplied with SpecWin software and a full calibration. The DTS320-101 model is ideal for testing displays in the automotive and aerospace industries. It is also suitable for all applications that require high levels of sensitivity for very small measuring spots. The DTS320-201 with a cooled photomultiplier was specially developed for measuring night-vision compatibility according to the MIL-L-85762A specification.

Special fiber-optic coupling

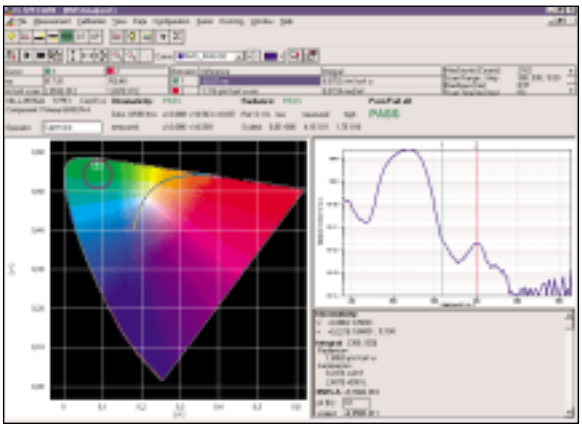
The flexible TOP 100 fiber-optic coupling with integrated mode mixing provides a wide range of advantages. The test system can easily be reconfigured for different scenarios without loss of calibration. The fiber-optic coupling also acts as a polarization scrambler that permits accurate measurements from polarized sources such as LCDs and TFT displays. Furthermore, unlike other systems coupled directly with Pritchard style optics, the various spot sizes of the TOP 100 do not affect the spectral bandwidth or wavelength accuracy of the spectrometer. Consistent results are thereby obtained for different measuring-spot sizes.

An Eye for Detail: TOP 100 Telescope Optical Probe

The measuring spot is adjusted using the focusing eyepiece, and different apertures can then be selected. The fixed focal length, HRL-90 high-resolution lens permits measurements of graphics and structures as small as 0.15 mm in diameter (0.006”). Other TOP 100 objective lenses are also available and attach to the basic unit with the universal bayonet connector. The DTSISP-100 accessory allows users to measure the daytime reflection characteristics of extremely small structures.

If displays are designed for use with NVGs (night vision goggles), the test system must be capable of capturing the difference in dynamic range between the eye (visible spectrum) and the night vision goggles (near infrared range) in a single scan. This measurement scenario demands a high-end spectroradiometer with low stray light and wide signal dynamic range of at least 5 decades. INSTRUMENT SYSTEMS pioneered fast NVIS measurements by developing the DTS320-201 Display Test System based on the SPECTRO 320 and a cooled photomultiplier. The market leading DTS320-201 allows NVIS-A and NVIS-B radiance to be measured within 1 to 2 minutes. Traditional systems might require up to one hour to carry out a comparable measurement.

The standard version of the DTS320-201 has integrated cooling (-5° C) for the photomultiplier, and this favors mobile applications. There is also an optional external cooling system for -10° C with additional reduced signal noise. The sensitivity threshold is just 10E-13 W/cm²sr nm with the optional direct fiber input, permitting NVIS radiance measurements at 0.1 fL.



A special NVIS measurement mode in the SpecWin software contains the full nomenclature in conformity with MIL-L-85762A and an automatic Pass/Fail test.

