

PRESENTATION

OVERVIEW OF THE DIFFERENT PRODUCTS

Gentec Electro-Optics specializes in the measurement of laser radiation, in all its forms. This is why we have developed very specialized products over the years, that were first aimed at customized applications, but that became standard products as the demand grew stronger.



MACH 6



ULTRAFAST JOULEMETER

- High Speed Digital Joulemeter: Measures EVERY PULSE up to 200 kHz
- Capture and Store up to 4 Million Pulses at the Maximum Repetition Rate
- Track Missing Pulses and Pulses below Threshold
- Wide Energy Range: Measure from pJ to mJ
- Spectral Range from 0.35 to 2.5 μm
- Sensors include Si, InGaAs and Pyroelectric
- Easy USB 2.0 Connection
- Includes Powerful LabView Software with Diagnostic Features

See page 56

■ THE FASTEST ENERGY METER ON THE MARKET:
MEASURE EVERY PULSE UP TO 200 kHz

DISCRETE PYROS

- TO5/TO8 Discrete or Hybrid Pyroelectric Detectors
- Available in 4 Sizes: 2, 3, 5 and 9 mm \varnothing Apertures
- 4 Families of products to choose from
- Test Box Available for Hybrid Detectors

■ DISCRETE OR HYBRID PYROS
■ SMALL TO5/TO8 PACKAGES

See page 158



QS SERIES

POSITION SENSING DETECTORS

- Position Sensing QUADrant Pyroelectric Detectors
- Available for both Power (QUAD-P) and Energy (QUAD-E) Measurements
- Measure, Track and Align your Beam in Real Time
- For Wavelengths from UV to IR and even THz
- Large Apertures up to 20 x 20 mm



QUAD

■ POSITION SENSING QUADRANT DETECTORS

See page 164

PRESENTATION

CUSTOM PRODUCTS

After over 45 years of experience in the Laser Beam Measurement business, we have developed many customized solutions, sometimes for very unusual applications! This section is only a small portion of the projects we have accomplished for our customers, so do not hesitate to contact us with any special need you may have. We are always striving to find the perfect solution for your application!

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CALORIMETERS

A Gentec-EO calorimeter is the only reliable solution available for the largest and highest energy laser beams. Through cooperation with several leading research facilities around the world, Gentec-EO has become the expert in manufacturing, calibrating and servicing calorimeters for use in high energy inertial confinement fusion calorimetric measurement.

■ EXTRA LARGE APERTURES UP TO 16 000 JOULES/PULSE

See page **172**



DISCRETE PYROS

MONITORS

ENERGY DETECTORS

POWER DETECTORS

HIGH POWER SOLUTIONS

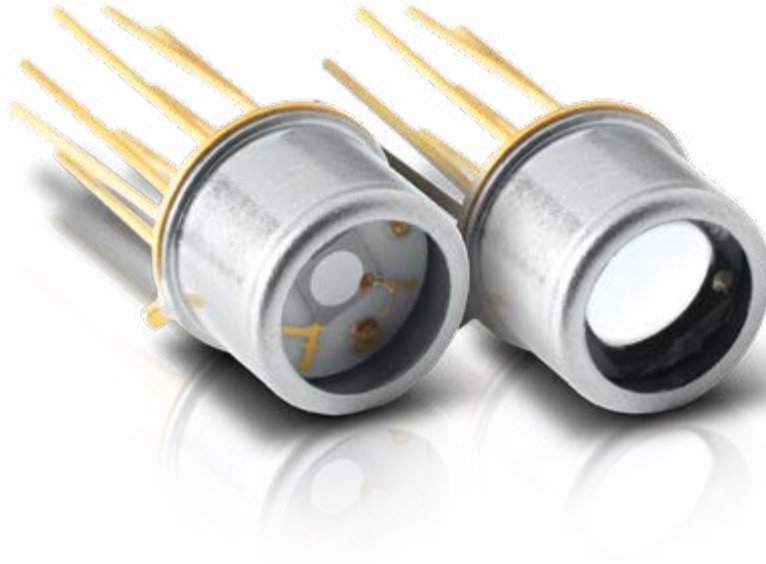
PHOTO DETECTORS

THZ DETECTORS

OEM DETECTORS

SPECIAL PRODUCTS

BEAM DIAGNOSTICS



KEY FEATURES

- BROAD SPECTRAL RESPONSE**
From 0.1 to 1000 μm
- EASY TO INTEGRATE FORMAT**
T05 and T08 packages make the QS detectors small and easy to integrate in an existing system
- LARGE AREA SENSORS**
5 mm \varnothing and 9 mm \varnothing diameter pyroelectric sensors make optical alignment easier
- SEVERAL IR WINDOWS IN OPTION**
 - Quartz: 0.2 – 3.0 μm
 - Barium Fluoride: 0.2 – 17.5 μm
 - Sapphire: 0.1 – 7.0 μm
 - Silicon: 1.1 – 9.0 μm and 50 – 1000 μm
 - AR Germanium: 8 – 14 μm

