COHERENT®

Laser Measurement and Control

2013 Product Catalog

Power and Energy Measurement

Custom Power and Energy Solutions

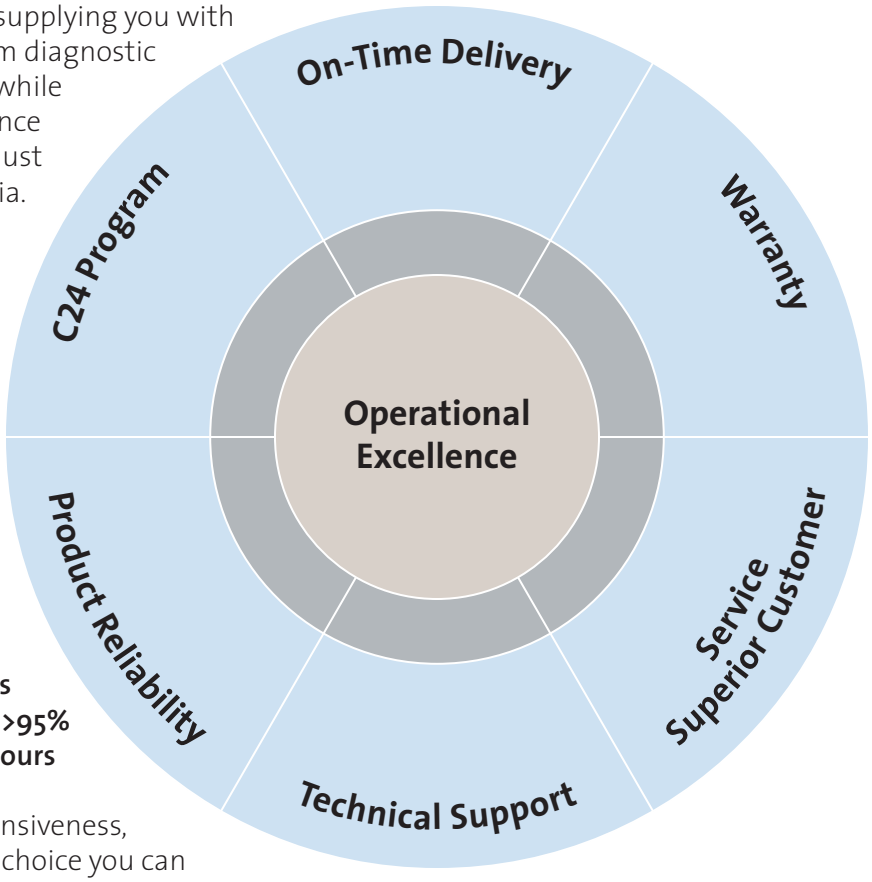
Beam Diagnostics

Superior Reliability & Performance

Coherent Operational Excellence

Operational Experience You Can Count On

For over 40 years, Coherent has been supplying you with the best laser measurement and beam diagnostic equipment available. We realize that while technical specifications greatly influence your purchasing decisions, you also must consider many other important criteria.



Through customer surveys we found that Product Reliability, Speed of Responsiveness, and Technical Support are the three top criteria when choosing a laser test and measurement supplier. That's why we place as much emphasis on Operational Excellence as we do on technical superiority. Operational Excellence means:

- **Overall product warranty rate <1%**
- **Calibration turnaround time <5 days**
- **On-time delivery for all new orders >95%**
- **Shipment of C24 orders within 24 hours**

For Product Reliability, Speed of Responsiveness, and Technical Support, make the safe choice you can always count on – Coherent.

The Coherent Laser Measurement Newsletter

To keep informed about our latest laser measurement and beam diagnostics product releases, product upgrades, and special promotions, please sign up for our electronic newsletter at: www.Coherent.com/LMC.

We Want You to Know What's New

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Visit the Coherent Website Inside Back Cover

New Products

New to the Catalog

ISO/IEC 17025:2005 Accredited

Coherent's Wilsonville, Oregon calibration laboratory is fully accredited to ISO/IEC 17025:2005 by ACLASS, a brand of the ANSI-ASQ National Accreditation Board and recognized internationally by ILAC, APLAC, and IAAC. Certification to ISO 17025 is a formal recognition that a calibration laboratory is using valid and appropriate methods and is competent to carry out specified tests or calibrations.

ACLASS

CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board/ACLASS
500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

Coherent LSM
27650 SW 95th Ave.
Wilsonville, OR 97070

has been assessed by ACLASS
and meets the requirements of international standard

ISO/IEC 17025:2005

while demonstrating technical competence in the field(s) of

CALIBRATION

Refer to the accompanying Scope(s) of Accreditation for information regarding the types of calibrations to which this accreditation applies.

AC-1630
Certificate Number

ACLASS Approval

Certificate Valid 03/15/2012-03/15/2014
Version No. 001

ANSI-ASQ NATIONAL ACCREDITATION BOARD ACLASS ISO/IEC 17025

ilac-MRA ACLASS

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated January 2009*).

New Products

New to the Catalog

PowerMax-USB UV/VIS Wand

PowerMax-USB UV/VIS
Quantum Sensor Wand

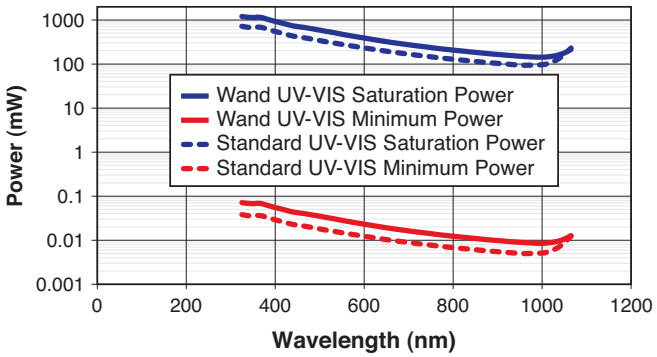
Features

- Large 8 mm aperture
- High-sensitivity Silicon photodiode
- Low power measurements down to 8.5 µW (wavelength dependent)
- Spectral response from 325 nm to 1065 nm

The PowerMax-USB UV/VIS Wand sensor incorporates a Silicon photodiode, for measurement of power from 8.5 µW to over a hundred milliwatts. The measureable power varies significantly by wavelength. See the chart at right.

Spectrally calibrated filters are used to attenuate the laser beam, thus allowing for a higher average power measurement than is typically possible with a photodiode. They work with CW (continuous wave) as well as pulsed sources greater than 50 pps.

Saturation and Minimum Power
UV/VIS Sensors Over Wavelength



Power and Energy Measurement Solutions

Sensor Technologies

Coherent offers three different sensor technologies (thermopile, semiconductor/optical, and pyroelectric) that address a broad range of measurement parameters and laser characteristics.

Thermopile

PM Model Thermopiles

LM Model Thermopiles

Thermopile sensors are a great all-purpose technology suitable for many lasers. They are used for measuring CW laser power, average power in pulsed lasers, and are often used to integrate the energy of long pulses.

Thermopile sensors absorb incident laser radiation and convert it into heat. This heat ultimately flows to a heat sink that is held at ambient temperature by either convection-cooling or water-cooling. The temperature difference between the absorber and the heat sink is converted into an electrical signal by a thermocouple junction.

Thermopiles operate across a wide range of input powers, and unlike a semiconductor sensor they will not saturate. The spectral range is dependent upon the coating applied to absorb the laser energy. The coating used on many thermopiles is broadband in nature and is relatively flat from the ultraviolet through the infrared. These sensors have natural response times on the order of several seconds for a low power sensor and up to one minute for a kilowatt sensor. When combined with a Coherent meter a speed-up algorithm provides a much faster response – on the order of seconds for most sensors.

Coherent has two lines of thermopile sensors. The "LM Model" line utilizes a unique thermopile disk in which the thermocouples are split into four quadrants, allowing the sensors to provide beam position information in addition to power measurement. LM Model sensors can be found on pages 37 to 41. The "PM Model" line incorporates traditional thermopile disks that provide power measurement, found on pages 42 to 53.

Quad Positioning Enabled

Semiconductor/Optical

Model OP-2/LM-2

Semiconductor sensors convert incident photons into current that can be measured by our instruments. The photodiodes used in these types of sensors offer high sensitivity and low noise, enabling them to detect very low light levels. They saturate above approximately 1W/cm², so attenuating filters must be used when operating above the milliwatt level.

Photodiodes also have a fast response time, so they are convenient for tuning and peaking lasers. The spectral range is more limited than our other sensor technologies. These devices are also referred to as optical sensors. Semiconductor/optical sensors are limited to measuring CW laser power.

Power and Energy Measurement Solutions

Sensor Technologies

Pyroelectric

EnergyMax - Laser Energy Sensors

Coherent energy sensors use a pyroelectric element to measure the energy in a laser pulse. It does this by producing a large electrical charge for a small change in temperature. The active sensor circuit takes the current from the sensor element and converts it to a voltage that can be measured by a peak detector circuit or a Coherent meter. Pyroelectrics can only be used with pulsed lasers.

Pyroelectric sensors are ideal for measuring the output of pulsed lasers. These devices can be used at repetition rates to 10 kHz and beyond, and can be used to measure laser pulses beyond a Joule.

Sensor Technology Measurement Range

The following information can help determine which sensor technology to choose based upon the type of laser used and the type of measurement needed.

Laser Type	Measurement Needed	Power Range	Wavelength Range	Sensor Type
CW Laser	Average Power	10 nW to 50 mW 100 µW to >5 kW	250 nm to 1800 nm 0.19 µm to 11 µm	Optical Thermopile
Pulsed Laser	Average Power	100 µW to >5 kW	0.19 µm to 11 µm	Thermopile
Pulsed Laser	Energy Per Pulse	100 nJ to >10J	0.19 µm to 11 µm	Pyroelectric
Long Pulse Laser (>1 ms)	Single Pulse Integrated Energy	1 mJ to >300J	0.19 µm to 11 µm	Thermopile

The spectral range of these sensor technologies and absorbing coatings are shown in the table below. After identifying a sensor type and coating, the detailed specifications in this catalog can be used to select a specific sensor model for your application.

	Model	Wavelength (nm)	Wavelength (nm) 100 1000 10,000
Thermal Sensors	PowerMax - UV Coating	150 to 1000	
	PowerMax - Broadband Coating	190 to 11,000	
	Volume Absorber	250 to 3000	
Semiconductor Sensors	UV	200 to 400	
	VIS	400 to 1064	
	IR	800 to 1800	
Energy Sensors	MaxBlack Coating	190 nm 12,000	
	MaxUV Coating	190 to 2100	
	Diffuse Metallic Coating	190 to 2100	

After selecting a sensor model, the final step is to identify a meter to measure, display and analyze the sensor output. The information on the next page summarizes the capabilities and features of our meters and lists their compatibility with different sensors. Visit www.Coherent.com/LMC and use our Product Finder to assist you in making your sensor and meter selections.

Power and Energy Meter Quick Reference Guide

Meter Features Summary Table

	FieldMate	FieldMaxII -TOP	FieldMaxII -TO	FieldMaxII -P	LabMax -TOP	LabMax -TO	LaserCheck
Page Reference	15	13	13	13	10	10	16
Measurement Modes							
CW Power	•	•	•		•	•	•
Avg. Power of Pulsed Lasers	•	•	•		•	•	
Long-Pulse Joules		•			•	•	
Pulse Energy		•		•	•		
Max. Rep. Rate (Hz)		300		300	10,000[1]		
Display Types							
Digital Readout	•	•	•	•	•	•	•
Analog Needle Tuning	•						
Graphical Tuning		•	•	•	•	•	
Strip Chart/Trending					•	•	
Measurement Analysis Supported							
Beam Position					•	•	
Statistics		•	•	•	•	•	
Display Smoothing		•	•	•	•	•	
2-Channel/Ratiometric							
Correction Factors Supported							
Wavelength Correction	•	•	•	•	•	•	•
Attenuation Factor		•	•	•	•	•	
PC Interfaces							
USB		•	•	•	•	•	
RS-232					•	•	
GPIB					•[2]		
Analog Output	•	•	•	•	•	•	
Electrical Power Options							
Battery (rechargeable)		•	•	•	•	•	
Battery (non-rechargeable)	•						•
AC Powered	•	•	•	•	•	•	

Meter and Sensor Compatibility Table

Power Sensors							
PM Model	•	•	•		•	•	
PS Model	•	•	•		•	•	
OP-2 Model	•	•	•		•	•	
LM Model and Beamfinder	•[3]	•[3]	•[3]		•	•	
LM-2 Model	•[3]	•[3]	•[3]		•	•	
Energy Sensors							
EnergyMax		•[4]		•[4]	•		

[1] 10,000 Hz sampled; 1000 Hz every pulse.
[2] LabMax-TOP w/GPIB model only.
[3] Compatible when used with Thermal SmartSensor Adapter #1056827.
[4] Our J-50MT-10KHz, J-25MT-10KHz, J-10MT-10KHz, J-10Si, and J-10Ge EnergyMax Sensors are not compatible with FieldMaxII-TOP meters. For legacy sensor models not listed, please contact Coherent or your local representative for assistance.

Power and Energy Measurement Overview

Compatibility Chart for Our Most Popular Meters and Sensors

POWER

Meters

FieldMate

FieldMaxII

LabMax

Sensors

PM & PS Model Thermopile Sensors/OP-2 Model Optical Sensors

Thermal SmartSensor Adapter

LM Model Thermopile Sensors/ LM-2 Model Optical Sensors

Power meters compatible with PM & PS Model Thermopile Sensors

Power meter compatible with LM Model Thermopile Sensors

Power meters need the Thermal SmartSensor Adapter to use LM Model Thermopile Sensors

ENERGY

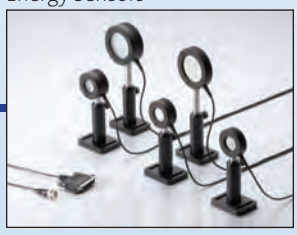
Meters

FieldMaxII-TOP and -P

LabMax-TOP

Sensors

EnergyMax Pyroelectric Energy Sensors



LabMax Meters

Laser Power and Energy Meters

LabMax-TOP Power and Energy Meter

Features

- Measure power and energy
- Ergonomic design enhances user experience
- Directly compatible with PM Model and LM Model thermopiles
- Display beam position with LM Model thermopiles
- Log data to internal memory, directly onto USB flash drive, or to PC
- USB, RS-232, and GPIB PC interfaces
- Software:
  - LabMax PC applications software
  - LabVIEW instrument driver and ActiveX control
  - XP/Vista (32-bit)/Windows 7 (32-bit and 64-bit) compatible

Models

- LabMax-TOP is compatible with thermopile, optical and pyroelectric (power & energy)
- LabMax-TOP w/GPIB adds IEEE-488 GPIB PC interface (cable included)
- LabMax-TO is compatible with thermopile and optical (power and long-pulse Joules)

LabMax is a versatile meter suitable for anyone who needs to analyze laser output. It analyzes and monitors laser output via onboard data logging. It also supports logging data directly to a USB flash drive, provides enhanced data analysis and statistics, as well as a form factor that allows flexible positioning and viewing angles so it can be used in areas with limited bench space. These meters provide direct compatibility with LM Model and PM Model sensors with no need for adapters.

Sensor Compatibility

LabMax displays beam position for quick and accurate setup, and is directly compatible with most Coherent thermal, pyroelectric and semiconductor sensors. These sensors offer wavelength coverage from 190 nm to 12 µm, measure from nW to kW, from nJ to J, and from single shot to 10 kHz.

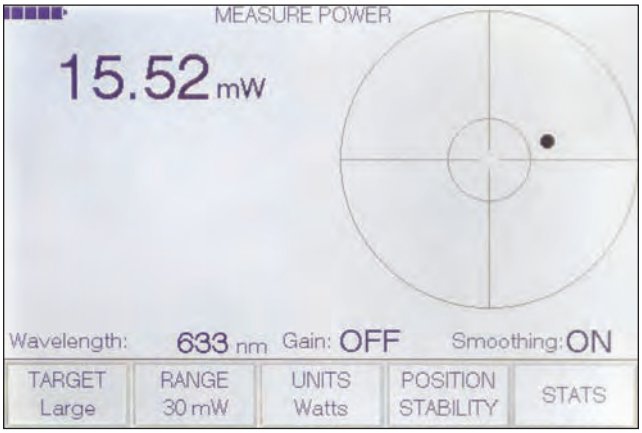
Beam Positioning

The position of the laser beam on the sensor can be displayed by LabMax when using an LM Model thermopile sensor. This makes it easier to align the laser beam during setup, especially for infrared laser beams. There is also a trending feature to monitor the position of the beam over time, and the position data can be logged to a file. Beam position sensors are on pages 37 to 41.

LM-45 HTD sensor with beam position

Data Logging

Data logging of unlimited size can be performed directly to a USB flash drive, and additionally over 400,000 points can be retained onboard the meter itself in flash memory. The meter has a file management system that allows naming and renaming files, auto increments file names for repetitive logging events, folder creation and renaming, and transferring files and folders from the meter storage to a USB flash drive. Data can also be logged to a file with the LabMax PC applications software.



LabMax beam position display

LabMax Meters

Laser Power and Energy Meters

Ergonomic Design

LabMax features a large, backlit graphical display with an ergonomic interface with easily accessible buttons for all features and modes. The Measure, Tune, and Trend modes are directly accessible via front panel buttons.

Front panel buttons

Flexible Positioning

The LabMax display and meter can be positioned at many different angles within the limited bench space typically available in a laser lab, while still making the display easy to view.

Additional Inputs/Outputs

In addition to PC interfacing, LabMax also includes an analog output with user-selectable voltages of 0 to 1V, 2V, or 4V. Pyroelectric triggering can be achieved with an external trigger input or an internal trigger that is user-adjustable from 2% to 20% percent of full-scale range.

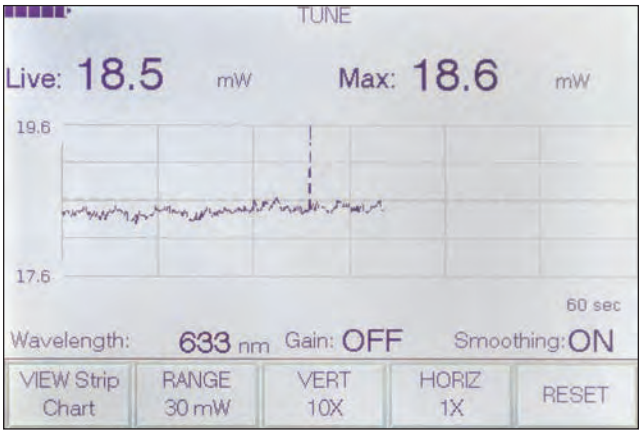
Measurement Analysis

LabMax meters contain several advanced analysis capabilities, including:

Onboard statistics – mean, minimum, maximum, standard deviation, range, three stability parameters, as well as missed pulses. Users can also select which statistical parameters to display, up to six at a time.

Trend charting – trend chart with statistical display and the ability to log data to a file.

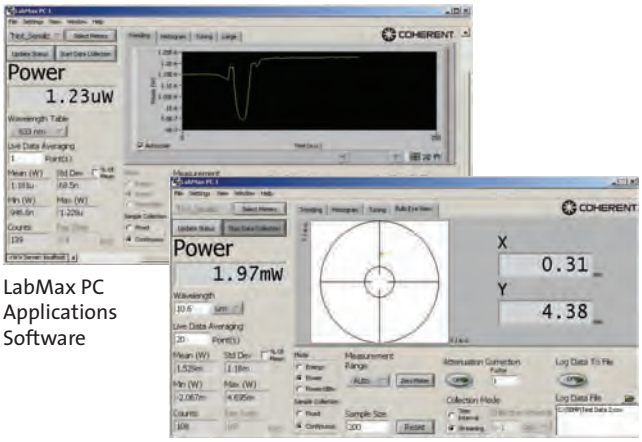
Digital tuning indicators – horizontal bar and trend chart formats with peak indicators.



LabMax Tune Chart

PC Interfacing and Applications Software

Data can also be analyzed directly on a PC through USB, RS-232, or GPIB connections, or by logging data to a USB flash drive attached directly to the meter. Installable applications software and LabVIEW drivers are provided to support PC interfacing.



LabMax PC Applications Software

LabMax Meters

Laser Power and Energy Meters

Device Specifications

Model	LabMax-TOP w/GPIB	LabMax-TOP	LabMax-TO
Measurement Resolution	0.1 % of full-scale		
Displayable Resolution	3 or 4 digits pyroelectric; 3, 4, or 5 digits thermopile and optical (user-selectable)		3, 4, or 5 digits (user-selectable)
Measurement Range	Sensor dependent (reference sensor specifications)		
Accuracy			
Digital Meter	±1.0% ±2LSD		
System	Meter accuracy + sensor accuracy		
Analog Output (%)	±1.0		
Calibration Uncertainty (%)(k=2)	±1.0		
Power Sampling Rate (Hz)	10		
Maximum Repetition Rate (Hz)	10,000 sampling (1000 Hz every pulse)		
Minimum Positional Resolution (mm)	0.1		
Display	112 x 78 mm backlight graphic LCD, 480 x 320 pixels. Adjustable contrast and viewing angle		
Measurement Analysis	Min., max., mean, range, std. dev., dose, stability; trending, tuning, beam position		
Computer Interface	GPIB, USB and RS-232	USB and RS-232	
Pulse Triggering	Internal and external (selectable)		–
Analog Output (VDC)	0 to 1, 2, or 4 VDC (selectable)		
Analog Output Update Rate	Up to 1000 Hz for pyroelectric; 10 Hz for thermopile and optical		10 Hz
Temperature			
Operating Range	5 to 40°C (41 to 104°F)		
Storage Range	-20 to 70°C (-68 to 158°F)		
Instrument Power	90 to 260 VAC, 50/60 Hz		
Instrument Batteries	4400 mAH Rechargeable Li-ion Pack		
Compliance	CE, RoHS, WEEE, ISO 17025		
Dimensions (H x W x D)	152 x 229 x 53 mm (6.0 x 9.0 x 2.1 in.)		
Weight	1.25 kg (2.8 lbs.)		
Front Panel			
PWR	Turn meter on and off		
ZERO	Reset ambient offset for thermal and optical sensors		
MEASURE	Main measure mode including statistics		
TUNE	View tuning features		
TREND	Display measured values over a period of time and log data to file		
SETUP	Setup meter parameters		
HELP	Onboard context sensitive help - available from any screen		
BACKLIGHT	Toggle backlight on and off		
KNOB	Turn knob to change settings; press the knob to save settings		
Left Side Panel	USB flash drive port USB PC interface port RS-232 PC interface port DB-25 sensor port Power jack		
Rear Panel	Analog output		
	External trigger input		–
	GPIB PC interface port	–	
Part Number*	1104620	1104622	1104619

* Meter supplied with 4400 mAH Li-ion battery, AC power adapter, power cord, 1.8-meter USB cable, RS-232 adapter, USB flash drive, RCA-to-BNC adapters, software and driver CD, soft carrying case, and certificate of calibration. LabMax-TOP w/GPIB also includes a GPIB cable.

FieldMaxII Meters

Laser Power and Energy Meters

FieldMaxII-TOP Power and Energy Meter

FieldMaxII-TO Power Meter

Features

- Measure energy of pulsed lasers up to 300 pps
- Large, backlight LCD display
- Compatible with thermopile, optical, and pyroelectric sensors
- Simulated analog-like movement for laser tuning
- USB interface with FieldMaxII PC applications software, LabVIEW instrument driver and ActiveX control
- XP/Vista (32-bit)/Windows 7 (32-bit and 64-bit) compatible
- Area function for density measurements (J/cm² or W/cm²)

Models

- FieldMaxII-TOP is compatible with thermopile, optical and pyroelectric sensors (power & energy)
- FieldMaxII-TO is compatible with thermopile and optical (power only)
- FieldMaxII-P is compatible with pyroelectric (energy only)

FieldMaxII is an affordable, versatile, easy-to-use digital power and energy meter platform designed for a variety of applications ranging from field service to production test applications.

FieldMaxII features a large, easy-to-read backlit LCD and an intuitive user interface offering button-driven control for simple operation. The meter supports onboard analysis of mean, min., max., and standard deviation statistics. It can measure power from nW to kW, and pulse energy from nJ to J at up to 300 pps. In addition, long-pulse Joules energy measurements can be made on the FieldMaxII-TOP model when using thermopiles.

The meter includes a USB PC interface as well as an analog output. The FieldMaxII PC applications software supports trend charting, tuning, statistics, and logging data to a file. A LabVIEW instrument driver with ActiveX control is provided to support custom software developments.

FieldMaxII PC Application

Features

- USB PC Interface
- FieldMaxII PC is completely open-source so that you can use it to help develop your own customized applications
- Multiple meters can be run on a single PC – useful for final test and burn-in applications
- Meters can be operated remotely via host interface and included drivers
- Software features:
  - Measure, Tune, Trend displays
  - Statistics
- LabVIEW instrument driver and ActiveX DLL server included

FieldMaxII Meters

Laser Power and Energy Meters

Device Specifications

Model	FieldMaxII-TOP	FieldMaxII-TO	FieldMaxII-P
Function	Power and energy	Power	Energy
Measurement Resolution	0.1% of full-scale		
Measurement Range	Sensor dependent - reference sensor specifications		
Accuracy			
System	Meter accuracy + sensor accuracy		
Analog Output (%)	±1.0		
Calibration Uncertainty (%)(k=2)	±1.0		
Power Sampling Rate (Hz)	10	10	–
Maximum Pulse Rep. Rate (Hz)	300	–	300
Display	58 x 73 mm , fixed-segment LCD with backlight		
Digital Tuning Indicator	100 msec time constant		
Statistics	Mean, max., min., standard deviation		
PC Interface	USB 1.1		
Analog Output	0 to 1, 2, or 5 VDC (selectable)		
Internal Trigger	2 to 20% of full-scale, selectable	–	2% to 20% of full-scale, selectable
Temperature			
Operating Range	5 to 40°C (41 to 104°F)		
Storage Range	-20 to 70°C (-68 to 158°F)		
Instrument Power	100 to 240 VAC, 50/60 Hz		
Instrument Batteries	Rechargeable NiMH battery pack		
Compliance	CE, RoHS, WEEE, ISO 17025		
Dimensions (H x W x D)	200 x 100 x 40 mm, (7.87 x 3.94 x 1.57 in.)		
Weight	1.0 kg (2.2 lbs.)		
Front Panel			
PWR	Toggle power switch and backlight		
HZ	Display rep. rate	–	Display rep. rate
J/W	Select Joules or Watts mode	–	–
ZERO	Reset ambient offset for thermal and optical sensors		Zero stats
AUTO	Engage auto-ranging with power sensors		–
STAT	Display statistics: mean, max., min., standard deviation		
AVG	Engage display averaging		
λ	Enter wavelength and engage wavelength compensation		
ATTEN	Enter attenuation factor and engage attenuation		
AREA	J/cm² (fluence) W/cm² (power density)	W/cm² (power density)	J/cm² (fluence)
HOLD	–	Holds displayed values on screen	–
TRIG	Select trigger level with energy sensors	–	Select trigger level with energy sensors
SETUP / LOCAL	Set and enter button/Takes local control of meter back from PC		
ARROW KEYS	Manually control range; Select Stats parameter; Select and change numerical values		
Left Side Panels	Power jack USB PC interface port Analog output		
Right Side Panels	DB-25 sensor port		
Part Number*	1098580	1098579	1098581

* Meter supplied with NiMH rechargeable battery pack, power cord, AC adapter, USB cable (1.8m), RCA-to-BNC analog output adapter, installation CD with FieldMaxII PC and drivers, soft carrying case, and certificate of calibration.

FieldMate

Laser Power Meter

FieldMate Power Meter

Features

- **Analog needle for tuning**
- **Large digital LCD display**
- **Compatible with thermopile and optical sensors**
- **Wavelength compensation**
- **Analog output**
- **Compact and portable**
- **AC and battery power**
- **Auto ranging**

FieldMate combines a digital display and analog meter with sophisticated digital processing to enable rapid, sensitive laser adjustment. This meter also offers an economical way of measuring laser power when advanced data analysis is not necessary.

Device Specifications

AC-1630

Model	FieldMate
Power Resolution	0.1% of full-scale for all ranges in the 10s scale 0.3% of full-scale for all ranges in the 3s scale
Measurement Range	Sensor dependent (reference sensor specifications)
Accuracy	
System	Meter accuracy + sensor accuracy
Analog Meter (%)	±3.0
Analog Output (%)	±1.0
Calibration Uncertainty (%)(k=2)	±1.0
Power Sampling Rate	20 Hz (thermopile and optical)
Display	26 x 89 mm, custom fixed-segment LCD
Analog Needle	
Scale	0 to 10 (100 divisions), 0 to 3 (60 divisions)
Response	80 ms time constant
Analog Output	
Voltage	0 to 2 VDC
Update Rate	20 times/sec.
Temperature	
Operating Range	5 to 40°C (41 to 104°F)
Storage Range	-20 to 70°C (-68 to 158°F)
Instrument Power	100 to 240 VAC, 50/60 Hz
Instrument Batteries	Two 9V alkaline batteries
Compliance	CE, RoHS, WEEE, ISO 17025
Dimensions (H x W x D)	193 x 117 x 46 mm, (7.6 x 4.6 x 1.8 in.)
Weight	0.8 kg (1.8 lbs.)
Front Panel	
PWR	Toggle power
ZERO	Ambient offset
AUTO	Engage auto-ranging
λ	Enter wavelength compensation
ARROW KEYS	Manually control range; select and change numerical values
Left Side Panel	Power jack Analog output DB-25 sensor port
Part Number*	1098297

* Meter supplied with two alkaline 9V batteries, power cord, AC power adapter, RCA-to-BNC analog output adapter, and certificate of calibration.

LaserCheck

Laser Power Meter

Features

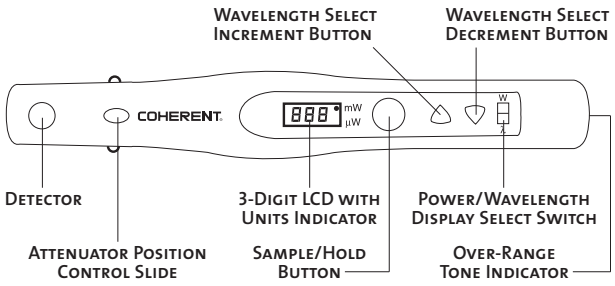
- Hand-held laser power meter
- Wavelength range: 400 nm to 1064 nm
- User-selectable spectral compensation
- Auto-ranging with peak sample and hold
- For CW and >1 MHz lasers

Device Specifications

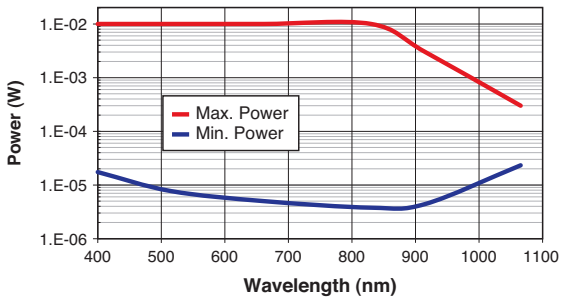
Model	LaserCheck
Active Area Diameter (mm)	8
Spectral Range (nm)	400 to 1064
Accuracy (%)	±5
Measurement Range[1]	
without Attenuator	10 µW to 10 mW
with Attenuator	1 mW to 1W
Display Power Ranges	9.99 µW to 999 mW
Calibration Uncertainty (%)(k=2)	5
Minimum Power Resolution (µW)	0.01
Maximum Peak Power Density	
without Attenuator	0.5 W/cm²
with Attenuator	30 W/cm²
Display	3-digit LCD display with power unit indicator
Compliance	CE, WEEE, RoHS
Dimensions (H x W x D)	168 x 24 x 20 mm (6.6 x 0.9 x 0.7 in.)
Weight	44 g (0.09 lbs.)
Part Number (RoHS)	1098293

[1] Power range is wavelength dependent. See charts below. Ensure peak power density does not exceed limits to avoid localized diode saturation.

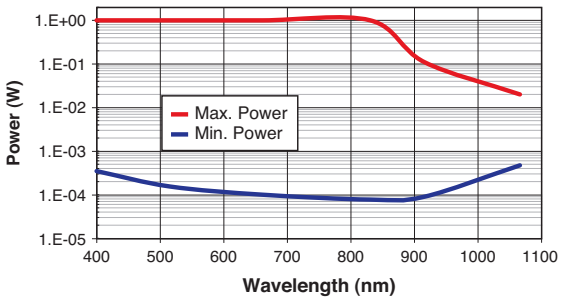
LaserCheck



Measurable Power vs. Wavelength
LaserCheck without Attenuator



Measurable Power vs. Wavelength
LaserCheck with Attenuator



Meter Accessories

Power Supplies

Part Number	Description
1105427	12V External Power Supply for FieldMate, FieldMaxII, LabMax

Rechargeable Batteries

Part Number	Description
1092395	7.2V 750 mAh NiMH Rechargeable Battery Pack for FieldMaxII
1110945	7.4V 5100 mAh Li-ion Rechargeable Battery Pack for LabMax

Soft Carrying Case

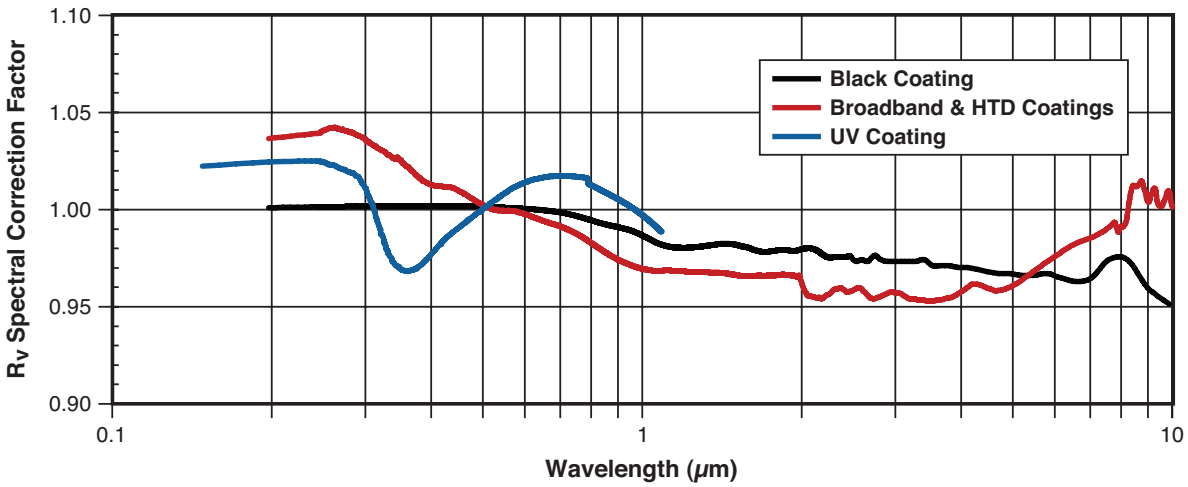
Part Number	Description
1212401	Soft Carrying Case for FieldMate
1122466	Soft Carrying Case for FieldMaxII, LabMax

Power Sensors Introduction

Introduction and Selection Charts

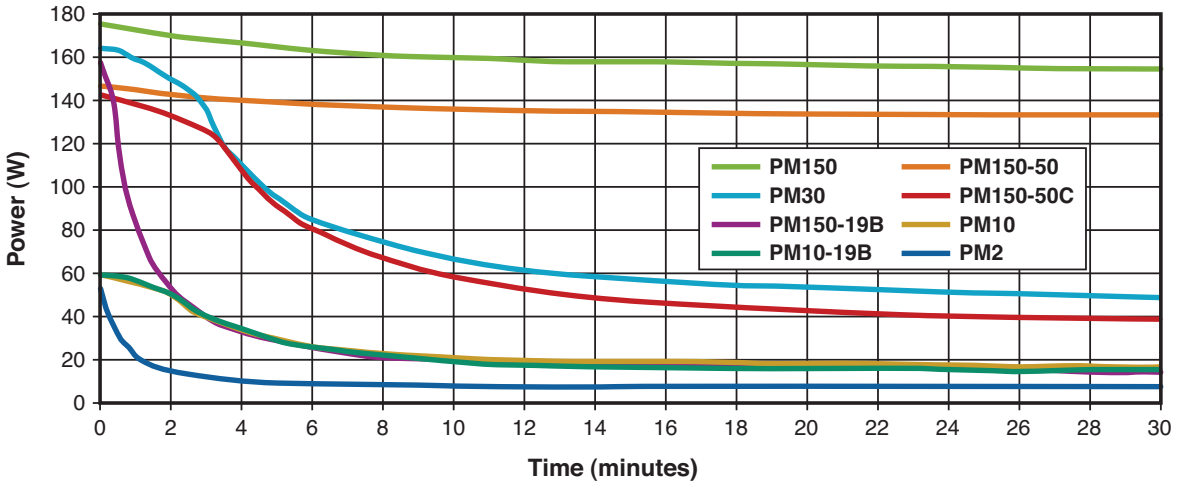
Coherent uses three primary coatings to capture the incident radiation on our thermal sensors. The specifications for each sensor list which coating is used. Typical wavelength ranges and response curves for these coatings are shown in the chart below. Each sensor contains a spectral curve generated from reflectance measurements taken with spectrometers. The reflectance data are converted into a wavelength compensation look-up table that is loaded into the sensor. This data is accessed by selecting a wavelength of operation in the meters.

R_V Spectral Correction for Thermal Sensors (normalized to 514 nm)



Many of our thermal sensors can measure power at levels greater than the maximum power rating for limited amounts of time. The following chart outlines how much power can be measured over a range of exposure times (Note: Water-cooled sensors are power-rated in air-cooled mode in this chart).

Exposure Limit vs. Power



Power Sensors Introduction

Long-Pulse Energy Measurement with a Thermopile

Models PM10-19C, PM150-50C and PM150-50XC

Application Example 1

Laser Pulse Width	50 ms
Maximum Energy	10J
Solution	Choose a PM10

Application Example 2

Laser Pulse Width	300 ms
Maximum Energy	80J
Solution	Choose a PM150 or PM150-50C*

* Specific sensor choice depends upon aperture and mechanical constraints.

Thermopile sensors are most commonly used for average power measurements on pulsed and CW lasers. Thermopiles are also capable of integrating long pulse widths. This allows the thermopile to measure the energy of single pulses between 1 millisecond and 10 seconds in length, and with energies from millijoules to hundreds of Joules. Long-pulse measurement is only possible when the thermopiles are used in conjunction with LabMax-TOP, LabMax-TO, or FieldMaxII-TOP meters, or when using a PowerMax-USB/RS sensor.

This ability to integrate relatively long laser pulses with a thermopile is necessary when the laser pulse width exceeds the maximum pulse width rating of pyroelectric sensors. Pyroelectric sensors are typically limited to maximum pulse widths in the millisecond range. When the pulse width exceeds milliseconds, a thermopile is a good solution.

A good "rule of thumb" for using a thermopile for this type of measurement is to compare the maximum pulse energy you need to measure with the maximum power rating of a sensor (maximum power ratings can be found in the Power Sensor Summary Specifications on pages 35 to 36 or in the detailed product specifications contained on each product page).

Common applications for this type of measurement are in the medical field, especially skin resurfacing and hair removal, and in material processing applications such as laser welding. These laser systems often utilize high-energy diode lasers that have large beam sizes and relatively long pulses. A detector like the PM150-50C is ideal for these measurements. It features a large 50 mm aperture size, can handle pulse energies up to 150J, and can be used air-cooled for single pulse energy measurements (a PM150-50C will normally need to be water-cooled for continuous power measurements).

Using a LabMax power/energy meter, or a PowerMax-USB/RS sensor, expands the range of long-pulse Joule measurements down into the low millijoule level when used with thermopiles such as the PS10, PS10Q, PS19, and PS19Q sensors.

Long-pulse measurements are limited to single pulses in order to achieve the most accurate measurements.

PowerMax-USB/RS Sensors

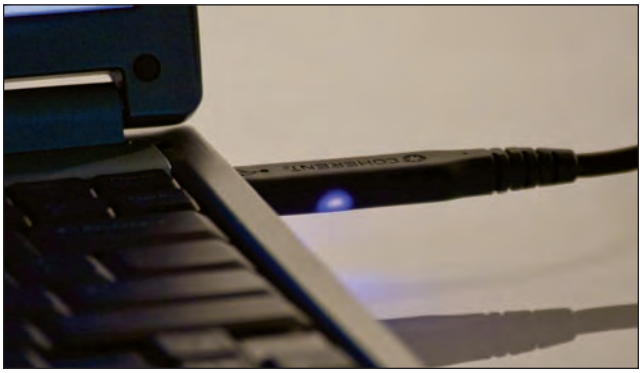
Product Overview

Models LM-45, LM-10 and LM-3

Coherent PowerMax-USB sensors provide plug and play laser power measurement directly on a PC without the need for additional electronic instrumentation. The measurement circuitry typically found in a standalone meter has been reduced in size to the extent that it can now fit inside a USB connector. The circuitry and USB connector have been adapted into a 'PowerMax-USB' cable that can be integrated to most Coherent power sensors providing accurate power measurements of all types of CW and pulsed sources from the UV to Far IR.

This measurement platform can also be used to measure the energy in a long laser pulse (typically greater than 1 millisecond in pulse width) by integrating the output of a thermopile sensor.

The PowerMax-RS sensors incorporate the same circuitry inside an RS-232 connector to provide a convenient platform for integrating power measurement inside laser processing systems that often incorporate RS-232 inputs instead of USB.



