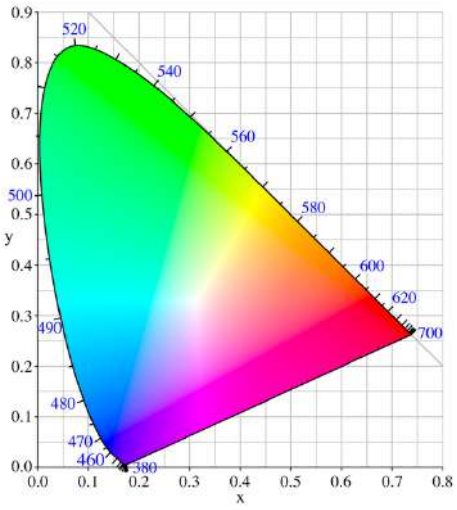
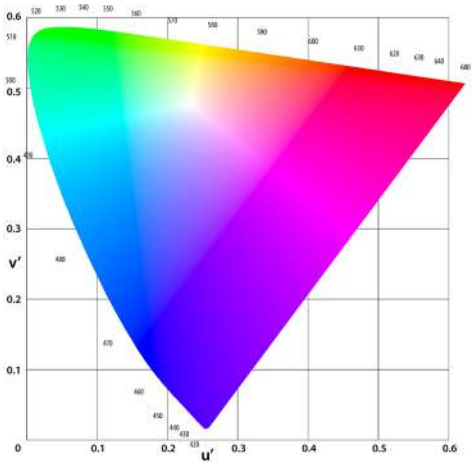
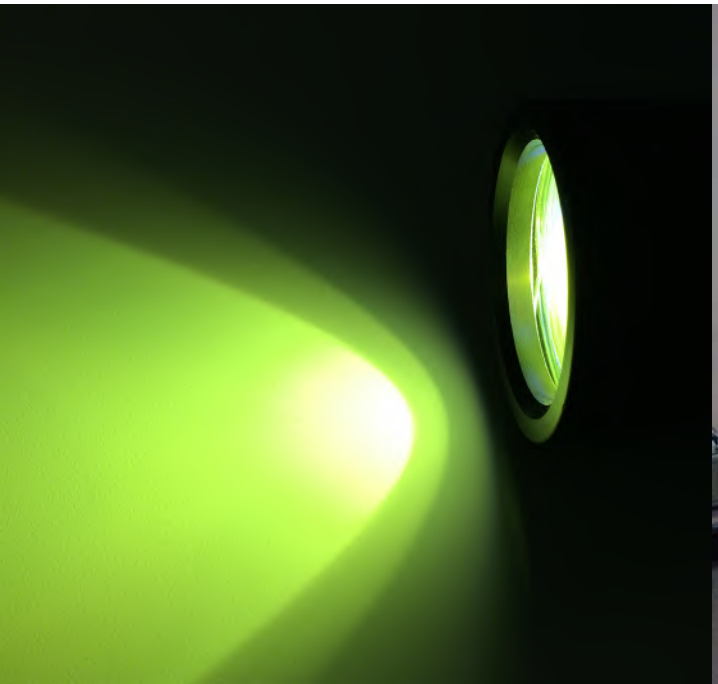
OPTIMUM OPTOELECTRONICS CORP.



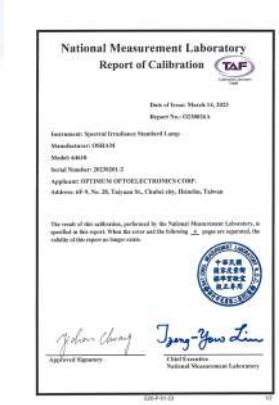


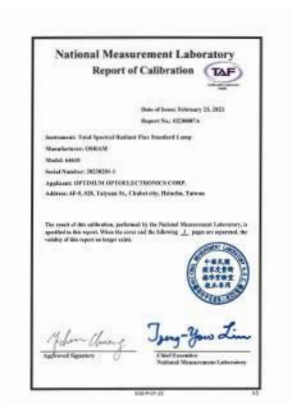


Company Profile

Optimum Optoelectronics Corp. was started in 1996 with a mission to provide reasonable cost, accurate and personalized light measurement solutions for R&D, QC and Manufacturing test.
Since then Optimum has been helping customers by providing precise, versatile and easy to use light measurement systems.
Today Optimum supplies a complete range of light measurement products such as spectroradiometers, integrating spheres, photodetectors, uniform light sources and goniometers. Standard Solutions include Portable Spectrometers, LED Test systems (Sphere and Goniometer), Lighting and Color Test systems, Reflectance and Transmission systems and a complete range of Integrating Sphere systems.

Due to the many varied light measurement applications, custom solutions are sometimes required. Because of this, Optimum also specializes developing and integrating custom solutions for both laboratory and production applications.
Optimum Optoelectronics is headquartered at Chubei, Taiwan. R&D, Manufacturing and Sales are located in Taiwan. Additional R&D and Sales facility is located in California, USA.


National Measurement Laboratory
Report of Calibration


National Measurement Laboratory
Report of Calibration

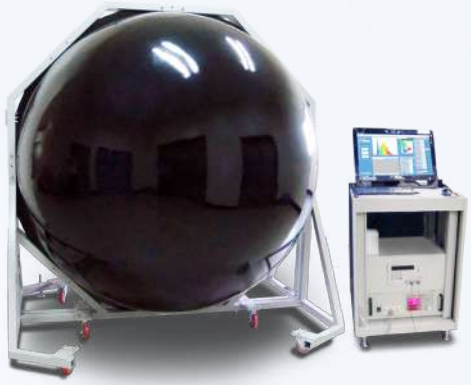

VERIFICATION OF COMPLIANCE


VERIFICATION OF COMPLIANCE


REPORT OF CALIBRATION

Total Spectral Radiant/Luminous Flux System LM-ISP

The determination of total spectral radiant flux or its' photometric counterpart, luminous flux, requires the total output of the source to be measured.