NVIS measurements in conformity with MIL-L-85762A

TECHNICAL SPECIFICATIONS FOR DISPLAY MEASUREMENTS			
Spectrometer model		**DTS320-101**	**DTS320-201 (NVIS)**
Spectral range		350 – 930 nm	380 – 930 nm
Grating		600 g/mm, 500 nm blaze	651g/mm, 730 nm blaze
Photomultiplier		PMT3	PMT3, cooled *1
Measuring range / Sensitivity *2			
Luminance measuring range *3	Aperture 1	0.5 – 10E7 cd/m²	0.05 – 10E7 cd/m²
	Aperture 2	0.2 – 10E7 cd/m²	0.02 – 10E7 cd/m²
	Aperture 3	0.05 – 10E6 cd/m²	0.005 – 10E6 cd/m²
Radiance sensitivity *4		10E-11 W/cm²sr nm	10E-12 W/cm²sr nm
Accuracy			
Luminance *5		± 4 %	
Radiance *5		± 5 %	
Chromaticity (x,y) *6		± 0.0015	
Dominant wavelength *6		± 0.3 nm	
Dynamic measuring range *7		6 decades	
Polarization sensitivity		± 3 %	
TOP 100 Telescope Optical Probe			
Objective lens		HRL 90, 9 cm distance to display	
Objective lens stray light *8		Approx. 0.1%	
Measuring-spot sizes		Aperture 1: 0.15 mm / Aperture 2: 0.3 mm / Aperture 3: 0.6 mm	
Fiber-optic cable *9		1 mm diameter, minimum bending radius 20 cm	
Dimensions TOP100 (H x W X D)		150 x 150 x 95 mm	
Weight TOP100		2.5 kg	

**1 Internal cooler to –5° C is standard. Optional external cooler to –10° C for approx. 1.5-fold reduced noise.*

**2 Minimum value applies to largest slit.*

**3 Applies to a signal-to-noise ratio of 10:1 in the spectrum, measured from standard illuminant A with density filter. The measuring sensitivity improves 5-fold when taking measurements of narrow-band spectra (e.g. LED displays).*

**4 Applies to a signal-to-noise ratio of 10: 1 in the spectrum with aperture 3 and standard fiber. For DFI with fiber bundle and aperture 5 approx. 10-fold improved sensitivity.*

**5 Immediately after calibration with the calibration standard.*

**6 At adequate signal dynamic range and after calibration. The specified errors apply a twofold standard deviation.*

**7 In the near infrared part of the spectrum taking account of the cut filters. (RG610 in add. for NVIS)*

**8 Measured at the smallest measuring spot in conformity with MIL-L-85762A.*

**9 For optional DFI: 3 mm diameter, minimum bending radius is 15 cm.*

Calibrated measurement of optical quantities

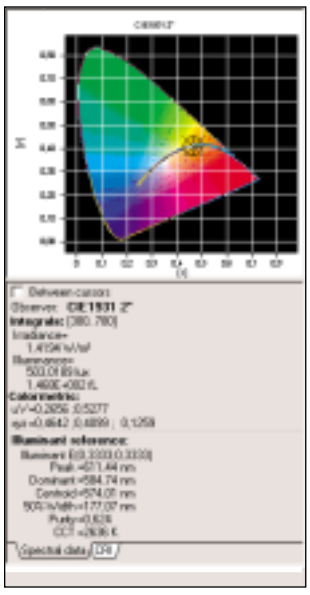
INSTRUMENT SYSTEMS supplies a complete range of adapters for measuring optical radiation. A number of fiber-optic probes with cosine correction are available for determining irradiance and illuminance. The SPECTRO 320 can also be easily connected to a large integrating sphere via a fiber-optic adapter. Measuring the total radiant power and luminous flux emitted by lamps or LEDs in lighting applications is one example for this setup.

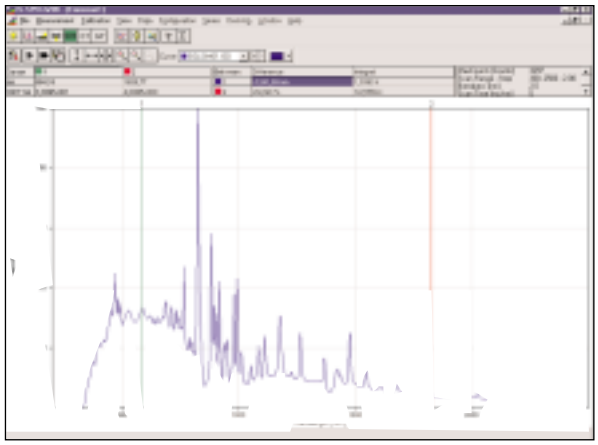
The SPECTRO 320 D double monochromator with cooled photomultiplier and cosine corrected fiber-optic probes provides extremely accurate measurements in the calibration laboratory (photo courtesy of Novartis / Aventis)

