LASER POWER DETECTORS

PH series

INSTRUCTION MANUAL

121-200774



Version 1.7

May 2008

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: info@gentec-eo.com
Web: 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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TABLE OF CONTENTS

WARRANTY II

First Year Warranty ii

Lifetime Warranty ii

TABLE OF CONTENTS III

LIST OF ILLUSTRATIONS IV

LIST OF TABLES IV

1 PH SERIES PHOTO DETECTORS 1

1.1 INTRODUCTION 1

1.2 PHOTO DETECTOR CONNECTORS 2
1.2.1 DB-15 “intelligent” connector 2
1.2.2 Dimensions 3

1.3 PH SERIES SPECIFICATIONS 4

2 OPERATING INSTRUCTIONS 6

2.1 WITH THE SOLO AND P-LINK MONITORS 6

2.2 QUICK POWER MEASUREMENT PROCEDURE 6

3 DAMAGE TO THE OPTICAL ABSORBER MATERIAL 7

4 ERROR SOURCES 7

4.1 OFFSET 7

4.2 OFFSET DRIFT DUE TO TEMPERATURE 8

4.3 SATURATION 9
4.3.1 Procedure with a known transmission value filter 9
4.3.2 Attenuator calibration procedure 9

4.4 MEASUREMENT OF THE AVERAGE POWER OF A PULSE LASER BEAM 9

4.5 WAVELENGTH 10
4.5.1 Example 10

APPENDIX A: WEEE DIRECTIVE 12

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LIST OF ILLUSTRATIONS

FIG. 1-1 PHOTO DETECTOR DIMENSIONS.....3

FIG 1-2 TYPICAL PH20-GE TEMPERATURE DEPENDENCE VS THE TEMPERATURE.....8

FIG 1-3 TYPICAL PH100-SI AND PH100-SIUV TEMPERATURE DEPENDENCE VS THE TEMPERATURE 9

FIG. 1-4 PH100-SI AND PH100-SIUV TYPICAL SPECTRAL RESPONSE 11

FIG. 1-5 PH20-GE TYPICAL SPECTRAL RESPONSE.....11

LIST OF TABLES

TABLE I. MEASURING RANGES OF GENTEC-EO PH PHOTO DETECTORS 1

TABLE II. THE DB-15 CONNECTOR PIN-OUT.....2

TABLE III. PH SERIES SPECIFICATIONS FOR SOLO AND P-LINK MONITORS 4

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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 26.5mm thick by 36 mm in diameter.

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

Configuration	PH100-Si series	PH100-SiUV series	PH20 series
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 SOLO and P-LINK.