This is typically performed with an integrating sphere input optic which samples all light output from the source. Depending on the size of the source to be measured, Optimum supplies integrating spheres from 35mm to 3M diameter, the former being typically employed for the measurement of the single LEDs and LED lighting.

Fully automated data collection reported out on PDF, text or Microsoft Excel formats.

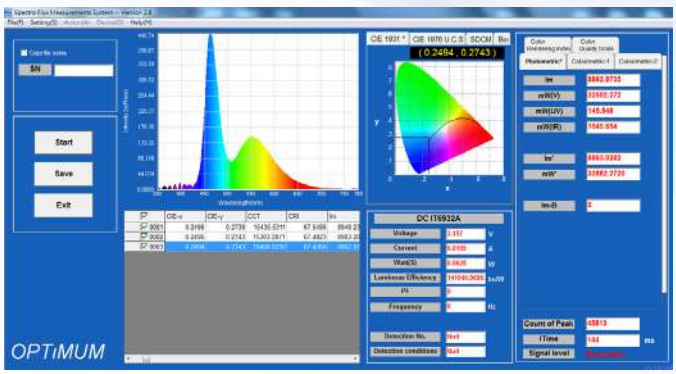
Fully automated calibration software routines using standard lamps calibrated for directional spectral intensity.

The main measurement function

Colorimetric parameters
chromaticity coordinates(x, y), (u ', v')/ Dominant wavelength(λd)/ Ppeak wavelength(λp)/ FWHM (Δλd)/ Color Rendering Index(R1-R15)/ Color purity/ Correlated color temperature(TC)
Photometric parameters: radiant flux(mW), lumens(lm)
Electrical parameters: optical efficiency(PF), luminous efficacy(W/lm)

Hardware Configuration

1. Spectrophotometer (SM-2000)
2. Depending on the size of the analyze with a suitable integrating sphere size
3. DC Power Supply
4. AC Power Supply
5. Computer and Microsoft Windows operating measurement software
6. Standard Lamp (correction system) can be traced back to national standards laboratory (NML)
7. Instrument cabinet



Summary of Technical Specifications

Item	Range	Accuracy
Peak Wavelength(λp)	380-780nm	±0.5nm
Dominate Wavelength(λd)	380-780nm	±0.5nm
Luminous Flux (lm)	1lm-250,000lm	±4%
	repeatability	±0.2%
Color Temperature	1000K to 10,000K	Follow (x,y)
Chromaticity Coordinates	CIE 1931 (x,y)	±0.003
	repeatability	±0.2%
Correlated Color Temperature	CCT, 1,000 -100,000K	Follow (x,y)
FWHM	0-200nm	±0.5nm
Purity	100%	±5%
CRI(R1-R15)	0-100%	±3%
L-I-V test		
Long Term Test		
Binning function		

LED Rotating Luminaire Goniophotometer

A Goniophotometer is a device used for measurement of the light emitted from an object at different angles. The use of goniophotometers has been increasing in recent years with the introduction of LED-light sources, which are mostly directed light sources, where the spatial distribution of light is not inhomogeneous.

LID-120

Type C

Fixed vertical axis perpendicular to the line of measurement, with a horizontal axis parallel to the main output direction of the light source.
Type C are single column structures. The single column structure is created when the assistant column is taken down from double columns structure. This type is applied to a fixed tube lamp, spot lamp, or other devices. The axis radiation of lamp and the horizontal of rotating supporter is coaxial. Type C corresponds to type B, if the light source is rotated by 90° .

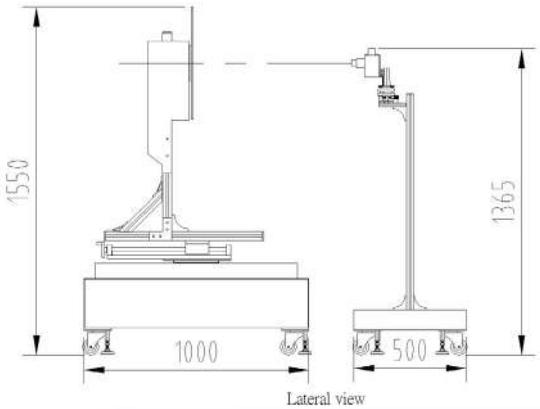
Features

- According to CIE Type C-γ measurement methods with horizontal optical axis
- Measures samples up to 1200mm in diameter and 25kg in weight
- Angular analysis of spectral and colorimetric quantities
- Measures luminous intensity distribution and luminous flux
- Exceptional accuracy via high-resolution bandwidth coverage
- Precision horizontal and vertical cross laser alignment to align the center of the lamp

