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70310 Multifunction Optical Power Meter (OPM™) and detectors.

- **Universal detector readout**
- **Picoammeter and millivoltmeter**
- **RS-232 and IEEE-488.2 computer interfaces**
- **Measure absolute DC signal or true RMS value for AC signals up to 100 kHz (with appropriate detector)**
- **Calibrated readings**
- **Autoranging or fixed scale with linear or dB units**
- **Works with almost any UV, VIS, or IR detector**

The 70310 Multifunction Optical Power Meter (OPM™) is a universal detector readout with brains! It works with almost any cooled, or room temperature detector for measurement of continuous or modulated radiation. RS-232 and IEEE-488.2 interfaces are included for transferring data to your PC and to allow control of the instrument from the PC. You can also use the OPM™ as a stand alone readout for bench-top power measurements or use its analog output to record readings with any data logger. A family of UV, VIS, and IR calibrated detectors is offered. A sophisticated, but intuitive, Windows™ based data acquisition package is available for spectro-radiometric measurements with Oriel's family of monochromators, or for simple data logging.

OPM™ FAMILY OF DETECTORS

We know that researchers' needs change frequently; we address this by offering modular components that can be easily interchanged, yet all are designed to work together. We offer cooled and room temperature, calibrated or non-calibrated detectors for the UV, VIS or IR. We list these choices in Table 1. You can add your own detector to this family as long as its output falls within the picoampere to milliampere or microvolt to volt range. ±5 V is available from the OPM™ to power your detector's amplifier, if needed.

Table 1 OPM™ Family of Detectors

Detector Type	Wavelength Range	Detail Page
PMTs	160 nm - 1000 nm	**6-22**
GaN	180 nm - 365 nm	**6-23**
Silicon	180 nm - 1100 nm	**6-23**
InGaAs	800 nm - 1700 nm	**6-23**
Ge	800 nm - 1800 nm	**6-23**
Thermopiles	180 nm - 40 µm	**6-25**

HOW DOES THE OPM™ SYSTEM WORK?

The basic OPM™ system is made up of a detector and the 70310 OPM™ Readout. The readout digitizes the analog signals from the detector and displays them as optical power, current or voltage. The same reading can be transferred to the PC for data analysis and storage. Analog output allows the use of a chart recorder or a data logger. Because of the large selection of detectors, we offer the OPM™ readout and detectors as separate components. You can also use your own detector with the OPM™.

DISPLAY & FUNCTION

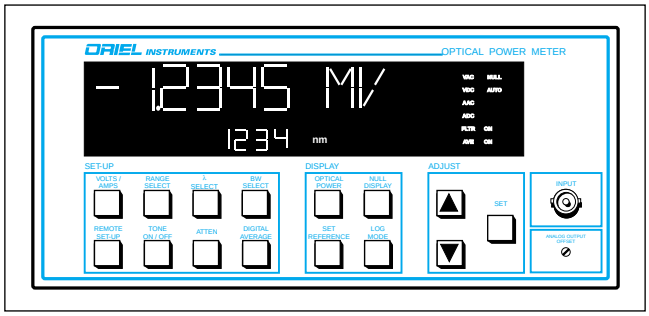


Fig. 1 The front panel of the OPM™.

Picoammeter

1 pA (least significant digit) to 2 mA current levels can be measured by the low noise amplifier with microprocessor switchable seven decades of transimpedance gain.

Microvolt Meter

Four decades of microprocessor switchable gain of the voltage amplifier allow 1 µV (least significant digit) to 2 V input signals to be displayed or converted into optical power units.

True RMS Meter

When AC mode is selected true RMS value is displayed for signals with cresting factor (peak value/RMS value) less than ~10. In DC mode the OPM™ circuitry measures the steady state level of slow varying signals. Use the combination of the two modes to measure the ripple content of your signal.

Contact us for further information on any of the products in this catalog

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Calibrated Optical Power Readings

We offer many NIST traceable calibrated Si, InGaAs, Ge and Thermopile detectors. OPM™ reads the calibration information from the detector's PROM and then, when you select your working wavelength, displays the spectrally corrected absolute power readings. Calibration data is provided in multiple formats for your convenience: detector's PROM for direct use by the OPM™, ASCII format on a 3½ inch diskette for use in your computerized applications, and on a printed certificate of calibration for the quickest access. You can also enter your own responsivity values into the OPM™ to obtain custom power readings. Please call Oriel if your application calls for the use of your own detector which needs to be calibrated; we often perform custom calibrations within the spectral ranges covered by our calibration standards.

Recalibration

The OPM™ and its family of detectors are designed for long term stable performance. However, nothing lasts forever and we suggest annual recalibration when NIST traceable measurements are required. More frequent recalibration may be required when the units are used under extreme conditions.