The SPECTRO 320: compact, portable and easy to handle

The SPECTRO 320 is superb for spectroradiometric applications by offering a wide spectral range spanning UV to IR. The robust, shock-mounted optical system ensures extremely stable measurements and absolute wavelength accuracy even over a broad temperature range. As with all our spectroradiometers, no re-calibration is usually required following transport. Compared to array spectrometers, the SPECTRO 320 also offers the advantage of software selectable spectral (bandpass) resolution and significantly lower stray light.

All radiometric, photometric and colorimetric values (including color rendering index and color temperature) are calculated automatically from the spectral data obtained. The radiometric and photometric unit is referenced to the calibration of the particular setup.





Example of a solar simulator:
The fast scanning technology of the SPECTRO 320 allows you to measure a spectral range from 190 to 2500 nm in less than a minute, depending on the fiber type and optical probe

INSTRUMENT SYSTEMS supplies a complete spectroradiometer based on the SPECTRO 320 D double monochromator version that is fully compliant with the specific requirements for extremely accurate and sensitive measurements in the UV range. Determining the irradiance of solar radiation close to the earth's surface, as well as testing lamps, tanning beds and solar simulators are just a few examples of possible applications.

SPECTRO 320 D double monochromator

- Fast scanning
- 7 decades dynamic measuring range in a single scan
- Extremely low stray light
- High measuring sensitivity with cooled PMT
- Absolute wavelength accuracy ± 0.03 nm

High wavelength accuracy

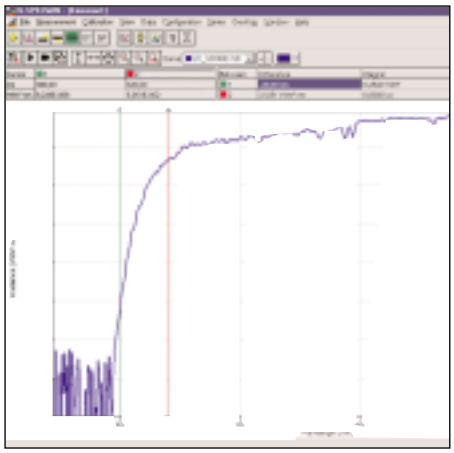
Wavelength accuracy is a key parameter since the radiometric value measured is changing rapidly as a function of wavelength. And a small wavelength error can lead to large errors in UV-B solar irradiance calculations. The innovative scanning technology of the direct grating drive combines with the precision angle encoder to offer uniform and high wavelength accuracy over a broad temperature range.

Ahead of the weather

A digitally controlled DC motor ensures smooth, fast rotation of the grating without mechanical vibration. This design yields short scan times and accurate results, even under rapidly changing weather conditions. By contrast, conventional spectroradiometers with stepper motors and discrete wavelength increments take several minutes to record a spectrum – enough time for solar irradiance to change if clouds are passing overhead.

High measuring sensitivity

Combining high signal sensitivity with short measuring times provides a distinct advantage for UV-B monitoring. Continuous data reading by the SPECTRO 320 coupled with the cooled photomultiplier and an optical system optimized for light throughput creates the conditions for this very high signal sensitivity. The fast rise-time, DC-coupled amplifier also allows short readout times. Hence, accurate radiometric determination of the high dynamic range spectrum can still be achieved in short measurement times. By contrast, traditional lock-in amplifiers have the disadvantages of long time constants.

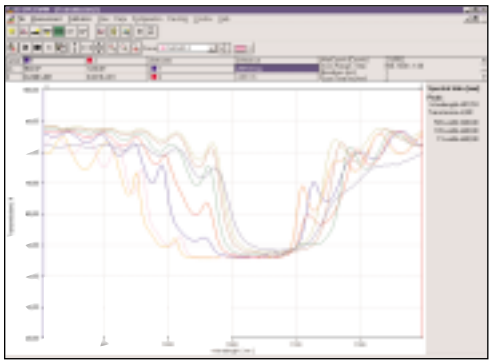


Measurement of solar irradiance over 7 decades – the signal noise is significantly lower than 10E-6 W/m²nm.

