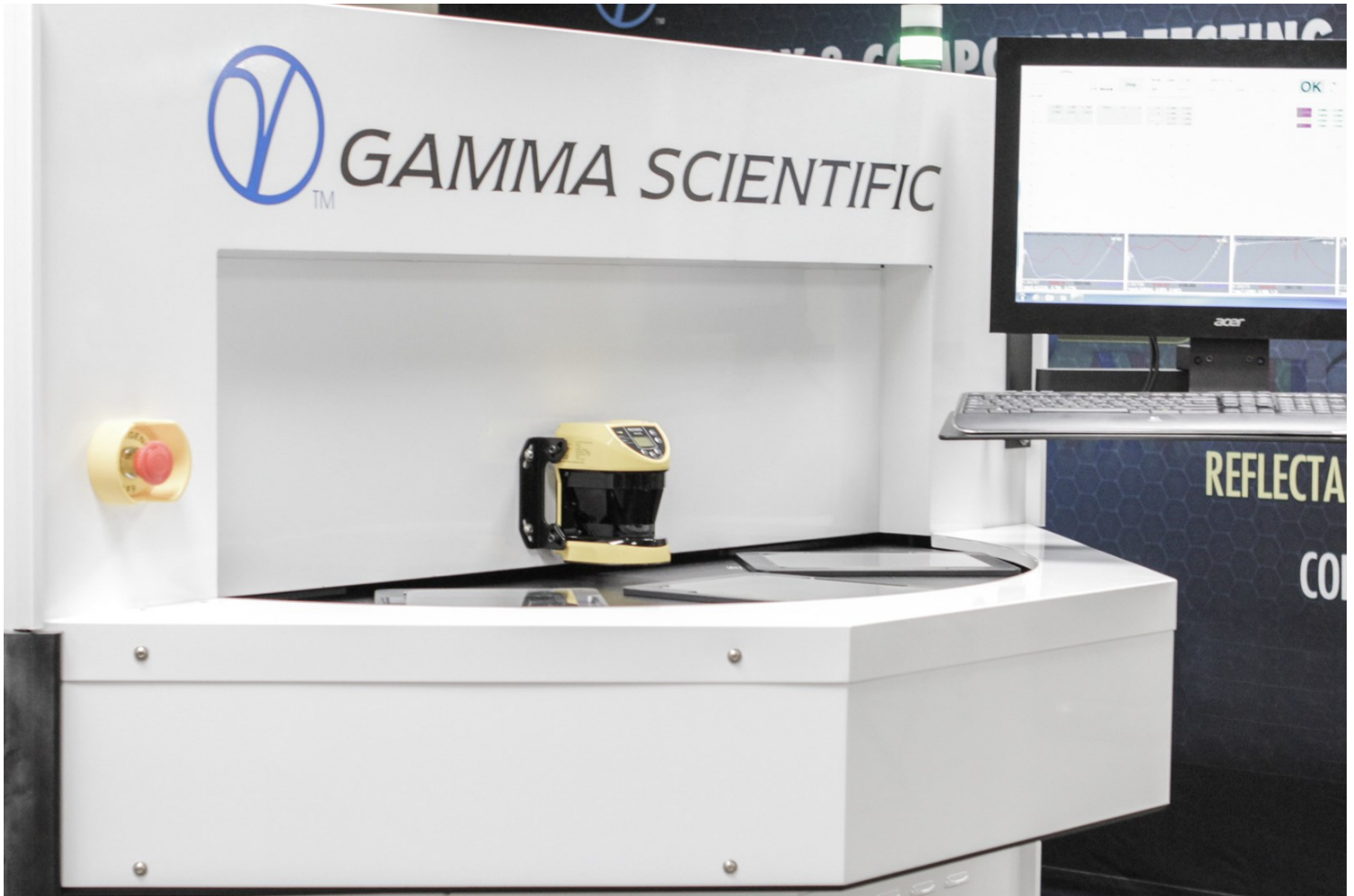




GAMMA SCIENTIFIC *Light Measurement Solutions*



Reflectance and Transmission Measurement Systems



GAMMA SCIENTIFIC *Light Measurement Solutions*

Reflectance and Transmission Measurement Systems

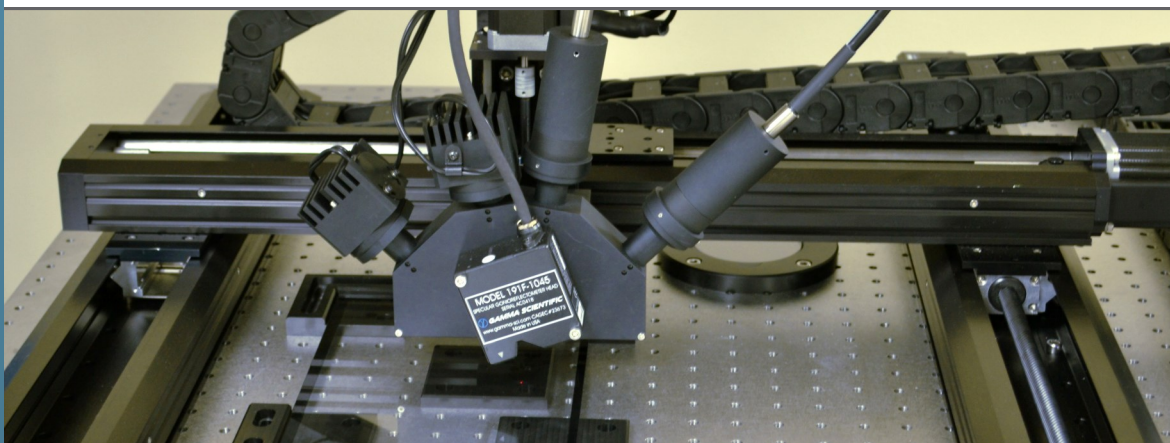
About Gamma Scientific

Since 1961 Gamma Scientific has produced LED, display and light measurement test solutions for production and R&D environments. Gamma Scientific instruments are trusted by leading global organizations that require high-speed, precision measurements and custom configurations for the most challenging environments.