AVAILABLE MODELS

4 families of products to choose from:

- QS-L Discrete Pyro Detectors, Low Noise Level
- QS-H Discrete Pyro Detectors, High Average Power
- QS-IF Hybrid Pyro Detectors, Current Mode, Fast Response
- QS-IL Hybrid Pyro Detectors, Current Mode, Low Noise Level

ACCESSORIES



QS-I-TEST
Evaluation Test Box (current)



Permanent IR Windows
(Various types available)



Pelican Carrying Case

SEE ALSO

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QS-L & QS-H



Approved or in the process of being approved*

SPECIFICATIONS

Discrete Pyro Detectors, Low Noise Level

	QS2-L	QS3-L	QS5-L	QS9-L
CURRENT RESPONSIVITY	0.5 $\mu\text{A/W}$	0.5 $\mu\text{A/W}$	0.25 $\mu\text{A/W}$	0.25 $\mu\text{A/W}$
EFFECTIVE APERTURE	2 mm \emptyset	3 mm \emptyset	5 mm \emptyset	9 mm \emptyset
PACKAGE	T05	T05	T05	T08

MEASUREMENT CAPABILITY				
Spectral Range	0.1 - 1000 μm	0.1 - 1000 μm	0.1 - 1000 μm	0.1 - 1000 μm
Max Average Power	50 mW	50 mW	50 mW	50 mW
Capacitance (at 1000 Hz)	22 pF	60 pF	90 pF	250 pF
Current Responsivity (at 630 nm)	0.5 $\mu\text{A/W}$	0.5 $\mu\text{A/W}$	0.25 $\mu\text{A/W}$	0.25 $\mu\text{A/W}$
Thermal Frequency (3 dB)	1.6 Hz	0.8 Hz	0.5 Hz	0.25 Hz
Temperature Coefficient	0.2%/°C	0.2%/°C	0.2%/°C	0.2%/°C

ORDERING INFORMATION				
Product Name	QS2-L	QS3-L	QS5-L	QS9-L
Product Number	201659	201662	201664	201666

Discrete Pyro Detectors, High Average Power

	QS2-H	QS3-H	QS5-H	QS9-H
MAX AVERAGE POWER	500 mW	500 mW	500 mW	500 mW
EFFECTIVE APERTURE	2 mm \emptyset	3 mm \emptyset	5 mm \emptyset	9 mm \emptyset
PACKAGE	T05	T05	T05	T08

MEASUREMENT CAPABILITY				
Spectral Range	0.1 - 1000 μm	0.1 - 1000 μm	0.1 - 1000 μm	0.1 - 1000 μm
Max Average Power	500 mW	500 mW	500 mW	500 mW
Capacitance (at 1000 Hz)	12 pF	30 pF	90 pF	250 pF
Current Responsivity (at 630 nm)	0.25 $\mu\text{A/W}$	0.25 $\mu\text{A/W}$	0.25 $\mu\text{A/W}$	0.25 $\mu\text{A/W}$
Thermal Frequency (3 dB)	5 Hz	5 Hz	5 Hz	5 Hz
Temperature Coefficient	0.2%/°C	0.2%/°C	0.2%/°C	0.2%/°C

ORDERING INFORMATION				
Product Name	QS2-L	QS3-L	QS5-L	QS9-L
Product Number	201661	201663	201665	201667

PHYSICAL CHARACTERISTICS				
Effective Aperture	2 mm \emptyset	3 mm \emptyset	5 mm \emptyset	9 mm \emptyset
Package	T05	T05	T05	T08
Sensor	Pyroelectric	Pyroelectric	Pyroelectric	Pyroelectric
Absorber	MT	MT	MT	MT
Dimensions (Excluding pins)	9.10 x 6.4D mm	9.10 x 6.4D mm	9.10 x 6.4D mm	15.20 x 6.4D mm
Weight	1.0 g	1.0 g	1.0 g	1.5 g

Specifications are subject to change without notice

QS-IF



Approved or in the process of being approved*

SPECIFICATIONS

Hybrid Pyro Detectors, Current Mode, Fast Response

	QS2-IF	QS3-IF	QS5-IF	QS9-IF
VOLTAGE RESPONSIVITY	50 V/W	50 V/W	25 V/W	25 V/W
CURRENT RESPONSIVITY	0.5 μ A/W	0.5 μ A/W	0.25 μ A/W	0.25 μ A/W
EFFECTIVE APERTURE	2 mm \emptyset	3 mm \emptyset	5 mm \emptyset	9 mm \emptyset
PACKAGE	T05	T05	T05	T08

