



USER MANUAL

IS series | Integrating spheres for laser power measurement

WARRANTY

First Year Warranty

The Gentec-EO integrating sphere series carries a one-year warranty (from date of shipment) against material and/or workmanship defects, when used under normal operating conditions. The warranty does not cover damages related to battery leakage or misuse.

Gentec-EO Inc. will repair or replace, at Gentec-EO Inc.'s option, any integrating sphere that proves to be defective during the warranty period, except in the case of product misuse.

Any attempt by an unauthorized person to alter or repair the product voids the warranty.

The manufacturer is not liable for consequential damages of any kind.

Contacting Gentec Electro-Optics Inc.

In case of malfunction, contact your local Gentec-EO distributor or nearest Gentec-EO Inc. office to obtain a return authorization number. The material should be returned to:

Gentec Electro-Optics, Inc.
445, St-Jean-Baptiste, Suite 160
Québec, QC
Canada, G2E 5N7

Tel: (418) 651-8003
Fax: (418) 651-1174
E-mail: service@gentec-eo.com
Website: gentec-eo.com

SAFETY INFORMATION

Do not use the integrating sphere if the device looks damaged, or if you suspect that the integrating sphere is not operating properly.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions, it may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, try to correct the interference by taking one or more of the following steps:

- Reorient or relocate the receiving antenna.
- Increase the distance between the equipment and receiver.
- Connect the equipment to an outlet that is on a different circuit than the receiver.
- Consult the dealer or an experienced radio/TV technician for help.

Caution: Changes or modifications not expressly approved in writing by Gentec-EO Inc. may void the user's authority to operate this equipment.

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1. Integrating sphere IS series – Power detectors

1.1. INCLUDED WITH YOUR IS

Description
IS series detector
Protective cap
Carrying case (only for the IS50A-1KW-RSi-INT/IDR-D0)
Calibration certificate

The following items can be purchased separately:

Description	Part name	Part number
Fiber optic adaptor FC/PC	FOA-FULL-FC	202367
Fiber optic adaptor SMA	FOA-FULL-SMA	202368
Fiber optic adaptor ST	FOA-FULL-ST	202369
Isolation tube	XLP12-TUBE	101449
Stand	See website	See website

1.2. INTRODUCTION

The Gentec-EO integrating sphere is a spherical cavity that holds our proprietary highly reflective coating. The coating is used to create multiple diffuse reflections inside the sphere. After these reflections, a small sample of the diffused light is captured by the silicon sensor. By using a silicon sensor, the response time is as fast as a photodiode. The integrating sphere offers multiple advantages, such as: high damage thresholds and higher measurable power than a standard photodiode. The integrating sphere detector is also less sensitive to: beam dimensions, intensity profile, angle of incidence, beam divergence and polarization. Gentec-EO integrating spheres have a NIST-traceable calibration for the entire spectral range. The calibration comes with a temperature compensation calibration for every sphere to ensure accurate and stable measurements through time.

Finally, the Gentec-EO integrating sphere works with PC-Gentec-EO software, the same way as other Gentec-EO detectors.

1.3. POWER DETECTOR CONNECTORS

1.3.1. Integra USB (INT)

The Integra USB connector is an integrated PC interface that allows to plug the head directly into a computer. It has the same serial commands as the MAESTRO and a few extra ones (see the PC-Gentec-EO user manual) and uses the same PC-Gentec-EO software. For additional information, consult the Integra user manual.

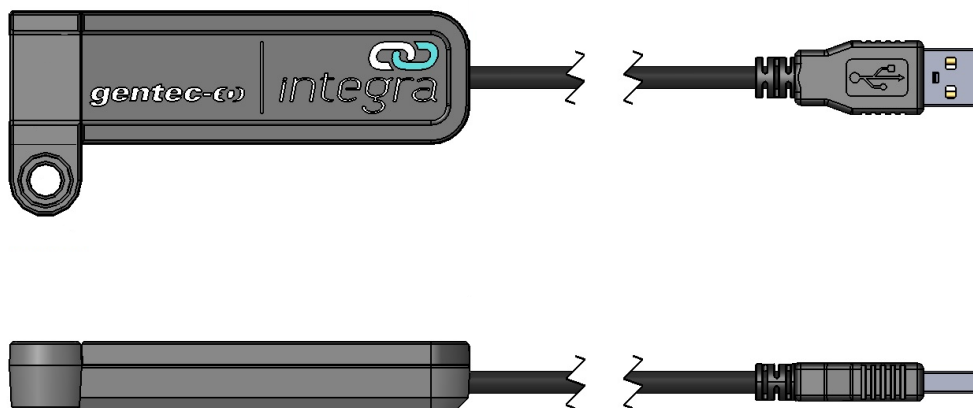


Figure 1: Layout Drawing, Integra USB (INT).

1.3.2. Integra RS-232 (IDR)

The Integra IDR connector is an integrated PC interface that allows you to communicate with the detector head through serial commands. The communication protocol is RS-232 and the connector is a DB-9. For additional information, consult the Integra manual.