Gamma Scientific also operates a NVLAP accredited laboratory that performs LM-79/LM-80 LED testing and is ISO 17025 compliant. NVLAP Lab Code 200823-0.

To view the complete line of test and measurement solutions from Gamma Scientific, please visit our website at www.gamma-sci.com.

Gamma Scientific
9925 Carroll Canyon Road
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Gamma Scientific's Reflectance and Transmission Measurement Systems provide quick spectral measurement of anti-reflection, band-pass and other thin film coatings on polished substrates

Gamma Scientific provides a unique, high performance option for reflectance and transmission testing. Controlled optical geometry and industry leading spectroradiometer performance offer quick, accurate reflection/transmission measurements for any glass or polished transmissive element.

When measuring reflectance, Gamma Scientific's unique technology allows manufacturers to perform **single sided inspection** on the first surface of any glass or polished, transmissive element while **excluding the second surface**.

These systems capture complete spectral and colorimetric properties of thin film coatings with scan times typically less than one second.

Specular and Diffuse Measurement Systems for Measuring Virtually Any Sample

Reflectance and Transmission test systems from Gamma Scientific are available in several configurations. Depending on the sample type and desired measurement result, a variety of system configurations are available for testing either polished (specular) or rough (diffuse) samples. A production selection guide is included in this brochure to help in configuring the best system for your needs.

These systems are ideal for manufacturers who need to obtain fast and accurate measurements of flat panel display glass, anti-reflection coating inspection, photovoltaic (solar cell) coatings, optical filters, lens coatings, paint samples, diffuse plastics and more.

Regardless of the sample, Gamma Scientific offers a solution for your reflectance or transmission measurement needs.





GAMMA SCIENTIFIC *Light Measurement Solutions*

Reflectance Measurement Systems

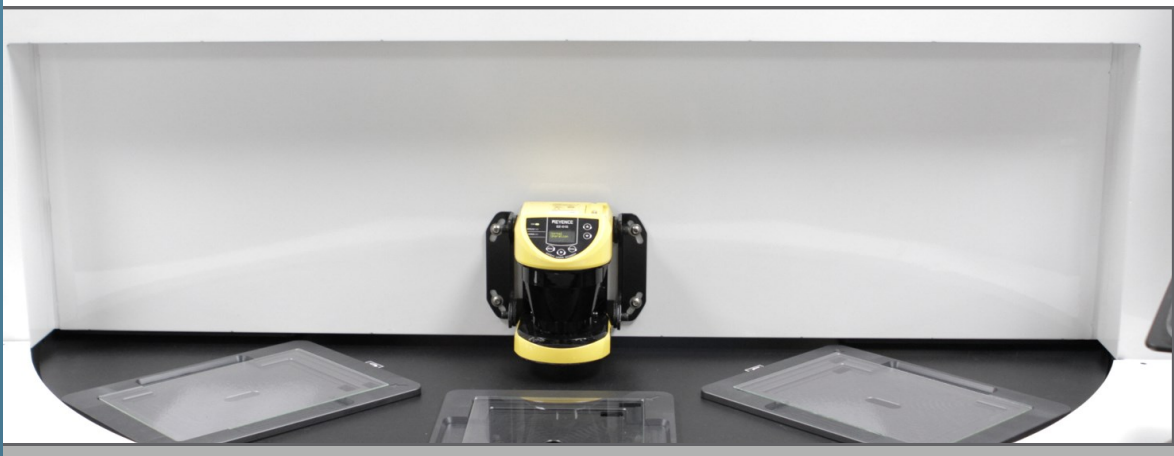
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Features

- Isolated First Surface Measurement of Thin Glass >500 μm Thick
- Complete Spectral Analysis
- Test Coating Uniformity and Color
- Full Cycle Testing for R&D or Production

System Types

- Fully Automated—Integrated Production Line Reflectance Measurement
- Semi-Automatic—Programmable X-Y Stage for Rapid Inspection, R&D, QA
- Tabletop and Handheld Systems—Primarily for R&D or Small Scale QA

Applications

- Flat Panel Display Glass
- Anti-Reflection (AR) Coating Inspection
- Touchscreen Display Glass
- Optical Filters/Lens Coatings
- Physical Vapor Deposition Coating Inspection (PVD)

System Components

- [Gamma Scientific Spectroradiometers](#)
- [Model 191 Specular Gonireflectometer Heads](#)
- [RS-4 Power Supplies](#)