MEASUREMENT CAPABILITY

Spectral Range	0.1 - 1000 μ m	0.1 - 1000 μ m	0.1 - 1000 μ m	0.1 - 1000 μ m
Max Average Power	50 mW	50 mW	50 mW	50 mW
Noise Equivalent Power ^a	8×10^{-8} W/(Hz) ^{1/2}	8×10^{-8} W/(Hz) ^{1/2}	1.6×10^{-7} W/(Hz) ^{1/2}	1.6×10^{-7} W/(Hz) ^{1/2}
Detectivity ^a	2.2×10^6 cm(Hz) ^{1/2} /W	3.3×10^6 cm(Hz) ^{1/2} /W	2.8×10^6 cm(Hz) ^{1/2} /W	5.0×10^6 cm(Hz) ^{1/2} /W
Capacitance (at 1000 Hz)	22 pF	60 pF	90 pF	250 pF
Current Responsivity (at 630 nm)	0.5 μ A/W	0.5 μ A/W	0.25 μ A/W	0.25 μ A/W
Voltage Responsivity ^b	50 V/W	50 V/W	25 V/W	25 V/W
Thermal Frequency (3 dB)	1.6 Hz	0.8 Hz	0.5 Hz	0.25 Hz
Feedback Resistor	100 M Ω	100 M Ω	100 M Ω	100 M Ω
Supply Voltage	\pm 12 V	\pm 12 V	\pm 12 V	\pm 12 V

PHYSICAL CHARACTERISTICS

Effective Aperture	2 mm \emptyset	3 mm \emptyset	5 mm \emptyset	9 mm \emptyset
Package	T05	T05	T05	T08
Sensor	Pyroelectric	Pyroelectric	Pyroelectric	Pyroelectric
Absorber	MT	MT	MT	MT
Dimensions	9.1 \emptyset x 6.4D mm	9.1 \emptyset x 6.4D mm	9.1 \emptyset x 6.4D mm	15.2 \emptyset x 6.4D mm
Weight	1.0 g	1.0 g	1.0 g	1.5 g

ORDERING INFORMATION

Product Name	QS2-IF	QS3-IF	QS5-IF	QS9-IF
Product Number	201680	201681	201682	201683

Specifications are subject to change without notice

a. 630 nm, 15 Hz, largeur de bande de 1 Hz

b. 630 nm, 15 Hz



QS-I-TEST EVALUATION TEST BOX

QS-I-TEST	
Batteries	+9V/-9V
R _i Resistors	10 ⁵ - 10 ¹⁰ Ω
C _i Compensating	Yes
Package	101.6H x 127L x 58.4P
Optical Mount	1/4-20 Threaded
Front Bezel	SM1 (1.035-40)
Product Number	201693

* For details, contact your Gentec-EO representative

QS-IL



Approved or in the process of being approved*

SPECIFICATIONS

Hybrid Pyro Detectors, Current Mode, Low Noise Level

	QS2-IL	QS3-IL	QS5-IL	QS9-IL
VOLTAGE RESPONSIVITY	25 kV/W	25 kV/W	13 kV/W	13 kV/W
CURRENT RESPONSIVITY	0.5 μ A/W	0.5 μ A/W	0.25 μ A/W	0.25 μ A/W
EFFECTIVE APERTURE	2 mm \emptyset	3 mm \emptyset	5 mm \emptyset	9 mm \emptyset
PACKAGE	T05	T05	T05	T08

MEASUREMENT CAPABILITY				
Spectral Range	0.1 - 1000 μ m	0.1 - 1000 μ m	0.1 - 1000 μ m	0.1 - 1000 μ m
Max Average Power	50 mW	50 mW	50 mW	50 mW
Noise Equivalent Power ^a	2×10^{-9} W/(Hz) ^{1/2}	2×10^{-9} W/(Hz) ^{1/2}	6×10^{-9} W/(Hz) ^{1/2}	6×10^{-9} W/(Hz) ^{1/2}
Detectivity ^a	9.0×10^7 cm(Hz) ^{1/2} /W	1.3×10^8 cm(Hz) ^{1/2} /W	7.0×10^7 cm(Hz) ^{1/2} /W	1.3×10^8 cm(Hz) ^{1/2} /W
Capacitance (at 1000 Hz)	22 pF	60 pF	90 pF	250 pF
Current Responsivity (at 630 nm)	0.5 μ A/W	0.5 μ A/W	0.25 μ A/W	0.25 μ A/W
Voltage Responsivity ^b	25 kV/W	25 kV/W	13 kV/W	13 kV/W
Thermal Frequency (3 dB)	1.6 Hz	0.8 Hz	0.5 Hz	0.25 Hz
Feedback Resistor	100 G Ω	100 G Ω	100 G Ω	100 G Ω
Supply Voltage	± 5 to ± 12 V	± 5 to ± 12 V	± 5 to ± 12 V	± 5 to ± 12 V

PHYSICAL CHARACTERISTICS				
Effective Aperture	2 mm \emptyset	3 mm \emptyset	5 mm \emptyset	9 mm \emptyset
Package	T05	T05	T05	T08
Sensor	Pyroelectric	Pyroelectric	Pyroelectric	Pyroelectric
Absorber	MT	MT	MT	MT
Dimensions	9.1 \emptyset x 6.4D mm	9.1 \emptyset x 6.4D mm	9.1 \emptyset x 6.4D mm	15.2 \emptyset x 6.4D mm
Weight	1.0 g	1.0 g	1.0 g	1.5 g