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.**

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

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1.2.2 Dimensions

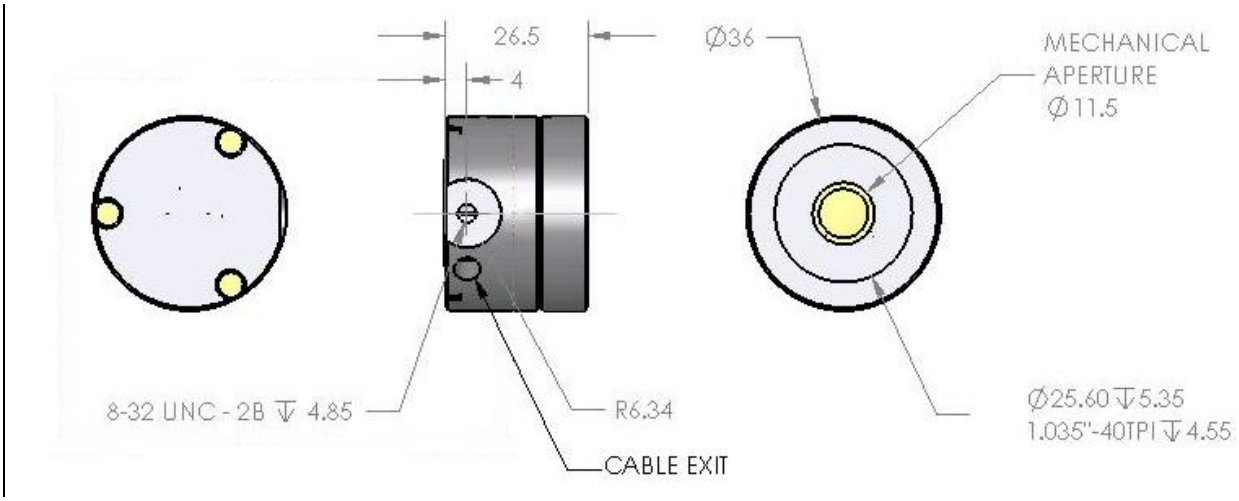


FIG. 1-1 PHOTO DETECTOR DIMENSIONS.

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1.3 PH SERIES SPECIFICATIONS

Table III. PH Series Specifications for SOLO and P-LINK Monitors

Detector	**PH100-Si**	**PH100-SiUV**	**PH20-Ge**
Absorber	Si	Si-UV	Ge
Bandwidth	(20 mA to 1 mA) 31 kHz (1 mA to 20 μA) 31 kHz (20 μA to 2 μA) 31 kHz (2 μA to 0.1 μA) 29 Hz (0.1 μA 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 μA) 155 kHz (20 μA to 2 μA) 155 kHz (2 μA to 0.1 μA) 145 Hz (0.1 μA to 1 nA) 80 Hz		
Spectral range	300 to 1100 nm	200 to 900 nm	800 to 1650 nm
Peak sensitivity	980 nm	970 nm	1550 nm
Maximum Power typ. [@ Power Density]	30 mW [30 mW/cm^2] (@ 1064 nm)	2.8 mW [55 mW/cm^2] (@ 532 nm)	30 mW [< 320 mW/cm^2] (@ 1064 nm)
Minimum Power[a]	0.6 nW @ 980 nm	0.6 nW @ 850 nm	2 nW @ 1550 nm
Maximum Average Power Density	100 W/cm^2	100 W/cm^2	100 W/cm^2
Typical Detector saturation current[b]	6.3 mA/cm^2	15.1 mA/cm^2	13.8 mA (<140mA/cm^2)
Uncertainty	300-399 nm: ±6.5% 400-999 nm: ±2.5% 1000-1049 nm: ±5% 1050-1100 nm: ±7%	200-219 nm : ±8% 220-399 nm : ±6.5% 400-900 nm : ±2.5%	800-1650 nm: ±3.5%
Resolution[c]	1.5 pW	1.5 pW	1.5 pW
Temperature offset dependence, typical	20 pA/°C	20 pA/°C	100 pA/°C
Aperture	11.28 mm diameter	11.28 mm diameter	5 mm diameter
Active Area	1 cm^2	1 cm^2	0.196 cm^2
Response time10-90%	0.2 sec	0.2 sec	0.2 sec

a 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 ±0.5 degrees.

b Prior to reaching ±3% linearity error

c Lowest scale + noise level. Nominal value. Depends on environmental electromagnetic interference.

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Beam Position Dependence	±1% @ 780 nm ±3% @ 1064 nm	±1% @652 nm	± 1 % @ 1064 nm ±3% @ 800 nm
Noise	5 pA	5 pA	60 pA
Dimensions	26.5mm x 36mm dia.	26.5mm x 36mm dia.	26.5mm x 36mm dia.
Max bias Voltage	3 V	5 V	5 V
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
With attenuator	**PH100-Si - OD1/OD2**	**PH100-SiUV - OD1/OD2**	**PH20-Ge- OD1/OD2**
Maximum Power typ. w/ OD-1	300 mW @ 1064 nm	25 mW @ 532 nm	300 mW @ 1064 nm
Minimum Power[a] 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 900 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[a] w/ OD-2	60 nW @ 980 nm	60 nW @ 850nm	200 nW @ 1550 nm
Spectral range w/ OD-2	600 to 1100 nm	600 to 900 nm	950 to 1650 nm
Uncertainty w/ OD-1 or OD-2 attenuator	400-1049 nm: ±5% 1050-1100 nm: ±7%	±5%	±5%

Specifications subject to change without notice.