OPM™ CONVENIENCE FEATURES:

Large LED Display

The large 4½ digit display, fed by a 20,000 count A/D converter, can be easily seen from across the room. Individually lit status indicators provide instant information on the selected mode of measurement.

Dedicated set-up buttons

You do not have to go through layers of menus to setup the OPM™. Clearly labeled dedicated buttons allow you to select the measurement mode (AC or DC, current or voltage), communication parameters, level of signal averaging, etc.

Lights-off Alignment

Since much of light related research is performed in darkened rooms, a frequently requested acoustical feedback has been designed into the OPM™. This feature provides a signal strength related, varying pitch tone, to indicate the degree of alignment of your system. The speaker can be turned off, when light is plentiful, to allow quiet working conditions.

Relative Measurements

Store a reference signal value and take relative power readings.

Automatic or User Defined Range Selection

Use the automatic range selection to take full advantage of the A/D converter resolution. Use the fixed ranges to control the number of significant digits displayed for a flicker-free power reading.

Digital Averaging

The OPM™ will display individual readings or allow the display of a digital running average of 8 or 32 digitizing cycles for easier reading of noisy or less stable signals.

Low Pass Input Filter

Turn on this single pole, 20 Hz input filter when taking measurements in a noisy environment or to minimize line frequency induced ripples.

Background Subtraction

Null out background light induced signal for true measurements under ambient conditions (but do watch out for detector saturation).

Multiple input connections

Use the front panel BNC connector for so equipped detectors. Use the 9-pin D-sub connector on the back panel for calibrated or amplified detectors.

Analog Output

Analog output, 0 to 2 V proportional to the displayed voltage or current value, provides easy interface to a chart recorder or data logger for computer-free data collection. This purely analog chain produced signal exhibits a notch every 20-60 seconds due to a drift zeroing switch. Use it for non-critical data collection and use one of the digital output modes for critical ones.

SOFTWARE FOR OPM™

OPM™ comes with a pair of diagnostic programs to test RS-232 and IEEE-488 communications. To run these simple applications you will need Windows™ '95, '98, or NT and a National Instruments GPIB card for the IEEE-488 version. These programs are an easy way to be sure your system is properly connected and configured, however, they are not data acquisition programs. For real measurements, we offer the TRACQ32™ program described below and some tools to assist you in writing your own software.

For LabView™ programming, we provide VIs for each communication type. For Visual Basic Programming, we include sample source code to get you started. This is the exact source code for the diagnostic programs mentioned above; it can be easily modified and extended to add more OPM™ features. As usual, we provide these tools free of charge to help experienced programmers build a customized system. Unfortunately, we cannot provide tutorials or assistance to beginning programmers.

TRACQ32™ SOFTWARE

The **new** TRACQ32™ is a spectroradiometric data collection software package. It works with most of Oriel's detection systems, including the OPM™, and Oriel Monochromators. TRACQ32™ collects, processes and saves wavelength dependent data. Basic math (e.g. ratio or subtraction) and graphing can be performed. See page 4-51 for details.

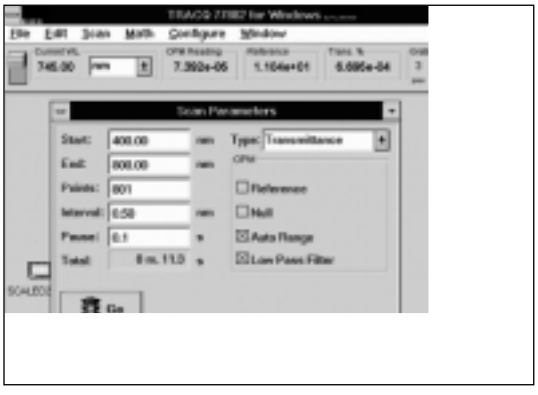


Fig. 2 TRACQ32™ Collects, processes and saves wavelength dependent data.

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WHAT ELSE DO I NEED FOR A COMPLETE DATA ACQUISITION SYSTEM?

TRACQ32™ communicates with Oriel's Instruments via RS-232 or IEEE-488 interfaces. If you are using the IEEE-488 interface, you need National Instruments' IEEE-488 software. OPM™ and the Cornerstone™ Monochromators come equipped with IEEE-488 and RS-232 interfaces. The computer itself should be at least a 486 with 16 MB of RAM, and should be running Windows™ '95, '98 or Windows™ NT. Order the necessary communication cables separately. TRACQ32™ is supplied on a CD-ROM and includes a detailed manual.

FOR ORDERING INFORMATION...

Ordering Information for the OPM™ Readout and family of detectors is on page 6-28.