ORDERING INFORMATION				
Product Name	QS2-IL	QS3-IL	QS5-IL	QS9-IL
Product Number	201685	201686	201687	201688

Specifications are subject to change without notice

- a. 630 nm, 5 Hz, 1 Hz Bandwidth
b. 630 nm, 15 Hz



QS-I-TEST EVALUATION TEST BOX

QS-I-TEST	
Batteries	+9V/-9V
R _f Resistors	10 ⁵ - 10 ¹⁰ Ω
C _f Compensating	Yes
Package	101.6H x 127L x 58.4P
Optical Mount	1/4-20 Threaded
Front Bezel	SM1 (1.035-40)
Product Number	201693

* For details, contact your Gentec-EO representative

DISCRETE PYROS

MONITORS

ENERGY DETECTORS

POWER DETECTORS

HIGH POWER SOLUTIONS

PHOTO DETECTORS

THZ DETECTORS

OEM DETECTORS

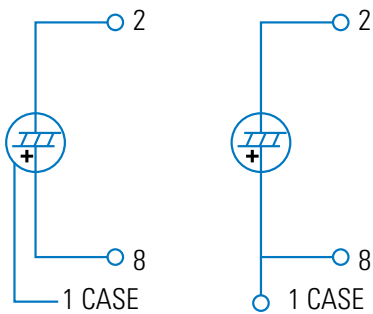
SPECIAL PRODUCTS

BEAM DIAGNOSTICS



PYROELECTRIC THERMAL DETECTORS

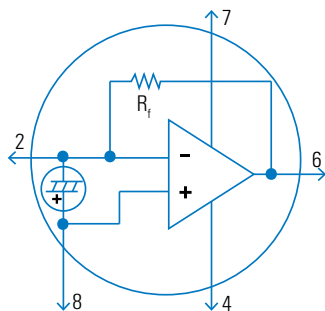
Our pyroelectric detectors are a class of room temperature thermal detectors that produce a current output that is directly proportional to the rate of change of temperature when exposed to a source of radiation. They are best described by an AC current source, capacitor and resistor. Their current output is governed by the equation $I = p(T) \cdot A \cdot dT/dt$, where I is current, $p(T)$ is the Pyro Coefficient, A is the area as defined by the front electrode, and dT/dt is the rate of temperature change of the pyro crystal. The advantages of a pyroelectric detector over other IR detectors are: room temperature operation, broad spectral response, high sensitivity (D^*) and fast response (sub-nsec into 50Ω).



QS-L (left) and QS-H (right) Pin-Outs

QS-L AND QS-H DISCRETE PYROS

Our passive Discrete Pyroelectric Detectors range from 1 to 9 mm in diameter and are provided in two configurations: high sensitivity or high average power. They present a pyroelectric detector element covered with our metallic coating (MT) and are packaged in a miniature TO-5 or TO-8 can. The diagram shown left identifies the Pin-out for both types of detectors. Our organic black coating (BL), increases the optical absorption and helps flatten the spectral response. We also offer a number of permanent IR Windows that can be added to the TO can. These discrete pyro detectors are ideal for pulsed laser applications.



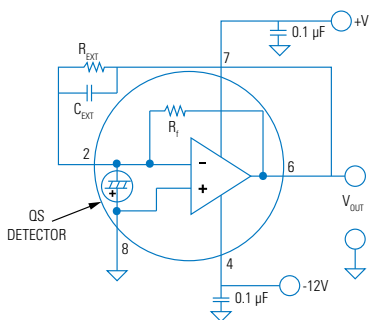
QS-IF and QS-IL Pin-Out

QS-IF AND QS-IL CURRENT MODE HYBRID PYROS

These detectors offer high gain ($>10^5$ V/W) and/or high bandwidth (>10 MHz). In this configuration, the pyroelectric detector element is combined to a low noise operational amplifier. The QS-IL models are designed for high performance at low to medium frequencies, while the QS-IF models offer good performance at medium to high frequencies. These detectors are very easy to use. Simply supply the +/- 10 to 15 V to power the operational amplifier and add an external resistor, if required, to adjust the bandwidth and you are ready to measure pulsed, modulated or chopped sources, from nJ to mJ and nW to W. These detectors also make great candidates for any variety of broadband analytical instruments or laser measurement products.