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2 OPERATING INSTRUCTIONS

2.1 WITH THE SOLO AND P-LINK MONITORS

To operate the PH Series photo detector, connect the detector head to the input socket on the rear of the SOLO or P-LINK monitor with the cable supplied by Gentec-EO before turning the monitor on. (See the SOLO and P-LINK monitor 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 applies to all SOLO versions. It will show you the fastest way of making a laser power measurement with the SOLO and a Gentec-EO power detector.

The monitor automatically recognizes all Gentec-EO photo detectors heads of version 5 or higher. Then the monitor automatically downloades 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- Turn the SOLO or P-LINK OFF and connect a version 5 (or higher) power detector head to the SOLO or P-LINK using the PROBE INPUT JACK. We recommend turning the SOLO or P-LINK 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. Use the I/O key on the SOLO or plug the P-LINK 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.

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10- To reset the zero, wait until the reading has stabilized. The power read by the SOLO or P-LINK 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- Select zeroing method. The **SOLO** has two offset options. **Set Diode Zero** will apply the offset nulling to every scale. **Zero Offset** on the **SOLO** will make the offset only on the current scale. **Zero Offset** on the P-LINK will make the offset nulling on every scale like the Set Diode Zero. For **Zero Offset**, select **CTRL>>Zero Offset**. Then select **Rezero.** You are now ready to make an accurate measurement. (To turn the **Zero Offset** off on the SOLO, select **Off** in the same menu. To reselect the previous offset, select **Undo**.)

12- To **Set Diode Zero**, select **CTRL**>>**Set Diode Zero**, and press the ↵ **Enter** key. A message appears 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 ↵ **Enter** key after taking the appropriate action with the cover. The SOLO passes through all the scales to determine the compensation to null each one. The message "Diode Zero Done" appears when the SOLO has finished. You are now ready to make an accurate measurement.

13- Apply the laser beam to the detector head.

14- The SOLO displays the laser beam average power in three ways for your convenience:

a. Digital value in real-time

b. Digital needle to see the laser beam power variation for tuning the laser or optics.

c. Histogram to evaluate the laser beam's long-term stability.

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

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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 phodiode 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.