TECHNICAL SPECIFICATIONS OF THE SPECTRO 320 D FOR UV-B MEASUREMENTS	
Spectral range	190 to 700 nm for spectroradiometer 220 to 500 nm for cosine-corrected optical probe
Spectral resolution / bandpass	0.1 to 5 nm, software selectable slit wheel
Absolute wavelength accuracy	± 0.03 nm
Wavelength reproducibility	± 0.01 nm
Scan time	5 msec/nm to 500 msec/nm, software selectable
Minimal measurable irradiance *1	5·10E-7 Watt/m² nm at 1 nm bandpass
Dynamic measuring range in one scan *2	7 decades
Stray light at 290 nm, for standard illuminant A	10E-8
Spectroradiometric accuracy *3	± 5 %
Spectroradiometric reproducibility *4	± 2 %

**1 With cooled photomultiplier, EOP-420 and fiber bundle with cross-section converter, 100 msec / nm scan time, signal-to-noise ratio of 2:1 and for 250 to 450 nm spectral range*
**2 With automatic gain switching*
**3 Immediately after calibration and after 3 hours warm-up time*
**4 After 3 hours warm-up time*

Transmission and Reflection Measurements



The high measuring speed of the SPECTRO 320 means that changes in transmission can be recorded quickly as a function of temperature for this liquid crystal filter.

The speed, accuracy, and low stray light of the SPECTRO 320 is also advantageous for measurements of optical filters and coatings.
INSTRUMENT SYSTEMS offers a comprehensive range of accessories for these measurements such as a test station that includes a sample compartment, sample mount and a complete light source unit. Measurements can even be taken from large samples with very different measurement geometries.

TRA100 Transmission adapter

The TRA 100 transmission adapter is supplied for specular transmission measurements. It comprises a light source with sample mount and focusing optics for the fiber-optic link. Alternatively, the LS-500 light source with an integrated deuterium and halogen lamp can be connected. This allows a spectral range from 190 to 2500 nm to be measured in a single scan.

ISP80 / ISP150 Integrating spheres

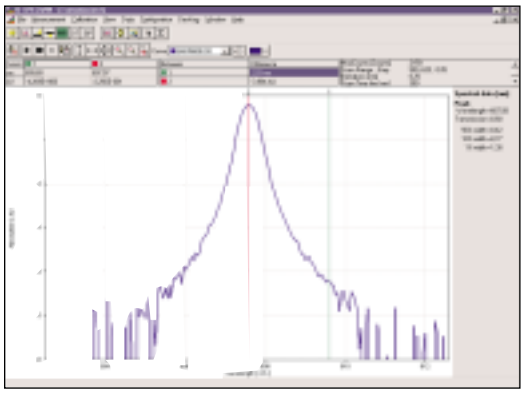
The compact integrating spheres of the ISP 80 and ISP 150 series were specially developed for diffuse reflection and transmission measurements. The two spheres are coated with BaSO4 and can be used for the spectral range from 300 to 2200 nm. The measuring setup is easy to reconfigure between reflection and transmission measurements.

GON360 Goniometer

The GON 360 goniometer can be used to obtain specular transmission and reflection measurements at variable angles over the spectral range from 200 to 2500 nm. An impressive feature of the GON 360 permits an absolute baseline scan for reflection measurements without using a reference standard.

Photometer unit for high absorption levels

The photometer unit (SP320-320) can be connected directly to the optical port (option SP320-310). This enables accurate measurements to be taken of planar samples up to a thickness of 12.5 mm. Heating effects due to absorption in the sample are avoided since the sample is scanned using monochromatic light. Up to 6 absorption units can be recorded in a single scan using the SPECTRO 320 D double monochromator version. Furthermore, the sample compartment is lightproof enabling the test setup to be used in the presence of ambient light.



