

# USER MANUAL

PH Series

Optical Power Detectors



gentec-eo

121-200774

WWW.GENTEC-EO.COM

## **Warranty**

### **First Year Warranty**

The Gentec-EO power and energy detectors carry 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 recalibration or damages related to misuse.

Gentec-EO will repair or replace at its option any wattmeter or joulemeter which proves to be defective during the warranty period, except in the case of product misuse.

Any unauthorized alteration or repair of the product is also not covered by the warranty.

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

Customers must fill in and mail the warranty card in order to validate the warranty.

In the case of a malfunction, contact the local Gentec-EO distributor or nearest Gentec-EO office to obtain a return authorization number. Return the material to the appropriate address below.

### **Contacting Gentec Electro-Optics Inc.**

To help us answer your calls more efficiently please have the model number of the detector you are using ready before calling Customer Support.

#### **All customers:**

Gentec-EO, Inc.  
445 St-Jean-Baptiste, Suite 160  
Quebec, QC, G2E 5N7  
Canada

Tel: (418) 651-8003  
Fax: (418) 651-1174  
Email: [service@gentec-eo.com](mailto:service@gentec-eo.com)  
Web: [www.gentec-eo.com](http://www.gentec-eo.com)

### **Lifetime Warranty**

Gentec-EO will warranty any power and energy detector head for its lifetime as long as it has been returned for recalibration annually from the date of shipment. This warranty includes parts and labor for all routine repairs including normal wear under normal operating conditions.

Gentec-EO will inspect and repair the detector during the annual recalibration. Exceptions to repair at other times will be at Gentec-EO's option.

Not included is the cost of annual recalibration or consequential damages from using the detector.

The only condition is that the detector head must not have been subject to unauthorized service or damaged by misuse. Misuse would include, but is not limited to, laser exposure outside Gentec-EO's published specifications, physical damage due to improper handling, and exposure to hostile environments. Hostile environments would include, but are not limited to excessive temperature, vibration, humidity, or surface contaminants; exposure to flame, solvents or water; and connection to improper electrical voltage.

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## 1 PH SERIES PHOTO DETECTORS

### 1.1 INTRODUCTION

The Gentec-EO PH Series photo detector family includes three photo\_detectors sensors (PH100-Si, PH100-SiUV and PH20-Ge).

The PH100-Si detectors use a silicon photodiode. The PH100-SiUV detectors also use a silicon photodiode but have enhanced sensitivity at shorter wavelengths. The PH20-Ge detectors use a germanium photodiode. All three detector heads are 27.4mm thick by 38.1 mm in diameter.

**Table I. Measuring ranges of Gentec-EO PH photo detectors**

<u>Configuration</u>	<u>PH100-Si series</u>	<u>PH100-SiUV series</u>	<u>PH20 series</u>
Detector alone	0.6 nW to 30 mW	0.6 nW to 2.8 mW	2 nW to 30 mW
With OD-1 attenuator	6 nW to 300 mW	6 nW to 25 mW	20 nW to 300 mW
With OD-2 Attenuator	60 nW to 750 mW	60 nW to 30 mW	200 nW to 500 mW

Note: quoted maximum ranges are average power at the 1064 nm wavelength for PH100-Si and PH20-Ge, 532 nm for PH100-SiUV, and 850 nm for PH100-SiUV with OD-2

quoted minimum ranges are average power at the 980nm for PH100-Si, 850 nm for PH-100-SiUV and 1550 nm for PH20-Ge

The PH series are supplied with a 180 cm long flexible cable terminated with a DB-15 "intelligent" male connector, for use with Gentec-EO Monitors.

NOTE: To eliminate possible damage, do not carry the detector using the connector cable.

The PH photo detectors may also be supplied with a stand.

Call your nearest Gentec-EO distributor to replace the sensor /or to recalibrate the head. See p. ii, **Contacting Gentec Electro-Optics Inc.**

## 1.2 PHOTO DETECTOR CONNECTORS

### 1.2.1 DB-15 “intelligent” connector

The DB-15 male "intelligent" connector contains an EEPROM (Erasable Electrical Programmable Read-Only Memory) that stores information such as the model of the detector, the calibration sensitivity of the available spectral range with or without attenuator and the applicable scales for that specific PH Series head. Wavelengths are not available where the sensor physical properties don't allow it.