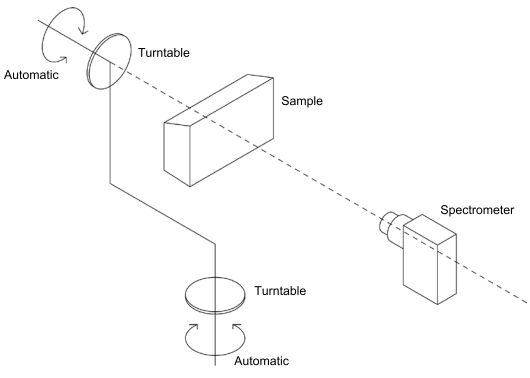
Summary of Technical Specifications

Measurement Method Type	Far field (or near filed)
Type	Benchtop Type C
Operation	Fully automated save and operation
Spectrometer	Optimum SM-2000(SPECTRALMETER)
Area Occupied by Goniometer	6m x 1.8m x 2m
Sensor Distance	0.5m to 6m
Device Limit Size Spectrometer	1.2 m length light tube
Max Lamp Weight	25kg
Wire Routing	To allow customer to route their own
Electric Connections	220V/2
Electrical Measurements	Lamp Power factor, voltage, and current
Lumen	1 ≥80000(need to validate with SM-2000)
Intensity Range (cd)	1 to >5000(need to validate with SM-2000)
Color Temperature	1000K TO 10,000K +/-35K
CRI	0-100 +/-0.7
Operating System	Windows 10
Angular Rotation	
Lateral Axis	2 degree / step
Vertical Axis	2 degree / step

Fully automated data collection reported out on IES, text or Microsoft Excel formats



Lateral view

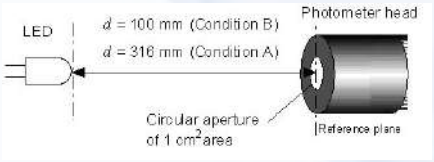


Product Code: LID-120S
LID-120S is a miniature version of LID-120, same function, two axes, same software, the only difference is the maximum load of 5kg. can put on the table, not floor type. Suitable for small LED lamps, flashlights, lightweight lamps.

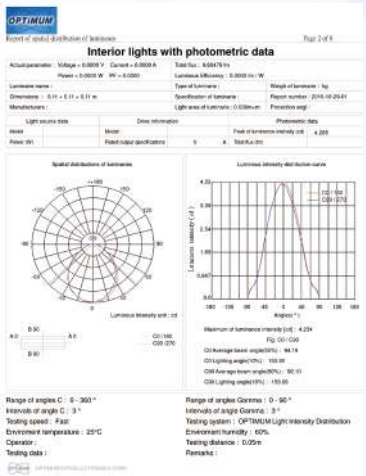
Dark-box Angular Intensity Distribution LID-060

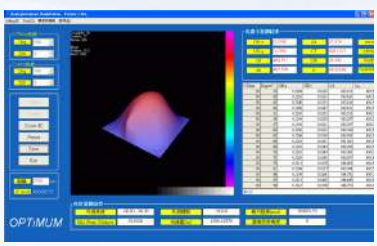
Product Code: LID-060
Designed for the determination of single LED angular intensity distribution, where point source conditions apply, the LED Goniometer includes double axis goniometer set at a distance of 500mm from a detector. Automated rotation of the LED on the goniometer permits the measurement of additional planes.

Average Intensity LI-100



Product Code：LI-100
CIE127 has introduced two standard near-field measurement conditions, A and B. The LED in such a case is positioned at ta precise distance (condition A-316mm, condition B-100mm) from a detector of a 100mm^2 area.
The Optimum CIE127 average Intensity optic employs an integrating sphere of 35mm diameter to substitute the aforementioned detector, and may be used as input optic to any Optimum spectra meter for the measurement of spectral average intensity.
With a calibration of spectral irradiance (with NML irradiance standard), the intensity can be found from the product of the measured irradiance by the measured condition distance squared.





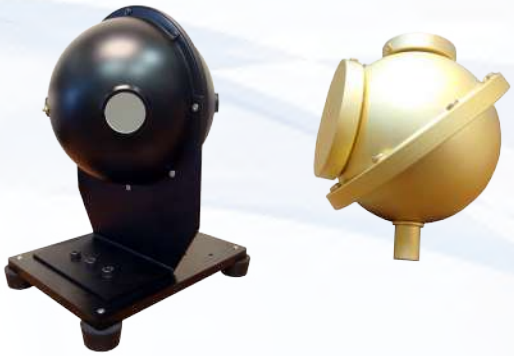
Integrating sphere ISP-XXXX

Custom Configurations for Accurate LED Testing

With closed 20 years of experience in designing integrating spheres. Optimum has the expertise to build custom spheres and sphere systems to meet your testing requirements.

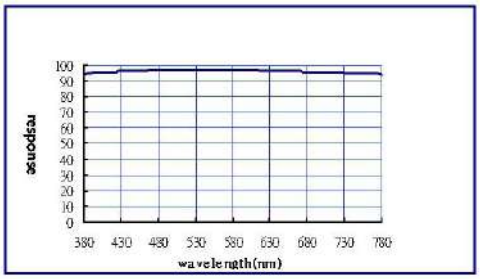
To measurement the power radiate flux the common applications is using integrating sphere. Integrating sphere is hollow sphere, the inner wall of the integrating sphere coated could be using barium-sulfate ($BaSO_4$), Teflon, or Gold. The light can be diffused reflectance thousand times inside the sphere, and output the uniform light in the ports.

Multi-Purpose Integrating Spheres from Optimum have been designed to provide maximum flexibility for a wide range of testing applications. With multi-purpose integrating spheres we can quickly build a custom sphere to meet your exact test requirements.



