CHAPTER 1

TEST MEASUREMENT

CHAPTER 1 TEST-MEASUREMENT

HIGHT SPEED MOVING MIRROR GONIOPHOTOMETER

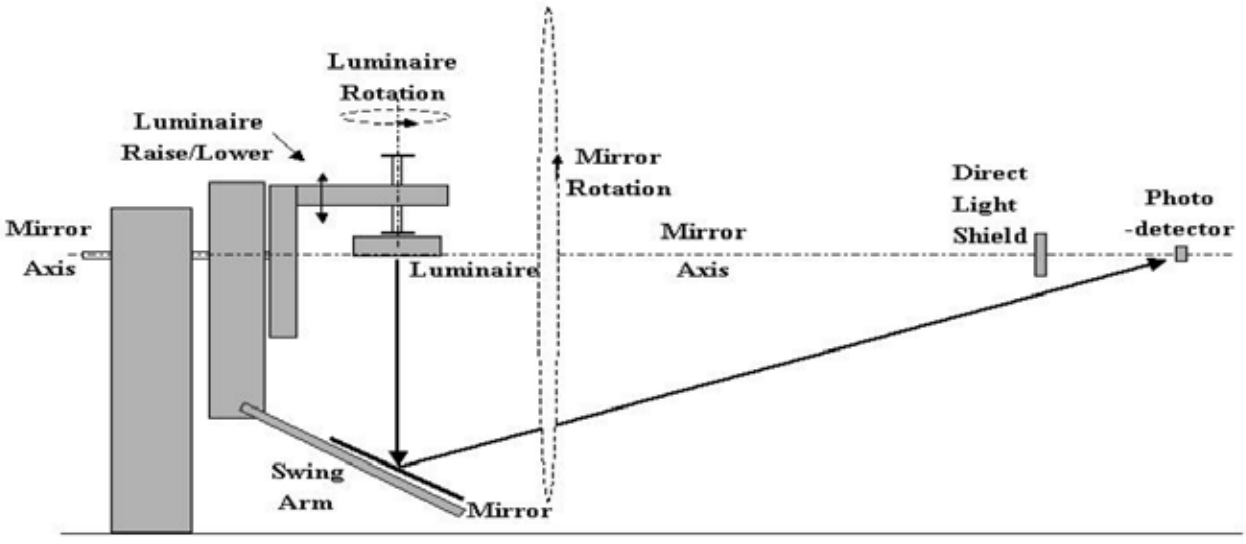
Over thirty years of continuous design refinements, software development and practical day-to-day usage enable Lighting Sciences Inc. to offer the High Speed Moving Mirror Goniophotometer as the standard of the lighting industry.

With truly unequaled speed, accuracy and functionality, LSI's photometric equipment is the most sophisticated available. Our clients know this is true, such that every major American lamp manufacturer has acquired Lighting Sciences' goniophotometers.

LSI's High Speed Moving Mirror Goniophotometer delivers fast operation with accurate results no matter what type of lamp or luminaire test may be required. State-of-the-art computer hardware, coupled with sophisticated data collection and analysis software, provide a fully-automated test system. The equipment meets all applicable CIE and IESNA requirements.

The performance of the High Speed Moving Mirror Goniophotometer is dramatically fast. Thanks to the unique electronic characteristics and computerized controls of the system, data collection can be accomplished in a fraction of the time needed by most conventional goniophotometers. (Typically 3 minutes for indoor luminaires, 11 minutes for outdoor luminaires.)

The mirror runs at speeds up to 6 rpm, and readings can be collected at the rate of 10,000 or 12,000 per second. This allows integration over a 50 to 60 Hz (user selectable) waveform to overcome any AC ripple. It also ensures proper capturing of even the narrowest intensity peaks.



GONIOPHOTOMETER COMPONENTS

The CIE type C High Speed Moving Mirror Goniophotometer consists of four basic components:

Mirror Swing-Arm and Support Structure
This component holds the test luminaire or lamp during testing and includes the support tower, mirror, swing-arm and luminaire mounting fixtures. The structure can be manufactured in several sizes, depending on the maximum size of item to be tested.

Photodetector Tower
A specially shielded unit houses the high-sensitivity photodetector used to obtain the photometric data. A rotating aperture mask that is sequenced with the mirror removes stray light. The photodetector is connected to a specially designed “Signal Maximizer” amplifier circuit, which automatically adjusts the system sensitivity or gain settings to ensure the highest possible accuracy throughout the test. A three-amplifier system is provided for exceptional dynamic range. The data are relayed to the computer interface through three 16-bit analog-to-digital converters.

Goniophotometer Integrated Console
This unit contains all of the system’s electric and electronic equipment including main power switches, test lamp voltage adjustment, motor controllers and computer interfaces.

Computer Station
This includes a Windows 7 computer and the photometric software to control the operation and data collection functions of the High Speed Moving Mirror Goniophotometer during testing. (Windows XP upon request) Additional software produces all forms of required reports and graphs (e.g. IES, CIE formats) and custom software packages.

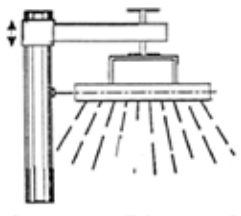


Figure A: Downlight Conversion

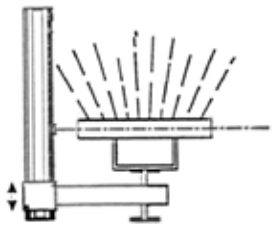


Figure B: Uplight Conversion

BENEFITS SUMMARY

- High-quality construction delivers years of trouble-free performance
- Precision digital drives provide unrivaled accuracy
- Luminaire remains at a fixed height during the test; mirror rotates around luminaire.
- Eliminates errors due to thermal effects in laboratory for temperature sensitive lamps such as fluorescent and LED’s.
- “Signal Maximizer” circuitry with three amplifiers enhances system sensitivity, dynamic range and ac curacy
- 16-bit analog-to-digital converters
- Computer system avoids error-prone operator inputs
- Luminaire mounting system lowers to average chest height. Avoids hazardous “step-ladder” operations
- Attention to detail in design and appearance
- Automatic dark current compensation reduces errors, boosts accuracy
- Rotating aperture mask in front of photodetector allows only light from the mirror to enter. Room reflections are almost entirely eliminated
- Unmatched software selection for any test situation with the convenience of using the test data with nearly any design and analysis software
- Luminaire hard-wire power connections eliminate wear and electrical resistance errors inherent with slip-ring systems
- High-speed data collection - needs only a fraction of the time required by competitive systems. Mirror speed up to 6 rpm.
- Backed by the foremost producer of mirror goniophotometer systems in North America
- Compliant with all applicable requirements of IES LM-79-08 and LM-80-08 for LED luminaire testing and Energy Star testing for U.S. Dept. of Energy and EPA.

CHAPTER 1 TEST-MEASUREMENT

SUMMARY OF TECHNICAL SPECIFICATIONS

Model 6220 (0.6 m × 0.6 m luminaire size)

- Required ceiling height: Approximately 2.8m (9.1 ft.), plus clearance
- Required room width: Approximately 2.8m (9.1 ft.) for 360° rotation system, plus clearance.
- Required room length: Depends on test distance. Approximately equal to required test distance, most commonly 3 m. (10 ft.).
- Total vertical travel of lamp/luminaire for mounting purposes (motorized): approximately 70cm (2.8 ft.).
- Approximate mirror size: 0.7 x 0.8m. (26 x 30 ins.) for 3 m test distance. Rectangular.

Model 6240 (0.6 m × 0.2 m luminaire size)

- Required ceiling height: Approximately 4.3m (14.0 ft.), plus clearance
- Required room width: Approximately 4.3m (14 ft.) for 360° rotation system, plus clearance.
- Required room length: Depends on test distance. Approximately equal to required test distance, most commonly 8 m. (26 ft.).
- Total vertical travel of lamp/luminaire for mounting purposes (motorized): approximately 1.5m (5.0 ft.).
- Approximate mirror size: 1.1 x 1.4m. (43 x 55 ins.) for 8 m test distance. Octagonal

Model 6440 (1.2 m × 1.2 m luminaire size)

- Required ceiling height: Approximately 5.4m (17.8 ft.), plus clearance
- Required room width: Approximately 5.4m (17.8 ft.) for 360° rotation system, plus clearance.
- Required room length: Depends on test distance. Approximately equal to required test distance, most commonly 8 m. (26 ft.).
- Total vertical travel of lamp/luminaire for mounting purposes (motorized): approximately 1.8m (5.9 ft.).
- Approximate mirror size: 1.3 x 1.7m. (52 x 63 ins.) for 8 m test distance. Octagonal

All Models

- Mirror type: 6mm float glass, protected silver backing. Tilt angle set for desired test distance.
- Rotational speed of mirror: up to 6 revs. per minute.
- Power delivery to test lamp/luminaire: Cable with attachment terminals. (No slip rings required.)
- Maximum luminaire weight: 60 kg (130 pounds) Counterweight: Balances mirror and swing arm.
- Digital stepping motor for mirror drive, resolution = 0.01°. Continuous rotation capability, or move to specific angles.
- Digital stepping motor for test lamp/luminaire drive, resolution = 0.01°. 360° rotation capability with automatic return to starting location at end of test. Manually can move to specific angles by computer command.
- Digital display of electrical power:
  - Yokogawa WT110 or equivalent, with computer interface
  - Frequency range 0.5Hz to 100kHz
  - Range:
    - Voltage 0-600v
    - Current 0-20 amps
    - Power 0-12,000 watts
  - Detailed accuracy specifications available. Additional meter is optionally available for use with calibration standard lamps.
- Electronic Protection: Separation of power electrical system and electronic system for prevention of electrical cross-talk.
- Photodetector Amplifier System: Located next to the photodetector to maximize signal-to-noise ratio.
  - Three simultaneously operating amplifiers with multiple gain (sensitivity) stages, digitally selected via LSI Signal Maxi mizer circuit and computer software for maximum dynamic range.
  - Amplifier linearity ± 1% over each amplifier gain stage from maximum reading to less than 1% of maximum
  - 16 bit resolution analog-to-digital converter for each of three amplifier channels.
- Silicon photo detector, corrected to CIE V(λ) spectral response curve, f 1 ' <1.5%. Mounted in housing with black screens to remove stray light and any direct light from the test item. DIN class L.
- Rotating aperture in photo detector housing, synchronized with mirror rotation, to further absorb room stray light. A pivoting collimating tube system is alternatively available – please request details.
- Input power: 120 VAC + 10%, 60 Hertz. Other voltages or 50 Hz available. Power supply details upon request.
- Test time: Data collection time for typical indoor luminaire: approximately 3 minutes.
- Test time: Data collection time for typical outdoor luminaire: approximately 11 minutes.
- Measurement range: At 8m test distance, approximately 10,000,000 candelas to < 1 candela

OPTIONAL EQUIPMENT

Available optional equipment consists of individual accessories or complete systems providing enhanced capabilities.

SLI-120: Intensity Standard Lamps. Provided with calibration for both directional intensity and total flux.

Lighting Sciences maintains equipment directly calibrated by the US National Institute of Standards and Technology. Standard lamps provided by LSI are calibrated in one step to this NIST-calibrated standard.

Intensity standard lamps are available also with total luminous flux calibration. LSI goniophotometers can be calibrated using either intensity or total flux, software selectable.
Pin base matches LSI Kelvin Socket KS-10

KS-10: Kelvin Socket, (four terminal)m for intensity standard lamps. Includes laser target for alignment

PSDC-120: Power supply for intensity, standard lamps 0-150 VDC.

DMM-10: High precision digital multimeter for standard lamp monitoring. Used in conjunction with PSDC-10 power supply.

PSAC-1250: Computer controlled AC power supply for automatic test lamp voltage or power control. Includes computer interfacing, automatic monitoring and adjustment software, and software controlled test lamp warm-up control.

BR-V-MED: Mounting bracket for medium screw base lamp, base up

BR-V-MOG: Mounting bracket for mogul screw base lamp, base up

BR-H: Mounting bracket for screw base lamp, horizontal. Uses medium or mogul socket from vertical bracket.

B-SL4: Holding bracket for 1.2m (4 ft.) fluorescent strip lights

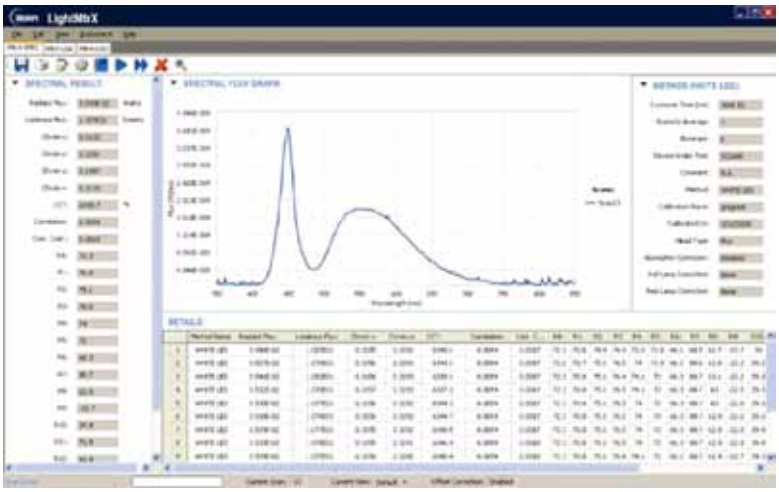
B-FL24: Holding bracket for fluorescent luminaires, 0.6 x 1.2m (2 x 4 ft.)

B-FLB24: Holding bracket for bare fluorescent lamps for use during calibration. Use with B-FL. Up to 4 lamps T5, T8 and T12. Includes black divider screens.

B-HID: Multi-purpose machined mounting plate for High Intensity Discharge luminaires.

CHAPTER 1 TEST-MEASUREMENT

LED MEASUREMENT-STARTER PACKAGES FOR TOTAL SPECTRAL FLUX



EASY-TO-USE

The Windows®-based LIghtMtrX software guides users through testing, providing straight-forward testing procedures and repeatable results to meet the needs of both new users and experienced researchers.

The light measurement sphere has a latch-free clamshell design for easy access to the device under test (DUT). The base port admits additional cables for assembled fixtures while the external port provides for the unobstructed positioning of boardmounted or heat-sinked devices for forward and partial flux measurements. Quick connect internal and external electrical contacts allow for effortless substitution between DUTs.

ACCURATE

The CSLMS LED Systems are affordably priced and easily customized through a variety of interchangeable light measurement accessories. NIST traceable total spectral flux standards enable simple in-house system recalibration and verification from 200 to 1100 nm.
The systems can be expanded to include an auxiliary lamp for the correction of absorption errors to ensure accurate test results.

Sphere diameters of 10 or 20-inches are coated with Spectraflect® which combines a 98% reflective surface with nearly perfect Lambertian reflectance.
Both durable and highly stable over time, this coating provides consistent integration of light over the lifetime of your sphere.

FAST

The CSLMS LED Systems combine intuitive software with high-speed hardware to simplify complex measurements. The coupling of application specific software with a CCD-based spectrometer, integrating sphere, and cosine receiver, makes it possible to deliver total spectral flux, luminous flux, radiometric flux, and colorimetric results in milliseconds. Designed with the user in mind, the LED Starter Solution is easy enough for you to use, even if it is your first time using light measurement systems.

FEATURES:

NIST Traceable Standards for In-house Recalibration Spectral Results in Milliseconds
Comprehensive Light Measurement Software

- Total Spectral Flux
- Luminous Flux
- Radiant Flux
- Chromaticity
- CCT
- CRI
- Peak Wavelength
- Dominant Wavelength

Spectraflect® Interior
CIE Recommended Geometry
Backed by an ISO 9001:2000 Registered Quality Management System

BEST FOR MEASURING:

- LEDs
- LED Sourced Systems
- Miniature Lamps
- LED Sourced Systems
- Large-area LED displays
- Automotive Lighting
- Architectural Lighting
- General Lighting

Model Number	CSLMS LED 1060 CSLMS LED 1061	CSLMS LED 2060 CSLMS LED 2061	CSLMS LED 4060 CSLMS LED 4061	CSLMS LED 6560 CSLMS LED 6561	CSLMS LED 7660 CSLMS LED 7661
System Properties and Performance					
Sphere Diameter	10 in (25 cm)	20 in (50 cm)	40 in (1.02 m)	650 in (1.65 m)	76 in (1.93 m)
Sphere Coating Reflectance	98%	98%	98%	98%	98%
Radiometric Range	100 W (max)	400 W (max)	1,500 W (max)	4,000 W (max)	5,000 W (max)
Photometric Range(Illuminant A)	0.4 - 13,000 lm	0.6 - 18,000 lm	2 - 72,500 lm	6 - 200,000 lm	0.08 - 260,000 lm
Red LED Range	0.06 - 4,600 lm	0.10 - 6,500 lm	0.62 - 26,000 lm	1.2 - 68,000 lm	1.7 - 93,000 lm
Green LED Range	0.12 - 5,700 lm	0.15 - 7,300 lm	0.60 - 28,500 lm	1.5 - 77,000 lm	2.0 - 10,000 lm
Blue LED Range	0.04 - 1,900 lm	0.05 - 2,100 lm	0.25 - 8,900 lm	0.50 - 23,000 lm	0.70 - 32,000 lm
Max Recommended DUT dimension	1 x 1 in (3 x 3 cm)	2 x 2 in (5 x 5 cm)	4 x 4 in (10 x 10 cm)	7 x 7 in (18 x 18 cm)	8 x 8 in (21 x 21 cm)
Maximum Tubular Lamp Length			24 in (60 cm)	34 in (86 cm)	52 in (1.3 m)
Sphere Weight	8 lbs (3.6 kg)	21 lbs (9.5 kg)	187 lbs (84.7 kg)	600 lbs (272 kg)	800 lbs (363 kg)
Sphere Dimension(W x D x H)	16.7 x 11.9 x 15.5 in	28.5 x 23.7 x 29.4 in	48.9 x 42.3 x 68.5 in	112.6 x 78.4 x 84.1 in	116.9 x 88.2 x 91.4 in

Spectrometer	CDS 600	CDS 610
Dimensions:	89.1 mm x 63.3 mm x 34.4 mm	89.1 mm x 63.3 mm x 34.4 mm
Detector range:	200-1100 nm	350-1050 nm
Pixels:	2048 pixels	2048 pixels
Pixel size:	14 µm x 200 µm	14 µm x 200 µm
Pixel well depth:	~62,500 electrons	~62,500 electrons
Sensitivity:	75 photons/count at 400 nm;	75 photons/count at 400 nm;
	41 photons/count at 600 nm	41 photons/count at 600 nm
Focal length:	42 mm input; 68 mm output	42 mm input; 68 mm output
Entrance aperture:	100 µm	100 µm
Wavelength range:	200-850 nm	350-1000 nm
Signal-to-noise ratio:	250:1 (at full signal)	250:1 (at full signal)
A/D resolution:	16 bit	16 bit
Dynamic range:	2 x 10^8 (system)	2 x 10^8 (system)
Integration time:	8 ms to 20 seconds	8 ms to 20 seconds
Stray light:	<0.05% at 600 nm;	<0.05% at 600 nm;
	<0.10% at 435 nm	<0.10% at 435 nm
Corrected linearity:	>99.8%	>99.8%

Lamp Standard	SCL-600 (10", 20")	SCL-1400 (40" plus)
Power	35 W	75 W
Approximate Luminous Flux	450 lm	1400 lm
Rated Life	300 hrs	2000 hrs
Calibration	Spectral Flux (W/nm) 350 - 1050 nm	Spectral Flux (W/nm) 350 - 1050 nm

Power Supply	LPS-100-0260 2.60 A 35 W	LPS 150-0268
Power Requirements	110/220 VAC, 50/60 Hz	110./220 VAC, 50/60 Hz
Current Stability	0.1%	+/- 0.01%
Current Rise Time	20 s	20 +/- 5 seconds
Regulated Current	2.60 A +/- 0.1%	2.679 A +/- 0.1%
Weight		6.5 lbs. (2.9 kg)
Dimension (W x D x H)	8.3 x 10.5 x 3.5 in (21.1 x 26.7 x 8.9 cm)	8.3 x 10.5 x 3.5 in (21.1 x 26.7 x 8.9 cm)
Compliance	CE	CE

Optional Accessories (10"~20")	(40"~76")
LS Series LED Sockets	LS Series LED Sockets
I 1000 Condition B Intensity Head	I 1000 Condition B Intensity Head
I 2000 Condition A & B Intensity Head	I 2000 Condition A & B Intensity Head
E 1000 Spectral Irradiance Head	E 1000 Spectral Irradiance Head
IES 1000 Intensity/Irradiance Calibration Lamp Standard	IES 1000 Intensity/Irradiance Calibration Lamp Standard
CAL-LX-IRR Calibration of E 1000 with Light MtrX and Spectrometer	CAL-LX-IRR Calibration of E 1000 with Light MtrX and Spectrometer
CAL-LX-INT Spectral Intensity Calibration	CAL-LX-INT Spectral Intensity Calibration
Absorption Correction Lamp AUX-35	Absorption Correction Lamp, AUX-100
Preset Power Supply LPS-100-0307 3.07 A 35 W	Preset Power Supply, LPS-100-0833, 8.33A 100W
Calibrated Spectral Flux Set CSFS-600	Calibrated Spectral Flux Set, CSFS-1400
50 mm Precision Aperture PA-200-050 MM	
Horizontal Lamp Mount Bracket	Horizontal Lamp Mount Bracket
Temperature Probe TP-100	Temperature Probe, TP-400
Temperature Probe and Monitor TPM-100	Temperature Probe and Monitor, TPM-400

CHAPTER 1 TEST-MEASUREMENT

LED MEASUREMENT-CHOICE PACKAGES FOR TOTAL SPECTRAL FLUX

FEATURES

- NIST traceable standards for in-house recalibration
- Spectral results in milliseconds
- LightX measurement software
- Total spectral flux
- Forward flux
- SpectraflectR interior
- CIE Recommended Geometry
- Backed by an ISO 9001:2000 Registered Quality
- Management System

BEST FOR MEASURING

- LEDs
- LED Sourced Systems
- Miniature Lamps
- Large-area LED displays
- Automotive lighting
- Architectural lighting
- General lighting

ACCURATE

The Choice Packages for the spectral flux of LEDs and small light sources combines intuitive software with high-speed ardware to simplify complex measurements. The coupling of application specific software with a high-end CCD spectrometer, and light measurement sphere makes it possible to deliver total spectral flux , luminous flux, radiometric flux and colorimetric results in milliseconds, while NIST traceable total spectral flux standards enable simple in-house calibration and verification from 350 to 1050 nm. The packages can also be expanded to include an auxiliary lamp for the correction of absorption errors to ensure accurate test results.

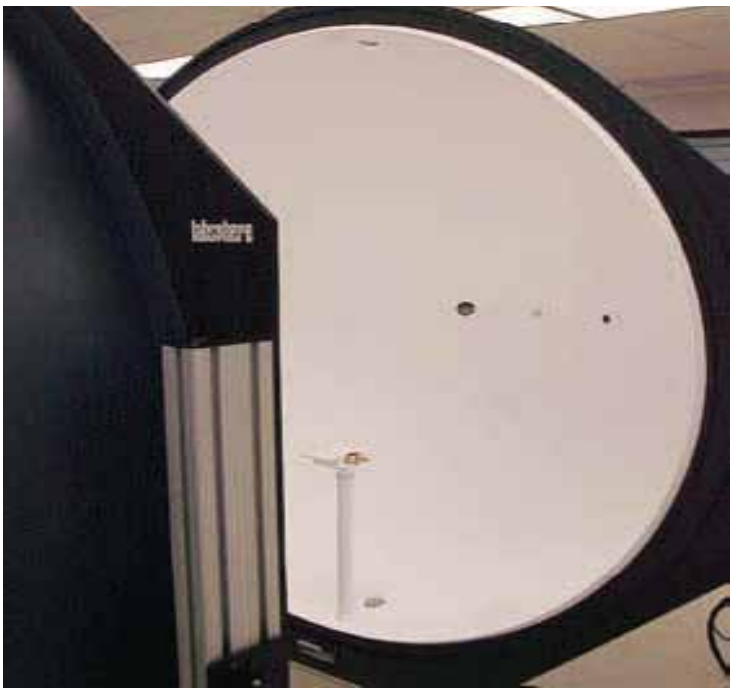
EASY-TO-USE

Spheres with diameters of 10 or 20-inches are coated with out Spectraflect which combines a 98% reflective surface with nearly perfect Lambertian reflectance. Both durable and highly stable over time, this coating provides consistent integration of light over the lifetime of the sphere.

The sphere has a latch free clamshell design for easy access to the device under test (DUT). A base port admits additional cables for assembled fixtures while the external port provides for unobstructed positioning of board-mounted or heat-sinked devices for forward and partial-flux measurements. Quick connect internal and external contacts allow for effortless substitution between DUTs.

When you are ready to increase your measuring capacity, the integral design and graphical user interface of the CDS 1100 and 2100 high-end spectrometers make it easy to transition accurately from research to production with the same high performance results.

The LightX software is the most intuitive platform for calibrating and analyzing spectral radiometric, photometric and colorimetric properties of light sources. Sources range from simple lamps and LEDs to solid state lighting assemblies and traditional indoor and outdoor lighting systems. LightX temporal feature allows you to monitor optical and electrical performance versus elapsed operating time.



Model Number Sphere	CSLMS1011/ CSLMS1021 10 in (25 cm)	CSLMS2011/ CSLMS2021 20 in (50 cm)	CSLMS4011/ CSLMS4021 40 in (1.02 m)	CSLMS6511/ CSLMS6521 65 in (1.65 m)	CSLMS7611/ CSLMS7621 76 in (1.93 m)
Sphere Coating Reflectance	98%	98%	98%	98%	98%
Radiometric Range	100 W (max)	400 W (max)	1,500 W (max)	4,000 W (max)	5,000 W (max)
Photometric Range (Illuminant A)	0.4 - 13,000 lm	0.6 - 18,000 lm	2 - 72,500 lm	6 - 200,000 lm	0.08 - 260,000 lm
Red LED Range	0.06 - 4,600 lm	0.10 - 6,500 lm	0.62 - 26,000 lm	1.2 - 68,000 lm	1.7 - 93,000 lm
Green LED Range	0.12 - 5,700 lm	0.15 - 7,300 lm	0.60 - 28,500 lm	1.5 - 77,000 lm	2.0 - 10,000 lm
Blue LED Range	0.04 - 1,900 lm	0.05 - 2,100 lm	0.25 - 8,900 lm	0.50 - 23,000 lm	0.70 - 32,000 lm
Max Recommended DUT dim.	1x1 in (3x3cm)	2x2 in (5 x 5cm)	4x4 in (10x10cm)	7x7 in (18x18 cm)	8x8 in (21x21 cm)
Maximum Tubular Lamp Length			24 in (60 cm)	34 in (86 cm)	52 in (1.3 m)
Sphere Weight	8 lbs (3.6 kg)	21 lbs (9.5 kg)	187 lbs (84.7 kg)	600 Lbs (272 kg)	800 lbs (363 kg)
Sphere Dimension (W x D x H)	16.7x11 9x5.5 in (42.4x30.2x 9.4 cm)	28.5x23.7x29.4 in (72.4x60.2x74.7cm)	48.9x42.3x68.5 in (1.24x1.07x1.74 m)	112.6x78.4x84.1 in (2.97x2.24x2.32 m)	116.9x88.2x91.4 in (2.86x1.99x2.13 m)

Spectrometer	CDS 1100	CDS 2100
Detector	TE Cooled 1044 x 64 CCD (back thinned)	TE Cooled 1044 x 64 CCD (back thinned)
Spectral range	250-850 nm	350-1050 nm
Resolution	1.5 FWHM	1.5 FWHM
Integration time	10 ms - 60 s	10 ms - 60 s
Cooling	10 +/- 0.05°C	10 +/- 0.05°C
TE Temp Drift	+/- 1°C	+/- 1°C
Linearity	+/- 0.5%	+/- 0.5%
Wavelength Accuracy	<+/- 0.4 nm	<+/- 0.4 nm
Stray light Broadband	<10-4 at 400nm w/ III A source	<10-4 at 400nm w/ III A source
Stray light LED/laser	<10-5 at 500nm w/633 nm laser	<10-5 at 500nm w/633 nm laser
Focal Length	100 mm	100 mm
Optical Input	Choice of Optical Fibers sold separately	Choice of Optical Fibers sold separately
Speed	0.1 scans /sec	0.1 scans /sec
Dynamic range (single scan)	30000:1	30000:1
Spectral Sample interval	0.25nm	0.25nm
Mechanical Shutter	Yes	Yes
Radiometric Sensitivity range	2E-7 - 20 W/m2-nm at 600nm	2E-7 - 20 W/m2-nm at 600nm
Sensitivity at 1s integration time	4E-6 W/m2-nm at 600nm	4E-6 W/m2-nm at 600nm
Spectroradiometric Accuracy	+/- 5%	+/- 5%
Chromaticity Accuracy (x,y)	<+/-0.001	<+/-0.001
Chromaticity Repeatability	+/-0.0001*	+/-0.0001*
Lamp Standard Uncertainty	<+/-3%	<+/-3%
AD Converter	16 bit	16 bit
A/D Rate	TBD	TBD
PC Interface	USB 2.0	USB 2.0

Lamp Standard	SCL-600	SCL-1400
Power	35 W	75 W
Approximate Luminous Flux	450 lm	1400 lm
Rated Life	300 hrs	2000 hrs
Calibration Spectral Flux (W/nm)	350 - 1050 nm	350 - 1050 nm

Power Supply	LPS-100-0260, 2.60 A, 35 W	LPS 150-0268
Power Requirements	110/220 VAC, 50/60 Hz	110./220 VAC, 50/60 Hz
Current Stability	0.1%	-0.0001
Current Rise Time	20 s	20 +/- 5s
Regulated Current	2.60 A +/- 0.1%	2.679 A +/- 0.1%
Weight	6.5 lbs (2.9 kg)	6.5 lbs. (2.9 kg)
Dimension (W x D x H)	8.3 x 10.5 x 3.5 in (21.1 x 26.7 x 8.9 cm)	8.3 x 10.5 x 3.5 in (21.1 x 26.7 x 8.9 cm)

Optional Accessories

LSA 3000 LS Series LED Sockets
LS TE Temperature Controlled Sockets
I 1000 Condition B Intensity Head
I 2000 Condition A & B Intensity Head
IE 1000 Spectral Irradiance Head
IES 1000 Intensity/Irradiance Calibration Lamp Standard
CAL-LX-IRR Calibration of IL 1000 with Light X and Spectrometer
Absorption Correction Lamp, AUX-35

Optional Accessories(10” 20”)

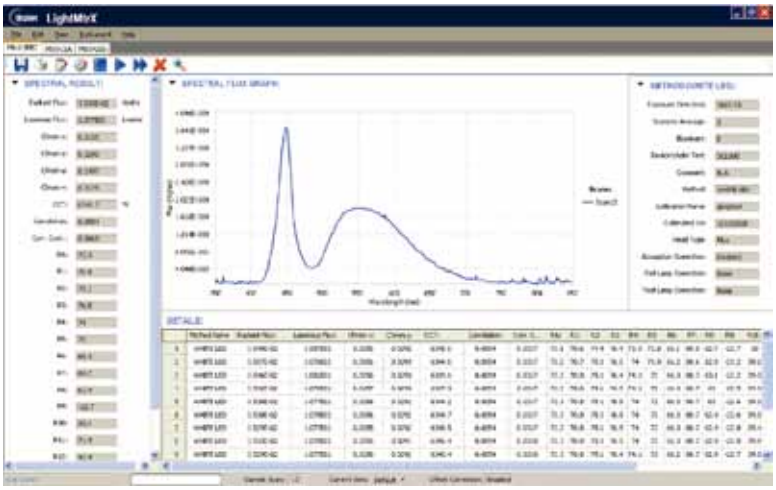
TP-100 Sphere Photometer Temperature Probe AS-02637-100
TPM-100 Sphere Photometer Monitor and Probe AS-02638-100
35W Absorption Correction Lamp, AUX-35

Optional Accessories(40” plus)

Sphere Photometer Temperature Probe, TP-400
Sphere Photometer Temperature Monitor and Probe, TPM-400
100W Absorption Correction Lamp, AUX-100

LED MEASUREMENT-STARTER PACKAGES FOR AVERAGE SPECTRAL INTENSITY

Easy-to-use LED measurement packages that provide accurate, repeatable results



ACCURATE

Labsphere's Starter Solutions for average spectral intensity are ideal for practical test applications. With NIST traceable results, the packages provide accurate repeatable results time and time again.

The solutions meet today's recommended requirements for LED measurement geometries while providing better quality with any packaged LED light source.

The solutions measure spectral intensity, luminous intensity, CIE chromaticity, correlated color temperature, color rendering, dominant wavelength, and purity in a matter of seconds.

FEATURES:

Load, light, and test in less than five seconds NIST Traceable standards for in-house recalibration Intensity results in milliseconds Spectraflect® interior Optional LED Sockets CIE Recommended Geometry Backed by an ISO 9001:2000 Registered Quality Management System

BEST FOR MEASURING:

- Packaged LEDs

EASY-TO-USE

Labsphere's Starter Solutions for testing the intensity of LEDs and small light sources are designed to position packaged LEDs for CIE average intensity as defined by CIE conditions A and B. The solutions measure spectral radiant intensity, luminous intensity, chromaticity, color, and color rendering properties of packaged LEDs.

Fed by an optical fiber from the intensity head to the spectrometer, the solution's software and spectrometer provide fast measurement results.

The out of the box design of the solutions make for easy set up while the software is simple to install with userfriendly interfaces to make intuitive calibration easier.

The small footprint of the package allows for a clutterfree workspace, while the practical, ergonomical design allows LEDs to be loaded, lit and measured in less than five seconds. Choose from Labsphere's wide variety of LS series LED sockets that are specially designed to fit with the intensity heads, or work with our engineers to develop a socket to specially fit your LED design.

Specifications

Starter Package Includes:

Choose one	Model	Description	Part Number
Intensity Head	I 1000	Condition B Intensity Head	AS-02700-100
	I 2000	Condition A & B Intensity Heads	AS-02700-316
Spectrometer	CDS 600	200 - 1100 nm	AS-02767-000
	CDS 610	350 - 1050 nm	AS-02767-100
Software	MtrX-SPEC	Spectral Light Measurement software	MtrX-SPEC
Calibration	CAL-LX-INT	Intensity Calibration	CAL-LX-INT

System Properties and Performance

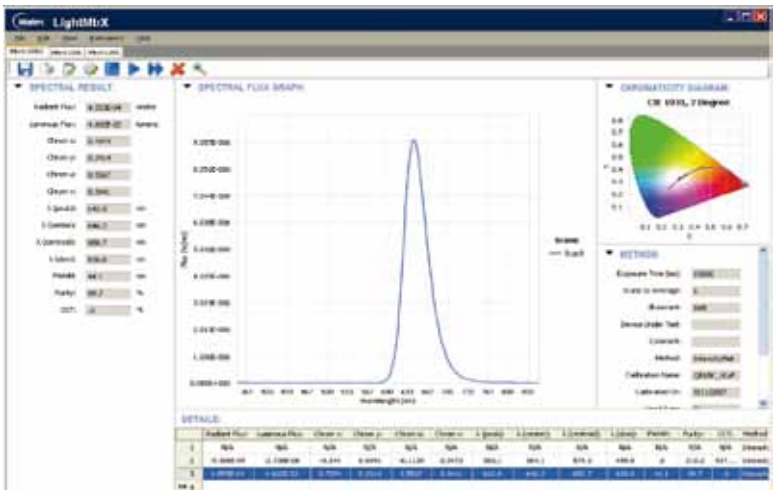
Spectral Intensity Head	I 1000	I 2000
Measurement Geometry	Condition B	ondition A and B
Solid Angle	0.1 sr	0.01 sr
Measurement Distance	10 cm	10cm and 31.6cm
Receiver Area	1 cm2	1cm2
Collection Optics	Near Cosine Spectralon Integrating Sphere	Near Cosine Spectralon Integrating Sphere
Fiber Connector	SMA	SMA
Alignment	Ring collar	Ring collar
Finish	Black Anodized	Black Anodized and White
Weight	2.10 lbs (0.95 kg)	2.78 lbs (1.26 kg)
Dimensions (W x D x H)	7.8 x 7.1 x 2.8 in (20 x 18 x 7 cm)	7.8 x 15.3 x 3.5 in (20 x 39 x 9 cm)

Spectrometer	CDS 600	CDS 610
Spectroscopic Wavelength range:	200 - 850 nm	350 - 1000 nm
Signal-to-noise ratio:	250:1 (at full signal)	250:1 (at full signal)
A/D resolution:	16 bit	16 bit
Dark noise: (correctable)	50 RMS counts	50 RMS counts
Dynamic range:	2 x 10^8 (system); 1300:1 for a single acquisition	2 x 10^8 (system); 1300:1 for a single acquisition
Integration time:	8 ms to 20 seconds	8 ms to 20 seconds
Stray light:	<0.05% at 600 nm; <0.10% at 435 nm	<0.05% at 600 nm; <0.10% at 435 nm
Corrected linearity:	>99.8%	>99.8%
Power consumption:	90 mA @ 5 VDC	90 mA @ 5 VDC
Connector:	10-pin connector	10-pin connector
Computer		
Operating systems:	Windows XP	Windows XP
	with USB port	with USB port
Computer interfaces:	USB 2.0 @ 480 Mbps	USB 2.0 @ 480 Mbps
Dimensions:	89.1 mm x 63.3 mm x 34.4 mm	89.1 mm x 63.3 mm x 34.4 mm
Weight:	190 grams	1 90 grams
Detector:	Sony ILX511 linear silicon CCD array	Sony ILX511 linear silicon CCD array
Detector range:	200 - 850 nm	350 - 1050 nm
Pixels:	2048 pixels	2048 pixels
Pixel size: 1	4 µm x 200 µm	14 µm x 200 µm
Pixel well depth:	~62,500 electrons	~62,500 electrons
Sensitivity:	75 photons/count at 400 nm;	75 photons/count at 400 nm;
	41 photons/count at 600 nm	41 photons/count at 600 nm
Design:	f/4, Symmetrical crossed Czerny-Turner	f/4, Symmetrical crossed Czerny-Turner
Focal length:	42 mm input; 68 mm output	42 mm input; 68 mm output
Entrance aperture:	100 µm	100 µm
Fiber optic connector:	SMA 905 to 0.22 numerical aperture	SMA 905 to 0.22 numerical aperture
	single-strand optical fiber	single-strand optical fiber

Optional Accessories

LSA 3000 Goniometer	AS-02707-000
LS LED Sockets	Choose your type
E 1000 Irradiance Head	AS-02700-000
IES 1000 Intensity/Irradiance Calibration Lamp Standard	AS-02700-602
CAL-LX-IRR Calibration of E 1000 with LightMtrX and Spectrometer	CAL-LX-IRR

LED MEASUREMENT-CHOICE PACKAGES FOR AVERAGE SPECTRAL INTENSITY



FEATURES:

- Load, light, and test in less than five seconds
- NIST traceable standards for In-house recalibration
- Intensity results in milliseconds
- Spectraflect® interior
- Optional LED Sockets
- CIE Recommended Geometry
- Backed by an ISO 9001:2000 Registered Quality
- Management System

BEST FOR MEASURING:

- Packaged LEDs

ACCURATE

With NIST traceable results, the Labsphere Choice Solutions for intensity of LED sand small light sources provide accurate repeatable results time and time again.

These packages meet today's standards for LED measurement while providing better quality from any packaged LED light source. Choice solutions measure average spectral intensity and luminous intensity, CIE chromaticity, correlated color temperature, dominant wavelength, and purity in a matter of milliseconds.

Labsphere's Choice Solutions are designed to position packaged LEDs for CIE average intensity as defined by CIE conditions A and B. Fed by an optical fiber from the intensity head to the CCD spectrometer, the package's software and spectrometer provide fast results of your specific LED.

EaSy-to-uSE

The out of the box design of these solutions make set up easy, while the software is simple to install with userfriendly interfaces to make intuitive calibration easier.

The small footprint of the hardware allows for a clutterfree workspace, while the practical, ergonomic design allows LEDs to be loaded, lit and measured in less than five seconds. Choose from Labsphere's wide variety of LS series LED sockets that are specially designed to fit with the intensity heads, or work with our engineers to develop a socket to specially fit your LED design.

When you are ready to increase your capacity, the integral design and graphical user interface of the CDS 1100 and 2100 high-end spectrometers make it easy to transition accurate measurement results from research to production with the same high performance you demand from the lab and with the ease of use that your operations team desires.

Users have the ability to calibrate their solutions with Labsphere's IES 1000 intensity standard and Labsphere's software, LightMtrX. The software module is the most intuitive platform for calibrating and analyzing spectral radiometric, photometric and colorimetric properties of light sources. Sources range from simple lamps and LEDs to solid state lighting assembles and traditional indoor and outdoor lighting systems. The LightMtrX temporal feature allows you to monitor optical and electrical performance versus elapsed operating time.

Specifications

Choice Package Includes:

	Model (Choose one)	Description	Part Number
Intensity Head	I 1000	Condition B Intensity Head	AS-02700-100
	I 2000	Condition A & B Intensity Head	AS-02700-316
Spectrometer	CDS 1100	280nm - 850nm	AS-02715-000
	CDS 2100	350nm - 1050nm	AS-02715-001
Software	MtrX-SPEC	Spectral Light Measurement Software	MtrX-SPEC
Calibration	CAL-LX-INT	Intensity Calibration, LightMtrX Software	CAL-LX-INT

System Properties and Performance

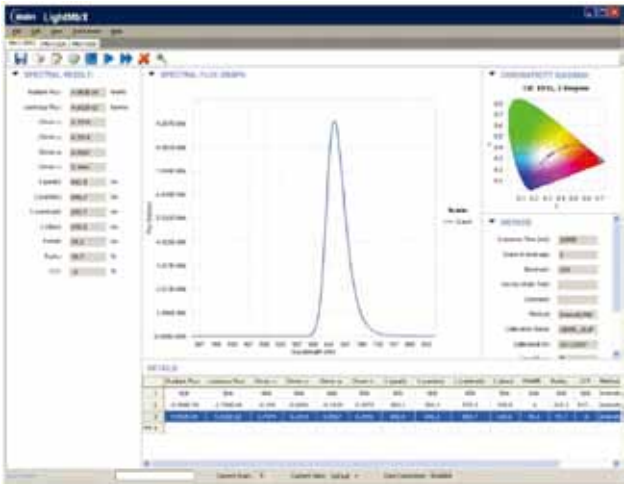
Intensity Heads	I 1000	I 2000
Measurement Geometry	Condition B	Condition A and B
Solid Angle	0.1 sr	0.01 sr
Measurement Distance	10 cm	10cm and 31.6cm
Receiver Area	1 cm2	1cm2
Collection Optics	Near Cosine Spectralon Integrating Sphere	Near Cosine Spectralon Integrating Sphere
Fiber Connector	SMA	SMA
Alignment	Ring collar	Ring collar
Finish	Black Anodized	Black Anodized and White
Weight	2.10 lbs (0.95 kg)	2.78 lbs (1.26 kg)
Dimensions (W x D x H)	7.8 x 7.1 x 2.8 in (20 x 18 x 7 cm)	7.8 x 15.3 x 3.5 in (20 x 39 x 9 cm)
Spectrometer	CDS 1100 with Condition B Intensity Head	CDS 2100 with Condition B Intensity Head
Detector	TE Cooled 1044 x 64 CCD (back thinned)	TE Cooled 1044 x 64 CCD (back thinned)
Spectral range	250-850 nm	350-1050 nm
Resolution	1.5 FWHM	1.5 FWHM
Integration time	10 ms – 60 s	10 ms - 60 s
Cooling	10 +/- 0.05 C	10 +/- 0.05 C
TE Temp Drift	+/- 1	C +/- 1 C
Linearity	+/- 0.5%	+/- 0.5%
Wavelength Accuracy	<+/- 0.4 nm	<+/- 0.4 nm
Stray light Broadband	<10-4 at 400nm w/ III A source	<10-4 at 400nm w/ III A source
Stray light LED/laser	<10-5 at 500nm w/633 nm laser	<10-5 at 500nm w/633 nm laser
Focal Length	100 mm	100 mm
Slit Width		
Optical Input	Choice of Optical Fibers sold separately	Choice of Optical Fibers sold separately
	(SMA connection)	(SMA connection)
Speed	0.1 scans /sec	0.1 scans /sec
Dynamic range (single scan)	30000:1	30000:1
Spectral Sample interva	I 0.25nm	0.25nm
Mechanical Shutter	Yes	Yes
Radiometric Sensitivity range	2E-7 - 20 W/m2-nm at 600nm	2E-7 - 20 W/m2-nm at 600nm
Sensitivity at 1s integration time	4E-6 W/m2-nm at 600nm	4E-6 W/m2-nm at 600nm
Spectroradiometric Accuracy	+/- 5%	+/- 5%
Chromaticity Accuracy (x,y)	<+/-0.001	<+/-0.001
Chromaticity Repeatability	+/-0.0001*	+/-0.0001*
Lamp Standard Uncertainty	<+/-3%	<+/-3%
AD Converter	16 bit	16 bit
A/D Rate	TBD	TBD
PC Interface	USB 2.0	USB 2.0
Trigger	11.3 lbs (5.04 kg)	11.3 lbs (5.04 kg)
Dimensions (W x D x H)	8.3 x 13.0 x 3.5 in (21.1 x 32.9 x 8.9 cm)	8.3 x 13.0 x 3.5 in (21.1 x 32.9 x 8.9 cm)

Optional Accessories

LSA 3000 Goniometer	AS-02707-000
LS LED Sockets	Choose your type
LS TE Temperature Controlled LED Sockets	Choose your type
IE 1000 Irradiance Head	AS-02700-000
CAL-LX-IRR Calibration of IE 1000 with LightMtrX and Spectrometer	CAL-LX-IRR
IES 1000 Intensity/Irradiance Calibration Lamp Standard	AS-02700-602

CHAPTER 1 TEST-MEASUREMENT

LIGHTMTRX SYSTEM SOFTWARE SOLUTION



COMPLETE YET FLEXIBLE

Labsphere is the first in the industry to develop commercially viable light test application software, proving its leadership with LightMtrX. LightMtrX software sets the pace for next generation light measurement software in response to your particular needs. Application solutions are available for controlling Labsphere's line of CDS spectrometers as well as auxiliary source meters and temperature controllers. The Windows® XP -compliant application modules are designed specifically to optimize use of Labsphere's light metrology products for R&D, QC and production applications.