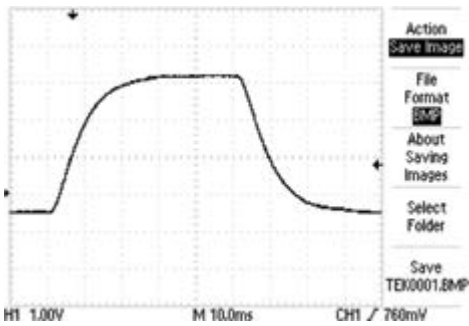
VOLTAGE OUTPUT VS. FREQUENCY

Our QS-VL and QS-IL Hybrid Detectors are designed to maximize voltage output at low frequencies and therefore include load and feedback resistors in the $100 \text{ G}\Omega$ to $300 \text{ G}\Omega$ range. They are also designed into 8-pin TO packages that allow the addition of an "external resistor" to lower the output and increase the bandwidth. The circuit diagram at the left shows a typical hook up for our QS5-IL detector (with our MT coating), using external resistors and capacitors. Our QS-IF series, on the other hand, are designed for high bandwidth applications and therefore include a smaller feedback resistor of $100 \text{ M}\Omega$. For expert help on designing a detector circuit please contact us info@gentec-eo.com.

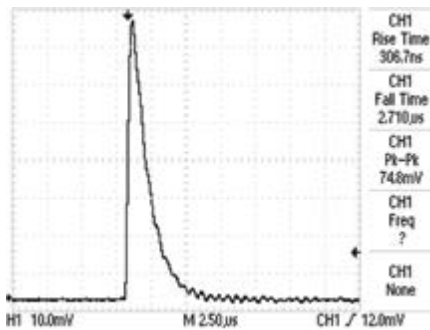


QS-VL and QS-IL Circuitry

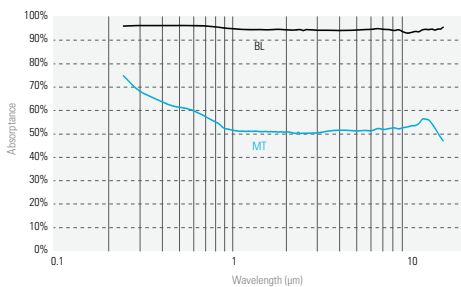
DISCRETE PYROS



Typical QS-IL Voltage Output in Power Measurement Mode



Typical QS-IL Voltage Output in Energy Measurement Mode



Absorption Curves of QS Pyroelectric Detectors

OPERATION IN POWER MEASUREMENT MODE

When using our QS-IL Hybrid Detector to measure the Power (in Watts) of your CW or High Rep Rate source (Quasi-CW), you will need to employ an optical chopper. The diagram at the left shows the typical voltage output of a QS5-IL when used with our QS-I-TEST evaluation test box. Note that the voltage output is an approximate “square wave” whose rise and fall times are governed by the RC time constant of the circuit. The optical power is directly proportional to the peak voltage minus the baseline voltage. We calibrate these devices when operating in this mode.

OPERATION IN ENERGY MEASUREMENT MODE

Our Pyroelectric Detectors are an ideal choice when measuring the performance of your pulsed laser in the range of nJ to mJ, across the full spectrum! The scope trace at the left represents the typical output from a QS9-IL, when used with our QS-I-TEST set up as an integrating Joulemeter. Note the fast rise to a peak and then slower decay governed by the RC time constant selected for the integrating circuit. In this configuration you can measure absolute pulse energy, rep rate, and pulse-to-pulse stability. The maximum pulse width of your source is determined by the RC time constant you select and there is no limit as to how short the pulse can be!

BROAD SPECTRAL RESPONSE

Unlike photoconductive and photovoltaic detectors, our Pyroelectric Thermal Detectors are not limited to a small part of the electromagnetic spectrum. They are truly broad spectrum detectors, sensitive from 0.1 μm to 3000 μm (EUV, FAR IR, and THz). Any and all radiation absorbed by our coatings or pyro crystal will result in a measurable signal. The two plots at the left show the relative spectral response of detectors with MT and BL coatings. Note that the well documented, NIST traceable calibrated portion of these curves runs from 0.25 μm to 15 μm . There are currently no traceable optical standards for measurements > 15 μm .

QUAD

Position Sensing Power & Energy Detectors



KEY FEATURES

1. **MEASURE, TRACK AND ALIGN**
With μm resolution in real time!
2. **4-CHANNEL DETECTORS**
Unique pyroelectric QUADrant detector technology handles high peak power without saturation
3. **FOR CW, PULSED AND HIGH REP RATE LASERS**
 - QUAD-E: Energy per pulse from μJ to mJ
 - QUAD-P: Powers from μW to mW
4. **FROM UV TO FIR AND THz**
Broadband detectors cover the full spectrum, from UV to Sub-Millimeter wavelengths
5. **LARGE AREA SENSORS**
9 mm and 20 mm square detectors
6. **FAST USB 2.0 CONNECTION**
Ensures full speed tracking
7. **INCLUDES APPLICATION SOFTWARE**
Complete LabView Application Software included, with many features

CONNECTIVITY



QUAD-9-MT-E
(9 x 9 mm-For Energy)



QUAD-20-MT-E
(20 x 20 mm-For Energy)



QUAD-9-MT-P
(9 x 9 mm-For Power)



QUAD-20-MT-P
(20 x 20 mm-For Power)

ACCESSORIES



Stand with Delrin Post
(Model Number: 200428)



Additional 9V Power Supply
(Model Number: 200960)



USB Cable
(Model Number: 202373)



SDC-500 Digital
Optical Chopper (for -P)