¤ Integrating sphere size:
35mm, 50mm, 100mm, 150mm, 200mm, 250mm, 300mm, 500mm, 1000mm, 1500mm, 2000mm, 3000mm

Barium sulfate material reflectance spectrum inside the sphere



The material $BaSO_4$ specification	
Reflectance From 380nm to 1100nm	96% ± 2 %
$BaSO_4$ Purified	≧ 99 %
CCT changed after go through sphere	≦ 0.5 %
Uniform (from port center to edge)	≧ 99 %

Your solution for Faster, More Accurate Measurements

As the inventors of the high-performance, computer-controlled spectroradiometers for LED testing, Optimum has continued to set the standard in spectroradiometer accuracy and reliability. Optimum spectroradiometers is ideally suited for the testing LED color and luminance, flat panel displays, reflectance, and transmittance measurements.

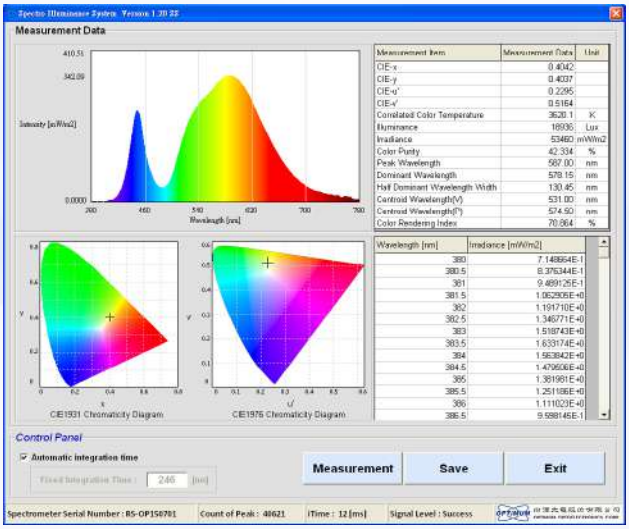
SM-2000 Spectroradiometers is designed to measure the light, colorimetric parameters, and spectrum instruments. SM-2000 owned a 2048 element linear CCD array, and longbench optical designed. It is millisecond speed and superior blue light region sensitivity and highly accurate measurement of wavelength, color and power.

Specification and application

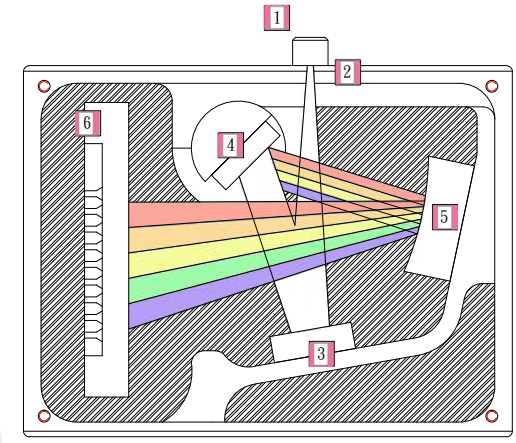
- High-resolution 0.5nm per pixel
- Multiple models covering UV, Visible and Near-IR wavelength ranges
- Near real-time (millisecond) measurement speed
- High-repeatability (stability), CIE (x,y) ±0.0003
- High-accuracy, CIE (x,y) ±0.003
- Low-noise (50/64000), high linearity (99.99%)
- Full luminosity hardware accessories (integrating sphere, light tubes, lenses) to achieve all photometric parameters measurements.
- Photometric specifications compliance with international standards
- Optimum can issued a formal verification report, traceable to the Taiwan National Standards Laboratory (also TAF) standard.

Applications

★ UV, Vis, and NIR: Spectroscopy / Spectroradiometry / Spectrophotometry
★ Wavelength Identification
★ Absorbance / Reflectance / Transmittance
★ Reaction Monitoring
★ Spectral Analysis
★ Multi-point Sampling
★ OEM Systems Integration



Optica path design of spectrometer



Characteristic	Symbol	Maximum value
V (λ) match	f_1	+/- 0.5%
UV response	μ	+/- 0.5%
IR response	γ	+/- 0.5%
Influence of non-uniform illumination	f_9	+/- 1.05%
Linearity	f_3	+/- 1.0%
Fatigue	f_5	0.473 %

Spectrometer and Photometer Comparison betwen

1. SMA 905 / Precision fiber coupler
2. Slit / Determines the photon flux and optical resolution
3. Collimation Mirror / Collimates and redirects the light beam towards the grating
4. Grating / Wavelength range and spectral resolution
5. Focusing Mirror / Refocuses the dispersed light onto the detector
6. Detector / 2048 pixel CCD Linear Array Detector

Detector Type	Linear CCD Array
Wavelength Range	250nm to 850nm (SM-25850) 380nm to 780nm (SM-2000) 700nm to 1050nm (SM-2000LS)
Spectrograph Optical Layout	Crossed Czemy-Turner
Detector pixels Format	2048 Elements @14um x 200um Per Element
Digitizer Resolution	16-bit or 65536:1
Integration time	1ms, Adjustable in 1μs increments
Grating	1200G/mm (SM-2000LS) 600G/mm (SM-2000, SM-25850)
Spectral Resolution	0.25nm to 0.35nm dependent on slit width and fiber diameter
Entrance Slit	50μm, 100μm, 150μm, 300μm, and 600μm
Dynamic Range	1300:1 Single Acquisition
Dimensions	98(L) x 65(W) x 36(H)mm
Operating Temperature	5ºC - 35ºC
Operational Relative Humidity	85% Non-condensing
Weight	263g
Computer Interface	USB 2.0
Operating Systems	Windows 7, 8, 10 (32-bit & 64-bit)

World Class Photonic Solutions

The SRI series uses an optical system made up of a collimating lens with a nano-imprint of diffraction lines and a highly quality CCD linear array sensor working in the range of 350-950nm or 650-1050nm. There is low stray light system providing 0.5 nm data acquisition intervals which is ideal for the measurement of LEDs and OLEDs and other light sources in the wide range.