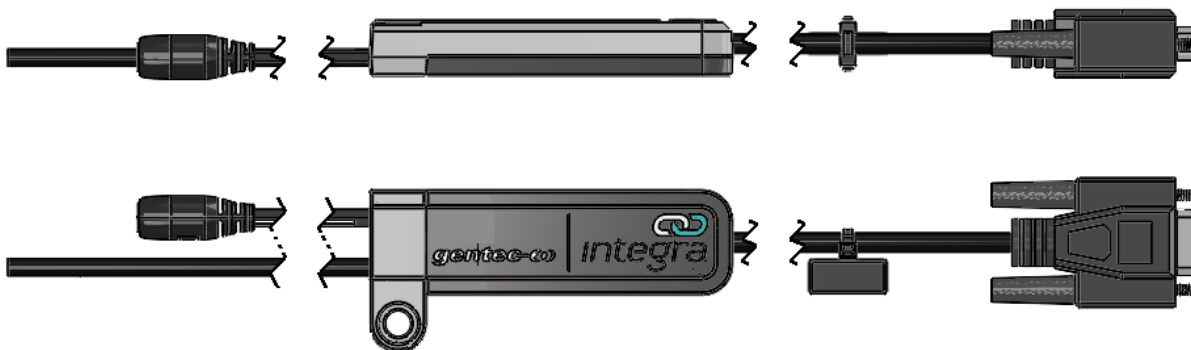


Figure 2: Layout Drawing, Integra IDR (RS-232).

1.3.3. Cooling water

The fluid used to cool the IS50A-1KW-RSi should be clean water. The IS50A is equipped with 1/4" OD plastic fittings. It must be used with 1/4" plastic semi-rigid tube. The fittings are not compatible with copper or stainless steel tubes.

In the case water is not available for cooling, other fluids can be used following a few rules:

- The heat capacity of the fluid must be equivalent to the heat capacity of water. Low heat capacity would result in a lack of heat extraction and could cause overheating of the detector.

- The fluid must be compatible with bare aluminum and anodize aluminum. Incompatible fluids could result in damage to the cooling circuit.

For water as a cooling fluid, we recommend the following parameters:

- The resistivity of the water must be over 100 kOhm-cm.
- Distilled water can be used, but it is not recommended to use highly deionized ultra-pure water since the water cavity is not completely inert.
- If an algaecide must be used in the chiller, we recommend Optishield Plus or equivalent.
- If chloride is present in the system, the concentration should not exceed 25 PPM and the pH maintained between 6.0 to 8.0.

The cooling water can be between 15°C and 25°C **AND must always remain above the dew point**. The ideal set point is 20.0°C, where the integrating sphere is calibrated.

1.4. INTEGRATING SPHERE IS SERIES SPECIFICATIONS

The Gentec-EO integrating sphere is a laser power detector with two possible outputs. The first output option is with the USB Integra PC interface. The second output option is with the RS-232 Integra PC interface.

The following specifications are based on a one-year calibration cycle, an operating temperature of 15 to 28°C and a relative humidity not exceeding 80%. The storage temperature should be between 10 to 65°C with a relative humidity not exceeding 90%.

The specifications for the integrating sphere IS12L-9S-RSi are presented below.

Table 1: IS12L-9S-RSi detector specifications.

	IS12L-9S-RSi-INT-D0	IS12L-9S-RSi-IDR-D0
Integrated PC interface	Integra (USB)	Integra (RS-232)
Sensor	Silicon	
Aperture	Ø 12 mm	
Sphere inner diameter	50 mm	
Spectral range	340 to 1100 nm	
Calibrated spectral range	400 to 1070 nm	
Uncertainty	± 2.5% @ 1070 nm ± 3.5% @ 500-1069 nm ± 5.0% @ 400-499 nm	
Minimum repetition rate ¹	155 kHz (25 mA to 1 µA) 1700 Hz (1 µA to 1 nA)	
Maximum power	9 W	
Typical back reflections ²	~ 6 %	
Linearity with power	± 1%	
Maximum divergence	10° (half angle)	
Maximum incidence angle	± 10°	
Repeatability	± 0.5%	
Damage threshold	2 kW/cm ² @ 1070 nm – CW 400 mJ/cm ² @ 1070 nm – 7 ns	

¹ For details, see section 1.6.

² For the integrating sphere IS12L-9S-RSi, the backscattered power (also known as back reflections) is concentrated in a cone with an apex located at the back of the sphere. The angle of the backscattered cone is 15° (7.5° half angle). There is no back reflection outside of the cone area in front of the optical aperture. The typical backscattering is calculated for a beam of 50% of the aperture diameter (6 mm for IS12L) at 1/e².

Noise equivalent power	1 μ W @ 1070 nm
Resolution	10 pW @ 1070 nm

Sampling rate	15 Hz ³
Response time (0-95%), typical	< 0.2 sec
Detector dimensions	78 mm x 66 mm x 66 mm
Weight	0.7 kg
Cable length	2 m
Mounting holes	M4 8-32
Fiber adapter compatibility	Thread for SM1 fiber adaptor

The beam diameter should be between 10% and 90% of the aperture diameter.

³ When used with serial commands. Reduced to 6.8 Hz when used with PC-Gentec-EO.

The specifications for the integrating sphere IS50A-1KW-RSi are presented below.