KEY FEATURES:

Save time on the learning curve with methods driven operations
You don't need to be a metrologist with LightMtrX's intuitive calibration processes Adhere to your quality management system with user calibration and validation processes Capture results instantly with real time graphics by selecting the parameters you want to see and hiding the rest Display, log, and store results for research pass/fail testing for production Intensity profile polar plots for modeling and marketing Spectral, electrical, and thermal control for complete characterization Temporal plots for life performance Windows® Office programs compatible

PIONEERING

DLL drivers are standard with the LightMtrX platform including examples written for today's most popular programming languages. When you are ready to increase your capacity, the integral design and user graphical interface make it easy for you to transition from research to production with the same high performance that you demand from the lab with the ease of use that your operations team desires.

MTRX-SPEC LIGHT MEASUREMENT

The MtrX-SPEC software module is the most intuitive platform for calibrating and analyzing spectral radiometric, photometric and colorimetric properties of light sources ranging from simple lamps and LEDs to solid state lighting assemblies and traditional indoor and outdoor lighting systems. Need to track life or performance with time?
Want to know how the dominant wavelength shifts with operation? The MtrX-SPEC temporal feature allows you to monitor optical and electrical performance versus elapsed operating time.

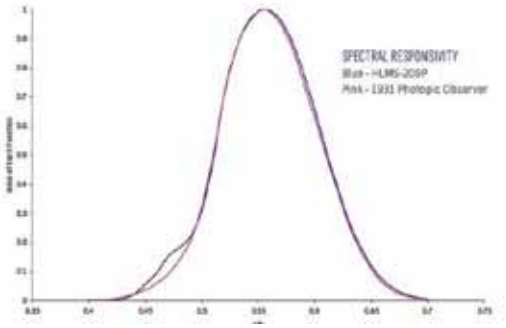
SPECIFICATIONS

	Model (Choose One)	Description	Part No.
Software	MtrX-SPEC	Spectral Light Measurement Software	MtrX-SPEC

LIGHTMTRX SOFTWARE MEASUREMENTS

Total spectral flux (Watts/nm)
Total radiant flux (Watts)
Total luminous flux (lumens)
Spectral intensity (Watts/sr-nm)
Averaged luminous intensity (lumens/sr)
Averaged radiant intensity (Watts/sr)
Spectral irradiance (Watts/cm2-nm)
Irradiance (Watts/cm2-nm)
Illuminance
Dominant wavelength
Spectral purity
Correlated color temperature
Peak wavelength
Color rendering index (CRI)
Chromaticity coordinates
Correlated color temperature
Spatial distribution
Electrical, thermal
Temporal (W/s, lm/s, CCT/s…)

HANDHELD PHOTOMETER



FEATURES

- NIST traceable calibration
- Programmable spectral correction
- Auto ranging
- Auto zero
- Ratio
- Display/hold function
- Automatic switch off
- 4 digit LCD display
- Low battery indicator
- Optional bench mount

BEST FOR MEASURING

- LEDs
- Small Lamps
- Fiber Illuminators

Accurate

The HLMS-200P Handheld Light Measurement System is an easy to-use, precision photometric instrument designed for use in the field, laboratory, or production floor. The instrument measures luminous flux from sources such as LEDs, small lamps, and fiber illuminators.

The instrument's photopically filtered silicon detector provides maximum sensitivity at low light levels. Sensitivity over five full decades provides the ability to measure from 0.05 to 7,000 lumens. A calibration certificate, with a calibration traceable to National Institute of Standards and Technology (NIST), is included.

Portable

The HLMS-200P consists of a compact, lightweight, handle-grip enclosure, with built-in microprocessor that performs several functions at the touch of a button. The instrument features a 2-inch diameter integrating sphere that collects the total light entering the sphere measurement port. The sphere interior is fabricated from SpectralonR reflectance material, a nearly Lambertian (perfectly diffuse) reflectance material.

Portable

Data is instantly displayed on an easy-to-read 4-digit front panel LCD display. Push button controls are easily accessible and clearly labeled on the front panel. The instrument is powered by a 9V battery and is calibrated to display lumens.

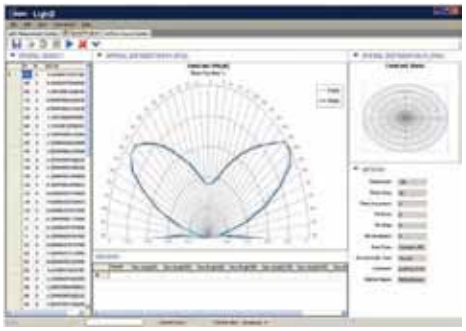
Model Number	HLMS-200P
Measurement:	Luminous Flux
Measurement units:	lumens
Measurement range:	0.05 to 7,000 lumens
Resolution:	0.001 to 9.999 lumens 10.00 to 99.99 lumens 100.0 to 999.9 lumens 1,000 to 7,000 lumens

System Properties and Performance	
Display:	0.05 to 0.1 ± 7% 0.1 to 1,000 ± 1% 1000 to 7,000 ± 3%
f1' Photopic correction:	4%
Response uniformity:	> 98% over 90° full angle
U,UV response:	0.1%
R, IR response:	0.1%
F3 Non linearity:	0.5%
F4 Readout error:	0.1%
F5 Fatigue:	0.5%
Est. Luminous Flux:	0.01 to 0.1 ± 7.6%
(Illuminant A)	0.1 to 1000 ± 3.1% 1,000 to 7,000 ± 4.2%
Range selection:	Auto Range
Sphere diameter:	2.0-inch (5.08 cm)
Entrance port diameter:	0.5-inch (1.27 cm)
Sphere interior:	Spectralon
Detector: Photopic;	Filtered Silicon
Readout:	4 digit, 2 x 8 LCD
Temperature range:	0^{o} C to 50^{o} C
Calibration:	NIST traceable
Compliance:	CE
Mounting Boss	1/4-20 or M6 (specify when ordering)

CHAPTER 1 TEST-MEASUREMENT

LED SPATIAL ANALYZER

Performs angle dependent spatial radiation characterization of LEDs



FEATURES

- Measurements are accurate and reproducible
- Complete solution for spectral intensity, spectral flux, spatial distribution and color
- Easy to test many different types of LEDs
- Easy interior access
- User selectable angular step intervals
- Measurements conform to internationally accepted standards

KEY APPLICATIONS:

- Far field spatial
- characterization of LEDs (Standard, and High Brightness)

RELIABLE

The LSA 3000 is an automated gonio-spectroradiometer that is designed to operate with our LightX software and LED test and measurement products. The LightX application software provides complete control of the LSA 3000 device under test (DUT) rotational stages, for spatial radiation measurement routines. The LSA 3000 performs accurate measurements from narrow-angled to broad, distributing LEDs at high angular resolution of 0.1° or greater intervals. The spatial software allows the user to measure relative intensity plot versus angle.

Combined with our spectrometers, light measurement software and the I 1000 or I 2000 the LSA 3000 can be used to slew the LED to any desired polar coordinate and measure its spectral radiant intensity, luminous intensity, chromaticity, color, and color rendering properties; while also being able to measure the far field hemispherical spatial distribution.

FLEXIBLE

Choose from a wide variety of The LS series LED sockets, or work with our team to design a socket that fits your LED specifications. The LSA 3000 has a staging area for the device under testing for Phi and Theta positioning. The Phi stage allows for adaptation of our LS series uncooled LED sockets, and LS-TE cooled LED sockets. The sensor active area is sized and located appropriately for the high resolution angular scale. The LSA 3000 accommodates our light sensors, including Condition A, and I 2000, and Condition B, I 1000, average spectral intensity heads. The primary use for the graphical user interface is to control the LSA 3000 and capture the spatial distribution of the DUTs. The software is designed so that the application of the LSA 3000 can be expanded for use with sensors other than its integrated receiver. The stages and detector are housed in an easy-access, light-tight enclosure.

Model	LSA 3000
Horizontal Range (theta)	-90° to +90°
Horizontal Resolution	0.1°
Horizontal Rotation Intervals	1, 2, 5, 10 and 15 degree
Horizontal Rotation Limits	Programmable start and stop
Axial Range (phi)	0° to 360°
Axial Resolution	0.1°
Axial Rotation Intervals	1, 5, 10, 15 and 30 degree
Axial Rotation Limits	Programmable start and stop
Scan time Fast (single sweep)	5 seconds
Scan Time Medium (5ointervals full scan)	9 minutes
Scan time Slow (1ointervals full scan)	2 hours
Distance from DUT to detector aperture	3.82 in (9.7 cm)
Detector Aperture Area	0.01mm^2
Dimensions (W x D x H)	13.9 x 18.0 x 10.9 in (35.3 x 45.7 x 35.3 cm)

ACCESSORIES

led sockets

LS-T 1 3/4
Designed to hold the T1-3/4 package High Brightness LED.

LS-K2
Designed to hold the Philips Lumiled LuxeonR K2 High Brightness LED.

LS-OSTAR
Designed to hold the OSRAM OSTARR-Lighting High Brightness LED.

LS—HEX STAR
Designed to hold he Philips Lumiled Luxeon V Star, Luxeon III Stars, Luxeon Stars High Brightness LEDs.

LS-DRAGON
Designed to hold the OSRAM Golden DRAGONR High Brightness LED.

spectral irradiance receiver

	E 1000
Measurement Geometry	Flux density W/cm^2-sim (W/cm^2 ,lux)
Measurement Distance	Any distance
Receiver Area	1 cm^2
Collection Optics	Near cosine receiver with opal flashed diffuser and Spectralon interior Integrating sphere
Fiber Connector	SMA
Mounting	Table-top or post mount (1/4-20)
Finish	Black Anodized
Weight	0.5 lbs (0.22 kg)
Dimensions (D x H)	2.25 x 1.70 in (4.3 x 1.1 cm)

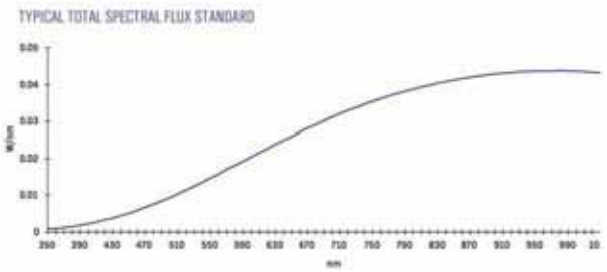
Intensity/irradiance calibration lamp standard

	IES 1000
Spectral Intensity	300 to 1050 nm
Spectral Irradiance	300 to 1050 nm at 50 cm
CCT	2950K
Operating Current	1.67 Amp
Cable length	3 m
Mating Connector Type	TYCO AMP #211398-1 compatible with our LPS 100 XXX power supply
Exitance Area	7.9 mm^2
Mounting	1/4-20 tapped female
Finish	Black Anodized
Weight	0.5 lbs (0.23 kg)
Dimensions (L x D)	4.32 x 1.73 in (11 x 4.4 cm)

CHAPTER 1 TEST-MEASUREMENT

PHOTOPIC LIGHT MEASUREMENT SYSTEMS

An accurate, flexible, and easy-to-use system for measuring total luminous flux



BEST FOR MEASURING:

- Indicator Lamps
- Automotive Lamps
- Miniature Lamps
- Indoor and Outdoor Lamps
- Specialty Lamps
- Architectural Lighting

FEATURES

- NIST Traceable Calibrated Spectral Flux Lamp Standard
- Spectraflect Interior
- External Forward Flux Port
- Latch-free Clamshell Design
- CIE Recommended Geometry for Total and Partial Flux
- Backed by an ISO 9000 Registered Quality Management System

FLEXIBLE DESIGN

The Medium PLMS integrating sphere photometers feature a Spectraflect coated lamp measurement sphere. Spectraflect combines 98% reflectance with nearly perfect Lambertian properties. Both durable and highly stable over time, this coating ensures optimal integration of light over the lifetime of your sphere.

A cosine receiver with an integrated photometer collects the average sphere wall radiance. The sphere design enables testing within CIE recommended geometries, reducing errors associated with directional lamps. The lamp standards of total luminous flux provide NIST traceable results with every measurement. An optional auxiliary lamp corrects for device under test (DUT) absorption differentials for added precision.

FLEXIBLE

The PLMS series are quickly enhanced or upgraded with a variety of interchangeable light measurement accessories. The base port design allows for additional cables for assembled fixtures. An external port permits unobstructed mounting of board-mounted or heat-sinked devices for forward and partial flux measurements.

EASY-TO-USE

This out-of-the-box solution offers a latch-free, easy-open clamshell design to permit fast access to the DUT. An adjustable internal mounting platform makes it easy to swap out different sized DUT's as does the quick connect internal and external electrical contacts.

Sphere Diameter	10 in (25 cm)	20 in (50 cm)	40 in. (1.02 m)	65 in. (1.6 m)	76 in. (2 m)
Sphere Coating Reflectance	98%	98%	98%	98%	98%
Radiometric Range	100 W (max)	400 W (max)	1500W (max)	4000W (max)	5000W (max)
Photometric Range	600 mlm - 2000 lm	2 lm - 6,500 lm	10 lm - 30000 lm	20 lm - 70000 lm	30 lm - 100 klm
Max Recommended DUT dimension	1x1 in (3x3 cm)	2x2 in (5x5 cm)	4x4 in(10x10 cm)	7x7 in(18x18 cm)	8x8 in(21x21 cm)
Maximum Tubular Lamp Length			24 in (60 cm)	34 in (86 cm)	52 in (1.3 m)
Sphere Weight	8 lbs (3.6 kg)	21 lbs (9.5 kg)	187 lbs (84.7 kg)	600 Lbs (272 kg)	800 lbs (363 kg)
Sphere Dimension (W x D x H)	16.7x11.9x15.5 in (42.4x30.2x39.4 cm)	28.5x23.7x29.4 in (72.4x60.2x74.7cm)	48.9x42.3x68.5 in (1.24x1.07x1.74 m)	112.6x78.4x84.1 in (2.86x1.99x2.13 m)	116.9x88.2x91.4 in (2.97x2.24x2.32 m)

Lamp Standard	CL-600	CL-1400
Power	35 W	75 W
Approximate Luminous Flux	450 lm	1400 lm
Rated Life	300 hrs	2000 hrs
Calibration Spectral Flux (W/nm)	350 - 1050 nm	350 - 1050 nm

Power Supply	LPS-100-0260, 2.60 A, 35 W	LPS 150-0268
Power Requirements	110/220 VAC, 50/60 Hz	110./220 VAC, 50/60 Hz
Current Stability	0.1%	-0.0001
Current Rise Time	20 s	20 +/- 5s
Regulated Current	2.60 A +/- 0.1%	2.679 A +/- 0.1%
Weight	6.5 lbs (2.9 kg)	6.5 lbs. (2.9 kg)
Dimension (W x D x H)	8.3 x 10.5 x 3.5 in (21.1 x 26.7 x 8.9 cm)	8.3 x 10.5 x 3.5 in (21.1 x 26.7 x 8.9 cm)
Compliance	CE	CE

Detector	Vλ Filter Silicon Photodiode
Active Area	5.7 mm^2
Range	Visible
f1'	4%
Connector	Triax

Radiometer/Photometer	SC-6000
Power Requirements	110./220 VAC ,50/60 Hz
Current Dynamic Range	1pA - 1mA
Voltage Dynamic Range	10mVdc – 50Vdc-
Computer Interface	Ethernet
Detector	VI Filter Silicon
Photodiode Active Area	5.7 mm2
Range	Visible
f1'	4%
Connector	Triax

Model Number: PLMS-1000, PLMS-2000, PLMS-4000, PLMS-6000, PLMS-7600

System Includes:

Lamp Measurement Sphere, LMS-100, LMS-200, LMS-400, LMS-600, LMS-760

Calibrated Lamp, CL-600(10", 20"), CL-1400(40", 60", 76")

Lamp Socket Assembly

Preset Power Supply*, LPS-100-0260, 2.60 A, 35 W, LPS-150-0268

Photopic Detector, SDA-P

Radiometer/Photometer*, SC-5500

Optional Accessories (10" , 20")

Absorption Correction Lamp, AUX-35

Preset Power Supply, LPS-100-0307, 3.07 A 35 W

Calibrated Luminous Flux Set ,CLFS-600

Spectrally Calibrated Lamp Set, CSFS-600

Bayonet Lamp Socket Assembly, LMP-1100 SC

Preset Power Supply, LPS-100-0260, 2.60 A, 35 W

50 mm Precision Aperture, PA-200-050 MM,

Horizontal Lamp Mount Bracket

Diode Array Spectrometer, DAS-1100

Diode Array Spectrometer, DAS-2100

Temperature Probe, TP-100

Temperature Probe and Monitor, TPM-100

Optional Accessories (40" plus)

AUX-100 Lamp Assembly

LPS-100-0833, Preset Power Supply 8.33A 100W

Preset LPS Mounting Kit

CLFS-1400, Calibrated Luminous Flux Set

CSFS-1400, Spectrally Calibrated Lamp Set

PA-200-050MM, 50mm Precision Aperture

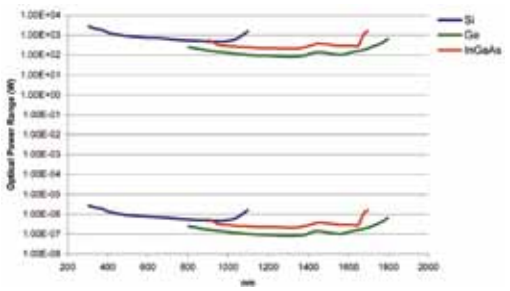
DAS-1100 Diode Array Spectrometer

DAS-2100 Diode Array Spectrometer

CHAPTER 1 TEST-MEASUREMENT

LASER POWER MEASUREMENT SYSTEMS

POWER MEASUREMENT RANGE* FOR LPMS-040-SF-SI SYSTEM (AS-02492-100)



* The above graph indicates the maximum power that can be introduced in the sphere before detector saturation appears. The maximum useable power range for Labsphere's LPMS systems is determined by the thermal stability limits of the sphere coating/material, which should not exceed 400OC for Spectralon, 100OC for Spectraflect, and 500OC for Infragold.

FEATURES:

- Spectraflect, Infragold or Spectralon sphere interiors for reduced alignment sensitivity
- Sturdy port frames for mounting fiber accessories
- Second detector port for a spectrometer or additional fiber
- Three integrating sphere size options
- Three detector options
- NIST traceable system calibrations

BEST FOR MEASURING:

- Lasers
- Laser diodes
- Laser diode modules
- Divergent monochromatic
- sources

OPTIMAL DESIGN FOR BEAM POWER MEASUREMENTS

The Labsphere Laser Power Measurement Systems (LPMS) series assures an accurate, reproducible method of determining the total power from a collimated or divergent laser or laser diode. Specifically designed for laser applications, LPMS spheres are ideal for measuring the total power of a beam of optical radiance.

Because of the unique geometry of the sphere, beam power measurements are independent of beam polarization, and are insensitive to beam alignment.

The attenuation which accompanies the sphere throughput also alleviates detector saturation. The systems can be used with an open port and can be apertured with an array of optional fiber adaptors for laser diode modules or port reducers.

ACCURATE

An input port that permits a beam of radiation is machined into the sphere. A detector, located 45°from the entrance port, views the sphere wall next to the entrance port. The field of view of the detector is designed to limit the viewing area so that highly divergent sources may be input without effecting measurement accuracy.

The systems provide options for laser power measurement over the 300 to 1800 nm wavelength region for optical powers ranging from 0.1uw to hundreds of watts.

The system's calibrations are traceable to the National Institute of Standards and Technology (NIST).

The 2-, 4-, or 6-inch diameter integrating spheres are coated with either Labsphere's Spectraflect® or Infragold®, or fabricated from our highly reflective diffuse material Spectralon®. Both durable and highly stable over time, these diffuse reflective interiors ensure the accurate integration of light.

FLEXIBLE DESIGN

Each system consists of a laser power measurement sphere, post, post holder and base assembly, a detector assembly, SC 6000 programmable radiometer/ photometer and multi-wavelength calibration. A second detector port gives the user the flexibility to add an additional detector assembly for broader spectral sensitivity, or add a spectrometer for spectral characterization.

Specifications				
Model	Coating	Si	GE	IN
LPMS-020-XX-YY	SF	AS-02489-	100 AS-02489-300	AS-02489-400
	SL	AS-02488-100	AS-02488-300	AS-02488-400
	IG		AS-02490-300	AS-02490-400
LPMS-040-XX-YY	SF	AS-02492-100	AS-02492-300	AS-02492-400
	SL	AS-02491-100	AS-02491-300	AS-02491-400
	IG		AS-02496-300	AS-02496-400
LPMS-060-XX-YY	SF	AS-02495-100	AS-02495-300	AS-02495-400
	SL	AS-02493-100	AS-02493-300	AS-02493-400
	IG		AS-02497-300	AS-02497-400

XX: Coatings: SF Spectraflect, SL Spectralon, IG Infragold

YY: Detectors: (Si) Silicon, (Ge) Germanium, (IN) InGaAs Indium Gallium Arsenide

SYSTEM INCLUDES:

Laser Power Measurement Sphere: 2 inch, 4 inch, or 6 inch

Detector: Si, Ge, or InGaAs

SCC-PM Calibration

SC 6000 Radiometer/Photometer

System Properties and Performance			
System Specifications	LPMS-020	LPMS-040	LPMS-060
Sphere Diameter	2 inch (5 cm)	4 inch (10 cm)	6 inch (14.4 cm)
Entrance Port Frame Diameter	0.5 inch (12.7 mm)	1 inch (2.5 cm)	1 inch (2.5 cm)
Sphere Coating Reflectance	98% Spectralflect		
	99% Spectralon		
	95% Infragold		
Detector Port #1 (holds standard	For system detector		
12.7mm diameter optical filters)			
Detector Port #2 (holds standard	Use for optional second detector	fiber spectrometer for spectral	
12.7mm diameter optical filters)	characterization	or cap when not in use	
Laser Power Measurement System		Standard Calibration	
Si Detector System	SCC-PM-SI	300 nm to 1100 nm in 25 nm increments LPMS, Silicon	
Ge Detector System	SCC-PM-GE	800 nm to 1800 nm in 25 nm increments LPMS, Germanium	
InGaAs Detector System	SCC-PM-IN	900 nm to 1700 nm in 25 nm increments LPMS, InGaAs	
Each standard system comes with a multiple wavelength spectral responsivity calibration. The SC 6000 radiometer is programmed to display the laser optical power in units of watts.			
Detector	Silicon	Germanium	InGaAs
Active Area	4.5 mm^2	19.6 mm^2	7 mm^2
Range	190 - 1100 nm	800 - 1800 nm	900 - 1700 nm
Peak Responsivity (A/W)	0.5 a/w @950 nm	0.9 a/w @1550 nm	0.9 a/w @1300 nm
Radiometer/Photometer	SC 6000		
Power Requirements	110./220 VAC	50/60 Hz	
Current Dynamic Range	1 pA – 20 mA		
Computer Interface	Ethernet		
Optional Calibration			
Single Wavelength Power Calibrations, SCC-PS: Calibration laser power meter at a single wavelength of choice. Specify desired wavelength of calibration when ordering.			
Optional Accessories			
Fiber Adaptors			
Detectors			
Optical Filters			
Port Plugs			

CHAPTER 1 TEST-MEASUREMENT

MODULAR INTEGRATING SPHERES

This easy-to-configure line is the ultimate choice for adaptability and value

ADAPTABLE

This line is designed to provide greater configuration flexibility than ever before. Choose your sphere by selecting size, ports, and reflectance material. Then design for your application by picking light sources, assemblies, port reducers, and more. The wide range of interchangeable accessories offer you an endless number of application options. This flexibility allows you to create your own uniform source or light measurement system, or modify an existing system in a matter of minutes. A variety of system calibration options enable systems to be customized for application specific tasks.

FEATURES

- Size- Miniature: 1 - 2 inches
  Standard: 3 - 6 inches
- Number of Ports
- 3: two ports on the equator of the sphere at 0° and 90°, one port at the top
  4: an additional port located opposite the 0° port
- Optional Light Sources
  Internal Halogen: 5 - 100 W
  External Halogen:
  Dichroic: 30 W, 80 W, 120 W
  Rhodium: 40 W, 75 W, 100 W
- Reflectance Material
  Spectralon, Spectraflect, Infragold coating
- Optional Detector Assemblies
  Silicon, Germanium, InGaAs
- A variety of accessories
  Illuminator or detector assemblies, Port reducers, Port plugs, Filters and more
- Multiple Calibration Options
  Total Spectral Flux Calibration, Radiance Calibration, Exit Port Uniformity Mapping and more

EASY-TO-USE

The Modular Spheres and Accessories offer you a one-stop shop for all of your application needs. The robust sphere design features sturdy port frames, easy access mounting options, and quick-change accessory options so a multitude of requirements can be met.

VALUE

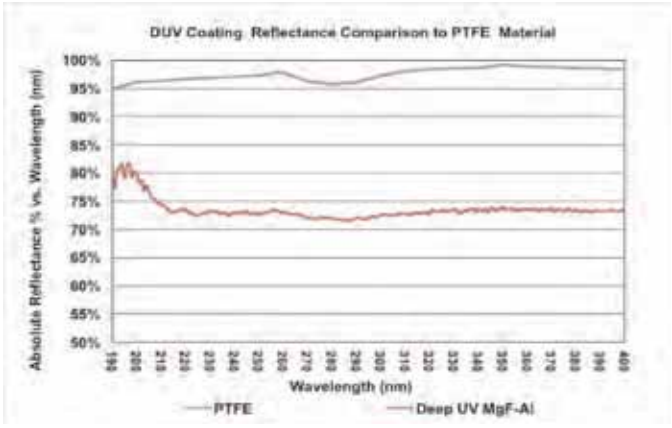
Own the craftsmanship of our solution while taking advantage of the full life of your sphere. The spheres are offered with Spectraflect, Spectralon or Infragold coating which combines a highly reflective surface with nearly perfect Lambertian reflectance. Both durable and highly stable over time, these coatings ensure optimal integration of light over the lifetime of your sphere. Simply change accessories to meet different application requirements or to upgrade your existing system. All of our products are created in an ISO 9001 registered environment and provide NIST traceable results upon calibration.

Sphere				Port Configuration (in)		
Model Number	Coating	Diameter(in)	Entrance/exit	90°	North Pole	180°
3P-GPS-030-SF	Spectraflect	3	1.00	1.00	1.00	
3P-GPS-040-SF	Spectraflect	4	1.50	1.00	1.00	
3P-GPS-060-SF	Spectraflect	6	2.50	1.00	1.00	
4P-GPS-030-SF	Spectraflect	3	1.00	1.00	1.00	1.00
4P-GPS-040-SF	Spectraflect	4	1.50	1.00	1.00	1.00
4P-GPS-060-SF	Spectraflect	6	2.50	1.00	1.00	1.00
3P-GPS-010-SL	Spectralon	1	0.25	0.25	0.25	
3P-GPS-020-SL	Spectralon	2	1.00	0.50	0.50	
3P-GPS-033-SL	Spectralon	3.3	1.50	1.00	1.00	
3P-GPS-053-SL	Spectralon	5.3	2.50	1.00	1.00	
4P-GPS-010-SL	Spectralon	1	0.25	0.25	0.25	0.25
4P-GPS-020-SL	Spectralon	2	1.00	0.50	0.50	0.50
4P-GPS-033-SL	Spectralon	3.3	1.50	1.00	1.00	1.00
4P-GPS-053-SL	Spectralon	5.3	2.50	1.00	1.00	1.00
3P-GPS-010-IG	Infragold	1	0.25	0.25	0.25	
3P-GPS-020-IG	Infragold	2	1.00	0.50	0.50	
3P-GPS-030-IG	Infragold	3	1.00	1.00	1.00	
3P-GPS-040-IG	Infragold	4	1.50	1.00	1.00	
3P-GPS-060-IG	Infragold	6	2.50	1.00	1.00	
4P-GPS-010-IG	Infragold	1	0.25	0.25	0.25	0.25
4P-GPS-020-IG	Infragold	2	1.00	0.50	0.50	0.50
4P-GPS-030-IG	Infragold	3	1.00	1.00	1.00	1.00
4P-GPS-040-IG	Infragold	4	1.50	1.00	1.00	1.00
4P-GPS-060-IG	Infragold	6	2.50	1.00	1.00	1.00

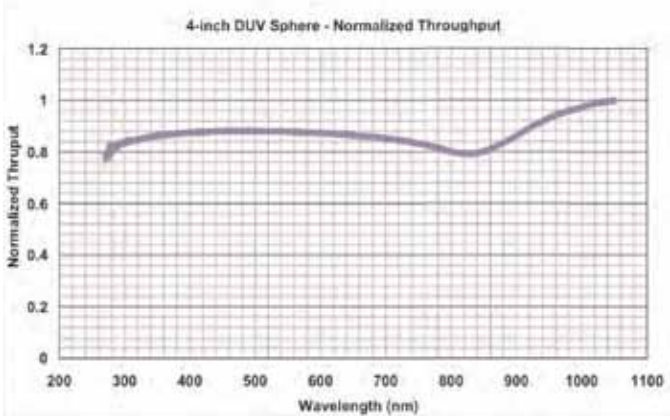
DUV SERIES INTEGRATING SPHERES

ABOUT OUR MGF-AL SPHERE COATING

Aluminum has a high intrinsic reflectance value in the UV region above 100 nm. The protective overcoat of magnesium fluoride helps protect the aluminum and optimizes its reflectivity. Our new MgF-Al coating is quickly becoming an industry and national laboratory choice of coating for applications in the UV wavelength regions. The coating is efficient for applications covering the 100 to 400 nm range and is more stable than PTFE materials in that region. Our deep UV coating provides three major advantages for use in the 100 to 400 nm region: non-fluorescence, damage resistance, and high stability. The coating has a reflectance of >90% over the wavelength region from 1000 to 2500 nm, so may also be used effectively for many VIS and NIR applications.



Absolute % Reflectance vs Wavelength - comparison of DUV coating to PTFE reflectance material



Normalized Throughput results using 4-inch diameter DUV integrating sphere

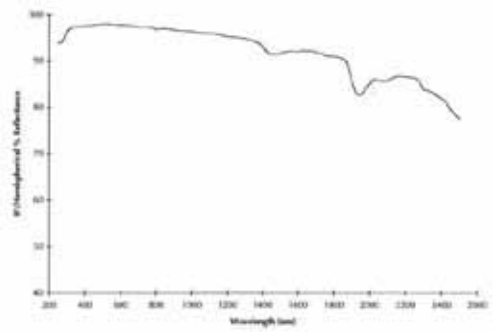
ORDER NUMBER	SPH-2UV-3K	SPH-2UV-4K	SPH-4UV-3K	SPHK-4UV-4K	SPH-6UV-3K	SPH-6UV-4K
Sphere size (inches)	2 inch	2 inch	4 inch	4 inch	6 inch	6 inch
Sphere size (cm)	5.08	5.08	10.2	10.2	15.2	15.2
Interior coating	MgF-Al	MgF-Al	MgF-Al	MgF-Al	MgF-Al	MgF-Al
Port locations	0,90 NP	0,90,270, NP	0,90 NP	0,90,270, NP	0,90 NP	0,90,270 NP
Port size (inches)	0.5	0.5	1	1	1.5	1.5
Port size (cm)	1.27	1.27	2.54	2.54	3.81	3.81
Baffle Placement	*	*	*	*	*	*
# Port Plugs included	1	2	1	2	1	2
Port Plug # 1 - size (inches)	PP-050-UV	PP-050-UV	PP-100-UV	PP-100-UV	PP-150-UV	PP-150-UV
SMA Adapter	SMA-050-UV	SMA-050-UV	SMA-100-UV	SMA-100-UV	SMA-150-UV	SMA-150-UV
TO5 Adapter	DA-TO5-050	DA-TO5-050	DA-TO5-100	DA-TO5-100	DA-TO5-150	DA-TO5-150
Sphere mounting boss	M4	M4	M6	M6	M6	M6
Converter/Center mounting Plate	M4-SPH-2	M4-SPH-2	M6-SPH-4	M6-SPH-4	M6-SPH-6	M6-SPH-6
Allen Wrench Set	AW -250	AW-250	AW -250	AW-250	AW -250	AW -250

* Baffle location-customer specified

CHAPTER 1 TEST-MEASUREMENT

REFLECTANCE/TRANSMITTANCE SPHERES

Accurate and flexible, designed for reflectance and transmittance measurements



FEATURES

- Reflectance and transmittance of materials
- Reflectance of opaque samples
- Transmittance of turbid samples
- Color Properties
- Reflectance System Design
- Infrared reflectance
- Reflectance vs. angle

ACCURATE

The Reflectance/Transmittance sphere assemblies constitute one of the most basic reflectance measurement products and can be used to measure the reflectance or transmittance of light through a wide variety of sample mediums.

Offered in two standard designs, each sphere is available in one of two reflective coatings; Spectraflect, our highly diffuse reflective coating effective over the 300 - 2400 nm range and Infragold, designed for use in the 0.7 - 20 um wavelength range.

The RT Spheres feature five 1-inch diameter ports to accommodate sample and reference beams necessary for a 9° double beam geometry, as well as port plugs required for 9° single beam geometry. A 0.5-inch detector port is located at the top of the sphere. A specular light trap is included for specular subtraction methods.

RTC Spheres add further versatility with a center-mounted sample holders so users are able to measure reflectance and transmittance versus incident angle of radiation. Five ports accommodate a sample and reference beams with a centermount stage located at the top of the sphere, and a 0.5-inch detector port located at the bottom of the sphere assembly.

Both sphere assemblies are suitable for all geometric transmittance measurements. The RT sphere assembly can perform reflectance measurements in the specular included (8°/h) and specular excluded (9°/d) geometries. The RTC integrating spheres provide specular included (9°/h) and specular excluded (9°/d) geometries measurement capabilities to the basic sphere design, as well as reflectance measurement capabilities at variable angles of incidence.

The sphere ports are knife-edged to permit collection of wide-angle scatter and the baffling is minimized to allow the detector a maximum view of the sphere wall. A detector port is located at the top or bottom of the sphere and baffled from receiving direct radiation from the sample and reference ports.

Model Number	RT-060-SF	RT-060-IG	RTC-060-SF	RTC-060-IG
Sphere Diameter:	6 inches	6 inches	6 inches	6 inches
Sphere Coating:	Spectraflect	Infragold	Spectraflect	Infragold
Optimum Spectral Range:	250 - 2500 nm	0.7 um - 20 um	250 - 2500 nm	0.7 um - 20 um
Detector Port Diameter:	0.5 inch	0.5 inch	0.5 inch	0.5 inch
Sample and Reference Ports:	Five	Five	Five	Five
Sample and Reference	1 inch (5)	1 inch (5)	1 inch (3)	1 inch (3)
Port Diameters (Qty):			1.25 inch (2)	1.25 inch (2)
Center-mount Sample Holder:	N/A	N/A	Jaw and Clip Styles	Jaw and Clip Styles
Sphere Mount:	1/4 - 20 boss mounting post and base assembly		Adjustable H - frame assembly	

CENTER MOUNT SAMPLE HOLDERS

Allows samples to be held in the center of RTC-060-SF Reflectance/Transmittance Sphere

MEASURE:

- Reflectance
- Transmittance
- Absorbance
- Scatter
- Powders
- Liquids
- Thin Films
- Solids

FEATURES:

- Compatible with the RTC-060-SF
- Positions in the center of the RTC-060-SF Reflectance Transmittance Sphere
- Coated with Spectraflect, high reflectance diffuse coating
- Integrated baffle screens sample from integrating sphere detector port.

CSMH-RTC-CUV-SF FEATURES:

Holds standard 12.5 mm square cuvette Positions cuvette normal to incident beam optical axis in the center of the RT-060-SF Sphere
Holds a cuvette used for liquids and powders for transmittance, absorbance and scatter characterization
Coated with Spectraflect®, diffuse reflectance coating Integrated baffle screens sample from detector port

CSMH-RTC-CLIP-SF FEATURES:

Holds thin films up to 50 mm diameter
Positions thin films in center of RTC-060-SF Reflectance/Transmittance Sphere
Sample rotation 0 to 360˚
For multi-angle reflectance and transmittance measurements
Coated with Spectraflect diffuse reflectance coating
Integrated baffle screens sample from detector port

CSMH-RTC-JAW-SF FEATURES:

Holds samples up to 50 mm diameter
Positions samples in center of RTC-060-SF
Reflectance/Transmittance Sphere
sample rotation 0 to 360˚
For multi-angle reflectance measurement
Coated with Spectraflect diffuse reflectance coating
Integrated baffle screens sample from detector port

CSMH-RTC-CUV-SF

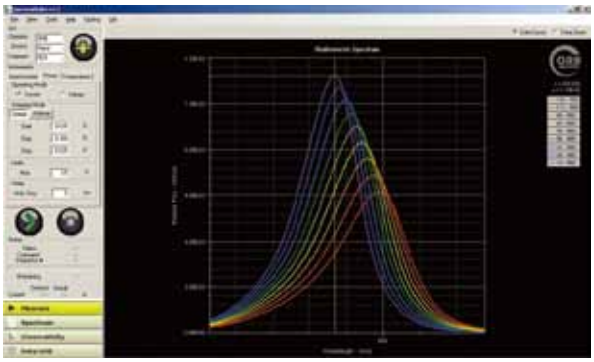
CSMH-RTC-CLIP-SF

CSMH-RTC-JAW-SF

ModeL no.	Coating Reflectance	Sample Size	Sample Rotation
CSMH-RTC-CUV-SF	98%	12.5 x 12.5 x 45 mm	Fixed
CSMH-RTC-CLIP-SF	98%	50 mm diameter	360˚
CSMH-RTC-JAW-SF	98%	5 to 50 mm round or square	360˚

CHAPTER 1 TEST-MEASUREMENT

ETΦ™ LED CHARACTERIZATION SYSTEM



FEATURES:

- Complete Electrical Thermal Optical Data
- Automated Data Aquisition and Analysis
- LED Spectral Measurement
- TEC Temperature Control and Monitoring
- DC and PWM Power Supply Control
- Vf and If 4-wire Measurement

BEST FOR:

Design & Development of Products using LEDs including:

- LED Selection
- LED Qualification
- LED Characterization
- LED Benchmark Analysis
- LED Thermal Engineering
- LED Optical Engineering
- LED Electrical Engineering

LED QA/QC

LED Manufacturers and Distributors

Highly Accurate LED measurements

ACCURATE

When testing the performance of an LED or LED based product one must keep the temperature of the LED in mind. As the temperature of an LED changed, the performance is altered. The optical wavelength can shift with different temperatures while a thermally stressed LED will lose efficiency, causing the light output to diminish, if the thermal management fails it could cause the LED junction to breakdown. Testing for these variances by LED manufacturers and users during the designing phases saves time, ensures product performance over time and allows for new industry compliances to be made.

The Orb Optronix designed ETΦ Electrical-Thermal-Optical LED Measurement System is designed to meet the new measurement standards that are being introduced to the industry for the complete characterization of the performance characteristics of LEDs and LED products at different operating temperatures.

Together with it's powerful, user driven software, SpectralSuite, the ET is able to give users readings on their LED's performance values at a wide range of temperatures.

EASY-TO-USE

The ET LED Characterization Systems combine intuitive software with high-speed hardware to simplify complex measurements. The coupling of application specific software with a CCD-based spectrometer, integrating sphere, with a device chiller plate and sophisticated electronics to control device temperature as well as voltage and current, makes it possible to deliver total spectral flux, luminous flux and colorimetric results at a wide range of device temperatures and voltages in milliseconds.

Available in a variety of sphere diameters, this versatile system allows for users with any needs to measure their LEDs.

POWERFUL SOFTWARE

The powerful software combined with the ETΦ System, SpectralSuite, allows for users to control the LED temperature and operating current at specifi ed ranges. This control enables the software to measure and characterize the LED at a wide range of temperatures.

Fast results are gained with the ability to sweep through temperature ranges, while capturing the optical and electrical parameters. The easy to use software essentially allows users to control either electrical or thermal parameters of the DUT and measure its light output.

SPECIFICATIONS

Model Name	Part Number	Sphere Size (in.)	Sphere Size (cm)	Number of Ports	Port Diameter (in.)	Port Diameter (cm)	Mounting Stand	DUT configuration	Auxillary Lamp
ETO-06-01	AA-00938-000	6	15.2	3	1.5	3.81	Pedestal	2π	Available

System Properties and Performance	
Array Resolution:	1024 pixel (SP-50-VIS) 2048 pixel (SP-50-NIR)
Spectral Range:	380 to 780nm (SP-50-VIS)
Optical Bandwidth:	4.1 nm (SP-50-VIS)
Wavelength Binning Resolution:	1 nm
Dynamic Range Resolution:	14 bit
Optical Input:	SMA Fiber Connector
Typical Flux Measurement Range:	1 Lm to 100000 Lm
Wavelength Accuracy:	± 0.5 nm
Wavelength Repeatability:	± 0.2 nm
Stray Light:	< 10-3
Chromaticity Accuracy (x,y):	± 0.002
Chromaticity Repeatability (x,y):	± 0.0005
CCT Reproducibility:	± 20°K (Illuminant A)
Integration Time Range:	5 to 5,000 ms
ETO-06-01 Pedestal Dimensions HxWxL:	42.54cm x 32.38cm x 37.15cm
Instrument Case Dimensions HxWxL:	19.00cm x 53.34cm x 54.61cm
ETO-06-01 Pedestal Weight:	~9.9 kg
Instrument Case Weight:	~15.4 kg
Operating Environment:	10°C to 40°C and < 85% relative humidity
Interface:	USB 2.0
Power Supply:	Keithley™ 2400 Series Model
Voltage Monitor	4-Wire
Thermal Control Range:	0°C to 100°C,2W to 50W
Thermal Control Repeatability:	+/- 0.5°C
Thermal Set-Point Resolution:	0.1°C
Interface:	USB 2.0 Connectivity

SPECTRALSUITE™ SOFTWARE CAPABILITIES:

Complete test sequencing for automated control of current, temperature and spectral measurements.

Complete data analysis capabilites for automatic graph generation.

CHAPTER 1 TEST-MEASUREMENT

LED LIFE TESTING STATIONS

FEATURES:

- Turnkey System for high volume testing
- Ergonomically designed workstation allows the operator
- to easily monitor tests
- Back-illuminated CCD Spectroradiometer provides high
- sensitivity
- Single measurement sequence simultane ously performs
- both optical and electrical tests
- Measures up to 20 discrete LEDs in less than 60 seconds

MEASURES:

- Total radiant flux
- Total luminous flux
- Peak wavelength
- Centroid wavelength
- Dominant wavelength
- Full width/Half max
- CIE purity
- CIE Chromaticity
- Forward voltage
- Forward current
- Leakage current

FLEXIBLE DESIGN

The LTS is comprised of a convenient workstation which houses a 9-inch Spectralon integrating sphere, precision power supplies, a back-lit research-grade CCD Spectrometer, a common single dimensional bar code reader, and a personal computer with monitor. The system is supplied with LED Carrier boards and 200 burn-in boards for lamp testing. A set of five tungstenhalogen spectral flux standards, with calibration traceable to National Institute of Standards and Technology (NIST), is included with each system.

ACCURATE

The system's integrating sphere incorporates a mirrored baffle and an infrared filter which help to minimize spatial sensitivity and stray light, and maximize optical accuracy. Spectral data from the spectrograph is evaluated in 1 nm increments. System software compares the spectral data to the flux data emitted by a calibration lamp. The spectral data is summed across the visible spectrum and converted to luminous data using the comparison method as recommended by CIE-127 technical report.

The electrical system includes a uniquely designed multiplexer board and an LED carrier board. The multiplexer board acts as the switching mechanism that sequentially drives through each LED mounted on the carrier board in as little as 3 seconds, simultaneously performing all optical and electrical measurements.