PowerMax-USB Connector

Features

- **PowerMax-USB provides direct USB 2.0 connection to PC. Power provided via USB connection. Software and driver is compatible with Microsoft XP, Vista (32-bit and 64-bit), and Windows 7 (32-bit and 64-bit). The driver is qualified and signed by Microsoft.**
- **PowerMax-RS provides RS-232 connectivity. Power input provided via +5 VDC input.**
- **Instrumentation platform is compatible with thermopiles and optical sensors**
- **Displays beam position with position-sensing quadrant thermopiles (with LM-model sensors like LM-10)**
- **High resolution 24-bit A/D converter supports measurement accuracy equivalent to that found in Coherent's top-of-the-line LabMax meter**
- **Four digits of measurement resolution**
- **Sensors include spectral compensation for accurate use at wavelengths that differ from the calibration wavelength. Each device receives a unique spectral compensation curve specific to the absorption of its specific element, as well as transmission characterization of any associated optics.**
- **Thermopile sensors include a speed-up algorithm that speeds up the natural response of the thermopile detector without overshoot**
- **LED status indicators inside USB and RS-232 connectors provide health-and-status information**
- **Long pulse joules capability using thermopile sensors**

PowerMax-USB/RS Sensors

Product Overview

Software Features

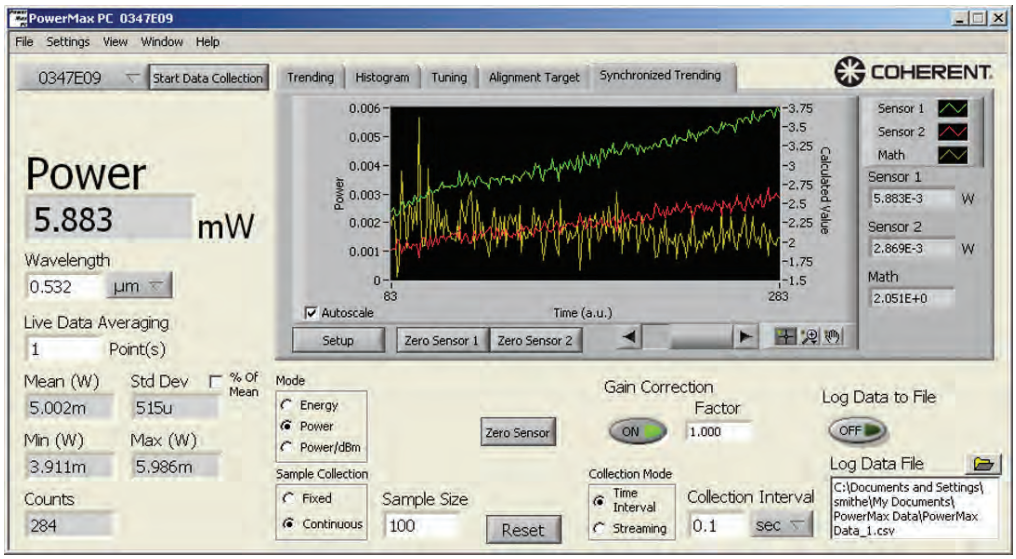
PowerMax PC applications software is supplied free with sensor and includes the following features:

- **Trending, tuning, histogram**
- **Statistics (mean, minimum, maximum, and standard deviation) and log batch to file**
- **Display beam position on position-sensing thermopiles and log results to file**
- **Operate multiple devices simultaneously and perform synchronized ratiometery (A/B analysis). Trend and log results to file.**

PowerMax PC operating with multiple sensors

For system integration and for implementations involving customer written software the sensors provide an in depth command set that is easy to access:

- **DLL driver supports simple ASCII host commands for remote interfacing using both USB and RS-232 sensors**
- **National Instruments LabVIEW drivers are supplied for easy LabVIEW integration**



PowerMax PC in synchronized ratiometric trending mode

Coherent has two main types of thermopile sensors. The "LM Model" line utilizes a unique thermopile disk in which the thermocouples are split into four quadrants, allowing the sensors to provide beam position information in addition to power measurement. The "PM Model" line incorporates traditional thermopile disks that provide power measurement without beam position information. Both types of sensors can be used with the PowerMax-USB and PowerMax-RS sensors.

Quad Positioning Enabled

PowerMax-USB/RS Sensors

Applying Wavelength Compensation Accuracy

Overall measurement accuracy is a combination of calibration uncertainty (found in the sensor specification tables) and the wavelength compensation accuracy (found in the "Wavelength Compensation Accuracy" table, below).

The combined accuracy is based upon practices outlined in the National Institute of Standards Guidelines for Evaluating and Expressing Uncertainty (NIST Technical Note 1297, 1994 Edition). The combined accuracy of the measurement is calculated by using the law of propagation of uncertainty using the "root-sum-of-square" (square root of the sum of squares), sometimes described as "summing in quadrature" where:

$$\text{Measurement Accuracy} = \sqrt{U^2 + W^2}$$

where U = 'Percent Calibration Uncertainty' and W = 'Wavelength Accuracy'

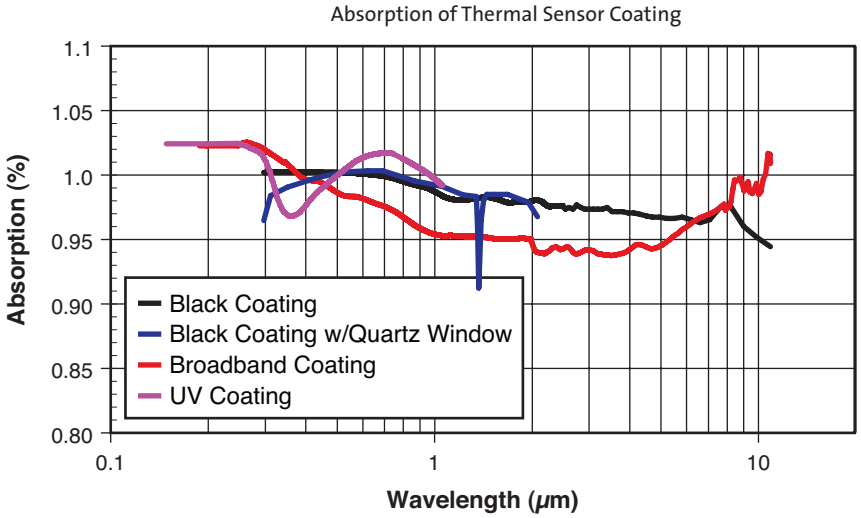
Example:

PowerMax-USB LM-10 used at 1064 nm

U = 2%
W = 1.5%

$$\text{Measurement Accuracy} = \sqrt{2^2 + 1.5^2} = \sqrt{4 + 2.3} = 2.5\%$$

Coherent uses three primary coatings to capture the incident radiation on our thermal sensors. The specifications for each sensor list which coating is used. Typical wavelength ranges and response curves for these coatings are shown in the chart below. Each sensor contains a spectral curve generated from reflectance measurements taken with spectrometers. The reflectance data are converted into a wavelength compensation look-up table that is loaded into the sensor. This data is accessed by selecting a wavelength of operation in the software.



Wavelength Compensation Accuracy

Sensor	Wavelength Compensation Accuracy (%)	Calibration Wavelength (nm)
All PM-model and LM-model thermopiles	±1.5	10,600
PS-model	±1.5	514
UV/VIS optical sensor	±4% (325 nm to 900 nm) ±5% (900 nm to 1065 nm)	514

PowerMax-USB/RS Sensors

100 µW to 1W

Models PS10, PS19Q, PM3

Features

- **Thermally stabilized design for low power sensitivity**
- **Noise equivalent power down to 3 µW**
- **Spectrally flat; good for broadband light sources**

The PS10 and PS19 model sensors are thermally stabilized, amplified thermopile power sensors with a broad spectral response, high sensitivity, and a large active area. These sensors are ideal for measuring laser diodes, HeNe and HeCd lasers, and small ion lasers. The PS10 model includes a light tube mounted to the front of the housing, which minimizes the effects of background radiation. The light tube can be removed and replaced by FC or SMA fiber connectors (see Accessories - page 34). Where optimum stability is required, specify the PS19Q, which include a wedged quartz window for applications from 0.3 to 2.1 µm. The quartz window more effectively eliminates thermal background radiation and the effects of air currents.

Device Specifications

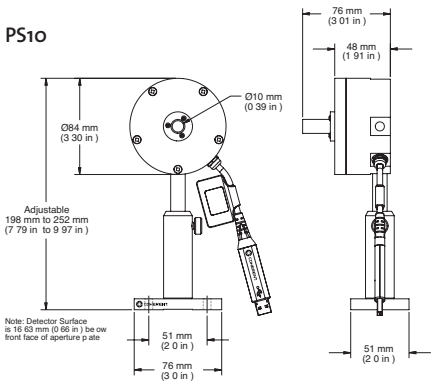
Model	PS10	PS19Q	PS19
Wavelength Range (nm)	190[3] to 11,000	300 to 2100	190[3] to 11,000
Power Range	100 µW to 1W	100 µW to 1W	100 µW to 1W
Max. Intermittent Power (W)(<5 min.)		3	
Long-pulse Joules (J)		0.001 to 1	
Noise Equivalent Power (µW)	3	3	5
Maximum Thermal Drift[1] (µW)	±40	±25	±400
Maximum Power Density (W/cm²)		500	
Maximum Energy Density (mJ/cm²)		50 (10 ns, 1064 nm)	
Response Time (sec.)(0% to 95%)			
Speed-up On	2	2	2
Speed-up Off	3	3	3
Detector Coating		Black	
Detector Element		Thermopile	
Optic	None	Quartz	None
Detector Diameter (mm)	10	19	19
Calibration Uncertainty (%)(k=2)		±1	
Power Linearity (%)		±1	
Spectral Compensation Accuracy (%)		±1.5	
Long-pulse Joules Accuracy (%)		±3	
Calibration Wavelength (nm)	514	514	514
Cooling Method		Air	
Cable Type		USB and RS	
Cable Length (m)		2.5 (USB)/0.3 (RS)	
Part Number[2]	1174260 (USB)	1168343 (USB) 1179504 (RS)	1174261 (USB)

[1] Power stability over 30 minutes in typical lab environment.

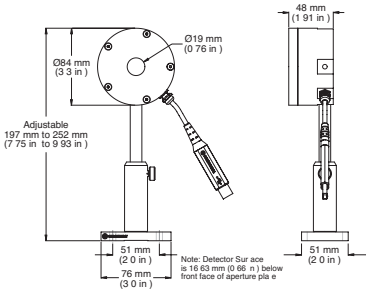
[2] Software and post stand included.

[3] 190 nm to 300 nm operation restricted to <100 mW average power and <250 W/cm² power density.

PS10



PS19Q/PS19



PowerMax-USB/RS Sensors

500 µW to 2W

Models PM3, PM3Q

Features

- **Amplified thermopile for low power measurements**
- **Noise equivalent power down to 20 µW**
- **Spectrally flat; good for broadband light sources**

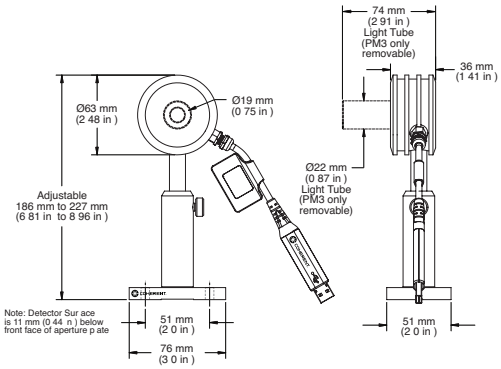
The PM3 model is an amplified thermopile with a high sensitivity and a very broad spectral response. This model has a slightly higher power range and a more compact housing than the PS10 and PS19 model sensors. For improved stability, the PM3Q adds a quartz window to help reduce the effects of background radiation and air currents.

Device Specifications

Model	PM3	PM3Q
Wavelength Range (nm)	190[3] to 11,000	300 to 2000
Power Range	500 µW to 2W	
Max. Intermittent Power (W)(<5 min.)	3	
Long-pulse Joules (J)	0.001 to 1	
Noise Equivalent Power (µW)	20	
Maximum Thermal Drift[1] (µW)	±1000	±500
Maximum Power Density (W/cm²)	500	
Maximum Energy Density (mJ/cm²)	50 (10 ns, 1064 nm)	
Response Time (sec.)(0% to 95%)		
Speed-up On	2	
Speed-up Off	4	
Detector Coating	Black	
Detector Element	Thermopile	
Optic	None	Quartz
Detector Diameter (mm)	19	10
Calibration Uncertainty (%)(k=2)	±1	
Power Linearity (%)	±1	
Spectral Compensation Accuracy (%)	±1.5	
Long-pulse Joules Accuracy (%)	±3	
Calibration Wavelength (nm)	10,600	514
Cooling Method	Air	
Cable Type	USB	
Cable Length (m)	2.5	
Part Number[2]	1174263 (USB)	1191133 (USB)

[1] Power stability over 30 minutes in typical lab environment.
[2] Software and post stand included.
[3] 190 nm to 300 nm operation restricted to <100 mW average power and <250 W/cm² power density.

PM3



PowerMax-USB/RS Sensors

5 µW to >100 mW

Models UV/VIS Wand, UV/VIS Sensor

Features

- **Large 8 mm and 10 mm apertures**
- **High-sensitivity Silicon photodiode**
- **Low power measurements down to 5 µW (wavelength dependent)**
- **Spectral response from 325 nm to 1065 nm**

The PowerMax-USB UV/VIS Quantum sensors incorporate a Silicon photodiode, for measurement of power from 5 µW to several hundred milliwatts. The measureable power varies significantly by wavelength. See the chart on the next page.

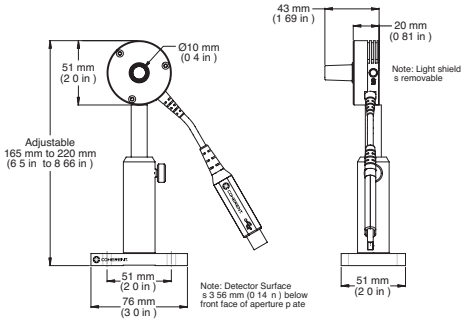
Spectrally calibrated filters are used to attenuate the laser beam, thus allowing for a higher average power measurement than is typically possible with a photodiode. They work with CW (continuous wave) as well as pulsed sources greater than 100 pps. The standard UV/VIS has a removable nose cone that can be used to reduce stray light, which is helpful when measuring on the low end of the power range, and the Wand UV/VIS incorporates a thin profile to fit into tight locations. See page 34 for Wand sensor fiber adapters.

Device Specifications

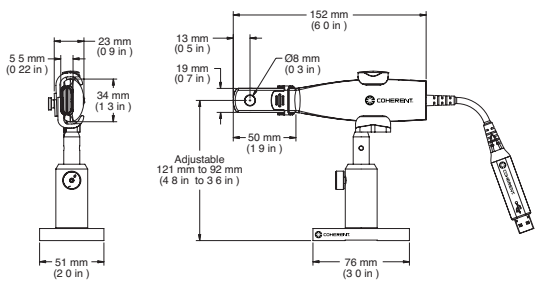
Model	UV/VIS	Wand UV/VIS
Wavelength Range (nm)	325 to 1065	
Power Range[1]	5 µW to >100 mW	8.5 µW to >140 mW
Noise Equivalent Power (nW)	100	170
Maximum Power Density (W/cm²)	20	
Response Time (sec.)		
Speed-up On	-	
Speed-up Off (0% to 100%)	0.1	0.5
Detector Element	Silicon photodiode	
Optic	ND2	Diffuse Quartz
Detector Diameter (mm)	10	8
Calibration Uncertainty (%)(k=2)	±1	
Power Linearity (%)	±1	
Spectral Compensation Accuracy (%)	±4 (325 to 900 nm) ±5 (900 to 1065 nm)	
Calibration Wavelength (nm)	514	
Cooling Method	Air	
Cable Type	USB	
Cable Length (m)	2.5	
Part Number[2]	1168337	1212310

[1] Wavelength dependent, see chart on next page.
[2] Software and post stand included.

UV/VIS Quantum



Wand UV/VIS Quantum



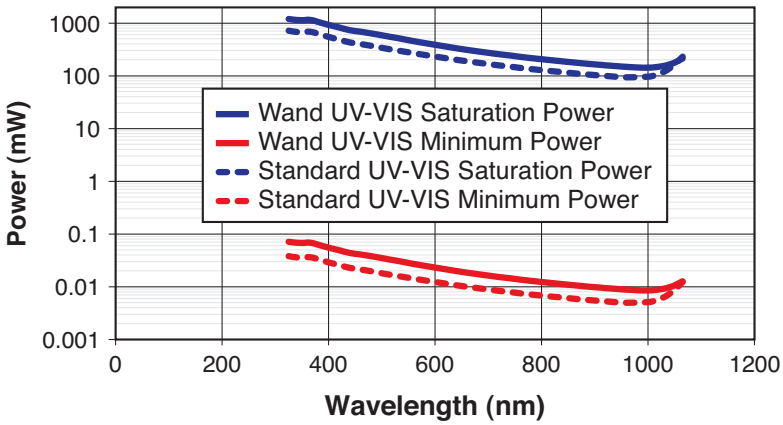
PowerMax-USB/RS Sensors

UV/VIS Quantum Overview

We incorporate spectral compensation in the PowerMax-USB UV/VIS sensors to provide accurate measurements across the 325 nm to 1065 nm spectrum. Because the spectral response of the filter and photodiode varies significantly across this wavelength range it is important to check the maximum measureable power at the wavelength of use to make sure the sensor is not being saturated.

This curve plots the maximum measurable power, which is the saturation level of the photodiode, as well as the minimum recommended power level, by wavelength.

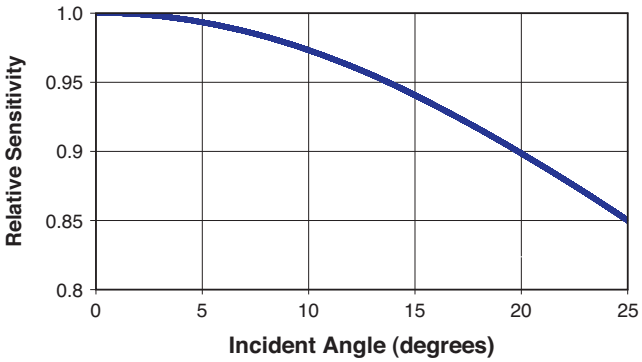
Saturation and Minimum Power
UV/VIS Sensors Over Wavelength



Angular Sensitivity

The following curves plot the sensitivity to incident angle, and numerical aperture in the case of non-collimated beams.

Angular Dependence



Numerical Ape ture Dependence

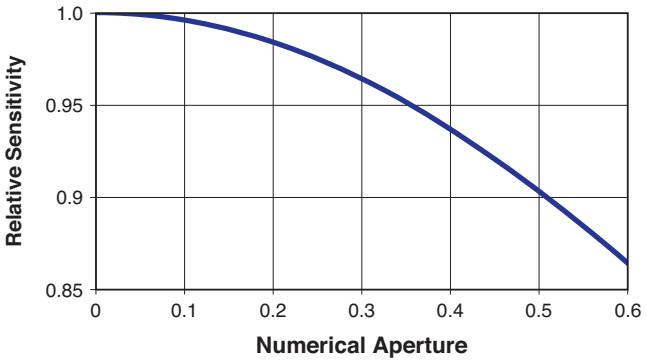
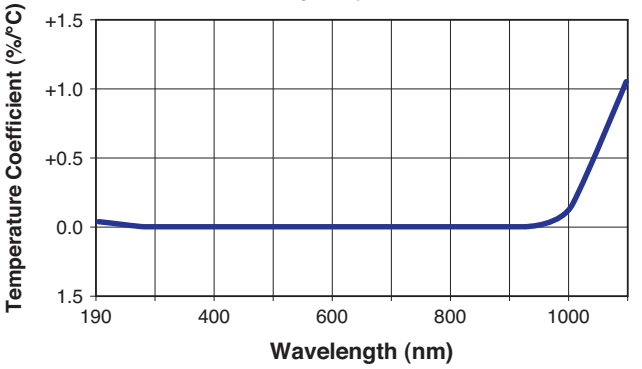


Photo Sensitivity Temperature Characteristic



Measurement Linearity

Like all silicon photodiodes, the UV/VIS Quantum sensor has temperature sensitivity in the infrared region.

At 1064 nm, for example, it has a 0.5%/°C thermal coefficient. Measurement error of up to 2% are present at 1064 nm after a 10 minute warm-up time due to the electronics inside the sensor, and additional error can be present if the ambient measurement environment differs from the calibration wavelength listed on the calibration certificate.

In practice, wavelengths shorter than 1000 nm have insignificant effects due to temperature.

See the chart at left to reference the thermal coefficient at the wavelength of use.

PowerMax-USB/RS Sensors

10 mW to 25W

Models LM-45, LM-10, LM-3

Features

- **Thermopile detector element for high power measurements**
- **Measures beam position on detector surface**
- **Noise equivalent power down to 0.4 mW**
- **Large 16 mm and 19 mm apertures**

Quad Positioning Enabled

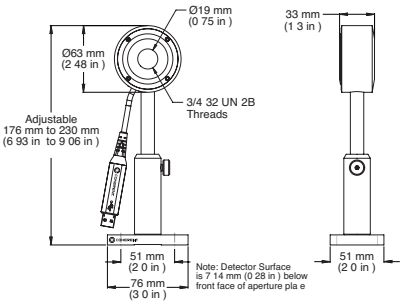
Thermopile sensors are a great all-purpose technology suitable for many lasers. They are used for measuring CW laser power, average power in pulsed lasers, and are often used to integrate the energy of long pulses. Thermopiles operate across a wide range of input powers, and unlike a photodiode-based sensor they will not saturate. These unique thermopiles incorporate a quadrant thermopile detector disk that enables them to sense the position of the laser beam on the detector surface while measuring the laser power. Fiber optic adapters are available on page 34.

Device Specifications

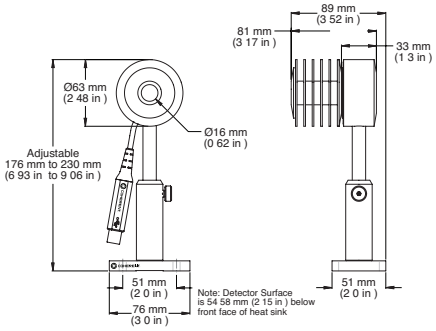
Model	LM-3	LM-10	LM-45
Wavelength Range (µm)		0.25 to 10.6	
Power Range	10 mW to 3W	10 mW to 10W	100 mW to 25W
Max. Intermittent Power (W)(<5 min.)	10	12	45
Long-Pulse Joules (J)	0.5 to 10	0.5 to 10	0.5 to 50
Noise Equivalent Power (mW)	0.4	0.4	2
Maximum Power Density (kW/cm²)		6	
Maximum Energy Density (mJ/cm²)		600 (10 ns, 1064 nm)	
Response Time (sec.)(0% to 95%)			
Speed-up On	2	2	3
Speed-up Off	4	4	4
Detector Coating		Broadband	
Detector Element		Thermopile	
Optic		None	
Detector Diameter (mm)	19	16	19
Calibration Uncertainty (%)(k=2)		±2	
Power Linearity (%)		±1	
Spectral Compensation Accuracy (%)		±1.5	
Long-Pulse Joules Accuracy (%)		±3	
Calibration Wavelength (nm)		10,600	
Cooling Method		Air	
Cable Type		USB and RS	
Cable Length (m)		2.5 (USB)/0.3 (RS)	
Part Number[1]	1168339 (USB)	1168340 (USB) 1168341 (RS)	1168342 (USB) 1211474 (RS)

[1] Software and post stand included.

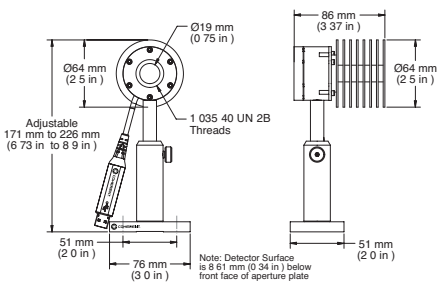
LM-3



LM-10



LM-45



PowerMax-USB/RS Sensors

100 mW to 200W

Models LM-20, LM-100, LM-200

Features

- Spectrally flat from 0.25 µm to 10.6 µm
- 19 mm apertures
- FC and SMA fiber connectors available for LM-200 (see page 34)

Quad Positioning Enabled

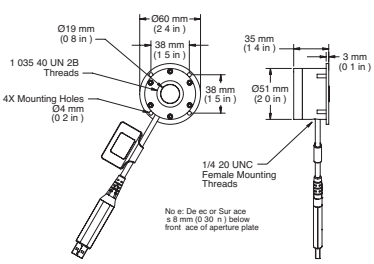
The LM-20 is designed for embedded use and must be mounted on a heat sink. The LM-200 is fan-cooled and is available in 110 VAC and 220 VAC configurations.

Device Specifications

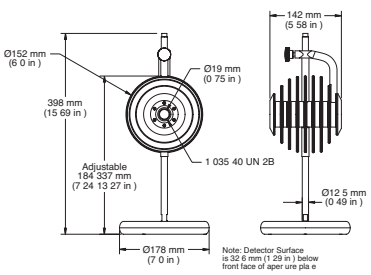
Model	LM-20	LM-100	LM-200
Wavelength Range (µm)		0.25 to 10.6	
Power Range	100 mW to 20W	100 mW to 100W	100 mW to 50W (w/o fan) 1W to 200W (with fan)
Long-Pulse Joules (J)		0.5 to 10	
Noise Equivalent Power (mW)	3	5	5 (w/o fan) 100 (with fan)
Maximum Power Density (kW/cm²)		6	
Maximum Energy Density (J/cm²)		0.5 (10 ns, 1064 nm)	
Detector Coating		Broadband	
Detector Element		Thermopile	
Optic		None	
Detector Diameter (mm)		19	
Calibration Uncertainty (%)(k=2)	±2	±2	±5
Power Linearity (%)		±1	
Spectral Compensation Accuracy (%)		±1.5	
Long-Pulse Joules Accuracy (%)		±3	
Calibration Wavelength (nm)		10,600	
Cooling Method	Air	Air	Fan
Cable Type		USB	
Cable Length (m)		2.5	
Part Number[1]	1174270	1193300	1193407 (110V) 1195840 (220V)

[1] Software and post stand included.

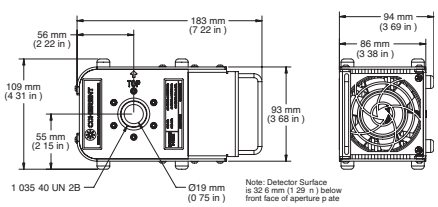
LM-20



LM-100



LM-200



PowerMax-USB/RS Sensors

50W to 3 kW

Models PM3K, PM1K-36C

Features

- **Water-cooled**
- **Spectrally flat from 0.25 µm to 10.6 µm**
- **36 mm to 50 mm apertures**

These kilowatt thermopile sensors are water-cooled for measuring laser output up to 3 kW and are excellent for use with CO_2 and Nd:YAG lasers.

Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details). See page 34 for RS model power supply accessory.

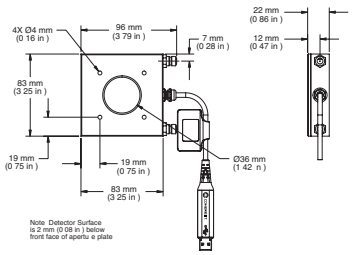
Device Specifications

Model	PM1K-36C	PM3K
Wavelength Range (µm)	0.25 to 10.6	
Power Range (W)	50 to 1000	50 to 3000
Noise Equivalent Power (mW)	20	
Maximum Power Density[1] (kW/cm²)	1 to 2.5	
Maximum Energy Density (mJ/cm²)	500	
Response Time (sec.)(0% to 95%)		
Speed-up On	4	
Speed-up Off	6	
Detector Coating	Broadband	
Detector Element	Thermopile	
Detector Diameter (mm)	36	50
Calibration Uncertainty (%)(k=2)	±5	
Power Linearity (%)	±1	
Spectral Compensation Accuracy (%)	±1.5	
Calibration Wavelength (nm)	10,600	
Cooling Method	Water	
Cable Type	USB and RS	
Cable Length (m)	2.5 (USB)/0.3 (RS)	
Part Number[2]	1174266 (USB) 1174267 (RS)	1191293 (RS)

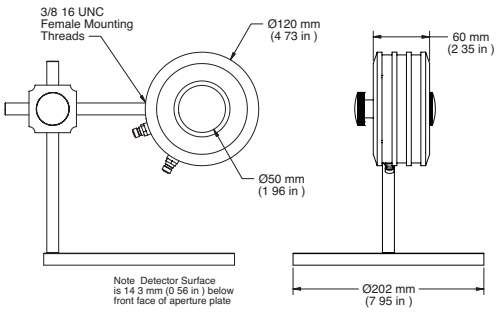
[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

[2] Software, water fittings and post stand included with LM-1000 and LM-5000.

PM1K-36C
USB



PM3K



POWER & ENERGY
Power & Energy Meters
USB/RS Power Sensors
DB-25 Power Sensors
USB/RS Energy Sensors
DB-25 Energy Sensors
Custom & OEM
BEAM DIAGNOSTICS
CALIBRATION & SERVICE
Laser Cross-Reference Index
Model Name Index

PowerMax-USB/RS Sensors

50W to 5 kW

Models LM-1000, BeamFinder

Features

- Water-cooled
- Spectrally flat from 0.25 µm to 10.6 µm
- 35 mm to 56 mm apertures

Quad Positioning Enabled

These position sensing kilowatt thermopile sensors are water-cooled for measuring laser output up to 3 kW and are excellent for use with CO_2 and Nd:YAG lasers.

Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details). See page 34 for RS model power supply accessory.

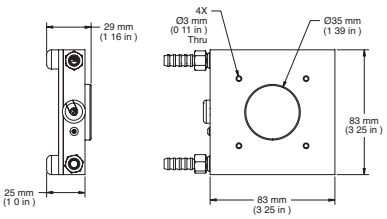
Device Specifications

Model	BeamFinder	LM-1000	LM-5000
Wavelength Range (µm)		0.25 to 10.6	
Power Range (W)	50 to 1000	50 to 1000	50 to 5000
Noise Equivalent Power (mW)		20	
Maximum Power Density[1] (kW/cm²)		1 to 2.5	
Maximum Energy Density (mJ/cm²)		500	
Response Time (sec.)(0% to 95%)			
Speed-up On		4	
Speed-up Off		6	
Detector Coating		Broadband	
Detector Element		Thermopile	
Detector Diameter (mm)	35	38	56
Calibration Uncertainty (%)(k=2)		±5	
Power Linearity (%)		±1	
Spectral Compensation Accuracy (%)		±1.5	
Calibration Wavelength (nm)		10,600	
Cooling Method		Water	
Cable Type		USB and RS	
Cable Length (m)		2.5 (USB)/0.3 (RS)	
Part Number[2]	1233118 (USB)	1174268 (USB) 1180872 (RS)	1174269 (USB) 1181653 (RS)

[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

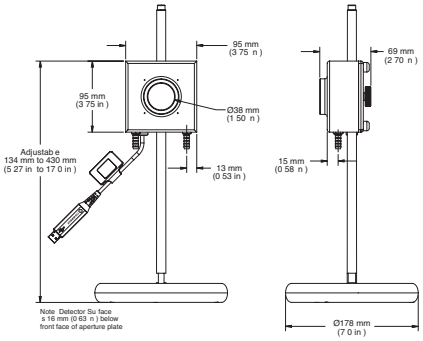
[2] Software, water fittings and post stand included with LM-1000 and LM-5000.

BeamFinder

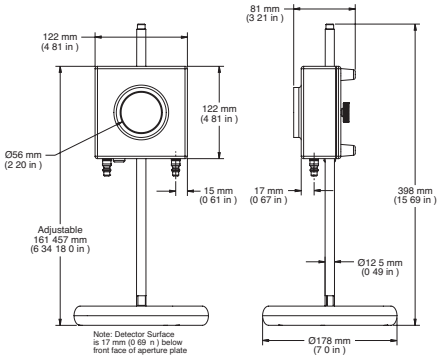


LM-1000

USB



LM-5000



PowerMax-USB/RS Sensors

5 mW to 30W

Models PM2, PM10, PM30

Features

- **Convective air-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **Noise equivalent power down to 0.2 mW**
- **19 mm aperture**

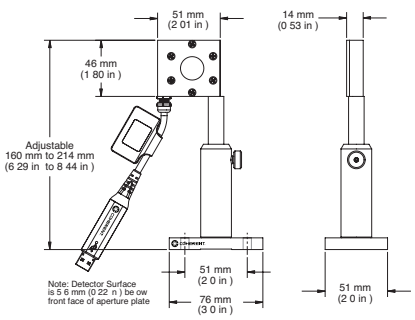
These thermopile sensors are used to measure CW and pulsed lasers from 5 mW up to 30W average power output. These sensors are able to dissipate heat via convection cooling, which makes them convenient to use.

Device Specifications

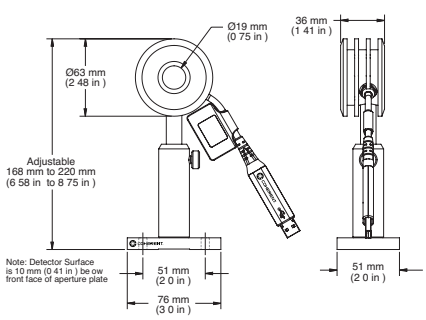
Model	PM2	PM10	PM30
Wavelength Range (µm)		0.19 to 11	
Power Range	5 mW to 2W	5 mW to 10W	10 mW to 30W
Long-Pulse Joules Range (J)	0.5 to 2	0.5 to 10	0.5 to 50
Max. Intermittent Power (<5 min.)(W)	5	30	50
Noise Equivalent Power (mW)	0.2	0.2	0.5
Maximum Power Density (kW/cm²)		6	
Maximum Energy Density (mJ/cm²)		600 (10 ns, 1064 nm)	
Response Time (sec.)(0% to 95%)			
Speed-up On	2	2	3
Speed-up Off	4	4	4
Detector Coating		Broadband	
Detector Element		Thermopile	
Optic		None	
Detector Diameter (mm)		19	
Calibration Uncertainty (%)(k=2)		±2	
Power Linearity (%)		±1	
Spectral Compensation Accuracy (%)		±1.5	
Long-Pulse Joules Accuracy (%)		±3	
Calibration Wavelength (nm)		10,600	
Cooling Method		Air	
Cable Type		USB and RS	
Cable Length (m)		2.5 (USB)/0.3 (RS)	
Part Number[1]	1174264 (USB)	1174262 (USB)	1174257 (USB) 1174258 (RS)

[1] Software and post stand included.

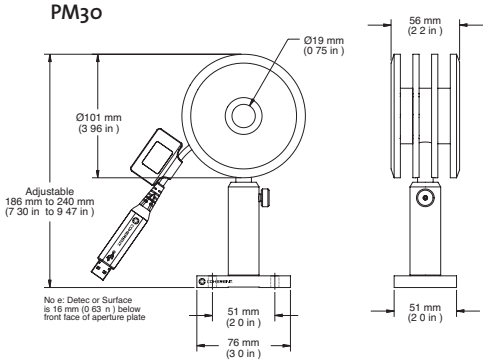
PM2



PM10



PM30



PowerMax-USB/RS Sensors

10 mW to 150W

Models PM10-19C, PM150-19C, PM150-50C, PM150-50

Features

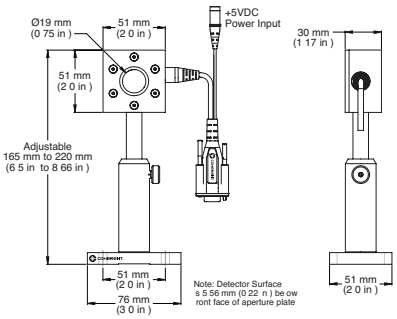
- Spectrally flat from 0.19 µm to 11 µm
- Noise equivalent 0.2 mW to 1 mW
- 19 mm and 50 mm apertures

The compact sensors must be water-cooled in order to achieve their full power specification during continuous operation. They can also be mounted to a heat sink or used standalone for intermittent use without water-cooling. Tap or distilled cooling water is recommended at a flow rate of 0.2 gallons per minute with these sensors – DI water can not be used. They are also very useful for air-cooled energy measurement of long-pulse (>1 ms) lasers using the long-pulsed Joules mode. See page 34 for RS model power supply accessory. Water fittings are included. For 150W air-cooled choose the PM150-50 sensor.

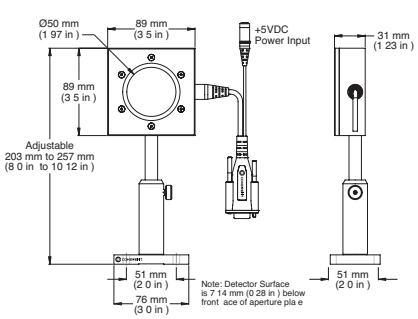
Device Specifications

Model	PM10-19C	PM150-19C	PM150-50C	PM150-50
Wavelength Range (µm)	0.19 to 11			
Power Range (water-cooled)	10 mW to 10W	300 mW to 150W	300 mW to 150W	300 mW to 150W
Max. Intermittent Power (W)(<5 min.)	5 (air-cooled)	20 (air-cooled)	80 (air-cooled)	300
Long-Pulse Joules (J)	0.5 to 10	1 to 150	1 to 150	1 to 150
Noise Equivalent Power (mW)	0.2	1	1	1
Maximum Power Density (kW/cm²)	6			
Maximum Energy Density (mJ/cm²)	600 (10 ns, 1064 nm)			
Response Time (sec.)(0% to 95%)				
Speed-up On	2	2	3	5
Speed-up Off	4	4	12	13
Detector Coating	Broadband			
Detector Element	Thermopile			
Optic	None			
Detector Diameter (mm)	19	19	50	50
Calibration Uncertainty (%)(k=2)	±2			
Power Linearity (%)	±1			
Spectral Compensation Accuracy (%)	±1.5			
Long-Pulse Joules Accuracy (%)	±3			
Calibration Wavelength (nm)	10,600			
Cooling Method	Water/Air (intermittent)			Air
Cable Type	USB and RS			
Cable Length (m)	2.5 (USB)/0.3 (RS)			
Part Number	1168344 (USB) 1168345 (RS)	1168346 (USB) 1168347 (RS)	1168348 (USB) 1168349 (RS)	1223336 (USB)

PM10-19C/PM150-19C
(shown with PowerMax-RS cable)

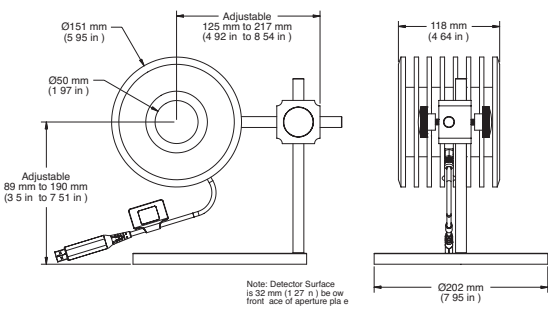


PM150-50C
(shown with PowerMax-RS cable)



PM150-50

USB



PowerMax-USB/RS Sensors

OEM Thermopiles Overview

Models PM150-50C, PM150-19C

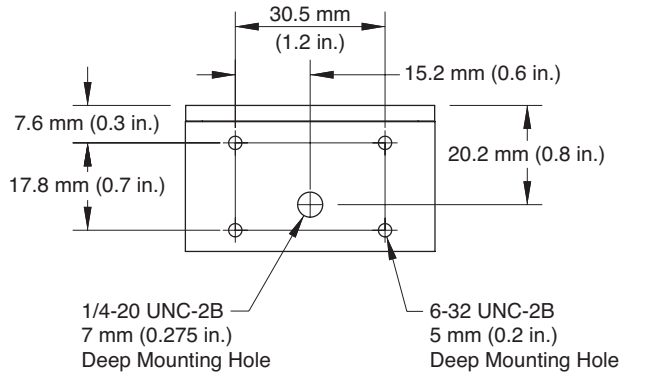
Unlike the PowerMax-USB that is powered through a PC's USB 2.0 connection, the PowerMax-RS sensors must powered externally with a +5 VDC power source. An external power supply may be plugged into the 6 mm barrel receptacle, or alternatively, for custom OEM installations power may be provided on Pin 1 through the DE-9 connector. Additional information concerning integration of the OEM thermopiles, including detailed housing drawings, can be found below.

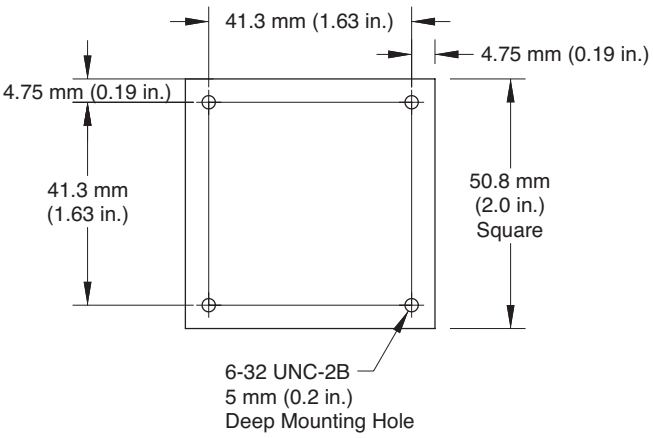
PowerMax-RS Information

PC Interface: RS-232
Connector: DE-9 female
Cable length: 300 mm. Use standard RS-232 cable to connect device to PC.
Communication: Pin 2 – Receive Data; Pin 3 – Transmit Data;
Pin 5 – Signal Ground
Required Power: +5 VDC ±5% with less than 100 mV RMS noise
Current draw: <300 mA
Power input connector: 6 mm barrel with 2 mm pin, center positive
Power supply: Optional equipment, order #1105557 for UL and
PSE certified power supply with power cord.
Alternate OEM power input: +5 VDC on Pin 1; Pin 5 – Ground
(shared with Signal Ground)

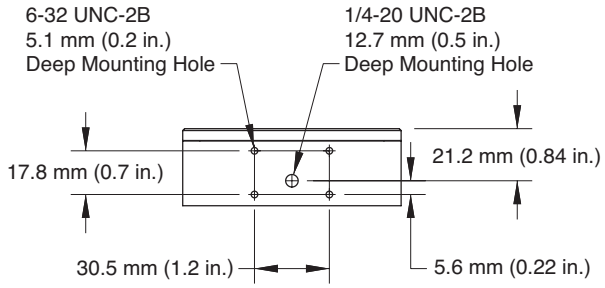
Mounting Hole Locations

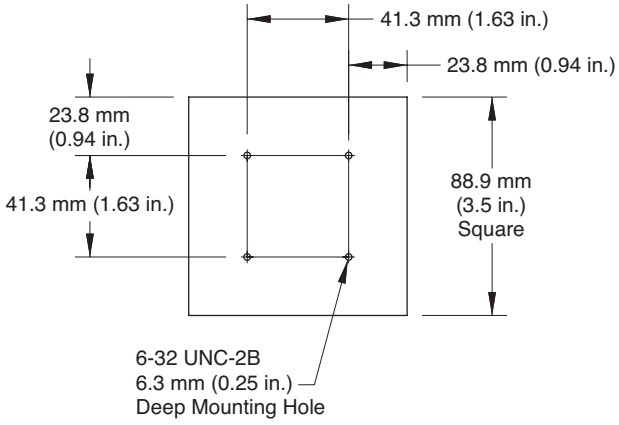
PM10-19C/PM150-19C





PM150-50C





PowerMax-USB/RS Sensor Accessories

Fiber-Optic Connector Adapters

SMA and FC Adapters

The following fiber-optic adapters can be mounted directly onto the 3/4-32 threads on the front of LM-3 and LM-10 sensors. These fiber adapters can also be used with our 1.035-40M adapter ring to fit on the LM-45, LM-20, and LM-200 sensors.

Part Number	Description	Sensors
1098589	SMA-Type Connector	LM-3, LM-10
1098339	FC/PC-Type Connector	LM-3, LM-10
33-9432-000	1.035-40M Adapter Ring	LM-45, LM-20, LM-100, LM-200

SMA and FC Adapters

The following fiber adapters can be mounted onto the front of the PS10 sensor in place of the removable light tube.