Table 2: IS50A-1KW-RSi detector specifications.

	IS50A-1KW-RSi-INT-D0	IS50A-1KW-RSi-IDR-D0
Integrated PC interface	Integra (USB)	Integra (RS-232)
Sensor	Silicon	
Aperture	Ø 50 mm	
Sphere inner diameter	100 mm	
Spectral range	340 to 1100 nm	
Calibrated spectral range	400 to 1070 nm	
Uncertainty	$\pm 2.5 \% @ 1070 \text{ nm}$ $\pm 3.5 \% @ 500 - 1069 \text{ nm}$ $\pm 5.0 \% @ 400 - 499 \text{ nm}$	
Min repetition rate ⁴	155 kHz (25 mA to 1 μA) 1700 Hz (1 μA to 1 nA)	
Maximum power	1000 W (continuous) 1500 W (10 seconds, cooling: 3 min)	
Maximum power without water cooling	13 W (continuous) 50 W (1 minute, cooling: 3 min)	
Typical back reflections ⁵	~ 12.5 %	
Linearity with power	$\pm 1 \%$	
Maximum divergence	10° (half angle)	
Maximum incidence angle	$\pm 25^\circ$ for beam diameter < Ø 12mm $\pm 5^\circ$ for beam diameter > Ø 12mm	
Repeatability	$\pm 0.5 \%$	
Damage threshold	5 kW/cm ² @ 1064 – 1070 nm – CW 400 mJ/cm ² @ 1064 – 1070 nm – 7 ns	
Noise equivalent power	10 μW @ 1070 nm	
Resolution	100 pW @ 1070 nm	
Sampling rate	15 Hz ⁶	

⁴ For details, see section 1.6.

⁵ For the integrating sphere IS50A-1KW-RSi, the backscattered power (also known as back reflections) is concentrated in a cone with an apex located at the back of the sphere. The angle of the backscattered cone is 30° (15° half angle). There is no back reflection outside of the cone area in front of the optical aperture. The typical backscattering is calculated for a beam of 50% of the aperture diameter (25 mm for IS50A) at $1/e^2$.

⁶ When used with serial commands. Reduced to 6.8 Hz when used with PC-Gentec-EO.

Response time (0-95%), typical	< 0.2 sec
Detector dimensions	140 mm (W) x 127 mm (H) x 115 mm (D)
Weight	4 kg
Cable length	2 m
Mounting holes	M6 ¼ - 20
Fiber adapter compatibility	Thread for SM2 fiber adaptor
Detector cooling	Water
Recommended cooling flow rate	3 LPM
Minimum cooling flow rate	2 LPM
Cooling temperature	15 – 25 °C
Cooling maximum input pressure	60 psi / 413 kPa

The beam diameter should be between 10% and 90% of the aperture diameter.

1.5. INTEGRATING SPHERE IS HEAD DIMENSIONS

The integrating sphere IS12L-9S-RSi has overall dimensions of 78mm wide, 66mm high and 66mm deep.