The Gentec-eo monitors use the data in this connector to adjust their characteristics automatically to the power sensor being connected. No calibration procedure is required when installing the power heads, allowing for faster set-up. The TPM300 and DUO monitors are not programmed to read the PH Series photo detectors.

**Table II. The DB-15 connector pin-out**

1-	USED BY, Monitors
2-	" " "
3-	" " "
4-	" " "
5-	" " "
6-	Cathode for PH100-Si, PH-100-SiUV and PH20-Ge.
7-	USED BY, Monitors
8-	" " "
9-	" " "
10-	" " "
11-	" " "
12-	" " "
13-	Anode for PH100-Si, PH-100-SiUV and PH20-Ge.
14-	USED BY, Monitors
15-	" " "
SHELL	- BODY GRND

### 1.2.2 Dimensions

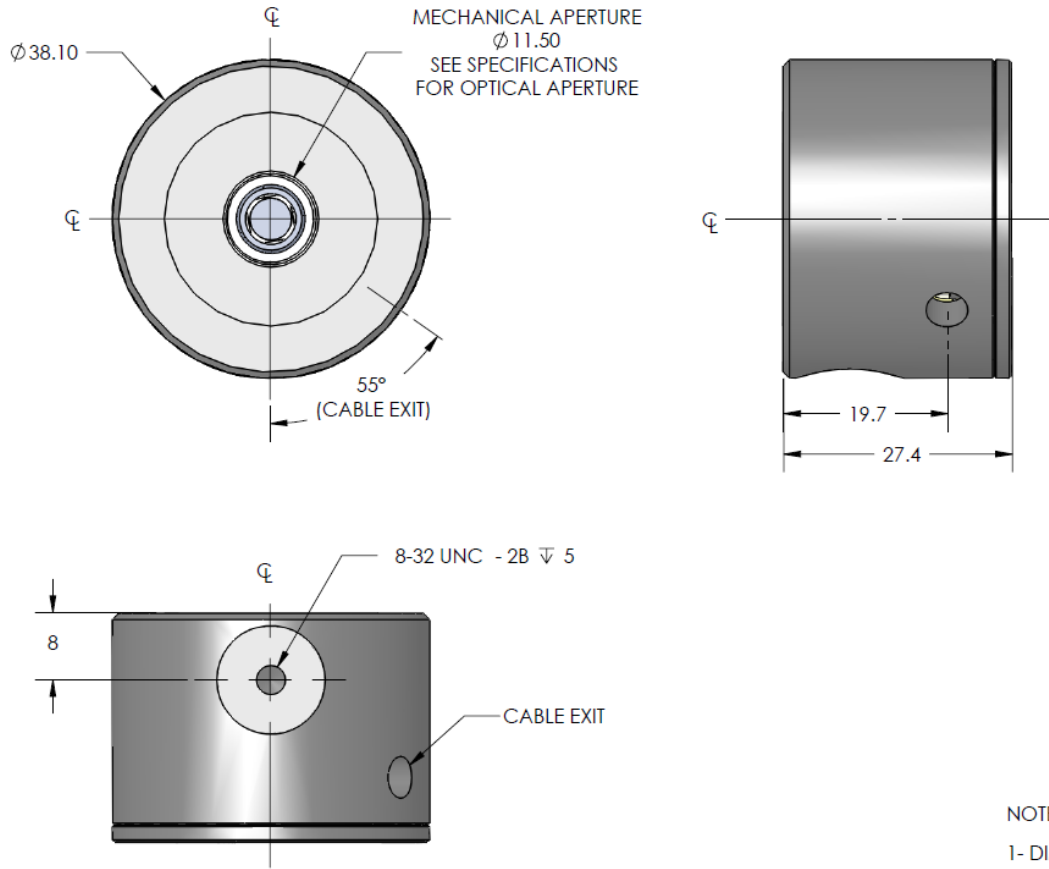


FIG. 1-1 PHOTO DETECTOR DIMENSIONS.