Part Number	Description	Sensors
0012-3860	PS-SMA-Type Connector	PS10
0012-3863	PS-FC-Type Connector	PS10

PowerMax-RS Sensor Power Supply

Part Number	Description
1105557	5V External Power Supply

PowerMax-USB Wand UV/VIS Adapters

Part Number	Description
1211488	Collimating Adapter
1211489	FC Fiber Adapter
1220619	FC-APC Fiber Adapter
1220621	SMA Fiber Adapter
1220622	7 mm Aperture

Power Sensors Specifications

Summary of Specifications

Part Number	Description	Wavelength Range (µm)	Power Min.	Power Max.	Power Resolution	Long-Pulse Energy Range (J)	Detector Diameter (mm)	Detector Coating	Detector Type	Calibration Wavelength (nm)	Calibration Uncertainty (±%) (k=2)	Connector
High-Sensitivity Semiconductor Sensors (to 50 mW)												
1098401	OP-2 UV	0.25 to 0.4	10 nW	30 mW	1 nW	–	6.0	–	Silicon	–	8	OP DB-25
1098313	OP-2 VIS	0.4 to 1.064	10 nW	30 mW	1 nW	–	7.9	–	Silicon	–	5	OP DB-25
1098416	OP-2 IR	0.8 to 1.8	10 nW	10 mW	1 nW	–	5.0	–	Germanium	–	4.5	OP DB-25
1098390	LM-2 UV	0.25 to 0.4	10 nW	30 mW	1 nW	–	6.0	–	Silicon	–	8	LM DB-25
1098298	LM-2 VIS	0.4 to 1.064	10 nW	30 mW	1 nW	–	7.9	–	Silicon	–	5	LM DB-25
1098342	LM-2 IR	0.8 to 1.55	10 nW	10 mW	1 nW	–	5.0	–	Germanium	–	4.5	LM DB-25
High-Sensitivity Thermopile Sensors (to 2W)												
1098350	PS10	0.19 to 11.0	100 µW	1W	10 µW	0.001 to 1	10	Black	–	514	1	PM DB-25
1098400	PS10Q	0.3 to 2.0	100 µW	1W	10 µW	0.001 to 1	10	Black	–	514	1	PM DB-25
1098413	PS19	0.19 to 11.0	100 µW	1W	10 µW	0.001 to 1	19	Black	–	514	1	PM DB-25
1098341	PS19Q	0.3 to 2.0	100 µW	1W	10 µW	0.001 to 1	19	Black	–	514	1	PM DB-25
1098336	PM3	0.19 to 11.0	500 µW	2W	50 µW	–	19	Black	–	514	1	PM DB-25
1098419	PM3Q	0.3 to 2.0	500 µW	2W	50 µW	–	10	Black	–	514	1	PM DB-25
Air-Cooled Thermopile Sensors (to 150W)												
1098329	PM2	0.25 to 11.0	10 mW	2W	1 mW	0.5 to 2	19	Broadband	–	514	1	PM DB-25
1098457	PM2X	0.15 to 1.0	10 mW	2W	1 mW	0.5 to 2	19	UV	–	514	1	PM DB-25
1097901	PM10	0.25 to 11.0	10 mW	10W	1 mW	0.5 to 10	19	Broadband	–	514	1	PM DB-25
1098423	PM10X	0.15 to 1.0	10 mW	10W	1 mW	0.5 to 10	19	UV	–	514	1	PM DB-25
1098314	PM30	0.25 to 11.0	100 mW	30W	10 mW	0.5 to 50	19	Broadband	–	514	1	PM DB-25
1098498	PM30X	0.15 to 1.0	100 mW	30W	10 mW	0.5 to 50	19	UV	–	514	1	PM DB-25
1098483	PM100-19C	0.25 to 11.0	300 mW	100W	30 mW	1 to 100	19	Broadband	–	514	1	PM DB-25
1098407	PM150	0.25 to 11.0	300 mW	150W	30 mW	1 to 150	19	Broadband	–	514	1	PM DB-25
1098398	PM150-50	0.25 to 11.0	300 mW	150W	30 mW	1 to 150	50	Broadband	–	514	1	PM DB-25
1098455	PM150X	0.15 to 1.0	300 mW	150W	30 mW	1 to 150	50	UV	–	514	1	PM DB-25
Water-Cooled Thermopile Sensors (to 300W)												
1098397	PM10-19C	0.25 to 11.0	10 mW	10W	1 mW	0.5 to 10	19	Broadband	–	514	1	PM DB-25
1098444	PM150-19C	0.25 to 11.0	300 mW	150W	30 mW	1 to 150	19	Broadband	–	514	1	PM DB-25
1098412	PM150-50C	0.25 to 11.0	300 mW	150W	30 mW	1 to 150	50	Broadband	–	514	1	PM DB-25
1098443	PM150-50XC	0.15 to 1.0	300 mW	150W	30 mW	1 to 150	50	UV	–	514	1	PM DB-25
1141474	PM300	0.25 to 11.0	1W	300W	0.1W	–	19	Broadband	–	514	1	PM DB-25
Fan-Cooled Thermopile Sensors (to 300W)												
1098480	PM200F-19	0.25 to 11.0	1W	200W	100 mW	1 to 200	19	Broadband	–	514	1	PM DB-25
1098472	PM200F-50	0.25 to 11.0	1W	200W	100 mW	1 to 200	50	Broadband	–	514	1	PM DB-25
1113493	PM200F-50X	0.15 to 1.0	1W	200W	100 mW	1 to 200	50	UV	–	514	1	PM DB-25
1098509	PM300F-19	0.25 to 11.0	1W	300W	100 mW	1 to 300	19	Broadband	–	514	1	PM DB-25
1098417	PM300F-50	0.25 to 11.0	1W	300W	100 mW	1 to 300	50	Broadband	–	514	1	PM DB-25
1098481	PM300F-50X	0.15 to 1.0	1W	300W	100 mW	1 to 300	50	UV	–	514	1	PM DB-25

Power Sensors Specifications

Summary of Specifications

Part Number	Description	Wavelength Range (µm)	Power Min.	Power Max.	Power Resolution	Long-Pulse Energy Range (J)	Detector Diameter (mm)	Detector Coating	Calibration Wavelength (nm)	Calibration Uncertainty (±%)(k=2)	Connector
High-Power Water-Cooled Thermopile Sensors (to 5 kW)											
1098392	PM1K	0.25 to 11.0	100W	1000W	1W	–	50	Broadband	1064	3	PM DB-25
1098462	PM3K	0.25 to 11.0	100W	3000W	1W	–	50	Broadband	1064	3	PM DB-25
1098454	PM5K	0.25 to 11.0	100W	5000W	1W	–	50	Broadband	1064	3	PM DB-25
Large-Area High-Power Water-Cooled Thermopile Sensors (to 5 kW)											
1098490	PM1K-100	0.25 to 11.0	100W	1000W	1W	–	100	Broadband	1064	3	PM DB-25
1098506	PM3K-100	0.25 to 11.0	100W	3000W	1W	–	100	Broadband	1064	3	PM DB-25
1098461	PM5K-100	0.25 to 11.0	100W	5000W	1W	–	100	Broadband	1064	3	PM DB-25
1098505	PM5K-200	0.25 to 11.0	100W	5000W	1W	–	200	Broadband	1064	3	PM DB-25
Position-Sensing Air-Cooled Thermopile Sensors (to 200W)											
1098328	LM-3	0.25 to 10.6	10 mW	3W	1 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098304	LM-10	0.25 to 10.6	10 mW	10W	1 mW	0.5 to 10	16	HTD	10600	2	LM DB-25
1098456	LM-20	0.25 to 10.6	100 mW	20W	10 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098320	LM-45	0.25 to 10.6	100 mW	45W	10 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098346	LM-100	0.25 to 10.6	100 mW	100W	10 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098394	LM-150 FS	0.25 to 10.6	100 mW	150W	10 mW	0.5 to 10	19	HTD	10600	5	LM DB-25
1098452	LM-150 LS	0.25 to 10.6	100 mW	150W	10 mW	0.5 to 10	19	HTD	10600	5	LM DB-25
1098450	LM-200 220V	0.25 to 10.6	100 mW	200W	10 mW	0.5 to 100	19	HTD	10600	5	LM DB-25
1098440	LM-200 110V	0.25 to 10.6	100 mW	200W	10 mW	0.5 to 100	19	HTD	10600	5	LM DB-25
Position-Sensing Water-Cooled Thermopile Sensors (to 5 kW)											
1098409	LM-1000	0.25 to 10.6	100W	1000W	1W	–	38	Broadband	10600	5	LM DB-25
1098437	LM-2500	0.25 to 10.6	100W	2500W	1W	–	55	Broadband	10600	5	LM DB-25
1098421	LM-5000	0.25 to 10.6	100W	5000W	1W	–	55	Broadband	10600	5	LM DB-25
High-Peak-Power Thermopile Sensors (to 30W)											
1098338	PM10V1	0.25 to 3.0	10 mW	10W	1 mW	–	19	Volume Absorber	514	1	PM DB-25
1098429	PM30V1	0.25 to 3.0	100 mW	30W	10 mW	–	19	Volume Absorber	514	1	PM DB-25
Off-the-Shelf OEM Power Sensors (to 1 kW)											
1098334	PM10-19A	0.19 to 11.0	10 mW	10W	1 mW	–	19	Broadband	514	1	4-pin connector
1098343	PM10-19B	0.19 to 11.0	10 mW	10W	1 mW	–	19	Broadband	514	1	BNC-terminated
1098418	PM150-19A	0.19 to 11.0	300 mW	150W	30 mW	–	19	Broadband	514	1	4-pin connector
1098321	PM150-19B	0.19 to 11.0	300 mW	150W	30 mW	–	19	Broadband	514	1	BNC-terminated
1098510	PM150-50A	0.19 to 11.0	300 mW	150W	30 mW	–	50	Broadband	514	1	4-pin connector
1098415	PM150-50B	0.19 to 11.0	300 mW	150W	30 mW	–	50	Broadband	514	1	BNC-terminated
1098441	PM150-50XB	0.15 to 1.0	300 mW	150W	30 mW	–	50	UV	514	1	BNC-terminated
1098333	PM1K-36B	0.19 to 11.0	100W	1000W	1W	–	36	Broadband	1064	3	BNC-terminated
1098427	BeamFinder	0.25 to 10.6	100W	1000W	1W	–	35	Broadband	10600	5	LM DB-25

Beam Position Sensing Thermopile Sensors

10 mW to 45W

Models LM-3, LM-10, LM-45

Features

- Spectrally flat from 0.19 µm to 11 µm
- 10 mW to 100 mW resolution
- 16 mm to 19 mm apertures
- FC and SMA fiber connectors available (see page 55)

Use with LabMax (see page 10)

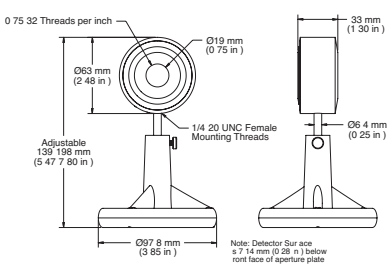
These unique thermopiles incorporate a quadrant thermopile disk that enables them to sense the position of the beam on the detector surface. This information is displayed by meters such as LabMax. All Coherent products which incorporate this position sensing technology are identified with the logo shown on the right.

Device Specifications

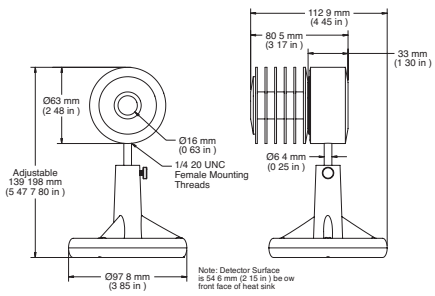
ilac-MRA ACLASS ACCREDITED CALIBRATION AC-1630

Model	LM-3	LM-10	LM-45
Wavelength Range (µm)		0.25 to 10.6	
Power Range	10 mW to 3W	10 mW to 10W	100 mW to 45W
Long-Pulse Joules Range (J)		0.5 to 10	
Resolution (mW)	1		10
Max. Power Density		6 kW/cm²	
Max. Energy Density		0.5 J/cm², 1064 nm, 10 ns	
Detector Coating		HTD	
Detector Diameter (mm)	19	16	19
Calibration Uncertainty (%)(k=2)		±2	
Calibration Wavelength (µm)		10.6	
Cooling Method		Air-cooled	
Cable Type		LM DB-25	
Cable Length (m)		1.8	
Part Number	1098328	1098304	1098320

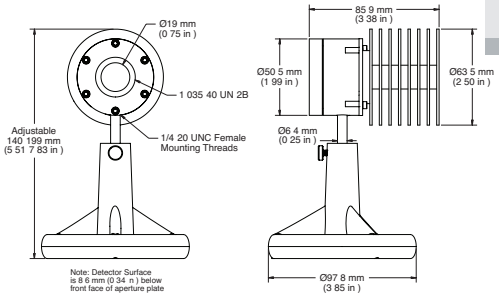
LM-3



LM-10

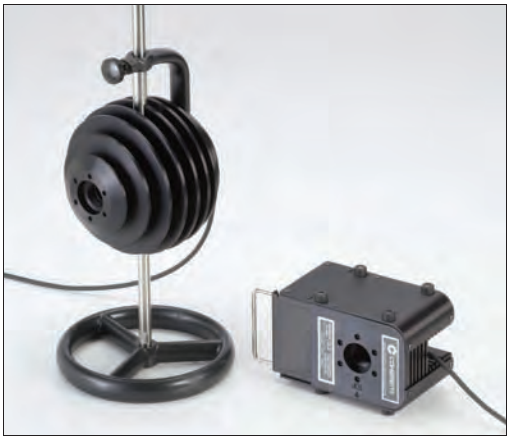


LM-45



Beam Position Sensing Thermopile Sensors

100 mW to 200W



Models LM-100, LM-200

Features

- Spectrally flat from 0.19 µm to 11 µm
- 10 mW resolution
- 19 mm apertures
- FC and SMA fiber connectors available (see page 55)

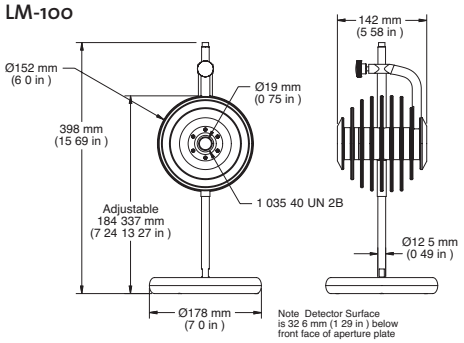
Use with LabMax (see page 10)

The LM-100 sensor is convectively-cooled for powers up to 100W. The LM-200 sensor is fan-cooled and is available in 110 VAC and 220 VAC configurations.

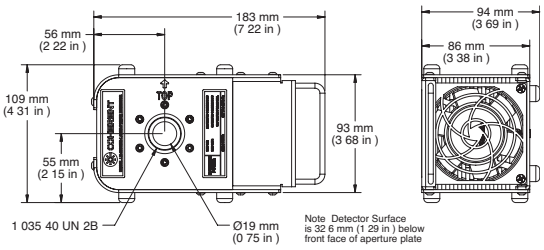
Device Specifications

Model	LM-100	LM-200
Wavelength Range (µm)	0.25 to 10.6	
Power Range	100 mW to 100W	100 mW to 200W
Long-Pulse Joules Range (J)	0.5 to 10	
Resolution (mW)	10	
Max. Power Density	6 kW/cm²	
Max. Energy Density	0.5 J/cm², 1064 nm, 10 ns	
Detector Coating	HTD	
Detector Diameter (mm)	19	
Calibration Uncertainty (%)(k=2)	±2	±5
Calibration Wavelength (µm)	10.6	
Cooling Method	Air-cooled	Fan-cooled
Cable Type	LM DB-25	
Cable Length (m)	1.8	
Part Number	1098346	1098440 (110VAC) 1098450 (220 VAC)

LM-100

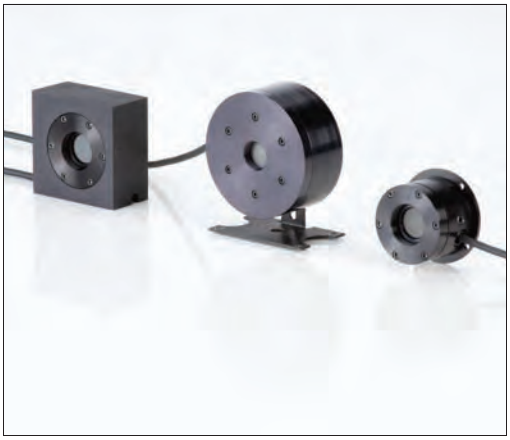


LM-200



Beam Position Sensing Thermopile Sensors

100 mW to 150W



Models LM-150LS, LM-150FS, LM-20

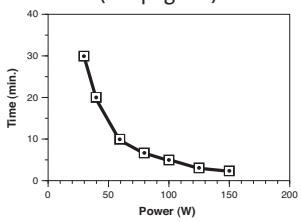
Features

- Spectrally flat from 0.19 µm to 11 µm
- 10 mW to 100 mW resolution
- 19 mm apertures
- FC and SMA fiber connectors available (see page 55)

Use with LabMax (see page 10)

The LM-20 is designed for embedded use and must be mounted on a heat sink. The LM-150 FS and LS sensors are designed for intermittent operation.

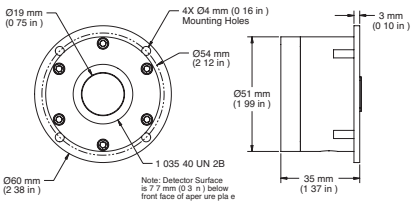
LM-150 FS and LS Power Duration



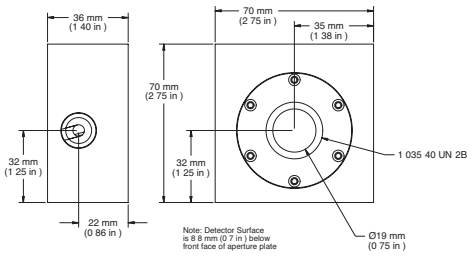
Device Specifications

Model	LM-20	LM-150 LS	LM-150 FS
Wavelength Range (µm)		0.25 to 10.6	
Power Range	100 mW to 20W	100 mW to 150W	100 mW to 150W
Long-Pulse Joules Range (J)		0.5 to 10	
Resolution (mW)		10	
Max. Power Density		6 kW/cm²	
Max. Energy Density		0.5 J/cm², 1064 nm, 10 ns	
Detector Coating		HTD	
Detector Diameter (mm)		19	
Calibration Uncertainty (%)(k=2)	±2	±5	±5
Calibration Wavelength (µm)		10.6	
Cooling Method	Conductive-cooled	Air-cooled	
Cable Type		LM DB-25	
Cable Length (m)		1.8	
Part Number	1098456	1098452	1098394

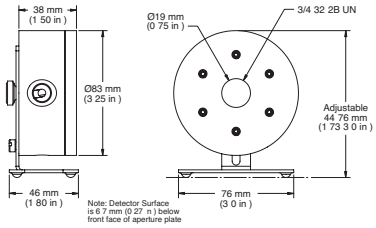
LM-20



LM-150 LS

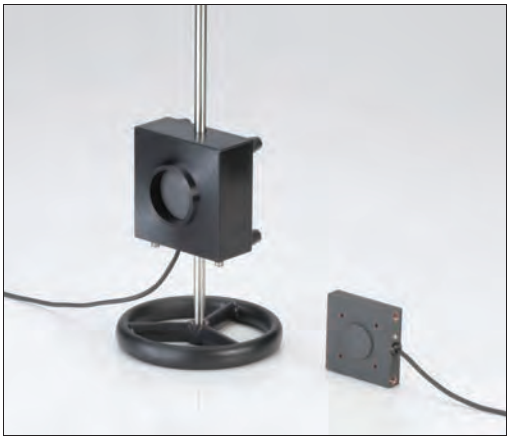


LM-150 FS



Beam Position Sensing Thermopile Sensors

100W to 5 kW



Models LM5000, BeamFinder

Features

- Water-cooled
- Spectrally flat from 0.19 µm to 11 µm
- 1W resolution
- 35 mm to 55 mm apertures

Use with LabMax (see page 10)

These kilowatt thermopile sensors are water-cooled for measuring output over 100W and are excellent for use with CO_2 and Nd:YAG lasers.

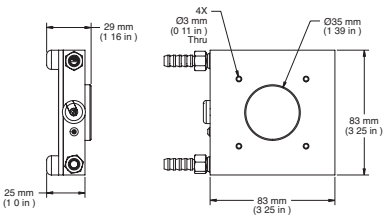
Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details). Water fittings are included.

Device Specifications

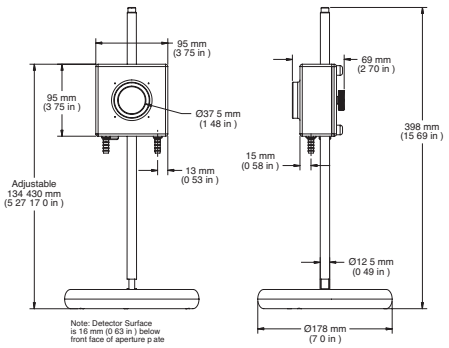
Model	BeamFinder	LM-1000	LM-2500	LM-5000
Wavelength Range (µm)	0.3 to 10.6		0.25 to 10.6	
Power Range (W)	100 to 1000		100 to 2500	100 to 5000
Resolution (W)	1			
Max. Power Density[1]	1 to 2.5 kW/cm²			
Max. Energy Density	0.5 J/cm², 1064 nm, 10 ns			
Detector Coating	H			
Active Area Diameter (mm)	35	38	56	
Calibration Uncertainty (%)(k=2)	±5			
Calibration Wavelength (µm)	10.6			
Cooling Method	Water-cooled			
Cable Type	LM DB-25			
Cable Length (m)	6			
Part Number	1098427	1098409	1098437	1098421

[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

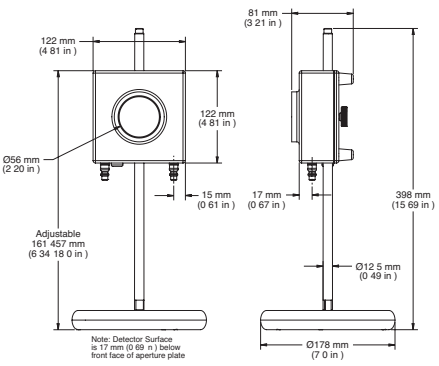
BeamFinder



LM-1000



LM-2500/LM-5000



High-Sensitivity Optical Power Sensors

10 nW to 50 mW, CW

Model OP-2/LM-2

Features

- **Si, Ge photodiodes**
- **Spectral range: 250 nm to 1800 nm**
- **Fiber-optic connector (optional, see page 55)**
- **1000:1 attenuator for measurement to 5W (optional, see page 54)**

These high-sensitivity semiconductor sensors are ideal for CW laser measurements in the nW to low mW level. They typically saturate in the 10 to 50 mW level, depending upon the model. For linear operation up to a maximum of 5 Watts, an optional 1000:1 attenuator is used. Light shield is removable.

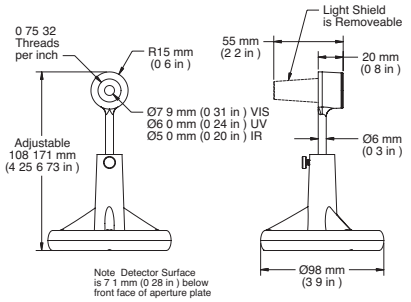
OP-2 models are compatible with FieldMate, FieldMaxII and LabMax meters. LM-2 models are directly compatible with LabMax meters.

Device Specifications

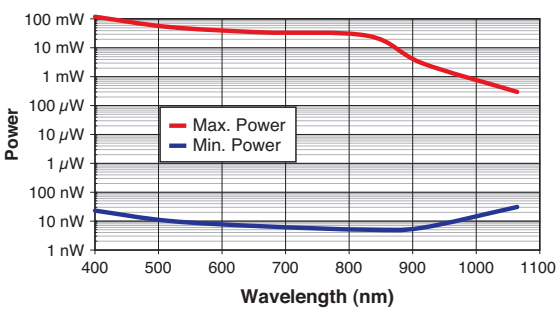
Model	OP-2/LM-2 UV	OP-2/LM-2 VIS	OP-2/LM-2 IR
Detector Material	Silicon		Germanium
Wavelength Range (µm)	0.25 to 0.4	0.4 to 1.06	0.8 to 1.80/0.8 to 1.5[1]
Power Range	10 nW to 30 mW	10 nW to 30 mW[2]	10 nW to 10 mW
Resolution (nW)		1	
Max. Power Density	0.3 W/cm²	1.0 W/cm²	0.5 W/cm²
Active Area Diameter (mm)	6	7.9	5
Calibration Uncertainty (%)(k=2)	±8	±5	±4.5
Calibration Wavelength (nm)	Monochromator calibration across wavelength range		
Cooling Method	Air-cooled		
Connector Type	OP DB-25/LM DB-25		
Cable Length (m)	1.8		
Part Number			
OP-2	1098401	1098313	1098416
LM-2	1098390	1098298	1098342

[1] OP-2 IR and LM-2 IR have different spectral ranges.
[2] Power range is wavelength dependent. See chart below.

OP-2 UV/OP-2 VIS/OP-2 IR
LM-2 UV/LM-2 VIS/LM-2 IR



Measurable Power vs. Wavelength
OP-2 VIS and LM-2 VIS



Accessories

1000:1 Attenuator

Fiber-Optic Connector Adapters

High-Sensitivity Thermopile Power Sensors

100 µW to 2W

Models PS19Q, PS19, PS10, PM3

Features

- **Thermally stabilized designs**
- **Spectrally flat from 0.3 µm to 11 µm**
- **10 µW resolution**
- **Fiber-optic connectors (optional, see page 55)**

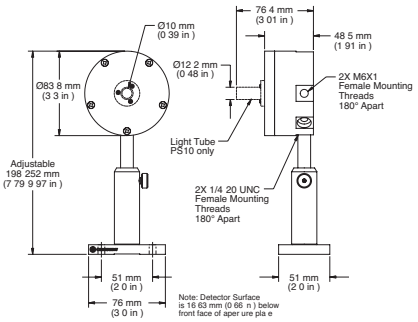
The PS10 and PS19 model sensors are thermally stabilized, amplified thermopile power sensors with a broad spectral response, high sensitivity, and a large active area. These sensors are ideal for measuring laser diodes, HeNe and HeCd lasers, and small ion lasers. The PS10 model includes a light tube mounted to the front of the housing, which minimizes the effects of background radiation. The light tube can be removed and replaced by FC or SMA fiber connectors (see Accessories - page 55). Where optimum stability is required, specify the PS10Q or PS19Q, which include a wedged quartz window for applications from 0.3 to 2.0 µm. The quartz window more effectively eliminates thermal background radiation and the effects of air currents.

Device Specifications

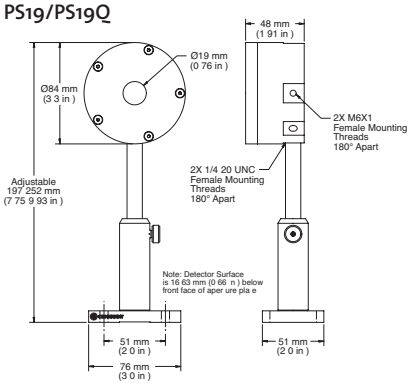
Model	PS10[2]	PS10Q	PS19	PS19Q	PM3[2]	PM3Q
Wavelength Range (µm)	0.19[3] to 11	0.3 to 2	0.19[3] to 11	0.3 to 2	0.19[3] to 11	0.3 to 2
Power Range	100 µW to 1W				500 µW to 2W	
Resolution (µW)	10				50	
Max. Thermal Drift[1]	±40 µW	±20 µW	±400 µW	±20 µW	±1 mW	±500 µW
Max. Avg. Power Density	0.5 kW/cm²					
Max. Pulse Energy Density	50 mJ/cm², 10 ns , 1064 nm					
Response Time (sec.)	2					
Detector Coating	Black					
Quartz Filter Window	No	Yes	No	Yes	No	Yes
Active Area Diameter (mm)	10		19		19	10
Calibration Uncertainty (%)(k=2)	±1					
Calibration Wavelength (nm)	514					
Cooling Method	Air-cooled					
Cable Type	PM DB-25					
Cable Length (m)	2					
Part Number	1098350	1098400	1098413	1098341	1098336	1098419

[1] Power stability over 30 minutes in a typical lab environment.
[2] Light tube supplied with PS10 and PM3 models only.
[3] 190nm to 300 nm operation restricted to <100 mW average power and <250W/cm² power density.

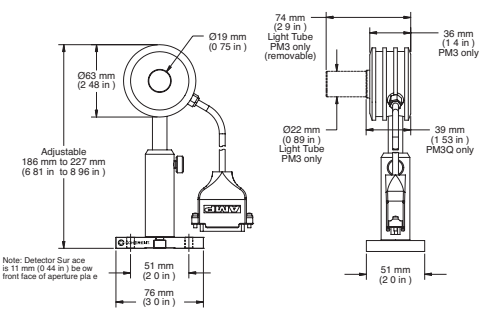
PS10/PS10Q



PS19/PS19Q



PM3/PM3Q



Air-Cooled Thermopile Sensors

10 mW to 30W

Models PM2, PM10, PM30

Features

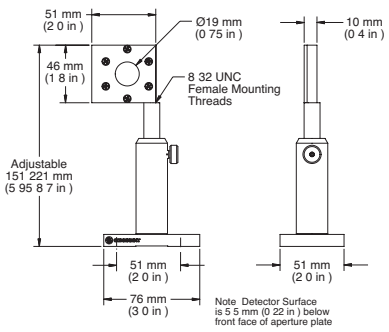
- Convective air-cooled
- Spectrally flat from 0.19 µm to 11 µm
- 1 to 10 mW resolution
- 19 mm aperture

These thermopile sensors are used to measure CW and pulsed lasers from 10 mW up to 30W average power output. These sensors are able to dissipate heat via convection cooling, which makes them convenient to use.

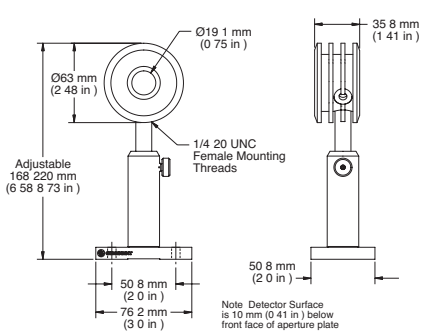
Device Specifications

Model	PM2	PM10	PM30
Wavelength Range (µm)		0.25 to 11	
Power Range	10 mW to 2W	10 mW to 10W	100 mW to 30W
Long-Pulse Joules Range (J)	0.5 to 2	0.5 to 10	0.5 to 50
Max. Intermittent Power (<5 min.)(W)	5	30	50
Resolution (mW)		1	10
Max. Power Density		6 kW/cm²	
Max. Energy Density		0.6 J/cm², 1064 nm, 10 ns	
Response Time (sec.)		2	
Detector Coating		Broadband	
Active Area Diameter (mm)		19	
Calibration Uncertainty (%)(k=2)		±1	
Calibration Wavelength (nm)		514	
Cooling Method		Air-cooled	
Cable Type		PM DB-25	
Cable Length (m)		2	
Part Number	1098329	1097901	1098314

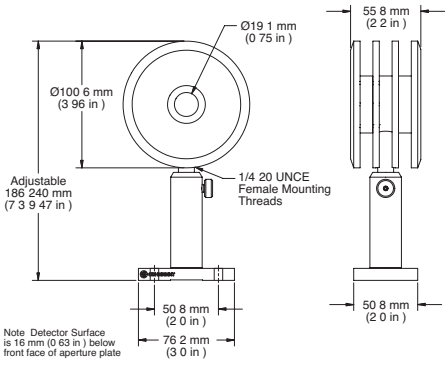
PM2



PM10

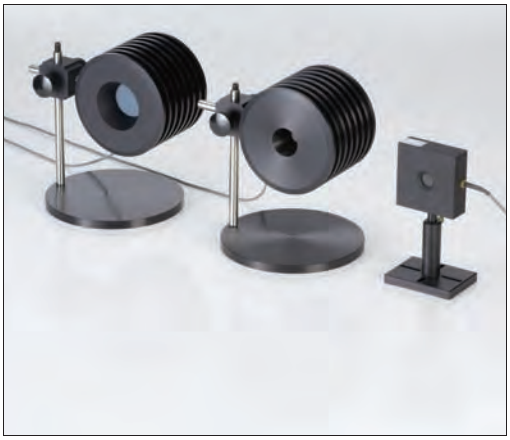


PM30



Air-Cooled Thermopile Sensors

300 mW to 150W



Models PM150-50, PM150, PM100-19C

Features

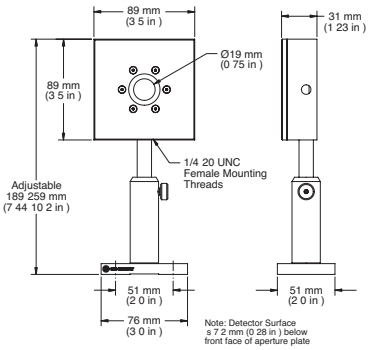
- Convective air-cooled
- Spectrally flat from 0.19 µm to 11 µm
- 30 mW resolution
- 19 mm and 50 mm apertures

Device Specifications

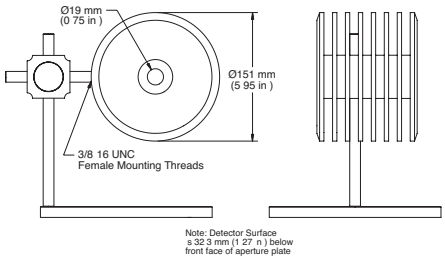
Model	PM100-19C[1]	PM150	PM150-50
Wavelength Range (µm)	0.25 to 11		
Power Range	300 mW to 100W	300 mW to 150W	
Long-Pulse Joules Range (J)	1 to 100	1 to 150	
Max. Intermittent Power (<5 min.)(W)	100	300	
Resolution (mW)	30		
Max. Power Density	6 kW/cm²		
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns		
Response Time (sec.)	2		5
Detector Coating	Broadband		
Active Area Diameter (mm)	19		50
Calibration Uncertainty (%)(k=2)	±1		
Calibration Wavelength (nm)	514		
Cooling Method	Air-cooled		
Cable Type	PM DB-25		
Cable Length (m)	2		
Part Number	1098483	1098407	1098398

[1] This sensor is designed for intermittent use only.

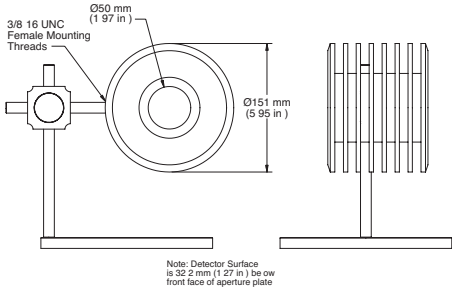
PM100-19C



PM150



PM150-50



Water-Cooled Thermopile Sensors

10 mW to 300W

Models PM300, PM150-50C, PM150-19C

Features

- **Water-cooled; but can be used air-cooled for short periods of time**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1 mW to 100 mW resolution**
- **19 mm and 50 mm apertures**

These compact sensors are ideal in tight spaces, but must be water-cooled in order to achieve their full power specification during continuous operation. They can also be mounted to a heat sink or used standalone for intermittent use. Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details). Water fittings are included.

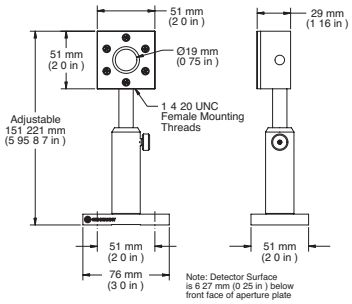
OEM versions of these sensors with passive and amplified outputs can be found on page 83.

Device Specifications

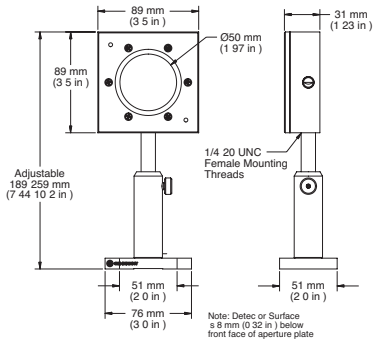
Model	PM10-19C	PM150-19C	PM150-50C	PM300
Wavelength Range (µm)	0.25 to 11			
Power Range (water-cooled)	10 mW to 10W	300 mW to 150W		1 W to 300W
Max. Intermittent Power (<5 min.)(W)	5W[1]	20W[1]	80W[1]	450W[2]
Long-Pulse Joules Range (J)	0.5 to 10	1 to 150		–
Resolution (mW)	1	30		100
Max. Power Density	6 kW/cm²			
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns			
Response Time (sec.)	2		5	
Detector Coating	Broadband			
Active Area Diameter (mm)	19		50	19
Calibration Uncertainty (%)(k=2)	±1			
Calibration Wavelength (nm)	514			
Cooling Method	Water-cooled			
Cable Type	PM DB-25			
Cable Length (m)	2			
Part Number	1098397	1098444	1098412	1141474

[1] This intermittent power rating is for when the sensor is used without water-cooling.
[2] This intermittent power rating is for when the sensor is used with water-cooling.

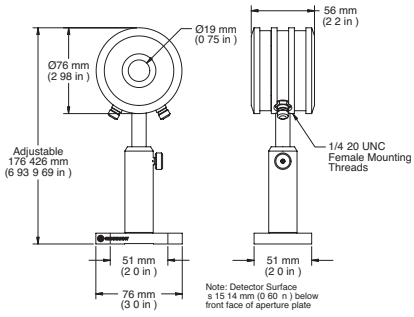
PM10-19C/PM150-19C



PM150-50C



PM300



Fan-Cooled Thermopile Sensors

1W to 300W

Models PM200F-50, PM300F-50

Features

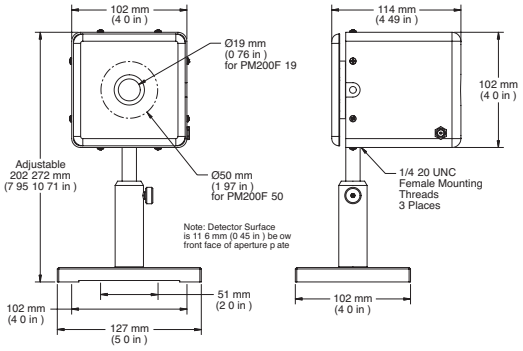
- Fan-cooled
- Spectrally flat from 0.19 µm to 11 µm
- 100 mW resolution
- 19 mm and 50 mm apertures

Fan-cooled sensors are an excellent choice for measuring high-power lasers when water-cooling is not possible. A compact power supply provides the 12 VDC required to power the fan.

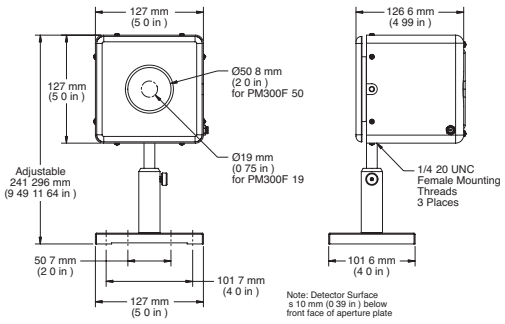
Device Specifications

Model	PM200F-19	PM200F-50	PM300F-19	PM300F-50
Wavelength Range (µm)	0.25 to 11			
Power Range (W)	1 to 200		1 to 300	
Long-Pulse Joules Range (J)	1 to 200		1 to 300	
Max. Intermittent Power (<5 min.)(W)	300		450	
Resolution (mW)	100			
Max. Power Density	6 kW/cm²			
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns			
Response Time (sec.)	2	5	2	5
Detector Coating	Broadband			
Active Area Diameter (mm)	19	50	19	50
Calibration Uncertainty (%)(k=2)	±1			
Calibration Wavelength (nm)	514			
Cooling Method	Fan-cooled			
Cable Type	PM DB-25			
Cable Length (m)	2			
Part Number	1098480	1098472	1098509	1098417

PM200F-19/PM200F-50

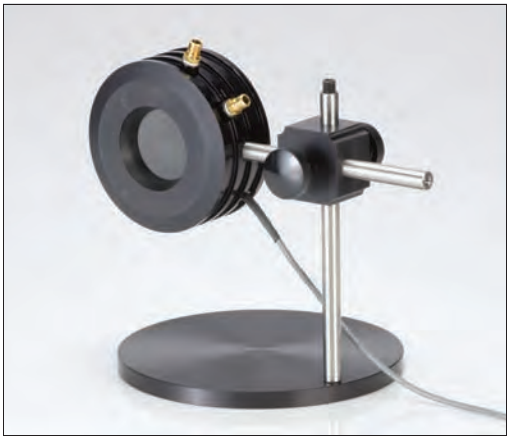


PM300F-19/PM300F-50



Water-Cooled Thermopile Sensors

100W to 5 kW



Model PM1K

Features

- **Water-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1W resolution**
- **50 mm apertures**

These water-cooled sensors are used to measure lasers over 300W average power output. They are excellent choices for measuring CO_2 and Nd:YAG lasers. Larger-area versions are available on the next page.

Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details). Water fittings are included.

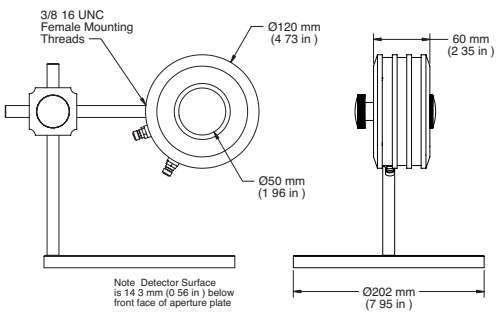
Device Specifications

Model	PM1K	PM3K	PM5K
Wavelength Range (µm)		0.25 to 11	
Power Range (W)	100 to 1000	100 to 3000	100 to 5000
Max. Intermittent Power (<5 min.)(W)[1]	3000	5000	10000
Resolution (W)		1	
Max. Power Density[2]		1 to 2.5 kW/cm²	
Max. Energy Density		0.6 J/cm², 1064 nm, 10 ns	
Response Time (sec.)		30	
Detector Coating		Broadband	
Active Area Diameter (mm)		50	
Calibration Uncertainty (%)(k=2)		±3	
Calibration Wavelength (nm)		1064	
Cooling Method		Water-cooled	
Cable Type		PM DB-25	
Cable Length (m)		2	
Part Number	1098392	1098462	1098454

[1] Intermittent power levels may be sustainable for longer than 5 minutes when used with lasers with large diameter, non-Gaussian beam profiles. Monitor closely for coating damage if used longer than five minutes at higher powers.