The carrier boards are designed to accommodate thru-hole LEDs with a 0.60 mm square 2-post mounting configuration capable of holding TO-46 heads. Up to 20 LEDs can be loaded manually onto an individual carrier board. The board is mounted into a specially designed holder inside the integrating sphere where an operator, with a simple computer keystroke, can select parameters for each test.

COMPLETE, EASY-TO-USE

The Labsphere's LTS LED Life test station is a customized multi-purpose LED test station designed for high volume throughput. The system applies a variety of optical and electrical test measurements to an array of up to twenty discrete LEDs in less than 60 seconds. Optical Measurements include total radiant and luminous flux, peak wavelength, dominant wavelength, full width/half max (FWHM), CIE purity and CIE chromaticity. Electrical measurements include forward voltage while controlling forward current and leakage current while controlling reverse voltage. This is achieved through database integration at each stage of the testing sequence.

Specifications

Model Number
LED LIfe Test Station (LTS)
System Includes
Integrating Sphere Assembly
Multiplexer box
Dell Computer with application software
Workstation Desk
A/C Control Box and Spectrometer
Keithly Source Meter
LPS-150 Lamp Power Supply
Various Electrical cabling
Spectrometer Fiber Optic Cable
Qty 3 , SCL-050 Spectral Flux Standards with 71 data point calibration data
10 spare extension boards
Install CD-ROMs
System Manual

System Properties and Performance

Integrating Sphere	
Reflectance Material	Spectralon®
Inner Diameter	9-inches
Reflectance	99%
Calibration Lamp	SCL-050
Electrical Rating	4.2V,1.05A
Photometric Ratings	50lm,3000K,600hrs
Optical Test data	
Spectral Range	380 - 7000 nm
Radiant Flux Range	1 mW - 100 W
Optical Specifications	
Spectral Range	380 - 720 nm
Wavelength Accuracy	0.5 nm
Color accuracy	+0.001 (x and y) Illuminant A
Optical Resolution	2 - 3 nm (Bandwidth)
Positional Sensitivity	< ±0.5%
Calibration Traceability	NIST
Optical Radiation levels	*
Typical Cycle Time	< 3 seconds per LED
Spectral Repeatability	< 0.2 nm
Electrical Specifications	
Forward Voltage Measurement	*
Voltage Uncertainty	0.02 Vdc (at 4.00 V)
Voltage Repeatability	0.01 Vdc (at 4.00 V)
Current Measurements	*
Current Uncertainty	< 1% (at 20 mA)
Current Repeatability	0.09 mA (at 20 mA)
Reverse Leakage Current Uncertainty	0.01 mA (at 10 Vdc)
Reverse Leakage Current Repeatability	0.01 mA (at 10 Vdc)
Burn-in and Carrier Board Temperature	850C
Dimensions	6 ft x 3 ft x 4.33 ft
Weight	280 lbs
Electrical requirements	115VAC 60Hz 20A (system draws 6A)

CHAPTER 1 TEST-MEASUREMENT

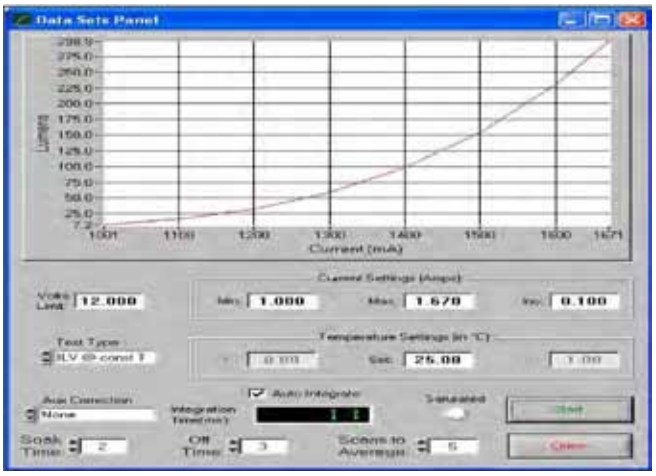
TOCS LED AND SSL THERMAL-ELECTICAL OPTICAL CHARACTERIZATION SYSTEM

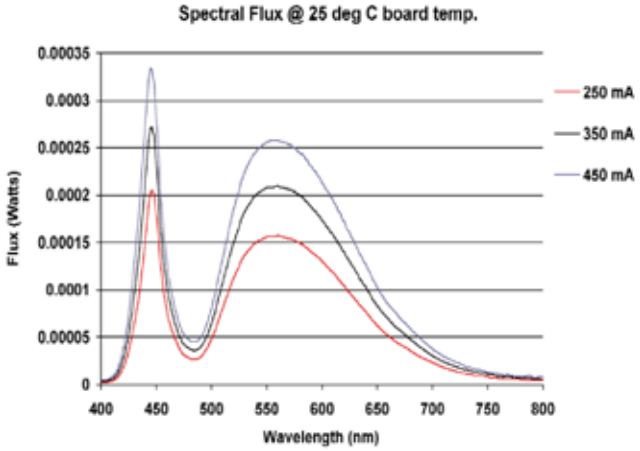
MEASURE:

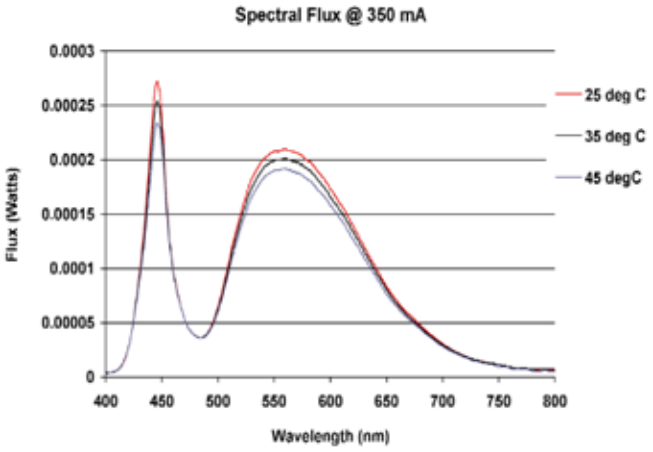
- ILV @ constant T step & control I, stabilize T, measure L & V
- VLI @ constant T step & control V, stabilize T, measure L & I
- TLV @ constant I step & control T, stabilize T, measure L & V
- TLI @ constant V step & control T, stabilize T, measure L & I
- ILV/T perform ILV@constant T, step T andrepeat at each T
- VLI/T perform VLI @ constant T, step T and repeat at each T

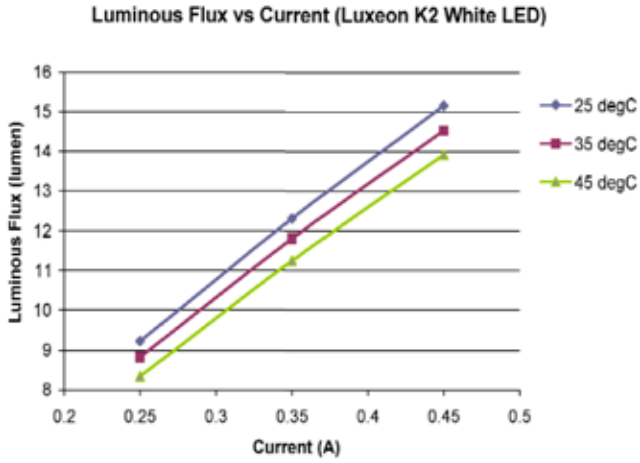
Key: L = Lumens
V = Voltage
I = Current
T = Temperature

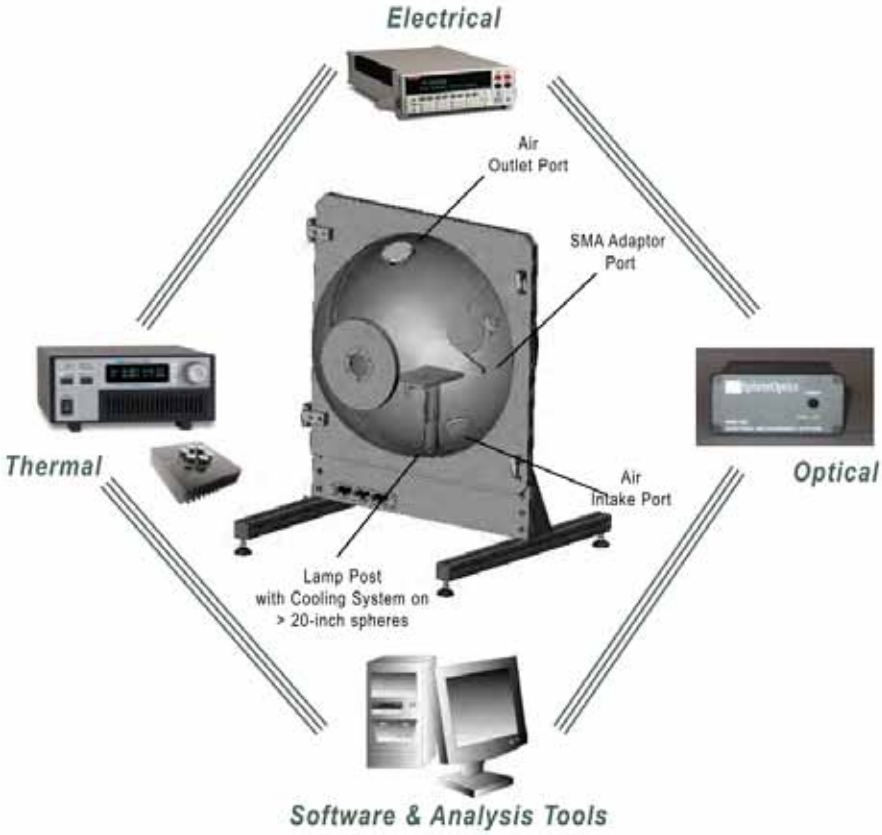
Our new TOCS series Thermal-Electrical-Optical Characterization systems enhance our standard line of Spectral Lamp Measurement Systems (SLM) or our LCS LED Characterization Systems with the ability to measure complete electrical and thermal characteristics of LED and SSL assemblies in addition to complete optical characterization.











SPECIFICATIONS

Order No:	TOCS-12	TOCS-20	TOCS-40	TOCS-65	TOCS-76
DUT Configuration:	2π	2π	2 or 4π	2 or 4π	2 or 4π
Temperature Range:	20° – 80°C	20° – 80°C	20° – 80°C	20° – 80°C	20° – 80°C
Rated Sphere Size:	12-inch	20-inch	40-inch	65-inch	76-inch
Typical Lumens Range:	0.15 to 12,000	0.5 to 25,000	2 to 75,000	5 to 150,000	7 to 250,000
TE Mounting Plate:	External (2π)	External (2π)	External (2π) & Internal (4π)	External (2π) & Internal (4π)	External (2π) & Internal (4π)
Ambient Air Control:	Available	Available	Available	Available	Available

Spectral Range:	360 to 1000 nm (standard model)
	300 to 1050 nm (extended range model)
Dynamic Range Resolution:	16 bit
Optical Input:	SMA Fiber Connector
Wavelength Accuracy:	±0.5 nm
Wavelength Repeatability:	±0.1 nm
Stray Light:	<10-3
Chromaticity Accuracy: (x,y)	±0.002
Chromaticity Repeatability: (x,y)	±0.0005
CCT Reproducibility:	< ± 5 K (Illuminant A)
Integration Time Range:	1ms - 4000ms
Power Supply:	Choice of Keithly 2400 DC Series Models
Thermal Control Range: (typical)	20° to 80° C, up to 80 W (contact sales)
Thermal Control Repeatability:	± 0.5 C
Thermal Set-Point Resolution:	0.1 C

CHAPTER 1 TEST-MEASUREMENT

SM-050 SPHERE MONITOR PHOTOMETER

A simple and economical way to monitor luminous flux, luminance, or illuminance.

SM-050

FEATURES:

- Spectral Correction
- Auto Ranging
- Auto Zero Ratio
- Display/Hold Function
- Automatic Switch Off
- 4-Digit LCD Display
- NIST Traceable Calibration

BEST FOR MEASURING:

- Camera Sensitivity
- Normalization
- Uniform Source Monitoring
- Light Measurement

EASY-TO-USE

SM-050 Sphere Monitor Photometer is designed to easily monitor the light level within an integrating sphere. This low-cost solution can be calibrated to provide luminous flux, luminance, or illuminance and works with any of Labsphere's modular line of integrating spheres.

PRACTICAL

The SM-050 can be used with any variety of integrating spheres. This low-cost unit can provide a variety of measurements including luminous flux in lumens, luminance in units (candela/m^2), or illuminance in lumens/m^2 and has a photometric range spanning five decades.

This compact, lightweight accessory with integrated radiometer comes in two models, filtered (P) or unfiltered (U). The filter version, SM-050-P, consists of a silicon detector with a photopic filter. This detector provides a response that resembles the CIE V(I) response (CIE) Photopic Response, as seen by the human eye. Calibrations are traceable to the National Institute of Standards and Technology (NIST).

ADAPTABLE

A built-in microprocessor performs multiple functions at the touch of a button. Data is instantly displayed on an easy-to-read 4-digit front panel LCD display. Simple push button controls are accessible and clearly labeled on the front panel. The instrument is designed for quick mounting to a Labsphere sphere and is powered by an external 9V DC transformer.

SM-050 on A general purpose Sphere

Specifications

Modeland Description	Order Number	Wavelength Range
SM-050-P Sphere Monitor, Photometer	AS-02476-300	400 - 700 nm
SM-050-U Sphere Monitor, Ratiometer	AS-02476-000	190 - 1100 nm
Luminance (candela/m2) 70 – 70,000		

System Properties and Performance

Sphere Diameter	Luminous Flux Min.	Luminous Flux Max.
2 inch	0.2	2000
3 inch	0.4	4000
4 inch	0.7	7000
6 inch	1.0	10,000

*Typical performance of given sphere-detector combination assuming a Spectraflect® coated sphere with three open or non-reflective ports.

	SM-050-P	SM-050-U
Display	±10.0%	N/A
f1' Photopic Correction	4.0%	N/A
U UV Response	0.1%	N/A
R IR Response	0.1%	N/A
F3 Non Linearity	0.5%	N/A
F4 Readout Error	0.1%	N/A
F5 Fatigue	0.5%	N/A
Range	Selection Auto	Range Auto Range
Detector	Photopic; Filtered Silicon	Unfiltered Silicon
Readout	4-Digit ,2x8 LCD	4-Digit, 2x8 LCD
Calibration	NIST Traceable	NIST Traceable
Mounting Port Diameter	0.5 inch (1.27 cm)	0.5 inch (1.27 cm)
Size	2.5 W x 8.0 H x 3.875 L inches	2.5 W x 8.0 H x 3.875 L inches
	(6.4 W x 2.0 H x 9.8 L cm)	(6.4 W x 2.0 H x 9.8 L cm)
Weight	0.252 lbs (0.115 kg)	0.252 lbs (0.115 kg)
Temperature Range	10° to 40° C	10° to 40° C
Compliance CE		

Optional Features

Calibrations require integration with integrating sphere

SCC-LU (P version only)

SCC-IL (P version only)

Luminance Responsivity (P version only)

Illuminance Responsivity (P version only)

Radiant Responsivity specify wavelength (U version only)

CHAPTER 1 TEST-MEASUREMENT

UV-2000S ULTRAVIOLET TRANSMITTANCE ANALYZER

Instantaneous UVA/UVB protection factor values of sunscreen samples

FEATURES:

- One touch sample analysis, with results in less than five seconds
- Manual stage for accurate sample positioning and pre and post irradiation
- New Wavelength standard that captures six rel evant spectral bands
- Easy-to-use menu driven application software
- Simple instrument performance validation routine ensures accurate, repeatable measurements
- Automatic calculation of SPF, UVA to UVB ratio, critical wavelength, COLIPA Method, Revised
- Boots Star Rating (pending), and the new FDA testing metod

ADVANCED

Labsphere's UV-2000S incorporates the latest component and software technology into an industry proven system architecture, to achieve accurate in-vitro SPF/UVA-Protection Factor analysis of sun care products developed to receive the "very high" sun protection label. Driven by rapidly evolving industry requirements to simplify product labeling and new in-vitro methods to validate product UVA Protection, the UV-2000S is designed to comply with recently approved in-vitro methods, such as COLIPA UVA-PF, Boots Star Rating and the US FDA, as well as several pending global standards/methods. The UV-2000S has replaced Labsphere's UV-1000S as the Industry's choice for not only laboratory invitro SPF/UVA analysis, but also production floor quality control.

FAST

The UV-2000S rapidly measures the diffuse transmittance of sunscreen samples in the ultraviolet wavelength region from 250 - 450 nm. Labsphere's Spectralon® integrating sphere incorporates a re-optimized xenon flash lamp to provide exceptional diffuse illumination of the product sample and minimize data integration time. New high performance diode array spectrometers coupled by new, advanced fiber optics are optimized at the system level for low stray light with superior wavelength stability and flash-to-flash repeatability.

IMPROVED

Many improvements are incorporated in the UV-2000S to realize a new industry de facto standard for in-vitro sun care product analysis. System improvements include new spectrometers, Xenon Flash Lamp, optical coupling fibers, optical head positioning mechanism, sample positioning stage and a new, robust software development platform.

The diode array spectrometers feature stable, custom concave diffractive optics for measurement integrity and repeatability, original holographic diffraction gratings, not replicated gratings, peaked for higher efficiency across the wavelength range, and longer pixel arrays for better pixel wavelength resolution.

Illumination is filtered at the integrating sphere to limit total exposure at the sample and to improve stray light performance.
A higher flash rate reduces exposure time, minimizing dark current and maximizing dynamic range.

Use of solarization resistant fibers maintains high system throughput over time. Longer fibers filter high order modes to provide cleaner grating illumination improving stray light performance.

EASY-TO-OPERATE

A built-in report function generates essential information atthe click of a button. Reports include necessary information such as date, time, operator name, sample identification, and test parameters. Reports are conveniently viewed on your PC, printed, or exported as text to data processing software for further review and analysis.

POWERFUL APPLICATION SOFTWARE

Developed with .NET Framework®, the license controlled UV-2000S Software features different in-vitro measurement methods for UVA/UVB protection factors of sunscreen including the COLIPA, Boots Star and FDA methods. By licensing the included software, users are able to receive free upgrades on their software for one year as new methods are released to the industry. This easy to use Vista® compatible software facilitates capture/archival/retrieval and export of all data including bare substrate data that may impact UVA-PF due to surface roughness.

UV-2000S application software includes an integrated Performance Validation Routine that allows for on-site validation and re-validation to ensure optimum instrument performance.
A set of calibrated standards, including a wavelength standard that captures six relevant spectral bands, is included with each UV Transmittance Analyzer.

Specifications
Included Model Name
UV-2000S
UV-2000S Control Software
25 HelioScreen HD2 Plates
25 HelioScreen HD6 Plates

System Properties and Performance	
Wavelength Range	250 to 450 nm*
Wavelength Accuracy	±1 nm
Bandwidth (FWHM)	<4 nm
Wavelength Step (Data Interval)	1 nm
Optical Geometry	Hemispherical Illumination/0° viewing (d/O)
Integrating Sphere Geometry S	Spectralon®
Integrating Sphere Port Area	< 5%
Sample Exposure Area	0.79 cm^2
Lamp	Xenon Flash Lamp
UV Dose Per Measurement Cycle	< 0.2 J/cm^2
Sample Positioning Stage	Manual Stage
Measurement Range	
Transmittance	0-100%
Absorbance	0 - 2.7 A (Dual Doped PMMA Method
SPF	1 - 50+
Scan Time	< 5 s
Measurement Methods Supported	
Bare Substrate Analysis and Data Archival	Yes
SPF	Yes
UVA/UVB	Yes
Critical Wavelength	Yes
UVA Protection Factor - COLIPA Method (2007a)**	Yes
UVA Protection - Revised Boots Star Rating (2008)**	Yes
UVA Protection Factor - FDA UV1/UVA**	Yes
UVA Protection Factor - ISO	Roadmap Upgrade
Computer Interface	USB
Min computer requirements	1.6 GHz processor, Windows®XP or Vista
	SVGA 800 x 600
	256MB RAM 400MB free disk space
Power Requirements	110 - 120/220 - 240 VAC, 60/50 Hz
Operating environment	0° - 50°C, 0% - 70% RH (non-condensing)
Dimensions	
With Stage	11H x 22.6D x 12.3W In (27.9H x 56.6D x 31.2W cm)
Without Stage	11H x 12.6D x 12.3W in (27.9H 32.0D x 31.2W cm)
Optional Accessories	
UV-2000S Starter Kit	AS-02796-000
HelioScreen HD2 Plates	PP-02097-000
HelioScreen HD6 Plates	PP-02101-000
Updated Software Subscription	UV-2000S Software

IN-VITRO SPF/UVA-PF TESTING SAMPLE PREPARATION STARTER KIT

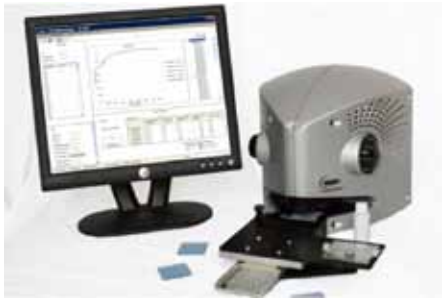
All the supplies needed to achieve accurate SPF/UVA-PF in-vitro results

COMPLETE

Preparing a proper product sample of your SPF formula for in-vitro testing can be difficult. From finding the correct substrate for your sample, and gathering all of the supplies you need to prepare your sample to the actual preparation of the product, one mistake and you have to begin the process all over again.

Labsphere, the manufacturer of the industry leading UV-2000S In-Vitro SPF Measurement Analyzer brings you the solution that you need for your sample preparation process, the In-Vitro SPF Testing Sample Preparation Starter Kit.

Everything that you need to prepare an accurate in-vitro SPF sample, all in one convenient kit. Combined with Labsphere's innovative UV-2000S SPF Sunscreen UV Analyzer and Helioscreen HD plates, you will be able to achieve the accurate SPF In-Vitro results that you need.



EASY-TO-USE

The In-Vitro SPF Sample Preparation Starter Kit contains all of the accessories that are recommended by the COLIPA and Boots Star measurement methods to prepare a successful SPF formula sample. Also included in the kit is a guide to proper sample preparation, created and tested by Labsphere experts in an effort to assist in establishing a correct standard sample preparation process for in-vitro SPF testing throughout the industry.

STARTER KIT CONTAINS:

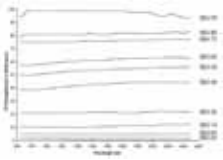
One 1 oz tube of Vaseline®
One Positive Displacement Pipette (10 - 100 µL Range)
One box of 60 Pipette Capillaries and Pistons (25 µL)
One box of 60 Pipette Capillaries and Pistons (100 µL)
one box of 144 Size Non-Powdered Finger Cots
Sample Preparation Guide

Specifications
Model Name
UV-2000 Starter Kit

STANDARDS

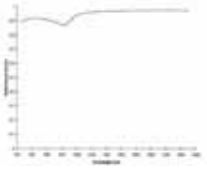
SPECTRALON DIFFUSE REFLECTANCE STANDARDS

High Lambertian reflectance over their effective spectral range



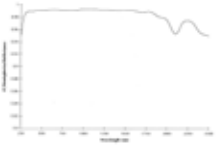
SPECULAR STANDARDS

UV enhanced standards for the calibration of spectrometers used for measuring highly specular materials



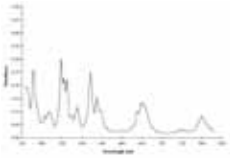
DIFFUSE REFLECTANCE TARGETS

Durable reflectance panels for laboratory and field applications that require exposure to harsh conditions



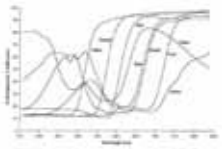
SPECTRALON WAVELENGTH CALIBRATION STANDARDS

Covering the UV-VIS-NIR region of the spectrum



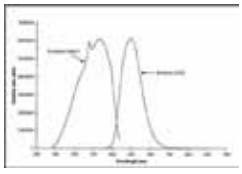
SPECTRALON DIFFUSE COLOR STANDARDS

Highly stable, durable Color standards for calibrating colorometers and Spectrophotometers



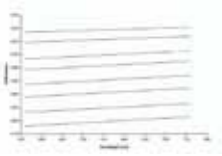
SPECTRALON FLUORESCENCE STANDARDS

Highly stable, durable fluorescence standards for calibrating colorometers and spectrophotometers



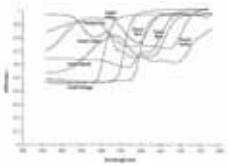
SPECTRALON HIGH-REFLECTANCE GRAY SCALE STANDARDS

Gray scale standards that offer consistent reflectance, thermal stability, and durability



SPECTRALON COLOR PASTEL STANDARDS

Consistent reflectance, thermal stability, and durability for unpredictable or tight color tolerance situations



CHAPTER 1 TEST-MEASUREMENT

UNIFORM SOURCE SYSTEMS

Exceptional uniformity for the precise calibration of imaging and non-imaging devices

BEST FOR MEASURING:

- Satellite Instrumentation
- Electronic Imaging Cameras
- Planar Arrays
- Photometers
- Spectroradiometers
- Electronic Imaging Cameras
- Displays
- Imaging Radiometers Cameras
- Telespectroradiometers
- Small-area remote sensing devices

FEATURES

- Stepped or Continuous Radiance Variability
- Better than 98% Radiance Uniformity
- SpectraflectR Interior
- Interchangeable Components
- Radiometric and Photometric Calibration Reports
- NIST Traceable Luminance Calibration
- Backed by ISO 9001:2000 Registered Quality Management System

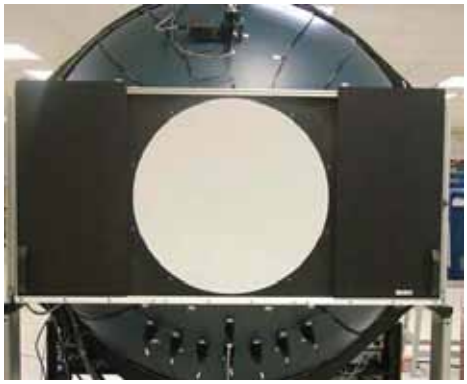
ACCURATE

The Uniform Source Systems are designed to provide exceptional uniform spectral radiance for the test and calibration of imaging and non-imaging detectors. The systems provide stepped luminance output, or continuous output with the addition of a variable attenuator. Each system monitors luminance levels in both cd/m2 and foot-lamberts and all calibrations are traceable to the National Institute of Standards and Technology (NIST).

Spheres are coated with Spectraflect which combines a 98% reflective surface with nearly perfect Lambertian properties. Both durable and highly stable over time, this coating ensures the consistent integration of light over the lifetime of your sphere.

FLEXIBLE DESIGN

Three ports and direct mount sockets enable the system's radiance levels to be easily modified with the addition or removal of light sources. To customize your system or to achieve lower radiance levels without losing performance, the system's ports can be capped or reduced in size with Spectraflect coated accessories. The sphere comes with two extra detector ports for expanded spectral monitoring and the electronics racks have room for additional motor controllers, power supplies, or a detector multiplexer. Let us design a system for your specific application.



Model Number	USS-4000C	USS-6500C	USS1200C	USS2000C	USS600C
Luminance Range (cd/m^2)	0 - 40000	0 - 34400	0 - 63	0 - 18	0- 2100
Luminance Range (ft-L)					0- 600
Illuminance Range (lux)					0 - 6600
Peak Radiance (mW/cm^2-sr-mm at 0.9mm)	117	99	180	55	6.0
Color temperature	3000K	3000K	3000K	3000K	3000K
Sphere Diameter	40 in. (102 cm)	65 in. (165 cm)	12 in (30 cm)	20 in (50 cm)	6 in (15 cm)
Exit Port Diameter	14 in. (36 cm)	22 in. (60 cm)	4 in (10 cm)	8 in (20 cm)	2 in (5 cm)
Lamp Assemblies	Qty 7, 150 W	Qty 17, 150 W	Qty 3, 35 W	Qty 3, 35 W	Qty 1, 35 W
	Qty 1, 100 W	Qty 1, 100 W	Qty 1, 100 W	Qty 1, 100 W	
	Qty 1, 75 W	Qty 1, 75 W			
	Qty 1, 35 W	Qty 1, 35 W			
Current Stability	6.25 A +/- 0.1%	6.25 A +/- 0.1%	3.07 A +/- 0.1%	3.07 A +/- 0.1%	3.07 A +/- 0.1%
	8.33 A +/- 0.1%	8.33 A +/- 0.1%	8.33 A +/- 0.1%	8.33 A +/- 0.1%	
	3.07 A +/- 0.1%	3.07 A +/- 0.1%			
	6.35 A +/-0.1%	6.35 A +/-0.1%			
Sphere Coating	Spectraflect	Spectraflect	Spectraflect	Spectraflect	Spectraflect
Sphere Coating Reflectance	98%	98%	98%	98%	98%
Luminance Uniformity	>98%	>98%	>98%	>98%	>98%
Radiometer/Photometer	SC-6000	SC-6000	SC-5500	SC-5500	SC-5500

MODEL NUMBER

Continuous Uniform Source System (USS-C)
Stepped Uniform Source System (USS-S) - optional

SYSTEM INCLUDES

Uniform Source Sphere
Internal Halogen Lamp Assemblies
Preset Power Supplies
External Halogen Lamp Assembly
Preset Power Supply
Photopic Detector
Variable Attenuator (C Series)
Motor Controller (C Series)
Radiometer/Photometer*, SC-6000

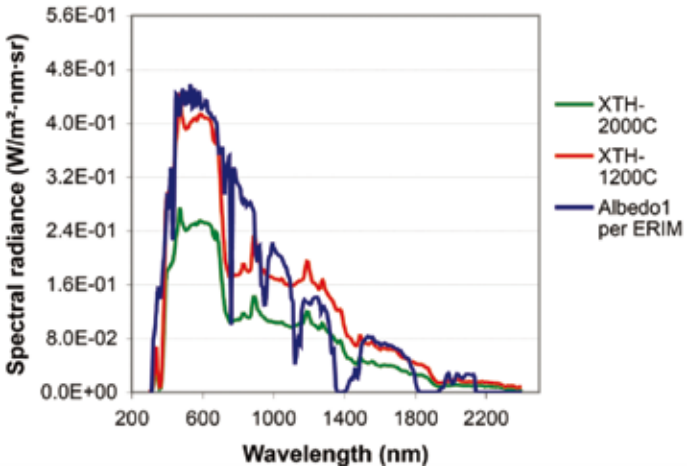
OPTIONAL ACCESSORIES/CALIBRATIONS

Internal & External Light Source Assemblies
Labsphere Power Supplies
Standard Spectral Radiance Calibrations
USC-SR Radiance Calibration
Exit Port Luminance Uniformity Mapping
Illuminance Calibration

Detector	Vλ Filter Silicon Photodiode
Active Area	5.7 mm^2
Range	Visible
f1'	4%
Connector	Triax

CHAPTER 1 TEST-MEASUREMENT

SOLAR SIMULATORS



FEATURES:

- Radiance uniformity >98%
- Approximates 100% albedo shape
- Approximates ASTM Standard D65
- Variable correlated color temperatures between 3000 K and 6000 K
- Two high-performance systems available
- Multiple detector options
- System calibration traceable to NIST
- CCD-based spectrometer monitoring from 350-1050nm
- Photopic detector for luminance monitoring

APPLICATIONS:

- Lambertian solar simulator
- Dynamic range, linearity and uniformity testing of focal plane arrays
- Characterization of spacebased imager systems
- Testing of speed video/film systems
- Single element broadband sensor testing
- Photovoltaic and quantum efficiency testing

SPECTRAL SHAPE SIMULATION

Labsphere's Solar Spectrum Uniform Source System approximates the spectral radiance albedo1 (defined by ERIM) by combining xenon and tungsten halogen sources within an integrating sphere. The system is designed to duplicate the spectral shape of solar radiation while also approximating any spectrum with color temperature ranges from 3000 K to 6000 K. The complete system is available in two models depending upon the customer's output radiance and illumination area requirements.

OFF-THE-SHELF SYSTEM

Labsphere's XTH-1200C and XTH-2000C systems feature a 12-inch (30 cm) diameter uniform source integrating sphere with 4-inch (10 cm) diameter port, and a 20-inch (51 cm) diameter uniform source integrating sphere with an 8-inch (20 cm) diameter port, respectively. The spheres are coated with Spectraflect® white reflectance coating which offers near-Lambertian characteristics and provides exceptional uniform radiance. A spectrometer-based spectral irradiance monitor enables users to accurately monitor the spectral distribution of the sphere for any lamp configuration or variable attenuator position. A photopic detector is also included for luminance monitoring. The system includes spectrometer software and uniform source control system software.

AUTOMATED CONTROL

Users can automatically control and monitor the spectral radiance through the exit port from zero to maximum output levels with Labsphere's motorized variable attenuators (VA-200-SC) and motor controllers (MC-1000). A high-dynamic range, low-noise CCDbased spectrometer monitors the spectral irradiance from 350 to 1050 nm. Labsphere's highly sensitive SDA-050-P-RTA detector and SC 6000 radiometer are calibrated for luminance responsivity and enable users to independently monitor luminance through the exit port in units of cd/m2 or fL. The combination of xenon and tungsten halogen sources allow users to obtain correlated color temperature spectrums from 3000 K to 6000 K.

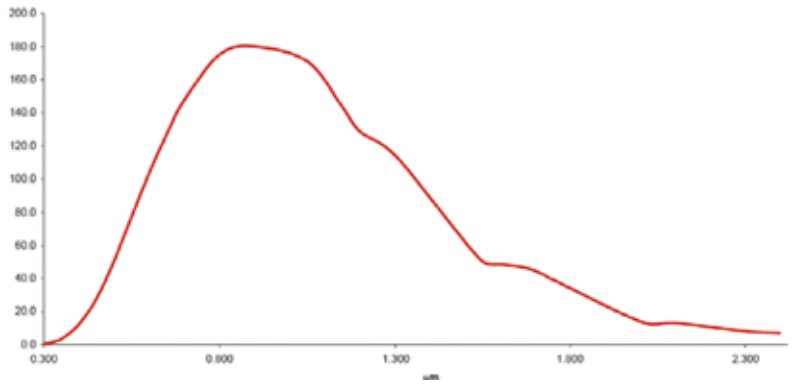
Specifications		
Model and Description	XTH-1200C	XTH-2000C
Continuous Xenon Tungsten Halogen	AA-00900-000	AA-00566-000
Uniform Source System		
System Includes		
12- or 20- inch Spectraflect Integrating Sphere	N/A	N/A
Light Source, EHLS-200-150	N/A	N/A
Halogen Lamp Power Supply, LPS-150-0625	AS-02656-625	AS-02656-625
Radiometer/Photometer, SC 6000	AS-02702-000	AS-02702-000
Detectors, SDA-050-P-RTA-CX	AS-02522-301	AS-02522-301
Variable Attenuators, (2) VA-200-SC	AS-02450-200	AS-02450-200
Motor Controller, (2) MC-1000		
CCD-Based Spectrometer	OOI USB 2000+	OOI USB 2000+
Spectrometer Software	OOI SpectraSuite	OOI SpectraSuite
Labsphere USS control software	AS-02743-001	AS-02743-001
Calibration, Spectral Irradiance (350-1050nm)	N/A	N/A
SCC-LU, Luminance	SCC-LU	SCC-LU

Typical System Properties and Performance		
Luminance range	0 - 20,500 cd/m2 @ 6000 K	0 - 7000 cd/m2 @ 6000 K
Luminance uniformity*	>98%	>98%
Correlated color temperature	3000 K - 6000 K (variable)	3200 K - 6000 K (variable)
Sphere coating	Spectraflect	Spectraflect
Sphere coating reflectance (nominal)	98%	98%
* Applies at maximum radiance uniformity may vary at lower radiance levels.		
Photopic Detector Assembly	SDA-050-P-RTA-CX	SDA-050-P-RTA-CX
Active area	4.5 mm2	4.5 mm2
Range	Visible	Visible
Connector	BNC	BNC
Radiometer/Photometer	SC 6000	SC 6000
Power requirements	110./220 VAC, 50/60 Hz	110./220 VAC, 50/60 Hz
Current dynamic range	1pA - 1 mA	1pA - 1 mA
Weight	4.1 lbs (1.86kg)	4.1 lbs (1.86kg)
Dimension W x D x H	1.75 x 8.25 x 10.5 in	1.75 x 8.25 x 10.5 in
	(4.4 x 20.9 x 26.4 cm)	(4.4 x 20.9 x 26.4 cm)
Computer Interface	Ethernet	Ethernet
Spectrometer	OOI USB 2000+	OOI USB 2000+
Integration time	10ms – >60sec	10ms – >60sec
Dynamic range	2 x 108	2 x 108
Signal-to-Noise	250:1 single acquisition	250:1 single acquisition
Readout noise (single dark spectrum)	3.5 counts RMS, 20 counts peak-to-peak	3.5 counts RMS, 20 counts peak-to-peak
Stray light	<0.05% at 600 nm; <0.10% at 435 nm	<0.05% at 600 nm; <0.10% at 435 nm
Spectrometer channels	One	One
Interface	USB USB 2.0, 480 Mbps	USB USB 2.0, 480 Mbps
	RS-232 2-wire RS-232	RS-232 2-wire RS-232
Optional Accessories/Calibrations		
Uniformity mapping	USC-PM	
Radiance calibration	SCC-RA	

CHAPTER 1 TEST-MEASUREMENT

STARLIGHT UNIFORM SOURCE

Provides irradiance levels comparable to those of an m=0 star in the UV, VIS, and IR.



FEATURES:

Simulate stellar radiance
Variable radiance levels
Uniformity <98%
12 inch integrating sphere
4 inch diameter exit port
Dual-band monitoring
Source filter wheel
Calibration
- Irradiance responsivity
- Spectral radiance and irrandiance

APPLICATIONS:

Calibrate and test UV/VIS/NIR sensors

ACCURATE

The USS-1200V-LL Uniform Source System is specifically designed to provide spectral irradiance levels comparable to those of an m=0 star in the UV, VIS, and IR. Irradiance is variable over more than eight decades. Uniformity is greater than 98%. The system is calibrated to display irradiance in phot/(s•cm2) in each of seven spectral bands.

PRACTICAL

The USS-1200V-LL includes a satellite sphere illuminator with an external halogen light source and a motorized variable attenuator to provide precise control of illumination levels. Light from the satellite sphere enters the main sphere by passing through a two-part filter system: A bandpass filter-wheel permits selection of a specific spectral channels, while neutral-density filters determine the system's irradiance range.

Two different detectors are installed to monitor the irradiance at the system's exit port. The SC 6000 System Controller includes a radiometer, which can process signals from either detector and also serves as the communication hub between the power supply, and optional detector multiplexer. The SC 6000 offers both an IEEE-488 bus and an RS-232 serial port for computer control of the system.

EASY-TO-USE

The USS-1200V-LL can be operated either directly, from the front-panel controls, or through Labsphere's standard USS software, which permits remote control of the lamp power supply, variable attenuator, and optional detector multiplexer. The software automatically corrects detector readings using programmable calibration factors, and corrected readings are displayed in graphic and numeric format.

Specifications	
Description and Model	USS-1200V-LL
12 Inch Low Level Light Uniform Source System	AA-00785-000
System Includes	USS-1200V-LL
12 Inch Spectraflect Uniform Source Sphere, US-120-SF	AS-02448-000
Two Radiometer/Photometers, SC 6000	AS-02702-000
75 Watt Rhodium External Light Source, EHLS-100-75R	AS-02247-075
Lamp Power Supply, LPS-100-0625	AS-02600-625
Unfiltered Silicon Detector Assembly, SDA-050-U-RTA-CX	AS-02522-400
InGaAs Detector Assembly, IDA-050-RTA-CX	AS-02522-400
1” Apeture Automated Variable Attenuator, VA-100-SC	AS-02450-100
2” Neutral Density Filter Sets, NDFS-200	AS-00148-600
Motor Controller, MC-1000	AS-02609-000

System Properties and Performance	
System Specifications	US-120-SF
Sphere Diameter	12 in (30 cm)
Exit Port	4 in (10 cm)
Irradiance Uniformity*	>98%
Dynamic Range	
at 0.400 µm:	10^{8} - 10^{14} phot/(s•cm^{2}• µm)
at 2.300 µm:	10^{5} - 10^{11} phot/(s•cm^{2}• µm)
Narrowband filter wavelength	400, 500, 600, 700, 800, 900, 1100 nm
Sphere Dimension (W x D x H)	17.1 x 11.3 x 19.7 in
	(43.4 x 28.7 x 50.0 cm)
Rack Dimension (W x D x H)	19.7 x 21.7 x 21.9 in
	(50 x 55 x 56 cm)
* Applies at maximum radiance	uniformity may vary at lower radiance levels.
Radiometer/Photometer	SC 6000
Power Requirements	110./220 VAC, 50/60 Hz
Current Dynamic Range	1 pA – 1 mA
Voltage Dynamic Range	10 mVdc – 50 Vdc-
Computer Interface	Ethernet
Power Supply	LPS-100-0625
Power Requirements	110./220 VAC, 50/60 Hz
Current Stability	0.01%
Current Rise Time	20 s
Regulated Current	2.60 A +/- 0.1%
Weight	6.5 lbs (2.9 kg)
Dimension (W x D x H)	8.3 x 10.5 x 3.5 in
	(21.1 x 26.7 x 8.9 cm)
Compliance	CE
Optional Accessories	
Replacement Lamp, 75W	OC-03125-000

CHAPTER 1 TEST-MEASUREMENT

LASER POWER & ENERGY METER

NIST* Traceable

WEEE/RoHS COMPLIANT





	SOLO 2	TUNER	UNO	S-LINK-2	P-LINK
Detector Compatibility					
Power (Thermopiles)	✓	✓	✓	✓	✓
Power (Photodetectors)	✓		✓		✓
Energy (Pyroelectrics)	✓			✓	
Energy (Thermopiles)	✓			✓	✓
Display Types	77 x 58 mm LCD, 23 mm Digits With Backlight	77 x 58 mm LCD With Tuning Needle	76 x 57 mm LCD, Huge 32 mm Digits High Contrast Fields	None (PC Screen)	None (PC Screen)
Display Modes					
Power	✓	✓	✓	✓	✓
Energy	✓			✓	Single Shot
Fluence	✓				
Histogram	✓			✓	✓
Line Plot	✓			✓	
Peak Power	✓				
Statistics	✓			✓	✓
Digital Needle	✓	With Tail, Bargraph and High/Low hold			✓
Ratio				✓	
Outputs					
USB	✓			✓	Standard
RS-232	✓				Optional
0-1V Analog Output	✓	✓			✓
Ethernet				Optional	
Features					
Number of Channels	1	1	1	2	1
PC Software Included	✓			✓	✓
Free Internet Updating	Software & Firmware			Software & Firmware	Software only
Maximum Rep. Rate	3 kHz			10 kHz/Channel	
Internal Data Storage	225 000 points				
Statistical Functions	Max, Min, Avg., Std. Dev.,RMS & PTP Stability, Pulse #, Rep. Rate, Avg. Power			Max, Min, Avg., Std. Dev.,RMS & PTP Stability, Pulse #, Rep. Rate, Avg. Power	Max, Min, Avg., Std. Dev.,RMS & PTP Stability, Time
Physical Characteristics					
Power Supply	Battery Pack + AC Adaptor	4 Alkaline AA Batteries	4 Alkaline AA Batteries	Through USB (Power supply needed for Ethernet Version)	Through USB (Power supply needed for RS-232 version)
Dimensions (mm)	122 (H) x 210 (W) x 44 (D)	122 (H) x 210 (W) x 44 (D)	122 (H) x 210 (W) x 44 (D)	33 (H) x 105 (W) x 230 (D)	26 (H) x 57 (W) x 91 (D)
Weight (kg)	0.5	0.5	0.5	0.42	0.12

SINGLE CHANNEL, POWER MONITOR WITH TUNING NEEDLE

FEATURES

ULTRA-FAST NEEDLE

Less than 1 second response time, for the most convenient laser tuning

READS POWER DETECTORS

All thermopiles piles

LARGE LCD DISPLAY

- 77 x 58 mm
- 17.5 mm digits
- Backlight (with AC adaptor)

3 DISPLAY FUNCTIONS FOR THE NEEDLE

- Normal
- Tail (indicates speed)
- Bargraph

Also HIGH and LOW values hold

SHIFT-KEY AND SINGLE-KEY NAVIGATION

Direct access and shift access to the main functions

LOW CONSUMPTION

Lasts 300 hours with 4 AA alkaline batteries

SPECIFICATIONS

Model	TUNER
Detector TypesDisplay	Thermopiles
DISPLAY	LCD with Tuning Needle and Backlight
POWER METER SPECIFICATIONS	
Power Range	1 µW to 10 kW
Digital Resolution	
XLP Series	1 µW
UP Series	1 mW
HP Series	100 mW(HP60A), 1 W (HP70A)
Monitor Accuracy	±0.5 % full scale
Statistics	None
DETECTOR COMPATIBILITY	
Thermopiles	Average Power
GENERAL SPECIFICATIONS	
Digital Display Size	77 x 58 mm LCD
Needle Display	Ultrafast Tuning Needle
Needle Accuracy	0.9 %
Refresh Rate	4 Hz
Dimensions (Without Stand)	210W x 122H x 44D mm
Weight (With Batteries)	0.5 kg
Battery Type	4 x AA Alkaline
Battery Life (Estimated)	+300 hours with detector
External Power Supply	100/240 VAC 50-60 Hz to 9 VDC 1.66 A

CHAPTER 1 TEST-MEASUREMENT

SINGLE CHANNEL, POWER & ENERGY MONITOR

SOLO 2 MONITOR Laser Power / Energy Meter

- New and improved!
- 20X faster data transfer rate
- Display 100% larger than previous SOLO
- Reads energy detectors
- (with metallic absorbers) up to 3 kHz
- Full statistical functions
- Power/Energy/Photo detectors

UNO MONITOR Laser Power Meter

- Simple to use, ergonomically designed
- Reads all power detectors
- (including photo detectors)
- Unbeatable price!