Android System

Our portable instrument provides reliable test results and high performance using the world's most powerful platform.

Integrating Sphere Measurement Head

Always use small integrating sphere as light collector to uniform the light and do the correct measurement, including the cosine corrected measurement head for illuminance/ irradiance measurement.

5" Touch Screen Display

This instrument doesn't require a computer to take measurements and immediately shows test result on the color touch screen. On the default page, the following parameters can be easily shows when you turn on the machine.

- full spectrum profile i.e. Spectral Power Distribution (mW/m^2)
- color coordinates
- chromaticity charts (x,y) according to CIE 1931 standards
- CRI, Ra

Dark Current Compensation

Automatically compensation for any change of noise, and provide excellent measurement stability.

Micro SD

50,0000 of light measurements data are saved on the 4GB micro SD card included.

Photometric and Radiometric Calibration

An absolute spectral calibration is provided for each spectrometer before delivery thereby enabling achieve the accurate measurement of various absolute values such as Lux, Lumen, and radiometric value.

USB

This instrument could be as a stand-alone unit, you can easily transfer data to you PC by USB cable. Or using the software interface to do the measurement go through your PC controlled.

Definition of lux

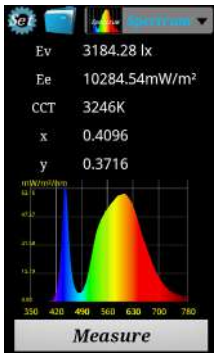
A unit of illumination equal to the direct illumination on a surface that is everywhere one meter from a uniform point source of one candle intensity or equal to one lumen per square meter.

Six Advantages :

- Using integrating sphere as light entrance port, consist perfect cosine effect at different angel.
- Unique long focal length, high precision spectralmeter for measurement.
- Fast Booting level, can perform instant measurement, no unnecessary action, measurement result is real time display.
- Huge storage capacity, can connect to PC to export the data, transfer and remote operation control.
- Spectral wavelength resolution 0.5nm, half-wavelength width resolution 6.0nm.
- Extensive model: SRI-2000UV, wavelength from 250-850nm. SRI-2000IR, wavelength from 350-950nm

SRI-2000-FB

Light collector can be detached by 1m or 2m optical fiber.



	Property	Description
Physical	Detector TypeC	ompact Czerny-Turner design
	Sensor array	2048 element linear Sony CCD array
	Cosine collector	10 ± 0.1 mm aperture 29 mm diameter integrating sphere
	Measurable distance	>10 cm
	Display5	” color LCD touchscreen, 400x800 resolution
	Data output portM	ini-USB 2.0
	Size (LWH)	219 mm * 117 mm * 39 mm
	Weight	660 g ± 20 g
Photometry	Wavelength range	Standard: 350 nm to 780 nm Extended: 350 nm to 950 nm UV: 250 nm to 850 nm Laser: 650 nm to 1050 nm
	Wavelength accuracy	± 0.5 nm
	Wavelength resolution	0.5 nm
	FWHM	6 nm
	Illuminance range	10 lx to 50,000 lx or 30 lx to 150,000 lx
	Illuminance accuracy	± 2% ± 4%
	Color accuracy	x,y: ± 0.0015 (Source A / other light source)
	Color repeatabilityx	,y: ± 0.001 (illuminance at > 200 lx)
	CCT accuracy	± 1% / ± 2% (CIE 1931)
	CRI accuracy @ Ra	± 0.8% / ± 1.5% (CIE 1931)
	Stray light	0.001%
	Exposure time	2 to 8,000 ms
	Capture mode	Single/Continuous
	Digital resolution	16 bit
Software	Data output format	json (compatible with Microsoft Excel)
	Data storage	Up to 500,000 files stored on device
Operating	Temperature range	0°C to 50°C
	Battery life	≧ 6 hours, 3400 mAh
	Charging time	6 hours

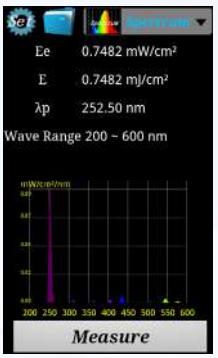
Definition of lux

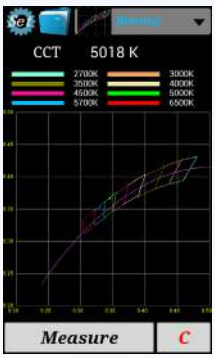
A unit of illumination equal to the direct illumination on a surface that is everywhere one meter from a uniform point source of one candle intensity or equal to one lumen per square meter.

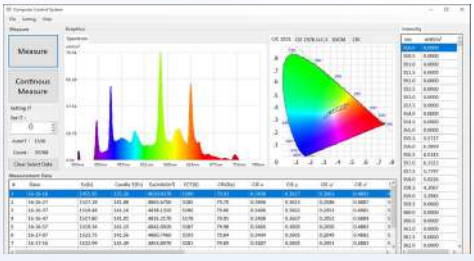
Five Advantages :

- Using integrating sphere as light entrance port, consist perfect cosine effect at different angel.
- Unique long focal length, high precision spectralmeter for measurement.
- Fast Booting level, can perform instant measurement, no unnecessary action, measurement result is real time display.
- Huge storage capacity, can connect to PC to export the data, transfer and remote operation control.
- Spectral wavelength resolution 0.5nm, half-wavelength width resolution 6.0nm.
- SRI-2000UV using Teflon integrating sphere.