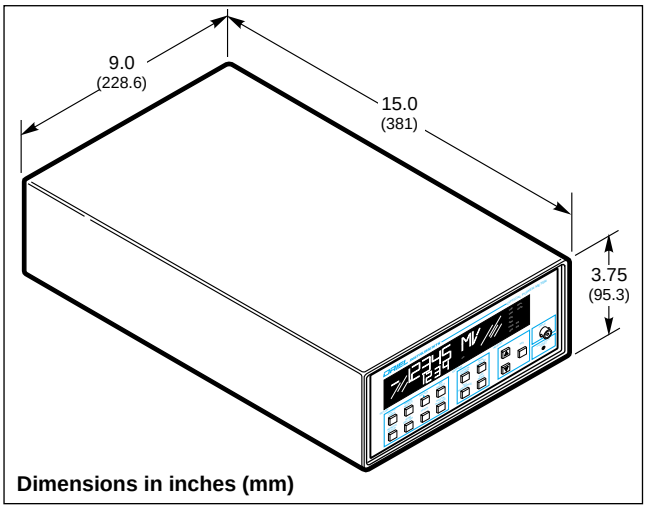


Fig. 3 Dimensional diagram of 70310 Multifunction Optical Power Meter (OPM™).

SPECIFICATIONS

Full Scale Input Ranges

DC current:*	Seven ranges from 2 nA (10^9 V/A gain) to 2 mA (10^3 V/A gain)
DC voltage:*	Four ranges from 2 mV (10^3 V/V gain) to 2 V (1 V/V gain)
RMS voltage:*	Four ranges from 2 mV (10^3 V/V gain) to 2 V (1 V/V gain); >100 kHz capability
Accuracy:	
DC:	±0.1% full scale
AC	±0.5% full scale
Analog output:	±2 V full scale
DC voltage supply:**	±5 V
Communications:	RS-232 and IEEE-488 (compliant with IEEE-488.2 standard)
Display:	4 ½ digit LED array
Display modes:	Optical power Volts/Amps Linear/log Absolute/relative (dB)
Power:	115 V/230 V, 50/60 Hz
Weight:	8.5 lbs (3.9 kg)

*** BNC Input connectors for detectors without calibration PROM, 9 pin D-Sub input connector for detectors with calibration option and/or requiring ±5V for amplifiers.**

**** Designed to power the amplifiers built into some of the Oriel family of detectors.**

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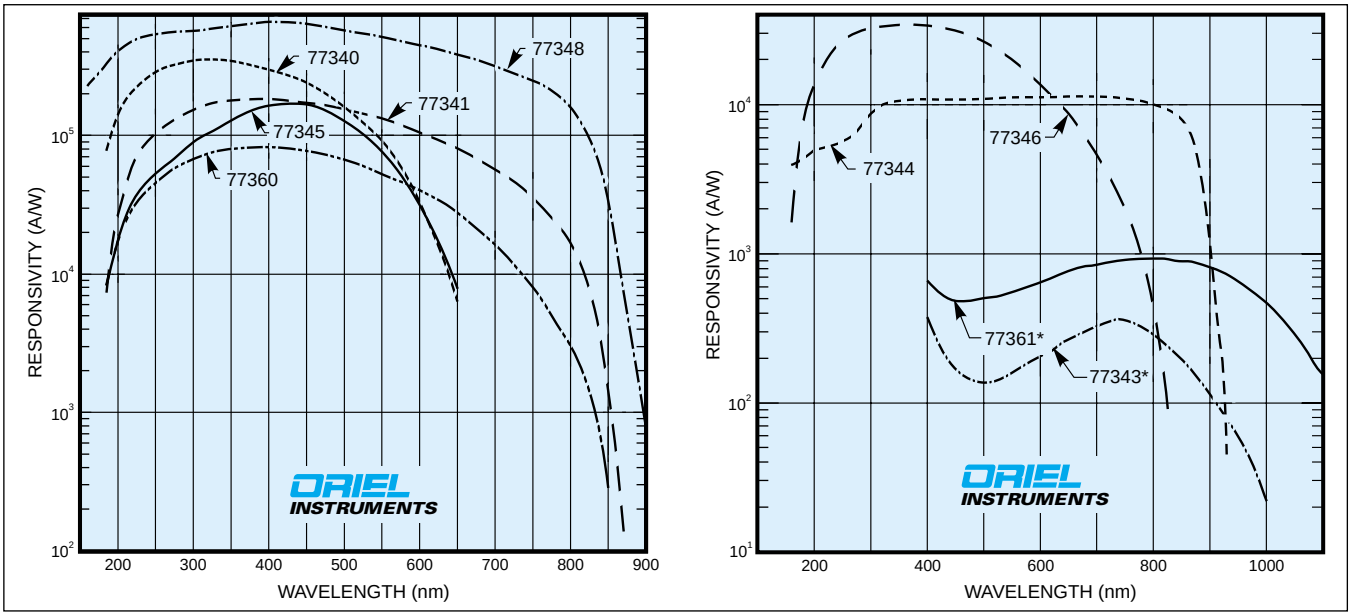


Fig. 4 Typical responsivity curves of photomultiplier tubes, at the supply voltages listed in Table 2.