[2] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

PM1K/PM3K/PM5K



Large-Area High-Power Water-Cooled Thermopile Sensors

10 mW to 5 kW

Models PM5K-200, PM3K-100

Features

- Water-cooled
- 100 mm and 200 mm apertures
- Spectrally flat from 0.19 µm to 11 µm

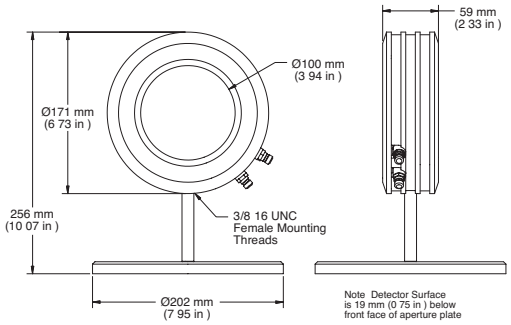
These large-area, water-cooled thermopiles are designed to measure large laser diode stacks and arrays, and other high-power divergent sources. Water fittings are included

Device Specifications

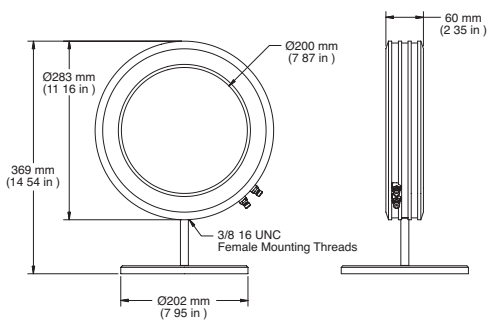
Model	PM1K-100	PM3K-100	PM5K-100	PM5K-200
Wavelength Range (µm)	0.25 to 11			
Power Range (W)	100 to 1000	100 to 3000	100 to 5000	100 to 5000
Max. Intermittent Power (<5 min.)(W)	1500	4000	7500	7500
Resolution (W)	1			
Max. Power Density[1]	1 to 2.5 kW/cm²			
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns			
Response Time (sec.)	45			
Detector Coating[1]	Broadband			
Detector Diameter (mm)	100			200
Calibration Uncertainty (%)(k=2)	±3			
Calibration Wavelength (nm)	1064			
Cooling Method	Water-cooled			
Cable Type	PM DB-25			
Cable Length (m)	2			
Part Number	1098490	1098506	1098461	1098505

[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

PM1K-100/PM3K-100/PM5K-100



PM5K-200



High-Peak-Power Thermopile Sensors

10 mW to 30W

Models PM30V1, PM10V1

Features

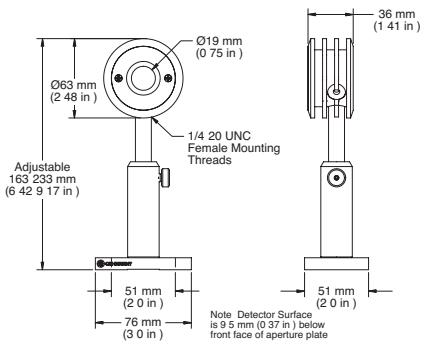
- **Volume absorber**
- **2 J/cm² at 1064 nm**

These sensors are designed for use with high-peak-power, low repetition rate, Q-switched Nd:YAG lasers. A volume-absorbing substrate mounted in front of the detector absorbs the bulk of the laser energy rather than all of the energy striking the front surface of the detector element. This results in a much higher damage threshold, approaching 2 J/cm², at relatively low repetition rates of approximately 10 pps. A removable front aperture allows easy replacement of the volume-absorbing substrate should it be damaged (replacement absorbers may be ordered using part number 0011-8935, PMV1-KIT).

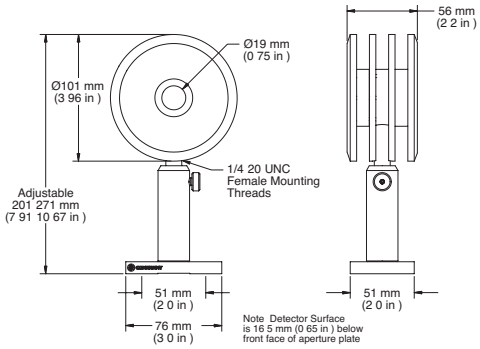
Device Specifications

Model	PM10V1	PM30V1
Wavelength Range (µm)	0.25 to 3	
Power Range	10 mW to 10W	100 mW to 30W
Max. Intermittent Power (<5 min.)(W)	15	50
Resolution (mW)	1	10
Max. Power Density	50 W/cm²	
Max. Energy Density	2 J/cm², 1064 nm, 10 ns	
Response Time (sec.)	3	
Detector Coating	Volume Absorbing	
Active Area Diameter (mm)	19	
Calibration Uncertainty (%)(k=2)	±1	
Calibration Wavelength (nm)	514	
Cooling Method	Air-cooled	
Cable Type	PM DB-25	
Cable Length (m)	2	
Part Number	1098338	1098429

PM10V1



PM30V1



Thermopile Sensors with UV Coating

10 mW to 30W

Model PM2X, PM10X, PM30X

Features

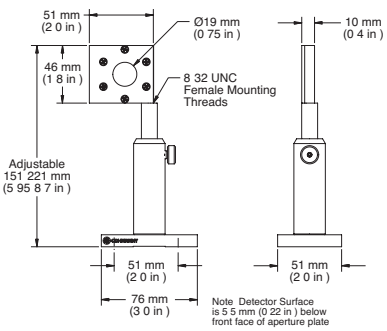
- **UV coating is optimized for DUV**
- **Spectral range: 0.15 µm to 1 µm**
- **1 mW to 10 mW resolution**
- **19 mm apertures**

The following sensors are similar to models shown on previous pages, except they incorporate a UV coating that is optimized for use at ultraviolet wavelengths. Spectral compensation allows the sensors to be used from 157 nm to 1064 nm.

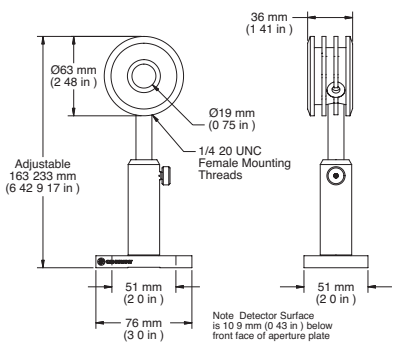
Device Specifications

Model	PM2X	PM10X	PM30X
Wavelength Range (µm)		0.15 to 1	
Power Range	10 mW to 2W	10 mW to 10W	100 mW to 30W
Long-Pulse Joules Range (J)	0.5 to 2	0.5 to 10	0.5 to 50
Max. Intermittent Power (<5 min.)(W)	5	30	50
Resolution (mW)	1	1	10
Max. Power Density		6 kW/cm²	
Max. Energy Density		0.6 J/cm², 1064 nm, 10 ns	
Response Time (sec.)		2	
Detector Coating		UV	
Active Area Diameter (mm)		19	
Calibration Uncertainty (%)(k=2)		±1	
Calibration Wavelength (nm)		514	
Cooling Method		Air-cooled	
Cable Type		PM DB-25	
Cable Length (m)		2	
Part Number	1098457	1098423	1098498

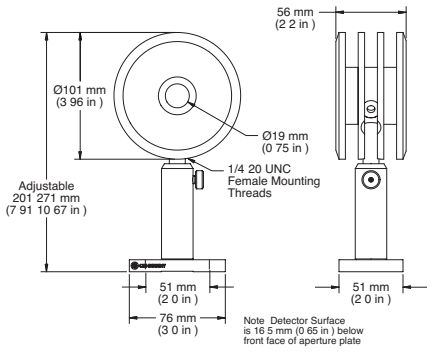
PM2X



PM10x

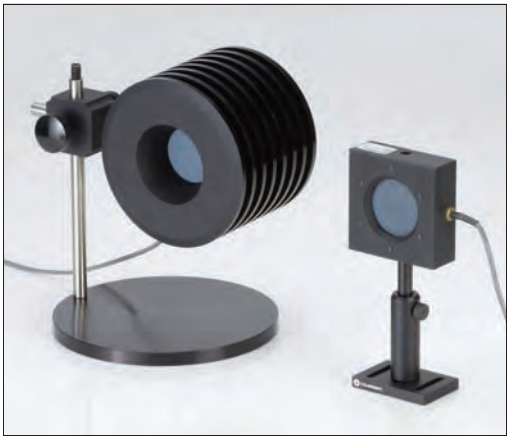


PM30x



Thermopile Sensors with UV Coating

300 mW to 150W



Model PM150X, PM150-50XC

Features

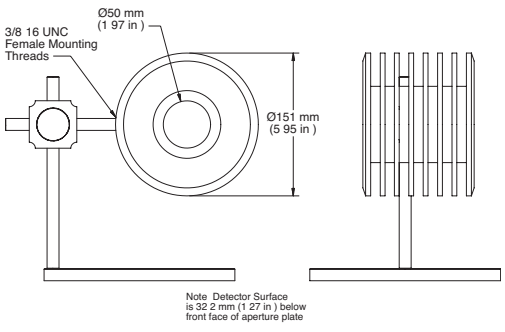
- UV coating is optimized for DUV
- Spectral Range: 0.15 µm to 1 µm
- 30 mW resolution
- 50 mm apertures

Device Specifications

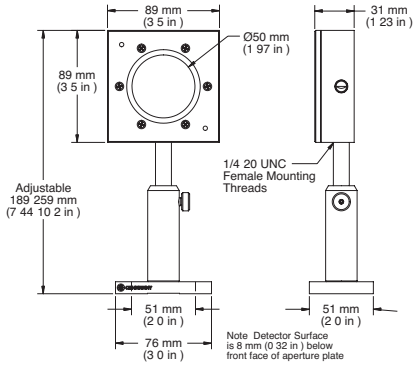
Model	PM150X	PM150-50XC
Wavelength Range (µm)	0.15 to 1	
Power Range	300 mW to 150W	
Long-Pulse Joules Range (J)	1 to 150	
Max. Intermittent Power (<5 min.)(W)	300	80 (air-cooled)
Resolution (mW)	30	
Max. Power Density	6 kW/cm²	
Max. Energy Density	0.6 J/cm2, 1064 nm, 10 ns	
Response Time (sec.)	5	
Detector Coating	UV	
Active Area Diameter (mm)	50	
Calibration Uncertainty (%)(k=2)	±1	
Calibration Wavelength (nm)	514	
Cooling Method	Air-cooled	Water-cooled
Cable Type	PM DB-25	
Cable Length (m)	2	
Part Number[1]	1098455	1098443

[1] Water fittings are included with PM150-50XC.

PM150X



PM150-50XC



Thermopile Sensors with UV Coating

1W to 300W

Model PM200F-50X, PM300F-50X

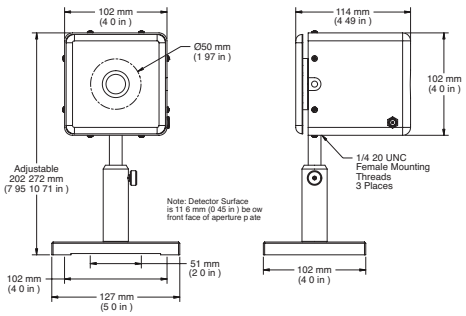
Features

- UV coating is optimized for DUV
- Spectral Range: 0.15 µm to 1 µm
- 100 mW resolution
- 50 mm apertures

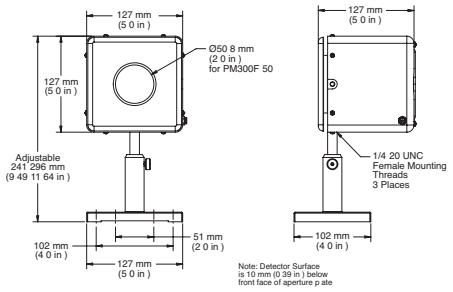
Device Specifications

Model	PM200F-50X	PM300F-50X
Wavelength Range (µm)	0.15 to 1	
Power Range (W)	1 to 200	1 to 300
Long-Pulse Joules Range (J)	1 to 200	1 to 300
Max. Intermittent Power (<5 min.)(W)	300	450
Resolution (mW)	100	100
Max. Power Density	6 kW/cm²	
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns	
Response Time (sec.)	5	
Detector Coating	UV	
Active Area Diameter (mm)	50	
Calibration Uncertainty (%)(k=2)	±1	
Calibration Wavelength (nm)	514	
Cooling Method	Fan-cooled	
Cable Type	PM DB-25	
Cable Length (m)	2	
Part Number[2]	1113493	1098481

PM200F-50X



PM300F-50X



Thermopile Sensors with UV Coating

100W to 1 kW

Model PM1KX, PM1KX-100

Features

- UV coating is optimized for DUV
- Spectral Range: 0.15 µm to 1 µm
- 1W resolution
- 50 mm and 100 mm apertures

Device Specifications

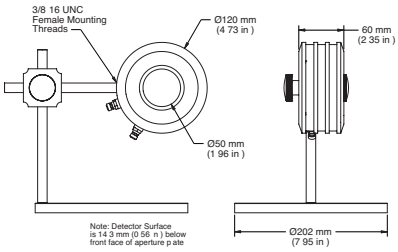
ilac-MRA ACLASS ACCREDITED CALIBRATION AC-1630

Model	PM1KX	PM1KX-100
Wavelength Range (µm)	0.15 to 1	
Power Range (W)	1 to 1000	
Long-Pulse Joules Range (J)	–	
Max. Intermittent Power (<5 min.)(W)	1500	
Resolution (mW)	1000	
Max. Power Density	1 to 2.5 kW/cm² [1]	
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns	
Response Time (sec.)	30	45
Detector Coating	UV	
Active Area Diameter (mm)	50	100
Calibration Uncertainty (%)(k=2)	±3	
Calibration Wavelength (nm)	1064	
Cooling Method	Water-cooled	
Cable Type	PM DB-25	
Cable Length (m)	2	
Part Number[2]	1115484	1152086

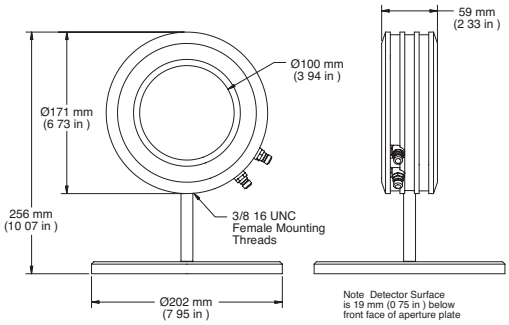
[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

[2] Water fittings are included with PM1KX and PM1KX-100.

PM1KX



PM1KX-100



Power Sensor Accessories

Thermal SmartSensor Adapter

Thermal SmartSensor Adapter

The Thermal SmartSensor Adapter converts LM-model position-sensing thermopiles and LM-2 optical sensors for use with FieldMaxII, FieldMate and EPM2000 meters.

Designed for use with multiple sensors, this adapter can read the sensor EEPROM contents and program itself when powered up via the meter connection.

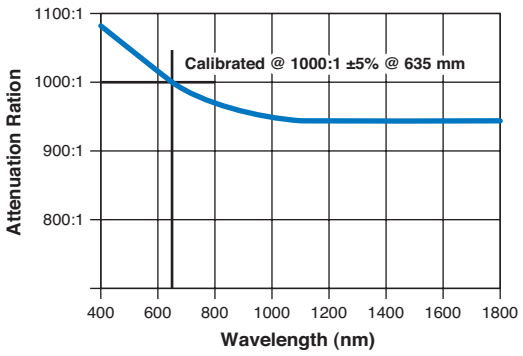
Note: Beam position information is not available when using these meters.

Part Number	Description
1056827	Thermal SmartSensor Adapter

1000:1 Attenuator

1000:1 Attenuator

This attenuator is used with OP-2 VIS, LM-2 VIS, OP-2 IR and LM-2 IR sensors to allow operation up to 5W in the visible and 3W in the infrared regions. The attenuator threads into the sensor in place of the light shield to provide from 1100:1 to 950:1 attenuation. Each attenuator is calibrated for 1000:1 ±5% at 635 nm and is supplied with a calibration certificate. The useful spectral range is 400 to 1800 nm.



Part Number	Description
1098318	1000:1 Attenuator for OP-2 and LM-2 Sensors

SMA and FC Adapters

Power Sensor Accessories

Fiber-Optic Connector Adapters

SMA and FC Adapters

The following fiber-optic adapters can be mounted directly onto the 3/4-32 threads on the front of LM-2, OP-2, LM-3, LM-10, and LM-150FS sensors. These fiber adapters can also be used with our 1.035-40M adapter ring to fit on the LM-20, LM-45, LM-100, LM-150 LS, and LM-200 sensors.

Part Number	Description	Sensors
1098589	SMA-Type Connector	LM-2, OP-2, LM-3, LM-10, LM-150 FS
1098339	FC/PC-Type Connector	LM-2, OP-2, LM-3, LM-10, LM-150 FS
33-9432-000	1.035-40M Adapter Ring	LM-20, LM-45, LM-100, LM-150 LS, LM-200

SMA and FC Adapters

The following fiber adapters can be mounted onto the front of the PS10 sensor in place of the removable light tube.

Part Number	Description	Sensors
0012-3860	PS-SMA-Type Connector	PS10
0012-3863	PS-FC-Type Connector	PS10

Post and Stand

2-inch Delrin Post, 2-inch Post/Stand Assembly,
4-inch Delrin Post, 4-inch Post/Stand Assembly

Part Number	Description
1257607	2-inch Height Post/Stand Assembly with 2-inch Delrin Post
1097917	4-inch Height Post/Stand Assembly with 4-inch Delrin Post (included with most Power Sensors, as pictured)
1257605	2-inch Delrin Post
0010-1220	4-inch Delrin Post

EnergyMax - Laser Energy Sensors

Introduction and Selection Charts

EnergyMax Sensors

Features

- **Superior damage resistance**
- **High repetition rate operation**
- **Large dynamic range gives each sensor broad coverage**
- **Low noise and excellent linearity for greater accuracy**
- **Large active area**

Coherent EnergyMax sensors enable laser pulse energy measurement over a broad range of wavelengths, repetition rates, pulse energies and beam diameters. With their unique combination of superior performance and user-friendly convenience, EnergyMax sensors are your best choice no matter what your particular laser energy measurement need. EnergyMax sensors are highly linear in terms of repetition rate, laser pulse width, and measured energy. They are also accurate across a broad range of wavelengths due to onboard wavelength compensation. In addition, automatic temperature compensation accounts for changes in ambient temperature, as well as for heat generated by absorption of the laser energy. Temperature compensation also enables the use of user-installable heat sinks for even higher average power handling capabilities. Coherent EnergyMax sensors are the most linear and accurate on the market.

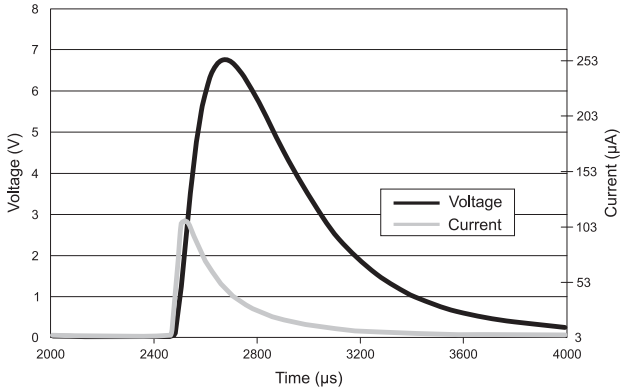
Standard DB-25 terminated sensors that are designed to work with our stand alone meters (such as LabMax and FieldMaxII) can be found on pages 71 to 77. Meterless USB and RS-232 models are on pages 64 to 70.

Fundamental Principles

Unlike all other thermal detectors, pyroelectrics measure the rate of change of the detector temperature, rather than the temperature value itself. As a result, the response speed of the pyroelectric is usually limited by its electrical circuit design and the thermal resistance of the absorptive coating. In contrast, other thermal detectors (such as thermopiles and bolometers) are limited by slower thermal response speeds, typically on the order of seconds. Pyroelectrics respond only to changing radiation that is chopped, pulsed, or otherwise modulated, so they ignore steady background radiation that is not changing with time. Their combination of wide uniform spectral response, sensitivity, and high speed makes pyroelectrics ideal choices for a vast number of electro-optic applications.

The EnergyMax sensor line uses a pyroelectric element to measure the energy in a laser pulse. It does this by producing a large electrical charge for a small change in temperature. The active sensor circuit takes the current from the sensor element and converts it to a voltage that the instrument can measure.

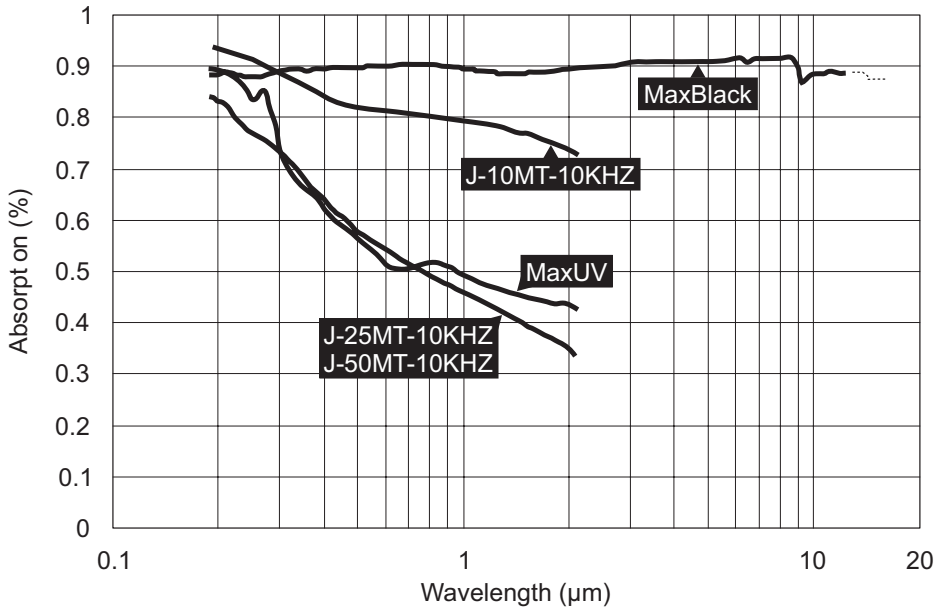
The figure below shows the relationship between the current response of the pyroelectric element and the output voltage of the sensor circuit. The relationship between the current response and the output voltage response is fixed so that the calibrated peak voltage of the output is the integrated energy of the laser pulse. Refer to the User Manual for information on Quantum EnergyMax sensors.

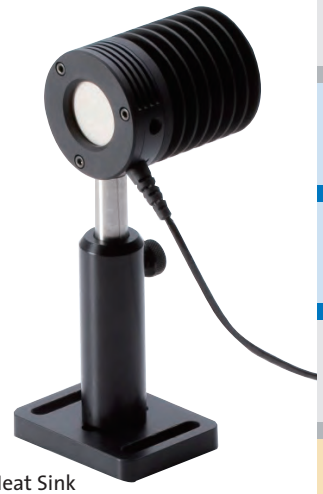


EnergyMax - Laser Energy Sensors

Introduction and Selection Charts

All pyroelectric EnergyMax sensors incorporate a diffuse coating to minimize specular reflections and eliminate spurious beams that can re-enter the laser cavity. In addition, all EnergyMax sensors include onboard electronics that contain built-in wavelength compensation factors. When using the sensor with a meter such as LabMax or FieldMaxII, enter the wavelength of the laser being measured into the meter and this will automatically compensate for the sensor output. The chart below plots the typical absorption percentage of each coating.





J-25MT-10KHZ
with Medium Heat Sink

Meter Compatibility Chart

	LabMax-TOP	FieldMaxII-TOP & -P	EPM2000
All J-10MB-, J-25MB-, J-50MB-, J-25MUV-, J-50MUV- EnergyMax Models	•	•	•
J-10MT-10KHZ, J-25MT-10KHz, J-50MT-10KHZ EnergyMax Models	•		•
J-10SI- and J-10GE Quantum EnegyMax Models	•		•

Explanation of Part Numbers

EnergyMax part numbers are "Smart" part numbers that have the following meaning:

J – **Active Area Diameter** – **Coating Type** – **Descriptive Suffix**

- Active Area Diameter: 10, 25, or 50 mm
- Coating Type: MT for Diffuse Metallic; MB for MaxBlack; MUV for MaxUV
- Descriptive Suffix: LE for Low Energy; HE for High Energy; 10 KHZ for Max. Rep. Rate; 193 and 248 Calibrated Wavelength

J: Represents an energy sensor

Example: J-10MB-LE is an energy sensor with a 10 mm active area diameter MaxBlack coating for low energy measurements

EnergyMax - Laser Energy Sensors

Applying Wavelength Compensation Accuracy

Overall measurement accuracy is a combination of calibration uncertainty (found in the sensor specification tables) and the wavelength compensation accuracy (found in the "Wavelength Compensation Accuracy" table, below).

The combined accuracy is based upon practices outlined in the National Institute of Standards Guidelines for Evaluating and Expressing Uncertainty (NIST Technical Note 1297, 1994 Edition). The combined accuracy of the measurement is calculated by using the law of propagation of uncertainty using the "root-sum-of-square" (square root of the sum of squares), sometimes described as "summing in quadrature" where:

$$\text{Measurement Accuracy} = \sqrt{U^2 + W^2}$$

where U = 'Percent Calibration Uncertainty' and W = 'Wavelength Accuracy'

Example 1

J-10SI-HE used at 355 nm

U = 3%
W = 5%

$$\text{Measurement Accuracy} = \sqrt{3^2 + 5^2} = \sqrt{9 + 25} = 5.8\%$$

Example 2

J-10MB-LE used at 532 nm

U = 2%
W = 2%

$$\text{Measurement Accuracy} = \sqrt{2^2 + 2^2} = \sqrt{4 + 4} = 2.8\%$$

Wavelength Compensation Accuracy

Model	Wavelength Compensation Accuracy (%) (for wavelengths other than the calibration wavelength)	Calibration Wavelength (nm)
All Multipurpose Sensors (MaxBlack Coating)	±2	1064
All High Repetition Rate Sensors (Diffuse Metallic Coating)	±3	1064
J-50MB-YAG	±2	1064
J-50MB-IR	±3	1064, 2940
J-25MB-IR	±4	1064
J-25MUV-193	±3	193
J-25MUV-248	±3	248
J-50MUV-193	±4	193
J-50MUV-248	±4	248
J-10SI-LE	±5	532
J-10SI-HE	±5	532
J-10GE	±5	1064

EnergyMax - Laser Energy Sensors

Introduction and Selection Charts

The next table summarizes the maximum average power rating for each sensor. These power levels are achieved by combining active temperature compensation circuitry and enhanced thermal management techniques. Maximum average power is wavelength dependent because absorption changes with wavelength. Reference the spectral absorption chart on the previous page for use at wavelengths other than those listed in the table below. Maximum average power is inversely proportional to the spectral absorption.

The 25 mm and 50 mm aperture sensors can accept optional heat sinks that users can install by mounting them on the back of the sensor. The heat sinks expand the average power handling capability as outlined below. See the Accessories section on page 78 for more information about heat sinks.

EnergyMax Average Power Capabilities[1]

Model	Wavelength[5] (nm)	Heat Sink			
		None	Small	Medium	Large
J-50MB-HE[2] & -LE[2]	1064	10W	–	–	24W
J-25MB-HE[3] & -LE[3]	1064	5W	10W	15W	–
J-10MB-HE[4] & -LE[4]	1064	4W	–	–	–
J-50MT-10KHZ[2]	1064	20W	–	–	49W
J-25MT-10KHZ[3]	1064	10W	20W	31W	–
J-10MT-10KHZ[4]	1064	1W	–	–	–
J-50MB-YAG[2]	1064	20W	–	–	48W
J-50MB-IR	1064, 2940	15W	–	–	–
J-25MB-IR[3]	1064	20W	41W	62W	–
J-50MUV-248[2] w/o Diffuser	248	10W	–	–	25W
J-50MUV-248[2] w/Diffuser	248	15W	–	–	36W
J-50MUV-193[2] w/o Diffuser	193	10W	–	–	30W
J-50MUV-193[2] w/Diffuser	193	18W	–	–	43W
J-25MUV-248[3]	248	5W	10W	16W	–
J-25MUV-193[3]	193	5W	10W	15W	–

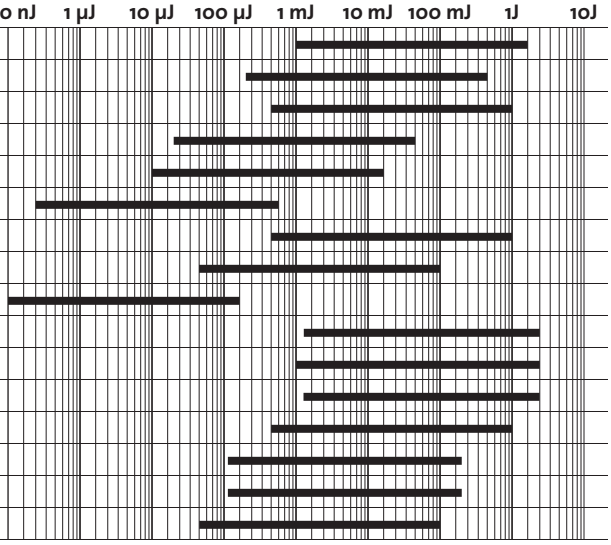
[1] Not applicable for Quantum EnergyMax sensors.
[2] 50 mm EnergyMax sensors are compatible with the large heat sink.
[3] 25 mm EnergyMax sensors are compatible with small and medium heat sinks.
[4] 10 mm EnergyMax sensors do not have a heat sink available.
[5] Average power ratings are based upon testing at the listed wavelength.

Use the following chart to identify the energy range for the standard DB-25 EnergyMax models. Selection charts on the following pages of this guide will help you select more exactly the best sensor for your application. See page 77 for typical dynamic range curves of Quantum EnergyMax Sensors.

Standard DB-25 EnergyMax Energy Range Capabilities

Model	Energy Range
J-50MB-HE (DB-25)	1 mJ to 2J
J-50MB-LE (DB-25)	250 µJ to 500 mJ
J-25MB-HE (DB-25)	500 µJ to 1J
J-25MB-LE (DB-25)	25 µJ to 50 mJ
J-10MB-HE (DB-25)	10 µJ to 20 mJ
J-10MB-LE (DB-25)	300 nJ to 600 µJ
J-50MT-10KHZ (DB-25)	500 µJ to 1J
J-25MT-10KHZ (DB-25)	50 µJ to 100 mJ
J-10MT-10KHZ (DB-25)	100 nJ to 200 µJ
J-50MB-YAG (DB-25)	1.5 mJ to 3J
J-50MB-IR (DB-25)	1 mJ to 3J
J-25MB-IR (DB-25)	1.5 mJ to 3J
J-50MUV-248 (DB-25)	500 µJ to 1J
J-50MUV-193 (DB-25)	125 µJ to 250 mJ
J-25MUV-248 (DB-25)	125 µJ to 250 mJ
J-25MUV-193 (DB-25)	50 µJ to 100 mJ

Wide Dynamic Range for All EnergyMax Sensor Categories



EnergyMax - Laser Energy Sensors

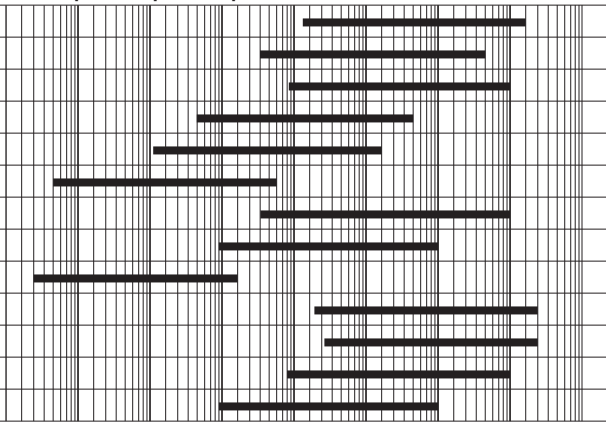
Introduction and Selection Charts

The following chart outlines the energy range for the "meterless" USB and RS-232 EnergyMax sensors. The meterless EnergyMax have a slightly different minimum energy specification compared to the standard models. See page 70 for typical dynamic range curves of the Quantum EnergyMax Sensor.

EnergyMax-USB/RS Energy Range Capabilities

Wide Dynamic Range for All EnergyMax Sensor Categories

Model	Energy Range
J-50MB-HE (USB/RS)	1.6 mJ to 2J
J-50MB-LE (USB/RS)	400 µJ to 500 mJ
J-25MB-HE (USB/RS)	850 µJ to 1J
J-25MB-LE (USB/RS)	50 µJ to 50 mJ
J-10MB-HE (USB/RS)	12 µJ to 20 mJ
J-10MB-LE (USB/RS)	500 nJ to 600 µJ
J-50MT-10KHZ (USB/RS)	400 µJ to 1J
J-25MT-10KHZ (USB/RS)	90 µJ to 100 mJ
J-10MT-10KHZ (USB/RS)	300 nJ to 200 µJ
J-50MB-YAG (USB/RS)	2.4 mJ to 3J
J-50MB-IR (USB/RS)	3.2 mJ to 3J
J-50MUV-248 w/Diffuser (USB/RS)	800 µJ to 1J
J-25MUV-193 (USB/RS)	90 µJ to 100 mJ



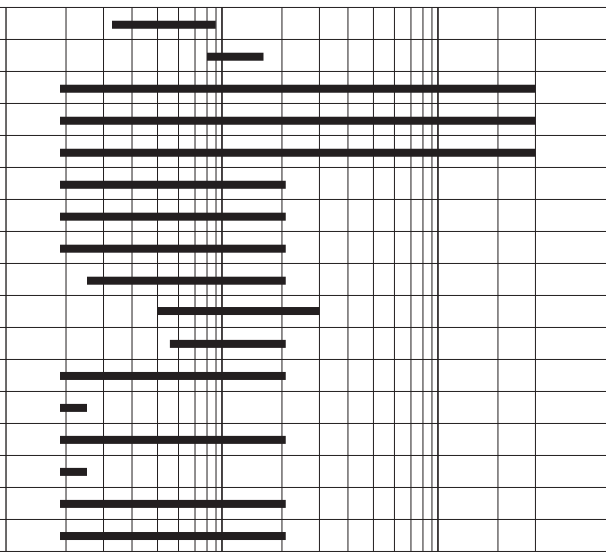
The next selection chart shows the range of wavelengths that can be measured with each sensor. This characteristic is coating dependent, so sensors with diffusers may have a narrower spectral range than similar sensors without diffusers.

The spectral compensation of each sensor is unique to that serial number, and is based upon spectral scans performed on each sensor disk (and on each optic if the sensor has a diffuser). The spectral compensation provides greater measurement accuracy for wavelengths that differ from the optical calibration wavelength.

EnergyMax Wavelength Capabilities

Wavelength (µm)

Model	Wavelength (µm)
J-10SI-HE & -LE	0.325 to 0.9
J-10GE	0.8 to 1.7
J-50MB-HE & -LE	0.19 to 12.0
J-25MB-HE & -LE	0.19 to 12.0
J-10MB-HE & -LE	0.19 to 12.0
J-50MT-10KHZ	0.19 to 2.1
J-25MT-10KHZ	0.19 to 2.1
J-10MT-10KHZ	0.19 to 2.1
J-50MB-YAG	0.266 to 2.1
J-50MB-IR	0.5 to 3.0
J-25MB-IR	0.532 to 2.1
J-50MUV-248 w/o Diffuser	0.19 to 2.1
J-50MUV-248 w/Diffuser	0.19 to 0.266
J-50MUV-193 w/o Diffuser	0.19 to 2.1
J-50MUV-193 w/Diffuser	0.19 to 0.266
J-25MUV-248	0.19 to 2.1
J-25MUV-193	0.19 to 2.1



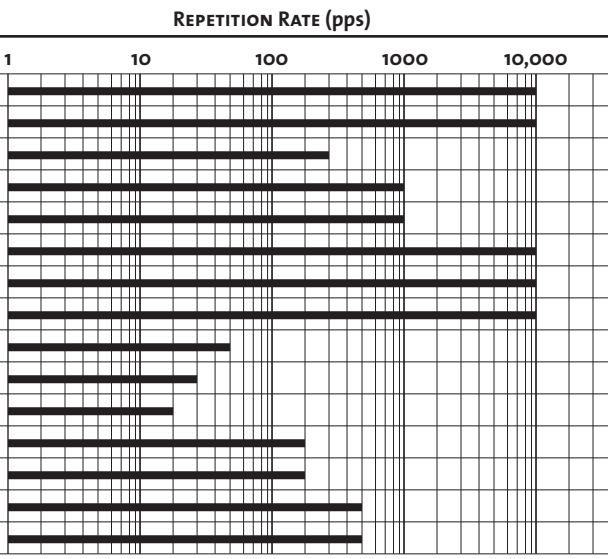
EnergyMax - Laser Energy Sensors

Introduction and Selection Charts

EnergyMax sensors are based upon pyroelectric technology and can therefore measure lasers at high repetition rates. The maximum repetition rate is primarily dependent upon the thermal resistance of the coating and the maximum pulse width the sensor is designed to measure. Refer to the specifications in product pages for maximum laser pulse width limitations.

EnergyMax Repetition Rate Capabilities

Model	Rep. Rate (pps)
J-10SI-HE & -LE	up to 10,000
J-10GE	up to 10,000
J-50MB-HE & -LE	up to 300
J-25MB-HE & -LE	up to 1000
J-10MB-HE & -LE	up to 1000
J-50MT-10KHZ	up to 10,000
J-25MT-10KHZ	up to 10,000
J-10MT-10KHZ	up to 10,000
J-50MB-YAG	up to 50
J-50MB-IR	up to 30
J-25MB-IR	up to 20
J-50MUV-248	up to 200
J-50MUV-193	up to 200
J-25MUV-248	up to 500
J-25MUV-193	up to 500



Before using a sensor, it is important to ensure that the laser beam will not damage the sensor coating. The damage threshold is also wavelength dependent, and maximum energy density thresholds are listed for common laser wavelengths in the table below. At other wavelengths it is safe to interpolate between the listed values.

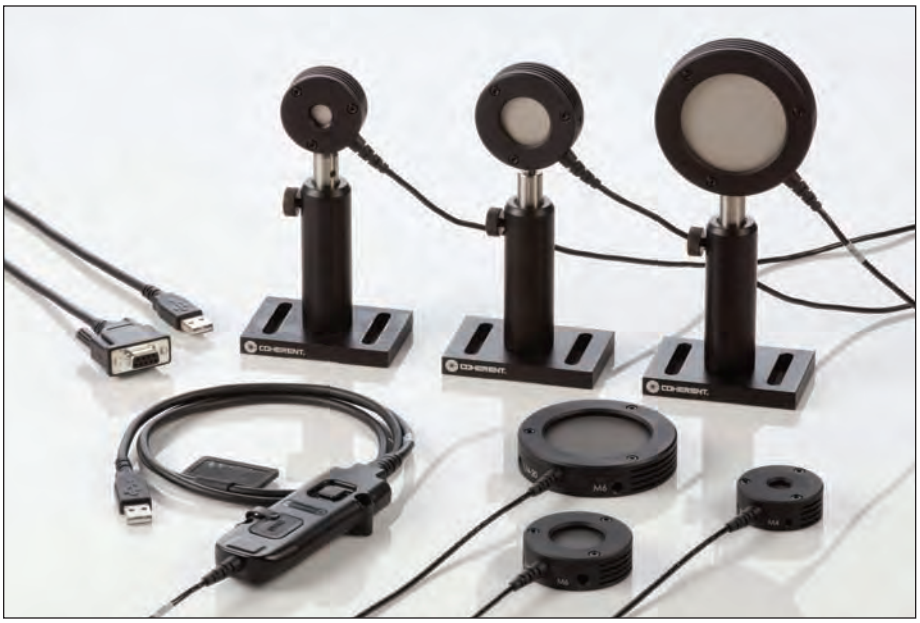
EnergyMax Damage Threshold Capabilities[1]

	Damage Threshold (mJ/cm²)					
Model	**193 nm**	**248 nm**	**266 nm**	**355 nm**	**532 nm**	**1064 nm**
J-50MB-HE	40	170	170	140	250	500
J-50MB-LE	40	170	170	140	250	500
J-25MB-HE	40	170	170	140	250	500
J-25MB-LE	40	170	170	140	250	500
J-10MB-HE	40	170	170	140	250	500
J-10MB-LE	40	170	170	140	250	500
J-50MT-10KHZ	150	200	200	390	500	500
J-25MT-10KHZ	150	200	200	390	500	500
J-10MT-10KHZ	40	40	40	50	50	50
J-50MB-YAG	–	–	1000	750	2800	14,000
J-25MB-IR	–	–	–	–	1500	5000
J-50MUV-248 w/o Diffuser	200	260	260	300	375	375
J-50MUV-248 w/Diffuser	400	520	520	–	–	–
J-50MUV-193 w/o Diffuser	200	260	260	300	375	375
J-50MUV-193 w/Diffuser	400	520	520	–	–	–
J-25MUV-248	200	260	260	300	375	375
J-25MUV-193	200	260	260	300	375	375

[1] Not applicable for Quantum EnergyMax sensors.

EnergyMax-USB/RS Sensors

Product Overview



Coherent's high performance EnergyMax sensors are also available in a meterless form factor with either RS-232 or USB 2.0 connectivity. This product range enables measurement of the energy per pulse or average power of pulsed lasers from the nanojoule to the multi-joule level, over wavelengths from the deep ultraviolet through the far infrared, and from single pulses to repetition rates of 10 kHz (with measurement of every pulse). Furthermore, multiple EnergyMax sensors can share a trigger (internal or external) for synchronized operation, such as to enable pulse ratiometry.

These meterless sensors are particularly attractive to system builders because their small size allows them to be easily embedded within instrumentation, and their RS-232 or USB communications capabilities facilitate automated operation by a host computer.

Furthermore, EnergyMax USB/RS sensors significantly reduce the user's overall cost of ownership by eliminating the need to purchase a separate, more costly meter with each sensor, and by reducing annual calibration costs associated with integrating the electronics into the sensor. These products are also useful in the lab and research setting because they can be used as standalone instruments with a computer, or integrated smoothly into any experiment with an automated control and data acquisition system.