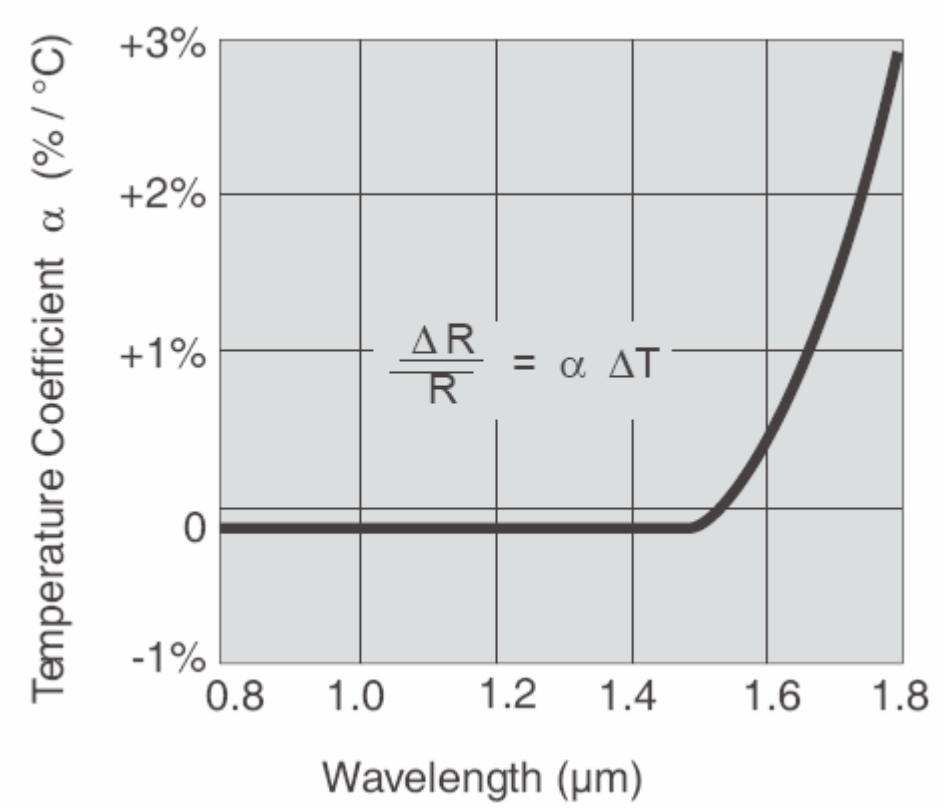


FIG 1-2 TYPICAL PH20-GE TEMPERATURE DEPENDENCE VS THE WAVELENGTH

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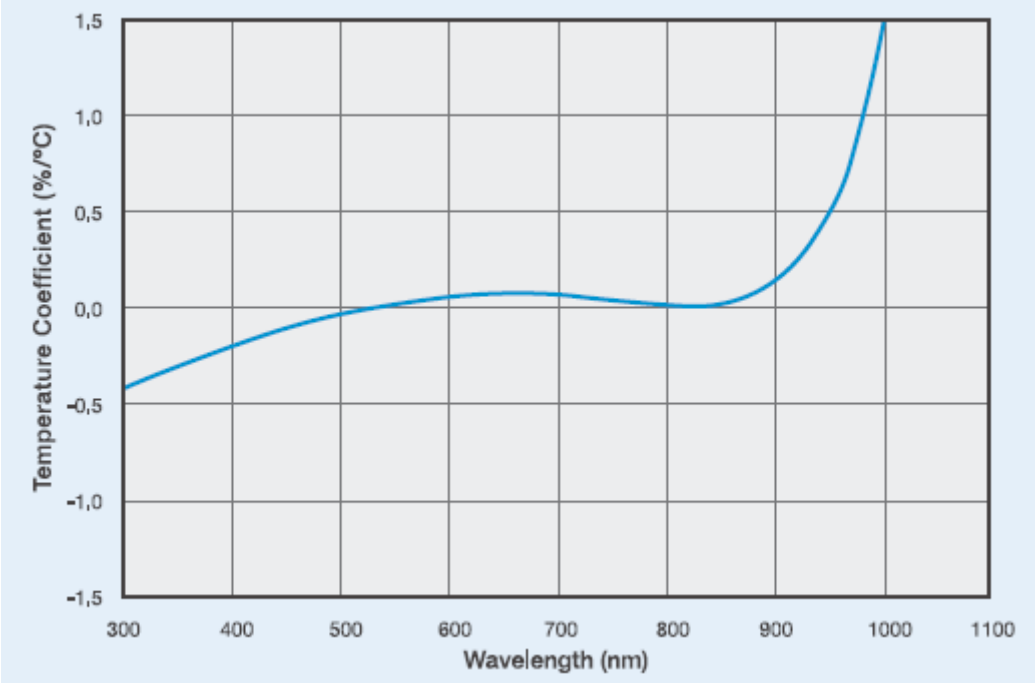


FIG 1-3 TYPICAL PH100-SI AND PH100-SIUV TEMPERATURE DEPENDENCE VS THE WAVELENGTH

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.

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4.5 WAVELENGTH

The photodiode response varies with wavelength. You may select your wavelength with the *Settings/Wavelength* menu of the SOLO or enter you wavelength in the *Settings/Custom* menu of the SOLO and PC-link.