GAMMA SCIENTIFIC *Light Measurement Solutions*

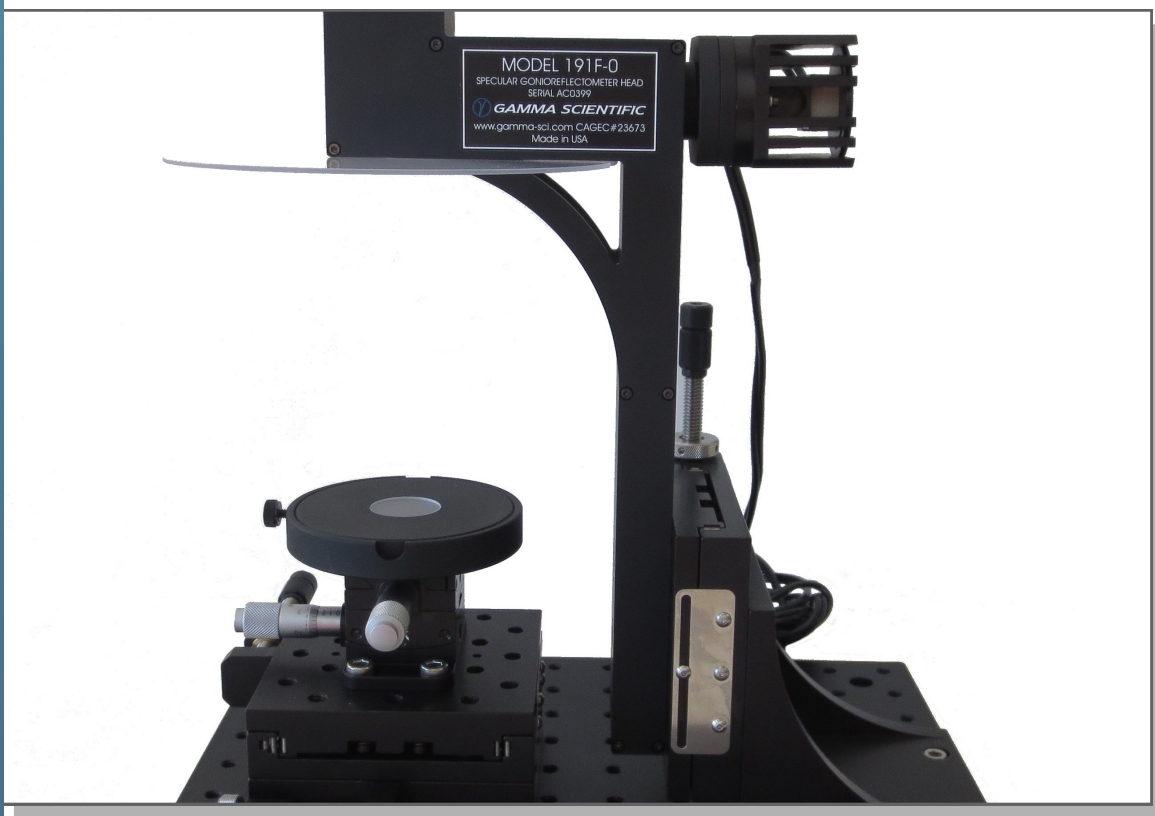
Transmission Measurement Systems

About Gamma Scientific

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Features

- Full Transmission Measurement of Specular or Diffuse Samples
- Complete Spectral Analysis
- Haze Measurement Option Available
- Test Sample Uniformity and Color
- Full Cycle Testing for R&D or Production
- Handheld Systems or Custom Automated Production Systems

Applications

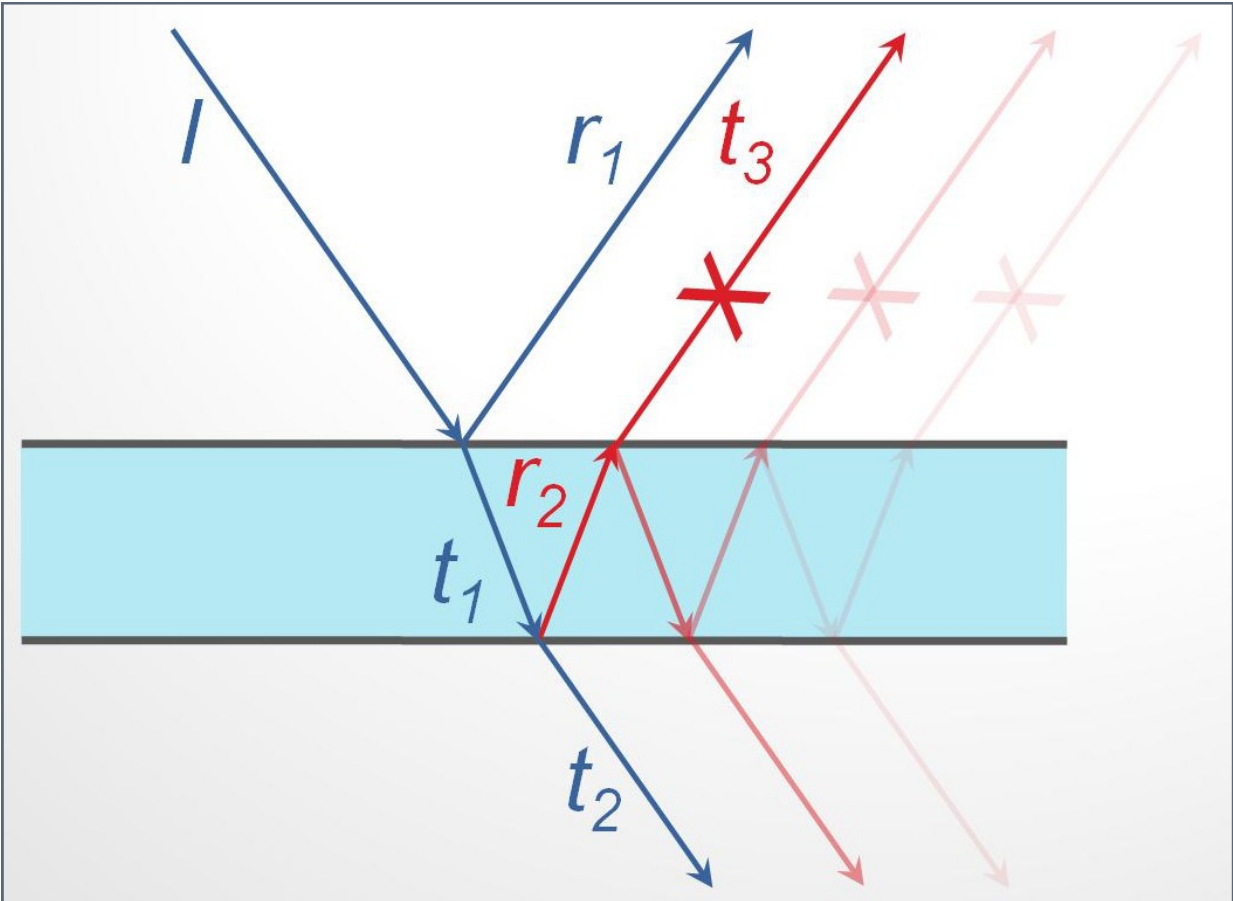
- Plastic Films and Tapes
- ITO Film Assemblies
- Protective Coatings
- Flat Panel Display Glass
- Anti-Reflection (AR) Coating Inspection
- Optical Filters/Lens Coatings
- Physical Vapor Deposition (PVD)