The Meterless Advantage

Low Cost of Ownership

- **Lower initial price – because no separate meter**
- **Lower calibration cost – because electronics are integrated into sensor**
- **Easy to adapt with apps software and drivers**
- **Less costly multi-channel operation**

Embedded OEM Integration

- **Flexibility of RS-232 and USB PC interfaces**
- **Compact size**
- **Easy ASCII host commands**
- **USB sensors attach as virtual COM port**

State-of-the-Art Sensor Energy Technology

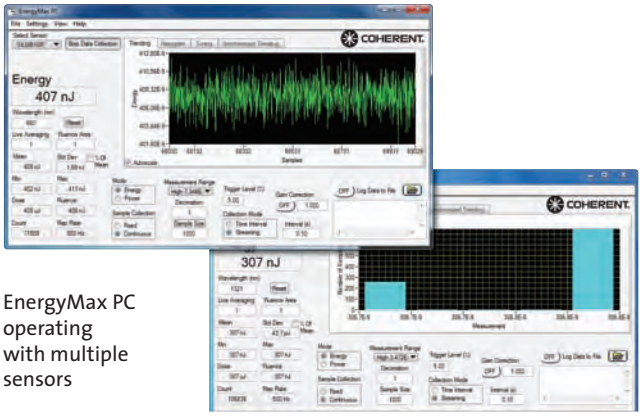
- **Based upon industry leading EnergyMax sensors**
- **High accuracy**
- **High damage threshold**
- **High repetition rate with large active areas**
- **High dynamic range**

EnergyMax-USB/RS Sensors

Product Overview

Main Product Features

- Able to measure every pulse up to 10 kHz and stream this data over the host port (USB only). RS-232 capable of measuring every pulse up to 10 Khz and streaming data over host port at a rate of 1 kHz.
- EnergyMax-USB provides direct USB high speed 2.0 connection to PC. Power provided via USB connection.
- EnergyMax-RS provides RS-232 connectivity. Power input provided via +4-20 VDC input.
- Fast 14-bit A/D converter supports measurement accuracy similar to that found in Coherent's top-of-the-line LabMax meter
- Up to five digits of measurement resolution
- Each sensor incorporates a unique spectral compensation curve for accurate use at wavelengths that differ from the calibration wavelength
- External and Internal triggering available
- Units can share triggers to provide synchronized measurements for applications such as ratiometry



EnergyMax PC operating with multiple sensors

Main Software Features

EnergyMax PC applications software is supplied free with sensor and includes the following features:

- Trending, tuning, histogram at data rate up to 1 kHz
- Statistics (mean, minimum, maximum, and standard deviation, dose, fluence, and missed pulses)
- Ability to log data to a file at up to 10kHz (in Turbo mode)
- Operate multiple devices simultaneously and perform synchronized ratiometery (A/B analysis). Trend and log results to file.

For system integration and for implementations involving customer written software the sensors provide an in depth command set that is easy to access:

- USB sensors connect on Virtual COM port, thus supporting simple ASCII host commands communication for remote interfacing
- National Instruments LabVIEW drivers are supplied for easy LabVIEW integration

EnergyMax PC in synchronized ratiometric trending mode

EnergyMax-USB/RS Sensors

MaxBlack Coating

Models J-50MB-HE, J-25MB-HE, J-10MB-HE

Features

- Unique MaxBlack coating increases damage threshold, allows high repetition rate operation, and improves mechanical durability
- Operate over the 190 nm to 12 µm range
- Enable pulse energy measurements from 500 nJ to 2J with high signal-to-noise characteristics
- Measure single shot to 1 kHz repetition rate
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation

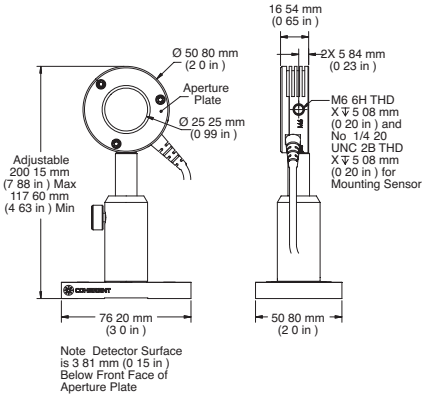
These sensors allow measurements over a wide range of wavelengths, beam diameters, average power levels, and repetition rates. The MaxBlack coating on these sensors provides significant damage resistance and mechanical durability characteristics compared to the black paint coatings often used on broadband sensors in the past.

Device Specifications

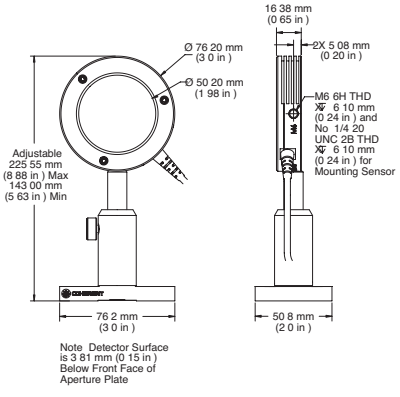
ilac-MRA ACLASS ACCREDITED CALIBRATION AC-1630

Model	J-50MB-HE	J-50MB-LE	J-25MB-HE	J-25MB-LE	J-10MB-HE	J-10MB-LE
Energy Range	1.6 mJ to 2J	400 µJ to 500 mJ	850 µJ to 1J	50 µJ to 50 mJ	12 µJ to 20 mJ	500 nJ to 600 µJ
Noise Equivalent Energy	<160 µJ	<40 µJ	<85 µJ	<5 µJ	<1.2 µJ	<50 nJ
Wavelength Range (µm)	0.19 to 12					
Active Area Diameter (mm)	50	50	25	25	10	10
Maximum Average Power (W)	10	10	5	5	4	4
Maximum Pulse Width (µs)	57		17			
Maximum Repetition Rate (pps)	300	300	1000	1000	1000	1000
Maximum Energy Density (mJ/cm²)	500 (at 1064 nm, 10 ns)					
Detector Coating	MaxBlack					
Diffuser	No					
Calibration Wavelength (nm)	1064					
Calibration Uncertainty (%)(k=2)	±2					
Energy Linearity (%)	±3					
Cable Length (m)	3					
Cable Type	USB and RS					
Part Number						
USB	1191444	1191443	1191442	1191441	1191436	1191435
RS	1191432	–	–	1191431	1191429	1191428

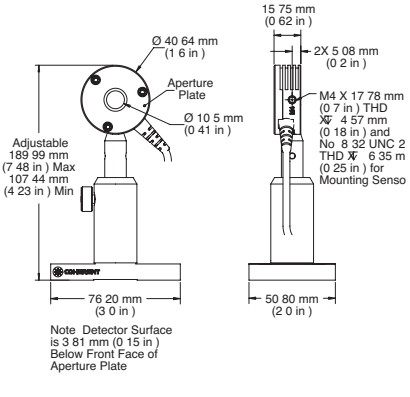
J-25MB-HE and -LE



J-50MB-HE and -LE



J-10MB-HE and -LE



EnergyMax-USB/RS Sensors

Diffuse Metallic Coating

Models J-50MT-10KHZ, J-25MT-10KHZ, J-10MT-10KHZ

Features

- Unique diffuse metallic coating delivers increased damage threshold, allows high repetition rate operation and reduces specular reflectance
- Operate over the entire 190 nm to 2.1 µm range
- Enable pulse energy measurements from 300 nJ to 1J with high signal-to-noise characteristics
- Measure every pulse up to 10 kHz repetition rate
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation*

These sensors use a diffuse metallic coating that enables measurements at high and low repetition rates across a wide range of energies, wavelengths and beam sizes. The damage resistance at 532 nm and shorter wavelengths is even greater than the MaxBlack coating. These are great all-purpose sensors for the 190 nm to 2.1 µm region and offer the lowest energy range of our EnergyMax line.

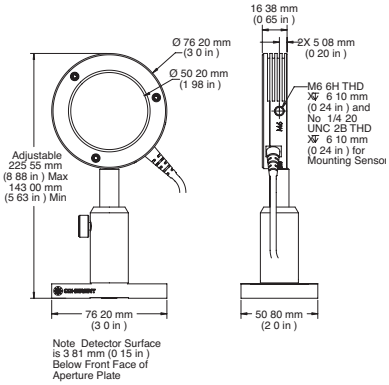
Device Specifications

ilac-MRA ACLASS ACCREDITED CALIBRATION AC-1630

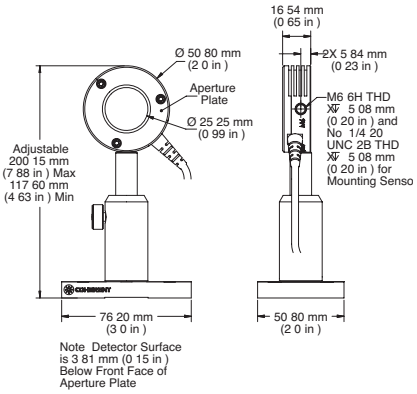
Model	J-50MT-10KHZ	J-25MT-10KHZ	J-10MT-10KHZ
Energy Range	400 µJ to 1J	90 µJ to 100 mJ	300 nJ to 200 µJ
Noise Equivalent Energy	<40 µJ	<9 µJ	<30 nJ
Wavelength Range (µm)	0.19 to 2.1		
Active Area Diameter (mm)	50	25	10
Maximum Average Power (W)	20	10	1
Maximum Pulse Width (µs)	1.7		
Maximum Repetition Rate (pps)	10,000		
Maximum Energy Density (mJ/cm²)	500 (at 1064 nm, 10 ns)		50 (at 1064 nm, 10 ns)
Detector Coating	Diffuse Metallic		
Diffuser	No		
Calibration Wavelength (nm)	1064		
Calibration Uncertainty (%)(k=2)	±2		
Energy Linearity (%)	±3		
Cable Length (m)	3		
Cable Type	USB and RS		
Part Number			
USB	1191447	1191446	1191445
RS	1191433	–	–

* Except J-10MT-10KHZ.

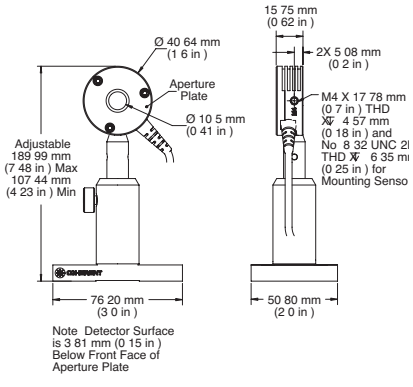
J-50MT-10KHZ



J-25MT-10KHZ



J-10MT-10KHZ



EnergyMax-USB/RS Sensors

MaxBlack Coating and Diffusers

Model J-50MB-YAG

Features

- **Very high energy and peak power handling capabilities**
- **Operate at Nd: YAG fundamental and harmonics**
- **Enable pulse energy measurements from 2.4 mJ to 15J**
- **Spectral compensation characteristics built into each unit**
- **Onboard sensors provide automatic temperature compensation**
- **No need to either change diffusers during use or perform your own spectral calibrations**

These sensors are specifically designed for high energy and high peak power lasers operating at relatively low repetition rates, such as those based on Nd:YAG, Ruby, Ho:YAG and Erbium. The J-50MB-YAG sensor can be used with beams up to 35 mm in diameter and can work at 1064 nm, 532 nm, 355 nm and 266 nm without the need to change or self-calibrate diffusers or any other accessories. Sensors combine a MaxBlack coating and a diffuser to produce superior damage resistance characteristics. This combination enables operation with lasers that produce either very high energy per pulse or very high peak fluences.

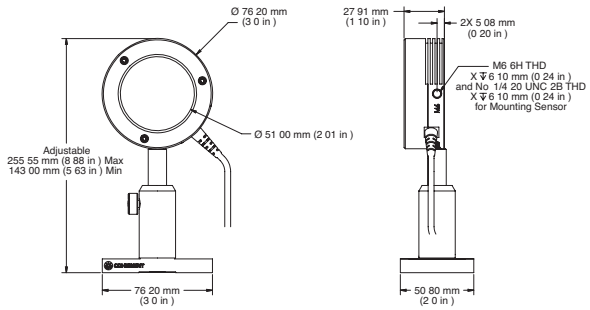
Device Specifications

ilac-MRA ACLASS ACCREDITED CALIBRATION AC-1630

Model	J-50MB-YAG	J-50MB-YAG-1528	J-50MB-YAG-1535
Energy Range	2.4 mJ to 3J	2.4 mJ to 3J	12 mJ to 15J
Noise Equivalent Energy (µJ)		<240	
Wavelength Range (µm)		0.266 to 2.1	
Maximum Beam Size (mm)		35	
Maximum Average Power (W)		20	
Maximum Pulse Width	340 µs	57 µs	2 ms[1]
Maximum Repetition Rate (pps)	50	300	10
Maximum Energy Density (J/cm²)		14.0 (at 1064 nm, 10 ns) 2.8 (at 532 nm, 10 ns) 0.75 (at 355 nm, 10 ns) 1.0 (at 266 nm, 10 ns)	
Detector Coating		MaxBlack	
Diffuser		YAG	
Calibration Wavelength (nm)		1064	
Calibration Uncertainty (%)(k=2)		±2	
Energy Linearity (%)		±3	
Cable Length (m)		3	
Cable Type		USB and RS	
Part Number			
USB	1191437	1191439	1191438
RS	1191430		1219962

[1] Pulsewidths up to 5 ms can be measured with an additional ±1% uncertainty.

J-50MB-YAG



EnergyMax-USB/RS Sensors

MaxBlack Coating and Diffusers

Model J-50MB-IR

Features

- Very high energy and peak power handling capabilities
- Operate throughout the IR
- Enable pulse energy measurements from 3.2 mJ to 15J
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation
- No need to either change diffusers during use or perform your own spectral calibrations

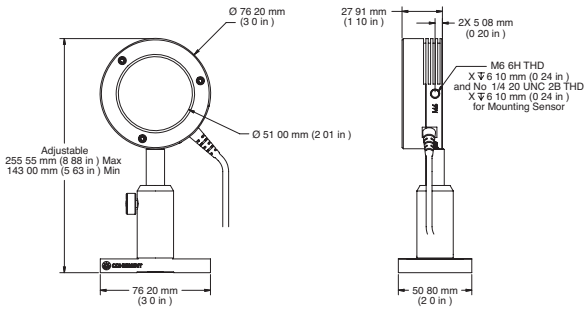
This sensor is much like the J-50MB-YAG on the previous. The difference is the J-50MB-IR has been designed for use farther into the infrared for use in medical applications using Erbium and Holmium lasers.

Device Specifications

ilac-MRA ACLASS ACCREDITED CALIBRATION AC-1630

Model	J-50MB-IR
Energy Range	3.2 mJ to 3J
Noise Equivalent Energy (µJ)	<320
Wavelength Range (µm)	0.5 to 3.0
Maximum Beam Size (mm)	30
Maximum Average Power (W)	15
Maximum Pulse Width (µs)	1000
Maximum Repetition Rate (pps)	30
Maximum Energy Density (J/cm²)	>100 (at 2940 nm, 100 µs)
Detector Coating	MaxBlack
Diffuser	IR
Calibration Wavelength (nm)	1064, 2940
Calibration Uncertainty (%)(k=2)	±2
Energy Linearity (%)	±3.5
Cable Length (m)	3
Cable Type	USB and RS
Part Number	
USB	1191440
RS	–

J-50MB-IR



EnergyMax-USB/RS Sensors

MaxUV Coating

Models J-50MUV-248 and J-25MUV-193

Features

- Unique MaxUV coating delivers highest DUV damage threshold and long-term UV exposure resistance
- Operate over the 190 nm to 2.1 µm range
- Enable pulse energy measurements from 90 µJ to 1J
- Measure up to 400 Hz repetition rate
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation

MaxUV-coated EnergyMax sensors are specifically optimized for use with ArF lasers operating at 193 nm and KrF lasers at 248 nm. These sensors feature high accuracy and large active areas (up to 50 mm), and use a unique coating called MaxUV that delivers superior long-term damage resistance.

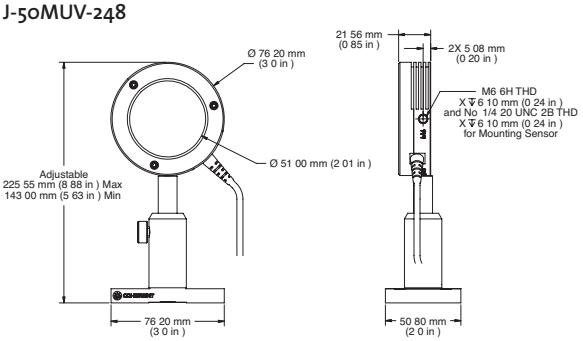
The 50 mm diameter models incorporate a DUV quartz diffuser for increased resistance to coating damage.

Device Specifications

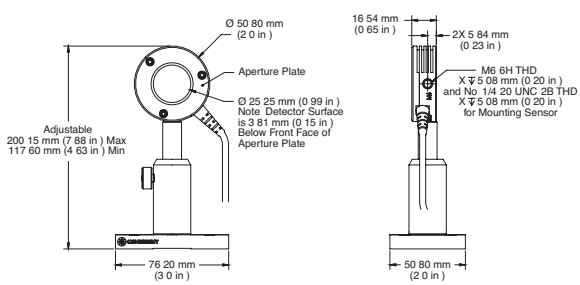
ilac-MRA ACLASS ACCREDITED CALIBRATION AC-1630

Model	J-50MUV-248 w/Diffuser	J-25MUV-193 w/o Diffuser
Energy Range	800 µJ to 1J	90 µJ to 100 mJ
Noise Equivalent Energy (µJ)	<80	<9
Wavelength Range (µm)	0.19 to 0.266	0.19 to 2.1
Active Area Diameter (mm)	50	25
Max. Average Power (W)	15	5
Max. Pulse Width (µs)	86	43
Max. Rep. Rate (pps)	200	500
Max. Energy Density (mJ/cm²)	520 (at 248 nm, 10 ns)	200 (at 193 nm, 10 ns)
Detector Coating	MaxUV	
Diffuser	DUV	No
Calibration Wavelength (nm)	248	193
Calibration Uncertainty (%)(k=2)	±3	
Energy Linearity (%)	±3	
Cable Length (m)	3	
Cable Type	USB	
Part Number USB	1191449	1191448

J-50MUV-248



J-25MUV-193



EnergyMax-USB/RS Sensors

Quantum Series

Model J-10SI-HE

Features

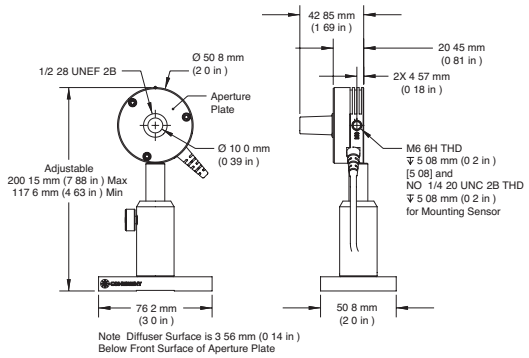
- **Pulse enegy measurement down to 750 pJ**
- **Average power measurement of pulsed sources from nW to mW level signal-to-noise characteristics**
- **Measures every pulse to 10,000 Hz**
- **Accurate spectral compensation - 325 nm to 900 nm**

Quantum EnergyMax sensors enable low energy pulse measurements as well as average power of pulsed systems from the nW to mW level, across a broad range of wavelengths. These sensors have a removable light shield on the front used to block stray light.

Device Specifications

Model	J-10SI-HE
Energy Range	750 pJ to 775 nJ (at 532 nm)
Noise Equivalent Energy (pJ)	<75 (at 532 nm)
Wavelength Range (nm)	325 to 900
Active Area Diameter (mm)	10
Max. Avg. Power (mW)	60
Max. Pulse Width (µs)	1
Max. Rep. Rate (pps)	10,000
Sensor	Silicon
Diffuser	ND2
Calibration Wavelength (nm)	532
Calibration Uncertainty (%)(k=2)	±3
Linearity (%)	±3
Cable Length (m)	3
Cable Type	USB and RS
Part Number	
USB	1191434
RS	1191427

J-10SI-HE



EnergyMax-USB/RS Sensors

Quantum Series

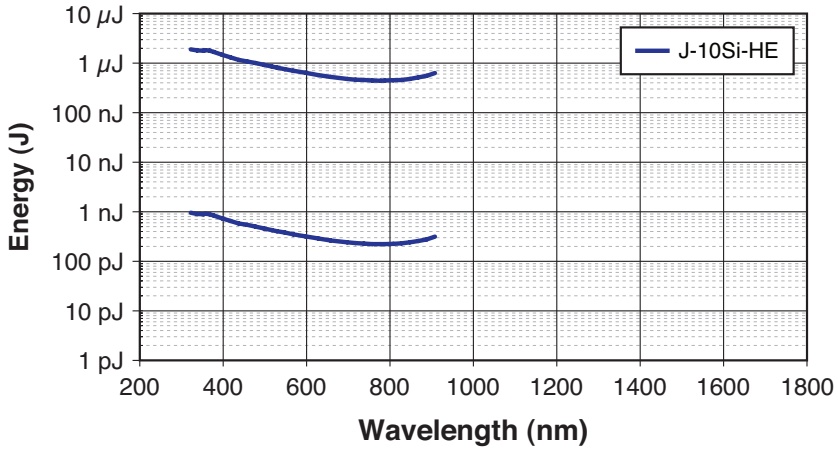
The Quantum EnergyMax sensor incorporates a Silicon photodiode, contains a large 10 mm clear aperture and operates at a repetition rate from single pulse up to 10 kHz (every pulse).

The main difference between a Quantum EnergyMax sensor and other Coherent EnergyMax sensors is their sensitivity. A Quantum EnergyMax sensor is capable of measuring considerably smaller signals than the rest of the EnergyMax sensor line. They do this by utilizing a photodiode—rather than a pyroelectric—element.

Due to the quantum nature of their response, photodiode sensors are inherently more sensitive than pyroelectric sensors, which are thermal-based. One consequence of this extra sensitivity is the possibility of measurement error or noise from stray modulated light sources (for example, stray reflections or room lights) in a laboratory environment. For this reason Quantum EnergyMax sensors are designed for use with a small integrated input beam tube, which limits the field of view of the sensor aperture. This tube is removable for alignment purposes and custom applications.

The following chart plots the minimum and maximum measurable energy across all wavelengths. This chart can be used to determine the measurable energy range for wavelengths other than that in the specifications table (532 nm).

Spectral Sensitivity Curves for Quantum EnergyMax Sensor



EnergyMax Sensors - Standard DB-25

MaxBlack Coating

J-50MB-HE, J-25MB-HE, J-10MB-HE

Features

- Unique MaxBlack coating increases damage threshold, allows high repetition rate operation, and improves mechanical durability
- Operate over the 190 nm to 12 µm range
- Enable pulse energy measurements from 300 nJ to 2J with high signal-to-noise characteristics
- Measure single shot to 1 kHz repetition rate
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation

These sensors allow measurements over a wide range of wavelengths, beam diameters, average power levels, and repetition rates. The MaxBlack coating on these sensors provides significant damage resistance and mechanical durability characteristics compared to the black paint coatings often used on broadband sensors in the past.

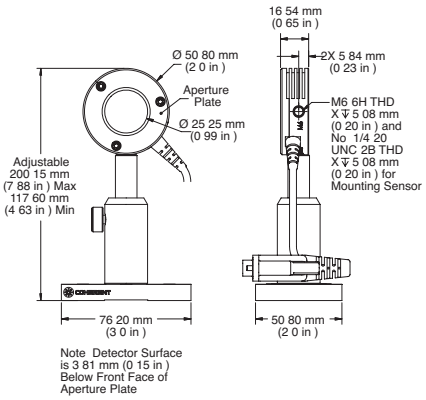
Device Specifications

Model	J-50MB-HE	J-50MB-LE	J-25MB-HE	J-25MB-LE	J-10MB-HE	J-10MB-LE
Energy Range	1 mJ to 2J	250 µJ to 500 mJ	500 µJ to 1J	25 µJ to 50 mJ	10 µJ to 20 mJ	300 nJ to 600 µJ
Noise Equivalent Energy	<33 µJ	<8 µJ	<16 µJ	<1 µJ	<0.5 µJ	<20 nJ
Wavelength Range (µm)	0.19 to 12					
Active Area Diameter (mm)	50	50	25	25	10	10
Maximum Average Power (W)[1]	10	10	5	5	4	4
Maximum Pulse Width (µs)	57		17			
Maximum Repetition Rate (pps)	300	300	1000	1000	1000	1000
Maximum Energy Density (mJ/cm²)	500 (at 1064 nm, 10 ns)					
Detector Coating	MaxBlack					
Diffuser	No					
Calibration Wavelength (nm)	1064					
Calibration Uncertainty (%)(k=2)	±2					
Energy Linearity (%)	±3					
Cable Length (m)[2]	2.5					
Cable Type	J DB-25					
Part Number	1110573	1110576	1110746	1110743	1110843	1110855

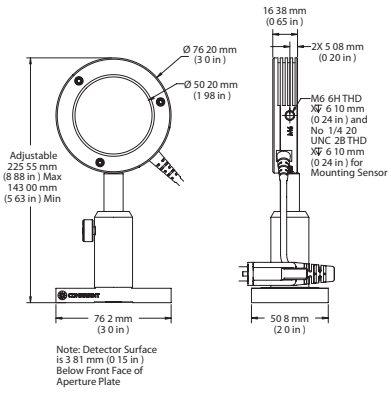
[1] Extend average power range with optional heat sink. See page 57 and 78.

[2] Cable lengths up to 10m possible. Contact factory.

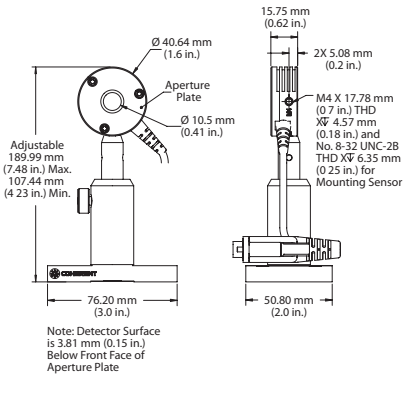
J-25MB-HE and -LE



J-50MB-HE and -LE



J-10MB-HE and -LE



EnergyMax Sensors - Standard DB-25

Diffuse Metallic Coating

J-50MT-10KHZ, J-25MT-10KHZ, J-10MT-10KHZ

Features

- **Unique diffuse metallic coating delivers increased damage threshold, allows high repetition rate operation and reduces specular reflectance**
- **Operate over the entire 190 nm to 2.1 µm range**
- **Enable pulse energy measurements from 100 nJ to 1J with high signal-to-noise characteristics**
- **Measure up to 10 kHz repetition rate**
- **Spectral compensation characteristics built into each unit**
- **Onboard sensors provide automatic temperature compensation[1]**

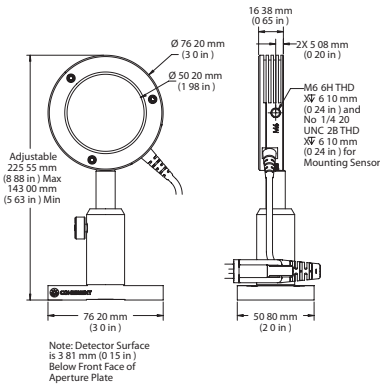
These sensors incorporate a diffuse metallic coating that enables measurements at high and low repetition rates across a wide range of energies, and wavelengths from 190 nm to 2.1 µm. The damage resistance at 532 nm and shorter wavelengths is higher than the MaxBlack coating. These sensors are not compatible with FieldMaxII meters because the response time is too fast. They are best suited for the LabMax-TOP meter.

Device Specifications

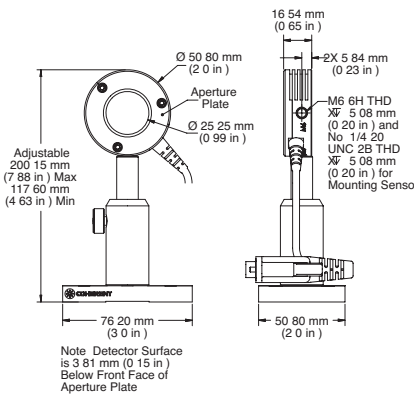
Model	J-50MT-10KHZ	J-25MT-10KHZ	J-10MT-10KHZ
Energy Range	500 µJ to 1J[2]	50 µJ to 100 mJ	100 nJ to 200 µJ
Noise Equivalent Energy	<16 µJ	<2 µJ	<10 nJ
Wavelength Range (µm)		0.19 to 2.1	
Active Area Diameter (mm)	50	25	10
Maximum Average Power (W)[3]	20	10	1
Maximum Pulse Width (µs)		1.7	
Maximum Repetition Rate (pps)		10,000	
Maximum Energy Density (mJ/cm²)	500 (at 1064 nm, 10 ns)		50 (at 1064 nm, 10 ns)
Detector Coating		Diffuse Metallic	
Diffuser		No	
Calibration Wavelength (nm)		1064	
Calibration Uncertainty (%)(k=2)		±2	
Energy Linearity (%)		±3	
Cable Length (m)[4]		2.5	
Cable Type		J DB-25	
Part Number	1110574	1110747	1110856

[1] Except J-10MT-10KHZ.
[2] Optional energy range 50 µJ to 100 mJ available.
[3] Extend average power range with optional heat sink. See page 57 and 78.
[4] Cable lengths up to 10m possible. Contact factory.

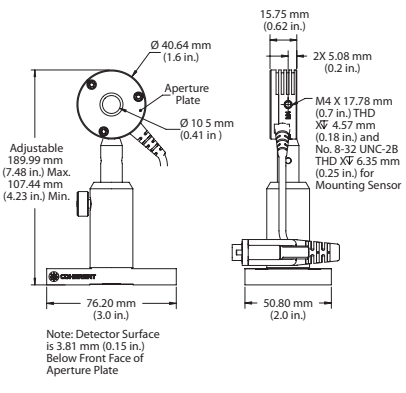
J-50MT-10KHZ



J-25MT-10KHZ



J-10MT-10KHZ



EnergyMax Sensors - Standard DB-25

MaxBlack Coating and Diffusers

J-50MB-YAG

Features

- High energy and peak power to 14 J/cm²
- Operate at Nd: YAG fundamental and harmonics
- Enable pulse energy measurements from 1 mJ to 15J
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation

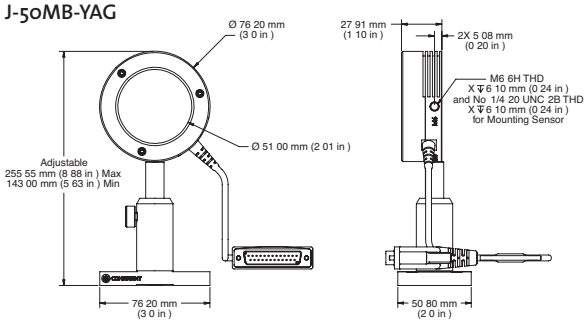
These sensors are specifically designed for high energy and high peak power lasers operating at relatively low repetition rates, such as those based on Nd:YAG, Ruby, Ho:YAG and Erbium. The J-50MB-YAG sensor can be used with beams up to 35 mm in diameter and can work at 1064 nm, 532 nm, 355 nm and 266 nm without the need to change or self-calibrate diffusers or any other accessories. Sensors combine a MaxBlack coating and a diffuser to produce superior damage resistance characteristics. This combination enables operation with lasers that produce either very high energy per pulse or very high peak fluences.

Device Specifications

Model	J-50MB-YAG	J-50MB-YAG-1528	J-50MB-YAG-1535	J-50MB-YAG-1561
Energy Range	1.5 mJ to 3J	1.5 mJ to 3J	12 mJ to 15J	50 µJ to 100 mJ
Noise Equivalent Energy (µJ)	<50			
Wavelength Range (µm)	0.266 to 2.1			
Maximum Beam Size (mm)	35			
Maximum Average Power (W)[1]	20			
Maximum Pulse Width	340 µs	57 µs	2 ms[2]	340 µs
Maximum Repetition Rate (pps)	50	300	10	50
Maximum Energy Density (J/cm²)	14.0 (at 1064 nm, 10 ns) 2.8 (at 532 nm, 10 ns) 0.75 (at 355 nm, 10 ns) 1.0 (at 266 nm, 10 ns)			
Detector Coating	MaxBlack			
Diffuser	YAG			
Calibration Wavelength (nm)	1064			
Calibration Uncertainty (%)(k=2)	±2			
Energy Linearity (%)	±3			
Cable Length (m)[3]	2.5			
Cable Type	J DB-25			
Part Number	1110744	1144701	1151431	1174756

[1] Extend average power range with optional heat sink. See page 57 and 78.
[2] Pulsewidths up to 5 ms can be measured with an additional ±1% uncertainty.
[3] Cable lengths up to 10m possible. Contact factory.

J-50MB-YAG



EnergyMax Sensors - Standard DB-25

MaxBlack Coating and Diffusers

J-50MB-IR and J-25MB-IR

Features

- High energy and peak power
- Operate throughout the IR
- Enable pulse energy measurements from 1 mJ to 3J
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation

These sensors are specifically designed for high energy and high peak power medical lasers operating at relatively low repetition rates, such as those based on Ruby, Ho:YAG and Erbium. Both sensors combine a MaxBlack coating and a diffuser to produce superior damage resistance characteristics. This combination enables operation with lasers that produce either very high energy per pulse or very high peak fluences.

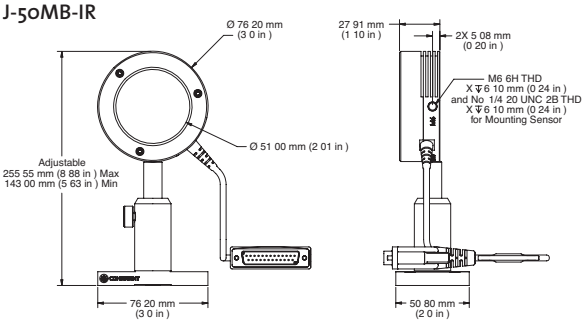
Device Specifications

ilac-MRA ACLASS ACCREDITED CALIBRATION AC-1630

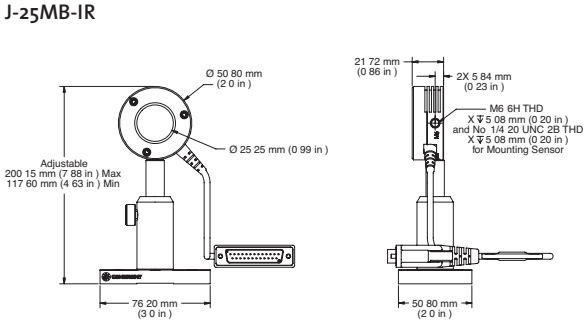
Model	J-50MB-IR	J-25MB-IR
Energy Range	1.0 mJ to 3J	1.5 mJ to 3J
Noise Equivalent Energy (µJ)	<100	<50
Wavelength Range (µm)	0.5 to 3.0	0.532 to 2.1
Maximum Beam Size (mm)	30	12.5
Maximum Average Power (W)[1]	15	20
Maximum Pulse Width (µs)	1000	860
Maximum Repetition Rate (pps)	30	20
Maximum Energy Density (J/cm²)	>100 (at 2940 nm, 100 µs)	5.0 (at 1064 nm, 10 ns)
Detector Coating	MaxBlack	
Diffuser	IR	
Calibration Wavelength (nm)	1064, 2940	1064
Calibration Uncertainty (%)(k=2)	±2	±3
Energy Linearity (%)	±3.5	±3
Cable Length (m)[2]	2.5	
Cable Type	J DB-25	
Part Number	1155722	1110577

[1] Extend average power range with optional heat sink. See page 57 and 78.
[2] Cable lengths up to 10m possible. Contact factory.

J-50MB-IR



J-25MB-IR



EnergyMax Sensors - Standard DB-25

MaxUV Coating

J-50MUV-248 and J-25MUV-248

Features

- Unique MaxUV coating delivers highest DUV damage threshold and long-term UV exposure resistance
- Operate over the 190 nm to 2.1 µm range
- Enable pulse energy measurements from 50 µJ to 1J
- Measure up to 400 Hz repetition rate
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation

MaxUV-coated EnergyMax sensors are specifically optimized for use with ArF lasers operating at 193 nm and KrF lasers at 248 nm. These sensors feature high accuracy and large active areas (up to 50 mm), and use a unique coating called MaxUV that delivers superior long-term damage resistance.

Two of the 50 mm diameter models incorporate a DUV quartz diffuser for increased resistance to coating damage.

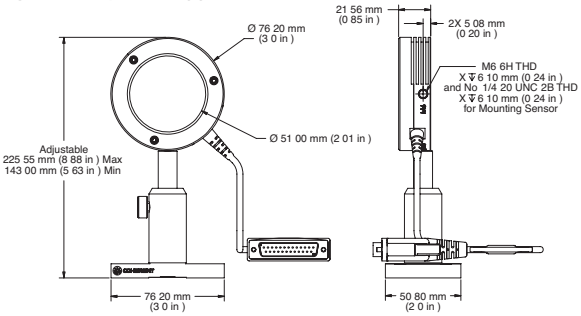
Device Specifications

Model	J-50MUV-248 w/o Diffuser	J-50MUV-248 w/Diffuser	J-50MUV-193 w/o Diffuser	J-50MUV-193 w/Diffuser	J-25MUV-248 w/o Diffuser	J-25MUV-193 w/o Diffuser
Energy Range	500 µJ to 1J	500 µJ to 1J	125 µJ to 250 mJ	125 µJ to 250 mJ	125 µJ to 250 mJ	50 µJ to 100 mJ
Noise Equivalent Energy (µJ)	<16	<16	<4	<4	<4	<2
Wavelength Range (µm)	0.19 to 2.1	0.19 to 0.266	0.19 to 2.1	0.19 to 0.266	0.19 to 2.1	0.19 to 2.1
Active Area Diameter (mm)	50	50	50	50	25	25
Max. Average Power (W)[1]	10	15	10	18	5	5
Max. Pulse Width (µs)	86	86	86	86	43	43
Max. Rep. Rate (pps)	200	200	200	200	500	500
Max. Energy Density (mJ/cm^2)	260 (at 248 nm, 10 ns)	520 (at 248 nm, 10 ns)	200 (at 193 nm, 10 ns)	400 (at 193 nm, 10 ns)	260 (at 248 nm, 10 ns)	200 (at 193 nm, 10 ns)
Detector Coating	MaxUV					
Diffuser	No	DUV	No	DUV	No	No
Calibration Wavelength (nm)	248	248	193	193	248	193
Calibration Uncertainty (%)(k=2)	±3					
Energy Linearity (%)	±3					
Cable Length (m)[2]	2.5					
Cable Type	J DB-25					
Part Number	1146243	1110572	1146237	1110575	1110745	1110741

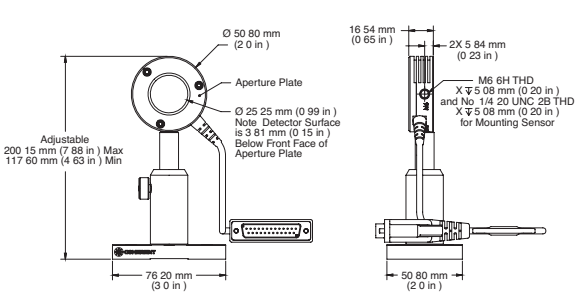
[1] Extend average power range with optional heat sink. See page 57 and 78.

[2] Cable lengths up to 10m possible. Contact factory.

J-50MUV-248 and -193



J-25MUV-248 and -193



EnergyMax Sensors - Standard DB-25

Quantum Series

J-10SI-LE

Features

- Pulse enegy measurement down to 8 pJ (within line; model dependent)
- Average power measurement of pulsed sources from nW to mW level signal-to-noise characteristics
- Measures single pulses to 10,000 Hz
- Accurate spectral compensation
  - 325 nm to 900 nm for Silicon
  - 800 nm to 1700 nm for Germanium
- Robust and reliable construction

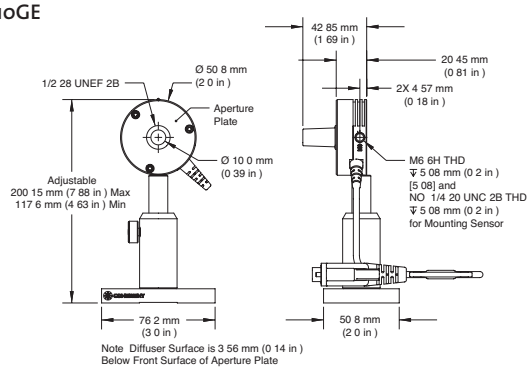
Quantum EnergyMax sensors enable low energy pulse measurements down to the 8 pJ level , as well as average power of pulsed systems from the nW to mW level, across a broad range of wavelengths. These models are not compatible with FieldMaxII meters because the response time is too fast. They are best suited for the LabMax-TOP meter. These sensors have a removable light shield on the front used to block stray light.

Device Specifications

Model	J-10SI-LE	J-10SI-HE	J-10GE
Energy Range	8 pJ to 80 nJ (at 532 nm)	60 pJ to 775 nJ (at 532 nm)	200 pJ to 600 nJ (at 1064 nm)
Noise Equivalent Energy	<0.8 pJ (at 532 nm)	<6 pJ (at 532 nm)	<8 pJ (at 1064 nm)
Wavelength Range (nm)	325 to 900	325 to 900	800 to 1700
Active Area Diameter (mm)	10	10	10
Max. Avg. Power (mW)	6	60	15
Max. Pulse Width (µs)	1	1	1
Max. Rep. Rate (pps)	10,000	10,000	10,000
Sensor	Silicon	Silicon	Germanium
Diffuser	ND2	ND2	ND2
Calibration Wavelength (nm)	532	532	1064
Calibration Uncertainty (%)(k=2)	±3	±3	±3
Linearity (%)	±3	±3	±3
Cable Length (m)[1]	3	3	3
Cable Type	J DB-25	J DB-25	J DB-25
Part Number	1140727	1150146	1140408

[1] Cable lengths up to 10m possible. Contact factory.

J-10SI-LE and -HE/J10GE



EnergyMax Sensors - Standard DB-25

Quantum Series

The Quantum EnergyMax series consists of three different models that provide very low pulse energy measurement down to 20 pJ. Two of the models (J-10SI-LE and J-10SI-HE) incorporate a Silicon photodiode, and one model (J-10GE) incorporates a Germanium photodiode. All three models contain large 10 mm clear apertures and operate at repetition rates from single pulse up to 10 kHz.

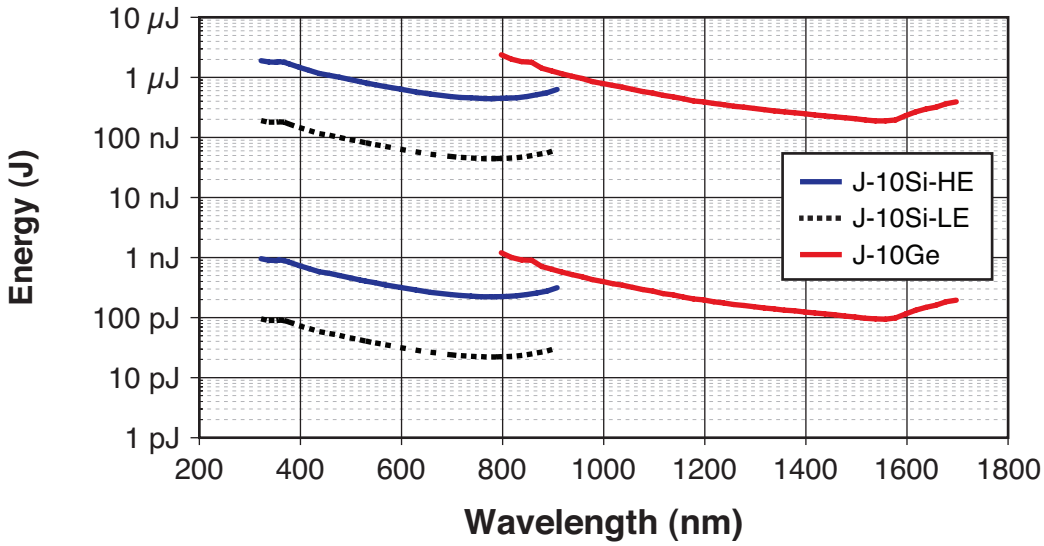
The main difference between Quantum EnergyMax sensors and other Coherent EnergyMax sensors is their sensitivity. Quantum EnergyMax sensors are capable of measuring considerably smaller signals than the rest of the EnergyMax sensor line. They do this by utilizing a photodiode—rather than a pyroelectric—element.