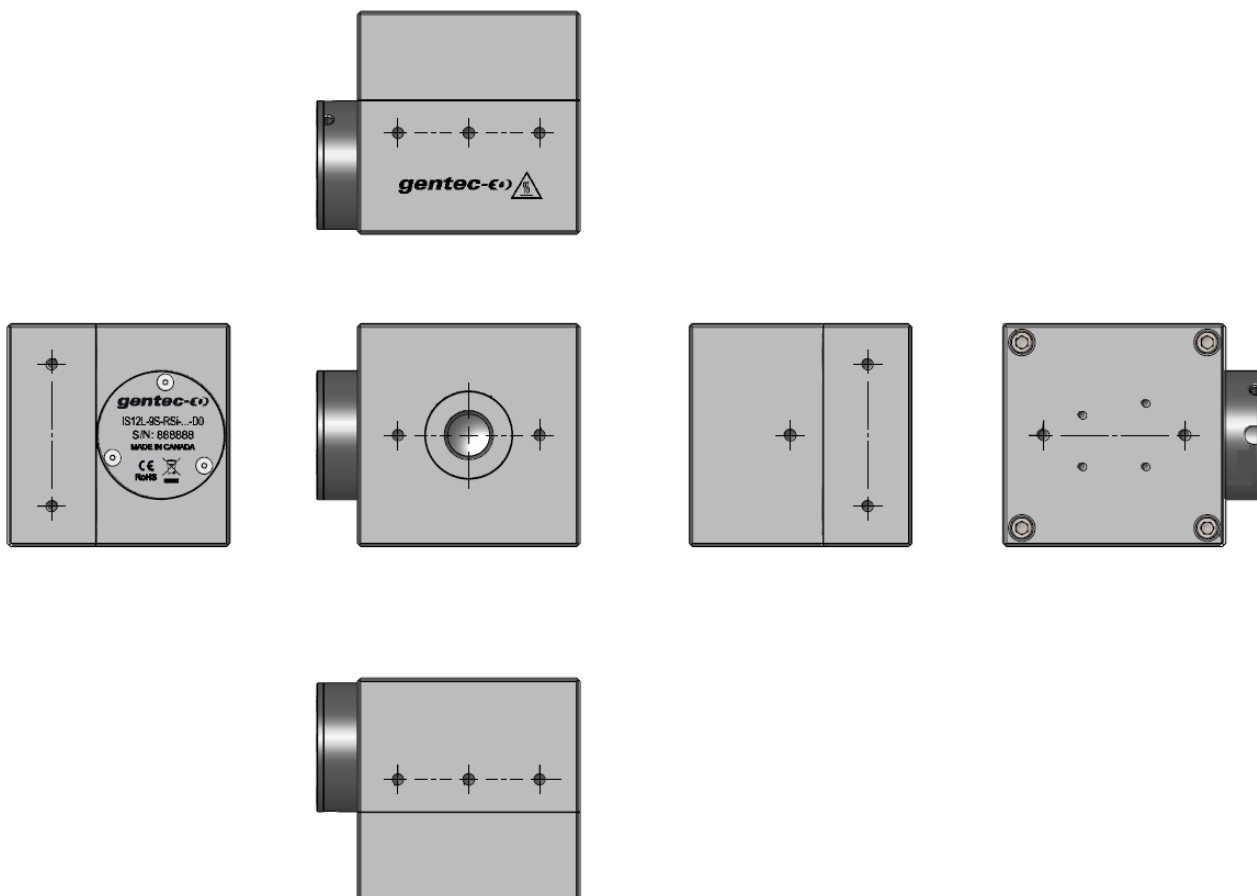


Figure 3: Layout drawing, IS12L-9S-RSi-INT/IDR-D0.

The 8-32 imperial threads, centered on the top, bottom and right views are compatible with the 2in x 3in stands (STAND-D-233, STAND-S-233). The other threads are all metric and of dimensions M4x0.7mm.

The integrating sphere IS50A-1KW-RSi has overall dimensions of 140 mm wide, 127 mm high and 115 mm deep.

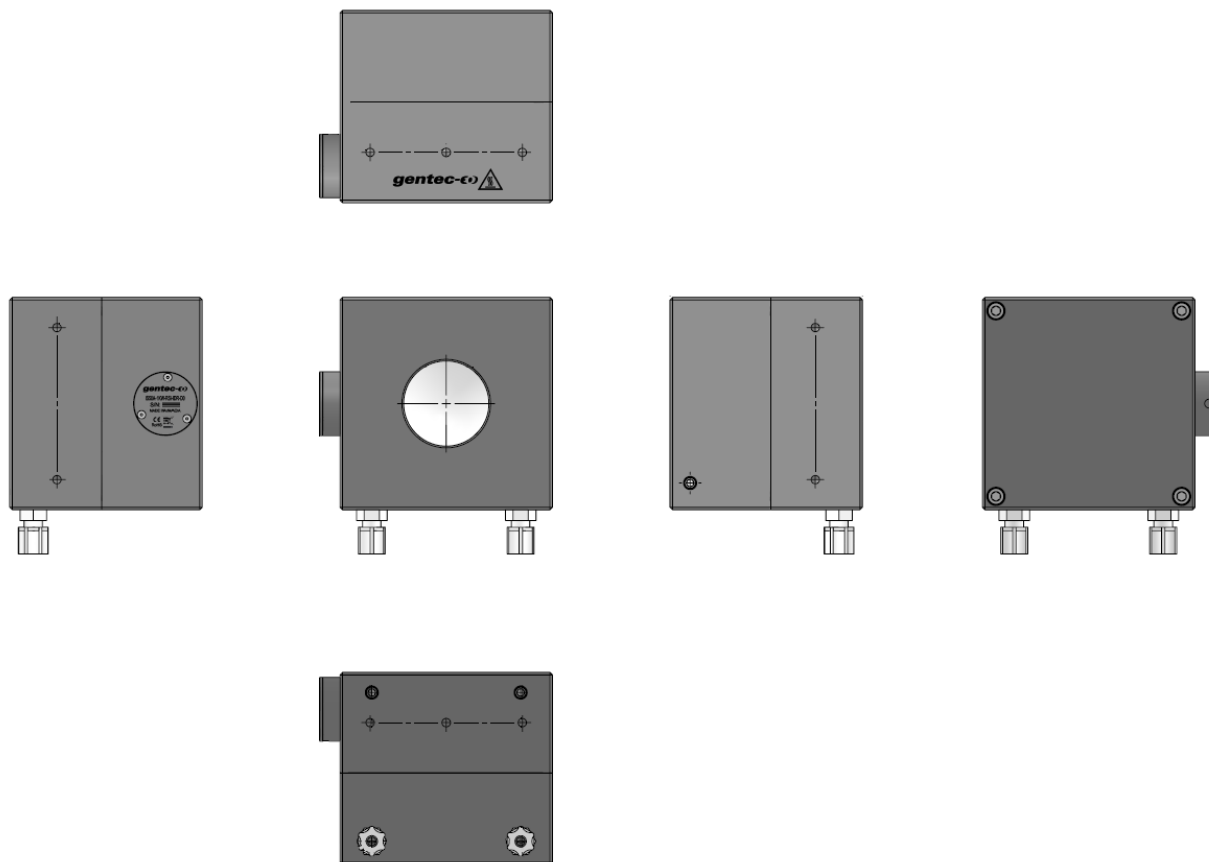


Figure 4: Layout drawing, IS50A-1KW-RSi-INT/IDR-D0.