GAMMA SCIENTIFIC *Light Measurement Solutions*

Reflectance Measurement Technology



- ♦ Gamma Scientific 191F Series Optical Heads isolate the first surface reflection
- ♦ The second surface is completely eliminated in a non-destructive manner
- ♦ Light reflecting off each surface will be slightly offset
- ♦ This offset is used to mechanically block light reflected off lower surfaces

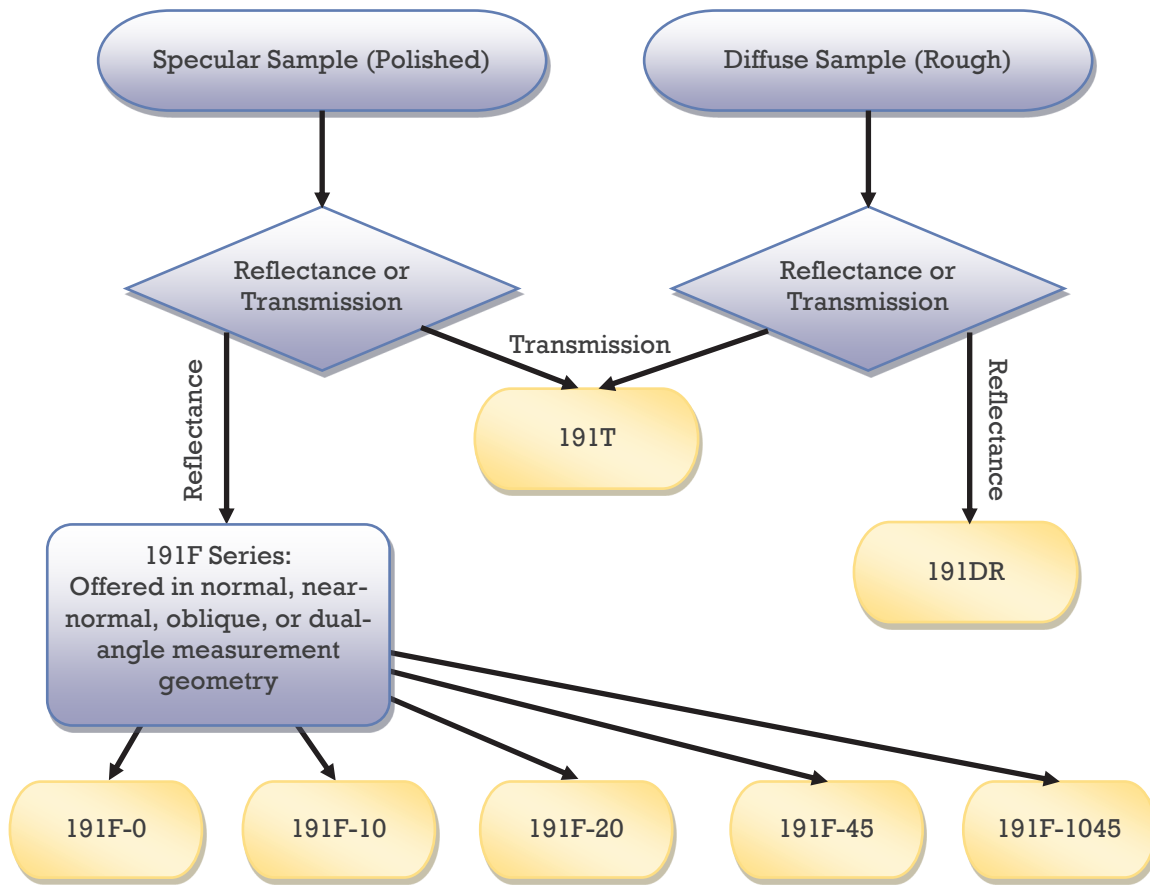




GAMMA SCIENTIFIC *Light Measurement Solutions*

Reflectance and Transmission Manual System Selection Guide

Manual System Selection Guide



Choose angle based on application requirements
Model numbers above are specified as "191F-*Angle*"

Production line and custom angle systems are also available,
please inquire for your custom solution

System Components

- [191 Series Optical Heads](#)
 - Select based on sample type and measurement requirements
- [GS-1220 Series Spectroradiometers](#)
 - Select based on desired spectral range
- [RS-4 Series Constant Current Power Supply](#)
 - For powering 191 Series light sources
- [Gamma Scientific ARMeasure Reflectance Software](#)
 - For spectral data collection and colorimetric analysis





