EnergyMax

Pulsed Laser Energy Sensors

Energy Sensor Guide

Superior Reliability & Performance

EnergyMax - Laser Energy Sensors

Introduction and Selection Charts

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**

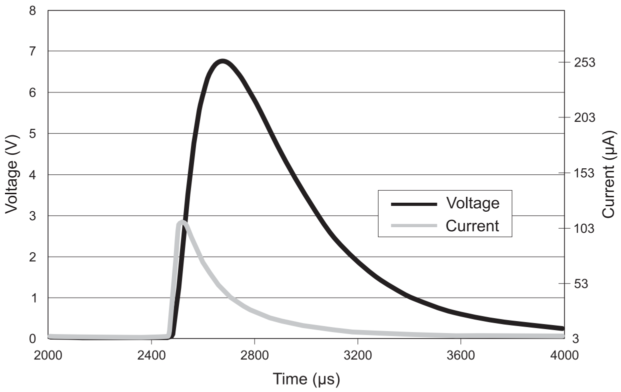
Coherent EnergyMax sensors enable laser pulse energy measurement over a broad range of wavelengths, repetition rates, pulse energies and beam diameters. With their unique combination of superior performance and user-friendly convenience, EnergyMax sensors are your best choice no matter what your particular 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.

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.



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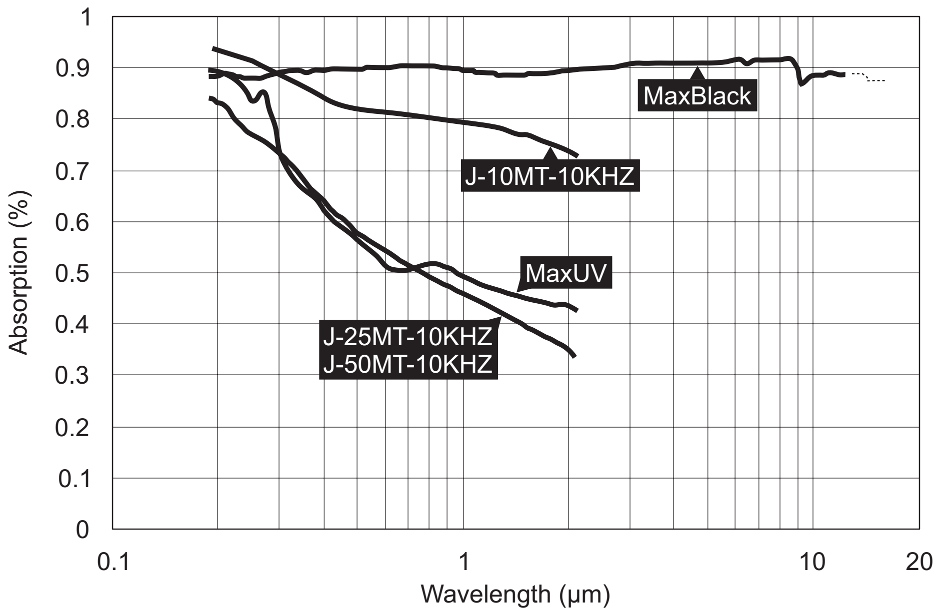
All pyroelectric EnergyMax sensors incorporate a diffuse coating to minimize specular reflections and eliminate spurious beams that can re-enter the laser cavity. In addition, all EnergyMax sensors include onboard electronics that contain built-in wavelength compensation factors. When using the sensor 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.



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	Coating Type	Descriptive Suffix
10, 25, or 50 mm	MT for Diffuse Metallic MB for MaxBlack™ MUV for MaxUV™	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

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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

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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 13 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	–

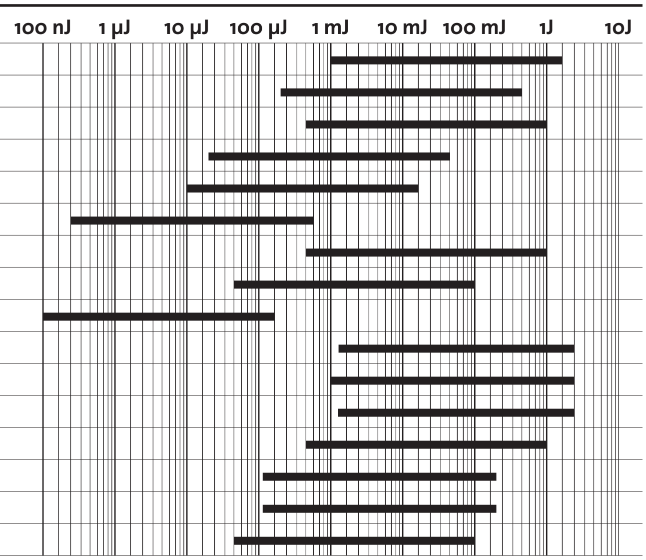
1 Not applicable for Quantum EnergyMax sensors.
2 50 mm EnergyMax sensors are compatible with the large heat sink.
3 25 mm EnergyMax sensors are compatible with small and medium heat sinks.
4 10 mm EnergyMax sensors do not have a heat sink available.
5 Average power ratings are based upon testing at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

Use the following chart to identify sensors that operate within the energy range you intend to measure. Selection charts on the following pages of this guide will help you select more exactly the best sensor for your application. See page 12 for typical dynamic range curves of Quantum EnergyMax Sensors.

Wide Dynamic Range for All EnergyMax Sensor Categories

EnergyMax Energy Range Capabilities

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



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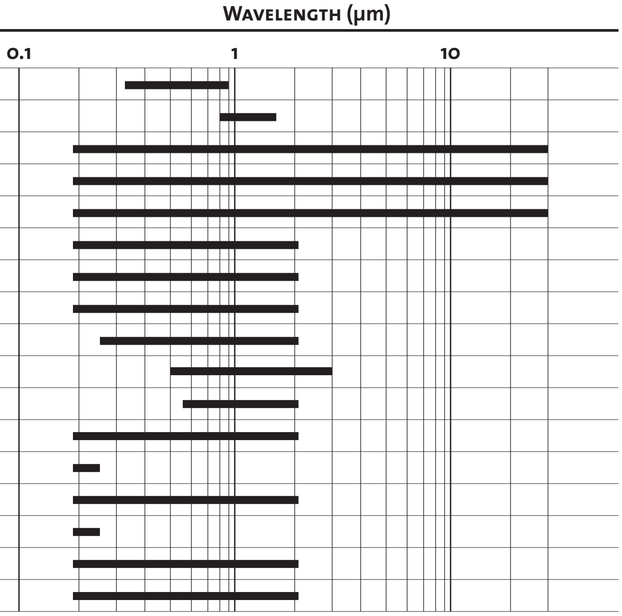
The next selection chart shows the range of wavelengths that can be measured with each sensor. This characteristic is coating dependent, so sensors with diffusers may have a narrower spectral range than similar sensors without diffusers.

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

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 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 summary table on page 6 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 400
J-25MUV-193	up to 400