The ¼-20 imperial threads, centered on the top and bottom views are compatible with the 4in x 4in stands (STAND-D-443, STAND-S-443, STAND-S-443-C). The other threads are all metric and of dimensions M6x1.0mm.

1.6. INTEGRATING SPHERE TYPICAL SPECTRAL RESPONSE

The spectral response of the integrating sphere is similar to a photodiode. For the integrating sphere IS12L-9S-RSi, the spectral response is showed in the figure below.

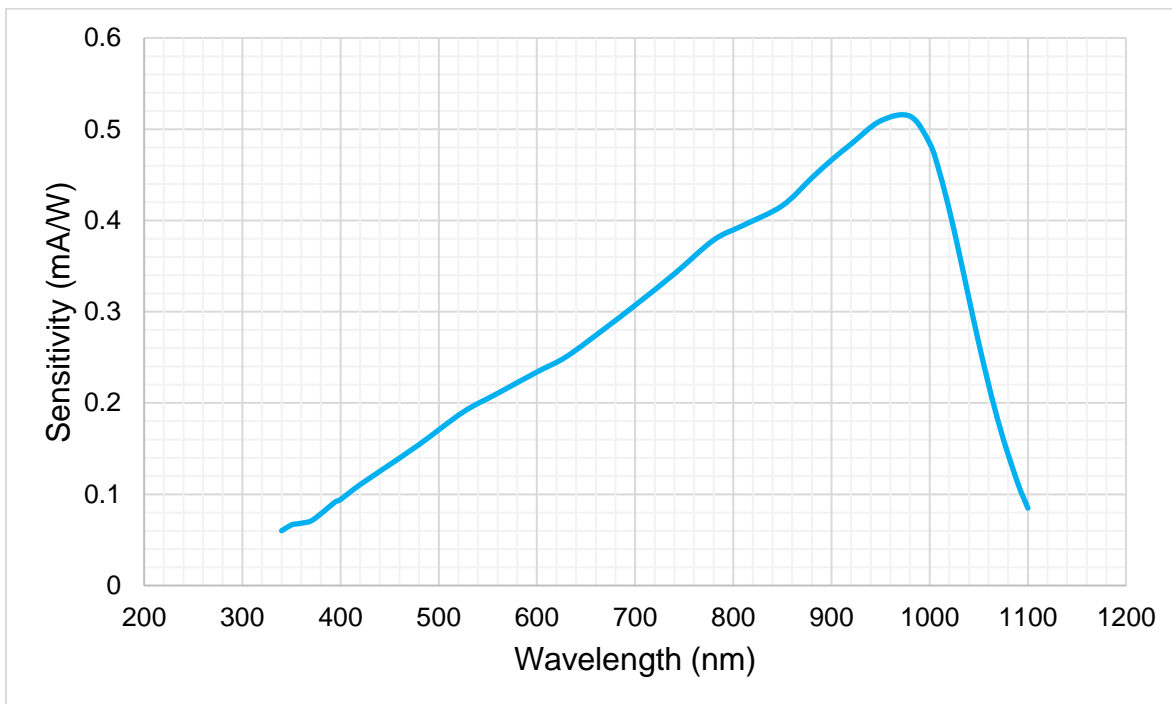


Figure 5: Typical sensitivity of the IS12L-9S-RSi.

For the integrating sphere IS50A-1KW-RSi, the spectral response is showed in the figure below.