The very low stray light and high spectral resolution of the SPECTRO 320 D permit measurement of this narrow-band Lidar filter with only 0.4 nm FWHM

The photometer unit allows accurate transmission measurements from samples at high absorption values.

TECHNICAL SPECIFICATIONS

Model		UV	VIS	IR1	IR2	IR3
General						
Detector		Si / PMT	Si / PMT	InGaAs	PbS	PbSe
Grating [g/mm] / blaze *1		1200 UV	1200 VIS	600 / 1000 nm	300 / 1300 nm	300 / 2000 nm
Grating type		Holographic	Holographic	Ruled	Ruled	Ruled
Spectral range *2		190 - 1050 nm	350 - 1100 nm	800 - 1700 nm	800 - 3200 nm	1000 - 5000 nm
Spectral resolution *3		0.2 / 0.07 nm	0.2 / 0.07 nm	0.4 / 0.1 nm	1 / 0.3 nm	2 / 0.6 nm
Data point interval *3		0.05 / 0.01 nm	0.05 / 0.01 nm	0.1 / 0.02 nm	0.2 / 0.04 nm	0.2 / 0.04 nm
Wavelength accuracy *4		± 0.1 / 0.03 nm	± 0.1 / 0.03 nm	± 0.2 / 0.05 nm	± 0.5 / 0.1 nm	± 0.5 / 0.1 nm
Wavelength reproducibility *4		± 0.05 / 0.01 nm	± 0.05 / 0.01 nm	± 0.1 / 0.02 nm	± 0.2 / 0.05 nm	± 0.2 / 0.05 nm
Scan time [msec/nm]		10 - 100	10 - 100	10 - 100	20 - 100	20 - 100
Sensitivity to direct launch *5		Si: $5 \cdot 10^{-11}$ W/nm PMT: $5 \cdot 10^{-15}$ W/nm	Si: $2 \cdot 10^{-11}$ W/nm PMT: $2 \cdot 10^{-15}$ W/nm	$2 \cdot 10^{-12}$ W/nm	$1 \cdot 10^{-10}$ W/nm	$1 \cdot 10^{-9}$ W/nm
Stray light (laser) *6	SP320	$1 \cdot 10^{-5}$	$1 \cdot 10^{-5}$	$5 \cdot 10^{-5}$	$1 \cdot 10^{-4}$	
	SP320D	$1 \cdot 10^{-9}$	$1 \cdot 10^{-9}$	$1 \cdot 10^{-8}$	$2 \cdot 10^{-8}$	
Stray light (broadband) *7	SP320	$1 \cdot 10^{-4}$ bei 285 nm	$1 \cdot 10^{-4}$ bei 400 nm	$2 \cdot 10^{-4}$ bei 950 nm	$2 \cdot 10^{-4}$ bei 1500 nm	
	SP320D	$1 \cdot 10^{-8}$ bei 285 nm	$1 \cdot 10^{-8}$ bei 400 nm	$5 \cdot 10^{-8}$ bei 950 nm	$1 \cdot 10^{-7}$ bei 1500 nm	
Spectroradiometry						
Sensitivity *8	SP320	$3 \cdot 10^{-7}$ W/m²nm	$1 \cdot 10^{-7}$ W/m²nm	$1 \cdot 10^{-5}$ W/m²nm	$7 \cdot 10^{-4}$ W/m²nm	$5 \cdot 10^{-3}$ W/m²nm
	SP320D	$1 \cdot 10^{-6}$ W/m²nm	$3 \cdot 10^{-7}$ W/m²nm	$3 \cdot 10^{-5}$ W/m²nm	$2 \cdot 10^{-3}$ W/m²nm	N/a
Spectroradiometric accuracy *9		± 5 %	± 5 %	± 5 %	± 7 %	± 8 %
Spectrophotometry *2						
Transmission measuring accuracy *10		± 0.1 % T or ± 0.004 A at 1 A	± 0.1 % T or ± 0.004 A at 1 A	± 0.15 % T or ± 0.006 A at 1 A	± 0.25 % T or ± 0.01 A at 1 A	± 0.5 % T or ± 0.02 A at 1 A
Baseline noise *11		± 0.05 % T	± 0.05 % T	± 0.05 % T	± 0.1 % T	± 0.3 % T
Baseline drift *12		0.2 %/h or 0.0008 A/h	0.2 %/h or 0.0008 A/h	0.2 %/h or 0.0008 A/h	0.5 %/h or 0.002 A/h	1 %/h or 0.004 A/h
Miscellaneous						
Focal length		320 mm, f/4.6; asymmetrical Czerny-Turner configuration				
Filter wheels *13		Density filters: density 1, 2 and 3; cut-off filters: 320, 570, 645 nm, Si, Ge				
PC Interface		Standard: RS-232 interface; optional: IEEE-488 Bus				
Trigger		Synchronization output (5 V TTL level)				
Operating temperature		15 - 35 °C; max. relative humidity 80 %, non-condensing				
Power supply		230 V or 115 V AC				
Power consumption		Approx. 40 Watt				
Dimensions (H, W, D)		SPECTRO 320: 220 x 425 x 560 mm³		SPECTRO 320 D: 260 x 425 x 560 mm³		
Weight		SPECTRO 320: approx. 23 kg		SPECTRO 320 D: approx. 35 kg		