The new SOLO 2 Energy and Power Meter will be more ergonomically shaped; with a wide screen 2 times bigger than the SOLO-PE, a transfer rate 20 times faster and the ability to read high repetition rate energy detectors up to 3 kHz.
The new UNO Power Meter will present the same inventive ergonomics as the new SOLO 2; a wide screen with large digit and easy onefinger navigation, but in a very affordable package that includes the most useful functions. Once again, with its SOLO 2 and UNO monitors, Gentec-EO is raising the bar for the highest quality/price ratio meters on the market.

Safety Options

See page 3-66

SPECIFICATIONS

Model	SOLO 2	UNO
		
Detector TypesDisplay	Thermopiles, Photo Detectors, Pyroelectrics	Thermopiles, Photo Detectors
DISPLAY	LCD with Backlight	LCD
POWER METER SPECIFICATIONS	SOLO 2	UNO
Power Range		5 pW to 10 kW
Thermopile	1 µW to 30 kW	Single wide range scale
Photo Detector	4 pW to 3 W	Accuracy
Monitor accuray	±0.5 % full scale	±1%
Statistics	Current Value, Max, Min, Average, Standard Deviation, RMS & PTP Stability, Time	None
ENERGY METER SPECIFICATIONS		
Energy Range	0.1 µJ to 30 kJ	---
Monitor Accuracy	±1 % full scale (<500 Hz)	---
Software Trigger Level	0.1 to 99.9%, 0.1% resolution, default 2% (3% for MT)	---
Repetition Rate	3 000 Hz / 10 000 Hz in sampling	---
Statistics	Current Value, Max, Min, Average, Std Dev., RMS & PTP Stability, Pulse #, Rep. Rate and Avg Power	---
DETECTOR COMPATIBILITY		
Thermopiles	Average Power & Single Shot Energy	Average Power
Photo Detector	Average Power (mW, dBm)	Average Power (mW)
Pyroelectric	Pulse Energy	
GENERAL SPECIFICATIONS		
Digital Display Size	77 x 58 mm LCD - 240 x 160 pixels	76 x 57 mm LCD
Digit Height	23 mm	32 mm
Digit Type	---	High Contrast Fields
Data Display	Real Time, Line Plot, Histogram, Statistics, Digital Tuning Needle	Real Time, Line
Analog output	0-1 Volt, Full Scale, ±1 %	---
Serial commands and Data Transfer Via	USB (standard) or RS-232 (cable in option)	---
Real-Time Data Transfer Rate	200 Hz	---
Data Storage Capacity	225 000 Points	---
Dimensions	210W x 122H x 44D mm	210W x 122H x 44D mm
Weight (With Batteries)	0.52 kg	0.47 kg
Battery Type	4 x Rechargeable 1.2 V Ni-MH AA	4 x AA Alkaline
Battery Life (Estimated)	11 hours, 6 hours with backlight	670 hours with detector
External Power Supply	100/240 VAC 50-60 Hz to 9 VDC 1.66 A	100/240 VAC 50-60 Hz to 9 VDC 1.66 A

CHAPTER 1 TEST-MEASUREMENT

DUAL CHANNEL, PC-BASED POWER AND ENERGY MONITOR

FEATURES

READS BOTH POWER AND ENERGY
Thermopiles and pyroelectrics

PC-BASED
Connects to your PC with included software

SERIAL COMMANDS
Serial commands are available on all versions to let you take full control

FASTEST DATA TRANSFER RATE
Get all the points transfered directly into your PC at 10 kHz/Channel

USB OR ETHERNET
Chose your favorite communications port.
The USB version is port-powered

EXTERNAL TRIGGER
Every model comes standard with a 2.4 V to 24 V external trigger

SPECIFICATIONS

Model	S-LINK-2
	
Detector TypesDisplay	Thermopiles, Pyroelectrics
DISPLAY	PC-Based
POWER METER SPECIFICATIONS	
Power Range	1 µW to 30 kW
Monitor Accuracy	±0.75 % for 25% to full scale
Statistics	Current Value, Max, Min, Average, Std Dev., RMS & PTP Stability, Time
ENERGY METER SPECIFICATIONS	
Energy Range	80 nJ to 30 kJ
Resolution (Digital)	Normal Mode: Current scale/4096
Monitor Accuracy	
<500 Hz (MB), <1200 Hz (MT)	1%
500 to 1 200 Hz (MB)	2%
1 200 to 6 000 Hz (MT)	3%
6 000 to 10 000 Hz (MT)	6%
Real Time Data Transfer	10 kHz/Channel in normal mode, no missing point
Statistics	Current Value, Max, Min, Average, Std Dev., RMS & PTP Stability, Pulse #, repetition Rate, Average Power
DETECTOR COMPATIBILITY	
Thermopiles	Average Power & Single Shot Energy
Pyroelectric	Pulse Energy
GENERAL SPECIFICATIONS	
Number of Channels	2
Digital Display	Computer Screen
Data Display	Real Time, Ratio, Line Plot, Histogram, Statistics and 3D Histogram
Serial Commands and Data Transfer Via	USB (standard) or Ethernet (option)
Real Time Data Transfer Rate	10 kHz/Channel in normal mode, no missing point (for pyroelectrics only)
Dimensions	106W x 34H x 147D mm
Weight	0.424 kg
Extemal Power Supply (Ethemet Version only)	100/240 VAC 50-60 Hz to 9 VDC 1.66 A

SINGLE CHANNEL, PC-BASED POWER MONITOR

FEATURES

READS ALL POWER DETECTORS TYPES
Both thermopile and photo detectors

PC-BASED
Connects to your PC with included software

SMALL SIZE
Only 91 mm (L) x 57 mm (W) x 26 mm (H)

SERIAL COMMANDS
Serial commands are available on both versions to let you take full control

REAL-TIME STATISTICAL FUNC-TIONS
Max, Min, Average, Standard Deviation, RMS and PTP Stability, Pulse # and Repetition Rate

USB OR RS-232
Chose your favorite communications port The USB version is port-powered

SPECIFICATIONS

Model	P-LINK
	
Detector TypesDisplay	Thermopiles, Photo Detectors
DISPLAY	PC-Based
POWER METER SPECIFICATIONS	
Power Range	
Thermopile	1 µW to 30 kW
Photo Detector	5 pW to 3 WMonitor
Monitor Accuracy	±0.5 % full scale
Statistics	Current Value, Max, Min, Average, Std Dev., RMS & PTP Stability, Time, Repetition Rate
DETECTOR COMPATIBILITY	
Thermopiles	Average Power & Single Shot EnergyPhoto
Photo Detector	Average Power (mW, dBm)
GENERAL SPECIFICATIONS	
Digital Display	Computer ScreenData
Data Display	Real Time, Histogram, Statistics, Digital Tuning NeedleAnalog
Analog Output	0 – 2 Volt, Adjustable, Full Scale, ±1 %
Serial Commands and Data Transfer Via	USB (standard) or RS-232 (option)
Real Time Data Transfer Rate	10 HzDimensions
Dimensions	57W x 26H x 91D mmWeight
Weight	0.12 kgExternal
Extemal Power Supply (Ethemet Version only)	100/240 VAC 50-60 Hz to 12 VDC 200 mAORDERING

CHAPTER 1 TEST-MEASUREMENT

ENERGY DETECTORS

ENERGY DETECTORS

Gentec Electro Optics provides a full range of products to meet your pulse energy measurement needs. They range from the tiny and sensitive QE4, the lean and portable QE12 and QE25 series, the large aperture QE50 series to our large world class custom calorimeters. Having introduced the first pyroelectric joulemeter over 30 years ago Gentec EO is well established as an experienced source of energy measurement expertise. Be it in the laboratory or an OEM application Gentec EO will have a solution.

HOW THEY WORK

In the simplest terms, a pulse of light is absorbed by the surface of the detector and heats it up. That in turn, changes the temperature in a pyroelectric material underneath. This separates electrical charges in the pyroelectric which creates a voltage as the pulse of heat energy passes through it to a heat sink. The heat sink removes the heat energy to allow the pyroelectric to be ready for another pulse and to prevent it from
over heating. The electrical voltage read by the measuring instrument is proportional to the energy. Figure 1 sketches out the basic structure of a pyroelectric joulemeter.

THE ABSORBER

The business end of the detector is the absorber that coats the side of the pyroelectric that is exposed to the laser. That material absorbs most of the light energy from the laser and converts it to heat. A small fraction is reflected. How much is shown by the spectral response curve for the material. The thermal mass of the absorber and its thickness determine how quickly the heat can flow to the pyroelectric detector and hence its
response time. Lowering the thermal impedance by using an absorber with a lower thermal mass or reducing the thickness of the absorber will increase its speed. The metallic MT coating is a good example. It allows for a measurement of each pulse up to 4000-6000 Hz with an oscilloscope.

THE PYROELECTRIC

The heart of every Gentec EO energy detector is a fast response pyroelectric material. It acts as a source of electrical current when subjected to changes in temperature provided by the absorber. Essentially it contains permanent electrical dipoles that are oriented in a specific direction. A rapid temperature change in the material will alter the orientation of these dipoles. That changes the internal electric field and causes an imbalance in electrical charge between the 2 large sides of the device. There are thin metal electrodes on these surfaces. They allow the charge to flow from one electrode into a circuit with a load resistor and then back to the crystal via the other electrode to eliminate the imbalance. The electrical current is converted into a voltage signal by the load resistor.

THE VOLTAGE RESPONSE

The result is a voltage pulse that rises quickly with the response time of the device to a level proportional to the laser energy (Figure 2). It then decays exponentially over a longer period of time that is a function of the pyroelectric device and load impedance. Figure 2 also shows that there is a longer recovery time to return to the initial state of the detector. This is a function of thermal phenomena and is not affected by the load impedance as are the rise and decay times. The integrated pulse energy over this period is proportional to the peak voltage.

THE MEASUREMENT

The laser energy is given by the change in voltage divided by the sensitivity (in Volts/Joule) of the detector. The measured voltage is the change from the initial reference voltage to the maximum voltage of the pulse. The sensitivity is provided by Gentec EO on our NIST-traceable calibration certificate. We measure this with extreme care with a well known laser energy provided by an NIST standard. This sensitivity is for the specific load impedance that is requested. The user can measure the voltage on an oscilloscope or computer data acquisition system and use the sensitivity value to make the energy measurement. An easier option is to read it directly in Joules from a Gentec EO SOLO PE or DUO monitor.

THERMALLY ROBUST

The energy detector will make accurate measurements in spite of changing temperature in the environment or heating of the detector as long as the maximum voltage does not saturate. This is because it is the difference between the initial and peak voltages that measure the pulse energy. This relative measurement is good until the peak voltage is prevented from reaching its natural value by the maximum voltage available in the electronics.

PULSE WIDTH VERSUS RISE TIME

Usually the applied laser pulse must be shorter than the rise time of the detector for all of its energy to be represented by the peak voltage. Pulse energy received after the detector voltage has peaked will not be fully integrated into that value. For very long pulses, the peak voltage will actually represent peak power rather than pulse energy.

DAMAGE THRESHOLD

Excessive pulse energy that is concentrated into to a small area can damage energy detectors. For the most demanding laser beams we offer the broadband MB coating which has pulse energy density thresholds that are among the best in the world. Slight discoloration from short pulses is due to a modification of the organic material in the absorber that does not affect the detector calibration. If enough of the coating is removed by ablation to expose the metal electrode underneath, then the output voltage may be affected too much for the application. Too much average power, (that is above the manufacturer's specification) can cause the detector to overheat. Contamination on the absorber surface can also interfere with the measurement or damage the detector by concentrating too much energy in one spot. Grease, dust, and fingerprints are some of the common contaminants to avoid.

QE SERIES ATTENUATORS

The QEA and QEAS attenuators have been designed to extend the performance of the Quanta Energy detectors in the spectral range of 400 nm to 2.5 µm for the QEA and 190 nm to 2.5 µm for the QEAS. They transmit 15% to 20% of the incident energy, depending on wavelength, to the energy detector. The QEA has been tested to a peak pulse energy density of 7 J/cm2 for short pulses (7 ns), at 1064 nm. The QEAS can take up to 1 J/cm2 at 266 nm for short pulses (7 ns). They are easy to install. They simply slide onto the Quanta Energy Series detectors. The QEA and QEAS attenuators can be used with models QE12, QE25, and QE50.

ENERGY DETECTORS





	XLE4	QE4	QE12	QE25	QE50
Size	Compact	Ultra Compact	12 x 12 mm	25 x 25 mm	50 x 50 mm
Spectral Range	0.35 - 2.5 µm	0.19 - 20 µm	0.19 - 20 µm	0.19 - 20 µm	0.19 - 20 µm
Energy Range(1)	150 nJ - 4 mJ	1 µJ - 43 mJ	0.7 µJ - 3.5 J	2 µJ - 20 J	10 µJ - 75 J
Max Pulse Widths	5 µs	10 - 100 µs	10 µs - 2 ms (2)	10 µs - 4 ms (2)	10 µs - 4 ms (3)
Max. Rep. Rate	2000 Hz	1200 - 6000 Hz	300 (3) - 6000 Hz	300 (4) - 6000 Hz	200 (4) - 4000 Hz
Technical Specifications					
Effective Aperture	4 mm Ø	3.7 mm Ø	12 x 12 mm	25 x 25 mm	50 x 50 mm
Rise Time (0-100%)	10 µs	20 - 200 µs	20 - 550 µs	20 - 550 µs	20 - 900 µs
Sensitivity	1100 V/J	150 - 200 V/J	60 - 100 V/J	10 - 20 V/J	3 - 4 V/J
Calibration Uncertainly	± 4%	± 4%	± 3%	± 3%	± 3%
Damage Thresholds(5)					
Max. Energy Density (1064 nm)	90 mJ/cm2	150 - 400 mJ/cm2	2 - 7 J/cm2	2 - 7 J/cm 2	2 - 7 J/cm2
Max. Energy Density (266 nm)	N/A	6 - 70 mJ/cm2	0.3 - 1 J/cm2	0.3 - 1 J/cm2	0.3 - 1 J/cm2
Max. Avg. Power	0.4 W	0.3 W	3 - 12.5 W	5 - 30 W	10 - 45 W
Available Modules					
Stand Alone	✓	✓	✓	✓	✓
Heatsink			✓	✓	✓
Absorber Types					
Black		✓			
Broadband					
Metallic (High Rep. Rates)	✓	✓	✓	✓	✓
Glass					
Options					
Attenuators/Diffusers			✓	✓	✓
Extra Long Pulse Capabilities (msec)			✓	✓	✓
Monitor Compatibility					
SOLO 2	✓	✓	✓	✓	✓
TUNER					
UNO					
S-LINK-2	✓	✓	✓	✓	✓
P-LINK					

* : All values are for an entire family and not a specific product. See the specification sheets for the values of individual detectors.
(1) : From Noise Equivalent Energy (NEE) to maximum measurable energy with QED attenuator (when applicable).
(2) : On special request only. Standard pulse widths are 10 µs, 150 µs and 400 µs.
(3) : On special request only. Standard pulse widths are 10 µs, 225 µs and 675 µs.
(4) : This value is dependant of the maximum pulse width chosen and can be lower than specified in this table.
(5) : With QED attenuator when applicable.

CHAPTER 1 TEST-MEASUREMENT

POWER DETECTORS

POWER DETECTORS

Well established in this field for over 30 years Gentec Electro Optics has been a leader in the field of laser power and energy measurement. The average power density damage threshold of 100 kW/cm2 that we introduced with the WB series in the mid 1990's is still unsurpassed. Gentec EO also offers you broadband spectrally flat power detectors for general use in the UP12E-H5 & UP19K-H5 series, high peak power pulse damage resistance for specific UV and IR bands with the UP19K-V series, and high average power detectors in the air and water cooled High Power UP25N-H9 & UP55N-H9 for the big jobs. All our detectors are available in OEM version and different size disks as well. Whatever your need Gentec Electro Optics has a solution.

HOW THEY WORK

The basic laser power detector is essentially a thermopile. The more familiar application for thermopiles, in fact where the common name "thermo electric cooler" comes from, is when a voltage is applied to cool one side of the thermopile and whatever it is bonded to. Thermopiles for laser power measurement however are used in the opposite fashion. That is, a temperature difference is used to create a voltage. On one side is material heated by the laser and on the other is a heat sink. The laser energy absorbed by that material is converted to heat. With the hot absorber on one surface and the cold heat sink on the other, there is a temperature difference across the thermo electric device as the heat flows through it. This temperature difference causes the thermopile to generate a voltage. That voltage is proportional to the temperature
difference which in turn is proportional to the laser power. The monitor measures this voltage to provide the laser power reading in watts. Figure 1 shows the fundamentals of the thermopile-based power detectors.

THE ABSORBER

The optically absorbing material is one of the most important parts of the detector. That is because its properties define much of the performance of the detector, especially its resistance to pulse damage. This material absorbs most of the light energy from the laser and converts it to heat. A fraction is reflected that can vary from a few percent to 50 percent of the total optical power, depending on the material and intended application. How much is shown by the spectral absorptivity response curve for the material. With an absorber like our broadband H coating, around 90% of the power may be absorbed across a very wide range of wavelengths (190 nm to 11 microns) with small variations. This is called a spectrally flat absorber. It is efficient and because of its low thermal mass it transfers the heat quickly.

THE HUMBLE BEGINNING

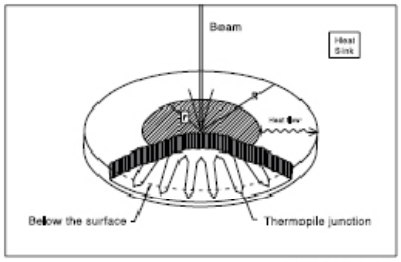
A thermopile is simply an array of thermocouples connected in series and close together. The fundamental technology of all state-of-the-art thermal laser power detectors actually goes back to 1821! That is when Thomas Seebeck joined two wires of dissimilar materials together at both ends and discovered electrical current flowing when he heated one end. Moreover, he found that the voltage between junctions was proportional to the temperature difference between them. That is called the Seebeck voltage and became the basis for the thermocouple. Years later Lord Kelvin (William Thomson) explained it. Essentially, the heat causes electrons to diffuse away from one end of a wire to the other. Since the effect is different for different metals, there is a net difference in voltage where the metals join, hence Seebeck's voltage. Peltier made his contribution in 1834 by observing that heat could be made to flow into, or out of, the junction depending on which way you make the current flow. Modern thermocouples are made by the joining of specially formulated metal alloys and even specially doped semiconductor materials.

THE THERMOCOUPLE

A practical view of a thermocouple is essentially 2 wires of different metals attached at both ends like in Figure 2. One junction goes to the "hot" side of the device and the other goes to the "reference" or cold side of the device. In laser power measurement, the hot junction is placed next to the absorber and the other next to the heat sink. Any temperature difference between the two junctions causes a voltage difference between them. That electrical voltage is proportional to the temperature difference, therefore to laser power. This is the voltage that is measured by the power monitor to provide the power reading.

THE THERMOPILE

The amount of voltage that can be produced by one thermocouple is small, so an array of thermocouples is connected in series to increase sensitivity and multiply the output. In the array, instead of the two wires being joined twice to each other, each wire is joined to two wires of the other type, but a different one at each end. The junctions alternate back and forth so that each wire has a junction on the hot side, and another on the cold side. This is easier to visualize in Figure 1. The more numerous and closer together the junctions are, the more sensitive the thermopile will be. So it gives more voltage for the same laser power.



r = radius of beam
R = Radius of disk

DISK THERMOPILE

Two kinds of thermopiles are used in laser power measurement. One is the disk thermopile shown in Figure 1 and the other is the wafer-type thermopile. The disk is made of one set of junctions laid out radially. One set of junctions is arrated under the aperture while the alternate set is near the edge of the disk which is attached to a massive heat sink. The laser power heats the absorber in the center and creates a temperature difference between the center and the edge. The thermocouples generate a voltage corresponding to this difference. The primary difference with the second type is that the heat flows radially through the disk which can handle more average power, especially with blown air or water cooling. The disk thermopile also has a much faster natural response time. Gentec EO offers a complete line that combined a new technology disk with different cooling way like heat-sink, fan or water cooling module.

WAFER-TYPE THERMOPILE

The second one resembles a wafer, or sandwich, with thermocouples running between the two sides. One rectangular face of the wafer thermopile receives the heat. That creates a large temperature gradient across the small distance to the other face that is in contact with the massive heat sink. The array of solid state thermocouples in the thermopile generates a voltage proportional to this gradient just like in the disk thermopile. Because of the close spacing of the thermocouples to each other, the resulting large number of thermocouples in the wafer, and the large temperature gradient across the two surfaces, the output voltage of this thermopile is the most sensitive to laser power and the least sensitive to beam position and size.

ANTICIPATION

The voltage response of a thermopile to the incoming power is predictable. It can be modeled. All Gentec EO monitors have circuitry and software that model the incoming pulse and accurately predict its peak value before it actually occurs. This “anticipation” circuitry allows the wafer type thermopiles to have a much faster accelerated response time when used with a Gentec EO monitor than the natural response time of the device.

AVERAGE POWER

An average power that is too high simply overheats the detector until it damages the thermocouple junctions. As a consequence, the thermopile itself and the cooling system determine the average power capacity of the detector. This is also what you risk if you exceed the manufacturer’s specification for too long. To avoid the overheats, we offer the UP series which can, with is newest design, take a lot more heat than the usual thermopile.

AVERAGE POWER DENSITY

Concentrating too much energy into too small an area can damage the absorber. Hence, the absorber determines how much energy and power density the detector can take. There are two fundamental types of damage. The first is from slow thermal effects and the second from short pulse impacts. The slow thermal damage is due to local heating when the average power density is too high. The result is melting, vaporizing and/or cracking of the absorber. CW, QUASI-CW and lasers with high repetition rates, such as used in micromachining can create high average power density, especially with small beam diameters. For these demanding laser beams we offer the W5 series which has, at 100 kW/cm2, the highest average power density threshold available today. For the most challenging cases, expanding the beam is often the easiest way to reduce the power density to something manageable.

PEAK POWER DENSITY (PULSED)

When the pulse energy is concentrated into too short a time, as well as space, it explosively vaporizes some of the absorber material at the surface. That ablates or knocks away some of the absorber. When the thermopile underneath is eventually exposed, the sensitivity may be affected too much for the application. The VM and VH series (volume absorbers) are designed to take the concentrated pulse energy by distributing it through a volume instead of just on the absorber surface. Unlike the broader band materials which absorb the energy right on the surface, the energy is absorbed throughout the thickness of the material. That spreads the energy throughout a cylindrical volume rather than just over an area of the beam diameter. Energy densities greater than 30 J/cm2 and peak power densities above 100 GW/cm2 can be handled this way depending on the wavelength. If damaged by excessive pulse energy density or peak pulse power density our absorbers can be easily replaced in the field.

WAVELENGTH

The other important consideration is wavelength. Energy from the longer wavelengths, like Mid and Far IR tends to penetrate deeper into the absorber. Damage from exceeding the specification may occur first at the absorber-thermopile interface and work its way up to the surface. In the shorter wavelengths the energy is concentrated closer to the absorber surface. In the case of UV the photons are so energetic and concentrated on the surface that they cause electronic as well as optical-thermal damage. Essentially, they knock electrons out of atoms in the absorber material. Gentec EO offers broadband absorbers for all
kind of wavelength as well as absorber for specific wavelength. In practice, a combination of the two mechanisms is often at play and both may be visible. If your application is pushing the limits pay attention to the damage thresholds provided by the manufacturer and the spectral absorptivity curve for the material to adjust for wavelength where necessary.

THE BOTTOM LINE

Damage to the absorber surface, whatever the mechanism (even if you scratch it), is only an issue when it changes the ratio of power reflected versus absorbed at your laser wavelength. Visible discolorations may not mean much at our wavelength of your laser if it is outside of the visible light spectrum. Then again they might. If more power is reflected, less will be absorbed so the detector will be less sensitive than when it was calibrated. When this damage is severe enough, and covers enough of the area under the beam to affect the accuracy required by the application, you should send the detector for recalibration, and possibly service. For many applications an annual recalibration is good policy.

QUALITY

Besides our attention to accuracy Gentec EO detectors are some of the sturdiest on the market. That makes them ideal for OEM applications that require robust instrumentation. You see our thoughtful quality even in the supporting features like the cables and stands.

CABLES

All Gentec EO power detectors come equipped with a top of line high quality audio cable. This pliant cable provides long flex life and outstanding EMI shielding. It is standard on our detectors

and another example of the high quality mark we set in the market.

SOLUTIONS FOR MANY NEEDS

Lasers come in many different varieties to serve a multitude of applications but most have one common requirement. That is to know how much laser power or energy there is somewhere in the optical train, from the laser to the target. The following tables will help you quickly locate the Gentec-EO products that best suit your need. As a former laser manufacturer, we are experts in solving laser power and energy measurement problems. Please consult your Gentec-EO representative for help selecting the right product for your application.

CHAPTER 1 TEST-MEASUREMENT

POWER DETECTORS






	XLP12	UP12E-H5	UP19K-H5(H9)	UP25N(Z)-H9	UP55N-H9	UP55G-H12
Size						
Optical Specifications						
Spectral Range	0.19 - 20 µm	0.19 - 20 µm	0.19 - 20 µm	0.19 - 20 µm	0.19 - 20 µm	0.19 - 20 µm
Power Range(1)	1 µW - 3 W	1 mW - 110 W	1 mW - 190 W	3 mW - 300 W	5 mW - 400 W	15 mW - 500 W
Energy Range(2) (in energy mode)	12 µJ - 5 J	20 mJ - 5 J	20 mJ - 25 J	0.2 J - 40 J	0.25 J - 200 J	0.2 J - 200 J
Technical Specifications						
Effective Aperture	12 mm Ø	12 mm Ø	19 mm Ø	25 mm Ø	55 mm Ø	55 mm Ø
Response Time (nominal)	2.5 sec	0.3 sec	0.6 - 1.5 sec	1.3 sec	2.5 sec	2.8 sec
Sensitivity (natural)	200 mV/W	0.5 mV/W	0.2 - 0.6 mV/W	0.1 - 0.2 mV/W	0.1 mV/W	0.06 mV/W
Calibration Uncertainly	± 2.5%	± 2.5%	± 2.5%	± 2.5%	± 2.5%	± 2.5%
Energy Mode						
Sensitivity	25 mV/J	0.84 mV/J	0.65 mV/J	0.14 mV/J	0.028 mV/J	0.01 mV/J
Max Measurable Energy	5 J	5 J	15 J	40 J	200 J	200 J
Noise Equivalent Energy	12 µJ	20 mJ	20 mJ	200 mJ	250 mJ	250 mJ
Min Repetition Period	16 sec	1.5 sec	4 sec	4.6 sec	11.1 sec	14.3 sec
Max Pulse Width	300 ms	50 ms	88 ms	123 - 133 ms	433 ms	433 ms
Accuracy in Single Shot	± 5%	± 5%	± 5%	± 5%	± 5%	± 5%
Damage Thresholds						
Max Avg. Power Density	1 kW/cm2	36 kW/cm2	36 - 45 kW/cm2	45 kW/cm2	45 kW/cm2	8 kW/cm2 @ 500 W
Max Energy Density (µs, ms)	5 J/cm2	5 J/cm2	5 - 9 J/cm2	9 J/cm2	9 J/cm2	9 J/cm2
Max Energy Density (fs, ns)	1 J/cm2	1 J/cm2	1 J/cm2	1 J/cm2	1 J/cm2	1 J/cm2
Available Modules						
Stand Alone	✓	✓	✓	✓	✓	
Heatsink		✓	✓	✓	✓	
Large Heatsink						
Fan Cooled					✓	✓
Water Cooled		✓			✓	
Monitor Compatibility						
SOLO 2	✓	✓	✓	✓	✓	✓
TUNER	✓	✓	✓	✓	✓	✓
UNO	✓	✓	✓	✓	✓	✓
S-LINK-2	✓	✓	✓	✓	✓	✓
P-LINK	✓	✓	✓	✓	✓	✓







UP17P-H5	UP17P-W5	UP19K-W5	UP50N-W9	UP19K-V	HP60(70)A	FLASH
0.19 - 20 µm	0.19 - 10 µm	0.19 - 10 µm	0.19 - 10 µm	0.19 - 2.5 µm	0.19 - 20 µm	0.19 - 20 µm
1 mW - 7 W	1 mW - 7 W	1 mW - 85 W	5 mW - 85 W	2 mW - 35 W	3 - 10 kW	5 W - 3000 W
20 mJ - 15 J	20 mJ - 200 J	20 mJ - 200 J	0.25 J - 500 J	20 mJ - 40 J		
17 mm Ø	17 mm Ø	17 mm Ø	50 mm Ø	18 mm Ø	60 - 70 mm Ø	55 mm Ø
0.8 sec	1.4 sec	1.4 sec	3.5 sec	2.5 sec	7 - 9 sec	10-12 sec
0.6 mV/W	0.6 mV/W	0.6 mV/W	0.12 mV/W	0.3 mV/W	0.5 - 0.7 mV/W	
± 2.5 %	± 2.5 %	± 2.5%	± 2.5 %	± 2.5%	± 5%	± 6%
0.7 mV/J	0.2 mV/J	0.33 mV/J	0.02 mV/J	0.1 mV/J		
15 J	200 J	200 J	500 J	40 J		
20 mJ	20 mJ	20 mJ	250 mJ	20 mJ		
4 sec	5 sec	5 sec	11.1 sec	4.5 sec		
88 ms	133 ms	133 ms	467 ms	90 ms		
± 5 %	± 5 %	± 5%	± 5%	± 5%		
36 kW/cm2	100 kW/cm2	100 kW/cm2	100 kW/cm2	700 W/cm2	10 - 15 kW/cm2	25 kW/cm2
5 J/cm2	100 J/cm2	100 J/cm2	100 J/cm2	40 J/cm2		
1 J/cm2	1.1 J/cm2	1.1 J/cm2	1.1 J/cm2	6 J/cm2		
✓	✓	✓	✓	✓		
		✓	✓	✓		
		✓				
		✓	✓			
		✓	✓		✓	
✓	✓	✓	✓	✓	✓	Come
✓	✓	✓	✓	✓	✓	with
✓	✓	✓	✓	✓	✓	their
✓	✓	✓	✓	✓	✓	own
✓	✓	✓	✓	✓	✓	display

CHAPTER 1 TEST-MEASUREMENT

PHOTO DETECTORS

LOW POWER

FEATURE

- Fast
- Small Size
- Si, Si-UV, Ge
- Full NIST-Traceability
- Smart Interface

(post hold & baseplate are optional)

PH100-Si

PHSERIESPHOTO DETECTOR SPECIFICATIONS

Gentec-EO offers a series of photo detectors that can extend your laser power measurement capability down to the picowatt range. We have a solution for your low power measurements for wavelengths from 200 nm to 1.65 micron. You have 3 models to choose from: silicon, UV-enhanced silicon and germanium. The silicon detectors provide a generous aperture for laser beams up to 10 mm in diameter. The threaded aperture allows you to install filters, attenuators, fiber optic adapters or other optics that suit your specific needs. All of the detectors have a NIST traceable calibration and Personal wavelength correction ™. Our photo detectors are compatible with the Gentec-EO SOLO PE and P-Link monitors.

SILICON

This is the choice for typical low power CW lasers from 300 to 1100 nm. Make measurements down to 600 pW and up to 0.75 W with an OD-2 attenuator.

SILICON-UV

For low power CW lasers working at shorter wavelengths we offer this photo detector sensitive to 200 nm. Maximum power with OD-2 attenuator is 30mW. Other performance characteristics are similar to the regular silicon detector.

GERMANIUM

For longer wavelengths, our germanium photo detector is a nice solution between 0.8 and 1.65 microns for laser beams up to 5 mm in diameter. With the attenuator it will go to 0.5 W.

ATTENUATORS

To extend the performance of the photo detectors to higher measurable powers you can select one of our attenuators. The transmission of the OD-1 is 10% and the transmission of the OD-2 is 1%.

	Si	Si-UV	Ge
Typical Lasers	• HeNe • Diode • Argon Ion	• HeCd • MicroYAG	• Diode • Tunable color center • Raman shifted YAG
Common Application	• Wafer inspection • Multimode fiber	• Data storage • Bioluminescence	• Diode pumps for single mode fiber amps • Telecom source testing

SPECIFICATIONS

Model	PH100-Si	PH-100Si^{UV}	PH20-Ge
200875Max Measurable Power	30 mW	28 mW	30 mW
Max Measurable Power (with OD-2)	750 mW	50 mW	500 mW
MEASUREMENT CAPABILITY			
Spectral Range	300 – 1100 nm	200 – 900 nm	800 – 1650 nm
With OD-1	400 – 1100 nm	400 – 900 nm	900 – 1650 nm
With OD-2	630 – 1100 nm	630 – 900 nm	950 – 1650 nm
Maximum Measurable Power	30 mW @ 1064 nm	2.8 mW @ 532 nm	30 mW @ 1064 nm
With OD-1	300 mW @ 1064 nm	25 mW @ 532 nm	300 mW @ 1064 nm
With OD-2	750 mW @ 1064 nm	30 mW @ 850 nm	500 mW @ 1064 nm
Minimum Measurable Power[a]	600 pW @ 980 nm	600 pW @ 850 nm	2 nW @ 1550 nm
With OD-1	6 nW @ 980 nm	6 nW @ 850 nm	20 nW @ 1550 nm
With OD-2	60 nW @ 980 nm	60 nW @ 850 nm	200 nW @ 1550 nmRise
Rise Time (nominal)	0.2 sec	0.2 sec	0.2 sec
Peak Sensitivity	0.5 A/W	0.45 A/W	0.98 A/W
Calibration Uncertainty	±6.5 % 300 - 399 nm ±2.5 % 400 - 999 nm ±5 % 1000 - 1049 nm ±7 % 1050 - 1100 nm	±8 % 200 - 219 nm ±6.5 % 220 - 399 nm ±2.5 % 400 - 900 nm	±3.5 % 800 - 1650 nm
Accuracy (with OD filters)	±5 %	±5 %	±5 %
DAMAGE THRESHOLDS			
Maximum Average Power Density	100 W/cm^2	100 W/cm^2	100 W/cm^2
Saturation Level	30 mW/cm2 @ 1064 nm	55 mW/cm2 @ 532 nm	320 mW/cm2 @ 1064 nm
PHYSICAL CHARACTERISTICS			
Effective Aperture Diameter	11.28 mm Ø	11.28 mm Ø	5 mm Ø
Dimensions	36 mm Ø x 26.5D mm	36 mm Ø x 26.5D mm	36 mm Ø x 26.5D mm
Weight (head only)	130 g	130 g	130 g

CHAPTER 1 TEST-MEASUREMENT

ECONOMIC POWER METER

Laser Power

FEATURES

- Provides digital output of four ranges of measurements to 20 mW
- Certified within 2% for each range at 632.8 nm; 10% for other wavelengths
- Zero offset to compensate for ambient light
- Provides a peak reading mode
- Detachable detector head for mounting on a ringstand or optical bench
- Coax connector on front panel for connecting meter output to oscilloscope, chart recorder or personal computer
- Has a ratiometric mode in 100% offset control; displays readings directly in percent
- Dual powered (AC or with two 9V batteries for portability)
- Calibration service available

45-545

This instrument provides the accuracy required for research applications and CDRH compliance measurements. It is designed with an LCD display with large 12 mm high numerals. Its four ranges have full-scale readings covering the range from 19.99μW 199.99mW, and 19.99 mW. Calibration is within 2% of full scale at the 632.8 nm He-Ne wavelength. For monochromatic light of other wavelengths within the 430-950 nm wavelength range, a built in radiometric filter provides accuracy to ±10% of they standard Each meter is calibrated by Onset's Quality Control Department , who attach a Certificate if Accuracy to the meter housing. This certificate lists both the meter's reading and the standard for test points on each of the four scales.

A unique feature of the 45-545 is the peak reading mode. This feature is invaluable when measuring scanned on transient laser beams.

FIBER OPTIC TEST SET
LOW COST POF LIGHT SOURCE AND OPTICAL POWER METER

A versatile and rugged fiber optic low-cost integrated test instrument specifically designed for use with plastic optical fiber. It features capabilities for:

- Performing fiber continuity checks
- Measuring fiber output power
- Calibrating and screening detectors
- Measuring LED power
- Measuring fiber attenuation

The Fiber Optic Test Set uses a silicon photodetector to measure optical power, which is calibrated at the two most commonly used wavelengths in plastic fiber 660 (red) and 850 (infrared) nanometers. Optical power upon the photodetector is displayed in an easy-to-read 3-1/2 LCD display that can be set in four different power ranges: 20 µW, 200 µW, 2 mW and 20 mW. The test set includes a 660 nm LED for fiber attenuation measurements, activated by a separate switch with automatic turn-off circuitry to save battery life. The detector and LED are both housed in industry-standard ST® female input connectors. The connectors permit measurements with any plastic fiber in an ST® male connector or connector-less fiber with an outer diameter of 2.5 mm or less. This meter is inexpensive enough for classroom budgets, yet offers the range, features and durability required for industrial applications.

CHAPTER 1 TEST-MEASUREMENT

VERSATILE POSITION SENSING AMPLIFIER

For: Duolateral, Teralateral, Quad One Dimensional, BiCell

FEATURES

- X,Y Analog Position Output Voltages Sum Output
- Wide Dynamic Range: 0.1 µA to 1.5mA DC to 15kHz
- CompatibleWith All Position Sensing Detectors
- Zero Offset/Nulling
- Calibration Adjust
- Automatic Detector Bias
- Position Independent of Beam Intensity

OT-301 Position Sensing Amplifier. Plug-And-play Convenience And Precision

The OT-301 Position Sensing Amplifier is the easiest, most precise way to process the current output from any position sensing detector (PSD) on the market.

PLUG-AND-PLAY... OUT OF THE BOX.

Truly plug-and-play, the OT-301 eliminates the hassle of having to design and build a custom amplification solution. Simply plug in the detector, switch on the power, and you're ready to go.

The benefit is greater convenience, efficiency and productivity... plus 100% compatibility with your future position sensing needs. The OT-301 pays for itself in
no time.

ANY APPLICATION... ANY DETECTOR.

From laser beam alignment, to beam centering, to mirror stabilization, the OT-301 is ideal for one- and two-dimensional absolute optical positioning or precision centering and nulling requirements.Read the X-Y position output and SUM output from duolateral, tetralateral, single axis, quadrant and bi-cell PSDs.

FOUR TRANSIMPEDANCE AMPLIFIERS.

Four transimpedance amplifier channels and precision signal processing electronics deliver the performance necessary for close-tolerance angle, surface uniformity, flatness, parallelism and straightness measurement.

X,Y ANALOG OUTPUT THAT'S DIRECTLY

ProportionalTo Beam Position The photocurrent generated from the position sensing detector is processed by the four-channel amplifier system using a position sensing algorithm. The result is X and Y analog outputs that are directly proportional to beam position—independent of changes in beam intensity.

SIX GAIN SETTINGS: 0.1UA TO1.5MA.

Six gain settings accommodate input current ranges from 0.1 uA to 1.5 mA with a frequency response to 15 kHz. A convenient ZERO adjust enables you to electronically move the zero to a relative position on the PSD. A CAL adjust allows calibration to absolute position.

FRONT PANEL

Gain: Transimpedance gain 4x103 V/A to 4x106 V/A Input current range 0.1uA to 1.5mA.

H: Input optical power exceeds range selected.

L: Input optical power lower than range selected. Set range switch at a position where both H/L indicators are off.

On: Power on Indicator.

X,YCal: Gain potentiometers to allow calibration of voltage output in terms of displacement (+ 10% of reading).

X,Y ZERO: Enables the user to electronically move the zero to a relative position on the PSD (+ 1V each axis).

PSD: DB9 Position Sensing Detector Input.

BACK PANEL

X Out: Normalized X axis output (+ 10V).

Y Out: Normalized Y axis output (+ 10V).

Sum: Total amplified detector output proportional to light intensity (0-6V).

CAL/ZERO: CAL/ZERO “ON” allows use of the X, Y, Zero and X, Y CAL features. CAL/ZERO “OFF” disables these features.

ON/OFF: Power ON/OFF.

Power: 12V DC 300mA AC adapter.

OT301 SPECIFICATIONS

Transimpedance Gain (V/A)	4x103 to 4 x106			
Input Current Range	0.1 µA to 1.5 mA			
Output Voltage				
Position X,Y	±10V			
Sum	0 - 10V			
Zero Offset (Offset Null)	±1V Each Axis			
Calibration Adjust	±10% of reading			
Detector Bias	0V + 5V (depending on detector)			
Linearity	±0.1%			
Frequency Response	DC to 15 kHz (range dependent)			
Gain-Bandwidth	G1	4 x103V/A	2.50 x10-4A/V	15 kHz
	G2	1.6 x104V/A	6.25 x10-5A/V	15 kHz
	G3	6.4 x104V/A	1.56 x10-5 A/V	5 kHz
	G4	2.56 x105V/A	3.90 x10-6A/V	1.25 kHz
	G5	1.024 x106V/A	9.77 x10-7 A/V	310 Hz
	G6	4 x106V/A	2.50 x10-7 A/V	80 Hz
Output Connectors	BNC			
Input Connector	9 Pin D Sub (DB9)			
Power Requirement	± 12V DC @ 300mA (AC Adapter)			
Dimensions	1.5 x5.5 x 6.00 inches (H xWxD)			

DISPLAY MODULE FOR POSITION SENSING AMPLIFIER

FEATURES

- LCD Display of Absolute Position
- LCD Backlight
- X,Y Position and Sum Display
- Metric (mm)or English (in)
- RS-232 Interface
- Push Button Zero Offset
- Computer Controlled or Stand Alone
- Front Panel Push Button Control
- High Resolution 0.1 Micron (0.0001")
- Display Update Control 0.1 to 25.5 Second Update Speed
- Calibration Features for all Size Detectors
- Fast/Slow Averaging

OT-302D DisplayModule.Comprehensive Data DisplayAndAnalysis.

The OT-302D Display Module brings a new level of ease and sophistication to display and analysis of position sensing data collected from the OT-301 Position Sensing Amplifier.
Utilize the module in three ways: as a standalone readout system, in tandem with BeamTrak data processing software (included), or with user-programmable routines via RS-232 communication.

STAND ALONE READOUT.

The OT-302D is an ideal stand alone display. The simple two-button front panel allows you to quickly set-up the OT-302D for your individual measurement applications. Press both buttons simultaneously to enter the configuration mode. Select the size of your position sensing detector, measurement units, and display update speed. Press the FAST / SLOW button to exit. The OT-302D is ready to displayposition data.

BEAMTRAK DISPLAY AND ANALYSIS SOFTWARE.

Complimentary BeamTrak software makes it easy to collect, display and analyze data from the OT-302D on your IBM PC compatible computer. Featuring a full toolset of “must have” functions from automatic data logging and history trace, to data averaging and autoscale — you’ll be up and running in no time.

RS-232 COMMUNICATION CONTROL.

All OT-302D commands are available through the RS-232 port — ideal for users writing custom application-specific programs. Address the OT-302D via the RS- 232 comm port with the following settings: 9600 Baud Rate, 8 Bits, 1 Stop Bit, No Parity.

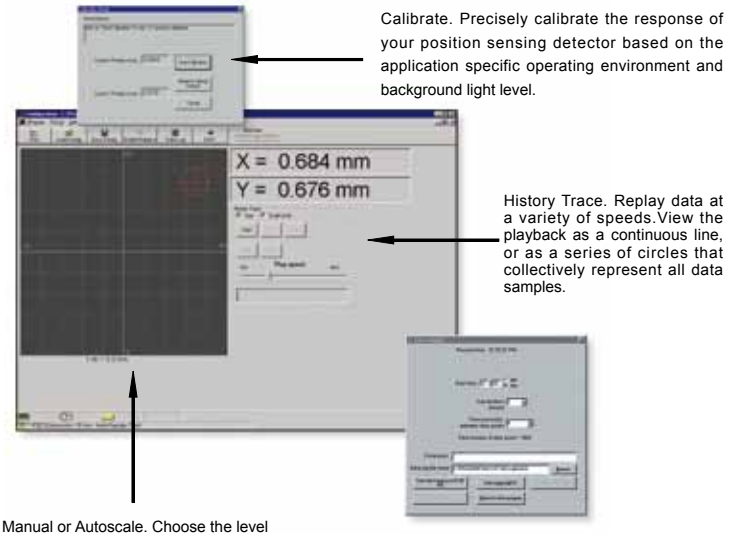
ABSOLUTE POSITION—MM AND INCHES.