GAMMA SCIENTIFIC

Light Measurement Solutions

191 Series Optical Head Specifications

191 Series Optical Heads				
191 Series Optical Head	191F	191T	191C	191DR
Measurement Type	Specular Reflection or Total Reflection	Total Transmission	Specular Reflection	Diffuse Reflection
Sample Types	Glass, Plastic, Metal, or any Polished Substrate	Glass, Plastic, or any Transmissive Element	Glass, Plastic, Metal, or any Polished Substrate	Opaque Materials, Matte Surfaces, Rough Substrates
Illumination Angle	Fixed Angle 0°, 10°, 20°, or 45° Options or Dual Angle 10° and 45°	0°	10° to 45° Variable	45°
Viewing Angle	Matches Selected Illumination Angle	2n (180°)	10° to 45° Variable	45°
System Configurations	Handheld, Tabletop, Semi-Automatic, Fully Automated	Tabletop	Handheld	Tabletop (Sphere Based)
Minimum Sample Thickness	Dependent on Angle (transparent samples)	None (transparent samples)	1.5mm (transparent samples) None (opaque samples)	None (opaque samples)
Spectral Range	365nm-900nm (default) UV / IR Options Available	365nm-900nm (default) UV / IR Options Available	365nm-900nm	365nm-900nm UV / IR Options Available
Illumination Spot Size (Area of Analysis)	1mm x 10µm	Ø 1mm, Ø 2mm, or Ø 3mm	1mm x 65µm	Ø 1mm, Ø 2mm, or Ø 3mm
Typical Measurement Speed (Sample Dependent)	≈500-1000ms	≈1000-3000ms	≈2000-15000ms	≈1000-3000ms
Optical Head Dimensions	Varies Depending on Model/Angle	Height: 350mm (13.75in) Width: 205mm (8.0in) Depth: 225mm (8.85in) Weight: 3.5kg (7.75lbs)	Height: 230mm (9in) Width: 150mm (6in) Depth: 150mm (6in) Weight: 1.6kg (3.5lbs)	Height: 300mm (12in) Width: 1000mm (40in) Depth: 300mm (12in) Weight: 12kg (25lbs)
Accuracy				
Spectral Reflectance/ Spectral Transmission	± 0.2%	± 0.5%	± 0.5%	± 0.5%
Tristimulus (CIE 1931 X, Y, Z)	± 0.05	± 0.05	± 0.05	± 0.05
Chromaticity (CIE 1931 x, y)	± 0.002	± 0.005	± 0.005	± 0.005
LAB Color (CIE 1976 L*, a*, b*)	L* ± 1.0 a*, b* ± 0.8	L* ± 2.0 a*, b* ± 0.8	L* ± 2.0 a*, b* ± 0.8	L* ± 2.0 a*, b* ± 0.8
Reported Parameters				
Spectral Data	Reflectance/Transmission as a function of wavelength			
Colorimetric Data	Tristimulus 1931 X, Y, Z Tristimulus 1964 X, Y, Z CIE 1931 x, y UCS 1960 u, v UCS 1976 u, v CIE 1976 L*, a*, b* CIE 1976 L*, u*, v*			
Illuminant Weighting	Illuminant A, Illuminant B, Illuminant C, Illuminant D65, or User Specified Custom Illuminant			
Wavelength Data	Dominant Wavelength, Peak Wavelength			

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GAMMA SCIENTIFIC *Light Measurement Solutions*

GS-1220 Spectroradiometers

About Gamma Scientific

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High Speed Light Measurement

GS-1220 [spectroradiometers](#) are optimized for quality control and high speed light measurement applications, with up to 100 ms optical integration time.

The GS-1220 spectroradiometer features a proprietary optical design and back illuminated CCD technology that provides exceptional low-light measurements, superior blue light sensitivity and highly accurate measurements of wavelength, color and power.

The 2048 pixel back illuminated CCD is temperature cooled for superior instrument repeatability.

Original system calibration is performed in Gamma Scientific's NVLAP accredited laboratory using NIST-traceable standards.

Features

- High resolution, temperature cooled-back illuminated 2048 pixel CCD Sensor
- Exceptional accuracy via high-resolution bandwidth coverage
- Superior wavelength and color accuracy
- Near-real-time measurement
- Spectral ranges: 250-900 nm, 360-900 nm, 360-1100 nm
- NIST-traceable calibration
- Integrated neutral density filter wheel
- Hardware input/output trigger
- Windows based control/analysis software with Excel integration