	Property	Description
Physical	Detector Type	Compact Czerny-Turner design
	Sensor array	2048 element linear Sony CCD array
	Cosine collector	6.6 ± 0.1 mm aperture 29 mm diameter Teflon integrating sphere
	Measurable distance	>10 cm
	Display	5" color LCD touchscreen, 400x800 resolution
	Data output port	Mini-USB 2.0
	Size (LWH)	200 mm x 92 mm x 30 mm
	Weight	660 g ± 20 g
Photometry	Wavelength range	250 nm to 850 nm
	Wavelength accuracy	± 0.3 nm
	Resolution	0.5 nm
	FWHM	6 nm
	Illuminance range	10 lx to 50,000 lx or 30 lx to 150,000 lx
	Illuminance accuracy	± 2% ± 4%
	Color accuracy	x,y: ± 0.0015 (Source A / other light source)
	Color repeatability	x,y: ± 0.001 (illuminance at > 200 lx)
	CCT accuracy	± 1% / ± 2% (CIE 1931)
	CRI accuracy @ Ra	± 0.8% / ± 1.5% (CIE 1931)
	Stray light	0.001%
	Exposure time	2 to 8,000 ms
	Capture mode	Single/Continuous
	Digital resolution	16 bit
Software	Data output format	CSV (compatible with Microsoft Excel)
	Data storage	Up to 500,000 files stored on device
Operating	Temperature range	0°C to 50°C
	Battery life	≧ 6 hours, 3400 mAh
	Charging time	6 hours







PC Remote Control Operation

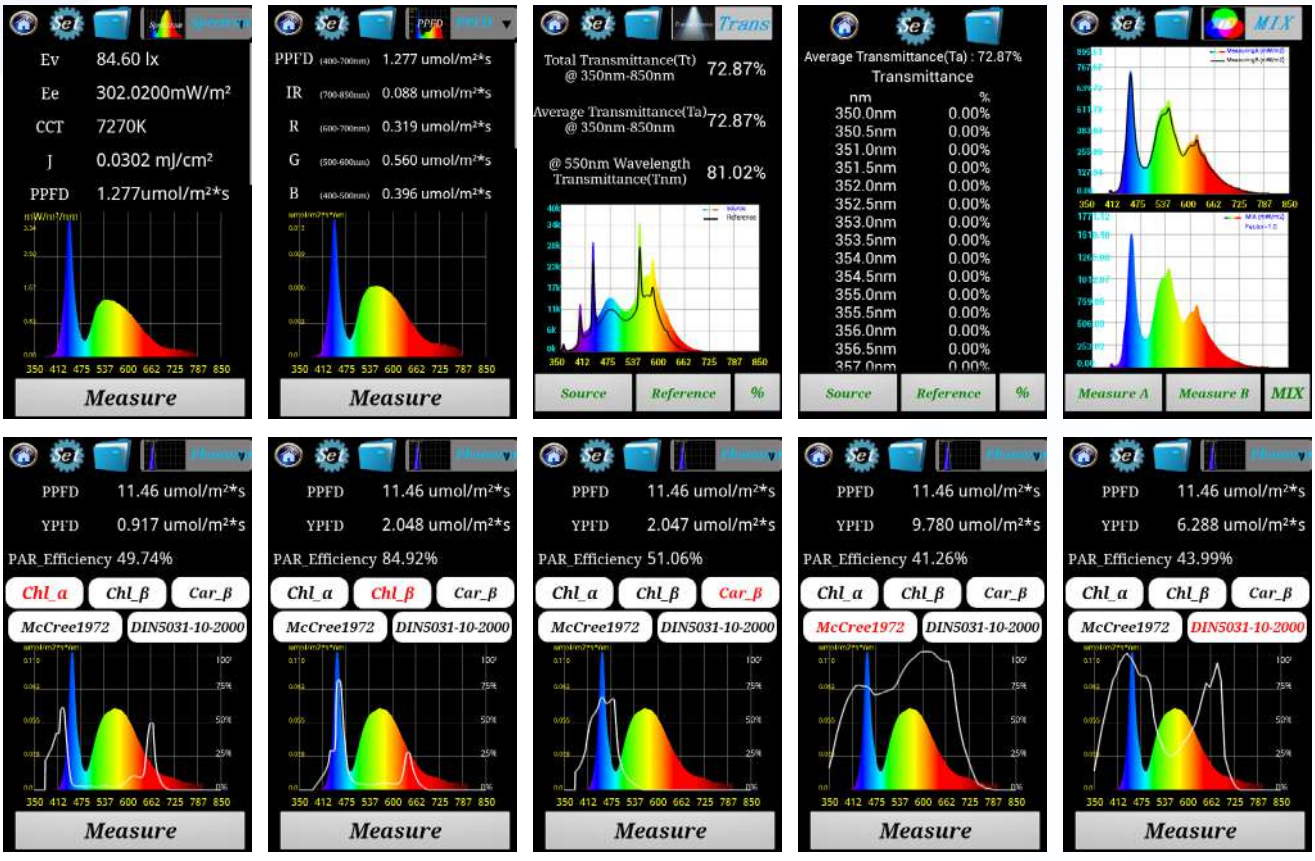
SRI-PL-6000 PAR Illuminance Spectrophotometer

The light visible to the human eye (approx. 380nm-780nm) is also used by plants. This part of the electromagnetic radiation, which powers photosynthesis, is named PAR and is usually found in wavelengths from 400nm to 700nm.
For plant growers, biologists and scientists the most important data in the light requirements for plants is PPFD (photosynthetic photon flux density). PPFD is a measurement of the amount of light that actually reaches a plant (the number of photosynthetically active photons that fall on a given surface each second).