Due to the quantum nature of their response, photodiode sensors are inherently more sensitive than pyroelectric sensors, which are thermal-based. One consequence of this extra sensitivity is the possibility of measurement error or noise from stray modulated light sources (for example, stray reflections or room lights) in a laboratory environment. For this reason Quantum EnergyMax sensors are designed for use with a small integrated input beam tube, which limits the field of view of the sensor aperture. This tube is removable for alignment purposes and custom applications.

The following chart plots the minimum and maximum measurable energy of each sensor across all wavelengths. This chart can be used to determine the measurable energy range for wavelengths other than those in the specifications table (1064 nm and 532 nm).

LabMax-TOP and J-10SI-LE

Spectral Sensitivity Curves for Quantum EnergyMax Sensors



EnergyMax Accessories

Heat Sinks

EnergyMax Heat Sinks

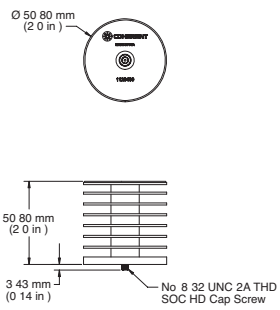
Features

- Extend EnergyMax average power
- Easily attach to EnergyMax sensors in the field
- Two heat sinks for 25 mm sensors (small and medium)
- One heat sink for 50 mm sensors (large)

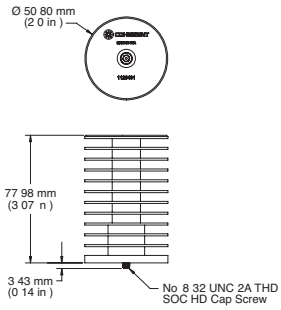
These heat sink accessories can be used to extend the energy and repetition rates of EnergyMax sensors by increasing the average power capability. Easily installed, they are simply theaded onto the back of a sensor housing with a cap screw retained within the heat sink.

See Average Power Capability table on page 57 for sensor specifications.

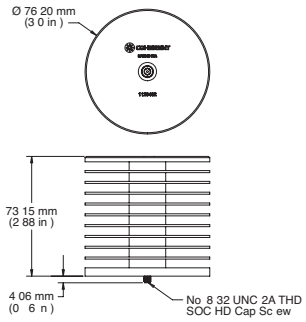
Small Heat Sink



Medium Heat Sink



Large Heat Sink



Part Number	Description
1123430	Small Heat Sink
1123431	Medium Heat Sink
1123432	Large Heat Sink

Post and Stand

2-inch and 3-inch Post/Stand Assembly

Part Number	Description
1136565	2-inch Height Post/Stand Assembly
1136566	3-inch Height Post/Stand Assembly (ships with all EnergyMax Sensors)

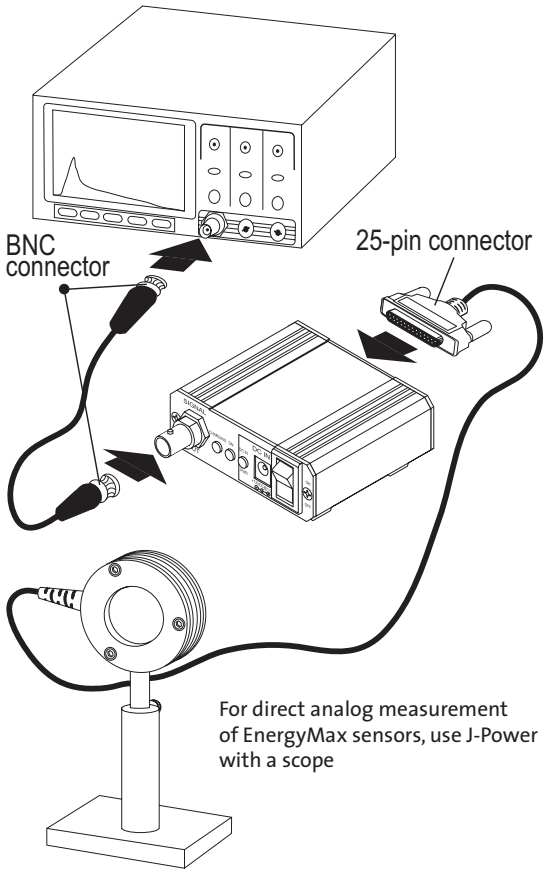
EnergyMax Accessories

J-Power Energy Sensor DB-25-to-BNC Adapter

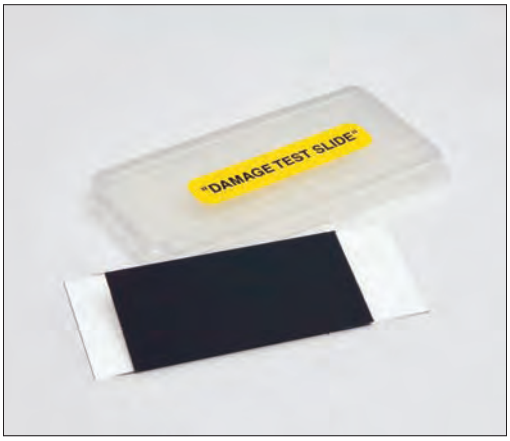
J-Power

The J-Power is a compact sensor adapter that powers the EnergyMax active sensor circuit and passes the raw output voltage of the sensor directly to the BNC connector. The peak voltage of the output (as referenced from baseline voltage) can then be measured using an oscilloscope or other analog-to-digital input device. The calibrated peak voltage represents the integrated energy of the laser pulse.

Part Number	Description
1132205	J-Power Energy Sensor Adapter



Pyroelectric Sensor Test Slides



Test Slides

For protection of your sensor when measuring unknown beams, the test slide is inserted into the beam and then examined for damage. These test slides are coated with the same absorbing coating as the pyroelectric sensors. If coating damage is visible, then attenuation is required before measuring the beam.

Part Number	Description
0011-4311	Pyroelectric Test Slide – Black Coating (used with legacy sensors)
1129175	Pyroelectric Test Slide – Diffuse Metallic Coating
0011-4313	Pyroelectric Test Slide – MUV Coating
0011-4314	Pyroelectric Test Slide – MB Coating

EnergyMax - Laser Energy Sensors

Measuring Energy with an Oscilloscope

To measure the energy of very high repetition rate and/or low-energy lasers, an oscilloscope can be used to monitor the output of an EnergyMax sensor.

This page presents a step-by-step procedure for setting up an oscilloscope and using a pyroelectric EnergyMax sensor to accurately read a peak voltage output.

1. To assure the accuracy of a pulse energy measurement, make sure the oscilloscope is calibrated properly. Also check the date for when the oscilloscope is due for recalibration.

2. Select a scope that has a sensitivity of at least 2 mV and a bandwidth of at least 20 MHz.

3. To connect an EnergyMax sensor to an oscilloscope you will need a J-POWER DB25-to-BNC accessory (available from Coherent).

4. Use the 1 Mohm input impedance of the oscilloscope when connecting any EnergyMax sensor.

5. Set up the scope as follows:
   - Bandwidth to 20 MHz
   - DC coupling
   - Trigger on "+" slope and "internal" source, or use the laser sync output and "external" source

6. Estimate the approximate EnergyMax sensor voltage output expected, based on the Rv (V/J) of the sensor (available on both the calibration certificate and the calibration sticker attached to the sensor cable), and the typical laser pulse energy.

7. If you know your expected laser pulse repetition rate, set the scope time base to show 2 pulses on the screen. This helps set the trigger and allows observation of the true "baseline" of the pulse. For example, for a laser running at 10 pps, set the scope time base to 20 msec/division. Once proper triggering occurs, use the vertical adjust to set the baseline of the EnergyMax voltage pulse to coincide with a horizontal grid line (see Figure 1). This setting becomes the zero for the peak voltage reading.

8. Adjust the "time base" of the scope to show a single EnergyMax pulse and then focus on the leading edge to accurately read the peak voltage (see Figure 2).

To avoid affecting the calibration of the sensor with a coaxial cable do not lengthen the cable when using the sensor with the oscilloscope.

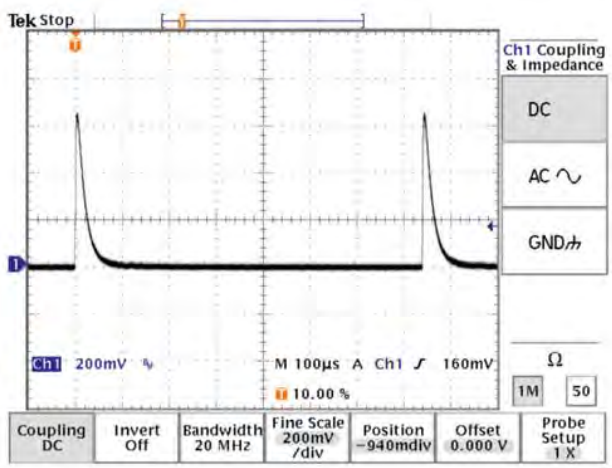


Figure 1

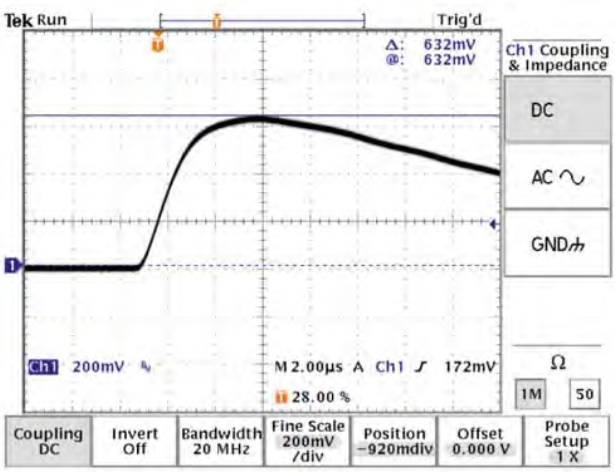
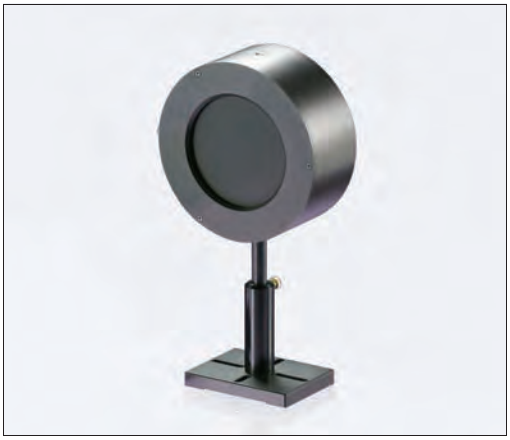


Figure 2

Miscellaneous Energy Sensors

J100 Energy Sensor



J100

Features

- Large-area 95 mm diameter
- Broad spectral response 0.3 µm to 12 µm
- Wide dynamic range of 0.4 mJ to 5J
- High average power to 20W
- JSA-BNC adapter (1098306) needed for use with FieldMaxII-TOP and LabMax-TOP

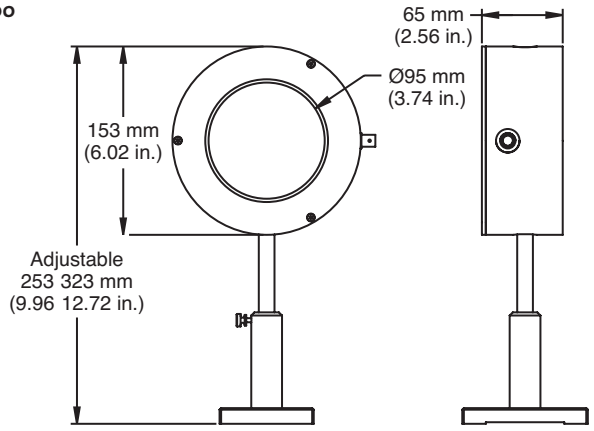
The J100 is a pyroelectric energy sensor with a flat, broad spectral response calibrated at 1064 nm. The 95 mm diameter active area is ideal for divergent sources and pulsed lasers used in applications such as laser range finding. The sensor output is through a BNC connector and the product ships with a 1.5 m BNC cable.

Device Specifications

Model	J100
Wavelength Range (µm)	0.3 to 12
Energy Range[1]	0.4 mJ to 5J
Max. Avg. Power	20
Typical Response (Rv) (V/J)	3
Max. Rep. Rate (pps)	50
Max. Pulse Width (µs)	200
Detector Coating	Black
Detector Diameter (mm)	95
Dimensions (mm)	Ø 153 x 65
Calibration Uncertainty (%)(k=2)	±2
Calibration Wavelength (nm)	1064
Connector Type	BNC
Cable Length (m)	1.5 (separate)
Part Number	0011-6100

[1] Maximum energy is pulse-width dependent.

J100



Custom and OEM Products Introduction

Complete Laser Measurement and Control Solutions

Laser system integrators frequently include laser measurement products in their systems to monitor system performance and status, or to provide real-time feedback for laser system control. In these instances custom measurement solutions or modifications to our existing products may be necessary due to size or performance constraints.

Coherent is well positioned to provide custom and modified measurement products. Following are some examples of services and products Coherent offers.

OEM Power and Energy Sensors
We provide an extensive line of OEM thermopile and energy sensors. Usually, a standard or existing modified standard product will fit your application.

Power Sensors
- Compact thermopile power sensors
- Water-cooled and air-cooled options
- BNC and 4-pin Molex signal output options
- Thermopile disks for integrating into heat-sinked applications
- Any standard thermopile with a cable can be integrated with an off-the-shelf interface module

Energy Sensors
- BNC-terminated energy sensors
- Compact designs to fit in tight locations
- A customer-supplied peak detection module or a Coherent meter or custom signal conditioning board is required

Off-the-Shelf Interface Modules
Several off-the-shelf electronic modules provide signal conditioning, measurement, and communication outputs.

Power Modules
- Amplification for very low power applications
- Noise filtering
- Analog output
- PC interfacing
- Beam position monitoring

Energy Modules
- Baseline and peak detection capabilities
- Noise filtering for greater peak detection accuracy
- Repetition rates as high as 100 kHz

Custom Measurement Products
Sometimes a completely custom product is required for a particular application. Our research and development teams of electrical, mechanical and software engineers, physicists, chemists and materials scientists can provide measurement systems to meet the most complex challenges. By involving Coherent early in your design phase we can provide the very best solution.

- Custom detectors and sensors
- Interface modules with unique communication protocols
- Extremely low energy and/or high repetition rate energy measurement

Modified Standard Products
Sometimes a slight modification to a standard catalog product is all that is needed to enable a special application.

Mechanical
- Longer or shorter cable
- Different type of connector
- Slight mechanical change

Calibration
- Different calibration wavelength

OEM Thermopiles

10 mW to 150W

Models PM10-19A, PM10-19B, PM150-50A

Features

- **10 mW to 150W**
- **Spectrally flat from 0.19 µm to 11 µm**
- **Compact designs**
- **Air-cooled or water-cooled**
- **Active area diameters from 19 mm to 50 mm**

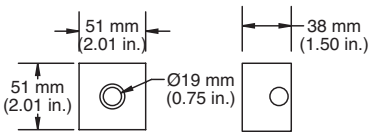
The sensors on the next two pages are small, compact OEM thermopiles designed for use in embedded applications. Power ratings are provided for water-cooled and air-cooled installations (see page 18 for additional air-cooled ratings for various exposure times). For conductively-cooled installations a good approximation is that doubling the surface area of the sensor housing doubles the air-cooled rating.

Models that end with "A" are amplified sensors with a 4-pin connector. They must be supplied with ±15 VDC and draw less than 20 mA. Models that end with "B" are passive sensors with a BNC output. Models with DB25 cables that are compatible with our instruments end with a "C" and can be found on page 45.

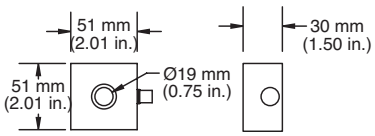
Device Specifications

Model	PM10-19A	PM10-19B	PM150-19A	PM150-19B	PM150-50A
Wavelength Range (µm)	0.19 to 11				
Resolution (mW)	1	1	30	30	30
Min. Water flow (gpm)	0.02	0.02	0.2	0.2	0.2
Max. Avg. Power (water-cooled) (W)	10		150		
Max. Avg. Power (air-cooled, 5 min.) (W)	5		20		80
Responsivity (typ.)	1 V/W	1 mV/W	40 mV/W	0.4 mV/W	40 mV/W
Max. Power Density	6 kW/cm²				
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns				
Response Time (sec.)	1	2	1	2	1
Detector Coating	Broadband				
Active Area Diameter (mm)	19				
Calibration Uncertainty (%)(k=2)	±1				
Calibration Wavelength (nm)	514				
Cooling Method	Water-cooled				
Connector Type	4-pin Molex 22-12-2044	BNC-terminated	4-pin Molex 22-12-2044	BNC-terminated	4-pin Molex 22-12-2044
Cable Length (m)	–	–	–	–	–
Part Number (RoHS)	1098334	1098343	1098418	1098321	1098510

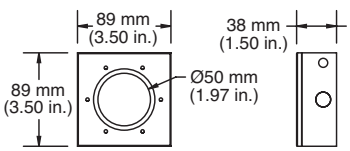
PM10-19A/PM150-19A



PM10-19B/PM150-19B



PM150-50A



OEM Thermopiles

300 mW to 1 kW

Model PM150-50B, PM150-50XB, PM1K-36B, BeamFinder

Features

- 300 mW to 1 kW
- Spectrally flat from 0.19 µm to 11 µm
- Compact designs
- Air-cooled or water-cooled
- Active area diameters from 19 mm to 50 mm
- Supplied with water fittings

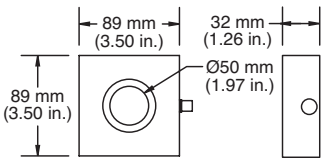
BeamFinder: Use with LabMax (see page 10)

Device Specifications

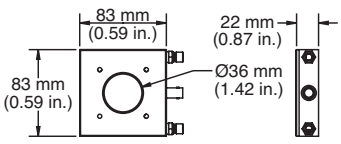
Model	PM150-50B	PM150-50XB	PM1K-36B	BeamFinder[1]
Wavelength Range (µm)	0.19 to 11	0.15 to 1	0.19 to 11	0.3 to 10.6
Resolution (mW)	30	30	1000	1000
Min. Water flow (gpm)	0.2	0.2	1.0	1.0
Max. Avg. Power (water-cooled) (W)	150		1000	
Max. Avg. Power (air-cooled, 5 min.) (W)	80		40	–
Responsivity (typ.)	0.4 mV/W		0.1 mV/W	–
Max. Power Density	6 kW/cm²		2.5 kW/cm²	
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns			0.5 J/cm², 1064 nm, 10 ns
Response Time (sec.)	5			10
Detector Coating	Broadband	UV	Broadband	H
Active Area Diameter (mm)	50		36	35
Calibration Uncertainty (%)(k=2)	±1		±3	±5
Calibration Wavelength (nm)	514		1064	10,600
Cooling Method	Water-cooled			
Connector Type	BNC-terminated			LM DB-25
Cable Length (m)	–	–	–	6
Part Number (RoHS)	1098415	1098441	1098333	1098427

[1] BeamFinder incorporates a quadrant thermopile disk that enables the position of the beam to be sensed.

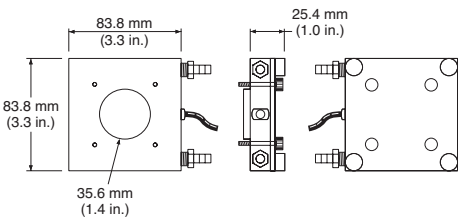
PM150-50B/PM150-50XB



PM1K-36B



BeamFinder



Custom and OEM Products

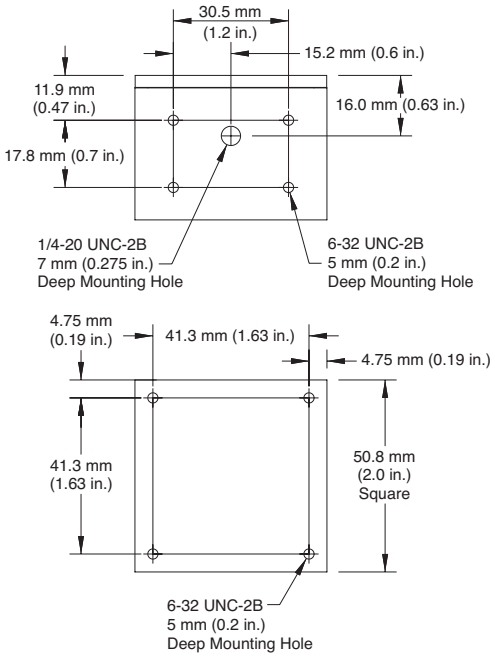
Complete Laser Measurement and Control Solutions

Additional electrical connection, water fitting, and mounting details for several of our OEM thermopiles can be found below.

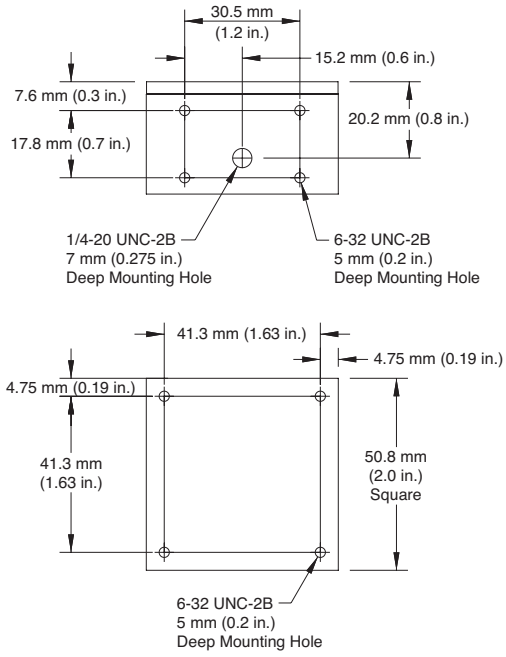
PM10-19A, PM150-19A, PM150-50A
Style: Active amplified output
Input/Output connector: 4-pin, Molex part no. 22-12-2044
pin 1: -10 to -20V power input
pin 2: Ground
pin 3: +10 to +20V power input
pin 4: Output signal
Current draw: Approx. 8 mA at -15 V, Approx. 18 mA at +15 V
Output impedance: 100 Ohm
Water connections: 1/8 NPT

PM10-19B, PM150-19B, PM150-50B, PM150-50XB, PM1K-36B
Style: Passive output
Output connector: BNC
Output impedance: 2500 Ohm
Water connections: 1/8 NPT

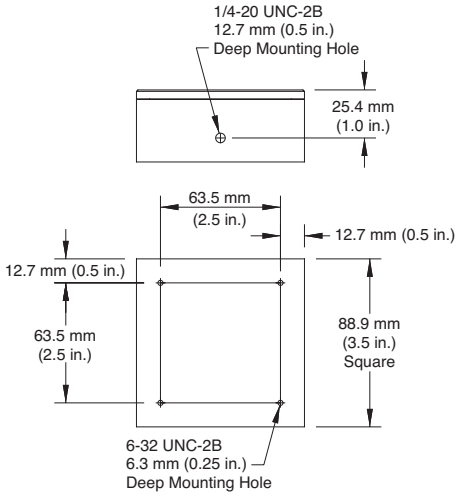
PM10-19A/ PM150-19A



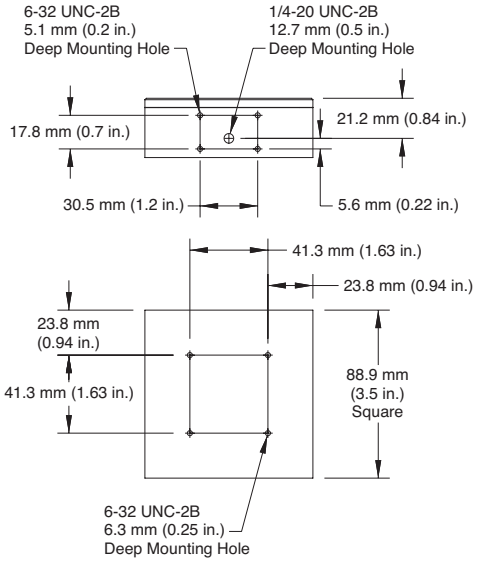
PM10-19B/ PM150-19B



PM150-50A



PM150-50B/ PM150-50XB

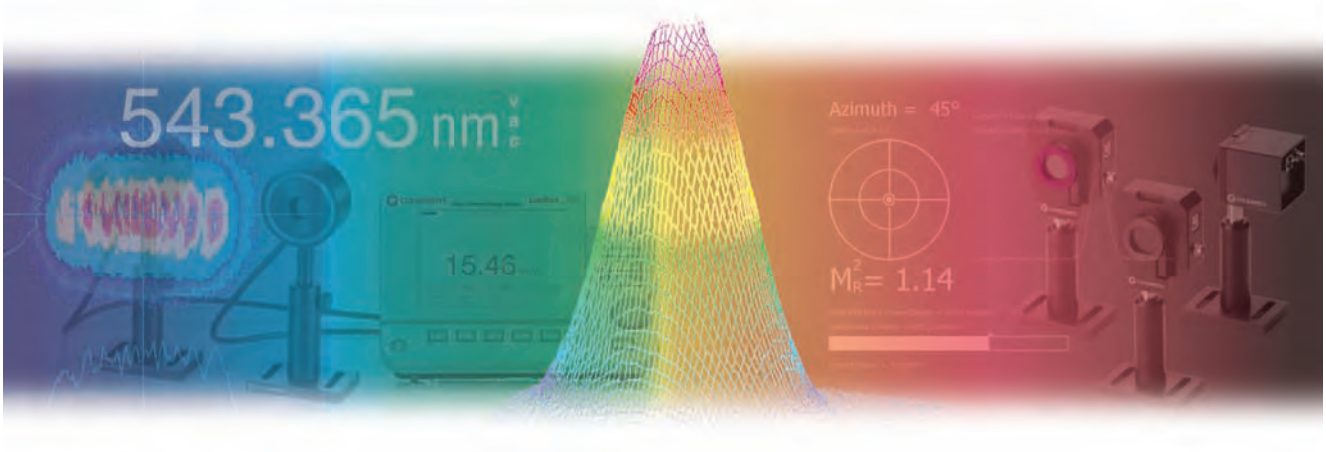


* Requires 15 VDC power input

Beam Diagnostics Introduction

Introduction to Laser Beam Diagnostics

In today's fast-paced photonics market it is important to understand the technical specifications of highly complex laser systems and their applications. As well as analyzing the power or energy, it is also useful to understand the shape, intensity profile, and propagation of a laser beam. For over 25 years Coherent has developed precision instruments that measure, characterize, and monitor these laser parameters for thousand of customers around the world.



Beam Profilers

As a laser beam propagates, changes in the laser cavity, as well as changes in divergence and interactions with optical elements, cause the width and spatial intensity of the beam to change in space and time. Spatial intensity distribution is a fundamental parameter for indicating how a laser beam will behave in any application. And while theory can sometimes predict the behavior of a beam, tolerance ranges in mirrors and lenses, as well as ambient conditions affecting the laser cavity and beam delivery system, necessitate verification.

Two types of beam profilers are available: those that use special cameras as the beam detectors (these are excellent for fast and detailed analyses of the intensity profile of pulsed and CW lasers); and systems that use moving knife-edges (these have a large dynamic range and can accurately measure small and focused beams). Coherent has both of these types available: the camera-based LaserCam-HR on pages 88 to 89 and an advanced knife-edge system—BeamMaster—on pages 99 to 101.

Beam Propagation

The Coherent ModeMaster beam propagation analyzer established an entirely new laser beam quality parameter that is now an ISO standard. M^2 is recognized as describing both how "close-to-perfect Gaussian" a beam is, and also how well the beam can be focused at its intended target.

Wavelength Meter

For many high performance tunable laser systems, or those using laser diodes, it is important to measure the wavelength. The WaveMaster laser wavelength meter accurately measures the wavelength of both CW and pulsed lasers of any repetition rate to an accuracy of 5 picometers. See page 108 for additional specifications for the WaveMaster.

Summary of Product Primary Measurement Capabilities

Model	BeamView Analyzer	BeamMaster	ModeMaster	WaveMaster
Wavelength	–	–	–	CW + Pulsed
Power	–	CW	–	–
Beam Position	CW + Pulsed	CW	CW	–
Propagation M^2	–	–	CW	–
Beam Profiles				
2D	CW + Pulsed	CW	CW	–
3D	CW + Pulsed	CW	–	–
Page Number	88	99	102	108

LaserCam-HR

Introduction to Camera-Based Beam Diagnostics

Coherent BeamView Analyzer systems are the recognized leader in software, hardware and optical components for laser beam analysis. Constant product improvement based on customer feedback, and innovation from beam analysis experts, have made BeamView Analyzer products the first choice for laboratory, factory and field measurements.

The key elements of a typical camera-based beam profiling system are the camera itself, Coherent Beamview analysis software running on an appropriate computer and, when necessary, beam attenuation optics. The key choice to make is matching the appropriate camera technology to your application.

Coherent beam diagnostic cameras are specifically designed or modified for laser analysis. They provide low noise, maximum linearity, and uniformity of response—needed for maximum measurement accuracy. All of these diagnostic cameras accept C-Mount optical accessories and are delivered without a cover (glass/plastic window) over the sensor array. Instead, a LDFP (Low-Distortion Face Plate) filter is supplied with each camera—a laser-grade neutral density filter made of glass specified and polished specifically for laser diagnostic analysis. The LDFP filter is mounted in a standard C-Mount ring and provides attenuation of ambient room light so that the camera can be used with normal room lights.

USB 2.0 Beam Diagnostic Camera Family
Coherent pioneered the ease-of-use of digital USB 2.0 bus-powered, high-resolution, large-area cameras requiring only a single cable for both video transfer and camera power. The LaserCam-HR family of beam diagnostic cameras now includes the LaserCam-HR-UV and the LaserCam-HR-InGaAs models, extending the measurement spectrum from the deep ultraviolet to the near-infrared wavelengths.

The same features, performance and convenience previously available only for wavelengths covered by the LaserCam-HR are now available to users of excimer lasers, telecommunication sources and military laser systems. With a broad spectral range covering 190 nm to 1700 nm, there is a LaserCam-HR camera profiler system ideally suited for nearly any demanding laser measurement application.

Important Considerations
- Ease-of-use connectivity
  - High-speed USB 2.0 Interface
  - USB bus-powered low voltage operation
- Broad spectral range
  - LaserCam-HR 300 nm to 1100 nm (400 to 1100 nm with LDFP) (190 to 355 nm with BIP-12F)
  - LaserCam-HR-UV DUV to 355 nm
  - LaserCam-InGaAs 900 nm to 1700 nm
- Large dynamic range
- Coherent Adaptive Pixel Technology (CAPT)
- Digital output through USB 2.0 eliminates the need for an interface card (frame-grabber)
- High-accuracy beam diameter calculations
- Excellent beam spatial uniformity
- Variable camera exposure time
- Compact size

- High-speed image capture rates (15 to 25 frames per second)
- Pass/Fail TTL level output
- RS-232 and TCP/IP communication protocols
- All LaserCam-HR camera systems are RoHS compliant

Coherent Adaptive Pixel Technology
Coherent tests each LaserCam-HR camera through a process called CAPT (Coherent Adaptive Pixel Technology). This uses a calibrated lightsource and a digital look-up table to give pixel-to-pixel linearity correction. In addition, any identified "hot" pixel is corrected by averaging the value of the four directly surrounding pixel intensities. Finally, the noise levels are carefully monitored through both a background noise subtraction and a user-selectable bias noise offset level. The CAPT process optimizes the performance of the camera array, directly improving beam measurement accuracy, especially with beam diameter calculations.

Multiple channel camera support of different LaserCam-HR camera models is available for all three LaserCam-HR camera types (UV, visible, and InGaAs).

Variable camera exposure time available with the entire LaserCam-HR camera family allows imaging of higher repetition rate sources and lets the user decrease/increase the signal intensity levels using exposure time instead of external attenuation. This feature is especially suited for the LaserCam-HR-InGaAs, with its impressive spatial uniformity characteristics.

Beam Diagnostic Cameras

LaserCam-HR and LaserCam-HR-UV

LaserCam-HR

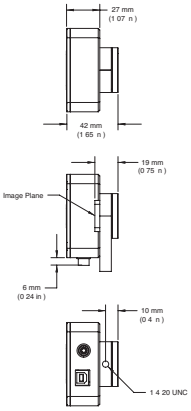
LaserCam-HR-UV

Features

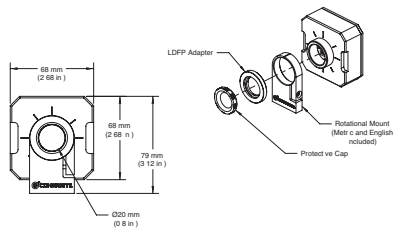
- USB 2.0, 10-bit digital output
- Large-area CMOS array, 8.5 mm x 6.8 mm
- Compact 68 x 68 x 34 mm package
- Metric and English mounts included
- CW and pulsed operation including external triggering
- Variable exposure time
- User-variable trigger delay
- Long-term UV sensor stability (with the LaserCam-HR-UV camera)
- C-mount thread for additional accessories

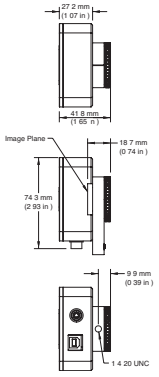
Device Specifications

Model	LaserCam-HR	LaserCam-HR-UV
Sensor Elements (pixels)	1280 x 1024	
Effective Pixel Resolution (µm)	–	20 x 20
Pixel Size (µm)	6.7 x 6.7	
Sensor Active Area (mm)(H x V)	8.5 x 6.8 (2/3 inch format)	
Spectral Range (nm)	300 to 1100 (without LDFP) 400 to 1100 (with LDFP included) 190 to 355 (with BIP-12F accessory)	190 to 355
Beam Diameters (mm)	0.2 to 6.0	0.5 to 6.0
Glassless Sensor	Low Distortion Face Plate is removable	
Low-Distortion Face Plate (LDFP, LDFP-UV)	Laser-grade ND filter, OD = 2.5 at 632.8 nm	UV-grade ND filter, OD = 3.0 at 248 nm
Electrical Interface	USB 2.0	
Capture Modes	Continuous (CW), pulsed	Continuous (CW), pulsed
Variable Exposure Time	1 msec to 1 sec, default at 10 msec	
Pulsed Mode Trigger Methods	Trigger In (TTL)	
Maximum Pulse Trigger in Rate (Hz)	100 (without averaging adjacent pulses)	
Maximum Frame Rate (FPS)		
Live video, no calculations	15	
Capture with calculations	10	
Damage Threshold	32 mJ/cm² (without LDFP) at 1064 nm	200 µJ/cm² (without LDFP-UV) at 248 nm
CW Saturation	40 mW/cm² (with LDFP) at 633 nm 16 µW/cm² (without LDFP) at 633 nm 800 mW/cm² (with LDFP) at 1064 nm 320 µW/cm² (without LDFP) at 1064 nm	90 mW/cm² (with LDFP-UV) at 248 nm 90 µW/cm² (without LDFP-UV) at 248 nm
Pulsed Saturation	8 mJ/cm² (with LDFP) at 1064 nm 3.2 µJ/cm² (without LDFP) at 1064 nm	5 mJ/cm² (with LDFP) at 248 nm 5 µJ/cm² (without LDFP) at 248 nm
USB 2.0 Cable	6 ft. standard A/B cable included	
Trigger Connector	BNC receptacle (trigger cable included)	
Part Number	1098577	1149004

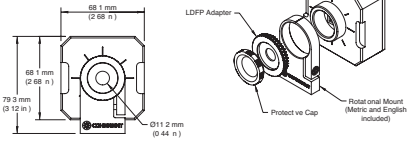


LaserCam-HR





LaserCam-HR-UV



Beam Diagnostic Cameras

LaserCam-HR-InGaAs

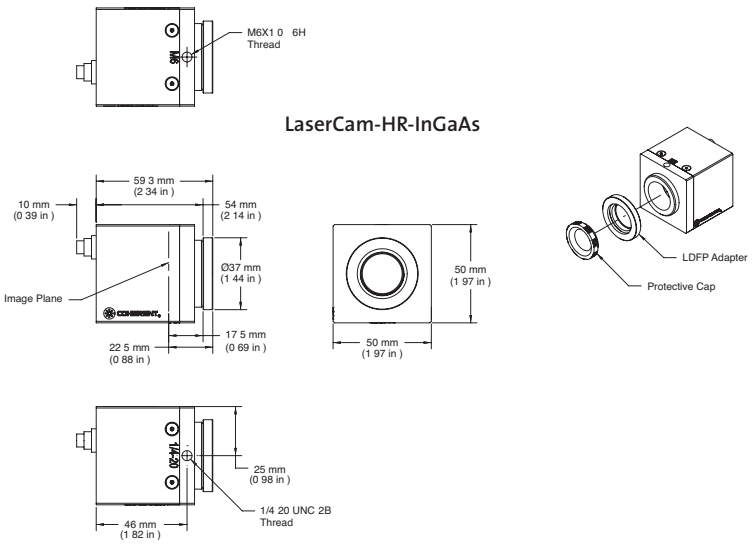
LaserCam-HR-InGaAs

Features

- USB 2.0 large-area, InGaAs sensor, 9.6 mm x 7.7 mm
- 14-bit digital output providing >1000:1 optical dynamic range
- Outstanding linearity error of <1%
- 30 µm x 30 µm pixel pitch
- Compact 50 x 50 x 68 mm package
- CW and pulsed operation including external triggering
- Coherent Adaptive Pixel Technology (CAPT) pixel-by-pixel offset, linearity and blemish correction
- Variable exposure time, 20 µsec to 25 msec
- User variable trigger delay
- C-mount thread for additional accessories

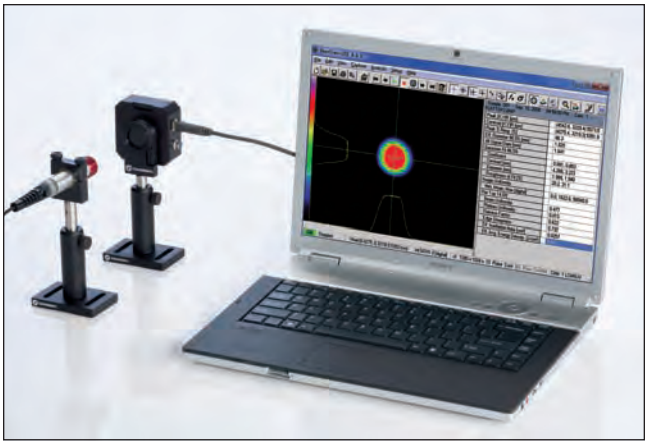
Device Specifications

Model	LaserCam-HR-InGaAs
Sensor Elements (pixels)	320 x 256
Pixel Size (µm)	30 x 30
Sensor Active Area (mm)(H x V)	9.6 x 7.7
Spectral Range (nm)	900 to 1700
Beam Diameters (mm)	0.5 to 6.0
Glassless Sensor	Low Distortion Face Plate is removable
Low-Distortion Face Plate (LDFP)	Laser-grade ND filter, OD = 2.5 at 632.8 nm
Electrical Interface	USB 2.0
Capture Modes	Continuous (CW), pulsed
Variable Exposure Time	20 µsec to 25 msec, default at 1 msec
Pulsed Mode Trigger Methods	Trigger In (TTL)
Maximum Frame Rate (FPS)	25 (live video, no calculations), 15 (capture with calculations)
Saturation	
CW (at 1064 nm)	3.5 mW/cm² (with LDFP), 50 µW/cm² (without LDFP)
CW (at 1523 nm)	350 µW/cm² (with LDFP), 30 µW/cm² (without LDFP)
Pulse (at 1064 nm)	5 µJ/cm² (with LDFP), 0.08 µJ/cm² (without LDFP)
USB 2.0 Cable	6 ft. standard A/B cable included
Trigger Connector	BNC receptacle (trigger cable included)
Part Number	1149002



BeamView Analyzer Software

Introduction to BeamView-USB Software



To monitor, analyze and archive laser beam images, BeamView Analyzer software is recognized as the leading laser beam profiling software. It has been designed to provide flexibility, speed, and user friendliness.

Features

- High-speed USB 2.0 camera interface
- Supports all three LaserCam-HR camera types
- Remote control interface
- Over 30 numerical analysis functions
- Multiple image import and export formats
- Automatic background noise subtraction
- Pass/Fail fault settings, alarms, configurable setups
- Easy-to-use, intuitive user interface
- Windows XP, Vista 32-bit, Vista 64-bit, Windows 7 32-bit, Windows 7 64-bit

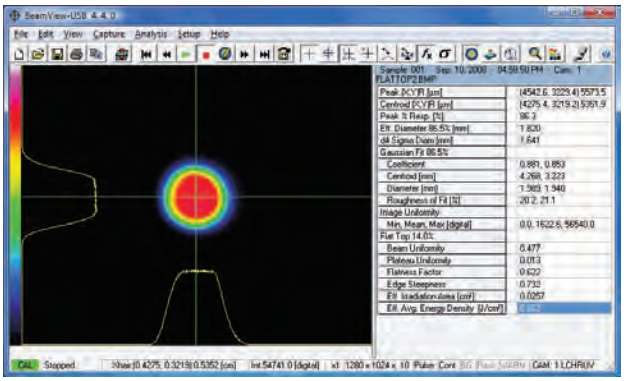
BeamView-USB Analyzer Software

BeamView-USB Analyzer Software
BeamView-USB software includes features that extend the analytic capabilities of the LaserCam-HR laser beam diagnostic systems:

- Supports both 10-bit and 14-bit LaserCam-HR camera types
- Multiple LaserCam-HR camera types can be connected to a single system
- Flat-top beam analysis
- Adjustable trigger delay
- Report generation
- Variable exposure time
- RS-232 and TCP/IP remote communication protocols

Flat-Top Beam Analysis
Six additional calculations are now available with BeamView-USB software for flat-top beam analysis. These calculations are based on the ISO 13694:2000 standards. The six calculations allow greater flexibility for the analysis of applications involving flat-top beam shapes. They also may assist in the analysis of beam uniformity of excimer and Nd:YAG lasers in the near field. The six new calculations are:

- Plateau Uniformity
- Flatness Factor
- Edge Steepness
- Beam Uniformity
- Effective Irradiation Area
- Effective Average Power/Energy Density



Screen shot of a flat-top beam image

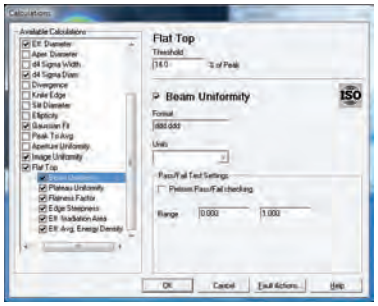


Image of dialog box for flat-top calculations.