Trusted for Over 50 Years

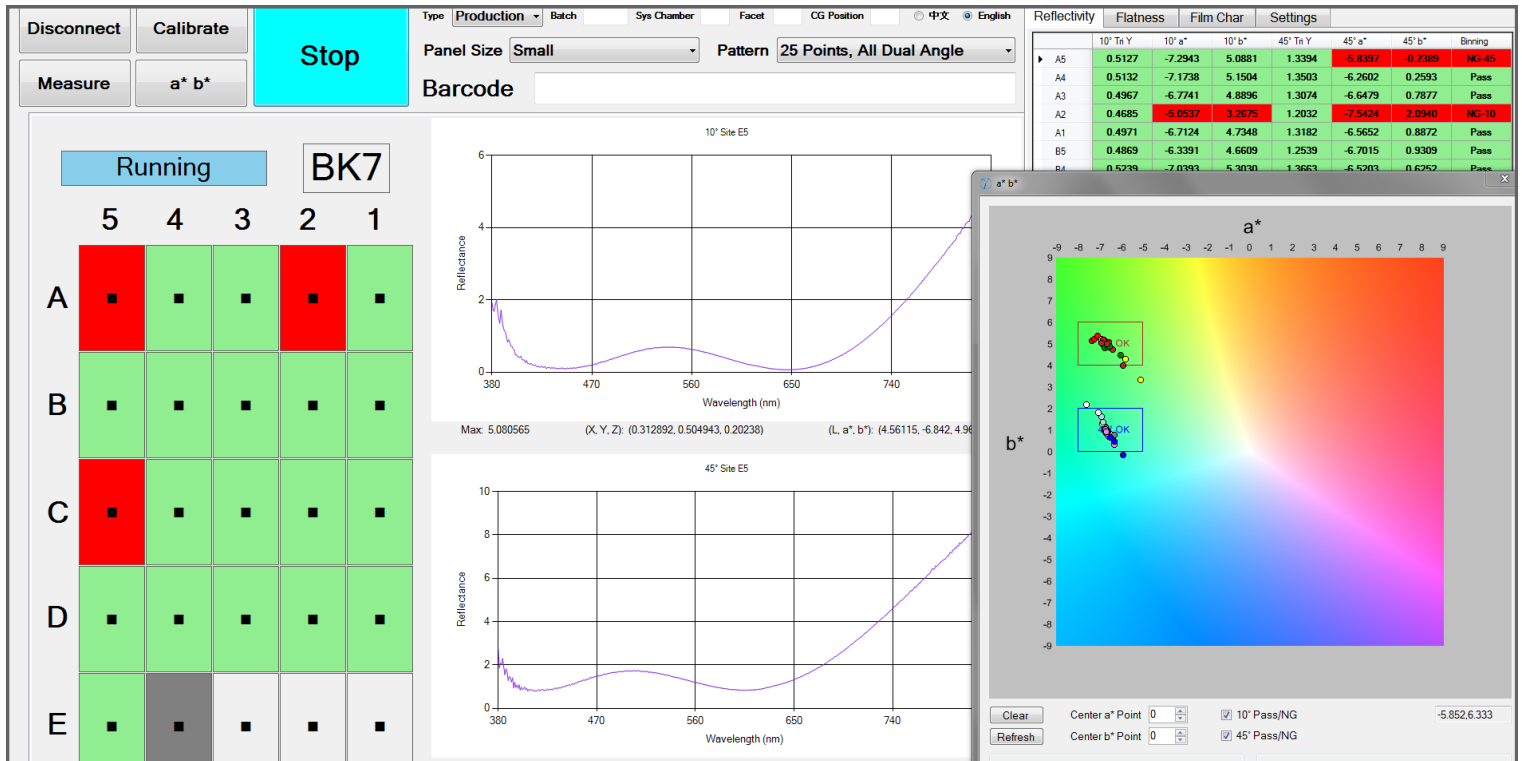
As the inventors of the first high-performance, computer-controlled LED spectroradiometers, Gamma Scientific has continued to set the standard in spectroradiometer accuracy and reliability. Gamma Scientific instruments have been trusted by the world's leading organizations to provide accurate measurements for over 50 years.





GAMMA SCIENTIFIC Light Measurement Solutions

Gamma Scientific ARMeasure Reflectance Software



Features

- ◆ Programmable, Multi-Location Measurement
- ◆ Real-Time a*, b* Color Chart
- ◆ Binning and Pass/Fail Compatibility
- ◆ Automated Calibration
- ◆ Simultaneous 10° and 45° Measurements
- ◆ Bar Code Reader (optional)





GAMMA SCIENTIFIC

Light Measurement Solutions

191F Reflectance Measurement Systems

Optical Specifications				
191 Optical Head	191F-0	191F-10	191F-20	191F-45
Measurement Type	Total Specular Reflection	First Surface or Total Specular Reflection	First Surface or Total Specular Reflection	First Surface or Total Specular Reflection
Sample Types	Glass Plastic Metal Any polished substrate	Glass Plastic Metal Any polished substrate	Glass Plastic Metal Any polished substrate	Glass Plastic Metal Any polished substrate
Illumination Angle	0°	10°	20°	45°
Viewing Angle	0°	10°	20°	45°
Minimum Sample Thickness	None (transparent samples) None (opaque samples)	0.5mm (transparent samples) None (opaque samples)	0.35mm (transparent samples) None (opaque samples)	0.15mm (transparent samples) None (opaque samples)
Maximum Sample Thickness	None	None	None	None
Minimum Sample Size	None	2.0in (50mm) diameter or 1.75 x 1.75in (45 x 45mm) square	2.0in (50mm) diameter or 1.75 x 1.75in (45 x 45mm) square	2.0in (50mm) diameter or 1.75 x 1.75in (45 x 45mm) square
Maximum Sample Size	Maximum 3.0in (75mm) diameter	None	None	None
Spectral Range	365nm-1100nm	365nm-1100nm	365nm-1100nm	365nm-1100nm
Illumination Spot Size (Area of Analysis)	Ø 0.5mm	1mm x 10µm	1mm x 10µm	1mm x 10µm
Measurement Speed (Sample Dependent)	≈500-10000ms	≈300-3000ms	≈300-3000ms	≈300-3000ms
Calibration Reference Standard	1in (25mm) BK-7 Polished Glass	6in (150mm) BK-7 Polished Glass	6in (150mm) BK-7 Polished Glass	6in (150mm) BK-7 Polished Glass
Optical Head Dimensions	Height: 375mm (15in) Width: 300mm (12in) Depth: 300mm (12in) Weight: 2.25kg (5lbs)	Height: 230mm (9in) Width: 150mm (6in) Depth: 150mm (6in) Weight: 1.6kg (3.5lbs)	Height: 230mm (9in) Width: 150mm (6in) Depth: 150mm (6in) Weight: 1.6kg (3.5lbs)	Height: 230mm (9in) Width: 150mm (6in) Depth: 150mm (6in) Weight: 1.6kg (3.5lbs)
Accuracy				
Spectral Reflectance	± 0.2%	± 0.2%	± 0.2%	± 0.2%
Tristimulus (CIE 1931 X, Y, Z)	± 0.05	± 0.05	± 0.05	± 0.05
Chromaticity (CIE 1931 x, y)	± 0.002	± 0.002	± 0.002	± 0.002
LAB Color (CIE 1976 L*, a*, b*)	L* ± 1.0 a*, b* ± 0.8	L* ± 1.0 a*, b* ± 0.8	L* ± 1.0 a*, b* ± 0.8	L* ± 1.0 a*, b* ± 0.8
Average Reflectance	± 0.1	± 0.1	± 0.1	± 0.1
Reported Parameters				
Spectral Data	Reflectance as a function of wavelength			
Colorimetric Data	Tristimulus 1931 X, Y, Z Tristimulus 1964 X, Y, Z CIE 1931 x, y UCS 1960 u, v UCS 1976 u, v CIE 1976 L*, a*, b* CIE 1976 L*, u*, v*			
Illuminant Weighting	Illuminant A, Illuminant B, Illuminant C, Illuminant D65, or User Specified Custom Illuminant			
Wavelength Data	Dominant Wavelength, Peak Wavelength			