## 1.3 PH SERIES SPECIFICATIONS

<b>Table III. PH Series Specifications for Gentec-eo Monitors</b>			
Detector	PH100-Si	PH100-SiUV	PH20-Ge
Monitor Compatibility	<b>Maestro, M-Link, P-Link, Uno, Tuner, Solo 2, Solo PE</b>		
Absorber	Si	Si-UV	Ge
Bandwidth	(20 mA to 1 mA) 31 kHz (1 mA to 20 $\mu$ A) 31 kHz (20 $\mu$ A to 2 $\mu$ A) 31 kHz (2 $\mu$ A to 0.1 $\mu$ A) 29 Hz (0.1 $\mu$ A to 1 nA) 16 Hz (Bandwidth Sampling Rate 50kHz, 2048 average values.)		
Minimum repetition rate for average power measurements of a pulse laser	(20 mA to 1 mA) 155 kHz (1 mA to 20 $\mu$ A) 155 kHz (20 $\mu$ A to 2 $\mu$ A) 155 kHz (2 $\mu$ A to 0.1 $\mu$ A) 145 Hz (0.1 $\mu$ A to 1 nA) 80 Hz		
Spectral range	320 to 1100 nm	210 to 1080 nm	800 to 1650 nm
Peak sensitivity	980 nm	980 nm	1550 nm
Maximum Power typ. [ $\text{@ Power Density}$ ]	36 mW [30 mW/cm <sup>2</sup> ] (@ 1064 nm)	4 mW [55 mW/cm <sup>2</sup> ] (@ 532 nm)	30 mW [< 320 mW/cm <sup>2</sup> ] (@ 1064 nm)
Minimum Power <sup>a</sup>	0.6 nW @ 980 nm	0.6 nW @ 850 nm	2 nW @ 1550 nm
Maximum Average Power Density	100 W/cm <sup>2</sup>	100 W/cm <sup>2</sup>	100 W/cm <sup>2</sup>
Typical Detector saturation current <sup>b</sup>	6.3 mA/cm <sup>2</sup>	15.1 mA/cm <sup>2</sup>	13.8 mA (<140mA/cm <sup>2</sup> )
Uncertainty	320-399 nm: $\pm 6.5\%$ 400-999 nm: $\pm 2.5\%$ 1000-1049 nm: $\pm 5\%$ 1050-1100 nm: $\pm 7\%$	210-219 nm : $\pm 8\%$ 220-399 nm : $\pm 6.5\%$ 400-899 nm : $\pm 2.5\%$ 900-999 nm : $\pm 3.5\%$ 1000-1049 nm: $\pm 5\%$ 1050-1080 nm: $\pm 7\%$	800-1650 nm: $\pm 3.5\%$
Resolution <sup>c</sup>	1.5 pW	1.5 pW	1.5 pW
Temperature offset dependence, typical	20 pA/ $^{\circ}$ C	20 pA/ $^{\circ}$ C	100 pA/ $^{\circ}$ C
Aperture	10 mm diameter	10 mm diameter	5 mm diameter

<sup>a</sup> Warm-up until the reading without laser power is stable for several minutes before offset nulling (zeroing the display). Null the offset after each new power up. Half an hour warm-up is recommended for measuring low powers. Temperature  $\pm 0.5$  degrees.

<sup>b</sup> Prior to reaching  $\pm 3\%$  linearity error

<sup>c</sup> Lowest scale + noise level. Nominal value. Depends on environmental electromagnetic interference.

Active Area	0.9 cm <sup>2</sup>	0.9 cm <sup>2</sup>	0.2 cm <sup>2</sup>
Response time10-90%	0.2 sec	0.2 sec	0.2 sec
Beam Position Dependence	±1% @ 780 nm ±3% @ 1064 nm	±1% @ 652 nm ±3% @ 1064 nm	± 1 % @ 1064 nm ±3% @ 800 nm
Noise	5 pA	5 pA	60 pA
Dimensions	27.4mm x 38.1mm dia.	27.4mm x 38.1mm dia.	27.4mm x 38.1mm dia.
Weight	130 g	130 g	130 g
Sensitivity, typical	0.5 A/W @ 980 nm	0.45 A/W @ 850 nm	0.98 A/W @ 1550 nm
<b>With attenuator</b>	<b>PH100-Si - OD1/OD2</b>	<b>PH100-SiUV - OD1/OD2</b>	<b>PH20-Ge- OD1/OD2</b>
Maximum Power typ. w/ OD-1	300 mW @ 1064 nm	25 mW @ 532 nm	300 mW @ 1064 nm
Minimum Power <sup>a</sup> w/ OD-1	6 nW @ 980 nm	6 nW @ 850 nm	20 nW @ 1550 nm
Spectral range w/ OD-1	400 to 1100 nm	400 to 1080 nm	900 to 1650 nm
Maximum Power typ. w/ OD-2	0.75 W @ 1064 nm	30 mW @ 850 nm	0.50 W @ 1064 nm
Minimum Power <sup>a</sup> w/ OD-2	60 nW @ 980 nm	60 nW @ 850nm	200 nW @ 1550 nm
Spectral range w/ OD-2	630 to 1100 nm	630 to 1080 nm	950 to 1650 nm
Uncertainty w/ OD-1 or OD-2 attenuator	400-1049 nm: ±5% 1050-1100 nm: ±7%	400-1049 nm: ±5 1050-1080 nm: ±7%	±5%