**1 The exact values for the groove density of the grating and the blaze may vary. *2 The values only apply to the silicon detector in UV and VIS models.*
**3 The first value applies to the standard version. The second value applies in conjunction with the SP320-200 high-resolution option. The values relate to the minimum relevant resolution, but it is possible to select larger values. There is a choice between the following slits: 2 / 1 / 0.5 / 0.25 / 0.1 mm (in addition for SP320-200: 0.05 / 0.025 / 0.01 mm).*
**4 The first value applies to the standard version. The second value applies in conjunction with the SP320-200 high-resolution option. The values relate to a continuous scanning for one hour. The accuracy of wavelength positioning in the monochromator mode is typically ± 2 nm.*
**5 Applies to a signal-to-noise ratio of 2 : 1 for the SP 320 single monochromator for the largest slit and in the optimum spectral range. The values for UV and VIS models relate to type PMT3 for the photomultiplier and to the standard (uncooled) silicon detector respectively. Sensitivity values for the optional extended InGaAs detectors in IR1 models are approx. 5 times higher for the 2200 version and 25 times higher for the 2500 nm version.*
**6 Measured at eight-fold bandpass distance to the laser line. UV, VIS: at 633 nm. IR1, IR2, IR3: at 1152 nm.*
**7 Broadband light source radiation according to standard illuminant A. Measured with the following cut-off filters: 320 nm (for 285 nm), 455 nm (for 400 nm), 1200 nm (for 950 nm), or 1800 nm (for 1500 nm) relative to the peak intensity of the unweighted spectral data.*
**8 Measured with the EOP-120 optical probe and OFG-415 fiber bundle, with maximum slit size, slowest scan speed, a data-point interval of 1 nm, a signal-to-noise ratio of 2 : 1 and without averaging. The following conditions apply to the relevant models: UV, VIS: with PMT3 photomultiplier, measurement at 600 nm; IR1, IR2, IR3: measurement at 1500 nm*
**9 Immediately after calibration relative to the calibration standard and without density filter*
**10 These values apply to the optimum spectral range and immediately after the baseline scan. Accuracy may be lower at the spectral ends.*
**11 This value is obtained at a relevant signal level and without averaging. The value improves with appropriate averaging (e.g. 9-fold averaging reduces noise 3-fold).*
**12 Applies to LS100-130 light source after 1 hour for warming up; typical value*
**13 Spectral ranges for density filters: density 1: 190 - 3200 nm; density 2 and 3: 320 - 2500 nm*

ORDERING INFORMATION

INSTRUMENT SYSTEMS is continually working to develop and improve products. Any technical changes, errors or misprints do not form grounds for compensation. The company's Terms of Delivery and Payment apply in all other respects.