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GAMMA SCIENTIFIC *Light Measurement Solutions*

GS-191SA-1045 Semi-Automated Dual Angle Reflectance Measurement Systems

Optical Specifications		
191 Optical Head	10 Degree Optics	45 Degree Optics
Measurement Type	First Surface Specular Reflection	First Surface Specular Reflection
Sample Types	Glass	Glass
Illumination Angle	10°	45°
Viewing Angle	10°	45°
Minimum Sample Thickness (First Surface Reflectance Only)	0.5mm (transparent samples)	0.25mm (transparent samples)
Maximum Sample Thickness	6mm	6mm
Maximum Sample Sizes	325mm x 225mm Panel	325mm x 225mm Panel
Spectral Range	360nm-830nm	360nm-830nm
Illumination Spot Size (Area of Analysis)	1mm x 10µm	1mm x 10µm
Measurement Speed (Sample Dependent)	<1500ms	<1500ms
Calibration Reference Standard	Built in BK-7 Polished Glass	Built in BK-7 Polished Glass
Semi-Auto System Specifications		
191 Optical Head	191F-1045 Dual Angle Optics	
Measurement Program Types	5 Selectable Program Types, Individually configurable for up to 5 different panel sizes Program Types: 5 Point Cross (all points 10° & 45°), 5 Point Cross (45° on center point only), 3 Point Diagonal (all points 10° & 45°), 25 Point Grid (all points 10° & 45°), 40 Point Grid (all points 10° & 45°)	
Measurement Locations	Position coordinates can be individually set for 5 different panel sizes with 1mm resolution Default settings have a grid starting 10mm in from each edge, with equal spacing between the corner locations	
Cycle Time	Program dependent, each measurement point takes ~1500ms	
System Dimensions	Height: 1.25m, Width: 1.0m, Depth: 1.0m Weight: approx. 300kg	
Measurement Accuracy		
Spectral Reflectance	± 0.5%	± 0.5%
Tristimulus (CIE 1931 X, Y, Z)	± 0.05	± 0.10
Chromaticity (CIE 1931 x, y)	± 0.005	± 0.005
LAB Color (CIE 1976 L*, a*, b*)	L* ± 2.0 a*, b* ± 0.8	L* ± 2.0 a*, b* ± 0.8
Average Reflectance	± 0.2	± 0.2
Reported Parameters		
Spectral Data	Reflectance as a function of wavelength	
Colorimetric Data	Tristimulus 1931 X, Y, Z Tristimulus 1964 X, Y, Z CIE 1931 x, y CIE 1976 L*, a*, b* CIE 1976 L*, u*, v*	
Wavelength Data	Dominant Wavelength, Peak Wavelength	

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GAMMA SCIENTIFIC

Light Measurement Solutions

GS-191FA-1045

Rotary Reflectance Measurement Systems

Optical Specifications		
191 Optical Head	10 Degree Optics	45 Degree Optics
Measurement Type	First Surface Specular Reflection	First Surface Specular Reflection
Sample Types	Glass	Glass
Illumination Angle	10°	45°
Viewing Angle	10°	45°
Minimum Sample Thickness (First Surface Reflectance Only)	0.5mm (transparent samples)	0.25mm (transparent samples)
Maximum Sample Thickness	6mm	6mm
Sample Sizes	Customer Defined Panel Size One Machine Can Support Three Different Panel Sizes	Customer Defined Panel Size One Machine Can Support Three Different Panel Sizes
Spectral Range	360nm-830nm	360nm-830nm
Illumination Spot Size (Area of Analysis)	1mm x 10µm	1mm x 10µm
Measurement Speed (Sample Dependent)	<1500ms	<1500ms
Calibration Reference Standard	Built in BK-7 Polished Glass	Built in BK-7 Polished Glass
Rotary System Specifications		
191 Optical Heads	191F-1045 Dual Angle Optics	
Measurement Locations Per Panel	3 Measurement Locations Standard, Configurable up to 5 locations Configurable for 10 and 45 degree measurement at any location	
Glass Stations	8 Glass Stations, 3 for loading/unloading and 5 for measurement optics	
Cycle Time	<6 seconds per panel, 3 seconds maximum for loading and unloading (cycle time increases if load/unload exceeds 3 seconds)	
System Dimensions	Height: 1.75m, Width: 1.6m, Depth: 1.6m Weight: approx.1000kg	
Measurement Accuracy		
Spectral Reflectance	± 0.5%	± 0.5%
Tristimulus (CIE 1931 X, Y, Z)	± 0.05	± 0.10
Chromaticity (CIE 1931 x, y)	± 0.005	± 0.005
LAB Color (CIE 1976 L*, a*, b*)	L* ± 2.0 a*, b* ± 0.8	L* ± 2.0 a*, b* ± 0.8
Average Reflectance	± 0.2	± 0.2
Reported Parameters		
Spectral Data	Reflectance as a function of wavelength	
Colorimetric Data	Tristimulus 1931 X, Y, Z Tristimulus 1964 X, Y, Z CIE 1931 x, y CIE 1976 L*, a*, b* CIE 1976 L*, u*, v*	
Wavelength Data	Dominant Wavelength, Peak Wavelength	