Specifications subject to change without notice.

## **2 OPERATING INSTRUCTIONS**



### **2.1 WITH GENTEC-EO MONITORS**

To operate the PH Series photo detector, connect the detector head to the input socket on Gentec-EO monitors with the cable supplied by Gentec-EO before turning the monitor on. (See monitor's instruction manual.)

Adjust the reading to zero before measurements for best accuracy. See procedure in section 2.2 below.

If you are using the fiber optic adapter, put the black protective cover on the detector head before making the offset nulling.

If you want to subtract the room light do the offset nulling with the cover off.

### **2.2 QUICK POWER MEASUREMENT PROCEDURE**

This section will show you the fastest way of making a laser power measurement with Gentec-EO monitors and power detector.

The monitor automatically recognizes all Gentec-EO photo detectors heads of version 5 or higher. Then the monitor automatically downloads all custom technical data for the detector from the EEPROM in the DB-15 connector. This data includes sensitivity, model, serial number, version, wavelength correction factors, and time response.

#### Quick power measurement procedure:

- 1- Install the power head on its optical stand.
- 2- Slide the connector latch to the right to unlock the connector.
- 3- Connect a version 5 (or higher) power detector head using the PROBE INPUT JACK. We recommend turning the monitor off before connecting a new head to avoid losing information from the detector head EEPROM.
- 4- Slide the latch to the left to lock the connector into place.
- 5- Switch the monitor ON or plug the monitor into the computer.
- 6- The monitor will default to autoscale and lowest wavelength without attenuator available. If you have a photodiode detector, you may want to obtain measurements in dBm rather than watts. To do that, select Settings>>Power Unit>>dBm.
- 7- Select the proper wavelength.
- 8- Remove the head's protective cover.

Put the detector head into the laser beam path. The entire laser beam must be within the sensor aperture. Do not exceed maximum specified densities, energies or powers. For the most accurate measurement, spread the beam across 90% of the sensor area.

#### **Adjusting the zero (steps 8 to 10)**

- 9- Block off laser radiation to the detector.
- 10- To reset the zero, wait until the reading has stabilized. The power read by the monitor 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.

- 11- **Set Diode Zero or Zero Offset or Offset**, (refer to monitor user manual). A message may appear requesting you to put the black cover on your photodiode. Put it on to block all light if you do not want to compensate for background illumination. Do not put it on if you want to remove the signal from ambient light. Press the **ok** after taking the appropriate action with the cover. The monitor passes through all the scales to determine the compensation to null each one. The message "Diode Zero Done" appears when the monitor has finished. You are now ready to make an accurate measurement.
- 12- Apply the laser beam to the detector head.
- 13- The monitor displays the laser beam average power.

### **3 DAMAGE TO THE OPTICAL ABSORBER MATERIAL**

Damage to the optical absorber material is usually caused by exceeding the manufacturer's specified maximum incident in the average power density.

Refer to the specifications pages for the PH Series power head specifications.

Cleaning: Use Alcohol and a clean cotton cloth.

### **4 ERROR SOURCES**

The photodiode and monitor are NIST traceable. Several errors source may affect your measurements.

#### **4.1 OFFSET**

Zero the offset before any measurement as described in Section 2.2 above. Otherwise all measurements will include a component not related to the laser power. This will add a systematic error to absolute power measurements. This error may disappear from relative power measurements. When you subtract two measurements made under identical conditions, the offset in the second measurement cancels the offset in the first if they are identical. We recommend zeroing the offset for all measurements to eliminate any drift that occurs between measurements.