PHOTOMULTIPLIERS FOR OPM™

- **High sensivity UV detectors**
- **Easy to use**
- **End-on and side-on models**

Photomultiplier tubes (PMTs) offer a most cost effective, low light level measurement solution. Because the permutations are many, we don't offer complete PMT systems, but rather offer the components so you can pick and choose. Here, we give you an overview of the family, and offer guidance in choosing the components to build a system. For more detailed information on all our tubes and accessories, please see page 6-65.

THE CHOICES

You need to answer two questions in order to choose the appropriate PMT components to build a system:

1. What wavelength range do you need?
   We have PMTs that are sensitive in the UV, as low as 160 nm, and in the NIR as high as 1100 nm. See Fig. 4 for responsivity curves.
2. Do you want a side-on or end-on PMT?
   Side-on PMTs are more economical; the end-on systems have a larger photocathode area and have a more uniform responsivity.

WHAT DO I NEED TO BUILD A SYSTEM?

For an economical, PMT based OPM™ measurement system, you'll need:

- OPM™ Readout
- 77265 End-on or 70680 Side-on PMT Housing
- Photomultiplier Tube (see Table 1 for selection)
- 70705 PMT Power Supply

The detectors housings come with a 6 ft. (1.8 m) long, low noise BNC cable to connect to the OPM™, and a high voltage cable for connection to the bias supply.

FOR ORDERING INFORMATION...

The Ordering Information for these and all other OPM™ detectors is on page 6-27.

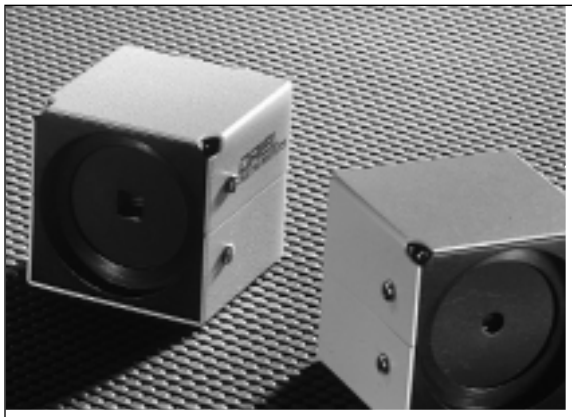
Table 2 Photomultiplier Tubes

Wavelength Range (nm)	Peak Wavelength (nm)	Photocathode Size W x H (mm)	NEP (W Hz $^{-1/2}$)*	Rise Time* (ns)	Supply Voltage*	Model No.
Side-on Tubes						
185 - 650	340	8 x 24	1.4×10^{-16}	2.2	1000	**77340**
185 - 870	330	8 x 24	2.8×10^{-16}	2.2	1000	**77341**
400 - 1000	730	8 x 24	1.2×10^{-13}	2.0	1250	**77343**
160 - 930	300 - 800	3 x 12	2.2×10^{-16}	2.0	1250	**77344**
160 - 900	400	8 x 24	1.2×10^{-16}	2.2	1000	**77348**
185 - 850	420	8 x 16	5.0×10^{-16}	1.2	1000	**77360**
End-on Tubes						
185 - 650	420	25 mm dia.	2.0×10^{-16}	12	1000	**77345**
185 - 850	420	25 mm dia.	6.6×10^{-16}	15	1000	**77346**
400 - 1100	800	25 mm dia.	4.2×10^{-13}	10	1250	**77361**

*** Typical values at the supply voltage listed.**

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OPM™ Photodiode Detectors

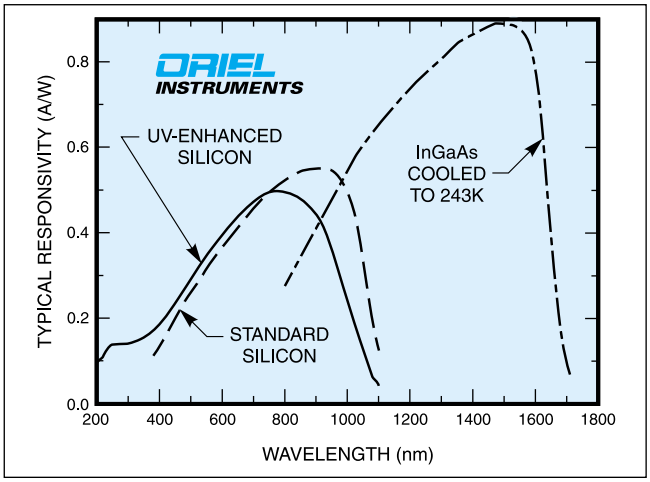


Fig. 5 Typical responsivities of Si and InGaAs Detectors.