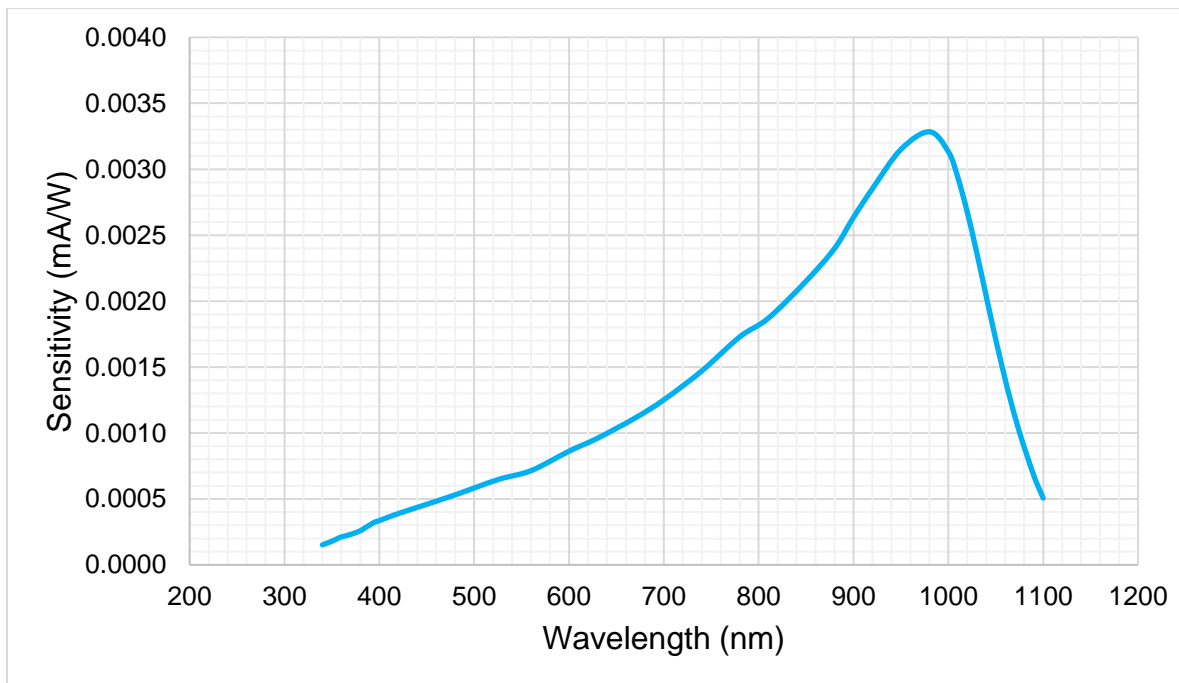


Figure 6: Typical sensitivity of the IS50A-1KW-RSi.

1.7. MINIMUM REPETITION RATE CALCULATION PROCEDURE

Integrating spheres can be used with pulsed lasers. The integrating sphere measures the average power of the laser pulses if the repetition rate is fast enough. The average power is measured correctly if the repetition rate of the laser is greater than the minimum repetition rate of the detector as defined in the specification sheet.

The minimum repetition rate depends on the level of current generated by the photodiode. To find the current level, you need to know the following: laser power and wavelength. The calculation procedure is as follows:

- 1) With the laser wavelength, find the corresponding sensitivity of the detector (calibration certificate or typical curve in section 1.5 of this manual).
- 2) Multiply the laser power by the sensitivity to get the level of current that is generated by the photodiode under a given condition.
- 3) Find the minimum repetition rate in the specification sheet based on the current level calculated in the previous step.

Example 1 :

The detector used is an IS12L-9S-RSi integrating sphere. The laser wavelength is 980 nm. The laser power is 8 W.

- 1) With the typical sensitivity curve in section 1.5, the sensitivity is approximately 0.52 mA/W.
- 2) By multiplying the laser power of 8 W by the sensitivity of 0.52 mA/W, we obtain a current level of 4.2 mA.
- 3) According to the specification sheet, the minimum repetition rate is 155 kHz since the current level of 4.2 mA is in the range 25 mA to 1 μ A.

Example 2 :

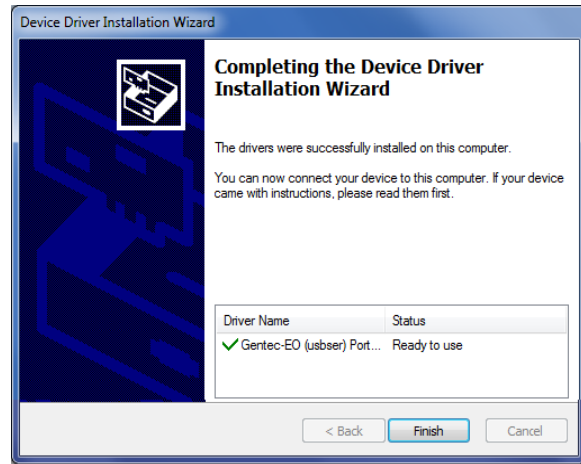
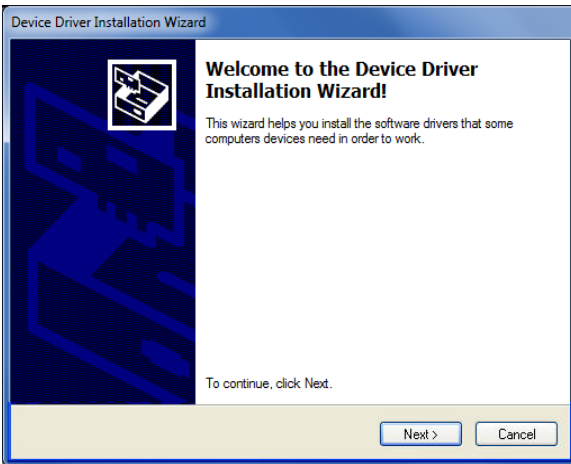
The detector used is an IS50A-1KW-RSi integrating sphere. The laser wavelength is 405 nm. The laser power is 1 mW.

- 1) With the typical sensitivity curve in section 1.5, the sensitivity is approximately 0.00036 mA/W.
- 2) By multiplying the laser power of 1 mW by the sensitivity of 0.00036 mA/W, we obtain a current level of 0.36 μ A.
- 3) According to the specification sheet, the minimum repetition rate is 1700 Hz since the current level of 0.36 μ A is in the range 1 μ A to 1 nA.

2. Quick start procedure

The integrating sphere comes with the Integra PC interface. For the USB version (INT), INTEGRA USB drivers will install a virtual COM port on your PC. Please download the USB driver at: <https://www.gentec-eo.com/resources/download-center>.