Pelican Carrying Case

SEE ALSO

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APPLICATION NOTES

LASER POSITION SENSING DETECTORS
AND MONITOR [201930](#)

SDC-500 DIGITAL OPTICAL CHOPPER [202154](#)

Watch the Introduction video available on our website at www.gentec-eo.com

QUAD



SPECIFICATIONS

	QUAD-9-MT-E / QUAD-9-MT-P	QUAD-20-MT-E / QUAD-20-MT-P		
MAX ENERGY / AVG POWER	20 mJ / 200 mW	20 mJ / 200 mW		
MAX POSITION RESOLUTION	1 μm / 10 μm	1 μm / 10 μm		
EFFECTIVE APERTURE	9 x 9 mm	20 x 20 mm		
MEASUREMENT CAPABILITY				
Spectral Range	0.1 - 3000 μm	0.1 - 3000 μm		
Min Beam Size ^a	≥ 4.5 mm \emptyset	≥ 10 mm \emptyset		
For -E (Energy sensors)				
Max Measurable Energy	20 mJ/Channel	20 mJ/Channel		
Noise Equivalent Energy	0.5 μJ	1.0 μJ		
Rise Time (0-100%)	150 μs	150 μs		
Max Repetition Rate	1000 Hz	1000 Hz		
Max Pulse Width	2.5 μsec	2.5 μsec		
Sensitivity	1000 V/J	1000 V/J		
For -P (Power sensors)				
Max Measurable Power	200 mW	200 mW		
Noise Equivalent Power	1 μW	2 μW		
Rise Time (0-100%)	< 0.02 s	< 0.02 s		
Max Chopping Frequency	50 Hz	50 Hz		
Sensitivity	2000 V/W	2000 V/W		
Calibration Uncertainty	$\pm 4\%$	$\pm 4\%$		
Minimum Position Resolution	-E: 1 μm	-E: 1 μm		
With QUAD-4Track Monitor	-P: 10 μm	-P: 10 μm		
DAMAGE THRESHOLDS				
Max Average Power Density (@ 1.064 μm)	100 mW/cm ²	100 mW/cm ²		
Max Energy Density (@ 1.064 μm 10 ns)	50 mJ/cm ²	50 mJ/cm ²		
PHYSICAL CHARACTERISTICS				
Effective Aperture	9 x 9 mm	20 x 20 mm		
Sensor	Pyroelectric	Pyroelectric		
Absorber	MT	MT		
Dimensions	63.5 \emptyset X 40.6D mm	63.5 \emptyset X 40.6D mm		
Weight	181 g	181 g		
ORDERING INFORMATION				
Product Name (Detectors)	QUAD-9-MT-E-D0	QUAD-9-MT-P-D0	QUAD-20-MT-E-D0	QUAD-20-MT-P-D0
Product Number (without stand)	201774	201776	201775	201777
Product Name (Module)	QUAD-4Track			
Product Number (without stand)	201517			

Specifications are subject to change without notice // Compatible stand: P/N 200160

a. For optimal performance.

* For details, contact your Gentec-EO representative

QUAD



QUAD-4Track
(Front View)



QUAD-4Track
(Rear View)



QUAD-4TRACK

The QUAD-4Track is a Laser Position Sensing system designed to support our unique Pyroelectric Quadrant Detectors, QUAD-P and QUAD-E. It is a 4-channel microprocessor-based system that measures the voltage output of each QUAD element and does the math necessary to provide a measurement of the X and Y displacement of a laser beam or image. It is fast and can be used to track, align and/or measure movement in real time, with a resolution of just a few microns!

SPECIFICATIONS & FEATURES

QUAD-4TRACK

Number of Channels	4
Full Scale Ranges (4 Decades) (E / P)	
Joulemeter Mode (with QUAD-E)	20 μ J to 20 mJ
Radiometer Mode (with QUAD-P)	200 μ W to 200 mW
USB Connection to Computer	YES (USB 2.0 Full Speed)
Power Supply	9VDC
Power On Light	YES
Detector Input	DB-25 Connector
Detector Analog Output	BNC Connector (0-2 V)
Trigger Input (TTL)	BNC Connector with LED Indicator
Product Number	201517

QUAD DETECTORS

Our large area Pyroelectric Quadrant Detectors provide unique advantages over other position sensing detectors like Silicon quads or lateral effect photodiodes. They are fast, handle high peak power of pulsed lasers without saturation and respond to lasers across the spectrum, from UV to Far IR and even THz. The QUAD-E is intended for use with pulsed sources at up to 1000 Hz, while the QUAD-P is designed for CW and High Repetition Rate (Quasi CW) sources. Both types of detectors can also be used as standalone units, in an analog mode, for incorporation into your own system application. We can provide a Lemo pigtail cable for this purpose.