PHOTODIODE DETECTORS FOR OPM™

- **Full featured family of diode detectors**
- **NIST traceable calibration**
- **DC to 100 kHz measurements**
- **Linear response from pW to mW**
- **UV to IR responsivity**

The **new** family of OPM™ detectors presented here is based on GaN, Si, InGaAs, and Ge photodiodes operated in photovoltaic mode for best DC and low frequency performance. We offer both room temperature and TE cooled models. The calibrated models allow you to take spectroradiometric measurements over the useful detection ranges of these devices. The OPM™ Readout downloads the PROM stored calibration data and utilizes it to calculate the incident power for display and for PC communications (RS-232 and IEEE-488). The RMS mode of operation of the OPM™ allows you to measure AC signals up to the 100 kHz bandwidth limit.

WHY PHOTOVOLTAIC OPERATION?

We have chosen to operate this family of photodiodes in a photovoltaic, unbiased mode. The photovoltaic mode of operation offers the lowest noise for DC and low frequency operation since it avoids the shot noise associated with bias currents.

THE CHOICES

The table below lists our photodiode detector line.

Table 3 Photodiode OPM™ Detectors

Detector Type	Size	Temperature	Model No.	
			Standard	Calibrated
GaN*	0.25 mm dia.	Room Temperature	**71630**	N/A
GaN, UV enhanced*	0.25 mm dia.	Room Temperature	**71631**	N/A
Si, UV enahnced**	10 x 10 mm	Room Temperature	**71608**	**71638**
Si, UV enahnced	10 x 10 mm	Room Temperature	**71610**	**71640**
Si, UV enahnced	5 mm dia.	TE Cooled	**71612**	**71642**
Si, VIS-IR	10 x 10 mm	Room Temperature	**71609**	**71639**
Si, VIS-IR	5 mm dia.	TE Cooled	**71611**	**71641**
InGaAs	3 mm dia.	Room Temperature	**71615**	**71645**
InGaAs	3 mm dia.	TE Cooled	**71616**	**71646**
Ge	5 mm dia.	Room Temperature	**71613**	**71643**
Ge	5 mm dia.	TE Cooled	**71614**	**71644**

*** Standard GaN offers 200-365 nm responsivities above 1 mA/W; the UV enhanced model pushes it down to 180 nm.**
**** Does not have a standard Oriel 1.5 Inch Series mounting flange.**

SPECTRAL RANGES

Fig. 5 shows the typical spectral responsivities of the very popular Si and InGaAs detectors. Choose the UV versions of Si detector if your work takes you below 400 nm. These Si detectors are sensitive down to 180 nm and offer calibrated performance down to 200 nm. The VIS-NIR version of Si detectors give you the best performance between 400 nm and 1.0 µm and useful performance to 1.1 µm. Use the InGaAs units for wavelengths up to the 1.7 µm long wavelength cut off point. Fig. 6 shows typical spectral responsivities of GaN and Ge detectors. GaN offers solar blind performance (it is unaffected by VIS or IR radiation). Ge extends the IR response, as compared to InGaAs, by ~0.1 µm.

We offer some TE cooled detectors for improved stability of response and to allow you to reach lower noise level performance, especialy for InGaAs and Ge. Cooling also has an effect on spectral responsivity, most significantly at longer wavelengths. The detector's cut-off wavelength shifts to slightly lower values as the temperature is lowered. It can change by about 0.1 µm for InGaAs or Ge when going from room temperature to 243 K. We talk more about cooling in the ***TECH NOTE*** on the following page.

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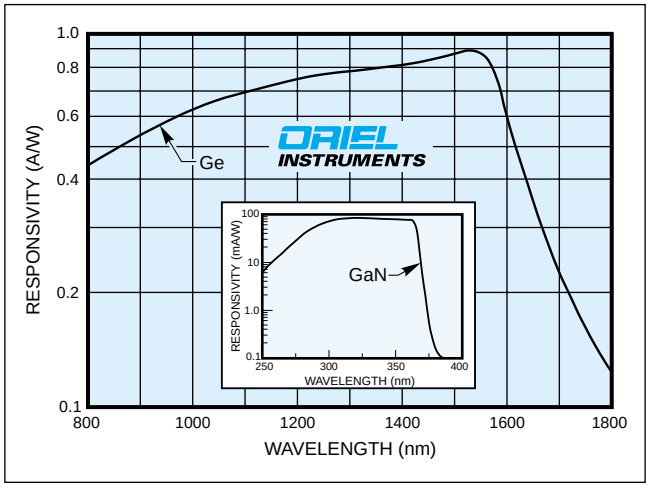


Fig. 6 Typical Spectral responsivities of GaN and Ge detectors.