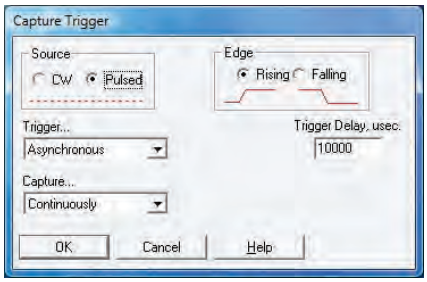
BeamView Analyzer Software

BeamView Analyzer Software Features

Adjustable Trigger Delay
The adjustable Trigger Delay feature lets users add default trigger delay to the LaserCam-HR camera. This assists by providing additional flexibility when firing the camera from an external trigger source such as the SYNC Output of a laser.

Adjustable Exposure Time
The camera exposure time is adjustable through the camera settings menu for all LaserCam-HR camera models.

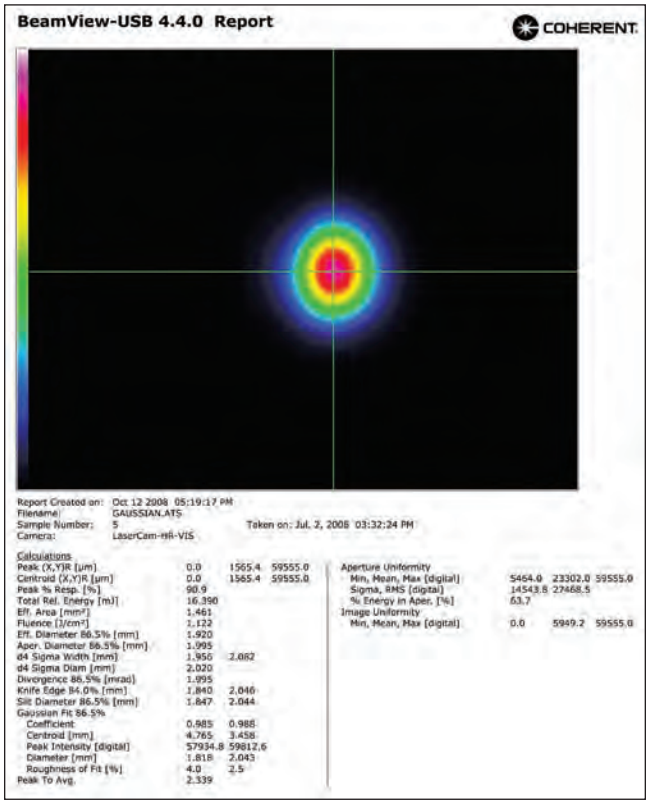
Report Generation
BeamView-USB includes a single-page report that can be sent directly to a printer, saved to a file (.txt), or converted to an Adobe .pdf file by using a pdf file converter. A simple screen print option is available from the same friendly dialog box used to generate a report.



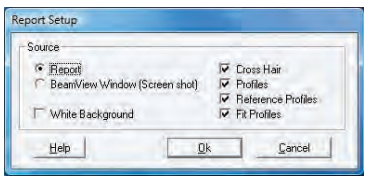
Screen shot of Capture/Trigger dialog box showing Trigger Delay setting

BeamView System Performance Optimization

BeamView software provides several functions that optimize the optical dynamic range available in the camera to achieve maximum measurement accuracy. The Automatic Background subtraction feature measures and stores the background noise "image" and automatically subtracts individual pixel noise levels from all subsequent laser images prior to analysis. The system also automatically monitors the background noise level to warn of changes that may effect measurement accuracy.

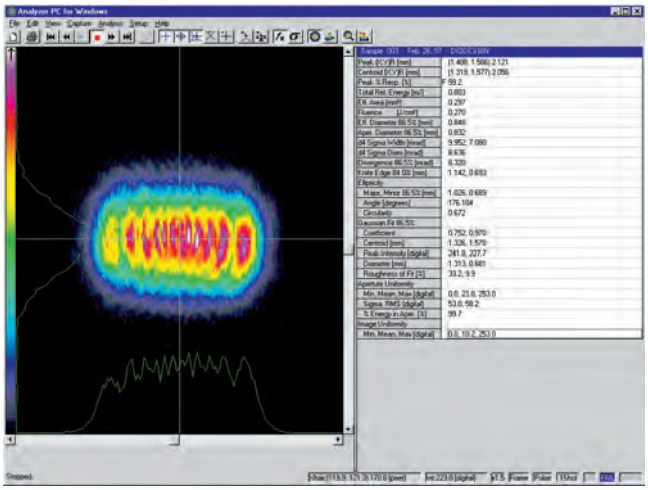


Screen shot of Print Screen dialog box and actual report



BeamView Analyzer Software

BeamView Analyzer Software Features

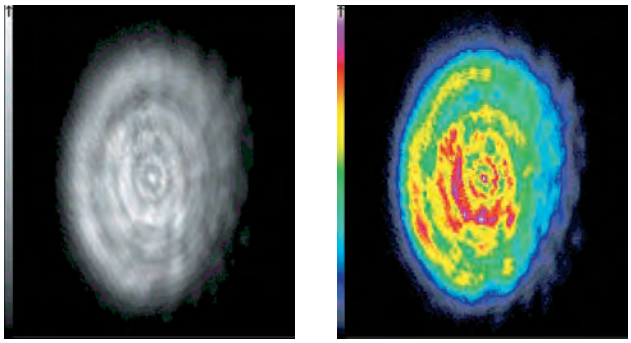


BeamView Analyzer Software Additional Features

- **More than 25 different numerical analysis functions**
- **Several different profile views**
- **Import and export of results data and profile data**
- **Pass/Fail settings and user-selectable fault actions**

Real-Time Laser Monitoring and Alignment

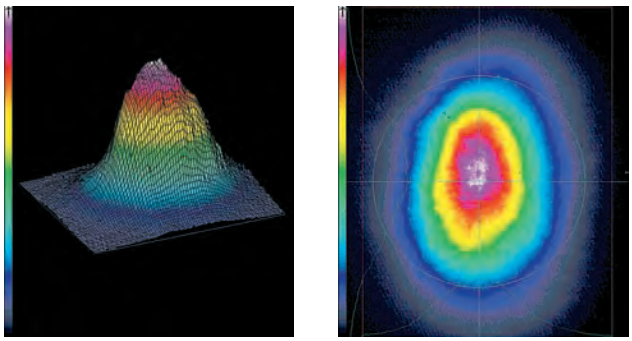
The Live Video mode provides a continuously updated image of the beam (~20 Hz to 25 Hz, depending on the speed of the processor) displayed in shades of gray or pseudo-color. This mode is ideal for monitoring the laser and observing changes in the form and structure of the beam as it is adjusted. It also allows for real-time tuning to achieve optimum beam profile quality and laser-cavity alignment. While operating in this mode, no beam or statistical data are displayed, but if Run is activated, the image is stored and can be analyzed later.



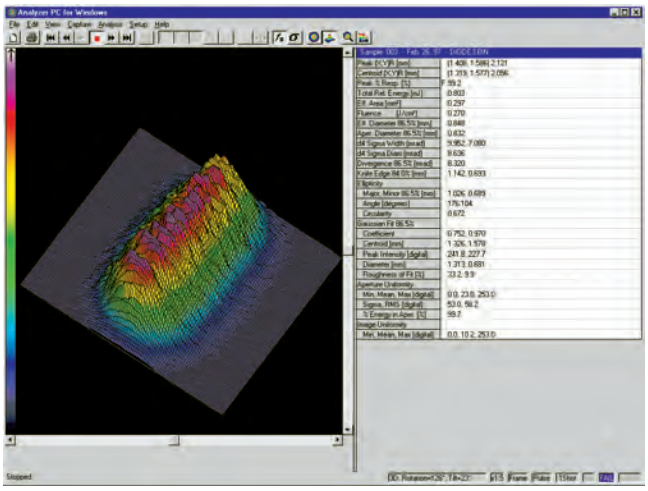
The Live Video mode

2D and 3D Intensity Plots

The Run command switches the BeamView Analyzer from the Stop or Live Video mode to continuous operation, which provides capture, analysis and display of beam image data. The view area of the computer monitor provides a choice of 2D or 3D images. The 2D contour maps and the 3D isometric plots display laser beam intensity profiles in a choice of color and gray-scale styles (fixed and autoscaling to a peak) and sizes (continuous zoom and pan control). The 2D maps can be shown with or without profiles (and Gaussian fit), reference position, variable aperture and rotatable crosshairs (with auto peak and auto centroid location). The 3D isometric plots can be displayed with transparent, hidden or solid wires, and can be rotated and viewed from different tilt angles.



Choice of 3D and 2D images



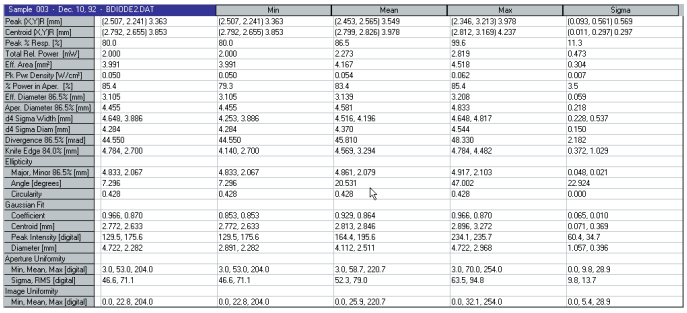
BeamView Analyzer display with 3D image and ISO-compatible results

BeamView Analyzer Software

BeamView Analyzer Software Features

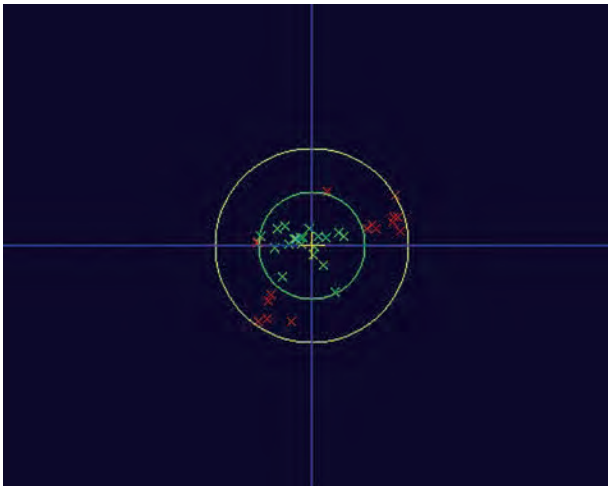
Beam Stability

The continuous on-line statistical analysis display shows results of all, or a combination of, functions and pass/fail parameters for all captured samples and accumulated results. The user can scroll through the analysis results of individual images, and also view the minimum, maximum and sigma (standard deviation) values. This makes comparing individual samples to the time-dependent statistical data easy. Thus, the jitter and stability of parameters, such as power, energy, pointing direction, ellipticity and beam size, etc., can be analyzed simultaneously with a polar beam wander plot.



Sample: 003 - Dec. 10, 92 - BDIODE2.DAT	Min	Mean	Max	Sigma
Peak (X,Y)R [mm]	(2.507, 2.241) 3.363	(2.507, 2.241) 3.363	(2.453, 2.565) 3.549	(2.346, 3.213) 3.978	(0.093, 0.561) 0.569
Centroid (X,Y)R [mm]	(2.792, 2.655) 3.853	(2.792, 2.655) 3.853	(2.799, 2.826) 3.978	(2.812, 3.169) 4.237	(0.011, 0.297) 0.297
Peak % Resp. [%]	80.0	80.0	86.5	99.6	11.3
Total Rel. Power [mW]	2.000	2.000	2.273	2.819	0.473
Eff. Area [mm²]	3.991	3.991	4.167	4.518	0.304
Pk. Pwr Density [W/cm²]	0.050	0.050	0.054	0.062	0.007
% Power in Aper. [%]	85.4	79.3	83.4	85.4	3.5
Eff. Diameter 86.5% [mm]	3.105	3.105	3.139	3.208	0.059
Aper. Diameter 86.5% [mm]	4.455	4.455	4.581	4.833	0.218
d4 Sigma Width [mm]	4.649, 3.886	4.253, 3.886	4.516, 4.196	4.649, 4.817	0.229, 0.537
d4 Sigma Diam [mm]	4.284	4.284	4.370	4.544	0.150
Divergence 86.5% [mrad]	44.550	44.550	45.810	48.330	2.182
Knife Edge 84.0% [mm]	4.784, 2.700	4.140, 2.700	4.569, 3.294	4.784, 4.482	0.372, 1.029
Ellipticity					
Major, Minor 86.5% [mm]	4.833, 2.067	4.833, 2.067	4.961, 2.079	4.917, 2.103	0.049, 0.021
Angle [degrees]	7.296	7.296	20.531	47.002	22.924
Circularity	0.428	0.428	0.428	0.428	0.000
Gaussian Fit					
Coefficient	0.966, 0.870	0.853, 0.853	0.929, 0.864	0.966, 0.870	0.065, 0.010
Centroid [mm]	2.772, 2.633	2.772, 2.633	2.813, 2.846	2.896, 3.272	0.071, 0.369
Peak Intensity [digital]	129.5, 175.6	129.5, 175.6	164.4, 195.6	234.1, 235.7	60.4, 34.7
Diameter [mm]	4.722, 2.282	2.891, 2.282	4.112, 2.511	4.722, 2.968	1.057, 0.396
Aperture Uniformity					
Min, Mean, Max [digital]	3.0, 53.0, 204.0	3.0, 53.0, 204.0	3.0, 59.7, 220.7	3.0, 70.0, 254.0	0.0, 9.8, 28.9
Sigma, RMS [digital]	46.6, 71.1	46.6, 71.1	52.3, 79.0	63.5, 94.8	9.8, 13.7
Image Uniformity					
Min, Mean, Max [digital]	0.0, 22.8, 204.0	0.0, 22.8, 204.0	0.0, 25.9, 220.7	0.0, 32.1, 254.0	0.0, 5.4, 28.9

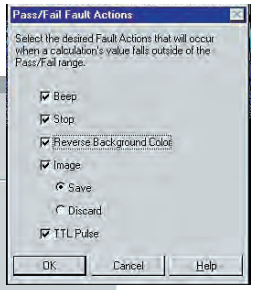
Continuous on-line statistical analysis display



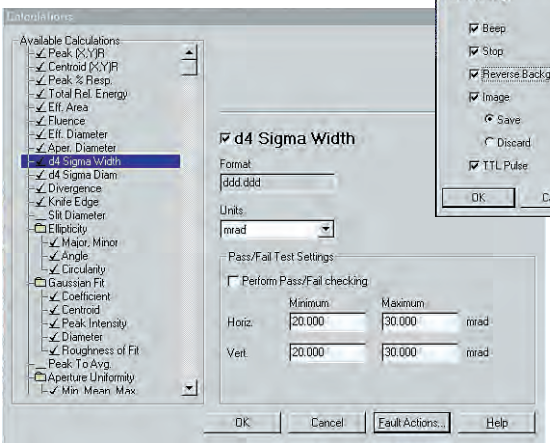
Polar beam wander plot screen

Pass/Fail Analysis

Pass/fail analysis allows simultaneous real-time monitoring of all, or any one of the analysis results against user-specified minimum/maximum limits. Any combination of, or all the fault actions can be activated to signal a test failure, initiate a visual alarm, an audio alarm, stop data capture, reject/save a failed sample, and generation of a TTL trigger pulse output signal.



Fault Actions Dialog Box



Calculations Pass/Fail test settings

Remote Control

The BeamView Analyzer provides remote control and data transfer through a TCP/IP or RS-232 connection on the host computer. A complete control and data transfer command set is provided to allow users to develop their own remote control application for interfacing with the BeamView Analyzer software platform. The BeamView-USB software package includes an example LabVIEW VI for remote access to most BeamView features at a host computer running LabVIEW.

Beam Analysis and Statistics

BeamView Analyzer software calculations are compatible with the International Standards Organization (ISO) guidelines for laser beam measurement:

- Peak and centroid beam position
- Beam ellipticity including angular position and major/minor axis information
- Circularity
- D4σ diameters and widths
- Guassian fit including coefficient, centroid, and "roughness of fit"
- Aperture fit and uniformity
- Total/relative power
- Peak power/energy density
- Percent power within an aperture

BeamView Analyzer Software

BeamView Analyzer Software Features Summary

Analysis, On-Line Pass/Fail Tests

- **Centroid position/wander**
- **Peak intensity/position**
- **Peak-to-average intensity**
- **Beam diameter/widths (selectable):**
  - Second moment (d4 Sigma)
  - Knife-edge
  - Slit
  - Aperture diameter
  - Effective diameter
- **Flat Top analysis (new in BeamView-USB 4.4):**
  - Beam uniformity
  - Plateau uniformity
  - Flatness factor
  - Effective irradiation area
  - Edge steepness
  - Effective average power/energy Density
- **Gaussian fits with:**
  - Correlation coefficient
  - Diameter
  - Centroid
  - Peak intensity
  - Fit roughness
- **Ellipticity at intensity slice:**
  - Major and minor axis diameter
  - Circularity (major/minor)
  - Axis orientation (rotation)
  - Auto align profiles to axis
- **Aperture analysis for circular, square, rectangular and elliptical beams:**
  - % power/energy in aperture
  - Uniformity in aperture
  - Aperture/diameter tracking
- **Selectable calculation area**
- **On-line statistical analysis (all results):**
  - Minimum, average, maximum
  - Sigma (standard deviation)
- **Pass/Fail test with fault action (all results):**
  - Ratio
  - Audio/visual alarms
  - Save/reject images
  - TTL pulse out
  - Stop data capture
- **Image averaging**
- **Peak energy/power density**
- **Relative energy/power**
- **Effective area**
- **Divergence at % energy/power**

Interactive Display Functions

- **On-line help**
- **Report generation:**
  - Report (.pdf)
  - BeamView window (screen capture)
- **Stored image paging**
- **Reference profile select**
- **Reference coordinate set**
- **Background subtraction**
- **Run/stop data analysis**
- **Control of cursors, profiles, aperture, position, rotation and size**
- **Live video on/off**
- **7 zoom levels**
- **Image and profile autoscale modes**
- **Auto peak/centroid locate**
- **“Hot” function keys**

BeamView Analyzer Software

BeamView Analyzer Software Features Summary

Image Capture and Storage

- Pulsed or CW (continuous) analysis
- Multi-channel (not simultaneous) camera input
- Support for multiple camera types
- Adjustable camera exposure time
- RS-232 and TCP/IP communication protocols
- Multiple trigger modes:
  - External trigger input
  - Autotrigger to a selected level
- 3 resolution modes with the LaserCam-HR and LaserCam-HR-UV cameras:
  - 1280 x 1024 x 10
  - 640 x 512 x 10
  - 640 x 512 x 8
- 1 resolution mode with the LaserCam-HR-InGaAs camera:
  - 320 x 256 x 14
- Various capture modes:
  - Continuous
  - Time interval
  - On command (keypress)
- High-speed sample mode capture
- Profile storage
- Configuration storage with password protection
- Image data file formats in binary (bin), ASCII (img), bmp, jpg, png, tif

Calibration Functions

- Fully automatic background map correction (pixel-by-pixel) with bias offset
- Automatic background monitor and warning
- Optical scale factor (magnification/reduction)
- Far-field optic focal length
- Power/energy calibration factor

Standard Graphics Feature

- Contour map with profiles/aperture overlay:
  - 3 plot types (contour/2D, 3D, Polar)
  - 4 scaling levels (fixed, scale-to-peak, low intensity, high intensity)
  - 4 style settings (gray, smooth, sharp, shaded bands)
- Live video mode
- Calculation inclusion area display
- Profile/peak/centroid position cursor
- Graphic zoom
- Auto-scale 2D or profile intensity
- Polar beam wander plot
- On/off axis simultaneous display of:
  - Position cursor
  - Cross-section profiles
  - Gaussian fit profiles
  - Reference profiles
  - Aperture overlay for:
    - Beam uniformity
    - % energy/power
- Rotatable color 3D isometric plot
  - 360°, 90° rotate/tilt
  - Hidden/transparent wire
  - Selectable wire density
  - Solid or single color
  - Auto-rotate mode

Beam Diagnostic Accessories

Laser-Grade Attenuation Optics for Cameras

Attenuation Optics and Accessories

Features

- **Laser-grade attenuation optics**
- **Compatible with all Coherent beam diagnostic cameras**
- **Virtually undistorted and interference-free attenuation**
- **Variable and fixed attenuation for beams up to 2000W/cm² or 50J/cm²**
- **C-Mount threads couple directly to cameras**

Most cameras are too sensitive for direct viewing of laser beams. For example, a typical diagnostics camera saturates at only ~0.5 µW/cm² power density (at ~633 nm) or at ~9 nJ/cm² (at 1064 nm) pulsed energy density. If the camera has an electronic shutter, it can be used for some CW beam attenuation, but there is more flexibility in using optical attenuation. Any attenuation optics introduced in the beam path must be manufactured to exacting specifications. The optics must be laser-grade substrate, and use the proper flatness and wedge to avoid etaloning and fringing, so that the beam is not distorted by the introduction of the attenuation. We offer attenuation optics that are designed to these specifications and packaged for use with our cameras.

Typical attenuations are 1:1 to 400,000:1, but even larger attenuations are possible. All Coherent diagnostic cameras accept C-Mount optics and accessories, and are delivered without a standard window in front of the sensor array. Such windows are liable to distort the optical beam. However, a LDFP (Low-Distortion Face Plate) filter is supplied with each camera purchased from Coherent. The LDFP is a laser-grade optic specified and polished for diagnostics use. It is mounted in a housing with C-Mount threads and provides attenuation of room light so that the camera can be used with the lights on. For operation below 400 nm, the LDFP must be removed.

The Continuously Variable Attenuator Modules (C-VARM and UV C-VARM) contain two wedge attenuators that are continuously variable and a step attenuator that allows attenuation from 10^7:1 down to 3000:1. The C-VARM and UV C-VARM can be finely adjusted to achieve both precise attenuation levels and maximum use of the camera's optical dynamic range.

The Variable Attenuator Module (VARM) is a triple-wheel filter holder that contains three filters per wheel. The filters are made to our exacting specifications for transmission value and material quality. The VARM is adjustable in attenuation in 64 discrete steps of approximately 16% reduction each time from 400,000:1 down to 1:1. The VARM can be easily returned to exactly the same attenuation level as previously used.

The BeamCUBE Fixed-Attenuator Modules (BCUBE and UV-BCUBE) provide fixed attenuation and beam pickoff for performing diagnostics on high-power laser sources. The BCUBE and UV-BCUBE utilize the front surface reflection from an uncoated laser mirror to achieve beam samples at 2% to 10% of the incident radiation, depending upon beam polarization. Multiple BCUBEs can be coupled together for even higher fixed attenuation levels.

Beam Diagnostic Accessories

Attenuation Optics for Cameras

BCUBE, UV-BCUBE, VARM, C-VARM, UV C-VARM and all other Coherent cameras have female C-Mount threading, making them easy to connect with the male C-Mount connection flange provided with each attenuator. Also, all attenuators have 1/4-20 tapped holes for independent post or plate mounting.

The C-Mount flanges (threaded rings) also have a female RMS microscope thread. This allows a microscope objective to be coupled to the attenuators and extension barrels in order to create a flexible close-up imaging system for analysis of small/focused beams, fiber optics, laser diodes or LEDs.

VARM, LaserCam-HR-InGaAs, C-VARM, BCUBE, C-Mount Flanges and Barrel

Avoiding Multi-Filter Beam Distortion

The wavefront distortion through a number of optical filters can be calculated by taking the square root of the sum of the squares of the wavefront distortion of the individual components. For example, if the individual optics are made to λ/10 specifications and six are used, a total λ/4 RMS wavefront distortion will be introduced to the beam:

$$\sqrt{0.1^2 + 0.1^2 + 0.1^2 + 0.1^2 + 0.1^2 + 0.1^2} = 0.25$$

In general, a camera cannot sense less than ~λ/4 total distortion in the beam, so if a series of filters is used, they must be made to very exacting laser-grade specifications. Attenuating optics from Coherent are manufactured to better than a λ/10 surface specification, so at least six optics in series can be used. Calculate the Low-Distortion Face Plate (LDFP) and each BCUBE as one optic, and the VARM or C-VARM as three optics each.

Attenuator Selection

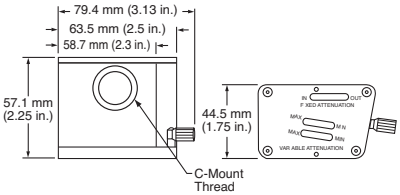
Attenuation is selected on the basis of power density in W/cm² or energy density in J/cm². The attenuation from the camera's Low-Distortion Face Plate (LDFP) will allow an average power density of up to 1.2 mW/cm². There are then only two more steps to attenuation selection:

1) Choose either the VARM or the C-VARM for up to 1W/cm².
2) In addition or alternatively, use a BCUBE beamsplitter module to pick off between 2% and 10% of the beam (depending on polarization and wavelength).

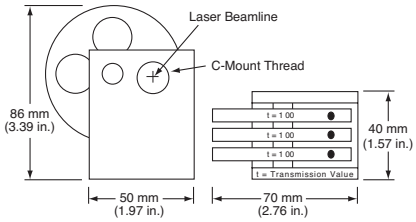
Device Specifications	Model	VARM	C-VARM	UV C-VARM	BCUBE	UV-BCUBE	BARREL SET (Barrels, 3 C-Mount Flanges)
Wavelength							
	Min. (nm)	380	380	190	380	190	–
	Max. (nm)	2200	2200	1100	2200	2200	–
Attenuation							
	From	4×10^5:1	10^7:1	10^5:1	50:1	50:1	–
	To	1:1	3000:1	300:1	10:1	10:1	–
Aperture (mm)		19	17	17	19	19	–
Max. Power Density (W/cm²)		1*	1*	1*	2.0×10^9	2.0×10^9	–
Max. Energy Density (J/cm²)		0.1*	0.1*	0.008	50	50	–
Damage Limit							
	(W/cm²)	5×10^7	5×10^7	–	2.5×10^9	2.5×10^9	–
	(J/cm²)	10	10	0.008	50	50	–
Beam Offset (mm)		–	–	–	4.0	4.0	–
Part Number		33-3328-000	33-3336-000	33-6859-000	1098403	1098466	1098426

* The maximum power and energy density listed are the levels at which thermal lensing occurs.

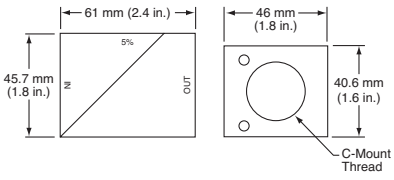
C-VARM and UV C-VARM



VARM



BCUBE and UV-BCUBE



Beam Diagnostic Accessories

Extreme-UV Beam Intensity Profiler (BIP) Optics

BIP-5000Z and BIP-12F attached to a LaserCam-HR

Features

- **UV operation from 10 nm to 355 nm**
- **Choice of 12 mm or 30 x 40 mm diameter apertures**
- **Operation with BeamView Analyzer Systems**

These Extreme-UV Beam Profiler Optics use UV-to-visible fluorescence converter face plates to couple the input laser beam to any appropriate Coherent camera. Any of our visible wavelength range cameras can be used with the Beam Intensity Profilers.

The Beam Intensity Profiler BIP-12F is a compact system accepting beams up to 12 mm in diameter from 10 nm to 355 nm. The front of the BIP-12F has a C-Mount thread, which allows it to be used in conjunction with the UV BeamCube when high-power attenuation is needed for the spectral region 190 nm to 355 nm (see Laser-Grade Attenuation Optics for Cameras on page 98). The Beam Intensity Profiler BIP-5000Z has a zoom magnification range of 6:1 to 1:1 and accepts beams up to 30 mm by 40 mm from 10 nm to 320 nm. It comes with the mount shown.

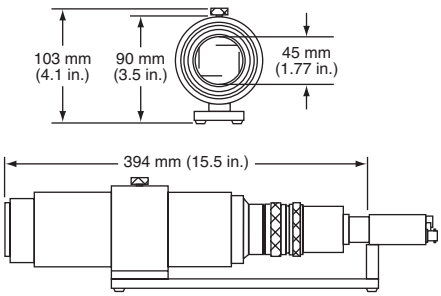
BIP-5000SPL Beamsplitter

When laser beam power or energy density exceeds recommended ranges, this beamsplitter provides additional high-power attenuation capability for the BIP-5000Z. It provides a right-angle pick-off function and attaches to the entrance aperture of the BIP-5000Z.

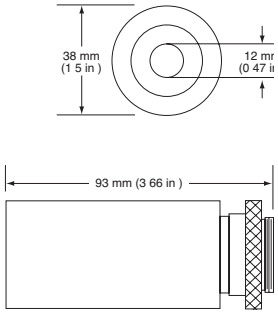
Device Specifications

Model	BIP-12F (2:1)	BIP-12F (1:1)	BIP-5000Z	BIP-5000SPL
Wavelength (nm)	10 to 355		10 to 320	10 to 320
Aperture (mm)	Ø12		30 x 40	Ø50
Resolution (camera-dependent)(µm)	20		70	–
Saturation				
at 193 to 248 nm	10 mJ/cm²		30 mJ/cm²	–
at 308 nm	50 mJ/cm²		50 mJ/cm2	–
Sensitivity	5 µJ/cm²		5 µJ/cm²	–
Damage Threshold				
CW	5W/cm²		1.5W/cm²	10W/cm²
Pulsed	500 mJ/cm²		600 mJ/cm²	50 J/cm²
Uniformity Over Aperture (%)	5			–
Image Persistence (fluorescence lifetime)	500 ns		5 µs	–
Image Magnification	2:1	1:1	6:1(Zoom) to 1:1	–
Part Number	33-3468-000	1053418	33-3484-000	33-3492-000

BIP-5000Z



BIP-12F



BeamMaster

Knife-Edge Beam Profiler

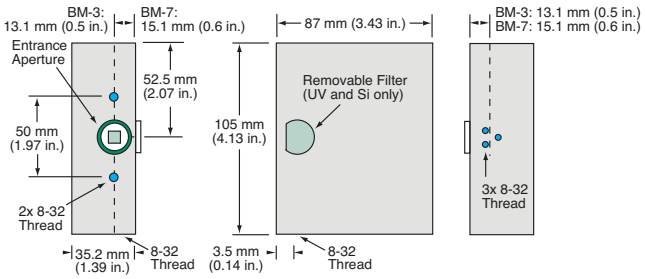
Features

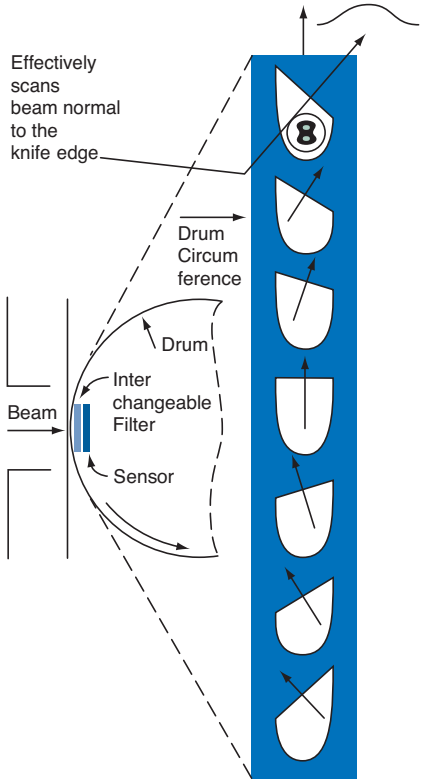
- CW laser beam shape, power and position measurements
- Beam sizes from 3 µm to 9 mm with 0.1 µm resolution and high dynamic range
- Real-time Windows display, analysis and data logging system
- Wavelengths from 190 nm to 1800 nm
- USB interface
- Windows XP, Vista 32-bit, Vista 64-bit, Windows 7 32-bit, Windows 7 64-bit

BeamMaster is a high-precision, multiple knife-edge scanning laser beam profiler which can be configured to sample, measure and display cross-sectional profiles and/or 2D and 3D image plots in real time up to 5 Hz. Selectable averaging of 1 to 20 samples provides noise reduction and maximizes measurement accuracy. Data can be collected, displayed, stored and continuously streamed via USB. All screen images can be captured and stored, or printed.

BeamMaster can measure focused beam spots as small as 3 µm with 0.1 µm resolution and has an aperture as large as 9 mm with 1 µm resolution for larger beams. Measurements can be made from 190 nm to 1100 nm (Si-Enhanced) and from 800 nm to 1800 nm (InGaAs). Input powers can be as low as 10 µW. There is automatic gain control and two internal distortion-free optical attenuation filters are included (Si-Enhanced models)

Multiple Knife-Edges for Greater Resolution and Accuracy
BeamMaster is an advancement over the more common types of beam profilers, which use two orthogonal knife-edges or slits to scan the beam profile. The BeamMaster model BM-7 uses seven individual knife-edges on a rotating drum to scan the beam through seven different axes in a single rotation. This provides more accurate measurements of the true beam shape and dimensions by tomographically combining the data from all seven scans to reconstruct a profile of the beam. This technique also makes locating the angular orientation of elliptical beam major/minor axes much easier than searching by rotating the sensor head around the optical beam axis. For applications with circular or near-Gaussian beams, the lower-cost BM-3, with only three knife-edges, is also available.

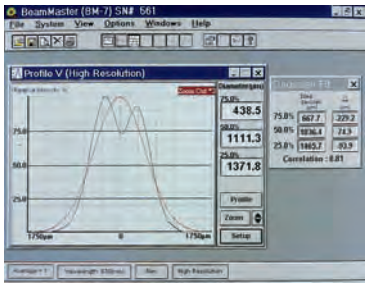


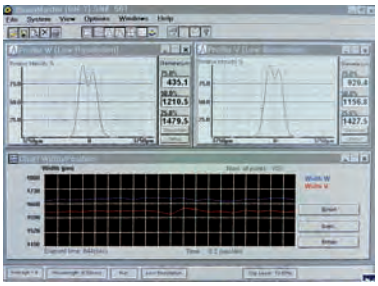


BeamMaster

Knife-Edge Beam Profiler

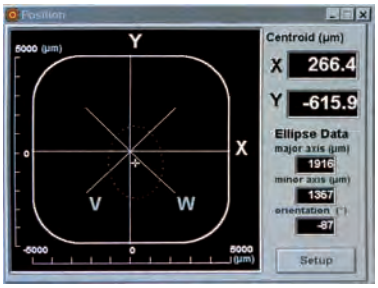
Beam Profiles and Widths





On each rotation of the drum, BeamMaster captures and processes the data from the passage of the seven knife edges across the beam (three knife edges with BM-3) as power, position and profile information. This information can be displayed every rotation, strip-charted, and sent to a file. Two orthogonal profiles can be displayed and the beam widths can be digitally displayed for any three user-chosen clip levels. A Gaussian-fit profile can be overlaid on any chosen measured profile and the fit and correlation parameters can be displayed.

To obtain the maximum profile detail, the system automatically centers the profile and zooms to display ~3 times the beam width, and the profile intensity data is autoscaled (optional) to fit the display height. Note: Unlike the PCI version, the USB model is always in high resolution mode for maximum detail.

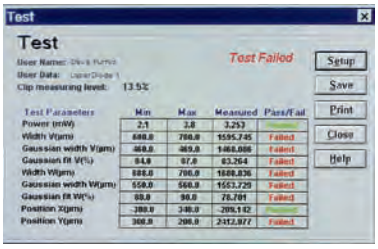


Beam Position and Ellipticity

The beam centroid position can be continuously monitored relative to the center of the sensor area, along with the beam shape, ellipticity (major and minor axes) and angular orientation. A zoom function is available and the user can choose the clip level and strip-chart the position (X and Y) data to monitor short-term or long-term, time-dependent stability or drift.

Power Measurement

The beam power can be displayed either as a digital readout or in combination with an analog "needle." Units can be chosen as µW, mW or dBm, and the user can offset the zero and zoom in on any part of the power range. Attenuator (filter) files can be selected, and a test range can be selected and displayed to monitor beam power within specific limits, with optional audio alarms.



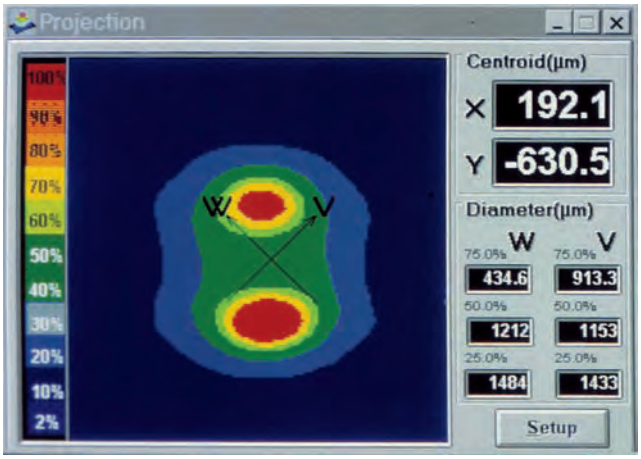
Data Collecting and QA Testing

Data regarding beam size, position and power can be continuously displayed in analog, digital and strip chart forms on the computer screen. Data can also be logged to a data file in real time for later processing or test report generation. Pass/Fail testing can be performed on measured results for acceptance within specific tolerances. All screen images also can be captured and stored as BMP or JPG files.

2D and 3D Intensity Plots

The projection function provides either a 2D or 3D view of the beam intensity profile. The projection is created using reconstructive tomography. The same method is used to produce 3D images with X-ray systems. The more knife edges, the greater the level of detail that can be obtained. For a beam distribution that is significantly non-Gaussian, such as that from a diode laser, the standard seven-knife-edge system can reconstruct a plot that closely matches the real beam. When examining near-Gaussian beams, the three-knife-edge system gives an accurate intensity distribution.

The 2D contour maps and the 3D isometric plots can be displayed with or without scan axis and grids, and the isometric plots can be rotated for easier viewing of the detailed structure.



BeamMaster 2D Intensity Plot

BeamMaster

BeamMaster Accessories

BeamMaster System Components

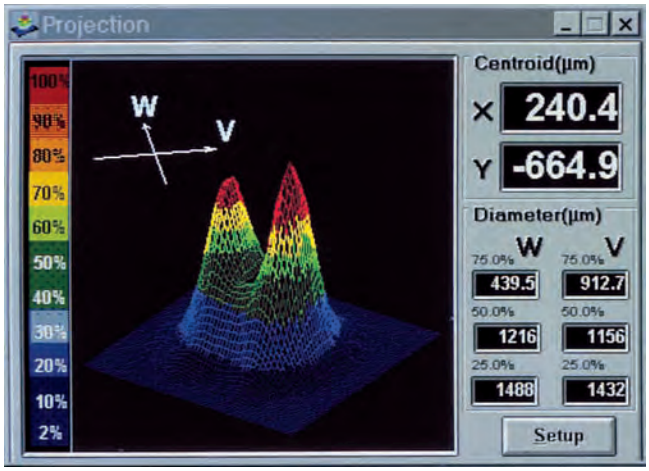
Each BeamMaster system consists of a sensor head, complete with a 1.8 m cable, USB interface module to plug into a PC computer, complete Windows software on a CD-ROM disk, a 0.5" mounting post (threaded 8-32) and stand, and optical filters (for Si-Enhanced).

Optical Filters

The BM-7 and BM-3 Si-Enhanced heads come with two neutral density filters. NG4 and NG9 filters (complete with transmission curves) are provided to extend the power range of the heads from 5 mW to 1W in the 400 nm to 1100 nm range. The NG4 filter comes pre-installed and provides ~10% transmission at 633 nm. The NG9 filter is in a protective filter case and provides ~0.5% transmission at 633 nm. There is no filter in the BeamMaster InGaAs head configurations.

BeamMaster Accessories

An optional mount is available to enable rotation of the BeamMaster sensor head about the optical axis. This mount has a 360-degree calibrated scale with a locking screw. An optional C-Mount Adapter Plate allows the attachment of any C-Mount, threaded optical accessory, such as a BCUBE high-power attenuator pickoff optic (see the Beam Diagnostics Accessories section on page 97).



BeamMaster 2D Intensity Plot

Device Specifications

Model	BeamMaster
Measurement Rate (Hz)	5
Wavelength Range (nm)	190 to 1100 [BM-7 Si-Enhanced, BM-3 Si-Enhanced] 800 to 1800 [BM-7 InGaAs (3 or 5 mm), BM-3 InGaAs (3 mm)]
Sensor Aperture	9 mm square [BM-7 (Si-Enhanced)] 5 mm circular [BM-3 (Si-Enhanced)] 3 mm circular [BM-3 and BM-7 (InGaAs)] (optional BM-7 InGaAs 5 mm available)
Minimum Beam Size (µm)	15 (BM-7 all models) 3 (BM-3 all models)
Beam Size Resolution	1 µm for beams >100 µm in size (0.1 µm for beams <100 µm in size)
Position Measurement Resolution (µm)	1
Position Measurement Accuracy (µm)	±15
Beam Width Measurement Accuracy (%)	±2
Beam Power Range	10 µW to 1 W (with supplied internal filters), saturation 0.1 W/cm² without filter, 20W/cm² with NG9 filter [BM-7, BM-3 (Si-Enhanced)] 10 µW to 5 mW (no filters provided), saturation 0.1 W/cm² [BM-3 InGaAs, BM-7 InGaAs]
Relative Power Measurement	0.1 µW resolution
Sensor Head Weight (g)	56 g
Part Number	
1224014	BeamMaster BM-7 Si-Enhanced - USB interface
1224012	BeamMaster BM-3 Si-Enhanced - USB interface
1224018	BeamMaster Bm-7 InGaAs (3 mm) - USB interface
1224020	BeamMaster BM-7 InGaAs (5 mm) - USB interface
1224016	BeamMaster BM-3 InGaAs (3 mm) - USB interface
1038024	BeamMaster Rotation Mount
33-7147-000	BeamMaster C-Mount Adapter Plate

ModeMaster PC

M^2 Beam Propagation Analyzer

Features

- Measurement and display of CW laser divergence, M^2 (or k) and astigmatism
- Beam sizes 0.2 mm to 25 mm
- Wavelengths from 220 nm to 1800 nm
- Determination of waist location and diameters (including D4σ diameter) and Rayleigh range
- Angular and translational beam-pointing stability

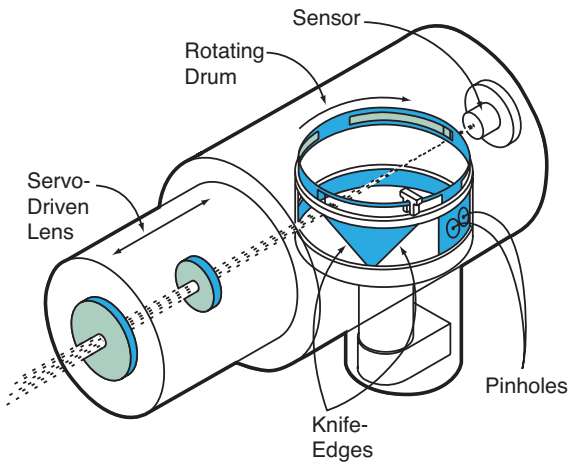
How Does the ModeMaster PC Work?