The OT-302D’s microprocessor-controlled module takes analog output voltage from the position sensing amplifier and converts it into absolute position — millimeters or inches. X/Y position and SUM output is simultaneously displayed on the backlit LCD to a resolution of 0.1 um (0.0001 inches).

BEAMTRAK SOFTWARE

IBM-PC compatible OT-302D BeamTrak Software is included at no extra charge—making it easy to collect, store and process data. This Windows-based program will have you up-and-running in minutes.

- Data Log. Automatically collect data points every two to 120 seconds for up to a 48 hour period. Then im port all data into your favorite spreadsheet program for comprehensive display and analysis.
- Calibrate. Precisely calibrate the response of your po sition sensing detector based on the application spe cific operating environment and background light level.
- History Trace. Replay data at a variety of speeds. View each playback as a continuous line, or a series of circles representing all data samples.
- Manual Or Auto Scale. Choose the level of fixed view ing resolution, or allow the software to autoscale for you.
- Axis Orientation. Reverse the orientation of the X and Y coordinates.
- Enable Relative. Set the current position to zero.



Calibrate. Precisely calibrate the response of your position sensing detector based on the application specific operating environment and background light level.

History Trace. Replay data at a variety of speeds.View the playback as a continuous line, or as a series of circles that collectively represent all data samples.

Manual or Autoscale. Choose the level of fixed viewing resolution, or allow the software to autoscale for you.

Data Log. Automatically collect data points every two to 120 seconds for up to a 48 hour period. Then import all data into your favorite spreadsheet program for comprehensive display and analysis.

RS-232 SOFTWARE CONTROL FUNCTIONS

The OT-302D is compatible with the complete range of On-Trak position sensing amplifiers. This microprocessor-controlled module takes analog output voltage from the position sensing amplifier and converts it into absolute position in both millimeters or inches. X/Y position output and SUM output is simultaneously displayed on the backlit LCD.

The OT-302D features RS232 communication to set metric or English position, scale factors for different size detectors, display update speeds and many more functions. The RS232 has a continuous or on demand position update for data logging and control.

The OT-302D Display Module can be controlled through the RS232 comm port with the following settings: 9600 Baud Rate, 8 Bits, 1 Stop Bit, No Parity.

a = average value in 1/10 second intervals
d = default selection (for multidrop)
e = echo on/off (echoes commands)
f = fast/slow averaging
h = help display commands
i = assigns ID number
j = X offset adjust
k = Y offset adjust
l = sensor length in mm
m = metric or English
n = sum offset adjust

o = sets current value to zero
p = data scroll
q = quiet mode
r = return position value
s = unit select
v = version and status display
w = write to eeprom
x = gain calibration X
y = gain calibration Y
z = gain calibration SUM

OT-302D Specifications	
Input Voltage Range	X, Y and Sum: 0 to + 10V
Update Speed	0.1 sec to 25.5 sec
Power Supply	12V DC 500mA wall adapter
Size	2.5 x 5.5 x 6.5 inches (H x W x D)
RS-232	9600 baud rate, 8 bits, 1 stop bit, no parity
Weight	1 lb. 10 oz.
Display Resolution	0.0001 inch (0.0001 mm)

CHAPTER 1 TEST-MEASUREMENT

OEM POSITION SENSING AMPLIFIER

OT301SL For Single Axis Position Sensing Detectors

FEATURES

- Detector Type: Single Axis PSD
- Analog Position OutputVoltage
- SumOutput
- Wide Dynamic Range — Three Decades 103V/A, 104V/A, 105V/A
- DC to 15kHz
- Calibration Adjust
- Zero Offset Adjust
- Automatic Detector Bias
- Position Independent of Beam Intensity

OT301DL For Duolateral Position Sensing Detectors

FEATURES

- Duolateral PSD
- X,Y Analog Position OutputVoltage
- SumOutput
- Wide Dynamic Range —Three Decades 103V/A, 104V/A, 105V/A
- DC to 15kHz
- Calibration Adjust X, Y
- Zero Offset Adjust X, Y
- Automatic Detector Bias
- Position Independent of Beam Intensity

SPECIFICATION	
Input Sensitivity	10^{-3}A/V, 10^{-4}A/V, 10^{-5}A/V
X,YOutput Signals	0V to ±10V
Sum Output Signal	10V max
Calibration Adjust	±10% of reading
X,Y Zero (offset)	±1.0V
BiasVoltage	0V or ±5V(OT301DL) 0V or ±5V or ±12V(OT301SL)
Linearity	±0.1%
Channel to Channel Tracking	1%
Power AC Adapter	±12V DC @ 500mA
Size	3.5 x 5.0 inches
Input Connector	Receptacle DB9
Output/Power Connector	Dual Row 10 PIN Header

POSITION SENSING DETECTORS THEORY OF OPERATION

DESCRIPTION

Position Sensing Detectors “PSD’s” are silicon photodiodes that provide an analog output directly proportional to the position of a light spot on the detector active area. The PSD allows you to simultaneously monitor position and light intensity. The PSD is a continuous analog position sensor. Compared to discrete element devices, the PSD offers outstanding position linearity, high analog resolution, fast response time, and simple operating circuits.

THEORY OF OPERATION

A Position Sensing Detector consists of n-type silicon substrate with two resistive layers separated by a p-n junction. The front side has an ion implanted p-type resistive layer with two contacts at opposite ends.

The back side has an ion implanted n-type resistive layer with two contacts at opposite ends placed orthogonally to the contacts on the front side. On a single axis PSD, the electrodes are placed at opposite ends of the p-type resistive layer. A light spot within the spectral range of silicon will generate a photocurrent that flows from the incident point through the resistive layers to the electrodes. The resistivity of the ion implanted layer is extremely uniform so the photogenerated current at each electrode is inversely proportional to the distance between the incident spot of light and electrodes. The PSD outputs track the motion of the “centroid of power density” to an extremely high resolution and ultra-high linearity. On-Trak Position Sensing Amplifiers take the photocurrent from each electrode and process the signals to provide X, Y outputs independent of light intensity.

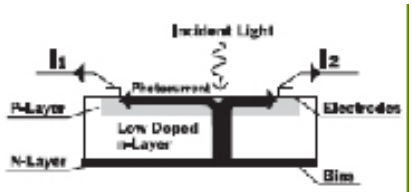
POSITION RESOLUTION

The position resolution of a PSD is the minimum detectable displacement of a spot of light on the detector surface. The position resolution of On-Trak PSDs are proven better than one part in a million. Resolution dependent on:

- Detector Size
- Detector Noise
- Light Input Intensity
- Bandwidth of the Electronic Signal Processing Circuits

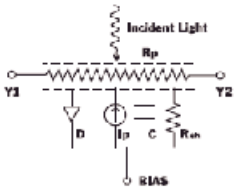
POSITION LINEARITY

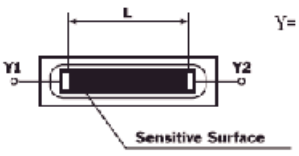
Position non-linearity is defined as geometric position error divided by detector length and is measured within 80% of the detector length. Position non-linearity is typically better than 0.05% for the single axis PSD and better than 0.3% for the duolateral. The On-Trak vs competitor two-dimensional linearity plot shows the ultra linear characteristic of these PSDs.



ONE-DIMENSIONAL PSD

The one-dimensional PSD detects a light spot moving over its surface in a single direction. The photoelectric current generated by the incident light flows through the device and is seen as an input bias current divided into two output currents. The distribution of the output currents show the light position on the detector.

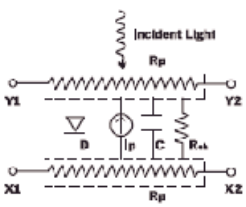


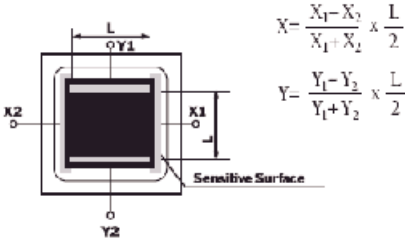


Ip = Photocurrent generated by incident light
D = Ideal diode, PN junction of PSD
C = Junction capacitance
Rsh= Shunt resistance
Rp = Position resistance

DUOLATERAL TWO-DIMENSIONAL PSD

The duolateral two-dimensional PSD detects an incident light spot position on its square surface. The photoelectric current generated by the incident light flows through the device and is seen as two input currents and two output currents. The distribution of the output currents show the light position of one dimension (Y), and the distribution of the input currents show the light position of the second dimension (X).

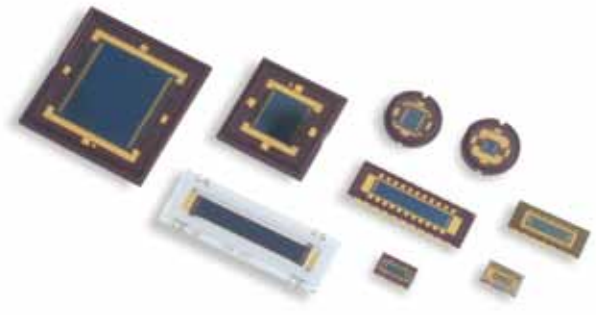




CHAPTER 1 TEST-MEASUREMENT

POSITION SENSING DETECTORS

For Non-Contact Measurement Of Position,Motion, Distance And Vibration



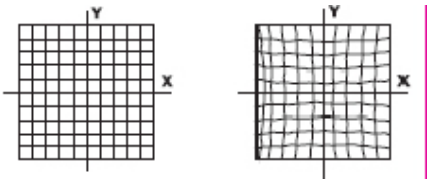
FEATURES

- Superior Linearity—Better Than 99.95% Over 80% of ActiveArea
- Proven Analog Resolution Better
- Than 1 Part Per Million
- Low Thermal Drift, Less Than
- 40 ppm/°C
- Fast Response Time
- Simultaneous Position and
- Intensity Measurement
- Wide Spectral Range
- Independent of Light Spot Size

Model	Active Area mm	Responsivity @ 940 nm A/W	Dark Current nA		Noise Current pA/Hz1/2		Capacitance pF@15V		Rise Time µs 10-90% 15V	
			Typ.	Max	Typ.	Max	Typ.	Max	Typ.	Max
One Dimensional PSD Series										
1L2.5SP	2.5 x 0.6	0.63	2	10	0.4	1.0	1.6	2.0	.03	.05
1L5SP	5.0 x 1.0	0.63	4	20	0.4	1.0	5	6	.05	.08
1L10	10.0 x 2.0	0.63	8	50	0.4	1.0	15	20	.20	.40
1L20	20.0 x 3.0	0.63	50	250	0.5	1.0	45	55	.50	1.0
1L30	30.0 x 4.0	0.63	150	1000	0.5	1.0	90	110	1.0	1.8
One Dimensional PSD SeriesWith Stray Light Elimination										
1L5NT	5.0 x 0.25	0.63	4	20	0.3	0.6	5	6	.25	.40
1L10NT	10.0 x 0.5	0.63	8	50	0.3	0.6	15	20	0.7	1.4
Two Dimensional PSD Series—Duolateral										
2L2SP	2.0 x 2.0	0.63	50	200	1.3	2.5	7	8	.03	0.6
2L4SP	4.0 x 4.0	0.63	50	200	1.3	2.5	20	25	.08	.16
2L10SP	10.0 x 10.0	0.63	100	500	1.3	2.5	90	110	.40	.80
2L20SP	20.0 x 20.0	0.63	200	2000	1.5	3.5	360	430	1.6	3.0

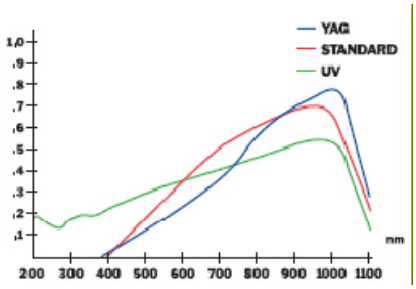
PSD GENERAL DESCRIPTION

We offers a broad range of Position Sensing Detectors (PSD) that enable you to simultaneously monitor position and light intensity.
Ideal for non-contact measurement of position, motion, distance and vibration, all devices are silicon-based detectors that provide an analog output directly proportional to the position of a light spot on the detector's active area.
The continuous analog-output of silicon-based detectors provides numerous advantages over discrete element devices. These advantages include superior position linearity, unsurpassed analog resolution, faster response time and simpler operating circuits.
For more information on Position Sensing Detectors, and how they can benefit your particular application, please call us.



On-Trak Duolateral PSD Linearity (typical)

Competitor PSD PSD Linearity (typical)



Reverse Bias V			Detector Resistance (kΩ)			Thermal Drift ppm/C°		Position Non-Linearity ±%	
Min	Typ.	Max	Min	Typ.	Max	Typ.	Max	Typ.	Max
5	15	20	40	50	80	20	100	0.1	0.2
5	15	20	40	50	80	20	100	0.1	0.2
5	15	20	40	50	80	20	100	0.1	0.2
5	15	20	40	50	80	20	100	0.1	0.2
5	15	20	40	50	80	20	100	0.1	0.2
5	15	20	160	200	300	20	100	0.1	0.2
5	15	20	160	200	300	20	100	0.1	0.2
5	15	20	7	10	16	40	200	0.3	1.0
5	15	20	7	10	16	40	200	0.3	0.8
5	15	20	7	10	16	40	200	0.3	0.8
5	15	20	7	10	16	40	200	0.3	0.8

CHAPTER 1 TEST-MEASUREMENT

POSITION SENSING MODULES

For Non-Contact Measurement Of: Position,Motion, Distance And Vibration

FEATURES

- Fully Packaged Position Sensing Detectors
- Silicon Linear: 400-1100 nm
  Silicon Duolateral: 400-1100 nm
  Silicon Quadrant: 400-1100 nm
  GermaniumTetra-Lateral: 800-1800 nm
- Removable Filter Holder Adapter
- Standard Mounting Holes
- Plug and Play Compatibility with all the
- Position Sensing Amplifiers(see page 8-20)

PSM Series Position Sensing Modules. Plug-And-Play Precision

Position Sensing Modules are fully packaged position sensing detectors that, when used with an On-Trak position sensing amplifier, provide an analog output directly proportional to the position of a light spot on the detector active area.
Yet, what truly sets them apart is heir proprietary, plug-and-play design. Never has position sensing been so convenient...or accurate.

FINALLY,APLUG-AND-PLAY SOLUTION.

No more hassling with breadboards, soldering, cutting and wiring. Instead, all Positron Sensing Modules (PSMs) incorporate a subminiature 9-pin connector that plugs directly into any Position Sensing Amplifier.
Just plug it in and go. It's that simple

SINGLE, DUOLATERAL, QUADRANT.

Select from several distinct configurations; each module contains a linear, duolateral, tetralateral, or quadrant position sensing detector. All modules are conveniently packaged to allow simultaneous monitoring of position and light intensity. Position Sensing Modules come in two package sizes: Standard and Compact. The standard measures 2.8" x 2.45" x 1.125". The ompact measures 1.25" x 1.25" x 0.975".

FILTERS AND FILTER HOLDER ADAPTERS.

Harsh ambient lighting conditions? No problem. Each module readily accepts a complete range of optional filters toreduce the effect of noise caused by ambient light. Moreover, a filter holder is included with each module at no extra cost.

STANDARD MOUNTING HOLES.

All PSMs feature standard mounting holes for easy mounting with your existing lab equipment. Whether your post and stands are 1/4 -20 or 8/32, you'll be up and running in a matter of minutes.

Robust Aluminum Housings.
The Position Sensing Modules are encased in rugged aluminum housings to protect your investment.

PSM SPECIFICATIONS

Model	Active Area (mm)	Detector Type	Wavelength Range	Package Type	Typ. Resolution	Typ. Linearity
PSM 1-2.5	2.5 x 0.6	Linear Silicon	400-1100 nm	Compact	62.5 nm	0.1%
PSM 1-5	5.0 x 1.0	Linear Silicon	400-1100 nm	Compact	125 nm	0.1%
PSM 1-10	10.0 x 2.0	Linear Silicon	400-1100 nm	Standard	250 nm	0.1%
PSM 1-20	20.0 x 3.0	Linear Silicon	400-1100 nm	Standard	500 nm	0.1%
PSM 1-30	30.0 x 4.0	Linear Silicon	400-1100 nm	Standard	750 nm	0.1%
PSM 2-2	2.0 x 2.0	Duolateral Silicon	400-1100 nm	Compact	50 nm	0.3%
PSM 2-4	4.0 x 4.0	Duolateral Silicon	400-1100 nm	Compact	100 nm	0.3%
PSM 2-4Q	4.0 x 4.0	Quadrant Silicon	400-1100 nm	Compact	100 nm	N/A*
PSM 2-5G	5.0 x 5.0	Pincushion Tetralateral Germanium	800-1800 nm	Compact	5 um	—
PSM 2-10	10.0 x 10.0	Duolateral Silicon	400-1100 nm	Standard	250 nm	0.3%
PSM 2-10Q	9.0 x 9.0	Quadrant Silicon	400-1100 nm	Standard	100 nm	N/A*
PSM 2-10G	10.0 x 10.0	Pincushion Tetralateral Germanium	800-1800 nm	Standard	5 um	—
PSM 2-20	20.0 x 20.0	Duolateral Silicon	400-1100 nm	Standard	500 nm	0.3%
PSM 2-45	45.0 x 45.0	Duolateral Silicon	400-1100 nm	Standard	1.25 um	0.3%

PSM ACCESSORIES

Model	Description
F12.5-632.2	12.5 mm optical filter. 632.8 nm, +2.0/-0 nm. FWHM 10 + 2 nm. 50% transmittance
F25-632.8	25 mm optical filter. 632.8 nm, +2.0/-0 nm. FWHM 10 + 2 nm. 50% transmittance
F12.5-635	12.5 mm optical filter. 635 nm, +5.0/-0 nm. FWHM 10 + 2 nm. 50% transmittance
F25-635	25 mm optical filter. 635 nm, +5.0/-0 nm. FWHM 10 + 2 nm. 50% transmittance
F12.5-670	12.5 mm optical filter. 670 nm, +3.0/-0 nm. FWHM 10 + 2 nm. 50% transmittance
F25-670	25 mm optical filter. 670 nm, +3.0/-0 nm. FWHM 10 + 2 nm. 50% transmittance
F12.5-HA	12.5 mm Blank Filter Holder Adapter
F25-HA	25 mm Blank Filter Holder Adapter
CA-DB9MM-5	5 foot molded cable. DB9 connector
CA-SC10FR-3	3 foot ribbon cable. 10 pin socket connector. Unterminated
PS-3	Post and Stand

CHAPTER 1 TEST-MEASUREMENT

LASER ALIGNMENT SYSTEM

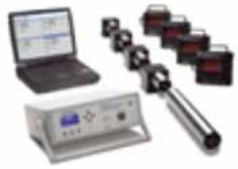
Line Laser Systems

OT-4040 SERIES

The OT-4040 Series Portable Laser Alignment System replaces conventional optical methods with the ultra precision of laser alignment. Use our OT-4040 Laser Alignment System to achieve 0.001” accuracy for shots up to 300 feet.

OT-6000 SERIES

The OT-6000 LL Ultralign Laser Alignment System is optimized for computerized precision laser alignment. Up to 7 targets may be used in one alignment path and monitored via IBM PC software to 0.001" over distances of 300 feet.



OT-7000 SERIES

On-Trak Photonics’ OT-7000 Laser Alignment System provides an autocentering and wireless solution for performing real-time measurement of multiple targets along a single reference laser line. The OT-7000 provides 0.001” resolution at distances up to 300 feet.

Rotating Laser Systems

OT-2020 SERIES

The OT-2020 Rotating Laser Target System, in tandem with a rotating laser, provides the fastest, most accurate way to measure flatness, squareness and straightness with a resolution up to 0.001” at distances up to 100 feet. Battery operated for maximum field portability.

OT-5000 SERIES

The OT-5000 Rotating Laser Alignment Target is designed to be used in a multi-drop loop of up to 20 targets. The OT-5000 RLT measures a laser rotating plane of laser light to 0.001” over distances of 100 feet.

CHAPTER 1 TEST-MEASUREMENT

POLARIMETER

PAX5710VIS-T
(Cables and Laptop Included)

PAX5700 APPLICATIONS

- Free Space and In-Fiber Polarimetry
- DOP Measurements
- ER Measurements on PMF
- Polarimeter Unit for the PMD5000 System
- Basic Unit for Jones and Mueller Matrix
- Measurements

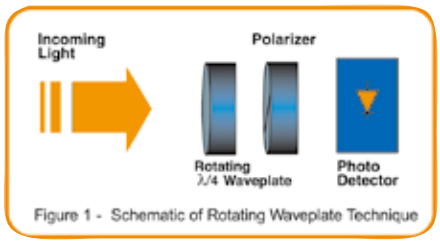
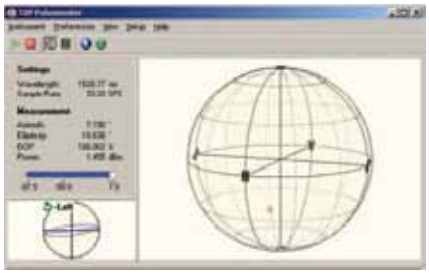


Figure 1 - Schematic of Rotating Waveplate Technique



The PAX5700 series polarimeter system was designed for different applications ranging from classic polarization measurements to complex tasks like evaluating optical components with the Jones or Mueller matrix algorithm. It is also well suited for determining the Extinction Ratio (ER) of polarization maintaining fibers (PMF) and alignment of PMF to laser modules.

The optical unit of a PAX5700 measurement sensor consists of a rotating quarter waveplate, a fixed polarizer and a photodiode (see Figure 1). The waveplate transforms the input polarization depending on the actual rotating angle. The polarizer only transmits the portion of light which is parallel to the transmission axis. So the polarization modulation is converted into an amplitude modulation. The photo detector supplies a current that is proportional to the optical power. A Fourier transformation is used to accurately calculate both the state of polarization (SOP) as well as the degree of polarization (DOP).

SOP and DOP Measurements

The PAX5700 analyzes the state of polarization and the degree of polarization of optical signals in either free space or in optical fibers. The resulting data can be viewed using the Graphical User Interface which is supplied with each PAX unit. The state of the input polarization is completely characterized by different representations. As can be seen in Figure 2, the polarization data is presented in a number of forms, on the Poincaré sphere, as Stokes parameters or as a polarization ellipse with the handedness noted. Additionally, the degree of polarization and the total optical power are also provided.

The modular design combined with the variety of models makes the PAX system an ideal tool for various types of polarization related measurement tasks in R&D laboratories, as well as for final inspection in manufacturing. The PAX5700 Series can be used for free space and fiber based applications covering the wavelength range of 400nm to 1700nm. See the following page for ordering information.

The PAX5710 consists of a TXP compatible card and an external polarization measurement sensor. The PAN5710 external measurement sensor facilitates polarization analysis in free space setups. It can easily be mounted to optical benches using the M4 or #8-32 mounting holes provided in the bottom of the head. It is also compatible with our extensive line of 30mm cage system components. The optical light field to be measured should enter the aperture of the sensor nearly perpendicular to the front panel. The beam diameter should be below 3mm to guarantee that all the light reaches the detector. All sensors are supplied with a fiber collimator for FC/PC optical cables to allow polarization measurements on fiber based systems, or you may choose to use the PAX5720, which is dedicated to fiber based measurements.

APPLICATION IDEA

External PAX – Sensor Heads

Posts, Cage Components
& Optics sold separately.

- High Dynamic Range
- Rotating Waveplate Based
- Four Wavelength Ranges
- Free Space & In-Fiber Polarimetry

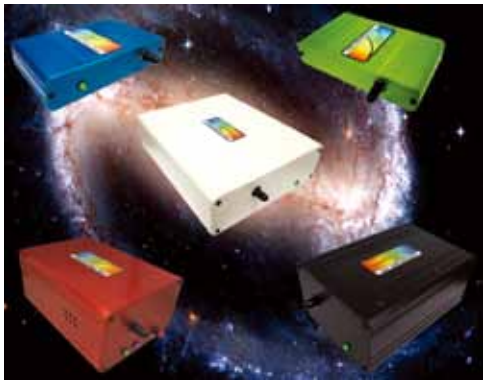
Item #	PAX5710VIS & PAX5720VIS	PAX5710IR1 & PAX5720IR1	PAX5710IR2 & PAX5720IR2	PAX5710IR3 & PAX5720IR3
Optical Parameters				
Wavelength Range	400 - 700 nm	700 - 1000 nm	1000 - 1350 nm	1300 - 1700 nm
Maximum Measurement Rate	333 S/s			
SOP Accuracy	±0.25° on Poincaré Sphere			
SOP Resolution	0.01° on Poincaré Sphere			
DOP Accuracy	±0.5%			
DOP Resolution	0.0001			
Dynamic Range	-60 to 10 dBm			
Free Space Aperture	Ø3 mm			
General Technical Data				
Operating Temperature Range	5 to 40 °C			
Storage Temperature Range	-40 to 70 °C			
Width	1 TXP slot (PAN5710xxx), 2 TXP slots (PAN5720xxx)			
Optical Input Connector	FC/PC			
Warm Up Time for Rated Accuracy	<15 min			
Analog Interface				
(via Front Panel D-Sub)	5 Analog Outputs: s1, s2, s3, DOP, Power			
1 Analog Input: Trigger				
Digital Interface	s1, s2, s3, Power (Watt/dBm), DOP, Azimuth, Ellipticity			
Analog Monitor Output	-2.5 to 2.5 V			

(All data are valid at 23 ±5°C and 45 ± 15% relative humidity)

CHAPTER 1 TEST-MEASUREMENT

INTRODUCTION TO PORTABLE SPECTRONETER

Fiber Optic Spectrometer Introduction



Onset provides a full line spectrometers which are miniature fiber optic instruments for UV, VIS, and NIR measurements in 190-2300nm ranges. Each unit contains a 2048 wavelength scan memory and can provide quick 4ms spectral data from a highly sensitive CCD or Photo Diode Array detector (14x200um pixels). Various models provide a choice of optical range and resolution and connect directly to a PCÕs EPP printer port eliminating the need for a separate 500 KHz A/D converter. A single strand fiber or probe assembly is input via standard SMA 905 fiber optic connector. Measure sample color, source irradiance or chemical concentrations. Perform emission spectrum analysis or material optical characterizations. The units are designed to be vibration tolerant with no moving parts or detector socket and are suitable for portable and industrial process applications or QC test and analysis. Up to 8 units may be daisychained on a single cable allowing simple configurations for dual and multi-beam process applications.

Options are available for various detector types, permanently installing a slit and/or order sorting filters. These units make ideal OEM components for application specific instrumentation designed for process control and/or QC monitoring. The Win95/98/NT based SpectraWiz¨ operating software is included for display of spectral data in real time for absorbance, transmittance, reflectance, irradiance, fluorescence, and emissions such as plasma and Raman scattering. Support services are readily available for custom application development. StellarNet has experts in the design & development of process control systems, Neural networks and PLS based concentration predicting applications, in addition to Color QC and CIELAB tolerancing.

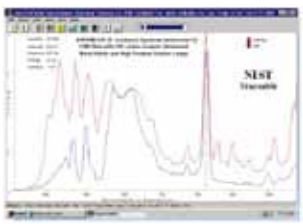
Measurement of absorbance allows determination of liquid sample concentration according to BeerÕs law for a specific path length. StellarNet offers both low cost, and ÒIndustrial StrengthÓ dip probes, flow cells and other sampling accessories. Transmission or reflectance measurements can be easily made for many different production samples. A few examples are the QC of optics such as sunglasses, filters, and thinilm coatings. Color is easily measured with our fiber optic reflectance or dip probes and then converted to CIELAB color values L*a*b* for both solid and fluid samples. Emission wavelength measurements for peak and centroid can be made for laser diodes, and light emitting diodes. These robust spectrometers can integrate for up to 60 seconds to detect fluorescence emitted by chemical reagents and fiber optic chemical sensors. This also includes Raman scattering which is induced by a laser beam focused on a sample. Our spectroradiometer measures irradiant Watts per square meter (or Moles/second with PAR) and illuminant Lux (Lumen/sq meter) and Footcandles.

SOPECTRAWIZ™ SOFTWARE

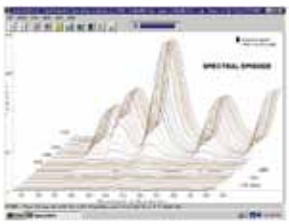
FEATURES

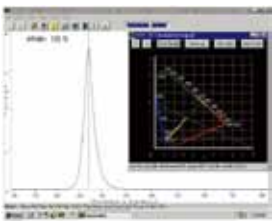
- Real-time Spectral Graphing and Instrument control with Data Save and Multi-File Plot
- Measure Spectral Absorbance, Transmittance, reflectance, Irradiance, and various Emissions
- Spectroradiometer App Measures Irradiant power Watts & Lux, and color of light, its Chromaticity
- Spectrocolorimeter App Measures CIELAB Color values and Detects Color Differences in Real-time
- ChemWizÚ Measures Concentrations via Methods

The SpectraWiz. operating software for most windowOS is included with the miniature fiber optic spectrometer systems. This includes all portable spectrometers. Measurement of absorbance allows the determination of sample concentration according to BeerÕs law for a specific path length and wavelength, according to established methods. Transmittance measurements are used to characterize optical materials such as glass and special filters. For solid samples, reflectance is also used to characterize materials and provide basic colorimetric information. The Spectrocolorimeter app converts this to CIELAB color values L* a* b* for both solid and liquid samples. Color differences between a sample and a pre-saved color standard are easily measured using the CIELAB Delta E* value indicator. With toolbar functions, emission measurement of peak, centroid, and area can be easily made for plasma, laser, LEDs, and fluorescence from chemical reagents, laser induced spectroscopy, and fiber optic chemical sensors. A SpectroRadiometer app measures irradiance in watts per meter^2 (per nanometer) or moles per meter^2 per second with integral PAR value. Illuminance is measured in lumen per meter^2 with LUX, mcd (/sr), and footcandles over 400-700nm. The CIE Color app displays 1931 xy chromaticity diagram with dominant wave & purity to measure colors of LEDs and lighting.

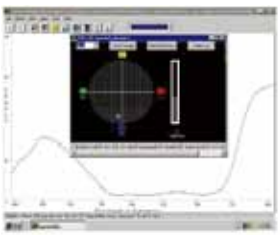


Spectral Time Series Analysis





SpectroRadiometry & LED xy Chromaticity



CIELAB SpectroColorimetry

Spectroscopy measurement applications are integrated into a single program to measure absorbance AU, %T, Concentrations, Reflectance, Colors, Fluorescence, Emissions, Absolute Intensities (watts, lumens, lux, moles), LED & Light xy Chromaticity, UVabc emission monitor (not shown). Optical Trigger, Graphing, Time series, and Multi-Channel features. Includes driver & examples for LabView, VC, VB, VBA, & Delphi.

StellarNET BLACK-COMET CONCAVE GRATING SPECTROMETERS FOR UV-VIS & NIR

Need a low cost spectrometer with research grade performance in a small ruggedized package ??

Each Comet spectrometer has fiber optic input and high speed USB-2 output to PC. The instruments are exceptionally robust with no moving

parts and are packaged in a small metal enclosure (2.75 x4 x6 inch) for a variety of spectroscopy measurements in the field, lab, process lines, or factory QC areas.

Two models for UV-VIS (190-850nm or 280-900nm), and two Super Range models (200-1080nm or 220-1100nm).

The Comet spectrometers utilize a 40mm diameter concave grating with aberration correction to provide superb spectral imaging. This significantly improves spectral shapes by reducing comma and astigmatism found in plane grating spectrograph designs. The flat field spectrograph architecture does not utilize mirrors and therefore provides the lowest possible stray light in the UV with a holographic grating.

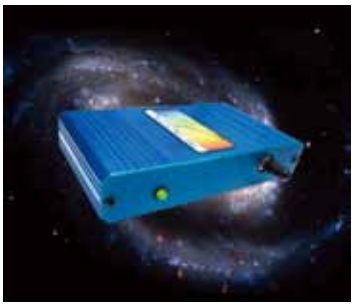
A multi-band filter is integrated into the spectrograph to provide order sorting and prevent optical aliasing. The instruments optical input is a standard SMA-905 connector, using single strand fiber optic cable with typical silica core diameters of_ 400/600/ and_1000um.

The SpectraWiz software is included free to accurately measure emissions, reflectance, transmission, absorption, fluorescence, concentrations, & absolute intensities for SpectroRadiometry. TEC cooling is optional.

Specifications	C-SR=200-1080 CXR-SR=220-1100		
Dynamic range:	2000:1 with 6 decades	Dimensions:	69 x 100 x 150 mm
Optical resolution:	25um slit<1nm, SR<1.5nm Power	consumption:	100 mA @ 5 VDC
Detector type:	2048 pixel CCD	Interface:	USB-2 cable
Pixel size:	14um wide x 200um tall	Digitizer:	14/16-bit @2.5MHz rate
Standard UV-VIS models:	C=190-850nm CXR=280-900nm	Detector Integration:	1ms to 65s
Super range -SR models:	C-SR=200-1080 CXR-SR=220-1100	Slit size options:	14, 25, 50, 100, 200um
Concave Grating:	Aberration corrected	Stray light:	.02% at 435nm; .2% at 200nm
Grating type:	Holographic, 590g/mm	Fiber optic input:	SMA905 0.22na single fiber
Spectrograph:	f/2, Flat field – No mirrors	Operating systems:	Win98/Me/00/XP/Vista
Order sorting filter:	Integrated multi-band	Software included:	SpectraWiz program & apps
Signal to noise:	1000:1	Also free programs for:	LabView/VC/VBA/Delphi

CHAPTER 1 TEST-MEASUREMENT

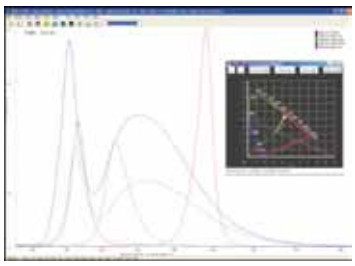
BLUE WAVE MINIATURE FIBER OPTIC SPECTROMETERS FOR UV-VIS-NIR & OEM



The StellarNet BLUE-Wave Spectrometers are fiber optic coupled instruments with a wide selection of models for measurements in 190-1150nm wavelength ranges using a 16-bit digitizer via high speed USB-2.

Each unit contains a USB-2 interface with a snap shot memory to provide instantaneous spectral image from the highly sensitive CCD or Photo Diode Array detectors with options for 2048 or 3648 elements. Various models provide a choice of grating range and slit resolutions.

A single strand fiber optic cable or probe assembly delivers input via standard SMA 905 fiber optic connector with a choice of cable lengths. The spectrograph optics are exceptionally robust in a vibration tolerant modular design, with no moving parts. The detachable spectrograph assembly and control electronics are protected inside a rugged metal enclosure, suitable for portable, process, and lab applications. Several units may be daisy-chained using a powered USB2 hub allowing simple configurations for dual and multi-beam applications in chemistry, spectro-radiometry, PORTA-LIBS, and industrial process controls.



The SpectraWiz software is included to accurately measure light emission intensity for LED, Laser, plasma, solar, xenon, and so on. Measurement applications include SpectroRadiometry (NIST traceable intensities, LED xy chromaticty), Spectro-Colorimetry (CIELAB L* a* b*), Chemistry concentration/reaction time analysis, UVabc monitors, Spectral-ID of elemental plasma emissions, and more.

Specifications			
Dynamic range:	2000:1 with 6 decades	Dimensions:	1x3x5 inch = 25x75x125mm
Optical resolution:	see model table - to 0.2nm	Weight:	14 ounces
Detector type:	CCD or PDA, 2k/3k pixels	Power consumption:	< 100 mA via USB port
Detector range:	200-1150nm (<350 extra$)	Interface:	USB-2 or USB-2 Hub
Pixel size:	14 x 200um or 7 x 200um	Detector Integration:	1ms to 65s
Diffraction Gratings:	Holographic & Ruled	Slit size options:	14, 25, 50, 100, 200um
Grating g/mm:	300, 600,1200,1800, 2400	Stray light:	<.1% at 435nm;<.05% at 600nm
Spectrograph:	f/4, SymX-Czerny–Turner	Fiber optic input:	SMA905 0.22na single fiber
Order sorting filters:	Integrated & High Pass	Operating systems:	Win9x, WinXP, Vista
Signal to noise:	1000:1	Software included:	SpectraWiz program & apps
Digitizer:	16-bit	Also free programs for:	LabView,Excel+VBA,Delphi

Additional measurement applications include emission wavelength monitoring /characterization of tunable lasers or LED's and other sources such as elemental emissions from plasma & Laser Induced Breakdown Spectroscopy. Also Bragg grating technology enables optical sensing of many parameters including temperature and pressure.

Thin film thickness measurements can be made using sample specular reflectance. The small size and weight makes the BLUE-Wave spectrometers just perfect for portable and OEM applications.

BLUE-Wave Spectrometer Configurations 2048 pixel CCD detector Predicted Slit Resolving Resolutions

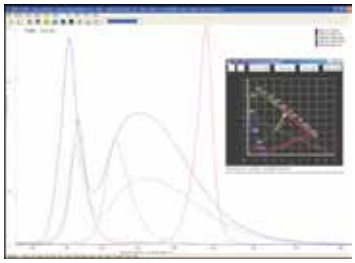
Model	Wavelength Range in nm	Grating g/mm	Slit-200 nm res.	Slit-100 nm res.	Slit-50 nm res.	Slit-25 nm res.	Slit-14 nm res.
UV	200-600	1200	3.0	1.6	0.8	0.50	0.40
UV2	200-400	2400	1.5	0.8	0.4	0.25	0.20
UV3	220-350	3600	1.0	0.5	0.25	0.16	0.13
UVIS	300-1100	600	6.0	3.2	1.6	1.00	0.80
VIS	350-1150	600	6.0	3.2	1.6	1.00	0.80
VIS2	380-780	1200	3.0	1.6	0.8	0.50	0.40
NIR	500-1150	600	6.0	3.2	1.6	1.00	0.80
NIR2	600-1000	1200	3.0	1.6	0.8	0.50	0.40
NIR2b	785-1150	1200	3.0	1.6	0.8	0.50	0.40
NIR3	550-840	1800	2.2	1.2	0.6	0.35	0.28
NIR3b	680-935	1800	2.2	1.2	0.6	0.35	0.28
NIR4	500-700	2400	1.5	0.8	0.4	0.25	0.20
NIR4b	600-800	2400	1.5	0.8	0.4	0.25	0.20
UVN	250-1100	600	6.0	3.2	1.6	1.00	0.80
UVNb	200-1050	600	6.0	3.2	1.6	1.00	0.80

GREEN-WAVE MINIATURE FIBER OPTIC SPECTROMETERS FOR UV-VIS-NIR & OEM

The StellarNet GREEN-Wave Spectrometers are fiber optic coupled instruments with a wide selection of models for measurements in 190-1150nm wavelength ranges.

Each unit contains a USB interface with a snap shot memory to provide instantaneous spectral image from the highly sensitive CCD or Photo Diode Array detectors with options for 2048 or 3648 elements. Various models provide a choice of grating range and slit resolutions.

A single strand fiber optic cable or probe assembly delivers input via standard SMA 905 fiber optic connector with a choice of cable lengths. The spectrograph optics are exceptionally robust in a vibration tolerant modular design, with no moving parts. The detachable spectrograph assembly and control electronics are protected inside a rugged metal enclosure, suitable for portable, process, and lab applications. Several units may be daisy-chained using a standard USB hub allowing simple configurations for dual and multi-beam applications in chemistry, spectroradiometry, and PORTA-LIBS.



The SpectraWiz software is included to accurately measure light emissions such as LED, Laser, plasma, solar, xenon, and others along with absolute intensities.

Additional measurements include sample color reflectance, transmission, chemical absorption and concentration. Applications include SpectroRadiometry (NIST traceable intensities & LED xy chromaticty), SpectroColorimetry (CIELAB L* a* b*), SpectroChemistry reaction time-series analysis, UVabc monitors, Spectral-ID of elemental plasma emissions, and more.

Specifications

Dynamic range:	2000:1 with 6 decades	Dimensions:	1x3x5 inch = 25x75x125mm
Optical resolution:	see model table - to 0.2nm	Weight:	14 ounces
Detector type:	CCD or PDA, 2k/3k pixels	Power consumption:	< 100 mA via USB port
Detector range:Pixel size:	200-1100nm (<350 extra$)	Interface:	USB1 or USB Hub
Pixel size:	14 x 200um or 7 x 200um	Detector Integration:	3ms to 65s
Diffraction Gratings:	Holographic & Ruled	Slit size options:	14, 25, 50, 100, 200um
Grating g/mm:	300, 600,1200,1800, 2400	Stray light:	<.1% at 435nm;<.05% at 600nm
Spectrograph:	f/4, SymX-Czerny–Turner	Fiber optic input:	SMA905 0.22na single fiber
Order sorting filters:	Integrated & High Pass	Operating systems:	Win9x, WinXP, Vista
Signal to noise:	300:1	Software included:	SpectraWiz program & apps
Digitizer:	12-bit	Also free programs for:	LabView,Excel+VBA,Delphi

Additional measurement applications include emission wavelength monitoring /characterization of tunable lasers or LED's and other sources such as elemental emissions from plasma & Laser Induced Breakdown Spectroscopy. Also Bragg grating technology enables optical sensing of many parameters including temperature and pressure.

Thin film thickness measurements can be made using sample specular reflectance. The small size and weight makes the GREEN-Wave spectrometers just perfect for portable and OEM applications.

GREEN-Wave Spectrometer Configurations 2048 pixel CCD detectors Predicted Slit Resolving Resolutions

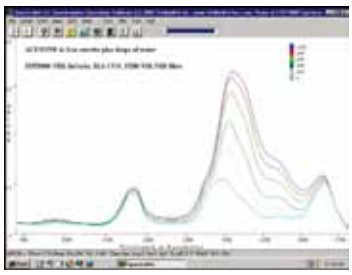
Model	Wavelength Range in nm	Grating g/mm	Slit-200 nm res.	Slit-100 nm res.	Slit-50 nm res.	Slit-25 nm res.	Slit-14 nm res.
UV	200-600	1200	3.0	1.6	0.8	0.50	0.40
UV2	200-400	2400	1.5	0.8	0.4	0.25	0.20
UV3	220-350	3600	1.0	0.5	0.25	0.16	0.13
UVIS	300-1100	600	6.0	3.2	1.6	1.00	0.80
VIS	350-1150	600	6.0	3.2	1.6	1.00	0.80
VIS2	380-780	1200	3.0	1.6	0.8	0.50	0.40
NIR	500-1150	600	6.0	3.2	1.6	1.00	0.80
NIR2	600-1000	1200	3.0	1.6	0.8	0.50	0.40
NIR2b	785-1150	1200	3.0	1.6	0.8	0.50	0.40
NIR3	550-840	1800	2.2	1.2	0.6	0.35	0.28
NIR3b	680-935	1800	2.2	1.2	0.6	0.35	0.28
NIR4	500-700	2400	1.5	0.8	0.4	0.25	0.20
NIR4b	600-800	2400	1.5	0.8	0.4	0.25	0.20
UVN	250-1100	600	6.0	3.2	1.6	1.00	0.80
UVNb	200-1050	600	6.0	3.2	1.6	1.00	0.80

CHAPTER 1 TEST-MEASUREMENT

RED-WAVE NIR SPECTROMETERS WITH 512 OR 1024 InGaAs DETECTOR ARRAYS

The RED-Wave NIR spectrometers are equipped with high performance InGaAs PDAs to cover the NIR wavelength range from 0.9-2.3 µm. The units are exceptionally robust with no moving parts and are packaged in small rugged metal enclosures (2.75" x 4" x 6") for portable, process, and lab applications. The InGaAs detector is a Sensors Unlimited linear photo diode array with 512 pixels (1024 optional) 25µm by 500µm tall to provide maximum sensitivity. The detector has an integrated thermo electric cooler (TEC) maintained at –10 °C, stabilized within +/-0.1 °C.

The NIR spectrometers take a single strand SMA 905 terminated fiber optic cable with low OH as input. Several models provide a variety of operational ranges and resolutions suitable for both spectroscopy and optical spectrum analysis. The units interface to a PC via USB-2 and can be operated simultaneously with StellarNet UV-VIS spectrometers to provide a Dual-Detector Super-Range (Dual-DSR) spectroscopy system. A list of NIR applications include chemical ID of solids and liquids, moisture analysis, SpectroRadiometry and optical power measurements including NIR laser characterization, microsensor applications, and multi-layer thin-film measurements.