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:

$$Sensitivity_{desired_\lambda} = Sens_{LOW_\lambda} + \Delta\lambda * Slope$$

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

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

Sensitivity $_{desired_\lambda}$: The sensitivity at the desired wavelength.

Slope: The slope of the linear interpolation.

$Sens_{LOW_\lambda}$: Sensitivity at λ_{LOW}.

$Sens_{HIGH_\lambda}$: Sensitivity at λ_{HIGH}.

λ_{LOW}: The next lowest available wavelength near your desired wavelength.

λ_{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,

$Sens_{LOW_\lambda}$ = 0.35 A/W
$Sens_{HIGH_\lambda}$ = 0.37 A/W

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λ_{LOW} = 630 nm

λ_{HIGH} = 640 nm

$\Delta\lambda$: 632.8 - 630 = 2.8 nm

Slope: (0.37-0.35)/(640-630) = 0.002

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

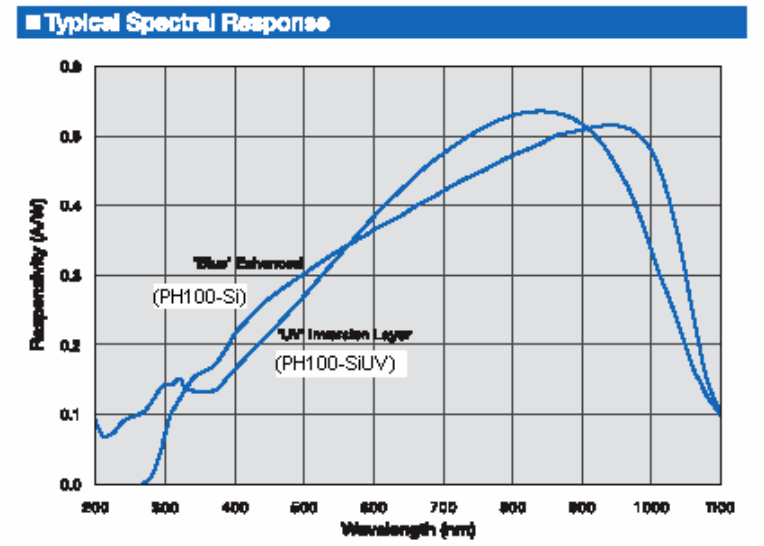


FIG. 1-4 PH100-SI AND PH100-SIUV TYPICAL SPECTRAL RESPONSE

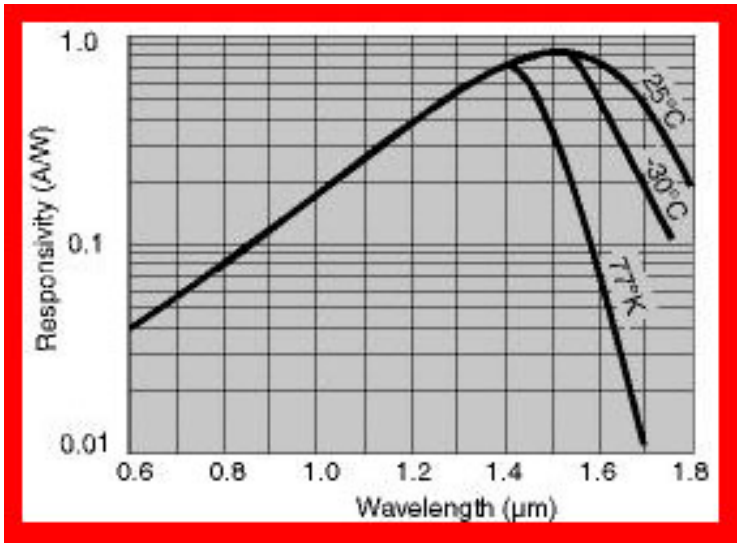


FIG. 1-5 PH20-GE TYPICAL SPECTRAL RESPONSE

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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 then 10 cm^2).

Aluminum: Detector casing.

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