The ModeMaster PC head is a dual-knife-edge beam profiler integrated with a diffraction-limited precision scanning lens, which is translated along the beam propagation axis. The lens focuses the beam to create an internal beam waist, and the two orthogonal knife edges (X and Y), which are mounted on a rotating drum, measure the beam diameter and beam axis location at 256 planes along the beam waist as the lens is translated. The powerful ModeMaster PC software then derives the M^2 factor, the size and location of the beam waist, the far-field divergence angle, the pointing direction, astigmatism and asymmetry, and the Rayleigh range.

Measurements also include ISO D4σ, second moment, knife-edge, slit and D86 beam diameters. The entire measuring process occurs in less than 30 seconds.

The ModeMaster PC also provides special weighting functions to help eliminate effects on measurement accuracy due to intermittent beam noise, vignetting or other transients during the focus scan. Real-time displays allow laser peaking or adjustment for minimum M^2, divergence, maximum power density, far-field pinhole profiles and pointing angle.

Complete Geometric Beam Characterization Along the Laser Beam Path

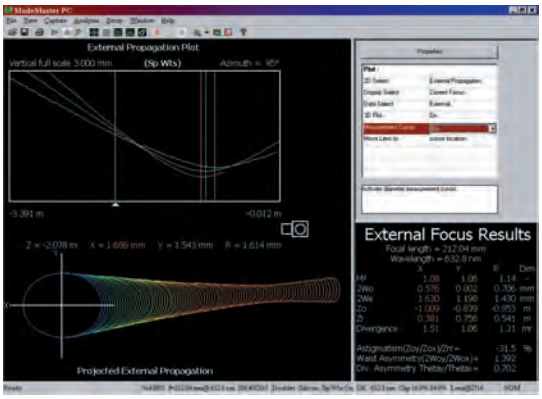


- Beam Quality – M^2
- Beam Diameter
- Waist Diameter & Location
- Divergence Angle
- Rayleigh Range
- Pointing Stability
- Power Density
- Beam Profiles
- Second-Moment Diameters
- Astigmatism
- Waist Asymmetry
- Divergence Asymmetry

Beam propagation is concerned with the energy distribution in a beam and the change of that distribution along the beam path. The ModeMaster Beam Propagation Analyzer established a new laser beam quality parameter, M^2, which has now become an ISO measurement standard. M^2 describes how close to "perfect-Gaussian" a laser beam is, and can be used to predict the beam size, beam shape and the smallest spot that can be created from the beam further downrange.

ModeMaster PC

M^2 Beam Propagation Analyzer



Beam Propagation Display

Coherent pioneered M^2 beam propagation analysis with the ModeMaster system a decade ago. Now, the new ModeMaster PC Laser Beam Propagation Analyzer combines all the ISO-compliant accuracy and powerful features needed for measuring M^2 and other beam propagation analysis functions for CW lasers. It also provides the added flexibility and value of a personal computer to provide optimum user control, data processing, storage and results display.

The ModeMaster PC includes a Universal Serial Bus (USB) control/interface console and Windows software for operation with Windows XP, Vista, and 7. The ModeMaster PC is also compatible with all existing ModeMaster systems, allowing legacy ModeMaster system users to easily upgrade their systems for use on a supported PC computer.

Easy Beam Alignment

The precision 5-axis head mount and beam position display of the ModeMaster PC provide easy angular alignment and translational centering of the lens and scan axis to the beam propagation path.

Second-Moment Diameters

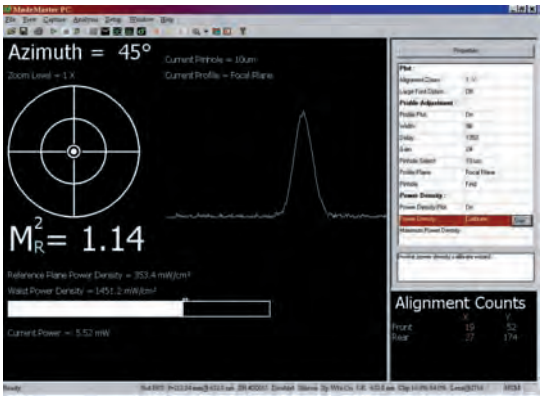
Beam diameter is a critical parameter in beam propagation measurements. Second-moment diameters ($D4\sigma$) give the best theoretical answers for beam propagation calculations. The ModeMaster PC measures second-moment diameters directly. The ModeMaster PC software also includes conversion algorithms from its knife-edge measurements to second-moment diameter measurements that are valid for stable resonator modes with M^2 of 1 to 4 (covering most commercially available lasers). Also included are conversions to D86 and slit diameters to allow comparison to other measurements.

Real-Time Power Density Adjustment

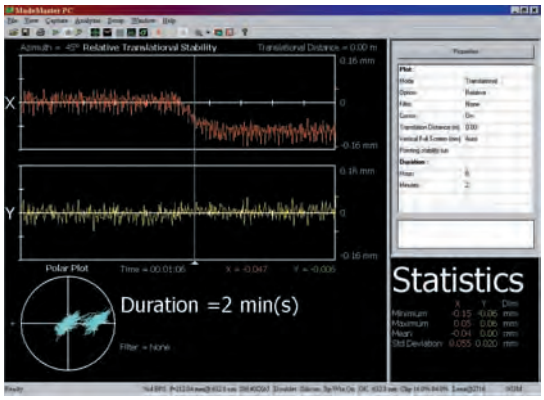
In most laser applications it is not laser power that does the work but power density. Using the ModeMaster PC, the point of maximum power density can be quickly located. A convenient power density tuning screen displays power density as a pseudo-analog "tune bar," giving real-time feedback as the laser mirrors are adjusted.

ModeMaster PC

M^2 Beam Propagation Analyzer



Real-Time Display



Pointing-Stability Display

Real-Time M^2 and Beam Profiles
The ModeMaster PC provides real-time measurement and display for fine tuning M^2 and many other beam propagation parameters, as well as the near-field or far-field pinhole intensity beam profiles.

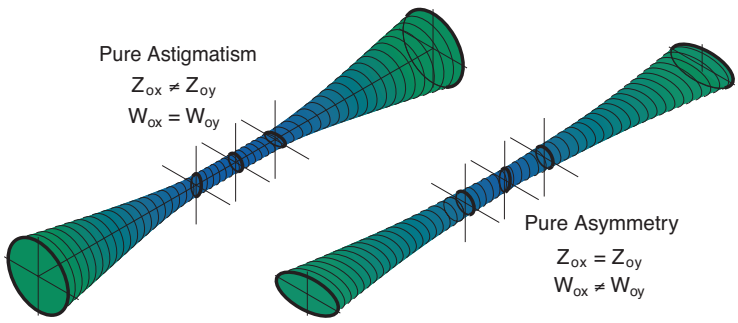
Beam-Pointing and Translational Stability
ModeMaster is able to measure and display both translational (parallel to the beam axis) or angular (from a pivot point) beam movement over a period of 2 minutes to 24 hours. The angular pivot point of the beam axis (often a single optical surface) can be located along the beam path. Statistical analysis of the beam axis location and angle are displayed for both the X and Y axes. Three levels of filtering reduce noise and increase the sensitivity of pointing-stability measurements.

Expanded Online Help
The ModeMaster PC provides complete online help. Help messages also suggest corrective measures when beam parameter limits are exceeded.

Upgrading to the ModeMaster PC
All previous versions of the ModeMaster systems can be upgraded to the ModeMaster PC. The original console unit and the LabMaster display are simply replaced with the ModeMaster PC Control/Interface Module and Software, installed in a user-supplied compatible PC computer. All original ModeMaster scan heads are fully compatible and can be plugged into the ModeMaster PC Control/Interface Module, which can be ordered separately with the software.

Beam Astigmatism and Asymmetry

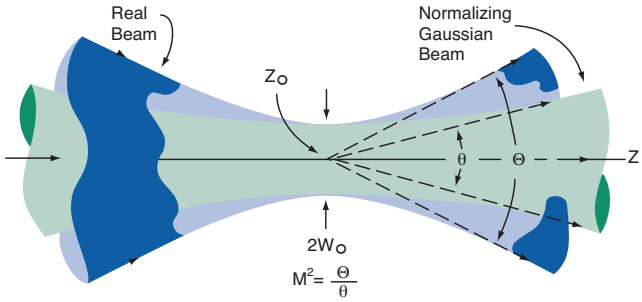
Changes in the shape of a propagating beam can be astigmatic, asymmetric or both. The beam shown at the near right has pure astigmatism; the waists (Wo) in the horizontal and vertical directions are the same size, but occur at different propagation distances (Zo). In asymmetric beams (far right) the two waists occur together, but are of different diameters. The ModeMaster PC provides complete analysis of these beam characteristics.



ModeMaster PC

Laser Beam Quality

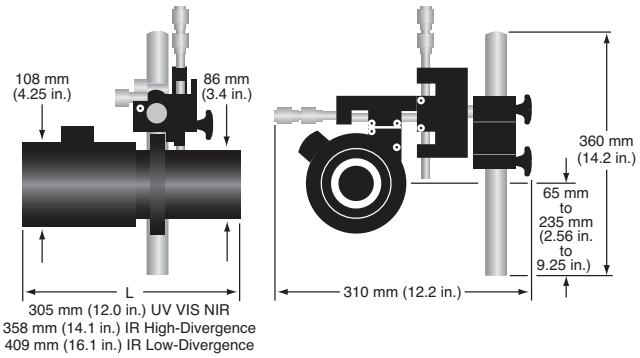
The closer an actual laser beam is to diffraction-limited, the more tightly it can be focused, the greater its depth of field, and the smaller the diameter of the beam optics can be to transmit the beam. M^2 is the ratio of the divergence of the actual beam to that of a theoretical diffraction-limited beam of the same waist size in the TEM_{00} mode. Thus, the angular size of the beam in the far field will be M^2 larger than calculated for a perfect Gaussian beam.



$\Theta = M^2 \times 2\lambda / (\pi W_o)$, FOR A BEAM WAIST DIAMETER $2W_o$.

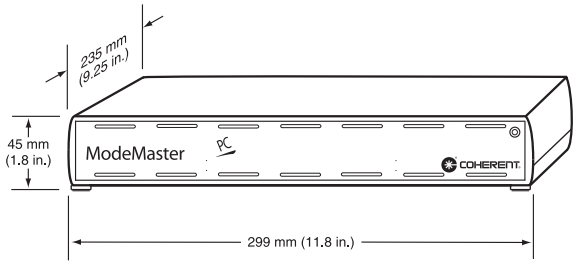
Device Specifications	Model	ModeMaster PC
	Accuracies	
	Waist Diameter (%)	±2
	Waist Location	±8% of input beam Rayleigh Range
	Beam Quality – M^2 (%)	±5
	Divergence (%)	±5
	Beam Translation	±5% of waist diameter +0.1 mm
	Pointing Angle	±5% of divergence +0.04 mrad
	Azimuth Angle Readout	±2°(10 to 200°)
	Knife-Edge Clip Levels	User-adjustable 0% to 100% in 1.5% steps
	ModeMaster PC Control/Interface Module Update Rate	<8 Hz (M^2, divergence, power density, waist diameter, profiles)
	Analog Outputs	Detector signal output, 0 to 13V maximum A/D control signal out, 0 to 5V pulse Trigger (syncs to drum rotation), 0 to 5V pulse
	Power	100 to 240 VAC, 47 to 63 Hz, 40W maximum

Scan Head and Precision Mount



305 mm (12.0 in.) UV VIS NIR
358 mm (14.1 in.) IR High-Divergence
409 mm (16.1 in.) IR Low-Divergence

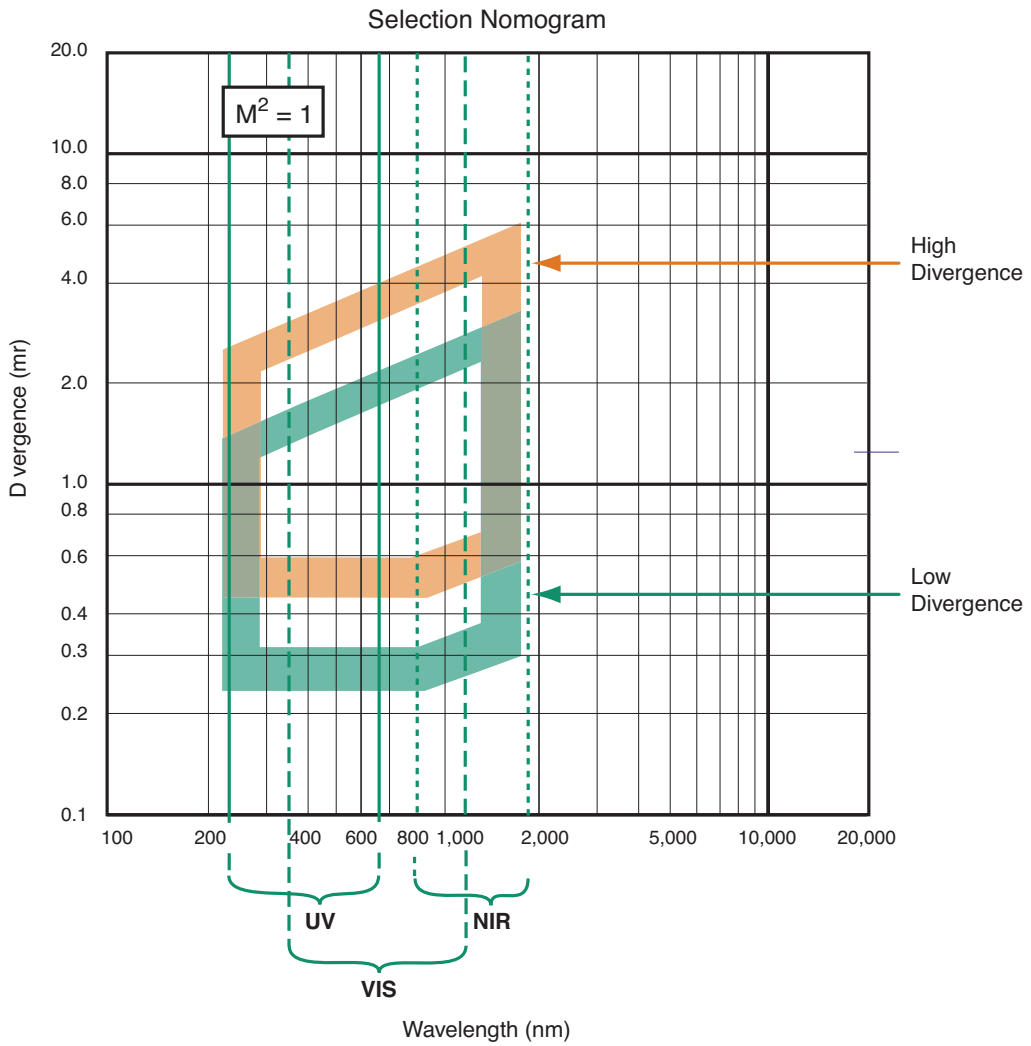
Control/Interface Console



ModeMaster PC

Selecting a ModeMaster PC System Configuration

ModeMaster PC systems are available in six standard configurations (all include scanning head, 5-axis mount, USB control/interface console, cables, PC software and manual). These configurations encompass three wavelength ranges, with two divergence ranges (high-divergence and low-divergence) within each wavelength range. Use the following steps, along with the Selection Nomogram Chart and Configuration Table (below), to select a ModeMaster PC configuration.



1. Choose between the three spectral ranges: UV (220 nm to 680 nm), VIS (340 to 1000 nm), and NIR (800 nm to 1800 nm).

2. Determine the approximate divergence of your laser beam and use the Selection Nomogram (Divergence vs. Wavelength) Chart to select the low-divergence or high-divergence configuration.

3. Confirm that your beam size is <25 mm diameter for the low-divergence configuration or <12 mm for the high-divergence configuration.

4. Use the table below to determine the part number of the ModeMaster PC configuration selected, and to verify all other beam specifications.

5. If more than one ModeMaster PC configuration appears to be needed in order to cover all required beam parameter ranges, optional Scanning Head Modular Components can be ordered to change the configuration of the ModeMaster PC system to cover other ranges (see next page for details).

ModeMaster PC

Complete Geometric Beam Characterization Along the Laser Beam Path

Standard Configuration

Name	UV Low-Divergence	UV High-Divergence	VIS Low-Divergence	VIS High-Divergence	NIR Low-Divergence	NIR High-Divergence
Model	MM-1	MM-1S	MM-2	MM-2S	MM-3	MM-3S
Spectral Range (µm)	0.22 to 0.68		0.34 to 1.00		0.80 to 1.80	
Detector Type	Silicon				Germanium	
INPUT BEAM REQUIREMENTS AT TEST WAVELENGTH						
Test Wavelength[1]	351 nm		514 nm		1.06 µm	
Minimum Power[2]	7.5 mW[3]		2.5 mW[3]		2.5 mW[3]	
Maximum Power[2]	10W[3]		25W[3]		2.5W	
Noise	<2% RMS and <5% peak-to-peak					
Min. Divergence (mrad)	0.24	0.46	0.24	0.46	0.25[5]	0.47[5]
Max. Divergence (mrad)[4]	1.7	3.2	2.0	3.6	2.7	5.0
Max. Beam Diameter (mm)[6]	25	12	25	12	25	12
Part Number	33-1843-000	33-2106-000	33-2221-000	33-2239-000	33-2387-000	33-2395-000

[1] Wavelength-dependent quanlities are input power levels, and minimum and maximum divergence (see Notes 2, 5, 6).
[2] Power levels are proportional to the inverse of the spectral response of the detector. The silicon detector peaks at 900 nm and is at half-peak sensitivity at 510 nm and 1050 nm. The germanium detector peaks at 1500 nm and is at half-peak sensitivity at 1100 nm and 1650 nm.
[3] These limits can be reduced by a factor of 10 (higher sensitivity) by user-removal of the light-restricting aperture in front of the detector.
[4] The maximum divergence limit is fixed by the inability to accurately locate the internal waist when the internal beam diameter growth (over the span of the drum) is too slight. Limits shown are for $M^2 = 1$ and test wavelength; limits scale as the square root of M^2 (test wavelength).
[5] Minimum divergence in this wavelength range scales as the square root of M^2 (test wavelength).
[6] Diameters are approximate; divergence takes precedence in choosing options. Refer to nomogram.

Components for Other Wavelength and Divergence Ranges
The body design of the ModeMaster PC scanning head has modular lens and detector sets that allow quick changes to other wavelength or divergence ranges to meet your measurement needs.

The UV-VIS-NIR body can be used in any of the UV, VIS or NIR spectral regions with the appropriate detector (silicon-Si for the UV and VIS; germanium-Ge for the NIR) and low- or high-divergence lenses. The UV lens can be used with the silicon detector and the VIS-NIR lens can be used with either the silicon or germanium detector.

Part Number	Description	Spectral Region(s)	Scan Head Body
33-2072-000	Silicon Detector (0.22 to 1.0 µm)	UV, VIS	UV-VIS-NIR
33-2080-000	Germanium Detector (0.8 to 1.8 µm)	NIR	UV-VIS-NIR
33-2114-000	High-Divergence Lens Kit	UV	UV-VIS-NIR
33-2130-000	Low-Divergence Lens Kit	UV	UV-VIS-NIR
33-2122-000	High-Divergence Lens Kit	VIS, NIR	UV-VIS-NIR
33-2148-000	Low-Divergence Lens Kit	VIS, NIR	UV-VIS-NIR

ModeMaster PC M^2 Beam Propagation Analyzer (standard system configuration)

Part Number	Description	Spectral Range
33-1843-000	ModeMaster PC System[1]	UV, Low-Divergence
33-2106-000	ModeMaster PC System[1]	UV, High-Divergence
33-2221-000	ModeMaster PC System[1]	VIS, Low-Divergence
33-2239-000	ModeMaster PC System[1]	VIS, High-Divergence
33-2387-000	ModeMaster PC System[1]	NIR, Low-Divergence
33-2395-000	ModeMaster PC System[1]	NIR, High-Divergence
33-1710-000	ModeMaster PC Control/Interface Console and Software	–

[1] All ModeMaster systems include scan head, mount, control/interface console and software.

WaveMaster

Laser Wavelength Meter

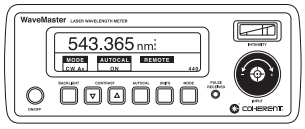
Features

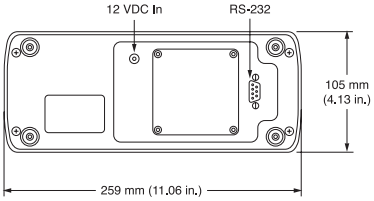
- 380 nm to 1095 nm wavelength range
- RS-232 interface
- Internal self-calibration
- Fiber input with sampling probe

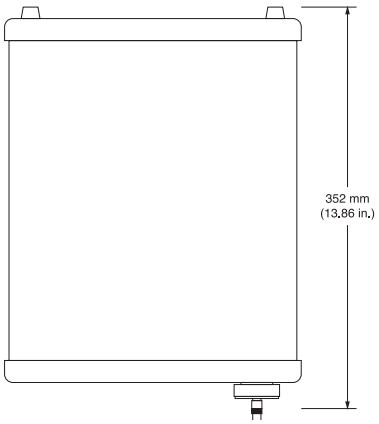
Device Specifications

Model	WaveMaster
Wavelength Coverage (nm)	380 to 1095
Accuracy (nm)	0.005
Resolution (nm)	0.001
Minimum Pulse Rep. Rate	Single shot
Maximum Pulse Rep. Rate	CW
Maximum Signal Bandwidth (nm)	2 at 400 3 at 600 5 at 1000
Minimum Signal	20 µW CW at 632 nm 2 mJ pulsed at 1064 nm
Maximum Signal	100 mW CW at 632 nm 100 mJ pulsed at 1064 nm
Display Update (Hz)	3
Size (W x H x D) (mm)	259 x 105 x 352
Storage	
Storage Condition	-10°C to 50°C (14°F to 122°F)
Relative Humidity	Non-condensing and <80%
Shock (g)	>4
Use Conditions	-10°C to 40°C (14°F to 104°F)
Relative Humidity	Non-condensing and <80%
Shock (g)	<4
Power Supply (included)	Universal 90 to 250 VAC; 40 to 72 Hz in; 12 VDC out
Part Number	33-2650-000

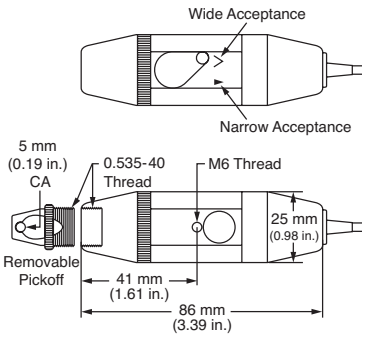
WaveMaster







Sampling Probe



WaveMaster

Laser Wavelength Meter

The WaveMaster measures the wavelength of both CW and pulsed lasers of any repetition rate. The wavelength can be displayed in GHz, wave numbers, or nanometers, with vacuum and air readings available. The WaveMaster will read the peak wavelength of sources as wide as 2 nm from 380 nm to 1095 nm. Bandwidths wider than 2 nm can be accommodated at the longer wavelengths.

The WaveMaster is easy to use. Just turn on the readout and get the beam within 10 degrees of normal incidence to the sampling probe. The probe has a 2-meter fiberoptic cable and takes up a minimum of beam path space. Most intensity variances are automatically accommodated, but for the strongest and weakest signals a front panel attenuator adjustment and intensity readout quickly produce accurate readings. No special triggering modes or setups are required for pulse capture.

User-Friendly
The WaveMaster is easy to read with front panel adjustments of contrast and back-lighting for the extra-large display. Parameters that have been set-up are clearly displayed, in addition to signal intensity and pulse-retrieved indicators. Configuration settings are maintained in memory and retrieved on start-up for convenience. Communication with the WaveMaster is also easy with a built-in RS-232 port.

Sophisticated algorithms that monitor the WaveMaster's response maintain calibration. Periodically, and upon indication from the algorithms, the WaveMaster is referenced to the fundamental lines of an internal NE source.

Pulse or CW Operation
The operational mode can be changed from CW, to CW with averaging, to pulse. In CW mode the display is updated at 3 Hz. In CW with averaging, the display is updated at 3 Hz with an average of the last 10 readings taken at 3 Hz. For pulse mode, when a valid pulse is received the display will show the wavelength reading of the pulse for 15 seconds, or until another valid pulse is received.

No Warm-Up Time
When the WaveMaster is first powered on, it will perform a self-test cycle and then enter the auto-calibration mode. After 10 seconds, the AUTOCAL message is cleared from the display and the WaveMaster is ready to make measurements.

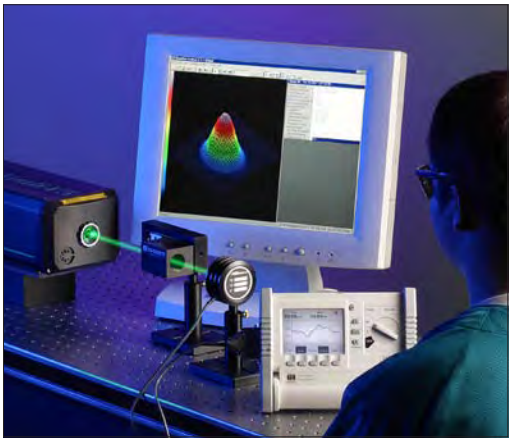
Accurate
With its self-monitoring algorithms and an internal spectral line source, the WaveMaster auto-calibrates the internal spectrometer to maintain accuracy.

Easy Set-Up
Feedback from the WaveMaster is straightforward. Once the signal is applied to the probe, the unit begins sampling to simplify set-up. In CW mode, the WaveMaster will auto-range to adjust the sensor integration time to match the incoming signal. This allows the quickest set-up and greatest versatility.

Selected Display Units
The wavelength readings can be displayed in nanometers in "air" at standard temperature and pressure (STP), or shown as a calculated conversion from STP to nanometers in a "vacuum", or displayed as wave numbers (cm^{-1}), or as frequency (GHz).

Calibration and Service

ISO 17025 Accreditation



ISO/IEC 17025:2005 Accredited

Coherent's Wilsonville, Oregon calibration laboratory is fully accredited to ISO/IEC 17025:2005 by ACLASS, a brand of the ANSI-ASQ National Accreditation Board and recognized internationally by ILAC, APLAC, and IAAC. **ISO 17025 is the single most important metrology standard for test and measurement products, and external accreditation is a formal recognition that a calibration laboratory is using valid and appropriate methods and is competent to carry out specified tests or calibrations.**

ACLASS

CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board/ACLASS
500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

Coherent LSM
27650 SW 95th Ave.
Wilsonville, OR 97070

has been assessed by ACLASS
and meets the requirements of international standard

ISO/IEC 17025:2005

while demonstrating technical competence in the field(s) of

CALIBRATION

Refer to the accompanying Scope(s) of Accreditation for information regarding the types of calibrations to which this accreditation applies.

AC-1630
Certificate Number

ACLASS Approval

Certificate Valid 03/15/2012-03/15/2014
Version No. 001

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC IAF Communiqué dated January 2009*).

Scope of Accreditation

The scope of accreditation applies to the laser/electrical calibration of nearly all the company's catalog pyroelectric laser energy sensors, thermopile laser power sensors and meter electronics. Pages in this catalog that contain products that fall within the scope of accreditation are clearly identified by the combined ILAC-MRA/ACLASS mark shown below:

ilac-MRA

ACLASS
ACCREDITED
CALIBRATION
AC-1630

The formal scope of accreditation can be found on the Coherent website at http:/www.coherent.com within Company tab > Quality. It can also be found within the ACLASS website at http://www.aclasscorp.com. Click the "Search Accredited Organizations" button on their homepage.

ISO 17025 is an international standard that governs calibration labs. It requires labs demonstrate that they operate a quality management system that controls the processes and documentation, including auditing and corrective action processes. It also requires adherence to rigorous technical requirements that ensure valid results are generated.

In terms of specific technical requirements, ISO/IEC 17025 ensures that a company:

- maintains testing facilities and equipment to specified standards
- ensures protocols are fully documented
- trains workers to an appropriate level of competence
- confirms validity and appropriateness of methods, especially so called "non-standard" methods such as those used to calibrate laser measurement equipment, which have been developed internally
- uses accepted mathematical methods for calculating results
- verifies that purchased test equipment meets proper requirements, and that all equipment used to produce accredited calibrations has itself received ISO 17025 accredited calibrations
- has a traceable path of calibration to independently maintained national or international standards
- provides both as received and outgoing testing data to customers in an approved format
- ensures the calibration certificate meets the requirements of the standard

The outcome of all these efforts is that customers can have confidence that a laboratory achieves verifiably correct results, and that these results will be reported in an unambiguous manner.

Calibration and Service

Warranty and RMA Instructions

Limited Warranty
Coherent, Inc., warrants to the original purchaser that its laser power and energy meters and sensors are free from defects in materials and workmanship and comply with all specifications, active at the time of purchase, for a period of twelve (12) months. Coherent, Inc., will, at its option, repair or replace any product or component found to be defective during the warranty period. This warranty applies only to the original purchaser and is not transferable.

Extended Warranty
Coherent, Inc., offers original purchasers of laser power and energy meters and sensors an extended twelve month warranty program, which includes all parts and labor. In order to qualify for this warranty, a Customer must return the Product to the Company for recalibration and recertification. The Company will recertify the Product, provide software upgrades, and perform any needed repairs, and recalibrate the Product, for a fixed service fee. If the Product fails and is returned to the Company within one year following the date of recalibration and recertification service, the Company will, at its option, repair or replace the Product or any component found to be defective.

Contact Coherent or visit www.Coherent.com/LMC for additional details and warranty limitations.

Obtaining Warranty Service
In order to arrange for warranty service or annual recalibration, first contact your closest Coherent service center to obtain a Return Material Authorization (RMA) number.

USA
Phone: 800 343 4912
Fax: 503 454 5727
E-mail: LMC.sales@coherent.com

Asia
Phone: 813 5635 8680
Fax: 813 5635 8701
E-mail: LMC.sales@coherent.com

Europe
Phone: 49 6071 9680
Fax: 49 6071 968499
E-mail: LMC.sales@coherent.com

Detailed instructions for preparing and shipping your instrument can be found below.

Instructions for Returning Equipment for Service and Calibration

To prepare your instrument, meter or sensor for return to Coherent, attach a tag to the unit that includes the name and address of the owner, the contact individual, the serial number, and the RMA number you received from Customer Service.

Wrap the product with polyethylene sheeting or equivalent material. If the original packing material and carton are not available, obtain a corrugated cardboard shipping carton with inside dimensions that are at least 6 in. (15 cm) taller, wider, and deeper than the product. The shipping carton must be constructed of cardboard with a minimum 375 lbs. (170 kg) test strength. Cushion the instrument unit in the shipping carton, using 3 in. (7.5 cm) of packing material or urethane foam on all sides, top, bottom, and between the carton and the instrument or sensor. Seal the shipping carton with shipping tape or an industrial stapler.

Shipping addresses for our repair and calibration facilities are given below:

USA
Coherent Laser Measurement
and Control Service Center
Attn: (your RMA number)
27650 SW 95th Avenue
Wilsonville, OR 97070
USA

Europe
Coherent (Deutschland) GmbH
Dieselstr. 5b
D-64807 Dieburg
Germany

Asia
Coherent Japan
Toyo MK Building
7-2-14 Toyo
Koto-Ku, Tokyo
135-0016 Japan

Measurement Products for Use with Coherent Lasers

Matrix of Recommendations*

CO_2 (Diamond) Lasers	Laser	Wavelength (µm)	Power Meter	Power Sensor
	C-30	10.6	FieldMaxII-TO	PM30
	C-40, C-55, C-70	10.6	FieldMaxII-TO	PM150
	G-100, G-150, E-150	10.2 to 10.7	FieldMaxII-TO	PM150
	G-100i	9.4 ±0.3	FieldMaxII-TO	PM150
	K-250, K-225i, K-300	10.4 to 10.8	FieldMaxII-TO	PM300F-19
	E-400, E-400i, K-500, E-1000	10.2 to 10.8	FieldMaxII-TO	PM1K
Diode Lasers	**Laser**	**Wavelength (nm)**	**Power Meter**	**Power Sensor**
	CUBE	375 to 785	FieldMaxII-TO	PS10
	CUBE FP	405, 445, 488, 640, 660	FieldMaxII-TO	PS10
	OBIS	375 to 785	FieldMaxII-TO	PS10
	OBIS FP	405, 445, 488, 637, 640, 647, 660	FieldMaxII-TO	PS10
	Radius	375 to 635	FieldMaxII-TO	PS10
	All Laser Diode Modules		FieldMaxII-TO	PS10
	HighLight FAP 30/60/100	800 to 820	LabMax-TOP	LM-150FS + SMA adapter
	HighLight D-Series (defocused)	965 to 985	FieldMaxII-TO	PM5K-200
	HighLight 4000L	800 to 820	FieldMaxII-TO	PM5K-100
	HighLight 1000F	965 to 985	FieldMaxII-TO	PM1K
Diode-Pumped Solid-State Lasers (CW)	**Laser**	**Wavelength (nm)**	**Power Meter**	**Power Sensor**
	Azure	266	FieldMaxII-TO	PM10X or PS10[2]
	Compass 115M, 215M, 315M	532	FieldMaxII-TO	PS10
	Compass 561	561	FieldMaxII-TO	PS10
	Genesis CX STM[1]	355, 460, 480, 488, 532, 577	FieldMaxII-TO	PM10
	Genesis MX STM[1]	460, 480, 488, 532, 561, 577	FieldMaxII-TO	PM10
	Genesis Taipan	460, 480, 488, 532, 561, 577	FieldMaxII-TO	PM10
	MBD 200	455 to 1070	FieldMaxII-TO	PS10
	MBD 266	266	FieldMaxII-TO	PM10X or PS10[2]
	Paladin 355	355	FieldMaxII-TO	PM10X
	Sapphire LP Family	458, 460, 488, 514, 532, 561, 568, 588	FieldMaxII-TO	PS10
	Sapphire 488 HP	488	FieldMaxII-TO	PM10
	Verdi V-Series, G-Series (<10W)	532	FieldMaxII-TO	PM10
	Verdi V-Series, G-Series (>10W)	532	FieldMaxII-TO	PM30
	Verdi IR	1064	FieldMaxII-TO	PM30
Diode-Pumped Solid-State Lasers (Pulsed)	**Laser**	**Wavelength (nm)**	**Power Meter**	**Power Sensor**
	AVIA (<10W)	266, 355	FieldMaxII-TO	PM10X
	AVIA (10W to 30W)	355, 532	FieldMaxII-TO	PM30X
	AVIA (>30W)	532	FieldMaxII-TO	PM150
	Mamba Green, IR	532, 1064	FieldMaxII-TO	PM1K
	MATRIX 532, 1064	532, 1064	FieldMaxII-TO	PM30
	MATRIX 355	355	FieldMaxII-TO	PM10X
	Talisker 500	355, 532, 1064	FieldMaxII-TO	PM30
	Talisker Ultra	355, 532, 1064	FieldMaxII-TO	PM30

* Other Coherent measurement product configurations may be compatible with these lasers. Coherent Family Plan pricing may apply (see page 119). Contact factory for more details.

[1] Available in OEM or end user versions.

[2] For these lasers, the PS10 can be selected for users who are looking for either higher resolution or low power measurements.

Measurement Products for Use with Coherent Lasers

Matrix of Recommendations*

Ion Lasers	**Laser**		**Wavelength (nm)**	**Power Meter**	**Power Sensor**	
	Innova (<1W)		200 to 1100	FieldMaxII-TO	PS10	
	Innova (>1W)		200 to 1100	FieldMaxII-TO	PM10	
Optically Pumped Semiconductor Lasers (OPSL)	**Laser**		**Wavelength (nm)**	**Power Meter**	**Power Sensor**	
	Genesis CX STM[1]		355, 460, 480, 488, 532, 577	FieldMaxII-TO	PM10	
	Genesis CX STM Compact		355	FieldMaxII-TO	PS10	
	Genesis CX SLM[1]		355, 460, 480, 488, 514, 532, 577	FieldMaxII-TO	PM10	
	Genesis MX MTM[1]		460, 480, 488, 514, 532, 561, 577 607, 639, 920, 1064, 1154	FieldMaxII-TO	PM10	
	Genesis MX STM[1]		460, 480, 488, 532, 561, 577	FieldMaxII-TO	PM10	
	Genesis Taipan		460, 480, 488, 532, 561, 577	FieldMaxII-TO	PM10	
	Sapphire LP Family		458, 460, 488, 514, 532, 561, 568, 588	FieldMaxII-TO	PS10	
	Sapphire 488 HP		488	FieldMaxII-TO	PM10	
	Verdi G-Series		532	FieldMaxII-TO	PM10	
	Verdi G2/G5 SLM		532	FieldMaxII-TO	PM10	
Q-Switched Lasers	**Laser**	**Wavelength (nm)**	**Power Meter**	**Power Sensor**	**Energy Meter**	**Energy Sensor**
	Evolution (<30W)	527	FieldMaxII-TOP	PM30	LabMax-TOP	J-25MT-10KHZ plus medium heat sink
	Evolution (>30W)	527	FieldMaxII-TOP	PM150		
Tunable Lasers	**Laser**		**Wavelength (nm)**	**Power Meter**	**Power Sensor**	
	MBR Ring		700 to 1030	FieldMaxII-TO	PM10	
Ultrafast Oscillators and Accessories	**Laser**		**Power Meter**	**Power Sensor**	**Energy Meter**	**Energy Sensor**
	Pump Lasers					
	Verdi V2, V5, V6, V8		FieldMaxII-TO	PM10	-	-
	Verdi V10, V12, V18		FieldMaxII-TO	PM30	-	-
	Evolution-15/30		FieldMaxII-TO	PM30	LabMax-TOP	J-25MT-10KHZ[2]
	Evolution-45/HE		FieldMaxII-TO	PM150	-	-
	Oscillators					
	Micra		FieldMaxII-TO	PM10 or PS10[3]	-	-
	Mira		FieldMaxII-TO	PM10	-	-
	Chameleon		FieldMaxII-TO	PM10	-	-
	Vitara		FieldMaxII-TO	PM10 or PS10[3]	-	-
	Vitesse		FieldMaxII-TO	PM10 or PS10[3]	-	-
	Mantis		FieldMaxII-TO	PM10 or PS10[3]	-	-
	Oscillator Accessories					
	Mira-OPO		FieldMaxII-TO	PS10	-	-
	Chameleon Compact OPO		FieldMaxII-TO	PS10	-	-

* Other Coherent measurement product configurations may be compatible with these lasers. Coherent Family Plan pricing may apply (see page 119). Contact factory for more details.

[1] Available in OEM or end user versions.

[2] With medium heat sink.

[3] The PS10 is recommended when making higher resolution or low power measurements.

Measurement Products for Use with Coherent Lasers

Matrix of Recommendations*

Ultrafast Amplifiers and Accessories

Laser	Power Meter	Power Sensor	Energy Meter	Energy Sensor
Pump Lasers				
Evolution-15/30	FieldMaxII-TO	PM30	LabMax-TOP	J-25MT-10KHZ[1]
Evolution-45/HE	FieldMaxII-TO	PM150	-	-
Amplifiers				
Legend Elite (all configurations)	FieldMaxII-TO	PM10	LabMax-TOP	J-25MT-10KHZ[1]
Legend Elite Cryo PA	FieldMaxII-TO	PM30	LabMax-TOP	J-25MT-10KHZ[1]
Legend Cryo	FieldMaxII-TO	PM10	LabMax-TOP	J-25MT-10KHZ
Libra	FieldMaxII-TO	PM10	LabMax-TOP	J-25MT-10KHZ
RegA	FieldMaxII-TO	PS10		
Hidra	FieldMaxII-TO	PM10V1	FieldMaxII-TOP	J-50MB-YAG
Amplifier Accessories				
OPerA Solo	FieldMaxII-TO	PM10 or PS10[2]	LabMax-TOP	J-10MT-10KHZ (<1 mJ pump) J-10MB-HE (>1 mJ pump)
TOPAS	FieldMaxII-TO	PM10 or PS10[2]	LabMax-TOP	J-10MT-10KHZ (<1 mJ pump) J-10MB-HE (>1 mJ pump)

Excimer Lasers

Laser	Wavelength (nm)	Power Meter	Power Sensor	Energy Meter	Energy Sensor
BraggStar M	248	FieldMaxII-TO	PM30X	LabMax-TOP	J-25MUV-248
BraggStar S-Industrial	193, 248	FieldMaxII-TO	PM10X	LabMax-TOP	J-25MT-10KHZ
COMPexPro F2	157	FieldMaxII-TO	PM10X	FieldMaxII-TOP	J-25MUV-193
COMPexPro 50, 102, 110, 201, 205	193	FieldMaxII-TO	PM150-50XC	FieldMaxII-TOP	J-50MUV-193
COMPexPro 50, 102, 110, 201, 205	248	FieldMaxII-TO	PM150X	FieldMaxII-TOP	J-50MUV-248 plus large heat sink
COMPexPro 102, 110, 201, 205	308, 351	FieldMaxII-TO	PM150X	FieldMaxII-TOP	J-25MT-YAG
ExciStar S	157, 193, 308	FieldMaxII-TO	PM10X	LabMax-TOP	J-25MT-10KHZ
ExciStar S	248	FieldMaxII-TO	PM30X	LabMax-TOP	J-25MT-10KHZ plus small heat sink
ExciStar XS 200	157, 193	FieldMaxII-TO	PM10X	FieldMaxII-TOP	J-25MUV-193
ExciStar XS 200	248, 351	FieldMaxII-TO	PM10X	FieldMaxII-TOP	J-25MUV-248
ExciStar XS 500	157, 193, 248, 351	FieldMaxII-TO	PM10X	LabMax-TOP	J-25MT-10KHZ
IndyStar	193, 248	FieldMaxII-TO	PM30X	LabMax-TOP	J-25MT-10KHZ plus small heat sink
LEAP	248, 308	FieldMaxII-TO	PM150X	-	-
LPFpro 205, 220	157	FieldMaxII-TO	PM150-50XC	FieldMaxII-TOP	J-50MUV-193
LPXpro 210, 220, 305	193, 248, 308, 351	FieldMaxII-TO	PM150X, PM150-50XC	-	-
Xantos XS	157, 193, 248, 351	FieldMaxII-TO	PM10X	LabMax-TOP	J-25MT-10KHZ
LAMBDA SX-Series	248	FieldMaxII-TO	PM300F-50X	-	-
LAMBDA SX-Series	308	FieldMaxII-TO	PM1KX	-	-
VYPER	308	FieldMaxII-TO	PM1KX	-	-

* Other Coherent measurement product configurations may be compatible with these lasers. Coherent Family Plan pricing may apply (see page 119). Contact factory for more details.

[1] With medium heat sink.

[2] The PS10 is recommended when making higher resolution or low power measurements.

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Notes

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Printed in the U.S.A. MC-037-13-1.5M0813