Measurement Capabilities:

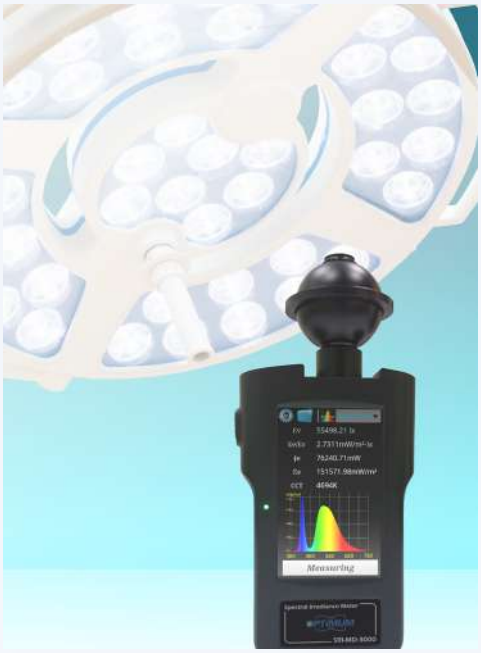
1. PPFD or Photosynthetic Photon Flux Density and
2. YPFD or Yield Photon Flux Density
3. Illuminance - Lux
4. Spectral Irradiance
5. CRI - Color Rendering Index, R1-R15, Ra
6. CIE1931 chromaticity (x,y) coordiantes
7. CIE1976 UVS(u’ ,v’) coordinates

This instrument equipped with LED luminosity, colorimetric parameters, PPFD, YPFD, two standards (McCree1972, DIN5031-10-2000) spectrum stack, and Chlorophyll-α, Chlorophyll-β, and Carotene-β with spectrum stack.



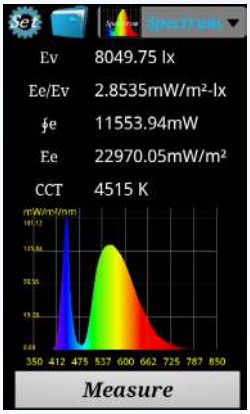
SRI-MD-3000 Medical LED Lamp Spectral Meter

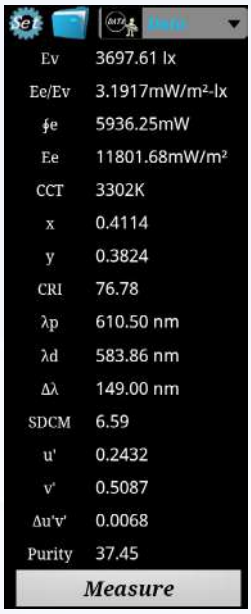
Seven Advantages :



- Meet Medical LED lamp specification requirement.
- Unique long focal length, high precision spectrometer for measurement.
- Fast Booting level, can perform instant measurement, no unnecessary action, measurement result is real time display.
- Can do / can perform sub-band measurements to calculate the light irradiance.
- Simple operation with accurate measurement, R1-R15 measurement are clearly shown.
- Spectral resolution 0.5nm, FWHM resolution 6.0nm.
- mW/m^2, mW(radiance power), mW/m^2-lx, three unique parameters to achieve different application requirement.

	Property	Description
Physical	Detector Type	Compact Czerny-Turner design
	Sensor array	2048 element linear Sony CCD array
	Cosine collector	14 mm aperture 50 mm diameter integrating sphere
	Measurable distance	≧100 cm
	Display	5” color LCD touchscreen, 400x800 resolution
	Data output portM	ini-USB 2.0
	Size (LWH)	270 mm * 117 mm * 39 mm
	Weight	660 g ± 20 g
Photometry	Wavelength range	Standard: 350 nm to 850 nm
	Wavelength accuracy	± 0.5 nm
	Wavelength resolution0	.5 nm
	FWHM	6 nm
	Illuminance range	150 lx - 600000 lx (Source A) 500 mW/m² - 2100000 mW/m²
	Illuminance accuracy	± 2% ± 4% (Source A / other light source)
	Color accuracy	x,y: ± 0.0015
	Color repeatability	x,y: ± 0.001 (illuminance at > 200 lx)
	CCT accuracy	± 1% / ± 2% (CIE 1931)
	CRI accuracy @ Ra	± 0.8% / ± 1.5% (CIE 1931)
	Stray light	0.001%
	Exposure time2	to 8,000 ms
	Capture mode	Single/Continuous
	Digital resolution	16 bit
Software	Data output format	json (compatible with Microsoft Excel)
	Data storage	Up to 500,000 files stored on device
Operating	Temperature range	0°C to 50°C
	Battery life	≧ 6 hours, 3400 mAh
	Charging time6	hours