#### **4.2 OFFSET DRIFT DUE TO TEMPERATURE**

The Photodiode Shunt Resistor is sensitive to temperature, this affects the offset value. When making very low power level measurements, allow your system to warm up for 30 minutes or until the offset power is stable for several minutes. The sensitivity of the photodiode also has temperature dependence. See Fig 1-2 and Fig 1-3 for the typical temperature sensitivity dependence over the spectral range for the PH20-Ge, PH100Si and PH100-SiUV.

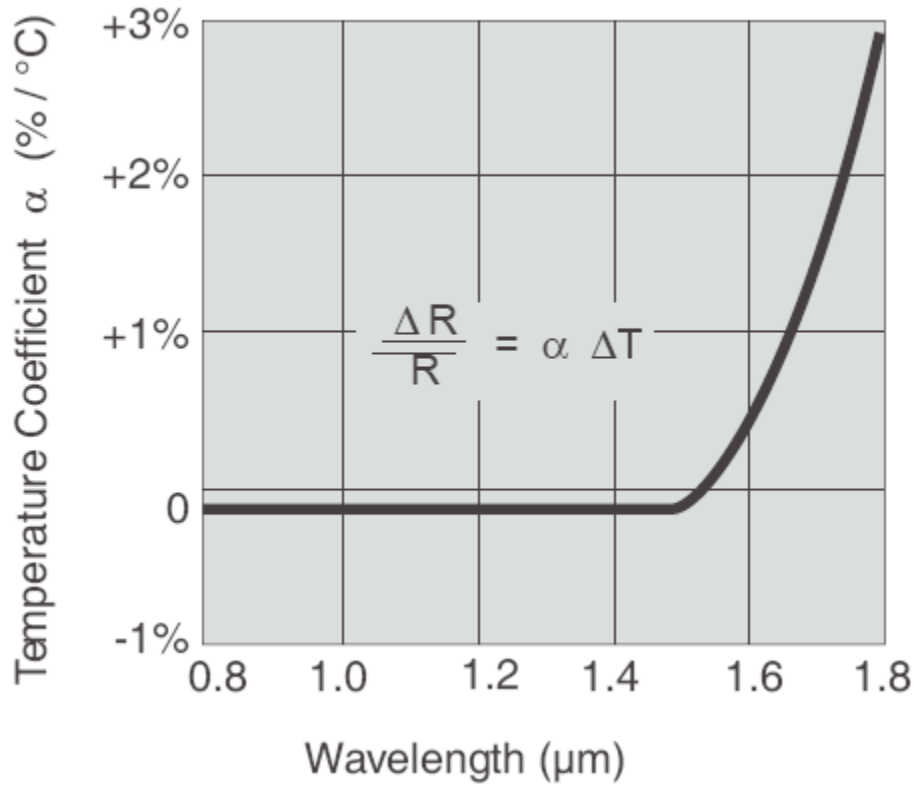


FIG 1-2 TYPICAL PH20-GE TEMPERATURE DEPENDENCE VS THE WAVELENGTH

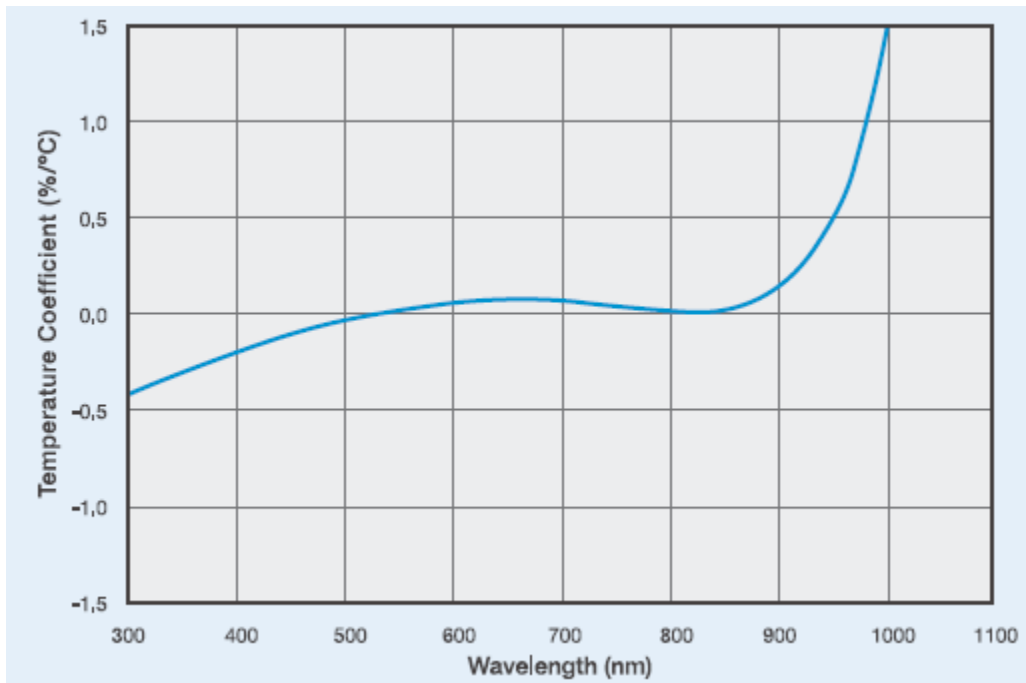


FIG 1-3 TYPICAL PH100-SI AND PH100-SIUV TEMPERATURE DEPENDENCE VS THE WAVELENGTH

### 4.3 SATURATION

The maximum power varies with wavelength, power density and from one diode to another. When making measurements near the saturation power, you must verify the saturation effect with a calibrated Filter.

### 4.3.1 Procedure with a known transmission value filter

Make the measurement with and without the filter.  
Your power ratio should be equal to the transmission value of the filter.

### 4.3.2 Attenuator calibration procedure

Make sure your stable power source is far below the saturation point.  
Make the measurement with and without the filter.  
The transmission value is the ratio of the measurement with filter / without filter.

## 4.4 MEASUREMENT OF THE AVERAGE POWER OF A PULSE LASER BEAM

Conditions to be met:

- The repetition rate must be at least 5 times the analog Bandwidth (see table III).
- The peak power must not saturate the detector.

To know if the detector is saturated, use procedure 4.3.1. Be careful when making the attenuator calibration in pulse mode. The peak power must be in the linear region of the photodiode.