The SpectraWiz software is included free and enables a variety of spectroscopy applications under every version of Windows including XP/Vista. Additional software is included for user customization via Excel with VBA or LabVIEW at no extra charge.

Specifications			
Dynamic range:	4000:1 with 5 decades	Dimensions:	150 x 100 x 68.8 mm
Resolving resolution:	3.1nm with 25µm slit	TEC Power	2 Amps @ 5 VDC
InGaAs Detector:	512 pixel cooled PDA array	Interface: USB-2	USB-2
Detector range:	0.9-1.7µm (900-1700nm)	Data transfer speed:	40x faster than USB-1
Pixel size:	25um x 500um	Detector Integration:	1 millisecond to 30 secs
Pixel well depth:	130 $x10^8$ electrons	Slit size options:	25, 50,100, or 200µm
Selectable well control:	130 x108 or 5 $x10^6$ el.	Operating systems:	Win98/NT/Me/00/XP
Signal to noise:	4000:1 with TEC cooling	Software included:	SpectraWiz program & apps
Digitizer:	14/16 bit @ 2.5 MHz rate	Also free programs for:	LabView,Excel+VBA,Delphi

The StellarNet RED-Wave fiber optic spectrometers are available in several models to provide optimal ranges and resolutions for various NIR applications in the standard 0.9-1.7µm and extended 1.5-2.2µm ranges. The standard detector is a 512 element photo diode array (PDA) with 25 x 500µm tall pixels and has zero defects. An optional 1024 element InGaAs PDA will double the resolution over the same range, however it can have <1% non-adjacent dropout pixels. The SpectraWiz software driver provides correction for any dropouts.

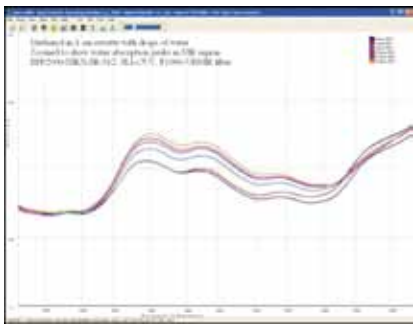
Extended range systems for 1.5-2.2µm are available in 512 or 1024 element InGaAs PDA's with 25 x 250um tall pixels. Because of reduced sensitivity and higher dark noise, the extended range InGaAs spectrometers are primarily used for measuring tunable lasers, characterizing optics, or chemical absorption & transmission thru cuvettes, flow cells, and dip probes.

InGaAs Model	Number of Elements	Spectrometer Range (nm)	Grating (g/mm)	Grating Range (nm)	Dispersion (nm/pixel)	Estimated Resolving Resolution
NIR	512	900-1700	250	800 nm	1.562	3.1 nm
NIRb	512	900-1600	300	650 nm	1.269	2.5 nm
NIR2	512	1250-1575	600	325 nm	0.634	1.3 nm
NIR2b	512	1150-1475	600	325 nm	0.634	1.3 nm
NIR	1024	1000-1700	600	700 nm	0.683	1.4 nm
NIR3-HR	512	1530-1605	1200	70 nm	0.195	0.4 nm
NIR3-HR	1024	1500-1640	1200	140 nm	0.195	0.4 nm
NIRX	512	1500-2200	300	700 nm	1.367	2.8 nm
NIRX	1024	1500-2200	600	700 nm	0.683	1.4 nm
NIRX-SR	512	900-2300	300	1400 nm	5.3	<13 nm
NIRX-SR	1024	900-2300	600	1400 nm	2.7	<7 nm

RED-WAVE-NIRX-SR InGaAs SPECTROMETERS FOR "SUPER RANGE" 0.9-2.3µm

The RED-Wave-NIRx-SR spectrometers cover the NIR wavelength range from 0.9-2.3µm in one instrument using extended range InGaAs detectors. The spectrometers are exceptionally robust with no moving parts and are packaged in small rugged metal enclosure (2.75" x 4" x 6") for portable, processes, and lab applications. The InGaAs detector is a Sensors Unlimited linear photo diode array with 512 pixels (1024 optional) 25µm by 500µm tall to provide maximum sensitivity. The detector has an integrated twostage thermo electric cooler (TEC) maintained at – 20 °C, stabilized within +/-0.1°C. The RED-Wave- NIRx-SR InGaAs spectrometers use single strand low OH fiber optic input cable with SMA905.

Extended range NIR applications include chemical ID of samples using molecular absorption. Liquids samples are measured via cuvette, Dip probe, and flow cell for process monitoring of concentrations.



Photonics applications include optical transmission characterization of materials for filter/coating applications. Laser and tunable laser wavelength monitoring, and micro-sensor applications.

The RED-Wave includes a high speed USB-2 interface cable to interface with notebook and desktop computers. SpectraWiz software is included for a variety of spectroscopy measurements.

Specifications			
Dynamic range:	4000:1 @ 5 milliseconds	Dimensions:	150 x 100 x 68.8 mm
Optical resolution:	13nm with 25µm slit	Power consumption:	2 Amps @ 5 VDC
InGaAs Detector:	512 pixel cooled PDA array	Interface:	USB-2
Detector range:	0.9-2.3µm (900-2300nm)	Data transfer speed:	3x / 40x faster than USB-1
Pixel size:	25µm x 250µm	Detector Integration:	1 to 250 milliseconds
Pixel well depth:	130 x10^8 electrons	Slit size (um):	25/50/100/200um
Selectable well control:	130 x10^8 or 5 x106 el.	Operating systems:	Windows XP/VISTA
Signal to noise:	400:1 with 2x TEC cooling	Software included:	SpectraWiz program & apps
Digitizer:	14/16 bit @ 2.5 MHz rate	Also free programs for:	LabView,Excel+VBA,Delphi

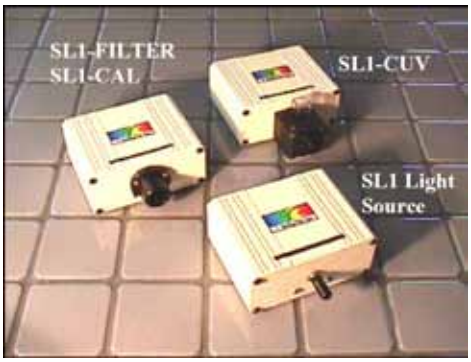
The SpectraWiz® software is included FREE for Windows to accurately measure wavelengths of emissions, reflectance, transmission, and absorption. Customizable programs and drivers are also included for operation in LabVIEW, Excel +VBA, VC, and Delphi.

The RED-Wave-NIRx-SR InGaAs spectrometers are available in two models to provide optimal resolutions for various NIR applications in the extended 0.9-2.3um range. The standard detector is a 512 element photo diode array (PDA) with 25 x 500µm tall pixels and has zero defects. An optional 1024 element InGaAs PDA will double the resolution over the same range, however it can have 1% non-adjacent dropout pixels. The SpectraWiz software driver provides correction for any dropouts.

Because of reduced sensitivity the extended range systems are primarily used for measuring chemical absorption and transmission in flow cells, dip probes, cuvettes, and optics.

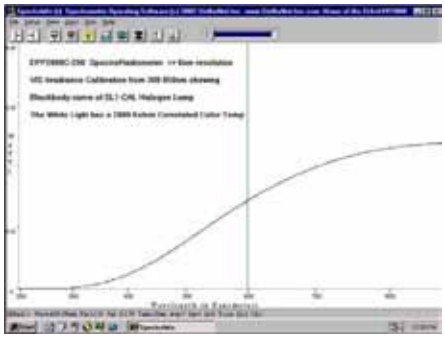
InGaAs Model	# of Array Elements	Wavelength Range (nm)	Grating (grooves/mm)	nm/pixel dispersion	Estimated Resolution (nm)
NIRχ-SR	512	900-2300	300	5.3	<13 nm
NIRχ-SR	1024	900-2300	600	2.7	<7 nm

SL1 TUNGSTEN HALOGEN LIGHT SOURCES FOR VIS-NIR



- 350 nm-2200nm Spectral Range- effective for color, reflectance and absorbance measure ments
- Extensive Life- The SL1 has a 10,000 hour Tungsten Halogen lamp filled with Krypton gas
- Great Compatibility/Versatility- manipulate output with color-enhancing or signal-attenuating filters.
- Small Footprint- only 1.5” x 3” x 3.5”
- Maximum Flexibility- several models and options to choose from to meet all your applica tion needs

The SL1-FILTER includes a 0.5 inch diameter filter holder nose cone. Customers can use a variety of filters for spectral attenuation, band pass, and more. Includes filter to improve blue sensitivity.



SL1-CAL is configured specifically for spectroradiometric calibrations (IRRAD-CALs). Includes diskette with intensity data that is used to irradiance calibrate any StellarNet spectroradiometer.

The SL1-CUV adds a 1cm cuvette holder with integrated collimating lenses. Dual purpose allows the collimating lens to be demounted for far field emission monitoring.

SL1-BAT is a unique option that adds a jack to the SL1 so it can be powered from 5VDC. Users can achieve complete portability with the BP1 battery pack for the spectrometer and the SL1-BAT.

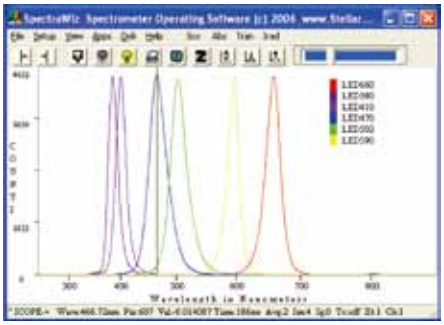
Item	Description
SL1	SL1 Tungsten Halogen light source - 10,000 hour
SL1-Filter	SL1 light source with filter holder nose + special filter
SL1-CUV	SL1 light source with integrated cuvette holder
SL1-CAL	SL1 light source with data diskette for 300-1100nm
SL1-BAT	Option connector allows +5V battery operatio
SL1-BLUE	SL1 with 470nm Blue LED, replacing halogen bul
SL1-LENS	for SL1-Filter, adds DCX+ triplet lens x4 light output

Specifications			
Weight	0.62 pounds (280 g)	Output to bulb	5VDC
Power consumptione	12 watts	Output regulation	0.2%
Spectral rang	300 – 2200nm	Internal filter accessory	2 inch square filter slot
Time to stabilize output	1 min	External filter slot	SL1-Filter only
Power output	200 watts	Bulb life	10,000 hours
Optical color temperature	2800K	Connector	SMA 905 30

SL1-BLUE AND SL1-LED EXCITATION SOURCES

- Spectral Range- LED dependant, optional white.
- Extensive Life- LEDs have extremely long life.
- Flexibility- user replaceable LEDs take less than a few seconds to replace.
- Small Footprint- only 1.5” x 3” x 3.5”.
- Maximum Flexibility- Swappable LED option.
- Powered Flexibility- 12VDC standard or 5VDCoption.

The SL1-Blue is a miniature light source with a very bright 470nm LED installed. A collimating lens is installed just in front of the SMA fiber optic connector output used for fluorescence excitation.



The SL1-LED includes a nose cone assembly with an LED kit consisting of 6 LEDs plus a White LED. LEDs can be swapped without any wiring changes, just pull one out and push the next one in. Each LED can be used to induce fluorescence in many experiments. 470nm LED works best for Riboflavin (vitamin D). Other wavelengths can be found more optimal for use with different species chemistry.

SL1-BAT is a unique option that adds a jack to the SL1 so it can be powered from 5VDC. Users can achieve complete portability with the BP1 battery pack for the spectrometer and the SL1-BAT.

Excitation Sources and Accessories

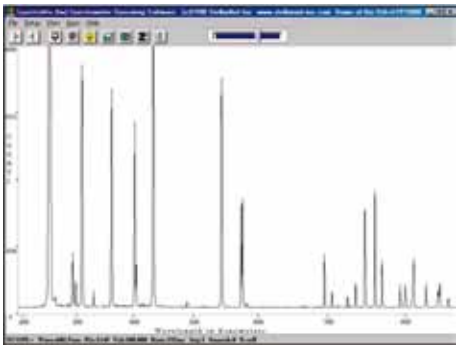
Item	Description
SL1-Blue	Miniature fiber optic light source with bright blue LED at 470nm for excitation.
SL1-LED	Miniature fiber optic light source with replaceable LED. Includes LED-Kit with set of 6 LEDs: LED-410, LED-470, LED-502, LED-590, LED-660, LED-white
SL1-BAT	Option connector allows +5V battery operation

Specifications			
Weight	0.62 pounds (280 g)	Output to bulb	5VDC
Power consumption	0.5 watts	Output regulation	0.2%
Spectral range	Depends on LED installed	Internal filter accessory	2” filter slot
Time to stabilize output	~ 1 second	External filter slot	0.5” diameter
LEDs in Kit	410, 470, 502, 590, 660nm, and White LED	LED life	100,000 hours
LED Type	T-5 mm	Connector	SMA 905

SL2 WAVELENGTH VERIFICATION STANDARD FOR UV-VIS-NIR

- Calibration Source- Verify or calibrate spectrometer wavelengths from 253.65 to 1013.98nm
- Convenient Operation- Includes U.S. style 5 Volt DC output power adapter for AC supply and optical fiber to check any spectrometer
- Portable- Miniature size 0.75 x 2.5 x 4.5 inch provides ultimate portability with 9 Volt DC battery operation makes the SL-2 perfect for field verifications

The SL2 fiber optic cal lamp provides Mercury and Argon gas emission lines which are utilized to verify or calibrate spectrometer wavelengths from 253.65 to 1013.98nm.



The lamp is designed so that the lowpressure emissions enable quick and accurate calibrations. A labeled chart provides spectral emission lines for Mercury and Argon at various wavelengths for easy and quick reference.
Portable operation is available from a standard 9 Volt DC battery (not included). The SL2 also includes a 5 Volt DC wall adapter for 120 Volt AC, U.S. style transformer and plug. Operation outside U.S. requires SL2-Y-cable or UP5V adapter.

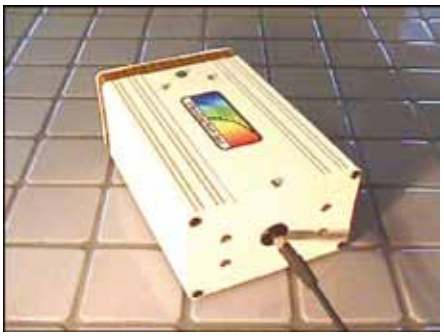
Note: the StellarNet spectrometers are wavelength calibrated at the factory using the SL2 and additional emission line sources. These instruments are ruggedized for portability and never need to be recalibrated. The SL2 can be used to easily verify any wavelength readouts.

Light Sources and Fiber Optic Accessories

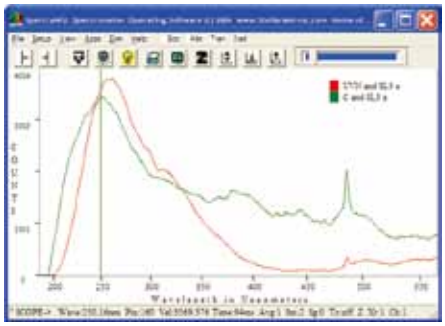
Item	Description
SL2	Mercury and Argon standard
SL2-Y-cable	Shares +5VDC from spectro

Specifications			
Weight	0.2 lbs, or 85 grams	Connectors	SMA-905 and +5 VDC
Power consumption	100ma	Battery operation	+9 VDC (optional)
Spectral Range	253.65 to 1013.98	Time to stabilize output	15 seconds

SL3 DEUTERIUM LIGHT SOURCE FOR UV



- UV Spectral Range - covers the deep UltraViolet spectral range from 190-450nm.
- Long Life - 4,000 hour performance due to special air flow design and ultra quite fan op eration. One of our U.K. customers has reported continuous operation for over a year!
- Exceptional Performance - designed for maximum stability with precision power control it is ideal for UV spectroscopy.
- Portability - small size allows for use in field or mobile spectroscopy applications.



The SThe SL3 Deuterium Light Source - emits a deep UV spectral output over the 190- 450nm range and higher. When using the StellarNet concave grating spectrometers, the SL3 level is good past 550nm. See the comparison graph showing spectral curves from concave grating and CT grating spectrometers.

DCX Lens Option - This add-on option increases the deuterium lamp intensity x7 times, and is highly recommended for highly absorbing samples and reflectance measurements.
Filter Options - Integrated filter holder fits standard size 0.5 inch diameter disk filters. The U330-filter removes the deuterium spikes seen near 485nm.

UV and Vis Light - The optional F400YB fiber optic bundle cable is used to combine the SL1 halogen and SL3 to cover wavelength ranges from 190–2200nm.

UV Light Source and Accessories

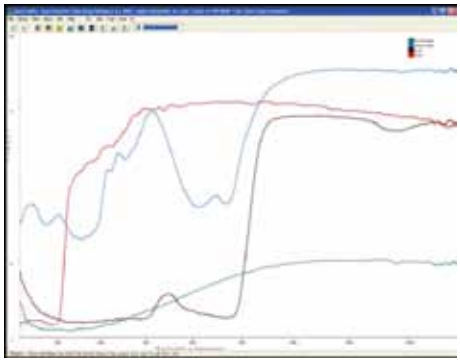
Item	Description
SL3	Fiber optic deuterium light source
SL3-CAL	With irradiance data diskette for 200-400nm
F400-YB-SRNIR	400um fiber optic Y bundle cable
Filter-U330	U330-Filter
LENS-DCX	Lens DCX add-on for x7 optical gain
SL3-spare bulb	Spare deuterium bulb - Hamamatsu L2D2

Specifications			
Weight	1.8 pounds (816.5 g)	Output from bulb	free space into fiber optic
Power consumption	30 watts	Output regulation	0.05%
Spectral Range	190 – 450nm	Internal filter accessory	n/a
Time to stabilize output	15 min	External filter slot	holds 0.5 inch diameter filters
Power output	15 watts	Spectral attenuation	none
Bulb Color Temp	4000K	Connector	SMA905

SL4-DT DEUTERIUM & TUNGSTEN LIGHT FOR UV-VIS-NIR

- 200-1700nm Spectral Range - Combines two light sources into one small package with Deuterium bulb plus Tungsten-halogen bulb that has one SMA 905 fiber optic connection.
- D-alpha line (654nm) eliminated in deuterium source.
- Dual Lamps – Shutter button on the front panel blocks the light output of both lamps, nec essary for taking dark reference spectrums without turning off the source.
- Portability - The combination of both lamps into one small enclosure reduces complexity and can be connected to the BP2 battery pack for field applications.

SL4-DT Deuterium & Tungsten Light is a miniature Deuterium and Tungsten-halogen light source that covers the 200- 1700nm range in a single light source for spectroscopy measurements. It's high output power enables use for reflectance measurements, where other low power light sources like SL5-DT are too weak.



Miniature Size - Small size of 72 mm x 40 mm x 90 mm makes it a perfect match for StellarNet miniature spectrometers: Concave 190-850nm & CSR 220-1100nm EPP2000-UVN-SR 200-1100nm GREEN-Wave UVNb 200-1050nm BLUE-Wave UVNb 200-1050nm

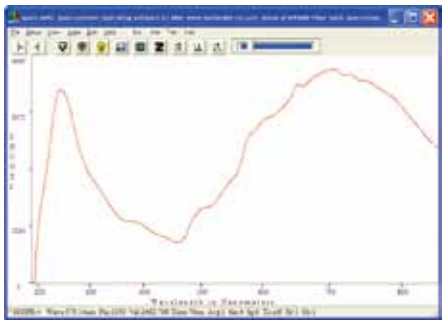
Item	Description
SL4-DT	High output Deuterium/Tungsten Lamp for UV-VIS
SL4-B-UV	Deuteruim replacement bulb for UV
SL4-B-VIS	Halogen replacement bulb for VIS

Specifications			
Power consumption	10 VA	Output fluctuation	0.004 %p-p
Spectral Range	200-1700nm	Deuterium bulb lifetime	800 hours
Time to stabilize output	5 min	Tungsten bulb lifetime	1000 hours
Optical power in Watts/m 2	15 UV – 45 VIS	Spectral attenuation	450nm dip
VIS Bulb Color Temp	2800K	Connector	SMA 905

SL5 DEUTERIUM HALOGEN LIGHT SOURCE FOR UV-VIS

- 200-1100nm Spectral Range - Combines two light sources into one small package with deuterium bulb plus tungstenhalogen bulb in one fiber optic connection.
- Miniature Size - Its small size of 1.5 x 2.5 x 6” makes it a perfect match for our UVN or EPP2000C UV-VIS spectrometer (as pictured).
- Dual Lamps - The deuterium and halogen lamps can be individually turned on/off and have a front panel shutter control button for taking a quick dark spectra reference.
- Portablility - The combination of both lamps into one small enclosure saves money and reduces complexity to provide the ultimate UV-VIS light source for portability.

The SL5 Deuterium Tungsten Halogen Light Source- is a miniature Deuterium and halogen light source that covers the 190-900nm range. The lamp combines the Deuterium Spectrum with the Tungsten Halogen spectrum to form a single optical path. The deuterium and halogen lamps can be individually turned on or off and have a front and rear panel shutter control. The SL5-DH lamp connects via fiber optic cable to cuvette holders, dip probes, and flow cells, with the return signal routed to the spectrometer SMA 905 input connector



SL5-CUV adds an external cuvette holder that is ideal for transmission and absorbance measurements for liquids using standard 1cm or shorter UV grade cuvettes.

SL5-Filter adds a nose cone to allow insertion of 0.5 inch diameter UV/VIS/NIR filters for special excitation applications. DCX lens option for x2 signal gain.

Light Sources and Accessories

Item	Description
SL5	SL5 Deuterium / Tungsten UV/Vis/NIR Lamp
SL5-CUV	SL5 with Cuvette Holder
SL5-FILTER	SL5 with Filter Holder
LENS-DCX	Lens DCX add-on for x2 gain SL5-FILTER only

Specifications			
Weight	1 pound (454 g)	Output to bulb	internal
Power consumption	6 watts	Output regulation	0.05%
Spectral Range	190-2200nm	External filter accessory	demountable
Time to stabilize output	5 min	External filter slot	0.5inch diameter filters
Power output	1 watt	Spectral attenuation	450nm dip
Bulb Color Temp	3000K	Connector	SMA 905

CHAPTER 1 TEST-MEASUREMENT

ADJUSTABLE REFLECTANCE & TRANSMISSION FIXTURES

The RPH-3 Reflectance probe holder includes asingle stage to hold reflectance probes (R400 or R600) in the 90o angle for specular measurements.

- **Precision alignment** using two locking screws to adjust the probe height. Rough course and fine adjustment enable reliable and consistent measurements.
- **The RPH-3** is ideal for Thin Film measurements or highly reflective surfaces such as mirrors or metallic samples.

The TXF-4 includes two collimating lenses which allows the sample to be oriented vertically as shown above.

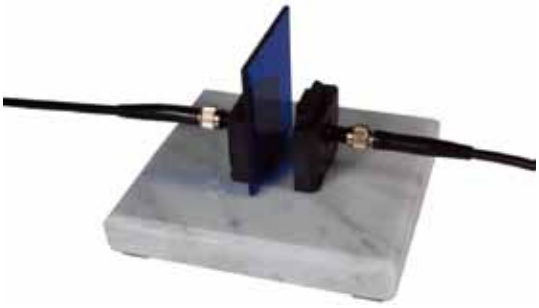
- **190 nm-2200nm Spectral Range** for transmission measurements of liquids, solids, and gases
- **Ultimate Flexibility-** standard fixture allows a variable pathlength from 0 to 7cm
- **Interchangeable parts** allow the TXF-4 to be easily converted into the RPH-3using the same base and stand.

Light Sources and Fiber Optic Accessories

Item	Description
RPH-3	Vertical reflectance probe holder stand for 90 o (specular) measurements
TXF-4	Vertical Transmission Fixture with 2 collimating lenses (LENS-QCOL)
RPH-3K	Horizontal bar with probe mount lock -adds to TXF-4 for use as RPH-3
TXF-4K	Horizontal plates with 2 LENS-QCOL -adds to RPH-3 for use as TXF-4

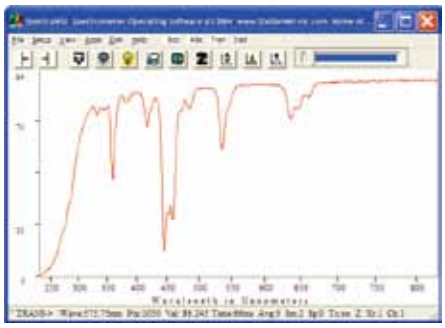
Specifications			
Weight	2.2 pounds (1.0 kg)	TXF-4 Fiber Options	400, 600, or 1000 micron
Size	6” x 6” x 6”	Pathlengths	Variable from 0 to 7cm or more
Spectral range	190 – 2200nm	Connectors	SMA 905

TXF1 TRANSMISSION FIXTURE FOR UV-VIS-NIR



- **190 nm-2200nm Spectral Range-** transmission or absorbance mea surements of liquids, solids, and gases
- **Flexibility-** a fixed 1cm open pathlength allows samples to be inserted between the illuminating and read fibers
- **Designed for simple use-** easy to attach fiber optic cables to connect light source and spectrometer. Two integrated collimating lenses send and receive light across the 1cm path for transmission measurements
- **Sturdy base-** made of marble, easily holds the text fixture in place

The Transmission Fixture includes 2 UV gradecollimating lenses, aligned and fixed 1cm apart.



Liquid measurements can easily be done with a standard 1cm cuvette or flow cell. Measure light absorbance and transmission.

Solid samples such as filters and other types of optics can be easily slid into the light path for transmission measurements. With open sides, large samples can be accommodated.

Gas analysis is easily done by measuring the atmospheric gas or by inserting a gas cell.

Fiber Optic Accessory

Item	Description
TXF1	Transmission Fixture

Specifications			
Weight	1.0 pounds (454g)	Fiber Options	200, 400, 600, or 1000 micron
Size	3.75” x 4” x 1.25”	Pathlength	10 mm
Spectral range	190 – 2200nm	Connectors	2 x SMA 905

COSINE RECEPTORS FOR SPECTRORADIOMETRY

- **Cosine Receptors** collect light with an 180o field of viewusing demount able diffusers with ~10% loss. A perfect cosine response provides accu rate absolute intensity when multiple lights are measured at same time.
- **Fiber-Less** adapter eliminates the need for fiber optics by enabling cosine receptors to be con nected directly to the spectrometer using the SMA-Coupler.
- **Irradiance Calibrations** are performed using NIST traceable light sources for 200-400nm and 300-1700nm.
- **Applications** include laser & light source characterization and varieties of UV light emis sion, LED color and spectral intensity, solar irradiance mea surements, and a variety of light measure ment in the field including under water.

CR1-UVN is a ½" diameter near cosine receptor using sanded fused silica diffuser for 200-1700nm. Has reduced 90° FOV and low 7% loss.
CR2 is a ¼" diameter UV-NIR cosine receptor using a polymer diffuser for 200-1100nm & 180° FOV.
CR2-AP is a 10% aperture for the CR2 that extends the system dynamic range by an order of magnitude, thus enabling spectral measurements of sources that are 10 times brighter without the need for recalibration using a brighter IRRAD-CAL lamp.
CR2-RA is a 90° right-angle Cosine Receptor cube.
CR1-TP or CR2-TP miniature tripods for the CR1- UVN or CR2.
CR-LENS is a cosine receptor lens assembly that reduces the field of view from 180 degrees to a small spot. Adjustable focus allows variable distance from target surface such as OLED displays.

SpectroRadiometry Accessories

Item	Description
CR1-UVN	Near Cosine Receptor, 0.25" diameter
CR1-TP or CR2-TP	Tripod for CR1-UVN, CR2, IC2, or IC6
CR2	Cosine Receptor, UV-Vis-NIR
CR2-AP	Aperture for CR2, screw on attachment
CR2-RA	Cosine Receptor at 90 o right angle
CR-LENS	Focus measurement to small spots on displays
SMA-Coupler	Fiber-less cosine receptor attachment

Specifications				
	CR1	CR1-UVN	CR2	CR2-RA
Wavelength	300-1100nm	190-1700nm	200-1100 nm	200-1100 nm
Diameter	½ inches	½ inches	¼ inches	¼ inches
Field of View	180°	90°	180°	180°

INTEGRATING SPHERES FOR RADIOMETRY & REFLECTANCE

- Collects light with a 180o field of view
- Flexibility- Integrating Spheres can be used to collect light (emissions) or as a reflectance accessory
- Irradiance Calibrations can be performed by StellarNet using NIST traceable lamps (IRRAD-CAL) or by the customer using a similar lamp and SpectraWiz software.
- Applications: light source characterization of spectral intensity distribution, color tempera ture, xy chromaticity, dominant wavelength (and more), for LED, laser, solar, industrial lighting, and any type of light emission.

Integrating Spheres are used to measure lightemis-sions including radiant or luminous flux or light re-flectance from sample surfaces.

The IC2 is a 2” cube with internal integrating sphere. It has 5/8” input port and SMA fiber optic output. Another SMA input can be used for reflectance illumination.

The LS4 and LS6 are 4” & 6” spheres with 1.5 and 2.5” input ports respectively, with 1 SMA fiber optic output and internal Spectralon coating.

The TP1 simplifies measurements by allowing the spheres to be mounted on a 3 legged tripod. This makes alignment and consistency easy.

Fibe Optic Integrating Spheres and Accessories

Item	Description
IC2	Integrating sphere, 5/8” input port
LS4	Integrating Sphere, 1.5” input port
LS6	Integrating Sphere, 2.5” input port
TP1	Tripod stand for sphere attachment

Specifications			
	IC2	LS4	LS6
Weight	0.45 pounds (204g)	1.5 pounds	2.0 pounds (910g)
Sphere diameter	2 inches	4 inches	6 inches
Field of View	180°	180°	180°

IRRADIANCE CALIBRATIONS FOR UV-VIS-NIR

NIST traceable Irradiance calibration service

Allows absolute intensity measurements using Irradiance Compensation File (ICF) generated by calibration. To enable, install MyCalnnnnn.exe.

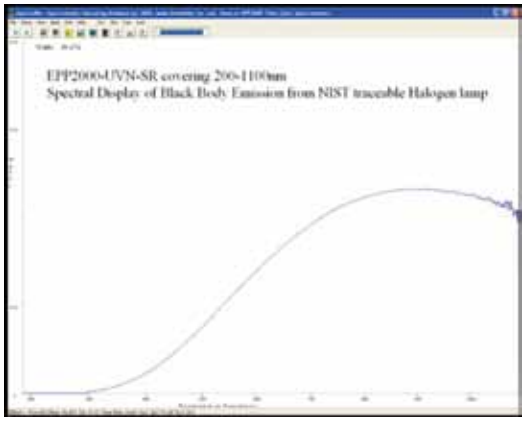
Absolute calibration accuracy within 10% at detector integration setting used for calibration.

Measure irradiance in watts/m2, microwatts/cm2, lumens/m2, LUX, moles per second, PAR, Footcandles, Radiant Flux, Luminous Flux, xy Chromaticity, color correlated temperature, +more.

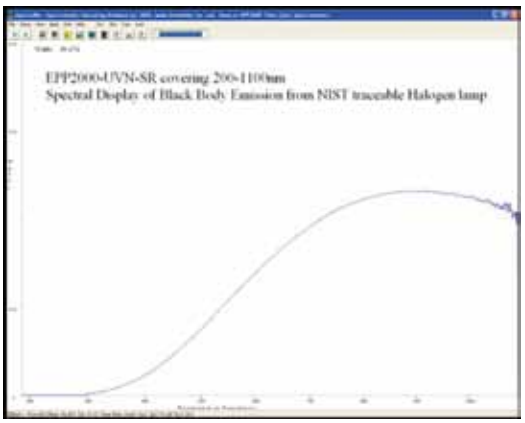
Fast turn around: most system can be calibrated within 1 week after receipt of order.

Can be calibrated with fiber optic accessories:

- **Integrating Sphere** such as IC2 or **cosine receptor** such as or CR2-UV-VIS-NIR, or user supplied.
- **F600um fiber optic cable** for 50um slit or larger
- **F1000um fiber optic cable** for 25um slit
- **Cosine Receptors** can be direct attach no fiber
- **Optional IRRAD-CAL Certificate**



UVN-SR Spectrometer 200-1100nm

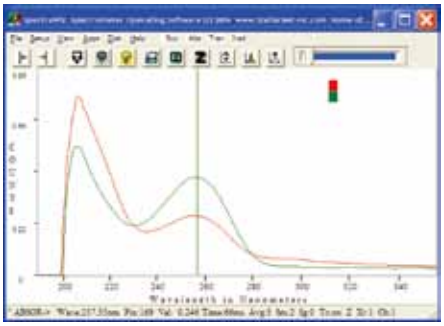


Dual DSR Spectrometer 280-1700nm

Item	Description
IRRAD-CAL	VIS-NIR for range 300-1100nm Note: actual spectrometer range can be smaller
IRRAD-CAL	NIR for range 900-1700nm Note: actual spectrometer range can be smaller
IRRADUV-CAL	UV for range 200-600nm Note: actual spectrometer range can be larger
IRRADCAL-UVN	UV-VIS for range 200-850nm Concave grating only, dual UV+VIS calibration
IRRAD-CAL-DOC	Optional IRRAD-CAL certificate with NIST traceable serial numbers

CUV1 FIBER OPTIC CUVETTE HOLDER FOR UV-VIS-NIR

- 190 nm-2200nm Spectral Range- effective for color, transmission and absor bance mea sure ments
- Standard 1 cm pathlength- holds 1 cm plastic, glass, and quartz cuvettes
- Fluorescence measurements- using the 90 degree pickup port and the black anod ized cover (not shown)
- Flexible design- can use up to 4 fiber optic ports or a low cost option with only 2 collimators



The CUV1 is used for transmission, absorbance, fluorescence, and color measurements in liquids. Includes 2 UV grade collimating lenses.

The CUV2 is the same as the CUV1 but we've added another collimating lens.

Typical applications include concentration measurements, color CIELAB measurements, kinetics studies, enzymatic reactions, spectral identification, and much more.

Recommended spectrometer for UV-Vis measurements are: EPP2000C concave grating spectrometer 190-850nm or UVN-SR composite grating spectrometer 200-1100nm. Also works with the SL5 Deuterium + Halogen light source.

Fibe Optic Accessories

Item	Description
CUV1	Cuvette Holder with 2 LENS-QCOL
CUV2	Cuvette Holder with 3 LENS-QCOL
LENS-COL	Collimating Lens
LENS-QCOL	Collimating UV Lens

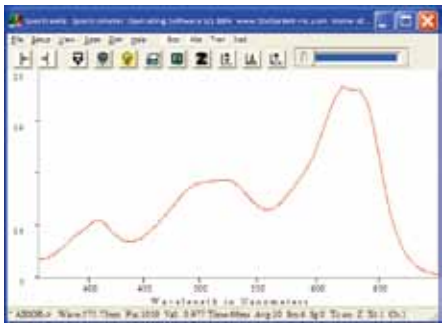
Specifications			
Weight	1.1 pounds (500 g)	Pathlength	1 cm
Size	4" x 4" x 2.5"	Z height	15 mm
Spectral range	190 – 2200nm	Connector	SMA 905

CHAPTER 1 TEST-MEASUREMENT

TRANSMISSION DIP PROBE FOR UV-VIS-NIR

- Large Spectral Range [190 nm-2200nm]
- Enhanced Design includes an integrated mode stripper which enables the end-user to move the probe after a reference has been taken.
- Variable Pathlength Design enables the end-user to adjust the optical pathlength of the mea surement [2, 5, 10, and 20 mm pathlengths are available].

The Dip Probe connects to a light source and a spectrometer to measure characteristics of liquid samples.



The Dip Probe Tip fixes the light path for consistent absorbance / transmission measurements, and is easily changed to shorter or longer path tips to measure lower or higher concentrations.

Typical applications include color measurements, chemical concentrations, process monitoring, and environmental chemistries.

Special mode mixer stabilizes fiber optic cable movements needed for low level measurements.

SpectroRadiometry Accessories

Item	Description
DP400-UVVIS-SR	Dip Probe for UV-Vis - solarization resistant
DP400-VISNIR	Dip Probe for Vis-NIR
DP-TIP-XX	Dip Probe Tips, specify 2, 5, 10 or 20 mm

Specifications			
Weight	0.22 pounds (100g)	Probe Tip Material	Stainless Steel
Size (Probe)	5.5” length 0.25” O.D.	Pathlengths	2, 5, 10, or 20 mm
Spectral range	190 – 2200nm	Connectors	2 x SMA 905

FIBER OPTIC CABLES FOR UV-VIS-NIR

SPECIALTY FIBERS FOR VARIOUS APPLICATIONS

- Y-cables to couple 2 spectrometer systems
- Y-bundled cables to couple 2 light sources
- 1 to 3 splitter cable
- Custom fibers to meet your application

Single strand, multimode fiber optic cables are available with SMA905 connectors, ¼ inch dia. steel mono-coil armor with black PVC jacket. Sizes include 400, 600, or 1000µm core diameters

Standard lengths are 1 and 2 meters

Custom lengths are available with a minimum price of a 1 meter fiber (extra delivery time also)

Solarization resistant fibers available for deep UV applications below 300nm in all diameters

High OH fibers (190-850 nm) are needed for UV and UV-VIS applications below 400nm

Low OH fibers (400-2200 nm) are needed for VIS-NIR applications. They offer lowest possible internal light attenuation. Intended for applications with long fiber lengths.

400 µm Fibers

Item	Description
F400-UVVis-SR	Armored, 2 meters, Solarization Resistant fiber optic cable
F400-VISNIR	Armored, 2 meters, fiber optic cable
F400-per meter	Price per additional meter, armored with black PVC jacket
F400YBNIRUVSR	Y-cable bundle, 0.5 meter, 4 SR & 3 NIR fibers connects SL1+SL3 lamps

600 µm Fibers

Item	Description
F600-UVVis-SR	Armored, 2 meters, Solarization Resistant fiber optic cable
F600-VisNIR	Armored, 2 meters, fiber optic cable
F600-per meter	Price per additional meter, armored with black PVC jacke
F600-Y-VISNIR	Armored Y cable, 1 meter, 1 SMA to 2 SMA, all for NIR
F600-Y-UVSRNIR	Armored Y cable, 1 meter, 1 SMA to 2 SMA, SR+NIR
F600-1TO3-SR	Armored splitter, 1 meter, 1 SMA to 3 SMA, all Solarization Resistant

1000 µm Fibers

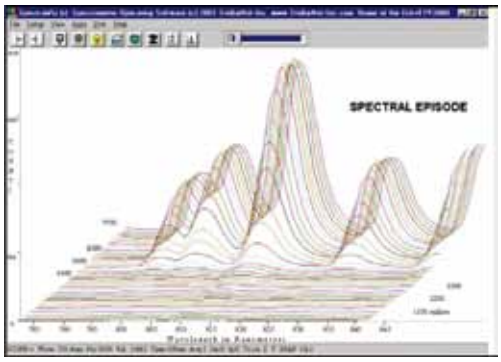
Item	Description
F1000-UVVis-SR-1	Armored, 1 meter, 1000um, Solarization Resistant fiber optic cable
F1000-VISNIR-1	Armored, 1 meter, 1000um fiber optic cable
F1000-per meter	Price per additional meter, armored with black PVC jacket

Specifications			
Weight	Varies on length/diameter	Fiber material	Silica core - silica clad
Length	1 – 2 meter, or custom	Diameter	400 µm or 600 um or 1000 µm
Spectral range	190 – 2200nm	Connectors	SMA 905
Numerical aperture	0.22 NA	Temperature range	0 – 50 Deg C

FIBER OPTIC MULTIPLEXER (FOMUX) OR UV-VIS-NIR

- 2 models to choose from: UV-Vis or VIS-NIR.
- Portable multiplexer is packaged in a miniature rugged enclosure and oper ates from +5VDC. Unit draws virtually no power after channel has been selected.
- Attaches directly to a computers high speed parallel printer port with channel selection control provided by the SpectraWiz software.
- Includes- 3 inputs (4th optional) and 1 output using SMA-905 connectors, software, parallel port cable, and UP5V adapter.
- Requires- 1000 µm fiber to spectrometer and 600 µm fibers on the inputs.

FOMUX reduces the number of spectrometer instruments required for simultaneous monitoring of several process locations at-line/on-line.



High performance optical switching accessory for StellarNet fiber optic spectrometers requiring high speed, high stability, and low power consumption.

Interface connection via SMA-905 fiber optic cables to send selectable signals to the UV-VIS or VIS-NIR spectrometer. Spectrometer type must be specified to ensure optimal internal fiber optics.

Key features- include high speed switching reliability, automatic dark shutter for each channel, low optical loss, no signal cross-talk, and low power operation.

Fiber Optic Accessory

Item	Description
FOMUX- UV-VIS	For UV-VIS applications (all fibers solarization resistant)
FOMUX-VIS-NIR	For VIS-NIR applications
4th Channel upgrade	Located on back of unit
F600-VIS-NIR-2	2 meter Fiber optic cable for each input
F1000-VIS-NIR-1	1 meter Fiber optic cable to spectrometer (required)

Specifications			
Weight	2 pounds (907 g)	Fiber Options	Specify UV-VIS or VIS-NIR
Size	4-¼" x 2-5/8" x 3-½"	Connectors	All SMA 905
Spectral range	190 nm – 2200 nm		

REFLECTANCE PROBES FOR UV-VIS-NIR

- 190 nm-2200nm Spectral Range- effective for color of solids and reflectance measure ments
- The RS50 is a 50mm diameter white reflectance standard made of Halon. It is used to t ake reference measurements using the R400 Reflectance Probe. The white standard will reflect >97% of the light from 300-1700nm.
- Simple to use Design- easy to attach light source and spectrometer via integrated 400um fiber optic cable
- Consistent Measurements- using the RPH1 reflectance probe holder, users can get re producible results time after time.

The Reflectance Probe has 6 illuminating fibers nd 1 read fiber bundled together using 400 micron fibers. As an option, the 2R probe has 5 illuminating fibers and 2 read fibers. All fibers are 00µm.

Increased sensitivity using a 7 around 1 design and increasing the fiber diameter to 600 micron. This allows up to 3x the signal gain than the 6:1 probe.

The RPH1 Reflectance Probe Holder sets the probe at a 45 degree angle and a set distance from the sample.

Typical applications include color CIELAB measurements of solid samples configured for diffuse reflectance using the RPH1.

Specular measurements can be taken using the RPH2 and RPH3 probe holders which holds the probe at a 90^{o} angel, with a locking set screw to maintain constant distance.

Fiber Optic Probe Accessories

Item	Description
R400-7-UVVIS	Reflectance Probe for UV and Visible; 6 around 1 with 400µm fibers
R400-7-VISNIR	Reflectance Probe for Visible and Near IR; 6 around 1 with 400µm fibers
R600-8-UVVIS-SR	Reflectance Probe for UV and Visible; 7 around 1 with 600µm fibers
R600-8-VisNIR	Reflectance Probe for Visible and Near IR; 7 around 1 with 600µm fibers
RPH1	Reflectance Probe Holder block for 45^{o} angle measurements
RPH2	Reflectance Probe Holder block for 90^{o} angle measurements
RPH3	Reflectance Probe Holder stand for 90^{o} angle measurements
RS50	White Reflectance Standard
RTIP45	45^{o} angled tip for Reflectance probes; includes locking screw for positioning

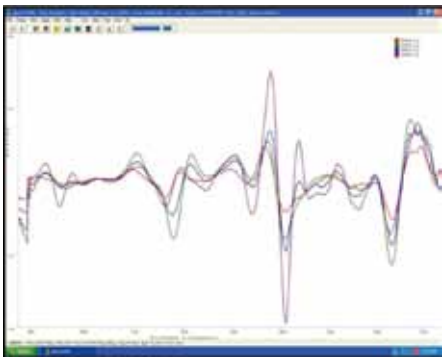
Specifications			
Weight	0.22 pounds (100g)	Probe Tip Material	Stainless Steel
Size (Probe)	3.5” length 0.25” O.D.	Number of Fibers	6:1, 7:1, or 2 read fibers
Spectral range	190 – 2200nm	Connector	2 x SMA 905

CHAPTER 1 TEST-MEASUREMENT

RFX REFLECTANCE FIXTURES FOR VIS-NIR

- 350 nm-2200 nm spectral range- measurements include reflectance and absor bance for VIS color measurements, NIR spectral signatures for material identi fication and chemical concentrations.
- Flexibility- can be used as a stand, or a portable handheld device for on-the-go measurements. Lightweight, 2-piece construction allows for easy storage and porta bility.
- Includes UP12V universal power adapter.
- Battery-pack option available.

RFX-1 VIS-NIR reflectance fixture with integrated 10 watt halogen bulb. Collimating lens reduces sample spot size to 5mm and feeds the SMA-905 fiber optic interface to the spectrometer.



RFX-2 VIS-NIR reflectance fixture with integrated 10,000 hour 5 watt halogen bulb. No collimating lens increases sample spot size to 20mm for the SMA-905 fiber optic interface to the spectrometer. Ideal for delta-E* color measurements. Ultimate stabil-ity achieved with 2 stage bulb power supply.