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GAMMA SCIENTIFIC

Light Measurement Solutions

191T Transmission Measurement Systems

Optical Specifications	
191 Optical Head	191T
Measurement Type	Total Transmission
Sample Types	Glass or any polished transmissive element
Illumination Angle	0°
Viewing Angle	2n (180°)
Minimum Sample Thickness	None
Maximum Sample Thickness	15mm
Minimum Sample Size	Ø 10mm
Maximum Sample Size	200mm x 200mm Panel
Illumination Spot Size (Area of Analysis)	Ø 1mm, Ø 2mm, or Ø 3mm (User selectable at time of purchase)
Measurement Speed (Sample Dependent)	≈300-3000ms
Calibration Reference Standard	BK-7 Polished Glass
Optical Head Dimensions	Height: 350mm (13.75in) Width: 205mm (8.0in) Depth: 225mm (8.85in) Weight: approx. 3.5kg (7.75lbs)
Measurement Accuracy	
Spectral Transmission	± 0.5%
Tristimulus (CIE 1931 X, Y, Z)	± 0.05
Chromaticity (CIE 1931 x, y)	± 0.005
LAB Color (CIE 1976 L*, a*, b*)	L* ± 2.0 a*, b* ± 0.8
Average Transmission	± 0.2
Reported Parameters	
Spectral Data	Transmission as a function of wavelength
Colorimetric Data	Tristimulus 1931 X, Y, Z Tristimulus 1964 X, Y, Z CIE 1931 x, y UCS 1960 u, v UCS 1976 u, v CIE 1976 L*, a*, b* CIE 1976 L*, u*, v*
Illuminant Weighting	Illuminant A, Illuminant B, Illuminant C, Illuminant D65, or User Specified Custom Illuminant
Wavelength Data	Dominant Wavelength, Peak Wavelength

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GAMMA SCIENTIFIC

Light Measurement Solutions

GS-1220 Spectroradiometer Specifications

Detector and Wavelength Specifications

Spectrometer Model	GS-1220-0	GS-1220-1	GS-1220-2
Nominal Spectral Range	250-900nm UV-VIS	360-900nm VIS	360-1100nm VIS-NIR
Datapoint Interval	0.32 nm	0.32 nm	0.35 nm
Spectral Bandwidth	Built-In User Selectable Half-Power Bandwidth (HPBW) Bold is factory setting		
	10 nm	10 nm	10 nm
	5.0 nm	5.0 nm	5.0 nm
	2.5 nm	2.5 nm	2.5 nm
	1.4 nm	1.4 nm	1.4 nm
	1.0 nm	1.0 nm	1.0 nm
Wavelength Repeatability	0.02 nm	0.02 nm	0.02 nm
Wavelength Accuracy	+/- 0.1 nm	+/- 0.1 nm	+/- 0.1 nm

Accuracy¹

Luminous Intensity	± 1%	± 1%	± 1%
Luminous Flux	± 1%	± 1%	± 1%
Chromaticity (CIE1931 xy) ²	x,y=±0.0015	x,y=±0.0015	x,y=±0.0015
Dominant Wavelength ³	± 0.5 nm	± 0.5 nm	± 0.5 nm

Sensitivity³

Luminous Intensity (10:1 signal-to-noise)	0.02 mcd to 15 kcd	0.02 mcd to 15 kcd	0.02 mcd to 15 kcd
Luminous Flux ⁴ (12" sphere ; 10:1 signal-to-noise)	1 mlm – 240 klm	1 mlm – 240 klm	1 mlm – 240 klm
Illuminance Sensitivity (10:1 signal-to-noise)	0.02 mlux - 15,000 lux	0.02 mlux - 15,000 lux	0.02 mlux - 15,000 lux
Measuring time (range)	2 µsec to 2.67 sec	2 µsec to 2.67 sec	2 µsec to 2.67 sec
Measuring Time at 1 mcd (10:1 signal-to-noise)	40 msec	40 msec	40 msec

Specifications for All Spectrometers

Stray Light	Less than 1×10^{-4} (at 8 times the HPBW from HeNe Laser Line)
Spectral Sensor	High Resolution 2048 pixel CCD Sensor
Temperature Stabilized Sensor	-5° C below ambient
Electrical Resolution	16 Bit
Dynamic Range (single scan)	6,670:1
Computer Interface	USB 2.0
Control Software	Light Touch LED software for Windows
Dimensions:	5.25" H x 12.00" W x 10.20" L (13.34" cm x 30.48 cm W x 25.91 cm L)
Weight	20 lbs. (9.1 kg)

- 1: Accuracy specifications assume sufficient signal to noise and are valid immediately after proper calibration, relative to the calibration standard.
- 2: Applies to colored LEDs with sufficient signal-to-noise ratio.
- 3: Sensitivity specifications assume a 10:1 signal-to-noise ratio for white 5000K CCT LED's.
- 4: Luminous flux is with a GS-IS300 integrating sphere calibrated with Deuterium and tungsten standards to cover a 250 to 860nm range
- 5: Specifications are subject to change at any time without notice
- 6: Standard Operating Range for Gamma Scientific Instruments- Temperature: Minimum: 0°C (32°F) - Maximum: 35°C (95°F); Relative Humidity (Non-Condensing): Minimum: 20% - Maximum 70%
- 7: Revised on April 14, 2015