COOLED OR ROOM TEMPERATURE?

You will do well with room temperature photodiodes under most measurement conditions. They are quite stable and, with the improvements in material growth technologies, even InGaAs can now be delivered with over 1 MΩ room temperature impedance for a 3 mm diameter device. The high impedance also signifies low noise performance.

However, as the ***TECH NOTE*** indicates, the responsivity of the diodes is sensitive to temperature changes. It can go up or down with temperature, depending on which part of the spectral range you are operating in. Therefore, when ever you are looking for measurement reproducibility of better than ~2%, temperature stabilization becomes a necessity. Our TE cooled devices, combined with the 77057 Temperature Controller (page 6-76), give you excellent stability of readings. The added benefit of TE cooling is the reduction of noise levels, which allows you to reach the limits of device performance.

InGaAs and Ge are offered with two stage TE coolers which allow stable operation down to 243 K. Si, which has a larger band gap and also much higher material quality, shows smaller noise reduction from operation at lower temperatures and therefore we offer it with only a single stage TE cooler for response stabilization.

CALIBRATION

NIST traceable calibrated models are available for most of these detectors. The OPM™ reads in the PROM-stored calibration information and uses it to calculate spectral corrections. The corrected values of incident power are then displayed and made available to your data collection PC through the included RS-232 or IEEE-488.2 interface. Data is also provided in ASCII format for use in any of your software driven applications.

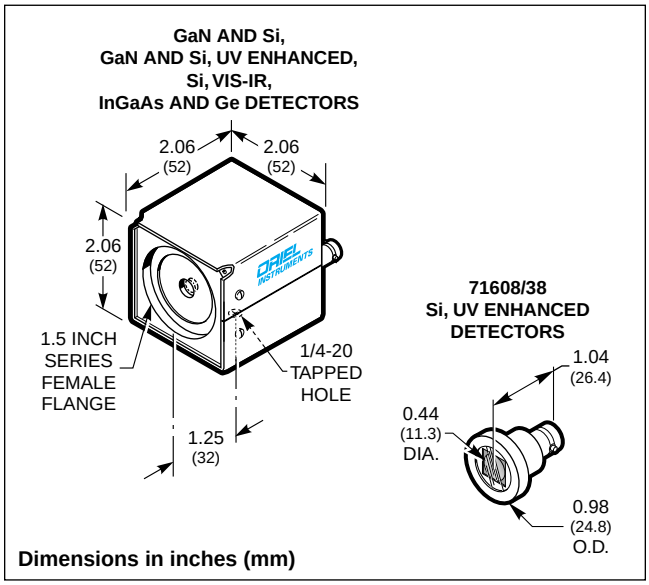


Fig. 7 Dimensional diagram of OPM™ Photodiode Detectors.

TECH NOTE

You may want to explore the best operating temperature, when working near the cut-off wavelength, to balance the noise reduction at lower temperatures, against the responsivity reduction due to the detection edge changes. The 77057 Temperature Controller allows a full range of detector operating temperatures. For the calibrated models, we run the InGaAs and Ge detectors at 253 K and the TE Cooled Si at 278 K. Please advise our Sales Engineers if you would like to operate at a different temperature and we will perform the calibration at your chosen operating point. Responsivity of the diode detectors is a function of temperature. Operation at temperatures other than the one used at the time of calibration will reduce the accuracy of your measurements. Responsivity changes vary from ±0.2%/K mid range to over 1%/K near the long wavelength limits of the spectral range.

MOUNTING AND CABLES

Mose of these detectors come mounted in housings with a 1.5 Inch Series female flange for direct mounting to Oriel Monochromators.

A lower cost, 11.3 mm diameter, UV enhanced Si detector, model 71608, has been added to our product line for cases when the 1.5 Inch Series flange is not required. All detectors are shipped with a BNC cable; calibrated models are terminated with a 9 pin D-sub connector.

WHAT ELSE DO I NEED?

A complete photodiode OPM™ system requires:

- OPM™ Readout
- Room temperature or cooled detector
- 77057 (110 V) or 77058 (220 V) Cooler Controller for cooled detectors

FOR ORDERING INFORMATION...

The Ordering Information for these and all other OPM™ detectors is on page 6-27.