**) Only for the UV-B version with direct fiber input*

Order Number	Description		
Spectrometer			
Single monochromator	Double monochromator	Model	Spectral range
SP320-110	SP320-160	VIS	350 - 1100 nm
SP320-111	SP320-161	UV	190 - 1050 nm
SP320-112	SP320-162	IR1	800 - 1700 nm
SP320-113	SP320-163	VIS-IR1	350 - 1700 nm
SP320-114	SP320-164	UV-IR1	190 - 1700 nm
SP320-115	SP320-165	VIS-IR2	350 - 3200 nm
SP320-116	SP320-166	UV-IR2	190 - 3200 nm
SP320-118	N/a	VIS-IR1-IR3	350 - 5000 nm
SP320-119	N/a	UV-IR1-IR3	190 - 5000 nm
Options			
SP320-200	High resolution encoder with 5-fold smaller data-point interval		
SP320-201	Expanding the spectral range to 2200 nm in IR1 models		
SP320-202	Expanding the spectral range to 2500 nm in IR1 models		
SP320-203	Additional silicon detector if PMT option is selected		
SP320-204	Cooled silicon detector		
SP320-211	PMT1 photomultiplier, 190 - 780 nm; 20 % sensitivity compared to PMT3		
SP320-213	PMT3 photomultiplier, 190 - 930 nm		
SP320-214	PMT4 photomultiplier, 190 - 850 nm; 10 % sensitivity compared to PMT3		
SP320-215	PMT5 photomultiplier, 190 - 700 nm; 5 times the sensitivity compared to PMT3		
SP320-218	Photomultiplier cooling, external to -10°C		
SP320-219	Photomultiplier cooling, internal to -5°C		
SP320-220	IEEE-488 bus (in addition to the RS-232 interface)		
Optical Port and Direct Fiber Input (DFI)			
SP320-310	Optical output and detector input, for fiber-plug adapters in the PLG-xxx series		
SP320-320	Photometer unit for transmission measurements at the optical port, requires SP320-310		
SP320-330	Halogen light source for optical input		
SP320-350	DFI for FC/PC fiber plug for SP320 single monochromator		
SP320-351	DFI for SMA fiber plug for SP320 single monochromator		
SP320-352	DFI for fiber bundle with cross-section converter for SP320 single monochromator		
SP320-360	DFI for FC/PC fiber plug for SP320D double monochromator *)		
SP320-361	DFI for SMA fiber plug for SP320D double monochromator *)		
SP320-362	DFI for fiber bundle with cross-section converter for SP320D double monochromator *)		
UV-B Spectroradiometer with Direct Fiber Input			
SP320-601	SPECTRO 320 D double monochromator with cooled PMT5, DFI, fiber-optic bundle with cross-section converter, EOP-420 optical probe, SpecWin software and calibration		
SP320-630	Option for weather-resistant optical probe with cosine correction		
DTS Models for display measurements and accessories			
DTS320-101	Display Test System for applications in the automotive and aerospace industry, 350 – 930 nm spectral range, TOP100 with HRL 90 objective lens		
DTS320-201	Display Test System for NVIS radiance measurements in conformity with MIL-L-85762A, 380 - 930 nm spectral range, cooled photomultiplier, TOP100 with HRL 90 objective lens		
DTS320-218	Upgrade for external cooling in DTS320-201		
DTSISP-101	Reflection measurement at small graphics comprising an integrating sphere, halogen lamp, power supply and mount for TOP100 (only suitable for HRL90 objective lens)		

Internet: www.instrumentsystems.de

Distributor/Representative

International (World Headquarters)
INSTRUMENT SYSTEMS GmbH
Neumarkter Str. 83
81673 Munich, Germany
Tel: +49-89-454943-0
Fax: +49-89-454943-11
E-mail: info@instrumentsystems.de

North America
INSTRUMENT SYSTEMS Canada
576 Golden Avenue
Ottawa, Ontario, Canada K2A 2E9
Tel: (613) 729-0614
Fax: (613) 729-9067
E-mail: info@instrumentsystems.com