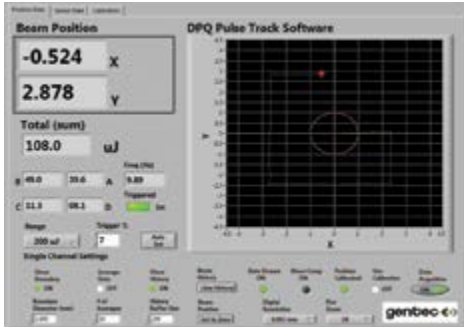
ANALOG OUTPUT

The analog output of the QUAD-4Track provides voltage that is directly proportional to the pulse energy or laser power irradiating each QUAD element. When the four voltage outputs are equal, the beam is centered on the QUAD detector. This provides a very useful tool when setting up our QUAD probes with your source for optical alignment.



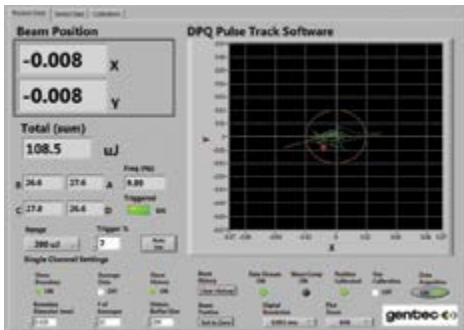
QUAD

MEASUREMENT SCREEN



QUAD-4Track includes powerful, stand alone, LabView Software which is used to control the instrument, process the data, and display X and Y position. It also displays the energy or power of your source and repetition rate. The large graphic in this screen shows the position of the centroid of the beam and tracks its movement in real time. The software includes many handy features like: set boundary, zoom (2X to 128X), set resolution, data logging, and many more. The green line represents the tracking history.

TRACKING THE BEAM OVER TIME



In the measurement screen shown on the left, we are tracking the beam stability of a pulsed Nd:YLF laser at 10 Hz. The resolution was set at 0.001 μm , the boundary is at 20 μm (red circle), and the zoom feature is at 64X. The total energy is 108.5 μJ , the final position of the laser is at -8 μm in X and -8 μm in Y. The green tracking line shows the movement of the laser about the zero position over a few hundred pulses.

POSITION CALIBRATION SCREEN

Set Positions	Measured Positions	Corrected Positions	Coefficients
-2.00E+0	-4.14E+0	-2.00E+0	7.32E-3
-1.50E+0	-3.66E+0	-1.50E+0	3.14E-1
-1.00E+0	-2.77E+0	-9.99E-1	-4.03E-3
-5.00E-1	-1.51E+0	-5.01E-1	9.94E-3
0.00E+0	-1.86E-2	1.46E-3	6.40E-4
5.00E-1	1.50E+0	4.99E-1	-8.66E-4
1.00E+0	2.76E+0	1.00E+0	-2.17E-5
1.50E+0	3.62E+0	1.50E+0	5.12E-5
2.00E+0	4.11E+0	2.00E+0	

We've developed a unique position calibration routine which allows you to calibrate our QUAD-4Track system when working with a uniformly round laser beam. It requires the use of a micrometer-driven linear stage (1-axis only). As you can see from the calibration screen on the left, the procedure involves zeroing the instrument, moving the QUAD probe to nine discrete positions (+2.000 to -2.000 mm) and then capturing the QUAD readings. It then determines correction coefficients (last column) and applies them to the raw data to arrive at "corrected positions". The QUAD probe is now calibrated!

DATA LOGGING

Time	Energy (uJ)	X	Y
54:01.9	100.3	-0.008	-0.023
54:05.9	100.3	-0.013	-0.024
54:09.9	100.4	-0.015	-0.02
54:13.9	100.4	0.04	0.025
54:17.9	100.4	0.029	-0.069
54:22.0	100.4	-0.376	-0.08
54:26.0	100.3	-0.041	-0.069
54:30.0	100.4	-0.036	-0.073

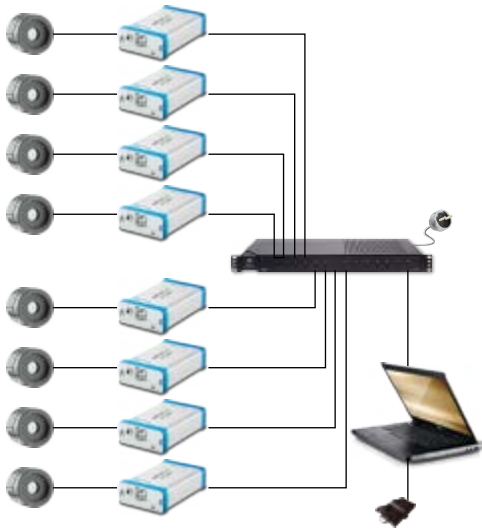
Another very handy feature is "data logging". This allows you to set up the QUAD-4Track to follow the displacement, energy and/or power of your laser over several minutes, hours or even days. Need to measure the "beam steering" of your laser as it warms up? This is how you do it! Need to measure the beam displacement vs laser repetition rate or energy level? Data logging will help you measure it!