Effortless solids measurement for samples such as plastics and textiles, by plac-ing the sample directly on the stand's surface.

Liquids and powders can easily be measure by placing the sample in a Petri dish or sample jar.

Fiber Optic Accessory

Item	Description
RFX-1	Reflectance Fixture
RFX-2	Reflectance Fixture for Color Measurements
F600-VIS-NIR-2	2 meter Fiber optic cable for RFX-1 (required)
F1000-VIS-NIR-1	1 meter Fiber optic cable for RFX-2 (required)

Specifications			
Weight	3.2 pounds (1452 g)	Fiber Options	1000 micron
Size	5" x 5-¼" ø top x 3-½" ø bottom	Sample port	1-¼" diameter
Spectral range	350 nm – 2200 nm	Connector	SMA 905

LASER INDUCED BREAKDOWN SPECTROSCOPY

PORTA-LIBS-2000 can be useful for a variety of applications. Here's just a few:

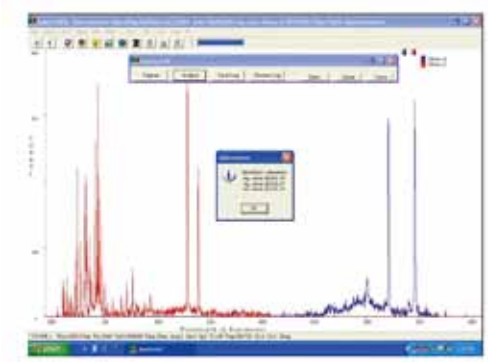
- Industrial materials analysis
- Prospecting & Mining
- Environmental monitoring
- Homeland security measures
- Military chemical and biological agents
- Forensics analysis
- Pharmaceutical R&D
- Engine Oil analysis
- Gemology and Counterfeit detection

The PORTA-LIBS-2000 is the first truly portable low cost analyzer that can be used for real-time qualitative measurements of trace elements. It can be used for dedicated applications in the field or just about anywhere. Portable high resolution EPP2000 spectrometers are integrated with a high intensity pulsed laser, and sample chamber, to permit UVVIS- NIR spectral analysis of unknown samples. The portable instrument case is just 18 x 14 x 7 inches and operates via 12 volt adapter or battery. Detection requirements determine the number of required spectrometer channels. Up to 8 high resolution spectrometers can be attached via USB-2 computer interface with 0.1 or 0.2nm resolution. Laser Induced Breakdown Spectroscopy or LIBS has become the common acronym for element detection via laser induced plasma. This permits real-time qualitative identification of trace elements in solids, gases, and liquids via optical detection of elemental emission spectra. Using this technique, little or no sample preparation is required and calibration-free quantitative analysis has been reported without matrix effects. The SpectraWiz software provides element identification via spectral database for qualitative measurements. Samples can be quickly measured and saved to log-file. Options allow customization of spectral search algorithms. Custom compound element libraries can be created or searched.

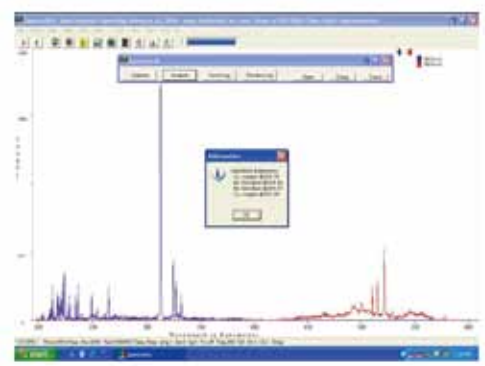
PORTA-LIBS-2000-LSR1 Specifi			
Spectrometer channels:	Expandable to 8	Case Dimensions:	7 x 14 x 18 inches
Spectrometer ranges:	190-1000nm wavelengths	Data transfer speed:	480 Mbits per second
Optical resolution:	HR=0.1nm or SR=0.2nm	Power consumption:	350 mA @ 12 VDC
Detector type:	2048 pixel CCD array	Computer Interface:	USB-2 port
Laser type:	Pulsed Nd-YAG @1.06um	Laser power:	25 milli-joules (4ns pulse)
Laser model & rep rate:	Kigre MK-367, 1 Hertz	Power to sample:	6 MegaWatts
Laser lifetime:	> 300,000 shots	Plasma chamber:	2 x 2 x 3 inches
SR wavelength range:	200nm =200-400/400-600	Operating systems:	Win98/Me/00/XP
HR wavelength range:	100nm =200-300/300-400	Software included:	SpectraWiz Spectral-ID
Additional channel:	SR or HR	Customizable software:	LabView,Excel+VBA,Delphi

EPP2000-UVN-SR Super Range Spectrometer for UV-VIS-NIR Applications

The PORTA-LIBS-2000 spectrometers are miniature fiber optic instruments for UV, VIS, and NIR measurements in 190-1000nm spectral ranges. Each unit contains a high speed integrated digitizer with a
4K word spectral scan memory to provide instantaneous spectral capture from the highly sensitive 2048 element CCD detectors. Various models provide a choice of grating range and slit resolution to fit detection requirements. Fiber optic cables deliver the spectral signal from the sample chamber and use standard SMA 905 connections. The spectrometer optics are exceptionally robust in a vibration tolerant modular design that has no moving parts. The detachable optics assembly and control electronics are protected inside a rugged metal enclosure, suitable for portable applications. Several units may be daisy-chained via USB-2 hub allowing for expandable configurations. The LHR high resolution spectrometers have double the resolution (0.1nm) over LSR standard models (0.2nm) with the same grating. The LSR models on the other hand have twice the wavelength range of the LHR allowing for a smaller number of channels when application requirements permit. Most elements have plasma emission spectra in the 200-500nm UV-VIS range, leaving just a few in the 500-925nm VIS-NIR range. Each PORTA-LIBS-2000 spectrometer includes fiber optic cable interface to sample chamber and high speed USB-2 computer interface with hub when needed. Additional cables are provided for battery operation and laser synchronization. Spectrometer optics include CCD detector upgrade for UV, order sorting filters, and slit. Optical alignment of each channel allows for 5nm of overlap outside of specified range. SpectraWiz software integrates all optical channels into single spectral graph for elemental analysis and display.



PORTA-LIBS spectral ID of 99.998% Silver



Spectral ID of 1.9% Beryllium + 98.1% Copper

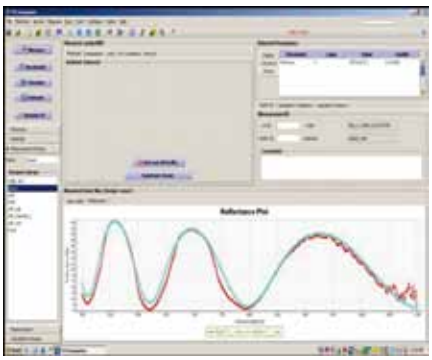
EPP2000 LSR Model	Wavelength Range in nm	Grating g/mm	Slit-14 nm res.
UV2	200-400	2400	0.20
VIS4	400-600	2400	0.20
VIS4b	600-800	2400	0.20
NIR3b	800-1000	1800	0.20

EPP2000 LHR model	Wavelength Range in nm	Grating g/mm	Slit-7 nm res.
UV3	200-300	1800	0.10
UV3b	300-400	1800	0.10
VIS3	400-500	1800	0.10
VIS3b	500-600	1800	0.10
VIS3c	600-700	1800	0.10
NIR3	700-800	1800	0.10
NIR2	800-925	1200	0.10

THIN FILM MEASUREMENT SYSTEMS FOR SINGLE AND MULTILAYER FILM STRUCTURES

FEATURES:

- Real-time Spectral Capture and Instrument control for Reflectance and/or Transmittance
- Includes Large Library of Materials Data
- Supports multilayer, freestanding, rough, and both thick and thin layer structures
- New materials can be easily added by measuring corresponding sample or importing data from file
- Supports Parameterized materials : Cauchy, Sellmeir, EMA (effective-medium approximation), Harmonic oscillator, Tauc-Lorentz oscillator, Drude-Lorentz



StellarNet's Thin Film measurement systems measure thickness and index of both single-layer and multilayer films in less than a second (up to 5+ layers). The non-contact thickness measurement systems come complete with instrumentation and software including a large library of materials data to support multilayer, freestanding, rough, and both thick & thin layer structures. With USB connectivity and the powerful, user-friendly TFCompanion software, daily complex measurements are made quick and simple! Several configurations are available for measuring thin films with spectral response in UV-VIS, VIS-NIR and NIR wavelength ranges (details on reverse).

STELLARNET'S THIN FILM MEASUREMENT SYSTEMS IDEAL FOR:

- Solar PV Films (TFPVs) including thin silicon, II-VI (primarily CdTe), CIGS, TCO stacks, and polymides.
- On-line thickness measurements of oxides, silicon nitride and many other semiconductor process films.
- In-situ measurement during MEMS patterning processes used to measure thick photoresist uniformity & thickness.
- Hardcoat measurements to measure thickness of protective films in the automotive and avia tion industries.
- StellarNet Systems are also typical in coating measurement applications.
- Measure LCD & OLED displays, cell gaps
- The thickness of rough layers on substrates such as steel, aluminum, brass, copper, ceramics and plastics ITO & polyamide structures.

The operating software includes a large library of refractive index (n) and extinction coefficient (k) values for the most common metallic, dielectric, amorphous and crystalline substrate materials. Analyze simple and most complex filmstacks - graded layers, periodic structures, very thick films, films on thin substrates, multi-sample measurements, etc.

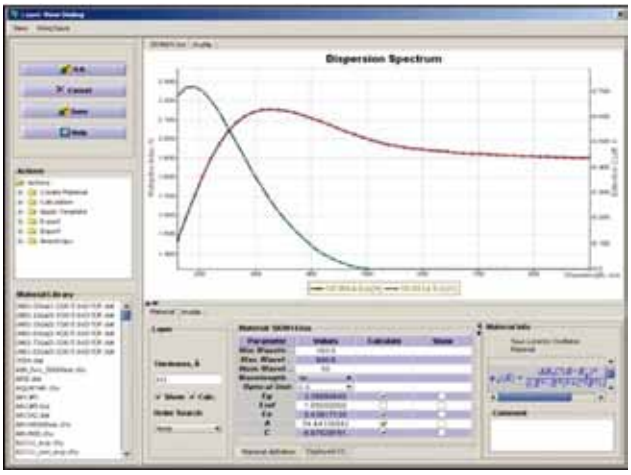
Measurements are made using reflectance/transmittance spectroscopy which measures the optical response of the layer structure. The user creates an optical model of the layer structure and uses data analysis to determine physical properties and the results are inferred from the best fit of measured & modeled data.

Simulation and error-estimator tools allow user better understand data and the expected precision. During in-situ, in-line or other long running measurements, conditions including surface roughness, ambient light, etc. may be changing. TFCompanion supports roughness and scaling correction that allows factoring in these effects.

TFCompanion also supports Parameterized materials e.g. Cauchy, Sellmeir, EMA (effectivemedium approximation), Harmonic oscillator, Tauc-Lorentz oscillator, Drude-Lorentz and many more approximations. These approximations represent optical dispersion of materials in desired spectral range using few coefficients that can be adjusted. For example, oxides are frequently represented using New materials can be added easily by measuring corresponding sample or importing data from the text file.

MODBUS TCP SERVER ADD-ON

The Modbus server plugin provides a communication interface over TCP IP. TFCompanion is deployed as a server and supports external program integration. This allows user to send a measurement request from any program and receive back the thickness results data.



Measured optical dispersion (n,k) of SiNx (ARC layer) represented using Tauc-Lorentz approximation.

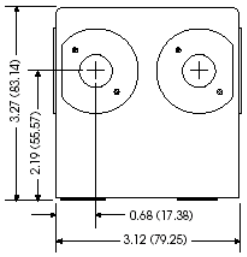
Transmittance of a free standing polymer. Estimated thickness is ~ 81.9um

SYSTEM	RANGE	RESOLUTION	THICKNESS	LAMP TYPE
TF-VIS	400-1000 nm	<2 nm	150A-20 um	Halogen SL1
TF-C-UVIS	190-850 nm	<2 nm	50A-20 um	Deuterium SL3
TF-C-UVIS-SR	220-1100 nm	<2.5 nm	50A-20 um	SL 1-F+ SL 3
TF-NIR	900-1700 nm	<5 nm	1000A-200 um	Halogen SL1
TF-VIS-NIR	400-1700 nm	<2 nm, 5>1000	150A-200 um	Halogen SL1
TF-C-UVIS-SRN	200-1700 nm	<2 nm, 5>1000	50A-200 um	Hal+Deut SL4

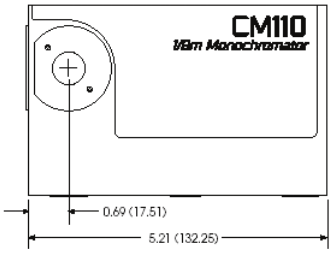
COMPACT 1/8 METER COMPUTER CONTROLLED MONOCHROMATOR / SPECTROGRAPH

Single piece base construction, direct grating drive, and anti-backlash gearing ensure this unit is rugged and stable enough for demanding applications. Loaded with CVI optics and able to hold two high quality gratings, the CM110 is ideal for spectrometry in the UV to IR spectrums. Each instrument is calibrated and certified prior to delivery and come with easy to use software.

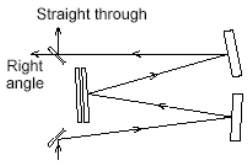
- Compact size - Only 51/4x31/4x31/4
- Connects to any computer via standard RS232 interface.
- Double grating turret, allow for a broad spectral range coverage
- May be factory configured as a mono chromator or a spectrograph
- Yields average efficiency TRIPLE that of a concave holographic grating monochro mator/spectrograph.
- Scans in both directions and in nanome ters, Angstroms, microns, wave-numbers, or eV.
- Change slits on the fly.
- Monochromator may be factory config ured for right angle or straight through beam path.
- Suitable for fluorescence, radiometry, pro cess control, colorimetry, tunable filtering, Raman spectroscopy, among others.



Front View Dimensions-inches (millimeters)



Side View



Optical Path

Specifications	
Design	Czerny-Turner, dual-grating turrets.
Focal Length	110mm
f/#	3.9
Beam Path	Straight Through standard, Right Angle provided on request.
Wavelength Drive	Worm and wheel withmicroprocessor control and anti-backlash gearing. Bi-directional. Usable in positive or negative grating orders.
Wavelength Precision	0.2nm
Wavelength Accuracy	±0.6nm
Slewing Speed	>100nm/second
Stray Light	$<10^{-5}$
Slits	Standard Set includes; 0.125mm, 0.15mm, 0.3mm, 0.6mm, 1.2mm and 2.4mm x 4.0mm.
Max Resolution	<1nm w/1200G/mm grating and standard slits.
Gratings	One to two gratings (30 x 30mm) must be purchased.
Software	Demonstration control program and LabView driver included.
Power	UL listed 110/220V power pack
Interface	RS232 Standard

Model	Description
CM110	Dual Grating Turret, 1/8 meter Monochromator
CMSP110	Dual Grating Turret, 1/8 meter Spectrograph

Options
Hand-held control module with function keys and display for local control
IEEE-488 interface
Interface cables
Gold optics

OPTIONS AND ACCESS ORIES, CMSERIES

Standard Ruled Gratings, Size = 30 x 30 mm

Part #	Ruling (g/mm)	Peak (nm)	Range (nm) @ > 30% T	Peak %T
AG2400-00240-303	2400	240	180 - 680	70
AG1200-00200-303	1200	200	180 - 450	65
AG1200-00300-303	1200	300	200 - 750	72
AG1200-00500-303	1200	500	330 -1500	82
AG1200-00600-303	1200	600	400 - 1500	80
AG1200-00750-303	1200	750	480 - 1500	85
AG0600-00500-303	600	500	350 - 1300	80
AG0600-01200-303	600	1200	800 - 3000	85
AG0300-00500-303	300	500	310 - 1100	80
AG0300-02500-303	300	2500	1500 - 6000	88
AG0150-00500-303	150	500	320 - 980	72
AG0150-04000-303	150	4000	2500 - 9000	93
AG0075-01700-303	75	1700	1100 - 2800	85
AG0075-08000-303	75	8000	5000 - 15000	82
AG-0045-01750-303	45	1750	1100 - 3000	78

NOTE: Ruled gratings blazed at different wavelengths and Holographic gratings are available on request. Response curves also available upon request.

OPTIONS

DK1201
Hand-held control module, 2 line x 20 character LCD display. Allows local operation of CM110/112 monochromators and CMSP110/112 spectrographs.

CMGPIB
IEEE-488/GPIB option for parallel interface operation of CM110 monochromators.

CMSP-TO-CM
Attachment to allow CMSP Spectrograph to operate as a monochrometer.

AB200
Single filter carrier that mounts directly between CM unit and accessories.

IR110
Infrared (gold) coating on CM110 mirrors. Enhances transmission by to 40% between 600 and 1100 nm.

IR110SP
Same as above for use with CMSP110

DK12AT
RS232 Cable for AT style computer

DK12PS
RS232 Cable for PS2 style computer

DK12MA
RS232 Cable for MAC style computer

DK1201 controller

SPECIAL SLIT SIZES
DKFS010 Pair, 10µm slits
DKFS020 Pair, 20µm slits
DKFS025 Pair, 25µm slits
DKFS050 Pair, 50µm slits

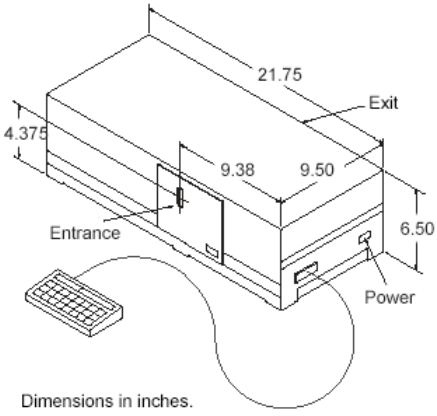
1/4 METER COMPUTER-CONTROLLED MONOCHROMATOR/SPECTROGRAPH

- Motorized slits
- Triple-grating turret allows high efficiency scanning across a broad spectral range
- May be factory configured as a monochromator or spectrograph ..
- Scans in both directions and with Con stant Spectral Resolution (CSR)
- Integrates with CVI filter wheel for auto matic filter switching
- Suitable for fluorescence and absorption studies,detector characterization, thin film measurement, etc.

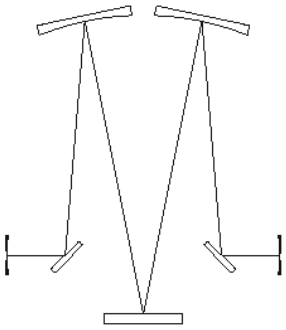
For DK240 models, List of grating

Grating Groove mm	Wavelength(nm)	Dispersion nm/mm	Resolution * (nm)/slit 0.01mm	0.125mm
1200	200	3.5	0.1	0.5
	800	3.3	0.1	0.4
	1500	1.9	<0.1	0.2
600	200	6.9	0.2	0.9
	1500	6.6	0.2	0.9
	3000	3.8	0.1	0.5
150	200	27.5	0.8	4
	5000	27.1	0.7	4
	10000	21.2	0.6	3

approximately equivalent to bandpass.



Dimensions in inches.


Optical Path

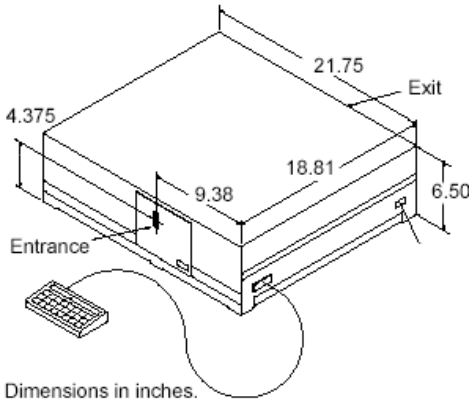
Specifications	
Design	Czerny-Turner. Triple-grating turret standard.
Focal Length	240mm
f/#	3.9
Wavelength Drive	Worm and wheel with computer control. Bidirectional. Usable in positive or negative grating orders.
Wavelength Precision and Reproducibility	0.007nm (with 1200 g/mm grating)
Wavelength Accuracy	± 0.30nm standard (with 1200 g/mm grating)
Scan Speed	1 to 1200nm/minute (with 1200 g/mm grating)
Stray Light:	< 0.01% at 220nm (NaI)
Slits	Unilateral, computer controlled, curved entrance and straight exit standard. Width :10µm to 3000µm, Height : 2mm to 20mm
Reciprocal Dispersion	3.2nm/mm (with 1200 g/mm grating)
Max Resolution	0.06nm (with 1200 g/mm grating)
Gratings	One to three gratings (68 x 68mm standard, 68 x 84mm optional) must be purchased.
Software	Demonstration control program and LabView driver included.
Power	100 - 240V, 50/60Hz, 60W 220/230/240V, 50/60HZ@ 0.5A
Interface	RS232 standard
Weight	35 lbs.
Options	DKBS - Bi-lateral slits DKGPIB - IEEE-488 communication interface (internal) DK2400 - Hand-held controllers for local control IR240 - Gold optics DK2PORT - Bifurcated fiber bundle for attaching 2 devices to 1 port AB300 - Automated 6 position filter wheel

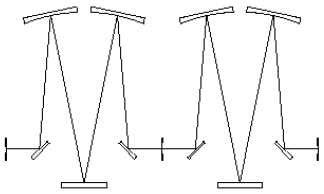
Model	Description
DK240	1/4 meter Monochromator
DKSP240	1/4 meter Spectrograph w / flat field and fine focus adjustment
DKSP240I	Imaging 1/4 meter Spectrograph

1/4 METER COUMPUTER-CONTROLLED DOUBLE MONOCHROMATOR/ SPEC-TROGRAPH

- Hands-off control of three slit assemblies and two grating turrets.Scans in both direc tions and with Constant Spectral Resolu tion.(CSR)
- Triple-grating turrets allow high efficiency scanning across a broad spectral range.
- Additive dispersion increases resolution and fluorescence studies, subtractive dispersion minimizes broadening of pulse sources.
- Integrates with CVI filter wheel for auto matic filter switching.

Model	Description
DK242	Triple Grating Turret, Double 1/4 meter Monochromator Specify additive or subtractive
DKSP242	Triple Grating Turret, Double 1/4 meter Spectrograph Specify additive or subtractive
DKSP242I	Triple Grating Turret,Imaging Double 1/4 meter Spectrograph Specify additive or subtractive



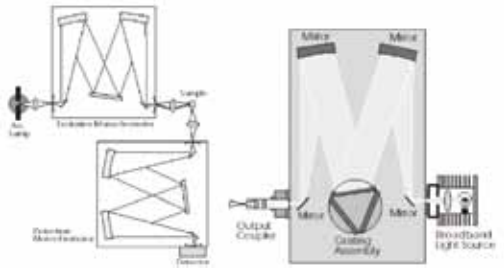


Specifications		
Design	Double cascaded Czerny-Turner. Triple-grating turrets standard in each section. Double-grating turret optional.	
Focal Length	240mm each section	
f/#	3.9 overall	
	Dual worm and wheel with electronic synchronization and computer Wavelength Drive control. Programmable in additive or subtractive dispersion with positive or negative grating orders.	
Scan Speed	> 1 to 1200nm/minute(with 1200 g/mm grating)	
Stray Light	< 10^{-9}	
Slits	Unilateral, computer controlled, Width : 10μm to 3000μm, Height : 2mm to 20mm	
Gratings	Two to six gratings(68 x 68mm standard, 68 x 84mm optional) must be purchased.	
Wavelength Precision	Additive	Subtractive
	0.01nm	0.01nm
Wavelength Accuracy	±0.3nm	±0.3nm
Reciprocal Dispersion	1.60nm/mm (with 1200 g/mm grating)	
Max Resolution	0.04nm	0.06nm
Pulse Broadening	200 ps max	10 fs max
Interface	RS232 standard.	
Software	Demonstration control program and LabView driver included.	
Power	110/120V,50/60Hz@1A standard.220/230/240V,50/60HZ@0.5A	
Options	DK24MS - Increased precision (microstep) option DKBS - Bi-lateral slits DKGPIB - IEEE-488 communication interface (internal) DK2400 - Hand-held controllers for local control IR240 - Gold optics DK2PORT - Bifurcated fiber bundle for attaching 2 devices to 1 port AB300 - Automated 6 position filter wheel	

1/2 METER COMPUTER-CONTROLLED MONOCHROMATOR/SPECTROGRAPH

- Motorized slits
- Triple-grating turret allows high effi ciency scanning across a broad spectral range
- May be factory configuerd as a mono chromator or spectrograph.
- Scans in both directions and with Con stant Spectral Resolution (CSR).
- Integrates with CVI filter wheel for au tomatic filter switching.
- Suitable for fluorescence and absorption studies, detector characterization, thin film measurements, etc.

Model	Description
DK480	1/2 meter Monochromator
DKSP480	1/2 meter Spectrograph w/ adjustment flat field and fine focus
DKSP480I	Imaging 1/2 meter Spectrograph



list of gratings

Grating Groove/mm	Wavelength(nm)	Dispersion nm/mm	Resolution (nm)/slit 0.01mm	0.125mm
1200	200	3.5	0.05	0.2
	800	3.3	0.05	0.2
	1500	1.9	<0.05	0.1
600	200	6.9	0.1	0.5
	1500	6.6	0.1	0.4
	3000	3.8	0.05	0.2
150	200	27.5	0.4	2
	5000	27.1	0.3	2
	10000	21.2	0.3	1

Specifications	
Design	Czerny-Turner, Triple-grating turret standard
Focal Length	480mm
f/#	7.8
Wavelength Drive	Worm and wheel with computer control. Bidirectional. Usable in positive or negative grating orders.
Wavelength Precision and Reproducibility	0.007nm standard (with 1200 g/mm grating)
Wavelength Accuracy	±0.3nm standard (with 1200 g/mm grating)
Scan Speed	1 to 1200nm/minute (with 1200 g/mm grating)
Stray Light	< 0.01% at 220nm (NaI)
Slits	Unilateral, computer controlled, curved entrance and straight exit standard. Width :10μm to 3000μm, Height : 2mm to 20mm
Reciprocal Dispersion	1.60nm/mm (with 1200 g/mm grating)
Max Resolution	0.03nm (with 1200 g/mm grating)
Gratings	One to three gratings (68 x 68mm standard, 68 x 84mm optional) must be purchased.
Software	Demonstration control program and LabView driver included.
Power	100 - 240V, 50/60Hz, 60W 220/230/240V, 50/60HZ@ 0.5A
Interface	RS232 standard
Weight	45 lbs.
Options	DKBS - Bi-lateral slits DKGPIB - IEEE-488 communication interface (internal) DK2400 and Palm Pilot - Hand-held controllers for local control IR480 - Gold optics DKPURGE - Purge port DK2PORT - Bifurcated fiber bundle for attaching 2 devices to 1 port. Interface Cables AB300 - Automated 6 position filter wheel

OPTIONS AND ACCESS ORIES, CMSERIES

Standard Ruled Gratings, size =68x68mm

Part Number	Ruling(g/mm)	Peak(nm)	Range(nm)@>30% T	Peak% T
AG2400-00240-686	2400	240	180-680	70
AG1200-00200-686	1200	200	180-450	65
AG1200-00250-686	1200	250	180-460	70
AG1200-00300-686	1200	300	200-750	72
AG1200-00500-686	1200	500	330-1000	83
AG1200-00600-686	1200	600	400-1500	80
AG1200-00750-686	1200	750	480-1500	85
AG1200-01000-686	1200	1000	550-1500	75
AG0600-00500-686	600	500	350-1300	80
AG0600-01250-686	600	1200	800-3000	85
AG0600-01600-686	600	1600	950-3000	93
AG0300-00500-686	300	500	310-1100	80
AG0300-02000-686	300	2000	1200-4000	88
AG0300-02500-686	300	2500	1500-6000	88
AG0300-03000-686	300	3000	1800-6000	80
AG0150-00500-686	150	500	320-980	72
AG0150-04000-686	150	4000	2500-9000	93
AG0075-08000-686	75	8000	5000-15000	82
AG0050-00600-686	50	600	400-1200	78
AG0050-12000-686	50	12000	7500-20000	82

NOTE: Ruled gratings blazed at different wavelengths and Holographic gratings are available on request. Wide gratings (68 x 84mm) are available add 'W' at the end of the part number. Response curves also available on request.

accessories

DKBS
Bi-lateral slit option for DK240/ 242/480. Both sides of slits are automatically controlled for maintaining image centering when wider slits are necessary (tolerance ±10µm).

DKGPIB
Internal IEEE-488/GPIB communication interface option for DK240/242/480. Separate output connector from Monochromator.

IR240
For use with DK240. Infrared (gold) coatings on optics for DK240. Enhances transmission by up to 40% between 600 -1100nm. Not suitable for work below 600nm.

IR240SP
Same as above, for use with DKSP240.

IR242
For use with DK242. Infrared (gold) coatings on optics for DK242. Enhances transmission by up to 80% between 600 - 1100nm.

IR242SP
Same as above, for use with DKSP242.

IR480
For use with DK480. Infrared (gold) coatings on optics for DK480. Enhances transmission by up to 40% between 600 -1100nm.

IR480SP
Same as above, for use with DKSP480.

DK2401
Hand-held monochromator controller for DK240/242/480. Allows local control of monochromator when computer is not available or in series with a computer.

DK24PS
RS232 Cable assembly for PS/2 style computer.

DK24MA
RS232 Cable assembly for MAC style computer.

DK24IC
IEEE-488/GPIB universal cable assembly.

AB300
Six position, 1" diameter automatic filter wheel assembly that bolts directly to DK entrance. Recieves power and commands directly through DK unit.

DKSP-TO-DK
Attachment to allow DKSP Spectrograph to operate as a monochrometer. It includes CM standard 6-fixed slit set.

AB200
Single filter carrier that mounts directly between DK unit and accessories.

DK2401

PbS/PbSe ARRAY SPECTROMETER

- Low Noise
- Cooled, Stable Operation
- 256 Detection Elements
- Accommodates spectral measurements in the 1.0 to 3.0 micron (PbS) or 1.5 to 5.0 micron (PbSe) region
- Optical input direct to slit or via fiber

The Choice for IR Spectral Applications

The SM301/SM301-EX is a versatile, high performance PbS/PbSe array spectrometer. Its active components include a TE cooler and a 256-element PbS/PbSe detector element array. Operation of the unit for research applications is easy with the included Windows based SM32Pro-based analysis software. The system is ideal for spectroscopic applications in the 1.0 to 3.0 micron (PbS) or 1.5 to 5.0 micron (PbSe) region.

Available system options include a built-in high-speed shutter and optical blank pixels for setting dark current offsets. The SM301/SM301-EX includes thermoelectric cooling to guarantee long-term operational stability.

The SM301-FCM employs a 256 element lead sulfide (PbS) detector array to generate spectra in the 1.0 to 3.0 micron wavelength region. After initial calibration, which typically takes less than one minute, data for all 256 wavelengths is generated simultaneously and continuously. The detector array is thermoelectrically cooled ensuring long-term operating stability. A tungsten halogen lamp is used as the light source and is stable after a power-on warm up period of about ten minutes. The instrument has been uniquely designed without moving parts, providing enhanced signal/noise and sensitivity and incorporates readily available industry standard components.

The detector and light source with electronics are built into a rugged aluminum case. At less than 20 pounds (9 Kg) the instrument also provides portability for remote and industrial process control applications. Operation of the unit for research is easy with the included Windows based analysis software through a USB interface. The software includes a wide range of options including saving data for analysis by Chemometric software.

Conventional spectrophotometers cost very high, are large in size, can require extensive calibration processes and may take several hours to generate spectra of various samples through scanning processes. The SM301-FCM is revolutionary at very low cost, no moving parts with data available minutes after power-on. Companies, universities, and agencies with limited budgets can now afford an infrared spectrometer due to the low cost and portability of the SM301-FCM. The unit is used to generate transmission spectra for liquids and solids in the 1.0 to 3.0 micron wavelength region including; alcohol, H2O, acetone, nitrogen, potassium, and various materials such as plastics.

The standard unit provides transmission data and is available with four weeks lead-time. It can be factory configured to meet application needs for transmission, absorbance, and other measurements including the possibility to extend the wavelength to 5.0 microns.

CHAPTER 1 TEST-MEASUREMENT

PHOTOMULTIPLIER DETECTION SYSTEM

AD111

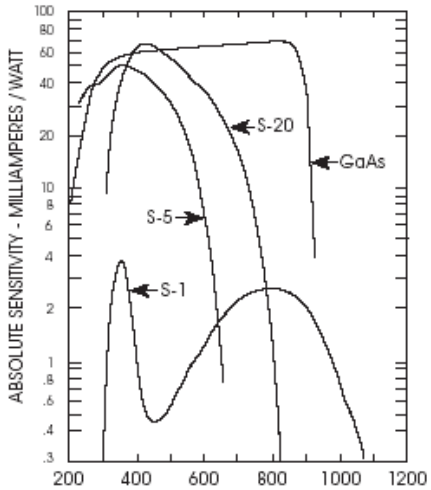
- Provides a complete detection system for DK series monochromators.
- Easy RS232 interface.
- Wide selection of PMTs.

PMTs for or use with the AD110:

Part #	PMT Type	Wavelength Range And Spectral
AD311	*R928P	185-900nmS-20(extended)
AD321	R212	185-650nm;S-5
AD322	R406	400-1100nm;S-1
AD323	R777	185-850nm:s-20
AD324	R636	185-930nm:GaAs(extended)

* selected for low noise
** Other PMTs are available by request

Model	Description
AD110A	Photobyte - P™ Photomultiplier Detection System
AD100	PMT Housing, for 1-1/8Ó side on PMTs from AD3xx series



Typical Photocathode Spectral Response Characteristics

Power Supply, Amplifier, Housing, Software In ONE Package

The AD111 is a convenient computer controlled photomultiplier detection system for use with Spectral Products¡¦ Digikrom line of monochromators. It features a detector housing that has a dynode divider chain and direct anode connection, mounts directly to exit-slit ports of Digikrom monochromators, and accommodates side-on photomultiplier tubes. (PMT¡¦s must be ordered separately.) It also features the Photomultiplier Amplifier, a compact electronic unit containing the preamplifier and high voltage power supply for the PMT. Coaxial cables for the high voltage and PMT output current signals connect between the detector housing and the amplifier unit.

The entire operation, including wavelength and bandpass selection, is controlled with a customer-supplied PC. (The Digikrom monochromator and the AD111 utilize one serial for monochromator and one USB port for AD111) An easy to use program is also included that allows full control of both PMT and monochromator. It graphically displays wavelength versus intensity, intensity versus time and allows ASCII data storage for importing to other user interfaces as desired.The AD111 is a convenient computer controlled photomultiplier detection system for use with our Digikrom line of monochromators. It features a detector housing that has a dynode divider chain and direct anode connection, mounts directly to exit-slit ports of Digikrom monochromators, and accommodates side-on photomultiplier tubes. (PMT's must be ordered separately.)
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Feature	Value
Wavelength Range:	Per PMT detector (see below)
High Voltage Range:	0-1000 VDC
A/D Resolution:	16 bit (Successive Approximation)
Response Rate:	USB2.0
High Voltage Resolution:	244mV
Input Voltage:	± 5 VDC
Data Resolution:	76.3 µV, (data range = 0-5V)
Time Constant per step:	Selectable from 1µS to 10 sec
Conversion time:	2µS (Maximum)
USB 2.0 Transfer Rate:	480 Mbits/sec
Amplification Gains:	x1 to x10 (programmable)
Supply Voltage:	100-240 VAC
Current Input Range:	0 to -5µ A

PHOTODETECTOR MODULE

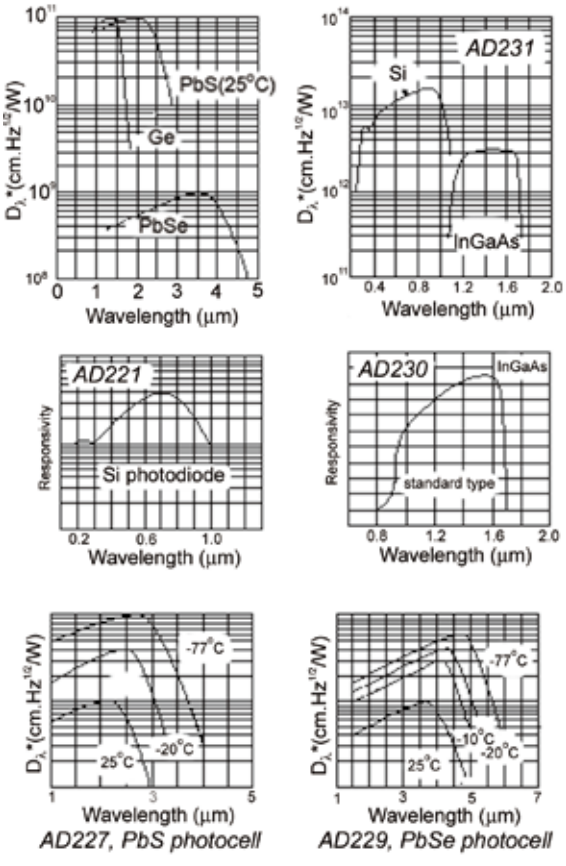
Part#	Detector	Size (mm)	Range (nm)	Temp	Sensitivity	Dark resistance or current
AD421	Si	5.8X5.8	190-1000	25°C	0.4A/W at 1550nm	20pA
AD427*	PbS	3X3	1000-2900	25°C	$5x10^4$V/W at 2200nm	0.5 to 2.5MΩ
AD429*	PbSe	3X3	1500-4800	25°C	$5x10^2$V/W at 4µm	0.3 to 1.5 MΩ
AD430	InGaAs	3dia	800-1700	25°C	0.95A/W at 1550nm	15nA
AD431	Si/InGaAs	2.4x2.4	300-1700	25°C	0.45A/W at 0.94µm	30pA
		1 dia		25°C	0.55A/W at 1.55µm	1nA
The following require the AD131 TC Thermoelectric Controller module in addition to the AD131 Photdetector or module						
AD427-C*	Cooled PbS	4x5	1000-2900	-10°C	$8x10^4$ V/W at 2.2µm	0.5 tp 10 MΩ
AD429-C*	Cooled PbSe	3x3	1500-4800	-10°C	$1x10^3$ V/W at 4 µm	1.7 to 7 MΩ
AD430-C	Cooled InGaAs	3 dia	800-1700	-10°C	0.95 A/W at 1.55 µm	1nA
AD431-C	Cooled	2.4x2.4	300-1700	25°C	0.45 (25°C) at 0.94 µm	30pA
	Si/InGaAs	1 dia		-10°C	0.55 at 1.55 µ m	0.07nA

*require 450Hz chopped optical signal

The AD131 is a computer controlled data acquisition device for photodiode detectors, covering a wide wavelength range with Si, InGaAs, PbS, and PbSe photocells from the AD4x series. The unit contains an internal programmable charge integration amplifier, a 20-bit A/D converter, and a microprocessor with a RS232 interface. Signal processing functions take place internal to the AD131 to greatly reduce the noise level of the measured signal, including Correlated Double Sampling (CDS) and signal oversampling for digital filtering. Windows¨ based software allows for stand-alone operation or integrated control and data acquisition with any of the DK monochromators.

Adding the AD131-TC Thermoelectric Controller module to the AD131 enables the use of AD4x series heads with cooling capability (designated by a -C on the model name). AD4x heads are easily exchanged on the same AD131 unit.

TYPICAL SPECTRAL AL RESPONSE CHARACTERISTICS



AD131

- Combines photodiode detector, programmable charge integrator, and data conversion in a compact package.
- Expandible with add-on modules for cooled sensor capability.
- Null function for background noise subtraction.
- Programmable gain ranges.
- Windows¨ based data acquisition software included.
- Easy to install and use on any Monochromator.
- Internal data averaging.

Specifications	
Wavelength Range	Per detector
A/D Resolution	20 bit
Sample Rate	Variable; integration period dependent.
Max. Samples Averaged per Measurement	128
Input Current Ranges	7.8mA max.
Internal Test Current	100nA ± 20nA
Communications	RS232
Software	
Windows control program for stand-alone use or integrated with Monochromators.	

Model	Description
AD131	Photodetector Module
AD131-TC	Thermoelectric Controller Module
	Order Detector Heads separately
AD421	Detector Head Type - Si
AD427	Detector Head Type - PbS
AD429	Detector Head Type - PbSe
AD430	Detector Head Type - InGaAs
AD431	Detector Head Type - Si/InGaAs
The following detector heads are for use with the AD131-TC	

Model	Description
AD427-C	TE Cooled
AD429-C	TE Cooled
AD430-C	TE Cooled
AD431-C	TE Cooled

CHAPTER 1 TEST-MEASUREMENT

SP800 800Hz OPTICAL CHOPPER

- Provides 800Hz chopped optical signal for use with PbS and PbSe Infrared Detectors.
- Mounts directly to all Spectral Products monochromators, detectors, light sources, filter wheels and filter carriers.
- High Reliability
- Light Spectrum Purity
- Low Profile
- Small Footprint when integrated with light source or detector
- Low Power
- High Shock Resistance
- High Temperature Resistance

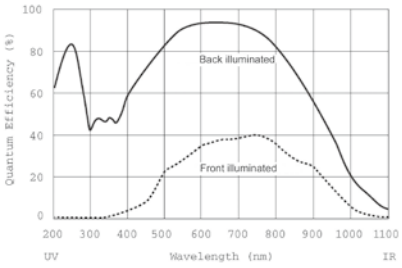
The Spectral Products 800 Hz optical chopper provides many unique advantages over a motorized chopper wheel or reciprocating blade. In an industrial product, the compact size, frequency stability and reliability permit many tough applications to become possible. The aperture motion or chopper window is produced by a high-Q resonating tuning fork that is highly resistant to vibration and shock. There is basically no moving part to jam or to wear down.

Spectral Products choppers will quickly reach stability after “power-on” in less than 2 seconds. Power consumption is typically around 20mW. Due to the compact size and special alloys, Spectral Products choppers can be mounted in close proximity to many hot filament sources.

COOLED CCD CAMERAS

A high quality cooled CCD Camera to package with your 1/4 meter , or 1/2 meter Dk Spectrograph.

Sophisticated spectroscopic applications require the ultra low-noise and low-temperature cooling features of cameras that normally cost tens of thousands of dollars. By employing superior optical coupling, stray light rejection, and versatile data acquisition software you can assemble your own affordable high-performance CCD/Spectrograph system. By offering the best value in CCD spectroscopy, you can select high resolution spectrographs for use with cameras operating from 200nm to 1100nm. Multiple input imaging is also supported by the larger 1/4 meter and 1/2 meter spectrograph systems. Cooled CCD cameras are available for your specific application and budgetary needs. Accessories such as fibers/fiber couplers, special probes, and light sources are also available to help complete your system.



Quantum efficiency curves for front and back illuminated CCDs.

Model	Description
AD202	CCD for CM or DK Series
AD205	CCD for DK Series
AD206	CCD for DK Series

Camera Specifications

	AD202	AD205	AD206
Wavelength Range	200 - 1100nm	200 - 1100nm	200 - 1100nm
Array (pixels)	512 x 122	1024 x 122	1024 x 250
Array Dimensions	12.3 x 2.9mm	24.6 x 2.9mm	24.6 x 6.0mm
Pixel Dimensions	24 x 24µm	24 x 24µm	24 x 24µm
Array Manufacturer	Hamamatsu	Hamamatsu	Hamamatsu
	S7031-0907	S7031-1007	S7030-1008
Read Noise typical (e-RMS)	10^{-15}	10^{-15}	10^{-15}
Dark Count (e-/pixel/sec)	4-5 @ -20°C	4-5 @ -20°C	4-5 @ -20°C
Well Depth (binned)	600,000 e-	600,000 e-	600,000 e-
Cooling	TE -40°C	TE -40°C	TE -40°C
Binning	1 x 1 to 8 x 64	1 x 1 to 8 x 64	1 x 1 to 8 x 64
	on chip	on chip	on chip
Exposure Time	0.03 sec min.	0.03 sec min.	0.03 sec min.
Remote Triggering	Yes	Yes	Yes
Shutter	Yes	Yes	Yes
Digital Resolution	16-bits	16-bits	16-bits
Illumination	Back	Back	Back

Additional AD2xx Series System Specifications

Frame Sizes	Full frame and subframe modes.
Cooling	Thermoelectric cooler with forced air. 45°C below ambient temperature. Soft ware programmable temperature.
Temperature Stability	± 0.1°C
System Gain	3.0 e-/ADU
Camera Head	6061-T6 Aluminum body, hard blue anodized. Tripod mount, BBAR coated silica windows. Camera head is 6x6 inches x 1.8 inches thick, plus additional 1.2" for heat sinks and fans. Weight is 3 lb.
Operating Environment	Temperature: -30° to 80° F. Relative humidity: 10 to 90% noncondensing
PC Interface	Parallel port. 10' cable. 37 pin D connector at camera end. 25W maximum power with shutter open and cooling maximum.
Software	KestralSpec for Windows (sold separately). Development drivers included
Options	Remote trigger; remote shutter.