1. Do not connect the INTEGRA to your computer
2. Follow the installation steps until you have the message INTEGRA ready to use.



3. You can now connect the INTEGRA and install/use the software PC-Gentec-EO.

After connection is made with PC-Gentec-EO, the software automatically recognizes all integrating sphere heads. Then, the software downloads all custom technical data for the detector from the Integra PC interface. The data includes sensitivity, model, serial number, version and wavelength correction factor.

To start using your integrating sphere, you should:

1. Install the head on its optical stand.
2. Connect the Integra USB directly on the PC. If you want to use the Integra IDR version (RS-232) with your PC, use a RS-232 to USB converter.
3. The PC-Gentec-EO software will default to autoscale and lowest wavelength.
4. Select the proper wavelength. If known, select the proper power scale (if not, use autoscale).
5. Remove the detector cover.
6. Align the detector into the laser beam path.
7. For the most accurate measurements, the beam should be centered on the optical aperture and the same diameter as written on the calibration certificate. Also, the beam divergence and the beam angle of incidence should be within specification.
8. Block the laser radiation to the detector.
9. To rest the zero, wait until the reading has stabilized.
The power read when no laser beam is incident on the detector may not be exactly zero if the detector or monitor is not thermally stabilized. Warm-up until the reading without laser power is stable for several minutes. Half an hour warm-up is recommended for measuring low powers.
10. Press the **ZERO** button in PC-Gentec-EO. By doing that you are removing the power compensation from background illumination. If you don't want to remove the contribution from background illumination, but the detector cover, press **ZERO** and then, remove the detector cover.
11. Apply the laser beam to the detector head.

12. PC-Gentec-EO displays the laser beam average power.

3. User interface

Please refer to the PC-Gentec-EO manual for more information concerning the user interface. The manual can be downloaded on our website at <https://gentec-eo.com/downloads/specsheets-manuals>.

4. Damage to the optical absorber material

Damage to the optical absorber material is usually caused by exceeding the manufacturer's specifications such as:

- Incident average power density
- Incident pulse energy density

Refer to the specifications in section 1.3. *INTEGRATING SPHERE IS SERIES SPECIFICATIONS*. Damage may also be caused if the absorber surface is contaminated. A slight discoloration of the coating does not affect the calibration.

In the event of significant damage to the coating, contact your local Gentec-EO representative for information on repair and recalibration. See page i **Contacting Gentec Electro-Optics Inc.**

APPENDIX A: DECLARATION OF CONFORMITY

Application of Council Directive(s): 2014/30/EU EMC Directive
tests in compliance with FCC part 15 subpart B

Manufacturer's Name: Gentec Electro Optics, Inc.
Manufacturer's Address: 445 St-Jean Baptiste, suite 160
(Québec), Canada G2E 5N7

Representative's Name: Laser Component S.A.S
Representative's Address: 45 bis Route des Gardes
92190 Meudon (France)

Type of Equipment: Laser Power/Energy Meter
Model No.: INTEGRA V2
Year of test & manufacture: 2016

Standard(s) to which Conformity is declared:
EN61326-1 (2013) Emission generic standard

Test Name Standards	Test Specifications	Performance Criterion	Results
Conducted Emissions FCC part 15 (2013) subpart B	Class A 150kHz-30MHz	N/A	Pass
Radiated Emissions FCC part 15 (2013) subpart B	Class A 30MHz-1GHz	N/A	Pass
Conducted Emissions CISPR11 (2009) A1 (2010)	Group 1 - class A 150kHz-30MHz	N/A	Pass
Radiated Emissions CISPR11 (2009) A1 (2010)	Group 1 - class A 30MHz-1GHz	N/A	Pass
Harmonic Current Emission Limits EN61000-3-2 (2006) A1 (2009) A2 (2009)	Class A	N/A	Pass
Voltage Fluctuations and Flicker Limitations EN61000-3-3 (2008)	Observation period for Pst : 10 min Observation period for Plt : 120 min	N/A	Pass
Electrostatic Discharge Immunity IEC61000-4-2 (2008)	Contact : ±4kV Air : ±8kV	B	Pass
Radiated Electromagnetic Field Immunity IEC61000-4-3 (2006) A1 (2007) A2 (2010)	80MHz-1000MHz : 10V/m 1.4GHz-2GHz : 3V/m 2GHz-2.7GHz : 1V/m	A	Pass
Electrical Fast Transient Immunity IEC61000-4-4 (2012)	Power : ±2kV / 5kHz I/O Ports : ±1kV / 5kHz Communication Ports : ±1kV / 5kHz	B	Pass
Surge Immunity IEC61000-4-5 (2005)	Power : ±2kV L-PE / ±1kV L-L I/O Ports : N/A Communication Ports : N/A	B	Pass

Test Name Standards	Test Specifications	Performance Criterion	Results
Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields IEC61000-4-6 (2008)	Power : 3V I/O Ports : 3V Communication Ports : 3V	A	Pass
Voltage Dips, Short Interruptions and Voltage Variation Immunity on AC Input IEC61000-4-11 (2004)	Voltage dips : 0% during 1 cycle 40% during 10 cycles 70% during 25 cycles Short interruptions : 0% during 250 cycles	B C C C	Pass