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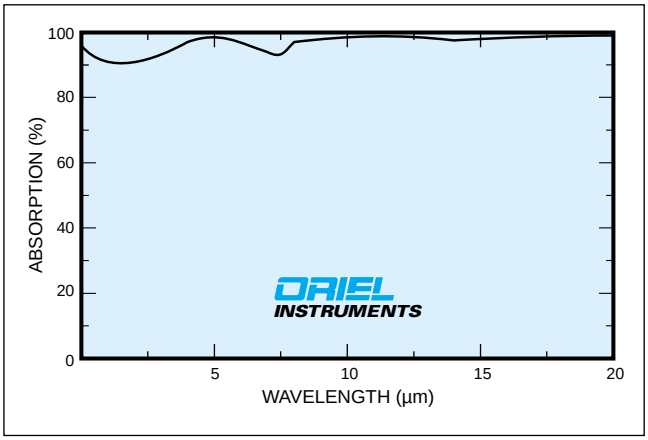


Fig. 8 Typical absorption of Thermopile Detector Coating.

THERMOPILE DETECTORS FOR OPM™

- **Broad spectral response - 0.2 to 40 µm**
- **Rugged thin film construction for high reliability**
- **Excellent long term stability**
- **No bias required**
- **Noise behavior ideal for DC or low frequency operation**

Thermal detectors of electromagnetic radiation operate by absorbing the radiation and measuring the subsequent temperature rise. Their broadband, wavelength-neutral response is only limited by the spectral flatness of their black coating and the transmission characteristics of any window materials used to protect them.

THE CHOICES

We sell two types of detectors: miniature versions packaged in 1.5 Inch Series flanged housings, listed in Table 4, and higher power units listed in Table 5.

DETECTOR ELEMENT COATIING

We coat the active detector element with a black, absorbing coating. The typical spectral properties (Fig. 8) of this coating are modified by the transmission properties of the windows used with them.

Table 6 Windows in Miniature Thermopile OPM™ Detectors

Material	Usable Spectral Range (µm)	Approximate Transmittance (%)	Water Solubility (g/100g)	Affected By Humidity
Calcium Fluoride (CaF_2)	0.13 - 11	94	0.0017	No
Sapphire	0.15 - 6	90	0.0	No
KRS-5	0.6 - 40	74	0.05	No

Additional information on miniature detectors can be found on pages 6-82 to 6-83.

Table 4 Miniature Thermopile OPM™ Detectors

Detector Area (mm)	Window	Maximum Irradiance* ($W\ cm^{-2}$)	Typical DC Responsivity (µA/W)	Typical Responsivity Time (s)	Typical Noise Equivalent Power (Filter on) nW	Model No.	
						Non Calibrated	Calibrated
0.51 x 0.55	Sapphire	0.1	200 - 300	0.012	3.5	**71967**	**71957**
0.51 x 0.55	CaF_2	0.1	200 - 300	0.012	3.5	**71968**	**71958**
0.51 x 0.55	KRS-5	0.1	200 - 300	0.012	3.5	**71971**	**71961**

*** For linear response.**

Table 5 High Powered Thermopile OPM™ Detectors

Detector Diameter (mm)	Window	Measurement Range		Max. Power Density ($W\ cm^{-2}$)	Max. Energy Density ($J\ cm^{-2}$)	Time Constant (s)	Model No.
		Power	Energy				
8	None	10 µW - 2 W	50 µJ - 230 mJ	4	0.6	0.3	**70262**
12	None	50 µW - 3 W	1 mJ - 2 J**	50	0.3@<10^{-8} s 0.5@ 1 µs	2.5	**71964**
16	None	2 mW - 10 W	3 mJ - 10 J	50	0.3	2.5	**71965**
50	None	100 mW - 40 W*	50 mJ - 200 J	20 kW cm^{-2}	0.3	2.5	**71966**

*** 150 W for short periods.**
**** Up to 10 J at some wavelengths.**

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CALIBRATION

The high powered detectors come with a calibration in µA/W. The miniature units are offered in calibrated and non-calibrated models. The calibration is in µA/(W m^2).

DETECTOR HOUSINGS

Our **new** Miniature Thermopile Detector Housings are compact and low cost, making the complete detector assembly an economical, broadband light measuring instrument.

WHAT ELSE DO I NEED?

For a thermopile based OMP™ system, you only need the following components:

- OPM™ Readout
- Thermopile Detector

Each thermopile detector is terminated with a series load resistor to provide current input to the very sensitive OPM™ picommeter circuitry, and comes with appropriate cable.

FOR ORDERING INFORMATION...

The Ordering Information for these and all other OPM™ detectors is on page 6-28.