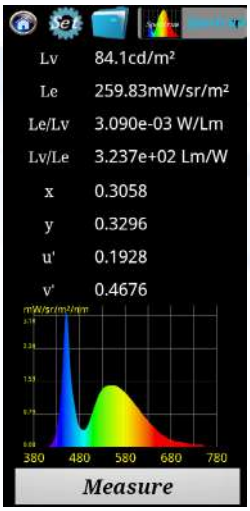


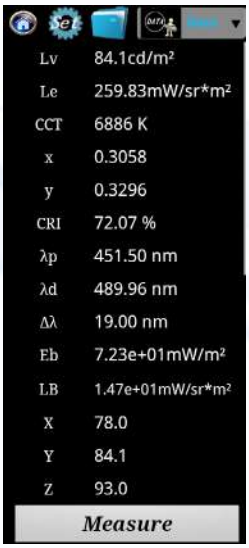


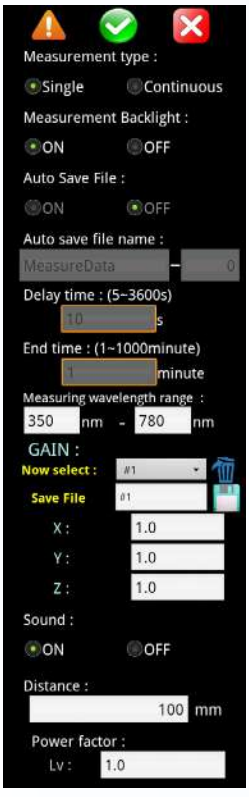
SRI-RL-5000 Spectral Luminance Meter

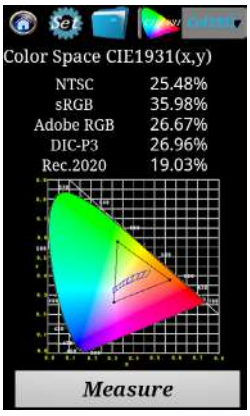
Luminance is the luminous intensity, projected on a given area and direction. Luminance is an objectively measurable attribute. The unit is Candela per Square Meter' (cd/m^2). So, different monitors can be adjusted to the same luminous intensity by measuring the luminance in cd/m^2. This instrument is the unique touchable Luminance meter, application in LCD panel, LED display, and LED, in unit of cd/m^2(nits).

Color Sapce measurement is available on one meter.







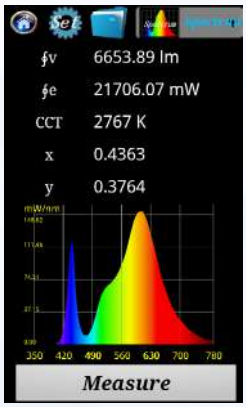


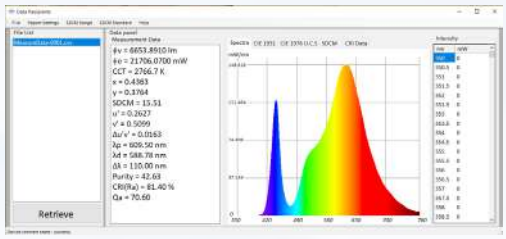
	Property	Description	
Physical	Detector Type	Compact Czerny-Turner design	
	Sensor array	2048 element linear Sony CCD array	
	Cosine collector	Lens designed, 5 mm or 10 mm	
	Display	5” color LCD touchscreen, 400x800 resolution	
	Data output portM	ini-USB 2.0	
	Size (LWH)	219 mm * 117 mm * 39 mm	
	Weight	660 g ± 20 g	
Photometry	Wavelength range	380 nm to 780 nm	
	Wavelength accuracy	± 0.5 nm	
	Wavelength resolution0	.5 nm	
	FWHM	6 nm	
	luminance range	S (5- 15,000 nits) H (10- 20,000 nits) P (50-100,000 nits)	(under Source A)
	luminance accuracy	Source A / other light source luminance at > 100 nits in CIE 1931	± 4%
	Color accuracy		x,y: ± 0.0015 / ± 0.003
	Color repeatability		x,y: ± 0.001
	CCT accuracy		± 1% / ± 2%
	CRI accuracy @ Ra		± 0.8% / ± 1.5%
	Stray light		0.001%
	Exposure time	2 to 8,000 ms	
	Capture mode	Single/Continuous	
	Digital resolution	16 bit	
Software	Data output format	json (compatible with Microsoft Excel)	
	Data storage	Up to 500,000 files stored on device	
Operating	Temperature range	0°C to 50°C	
	Battery life	≧ 6 hours, 3400 mAh	
	Charging time	6 hours	

Portable/Handheld Luminous Flux Measurement System

Total Spectral Radiant/Luminous Flux (value unit (lm))

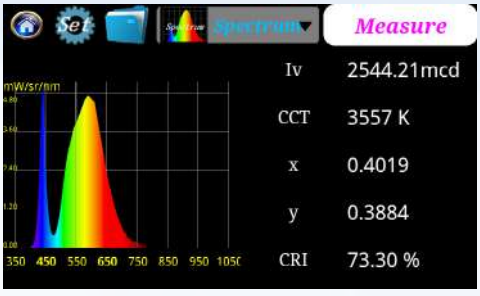
Product Code: SRI-2000LM
DEFINITION-----The determination of total spectral radiant flux or it's photometric counterpart, luminous flux, requires the total output of the source to be measured.
Combining SRI-2000-FB with integrating sphere, can achieve high resolution, high repeatable and precise measurements of total luminous Flux, total spectral flux, and other luminosity, colorimetric parameters. Suitable for single LED, COB, and small light source LED. For this type of measure Flux, 300mm integrating sphere is the largest size to suitable for this portable instrument. The same function with ISP-XXX-LM, it is a portable type.





Portable/Handheld Average Intensity Measurement

Product Code: SRI-2000LID
Complies with CIE127 condition B(100mm) standard, using SRI-2000 combining with 100mm light tube to measure of spectral average intensity, and other colorimetric parameters.



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