I, the undersigned, hereby declare that the equipment specified above
conforms to the above Directive(s) and Standard(s)

Place: Quebec (Quebec)

Date : July 15, 2016



(President)

APPENDIX B: UKCA DECLARATION OF CONFORMITY

Application of Council Directive(s): 2014/30/EU EMC Directive
tests in compliance with FCC part 15 subpart B

Manufacturer's Name: Gentec Electro Optics, Inc.
Manufacturer's Address: 445 St-Jean Baptiste, suite 160
(Québec), Canada G2E 5N7

Representative's Name: Laser Component S.A.S
Representative's Address: 45 bis Route des Gardes
92190 Meudon (France)

Type of Equipment: Laser Power/Energy Meter
Model No.: INTEGRA V2
Year of test & manufacture: 2016

Standard(s) to which Conformity is declared:
EN61326-1 (2013) Emission generic standard


Test Name Standards	Test Specifications	Performance Criterion	Results
Conducted Emissions FCC part 15 (2013) subpart B	Class A 150kHz-30MHz	N/A	Pass
Radiated Emissions FCC part 15 (2013) subpart B	Class A 30MHz-1GHz	N/A	Pass
Conducted Emissions CISPR11 (2009) A1 (2010)	Group 1 - class A 150kHz-30MHz	N/A	Pass
Radiated Emissions CISPR11 (2009) A1 (2010)	Group 1 - class A 30MHz-1GHz	N/A	Pass
Harmonic Current Emission Limits EN61000-3-2 (2006) A1 (2009) A2 (2009)	Class A	N/A	Pass
Voltage Fluctuations and Flicker Limitations EN61000-3-3 (2008)	Observation period for Pst : 10 min Observation period for Plt : 120 min	N/A	Pass
Electrostatic Discharge Immunity IEC61000-4-2 (2008)	Contact : ±4kV Air : ±8kV	B	Pass
Radiated Electromagnetic Field Immunity IEC61000-4-3 (2006) A1 (2007) A2 (2010)	80MHz-1000MHz : 10V/m 1.4GHz-2GHz : 3V/m 2GHz-2.7GHz : 1V/m	A	Pass
Electrical Fast Transient Immunity IEC61000-4-4 (2012)	Power : ±2kV / 5kHz I/O Ports : ±1kV / 5kHz Communication Ports : ±1kV / 5kHz	B	Pass
Surge Immunity IEC61000-4-5 (2005)	Power : ±2kV L-PE / ±1kV L-L I/O Ports : N/A Communication Ports : N/A	B	Pass

Test Name Standards	Test Specifications	Performance Criterion	Results
Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields IEC61000-4-6 (2008)	Power : 3V I/O Ports : 3V Communication Ports : 3V	A	Pass
Voltage Dips, Short Interruptions and Voltage Variation Immunity on AC Input IEC61000-4-11 (2004)	Voltage dips : 0% during 1 cycle 40% during 10 cycles 70% during 25 cycles Short interruptions : 0% during 250 cycles	B C C C	Pass

I, the undersigned, hereby declare that the equipment specified above
conforms to the above Directive(s) and Standard(s)

Place: Quebec (Quebec)

Date : December 01, 2021



(President)

APPENDIX C: WEEE DIRECTIVE

RECYCLING AND SEPARATION PROCEDURE FOR WEEE

This section is used by the recycling center when the detector reaches its end of its line. Breaking the calibration seal or opening the detector head or monitor case will void the warranty.

The complete detector contains:

- 1 integrating sphere with Integra PC interface
- 1 calibration certificate

SEPARATION

Paper: Calibration certificate

Plastic: Aperture cap (IS12L), Integra case, water fittings (IS50A)

Viton: O-Ring (IS50A)

Metal: Integrating sphere case, screws, aperture cap (IS50A)

Wires: Cable from head to Integra, USB cable

Printed circuit board: inside the integrating sphere and inside the Integra



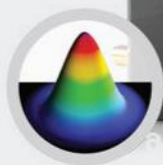
gentec-eo
PARTNERS for ACCURACY

WWW.GENTEC-EO.COM

LEADER IN LASER BEAM MEASUREMENT SINCE 1972



POWER & ENERGY METERS



BEAM PROFILING



THZ MEASUREMENT

CANADA

445 St-Jean-Baptiste, Suite 160
Quebec, QC, G2E 5N7
CANADA

T (418) 651-8003
F (418) 651-1174

info@gentec-eo.com

UNITED STATES

5825 Jean Road Center
Lake Oswego, OR, 97035
USA

T (503) 697-1870
F (503) 697-0633

info@gentec-eo.com

JAPAN

Office No. 101, EXL111 building,
Takinogawa, Kita-ku, Tokyo
114-0023, JAPAN

T +81-3-5972-1290
F +81-3-5972-1291

info@gentec-eo.com

CALIBRATION CENTERS

- 445 St-Jean-Baptiste, Suite 160
Quebec, QC, G2E 5N7, CANADA
- Werner von Siemens Str. 15
82140 Olching, GERMANY
- Office No. 101, EXL111 building,
Takinogawa, Kita-ku, Tokyo
114-0023, JAPAN