| Peak power = Energy per pulse / pulse width. Energy per pulse = Average power / repetition rate.

## 4.5 WAVELENGTH

The photodiode response varies with wavelength. You may select your wavelength with the *Settings/Wavelength* menu of the monitor or enter you wavelength in the *Settings/Custom* menu of the monitor.

If you decide to use the photo detector without a Gentec-EO monitor, you will have to use the sensitivity given by the photo detector calibration certificate to calculate the power on you laser beam. If your wavelength is not given by the calibration certificate, you will have to make a linear interpolation between two of the available calibration values. Fig. 1-4 and Fig. 1-5 shows the typical spectral response.

Linear interpolation formula:

$$Sensitivity_{y_{desired\_}\lambda} = Sens_{LOW\_}\lambda + \Delta\lambda * Slope$$

$$\Delta\lambda = \lambda_{DESIRED} - \lambda_{LOW}$$

$$Slope = \frac{(Sens_{HIGH\_}\lambda - Sens_{LOW\_}\lambda)}{(\lambda_{HIGH} - \lambda_{LOW})}$$

Sensitivity<sub>desired\_λ</sub> : The sensitivity at the desired wavelength.

Slope: The slope of the linear interpolation.

Sens<sub>LOW\_λ</sub>: Sensitivity at  $\lambda_{LOW}$ .

Sens<sub>HIGH\_λ</sub>: Sensitivity at  $\lambda_{HIGH}$ .

$\lambda_{LOW}$ : The next lowest available wavelength near your desired wavelength.

$\lambda_{HIGH}$ : The next highest available wavelength near your desired wavelength.

$\lambda_{DESIRED}$ : Desired Wavelength.

$\Delta\lambda$ : The difference between the desired wavelength and the inferior wavelength.

### 4.5.1 Example

You have a PH100-Si and your laser is at 632.8 nm.

See your CERTIFICATE OF CALIBRATION for the sensitivity of your power detector as a function of the wavelength.