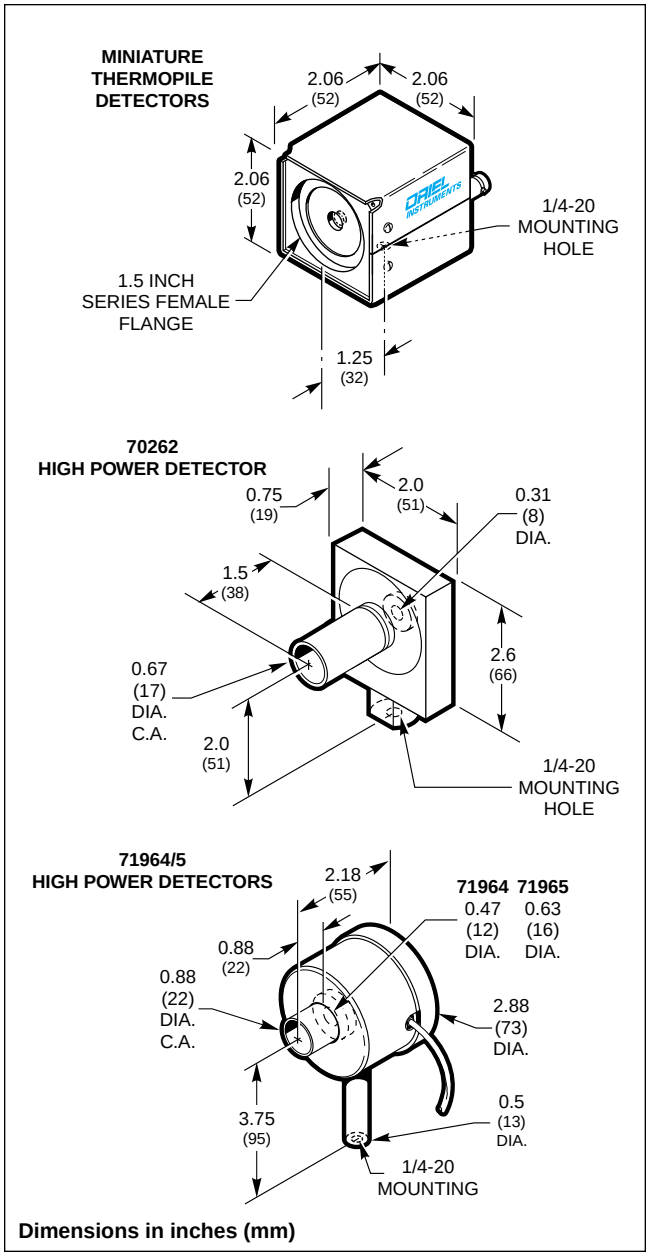


Fig. 9 Dimensional diagram of selected Thermopile OPM™ Detectors.

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ORDERING INFORMATION

70310 OPM™ Multifunction Optical Power Meter ....
70018 6 ft. (1.8 m) Long Low Noise BNC Cable.....
(Required if you are using your own Detector with OPM™ Readout)
70038 6 ft. (1.8 m) Long IEEE-488 (GPIB) .....
Stackable Cable
70040 6 ft. (1.8 m) Long RS-232 Cable .....
77888 TRACQ 32™ Radiometry Software .....

PHOTOMULTIPLIER DETECTORS

Detectors

Wavelength Range (nm)	Model No.	Price
Side-on		
185 - 650	**77340**	
185 - 870	**77341**	
400 - 1000	**77343**	
160 - 930	**77344**	
160 - 900	**77348**	
185 - 850	**77360**	
End-on		
185 - 650	**77345**	
185 - 850	**77346**	
400 - 1100	**77361**	

Accessories

77265 End-on PMT Housing.....
70680 Side-on PMT Housing.....
70705 High Voltage PMT Bias Supply..... **0**

THERMOPILE DETECTORS

Detectors

Detector Size	Window	Non-Calibrated		Calibrated	
		Model No.	Price	Model No.	Price
2 x 2 mm	Sapphire	**71967**		**71957**	
2 x 2 mm	CaF_2	**71968**		**71958**	
2 x 2 mm	KRS-5	**71971**		**71961**	
8 mm dia.	None			**70262**	
12 mm dia.	None			**71964**	
16 mm dia.	None			**71965**	
50 mm dia.	None			**71966**	

PHOTODIODE DETECTORS

Detectors

Detector Type	Size	Non-Calibrated		Calibrated	
		Model No.	Price	Model No.	Price
GaN	0.25 mm dia.	**71630**			
GaN, UV	0.25 mm dia.	**71631**			
Si, UV	11. 3 mm dia.	**71608**		**71638**	
Si, UV	10 x 10 mm	**71610**		**71640**	
Si, UV, TE Cooled	5 mm dia.	**71612**		**71642**	
Si, VIS-IR	10 x 10 mm	**71609**		**71639**	
Si, VIS-IR, TE Cooled	5 mm dia.	**71611**		**71641**	
InGaAs	3 mm dia.	**71615**		**71645**	
InGaAs, TE Cooled	3 mm dia.	**71616**		**71646**	
Ge	5 mm dia.	**71613**		**71643**	
Ge, TE Cooled	5 mm dia.	**71614**		**71644**	

Accessories

77057 Cooler Controller, 110 V.....
77058 Cooler Controller, 220 V.....

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