SELECTION GUIDE (at 500nm)

The following Spectrographs are compatible with our cooled CCD Cameras

	AD202		AD205		AD206	
	Bandwidth	Resolution	Bandwidth	Resolution	Bandwidth	Resolution
SPECTROGRAPHS	(nm)	nm/pixel	(nm)	nm/pixel	(nm)	nm/pixel
CMSP110 (maximum Flat Field = 12mm)						
DKSP240 (maximum Flat Field = 26mm)						
1200 g/mm	36	0.07	70	0.07	70	0.07
600 g/mm	72	0.14	140	0.14	140	0.14
300 g/mm	144	0.28	280	0.28	280	0.28
150 g/mm	288	0.56	560	0.56	560	0.56
DKSP242 (maximum Flat Field = 26mm)						
1200 g/mm	18	0.035	35	0.035	35	0.035
600 g/mm	36	0.07	70	0.07	70	0.07
300 g/mm	72	0.14	140	0.14	140	0.14
150 g/mm	177	0.56	280	0.56	280	0.56
DKSP480 (maximum Flat Field = 26mm)						
1200 g/mm	18	0.035	35	0.035	35	0.035
600 g/mm	36	0.07	70	0.07	70	0.07
300 g/mm	72	0.14	140	0.14	140	0.14
150 g/mm	144	0.56	280	0.56	280	0.56

AUTOMATED FILTER WHEEL

Specifications	
Accuracy	±0.004" from center of optical axis
Filter Change Speed	
	0.5 second per position
Drive	Stepper Motor
Capacity	Six 1.0" diameter filters
Clear Aperture/Maximum Filter Thickness	
	Slot 1.0" x 0.44" / 0.25" thick
Control	DCE, 8 bits protocol, no parity, RS232 (GPIB optional).
Software	Demo program and LabView¨ driver provided.
Manual Control	Push button switch with 1 position advance
Power and Control supplied through monochromator.	

A six position wheel that integrates with DK1/4 and 1/2 meter monochromators. Plugging directly into the DK, resident software commands allow easy manipulation to filter higher order energy. It can also be controlled by your hand-held controller. The AB300 uses 1" diameter filters.

Plug-in and Go with DK240/242/480. 6 positions - 1" filters.

APPLICATIONS

Not only are these filter wheels ideal for use with monochromators, spectrographs and spectrophotometers, but they can be easily integrated with microscopes, flow cytometers, fluorimeters, and fluorescence photometers. Neutral density filters will allow for photometric linearity and dynamic range studies. Modern communication multiplexing capabilities provide the capability of combining any number of these filter wheels together in an integrated system.

- RS232 controlled (GPIB optional).
- Multiple Filter Wheel systems available.
- Threaded capture rings allow easy change of filters (-T models only).

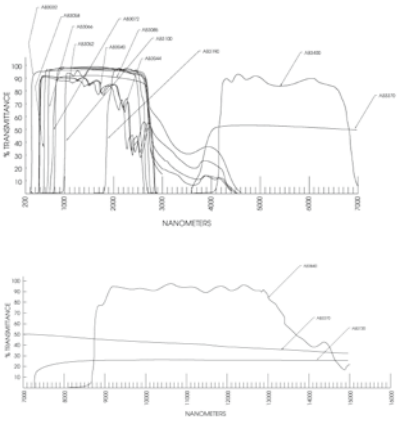
Sorting Filters

Specifications	
Size	25.4mm
Thickness	2.1mm typical
Material	Schott optical glass or equivalent
Surface Quality	Commercial polish

Part Number	Transition TM(nm)	Tolerance (± nm) TM
AB3032	320	7
AB3040	400	7
AB3044	440	7
AB3052	520	10
AB3058	580	5
AB3066	660	5
AB3072	720	10
AB3085	850	10
AB3100	1000	25
AB3190	1900	35
AB3300	3000	50
AB3370	3700	80
AB3400	4000	150
AB3580	5800	100
AB3720	7200	185
AB3840	8400	300

- Provides blocking of light radiation below filter specific
- transition or cut-on wavelength.
- Made from semi-conductor material.
- Allows for various mounting options.
- Offers several filter choices.

The AB30XX Series of Long Pass Order Sorting Filters provide blocking of light radiation below the filter specific transition or cut-on wavelength. They can be mounted in in the AB300 Automated Six Position Filter Wheel. The AB3032, AB3058, AB3066. AB3072, and AB3085 are long-wave pass, color glass filters and are available in 25.4 mm diameter. The AB3100, AB3190, AB3300, AB3370, AB3720, AB3400, and the AB3840 Order Sorting Filters are made of semiconductor materials. These long-wave pass filters are anti-reflection coated for operation from the longpass wavelength to at least twice that wavelength. The blocking average for all of the filters is 0.1% below the passband through the UV wavelengths.



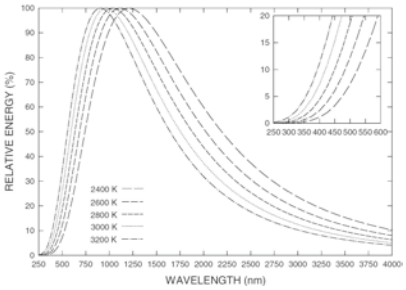
Transmittance curves of Order Sorting Filters

TUNGSTEN-HALOGEN VISIBLE SOURCE ASSEMBLY

ASB-W-020

- Offers excellent color temperature stability.
- Provides illumination for applications through optical fiber.
- Focus adjustable light source SMA and fiber bundle adaptor.
- Features built in current regulation.

Specifications	
Lamp	Tungsten-halogen
Power	Wall transformer, 120 VAC, 50/60 Hz to 24 VDC at 2.0 amps. 220 VAC version available
Current Regulation	Built-in, ± 0.4%
Color Temperature	3100°K
Bulb Life	2,000 hrs. average (nominal)
Spectral Distribution	Near blackbody (see Figure)
Housing	Aluminum, forced air cooled, Limited focus adjustment
Connector	SMA Fiber connector
Options	Spare lamp ASB-W-020B Mounting flange for 10mm fiber bundle Optical bench mounts Specify FC, ST or CS for specific fiber couplers.



Spectral distribution of light emitted by blackbodies at various color temperatures indicated in Kelvin (K)

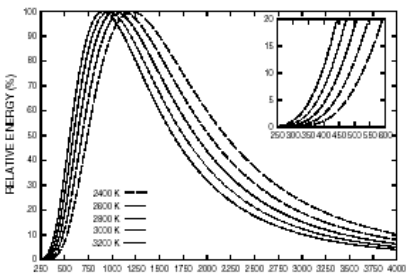
Model	Description
ASB-W020	Visible Source Assembly
ASB-W020B	Spare Lamp,20 watt ungsten-halogen

ASB-W-030

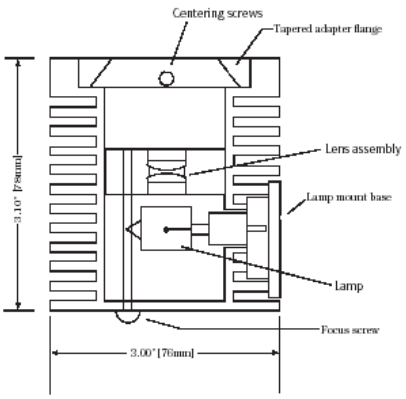
Tungstem-Halogen Visible Source.

- Provides optimal illumination to monochromators.
- Offers excellent color temperature stability.
- Features adjustable constant current power supply.
- Contains focusable fused silica lens assembly.
- Uses AF Series for remote fiber optic illumination.

Model	Description
ASB-W-030	Visible Source Assembly
ASB-W-030B	Spare Lamp, 30 Watt Tungsten-halogen



Spectral distribution of light emitted by blackbodies at various color temperatures indicated in Kelvin (K)



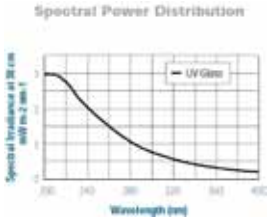
Lamp cross section

Specifications	
Lamp:	
Type	Tungsten-halogen
Filament size	1mm x 4mm
Power input	30 Watts (nominal)
Light Output	800 lumens (nominal)
Current	2.75 A (nominal)
Average Life	400 hours (nominal)
Color Temperature	3100°K
Spectral distribution	near blackbody (see Figure)
Mount	Tapered flange, adjustable, post mounting for standalone operation
Housing	Air cooled with focusable fused silica doublet collection lens, f/1.9 collection and f/3.9 output.
Power Input:	115 VAC, 50/60 Hz, 1 amp (standard) 220 VAC, 50/60 Hz, 0.5 amp (optional)
Power Output	
Type	constant current DC
Range	2.0 amp to 3.5 A
Regulation	0.05%
Options	Spare lamp ASB-W-030B AF Series for remote fiber optic illumination. An infrasil lens assembly is available by request for better lamp emission at wavelengths beyond 2600nm.

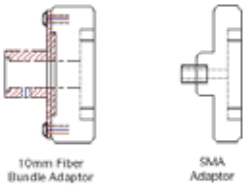
CHAPTER 1 TEST-MEASUREMENT

UV AND UV TO IR SOURCE ASSEMBLY

Deep UV Deuterium light Source Assembly



Spectral Output of ASB-D-030R



Fiber Adaptors (Specify when ordering)

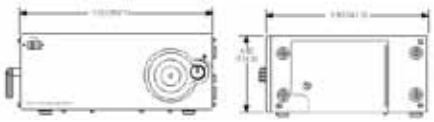
- Provides maximum possible illumination.
- Contains adjustable quartz lens assembly for optimum coupling.
- Quiet deuterium lamp.
- Assures maximum stability and lifetime of lamp.

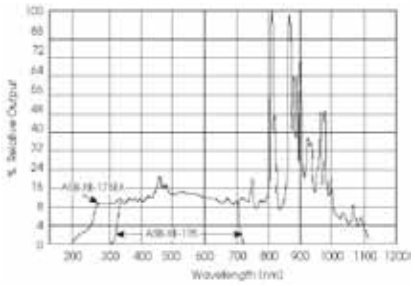
Specifications

Lamp:		Operating	
Type	Deuterium with fused silica jacket mounted and prealigned.	Temperature	5-35oC
Power input	30 Watt (nominal)	Regulation	+ 10 mA
Lamp current	300 ± 30 mAdc	Stability	100 ppm/oC
Average Life	1000 hours (nominal)	Options:	Spare lamp (mounted and prealigned)SMA Adaptor 10mm Fiber Bundle Adaptor Specify SM FC ST CL or CS for specific fiber couplers.
Lamp Housing	Adjustable quartz doublet collection lens. Convection cooled.		
Power Supply:			
Power input	115 vac, 50/60 Hz, 3 amps. 230 vac, 50/60 Hz, 1 amp, opticonal		
Power output	Constant current dc, 60-120vdc, selectable 300 mAdc		

Model	Description
ASBN-D130	Ultraviolet Fiber Lightsource Assembly
ASBN-D130B	Spare Deuterium Lamp Assembly
ASBN-D130	With Two 30W Deuterium Lamp

Xenon Fiber optic Light Source





FEATURES

- High Color Temperature (5600^{O}K)
- CERMAX¨ Collimated Xenon Lamp
- Brightness Control (0 - 100%)
- Portable and Light Weight
- Cool White Light with the UV/IR Suppressed ASB-XE-175
- Provides optimum illumination to fiber optics for remote applications.

APPLICATIONS

- Endoscopy
- Spectroscopy
- Microscopy
- Visual Inspection
- Boroscopes
- Machine Vision
- Optical Scanning
- Data and Video Projection

Specifications

Lamp		Environment	
Type	CERMAX¨ LX175F	Operating	+6 to +45^{O}C
Power	200 W (maximum)	Storage	-40 to +70^{O}C
Power Range	150-200 W	Front Panel	Brightness Control (0-100%) Output Aperture
Color Temperature	5600^{O}K	Side Panel	Main Power (On/Off)
Current	14 A DC (nominal)		Line Cord Jack (IEC 320)
Average Life	Typically 1000 hours (500 hours minimum)		(US to IEC Line Cord included) Fuse Holder - MDL-5
Voltage	12-17V (14V nominal)	Caution	Damage to glass or fused silica fiber optic lightguides can occur due to high temperatures associated with Xenon lamps. Use our liquid light guides (order separately).
Trigger Voltage	25 Kilovolts		
Boost Voltage	140-200 Volts		
Current Leakage	< 300mA		
Weight	7.5 lbs. (3.4 kg)		
Input Line	95-136 VAC, 50/60 Hz (only)		
Input Current	3.5 A.		

Model	Description
ASB-XE-175EX	Extended Xenon Source(200-1100nm)
ASB-XE-175	Ozone Blocking Xenon Source(320-700nm)
ASB-XE-175EX-BUV	Replacement Extended bulb FDHGD
ASB-XE-175-BF	Replacement Ozone Blocking bulb
AF5000-50001111-S10S	Liquid Light Guide(270-720nm) S Type
AF5000-50001111-V10S	Liquid Light Guide(340-750nm) V Type

PORTABLE SPECTRAL CALIBRATION SOURCE

Portable wavelength Cal. Source

Fiber coupling

- Argon enhanced Mercury portable calibration lamp.
- Highly repeatable wavelength, linewidth, and intensity calibration standard.
- Easily mounts to monochrometers and spectrographs.
- Couples to AF Series coupler for fiber optic output.
- Convenient Battery with AC adapter for use in the field.

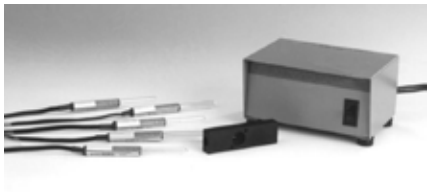
The atomic emission of the ASC Series lamps consists of discrete spectral lines of defined wavelength, spectral width, and relative intensity. Their stability makes them extremely useful for calibration, alignment, and resolution testing of spectrophotometric instrumentation, including monochromators, spectrographs, spectrophotometers, and detectors. Portable battery operation for field use.

Specifications	
Lamp	Atomic emmission lamps with double bore fused silica tubing
Housing	Black anodized Aluminum
Dimensions	4.125" x 1.25" x 0.875" (HxWxD)
AC Power	Wall transformer, 120 VAC, 50/60 Hz to 9 VDC
Battery	9 V
Battery Life	25-45 minutes On-time
Options	AF Series fiber optic couplers

Lamp	Application
Mercury	Strong lines throughout UV-VIS
Argon	Lines between 700-1000nm; lines with 1nm spacing for resolution testing

Direct coupling

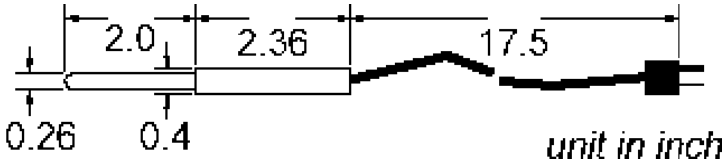
Spectral Calibration Lamps and Lamp Assembly



ASL series

- Accommodates compact pencil-style calibration lamps. Offering various lamp selections.
- Provides highly repeatable wavelength, line width, and intensity calibration standards.
- Allows quick-on/quick-off instrument mounting. Features post mount for optical bench.
- Five elemental emitters - Hg, Ne, Xe, Ar, and Kr.

Five different calibration lamps are available: Mercury (Hg); Neon (Ne); Argon (Ar); Krypton (Kr); and Xenon (Xe). The Mercury lamp has strong spectral lines throughout the UV-VIS region. The Neon lamp has a large number of lines of mid to high intensity in the 800nm to 3400nm range, which makes it useful for resolution testing in the NIR region. There are also a number of closely spaced lines of similiar intensity over this wavelength range. The Xenon lamp's distribution of lines of moderate intensity between 800nm and 3500nm is useful for calibration in the IR. These emission lines are relatively close to wavelengths used by fiber optic communication systems for data transfer. Testing of fibers and detectors for these systems can be performed without the inherent high cost of lasers for light sources. The Argon line spectrum features a number of lines of consistent high intensity between 700nm and 1000nm. These lines at such a high intensity are excellent for calibration in that region. There are also several lines spaced less than 1 nm apart that can be used for resolution testing.



Note: These lamps produce intense ultra-violet radiation and require that appropriate precautions be taken when used. Avoid prolonged exposure of eyes or skin to the lampsÕ rays.

Specifications	
Package	Sealed double bore fused silica tubing
Warm up	2-4 minutes
Lamp Lifetime	5000 hours (500 hours for Neon)
Power Supply	110 to 230 VAC, 50/60 Hz
Line Cord	6 ft. (1.83m), 3-wire ground type SJ
Output Connection	16" (40.6 cm) cord with polarized female connectors
Output Voltage	1600V rms, +10%, -0%
Output Current	0.018 Amp, +10%, -0%
Ambient Temperture	15°C-35°C
Options	AF2 Series Fiber Optic Couplers.

Model	Description
ASC-HGAR-DC	Argon Enhanced Mercury Spectral Calibration Lamp
ASC-AC	Spectral Calibration Lamp Assembly Includes power supply and lamp housing.
ASC-HG	Mercury (Hg) Spectral Calibration Lamp
ASC-NE	Neon (Ne) Spectral Calibration Lamp
ASC-XE	Xenon (Xe) Spectral Calibration Lamp
ASC-AR	Argon (Ar) Spectral Calibration Lamp
ASC-KR	Krypton (Kr) Spectral Calibration Lamp

SAMPLING ACCESSORIES

AB250 Fiber Coupled In-Line Attenuator

AT-IS-1 Integrating sphere (1" sphere)

AT-IS-1.5 Stand alone or directly attachable Integrating sphere (1.5" sphere) with internal source.

AT-IS-4 Stand alone Integrating sphere (4" sphere)

AT-SHC 1/2" x 1/2" cuvette holder with Fiber optic attachment.

AT-SHC-4 1/2" x 1/2" cuvette holder with four ports.

AT-SHL-9 Collimator assembly with lens.

AT-WRS White reflectance standard for reflectance measurement use.

AT-SHC-4 Four port curvette holder

AT-IS-4 Integrating Sphere

AT-IS-1.5 Integrating Sphere

AT-SHC Fiber Optic Sample Holder (shown with a light source)

INTEGRATING SPHERES


1" Integrating Sphere

TECHNOLOGY:

An integrating sphere is a hollow sphere coated internally with a matte finish, diffusing type material. The sphere is provided with ports or openings for an incoming beam of light, a sample specimen and a detector. Integrating spheres typically function as a light collection device. The collected light can then be used as a diffuse source or as a measurement device.

OPERATION:

Integrating spheres operate by allowing light to enter the sphere through a sample port, then through multiple reflections is scattered uniformly around the interior of the sphere by the diffuse internal sphere coating. The diffused light is then detected at a port configured with a detector device.

EFFICIENCY:

Integrating sphere efficiency is determined mainly by the physical size of the sphere, the number of ports and most importantly the diffuse nature and reflectivity of the internal sphere coating.

SPHERE CONSIDERATIONS:

Selection of the appropriate integrating sphere for your application typically can be determined by the following important factors:

INTERNAL SPHERE COATING:

The coating within the inside surface of the sphere must be a very efficient diffuse coating with high reflectance in order to deliver consistent integration and low absorption loss. Spectral Products uses a proprietary coating (ReflectraSpec) to provide high diffuse reflectance of light over a wide wavelength range. ReflectraSpec is effective from 400nm up to 2500nm. For 500nm to 20µm applications, diffuse AuSpec gold-coated spheres are available. For 180-400nm UV applications please contact Spectral Products regarding our new UVSpec coating.


1.5" Integrating Sphere

SPHERE SIZE:

The inside diameter of the sphere must be a minimum of 1.5 times larger than any device mounted within the sphere such as light source, sample or detector.

PORTS:

No more than 5% of a sphere internal surface area should be used for ports in order to provide proper sphere integration. If the number of ports exceeds 5%, a larger sphere should be considered. Contact Spectral Products for help determining surface to port area.

APPLICATIONS:

Integrating spheres are used in many scientific research and industrial applications such as:

- Color Measurements
- Lamp Measurement Photometry
- Fluorescence Studies
- Reflectance of specular or scattering samples
- Laser & LED Measurements
- Uniform Light Source

ISC INTEGRATING SPHERES

- Classical Integrating Sphere
- Four ports
- Post Mount

ISC integrating spheres come standard with ReflectraSpec coating (effective from 400nm-2500nm, four orthogonal ports (please specify orthogonal, 8 degree or custom configuration). Wall construction is cast aluminum (allows use of set screws).

ISQ Integrating Q Spheres

- New Product!
- Integrating sphere with cubical exterior.
- Machined port plugs match interior sphere curvature.
- Sits flat or can be used with optical post

Heavy duty construction (each sphere is composed of two halves, each machined from solid aluminum stock). Standard Q spheres come with ReflectraSpec coating, four orthogonal ports. Sphere can sit flat on work surface or be mounted on an optical mount post.

How to Select and Size an Integrating Sphere

In order to select the Spectral Products Integrating Sphere that is best suited for your application, several factors must be taken into consideration. The most important factors include the following:

Diameter/Source Ratio The diameter of the sphere should be at least 1.5 times the largest dimension of any device mounted within the sphere.

Surface-to-Port Area If ports cover more than 5% of the Integrating Sphere's surface, the Integrating Sphere may not integrate properly. If port requirements are greater than 5% of the sphere, a larger sphere should be purchased.

The following formulas can determine port area and sphere surface area:

r = Port radius, D = Sphere Diameter

Port Area = nr^2

Sphere Surface Area = nD^2

Integrating Sphere Coatings The coating of a Spectral Products Integrating Sphere is a high efficiency diffuse reflector that delivers reliable integration and low throughput loss. The reflectance is high in order to minimize absorption loss from multiple reflections, yet it must not reflect light specularly.

Spectral Products Integrating Sphere Coatings offer reflectance efficiencies between 95 and 99%. A Lambertian Source is a perfect diffuse source. When a perfect diffuse reflector is illuminated with uniform intensity, it acts as a Lambertian Source. Spectral Products uses a proprietary ReflectraSpec coating, effective from 400 up to 2500 nm, to provide these state-of-the-art Lambertian properties. AuSpec (for IR applications) and UVSpec (for UV applications) coatings are also available.

Model	Dia.	Port Size
ISC-020	2”	0.5”
ISC-040	4”	1.0”
ISC-060	6”	1.5”
ISC-080	8”	2.0”
ISC-100	10”	2.5”
ISC-200	20”	5.0”
ISQ-020	2”	0.5”
ISQ-040	4”	1.0”
ISQ-060	6”	1.5”
ISQ-080	8”	2.0”
ISQ-100	10”	2.5”
ISQ-200	20”	5.0”

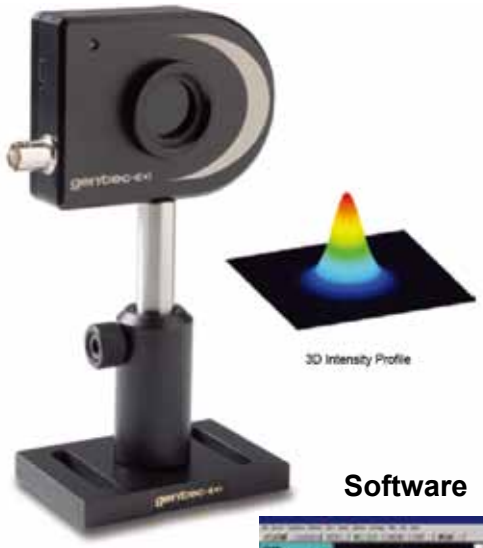
LASER BEAM PROFILERS





	Beamage	Beamage-Focus	Beam' R2	BeamMap2	BeamScope-P8
Description					
Profiling	X-Y	X-Y	X-Y	X-Y-Z-θ-φ	X-Y
Imaging	Digital (CCD)	Digital (CCD)			Pinhole with 2D-stage
Focusing, Pointing, Divergence and Collimating	Manual	Manual	Manual	Real Time	Manual
Alignement				✓	
M^2	With Optional 2D-Stage			Real Time	With Pinhole + 2D-stage (optional)
Method					
Pinhole					✓(with 2D-stage)
Scanning Slit			✓		✓
Scanning X-Y Slit				✓	✓
Slits in multiple planes			✓	✓	
Knife-edge Mode				✓	
CCD sensor	✓	✓			
Applications					
CW Lasers	✓	✓	✓	✓	✓
Pulsed Lasers	Up to 20 kHz single capture	Up to 20 kHz single capture	> 100 kHz	> 100 kHz	> 10 kHz
Wavelenght Ranges (nm)					
1 - 350	With UV Converter				
190 - 1150			Si Detector	Si Detector	Si Detector
260 - 380	-UV Version				
350 - 1150	Standard	Standard			
350 - 1330	-1310 Version	-1310 version			
675 - 1750			InGaAs Detector	InGaAs Detector	
800 - 1800					Ge Detector
1480- 1680	With CamIR Adapter or -IR				
800 - 2500			Extended InGaAs	Extended InGaAs	
1500 - 3500					InAs Detector
Features					
Best Resolution	1 µm	1.6 µm	0.5 µm	0.5 µm	0.1 µm
Update Rate	10 Hz	10 Hz	5 Hz (real time)	5 Hz (real time)	1 - 2 Hz (0.01 Hz with 2D-stage)

BEAMAGE



Key Features

PLUG AND PLAY
Direct USB2.0 connection

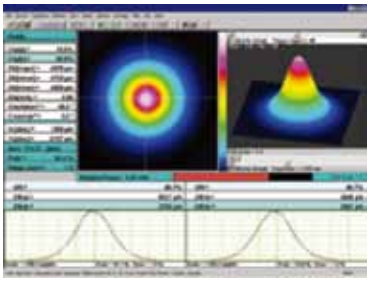
FOR CW OR PULSED LASERS
Suitable for both CW and pulsed lasers, with single pulse capture up to 20 kHz

USER-FRIENDLY SOFTWARE
- Background capture and substraction
- XY profiles and centroids
- Gaussian and top hat fits
- Beam wander tool

AUTO TRIGGER
Automatically synchronizes to pulsed lasers

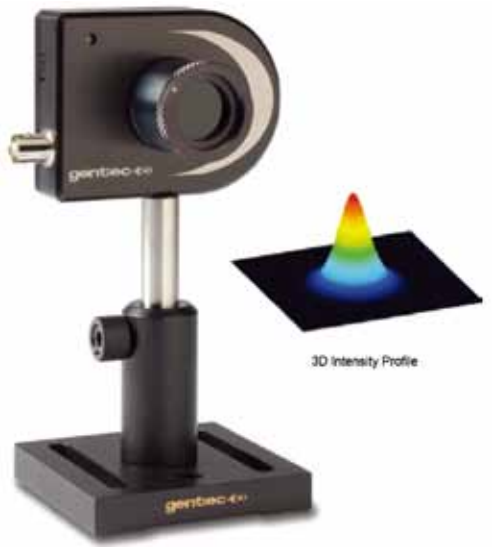
M2 CAPABILITIES
With optional M2 stage and lenses

Software



SPECIFICATIONS		
Models	Beamage-CCD12	Beamage-CCD23
Sensor Technology	CCD	CCD
Effective Aperture	6.3 x 4.8 mm	8.8 x 6.6 mm
MEASUREMENT CAPABILITIES	CCD12	CCD23
Pixel Count	1.4 MPixels	1.4 MPixels
H x V	1360 x 1024	1360 x 1024
Pixel Dimension	4.65 x 4.65 µm	6.45 x 6.45 µm
Minimum Measurable Beam	~47 µm	~65 µm
Shutter Type	Synchronous	Synchronous
Maximum Full Frame Rate	~10 Hz	~10 Hz
Single Pulse Capture	20 kHz	20 kHz
Signal to RMS Noise	1000:1	1000:1
Electronic Shutter Dynamic Range	43 dB	43 dB
ADC	14-bit	14-bit
WAVELENGTH RANGES		
Standard	350 - 1150 nm	350 - 1150 nm
-1310 (residual silicon response)	350 - 1350 nm	350 - 1350 nm
-IR (with Phosphor coating)[a]	1480 - 1680 nm	1480 - 1680 nm
-UV b	260 - 380 nm	260 - 380 nm
DAMAGE THRESHOLDS[c]		
Maximum Average Power	10 W	10 W
Saturation Level (1064 nm)		
Continuous Laser	10 W/cm^2	10 W/cm^2
Pulsed Laser	300 µJ/cm^2	300 µJ/cm^2
PHYSICAL CHARACTERISTICS		
Sensor Size	6.3 x 4.8 mm	8.8 x 6.6 mm
Dimensions (not including filter)	61H x 81.1W x 22.9D mm	61H x 81.1W x 22.9D mm
Weight (head only)	230 g	230 g
ORDERING INFORMATION		
Full Product Name	Beamage-CCD12	Beamage-CCD23

BEAMAGE FOCUS



Key Features

PLUG AND PLAY
Direct USB2.0 connection

FOR CW OR PULSED LASERS
Suitable for both CW and pulsed lasers, with single pulse capture up to 20 kHz

USER-FRIENDLY SOFTWARE
- Background capture and substraction
- XY profiles and centroids
- Gaussian and top hat fits
- Beam wander tool

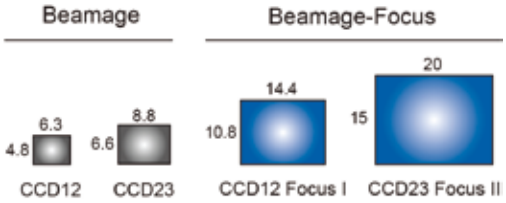
AUTO TRIGGER
Automatically synchronizes to pulsed lasers

Large Area Fiber Tapers

2 sizes for large beams:

- Focus I
- Focus II
- 11 x 14 mm
- 20 x 15 mm

Compare the aperture sizes



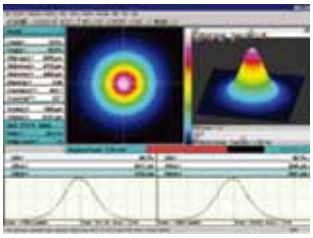
SPECIFICATIONS		
Sensor Technology	Focus I	Focus II
Models	CCD	CCD
Effective Aperture	14.4 x 10.8 mm	20 x 15 mm
MEASUREMENT CAPABILITIES	Focus I	Focus II
Pixel Count	1.4 MPixels	1.4 MPixels
H x V	1360 x 1024	1360 x 1024
Pixel Dimension	10.5 x 10.5 µm	14.5 x 14.5 µm
Minimum Measurable Beam	~105 µm	~145 µm
Pixel Multiplying Factor (PMF)	1.6	2.27
Shutter Type	Synchronous	Synchronous
Maximum Full Frame Rate	~10 Hz	~10 Hz
Single Pulse Capture	20 kHz	20 kHz
Signal to RMS Noise	1000:1	1000:1
Electronic Shutter Dynamic Range	43 dB	43 dB
ADC	4-bit	14-bit
WAVELENGTH RANGES		
Standard	350 - 1150 nm	350 - 1150 nm
-1310 (residual silicon response)	350 - 1350 nm	350 - 1350 nm
-UV[a]	260 - 380 nm	260 - 380 nm
DAMAGE THRESHOLDS[b]		
Maximum Average Power	10 W	10 W
Saturation Level (1064 nm)		
Continuous Laser	10 W/cm^2	10 W/cm^2
Pulsed Laser	300 µJ/cm^2	300 µJ/cm^2
PHYSICAL CHARACTERISTICS		
Effective Aperture	14.4 x 10.8 mm	20 x 15 mm
Sensor Size	6.3 x 4.8 mm (CCD12)	8.8 x 6.6 mm (CCD23)
Dimensions	61H x 81.1W x 48.6D mm	61H x 81.1W x 57.3D mm
Weight (head only)	310 g	310 g
ORDERING INFORMATION		
Full Product Name	Beamage Focus I	Beamage Focus II

CHAPTER 1 TEST-MEASUREMENT

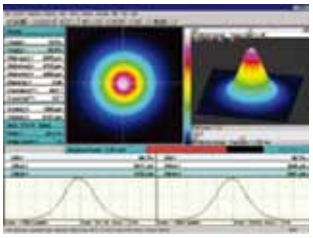
BEAM'R2 AND BEAMMAP2

SOFTWARE

Beam'R



BeamMap2



Key Features

PLUG AND PLAY

Direct USB2.0 connection

BEAM'R2

Each single plane XY beam profiling head contains a 2.5 µm slit pair for high dynamicrange slit mode & a 25 µm slit pair for 0.1 µmresolution Knife-Edge mode.

BEAMMAP2

Adds multiple Z-plane scanning to allow the measurement of:

- Real-time XYZ profiles, Focus position
- Real-time M2, Divergence, Collimation

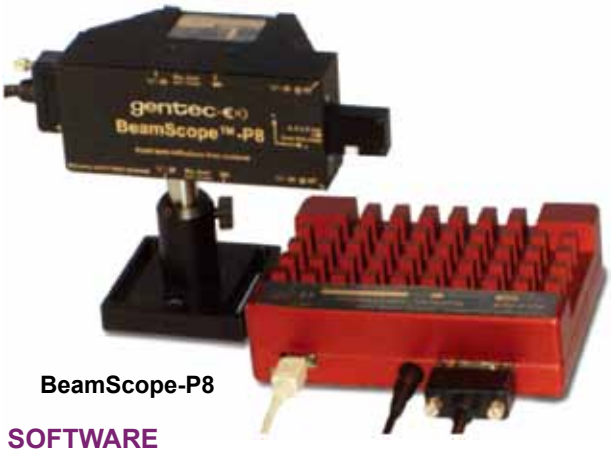
TRUE2D SLITS

0.4 µm thick metallic multilayer films on a sapphire substrate avoid the tunnel effect of air slits.

SPECIFICATIONS

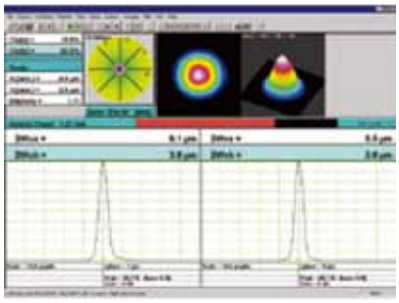
Models	Beam'R2	BeamMap2
Slit-Scan Planes	XY	XYZΘΦ
Scanned Area (Si)	6 x 5 mm	6 x 5 mm
MEASUREMENT CAPABILITIES	Beam'R2	BeamMap2
Dimensions of Capture Region		
Si	5 mm	5 mm
InGaAs	3 mm	3 mm
Extended InGaAs	1.5 mm	1.5 mm
Laser Types	CW or Pulsed (> 100 kHz)	CW or Pulsed (> 100 kHz)
Waist Diameters (2ω0)	0.5 - 1500 µm	0.5 - 1500 µm
Waist Diameter Resolution	0.2% of beam diameter	0.2% of beam diameter
Best Resolution	0.1 µm	0.1 µm
Precisions		
Beam Divergence	N/A	± 1 mrad over a ± 100 mrad range
Beam Pointing	N/A	± 1 mrad over a ± 100 mrad range
Beam M^2	N/A	± < 5%, M 2 = 1.0 to > 20
Waist Centroid Position	± 2 µm rms	± 2 µm rms
Auto Gain Range	40 dB (10 000:1)	40 dB (10 000:1)
Update Rate	5 Hz	5 Hz
WAVELENGTH RANGES		
Si	190 - 1050 nm	190 - 1050 nm
InGaAs	675 - 1750 nm	675 - 1750 nm
Extended InGaAs	0.8 - 2.5 µm	0.8 - 2.5 µm
DAMAGE THRESHOLDS		
Maximum Average Power	1 W	1 W
Maximum Irradiance		
> 500 nm	0.5 mW/µm^2	0.5 mW/µm^2
< 500 nm	0.25 mW/µm^2	0.25 mW/µm^2
PHYSICAL CHARACTERISTICS		
Scanned Areas		
Si	6 x 5 mm	6 x 5 mm
InGaAs	4 x 5 mm	4 x 5 mm
InAs	2.5 x 5 mm	2.5 x 5 mm
Dimensions	61.0H x 67.3W x 68.2D mm	61.0H x 67.3W x 68.2D mm
Weight (head only)	450 g	450 g
ORDERING INFORMATION		
Full Product Names		
Si	BR2-Si	BMS2-4XY250*-Si
InGaAs	BR2-IGA	BMS2-4XY250*-IGA
Extended InGaAs	BR2-IGA-X.X	BMS2-4XY250*-IGA-X.X

BEAMSCOPE-P8



BeamScope-P8

SOFTWARE



Key Features

PLUG AND PLAY
Direct USB2.0 connection

REAL-TIME MEASUREMENTS
- X-Y profile
- Angular divergence
- Ellipticity, Centroid and Gaussian fit
- Relative power

WIDE RANGE OF BEAM DIAMETERS
Can profile beams as small as 3 mm in diameter to 40 x 23 mm (with the 2D-stage)

WIDE WAVELENGTH RANGE
From 190 nm to 4 µm

HIGH RESOLUTION
Down to 0.5 mm (or 0.5%)

SPECIFICATIONS

Models		BeamScope-P8
Aperture Types		Pinholes, Single Slit, X-Y Slits
Scanned Area		up to 40 x 23 mm
MEASUREMENT CAPABILITIES		BeamScope-P8
Measured Profile Parameters		Gaussian beam diameter, Gaussian fit Second moment beam diameter, Knife-edge beam diameter, Centroid position (relative & absolute) Beam wander display
Displayed Profiles		X only Y only X & Y
		2-D plot, 3-D plot
Laser Types		CW or Pulsed (> 10 kHz)
Waist Diameters		2 µm - 15 mm
Measurement Resolution		<0.1 µm, or 0.1% of beam diameter
Optical Dynamic Range		42.5 dB optical (23 000:1)
Update Rate		>1 Hz typical, 2 Hz maximum
WAVELENGTH RANGES		
Si		190 - 1150 nm
Ge		800 - 1800 nm
InAs		1.5 - 3.5 µm
DAMAGE THRESHOLDS		
Maximum Average Power		1 W
Maximum Irradiance		
> 500 nm		0.5 mW/µm^2
< 500 nm		0.25 mW/µm^2
PHYSICAL CHARACTERISTICS		
Scanned Areas		
Pinholes (PA Series)	Line Scan	Pinhole diameter x 23 mm
Single Slits (SS Series)	Rectangle	Si: 7 x 23 mm, Ge: 5 x 23 mm,InAs: 3 x 23 mm
X-Y Slits (XY Series)	Trapezoid	Si: 5 x 15/5 mm, Ge: 3 x 15/5,InAs: 2 x 15/5 mm
2D-Stage (M2DU)	Rectangle	40 x 23 mm
Dimensions		51H x 115W x 62D mm
Weight (head only)		540 g

ORDERING INFORMATION

Full Product Name

	PA	SS	XY
Si	BS8-PAxx	BS8-SSyy	BS8-XYyy
Ge	BS8G-PAxx	BS8G-SSyy	BS8G-XYyy
InAs	BS8IA-PAxx	BS8IA-SSyy	BS8IA-XYyy

xx: For Pinhole apertures, replace xx by 5, 10, 25, 50 or 100 (µm)
yy: For single and dual slits, replace yy by 2.5, 5, 10, 25, 50 or 100(µm)

CHAPTER 1 TEST-MEASUREMENT

M² ANALYZER

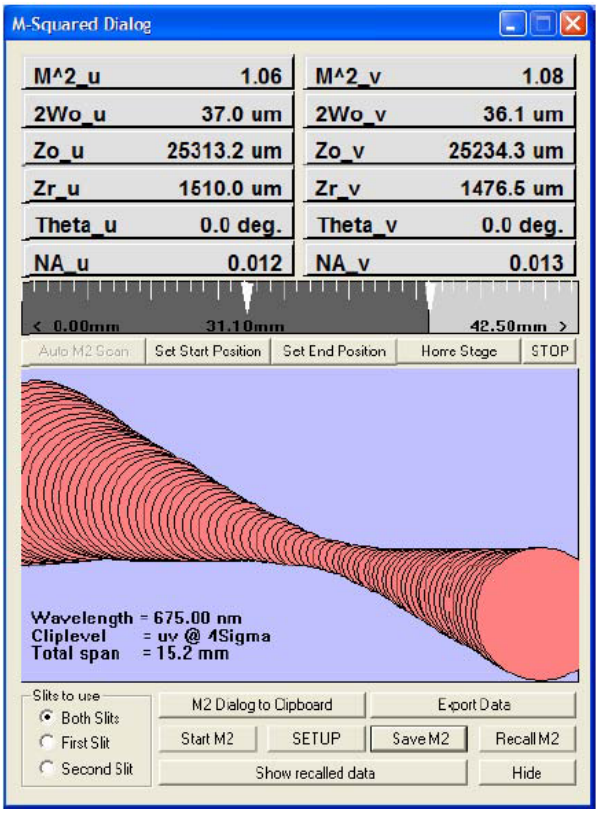
APPLICATIONS

M2 measurement of CW & pulsed lasers
M2 measurement of focused beams
Focus position of laser assemblies

FEATURES

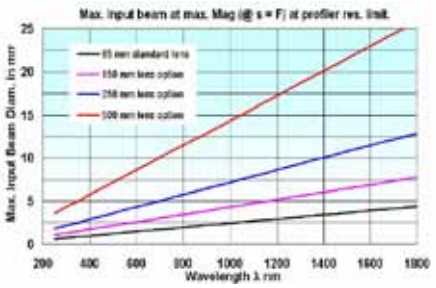
USB 2.0 for field service applications
Compact portable system
8” L x 3” W x 4.5” H (200 x 110 x 70 mm)
Total weight 4.4 lb, (2 kg)
Field-replaceable lens options

The USB 2.0 interfaced M2DU accessory converts any Beamage-XXXXX series beam profiling camera into a compact ISO 11146 compliant M^2 measurement system.
The M2DU system comprises a lens fixed to the front of amoving stage on which the Beamage camera moves up to 44 mm.
An 85 mm focal length, 400 to 900 nm, achromat refocuses an input beam to a waist within the stage travel range.(Alternative lens focal lengths and coatings will be recommended/supplied for some applications.)
Sampling in accordance with the ISO 11146 standard measures the hyperbolic region about the waist. A least squares hyperbolic fit to the second moment diameter data allows calculation of the M^2 value and related parameters.



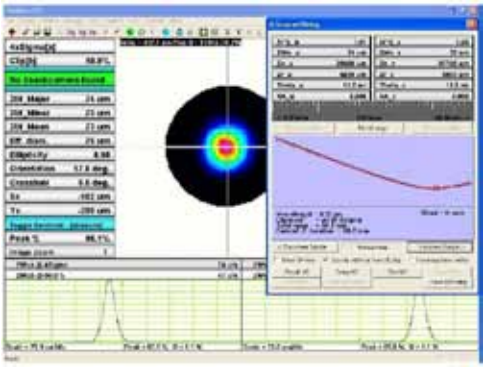
SPECIFICATIONS

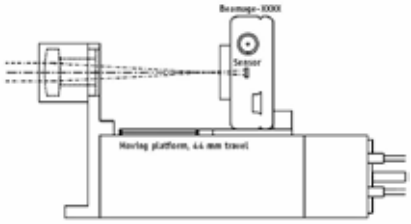
Beam diameters: See graph left.
400 to 900 nm with standard lens
355 to 1150 nm with optional lenses
To 1350 nm on high power beams with optional lenses
M^2 Repeatability +/- 2% (beam dependent)



Operation

Operation includes an Auto scan range mode which simplifies scanning a range in accordance with the ISO standard, and is described fully in the Application Note which accompanies the stage. An initial 20-point scan with an Average of 2 images at each positioned is performed over the total range of the stage. The software then establishes the optimal scan range for M^2 measurement in accordance with the Standard. Averaging is set to 5 images per position and 60 equi-spaced positions in z about the beam waist. A typical full scan takes 5 minutes, but coarser scans may be performed faster.





Applicable Standards

ISO 11146 is the applicable standard: 'Test methods for laser beam parameters: Beam widths,divergence angle, and beam propagation factor.'

It requires:

Use of the Second Moment (4σ) definition of the beam diameter.

Averaging of 5 samples at each position in z.

A minimum of ten samples in z. '… half of them shall be distributed within one Rayleigh length on either side of the beam waist and half of them should be distributed beyond two Rayleigh lengths from the beam waist.' (We offer from 10 to 60 samples in z).

A hyperbolic fit to the data.

Accuracy and Repeatability

Operated properly with a stable beam, you can achieve absolute M^2 accuracy of ±5 to ±10 %, and repeatability of ±2%. Achieving absolute accuracy better than ±5 % is possible, but can be difficult.

Ordering

1. Beamage-XXXX series head
2. M2DU system comprising the following items:

Beamage-Series USB 2.0 M2 Scan Stage with lens & adaptor plates: 2.5 µm steps, 44 mm travel + 3 m cable + Mounted 100 mm focal length fused silica singlet (17.5 mm aperture) for:

185-450 nm UV
400-800 nm VIS
630-1100 nm NIR
1030-1350 nm TEL

3. Available lenses* (focal lengths) for all wavelength ranges:

100 mm, 25 mm Ø (comes standard)
150 mm, 25 mm Ø
250 mm, 25 mm Ø
500 mm, 50 mm Ø

* All lenses include appropriate adapters and spacers.