Wavelength (nm)	Sensitivity (A/W)
620	0.32
630	0.35
640	0.37
650	0.40
660	0.43

632.8 nm is between 630 nm and 640 nm therefore,

$$\text{Sens}_{\text{LOW}_\lambda} = 0.35 \text{ A/W}$$

$$\text{Sens}_{\text{HIGH}_\lambda} = 0.37 \text{ A/W}$$

$$\lambda_{\text{LOW}} = 630 \text{ nm}$$

$$\lambda_{\text{HIGH}} = 640 \text{ nm}$$

$$\Delta\lambda : 632.8 - 630 = 2.8 \text{ nm}$$

$$\text{Slope: } (0.37 - 0.35) / (640 - 630) = 0.002$$

$$\text{Sensitivity}_{\text{desired}_\lambda} : 0.35 + 2.8 * 0.002 = 0.356 \text{ A/W}$$

#### Typical Spectral Response

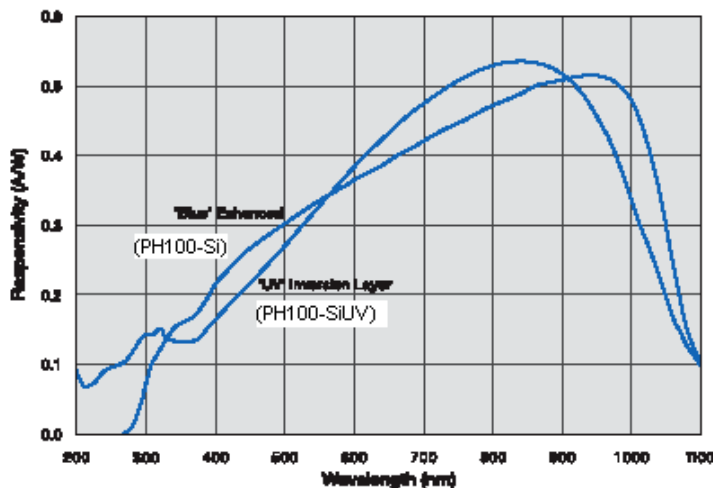


FIG. 1-4 PH100-SI AND PH100-SIUV TYPICAL SPECTRAL RESPONSE

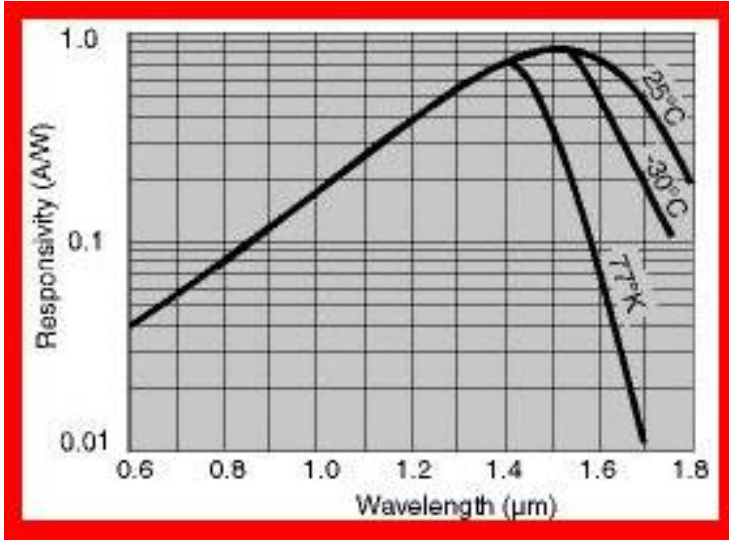


FIG. 1-5 PH20-GE TYPICAL SPECTRAL RESPONSE

## **Appendix A: WEEE directive**

### **1.1 Recycling and separation procedure for WEEE directive 2002/96/EC:**

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

The complete Detector contains

- 1 Detector with wires or DB-15.
- 1 instruction manual
- 1 calibration certificate

### **1.2 Separation:**

Paper : Manual and certificate

Wires: Cable Detector.

Printed circuit board: inside the Detector or DB-15, no need to separate (less than 10 cm<sup>2</sup>).

Aluminum: Detector casing.

# GENTEC-EO WORLDWIDE



LEADER IN  
LASER BEAM  
MEASUREMENT  
SINCE 1972

## CANADA

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

**T** (418) 651-8003

**F** (418) 651-1174

1 (888) 5GENTEC (Canada and USA only)  
service@gentec-eo.com

## UNITED STATES

5825 Jean Road Center  
Lake Oswego, OR, 97035, USA

**T** (503) 697-1870

**F** (503) 697-0633

1 (888) 5GENTEC (Canada and USA only)  
service@gentec-eo.com

## Calibration Centers

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

Werner von Siemens Str. 15  
82140 Olching, Germany