CUSTOM PRODUCTS



After over 45 years of experience in the Laser Beam Measurement business, we have developed many customized solutions, sometimes for very unusual applications! This section is only a small portion of the projects we have accomplished for our customers, so do not hesitate to contact us with any special need you may have. We are always striving to find the perfect solution for your application!

CUSTOM PRODUCTS



OCTOLINK

OCTOLINK is our multichannel software that was specifically designed for the simultaneous measurement of a large set of power detectors. As its name indicates, OCTOLINK allows the measurement of up to 8 devices simultaneously, all on a combined control screen. Furthermore, this tool offers full flexibility on the functionalities, allowing to control, compare and collect data of multiple detectors in a simple but effective manner. The channels can be user-set, allowing a transparent integration in the existing systems. Pass-fail feature and complete data logging make OCTOLINK an ideal and inexpensive solution for long term power monitoring.

- MEASURE 8 DETECTORS SIMULTANEOUSLY
- USER-SETTABLE INTERFACE

6-ELEMENT DETECTOR BAR

Custom detector integration that monitors multiple lasers in a system. This detector bar included six independent power sensors, covered by protection windows with anti-reflective coating, presence sensors, on-board signal conditioning and acquisition to instantly measure power and communicate with the system through industrial serial protocol.

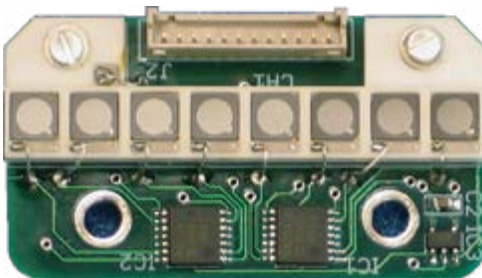
- 6 ELEMENTS ON ONE BOARD
- INSTANTANEOUS POWER MEASUREMENT OF ALL 6 ELEMENTS
- DETECTOR ELEMENTS PROTECTED BY WINDOWS WITH AR COATING

8-CHANNEL ARRAY FOR THZ TOMOGRAPHY

The 8 element Pyroelectric Array and electronics were designed for a Fiber Laser-based, multi-beam, THz Tomography project which was a joint venture between the Universities of Manchester, Southampton and Leeds in the UK.

The goal was to produce a high performance, low noise level, discrete array, capable of measuring 10 nW per channel in the 0.5 to 2 THz range.

- 8-CHANNEL PYROELECTRIC ARRAY
- 0.5 TO 2 THZ RANGE
- 10 nW PER CHANNEL



CUSTOM PRODUCTS

MONITORS

ENERGY DETECTORS

POWER DETECTORS

HIGH POWER SOLUTIONS

PHOTO DETECTORS

THZ DETECTORS

OEM DETECTORS

SPECIAL PRODUCTS

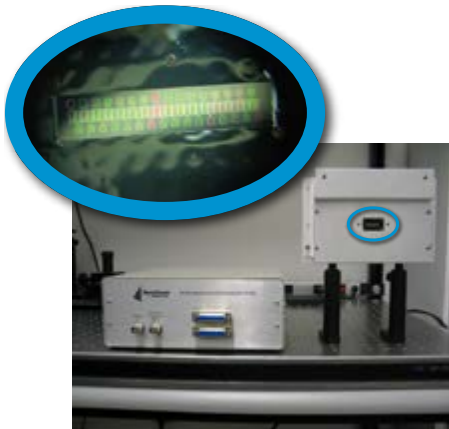
BEAM DIAGNOSTICS



OPTICAL TRAP DETECTORS

Don't Lose Your Photons Anymore.

The TRAP detectors have the Highest Efficiency Detectors in the Photonics World with a Quantum efficiency (QE) $\gg 99\%$. They also present incredible spatial uniformity, better than 0.02% . Their high QE and low calibration uncertainty ($< 0.5\%$) make them an excellent, standalone, calibration transfer standard. Heads are optimized for both CW or Pulsed Lasers and can be used for low divergence or collimated beams. Measure power from pW to mW when used with the TRAP-PREAMP amplifier that provides a direct digital readout.



32-CHANNEL THZ PYROELECTRIC ARRAY

The SDX-1105 is a 32-element Pyroelectric Array combined to a 32-channel multiplexing electronics that was designed for a THz Spectrometer Application. The system was designed to be able to measure a few nanojoules of energy from a pulsed THz source in the 0.1 to 20 THz region. As the Pyroelectric detectors are based on a thermal effect, the same device can be used with pulsed lasers from the DUV to FIR. The detector elements of the array are 1 mm tall by 0.5 mm wide and spaced on 0.5 mm centers.

TEMPERATURE-CONTROLLED POWER METERS

Temperature Controlled Power Sensors and Controller:

Each head is composed of a low noise detector, thermistor, TE cooler and heat sink to compensate for any temperature change

The Ultimate Choice in Measurement Stability:

Temperature control down to 0.05°C from 20 to 30°C gives a temperature coefficient $< 0.01\%$, thus a voltage output stable to 0.01%

2 Sizes Available for the TP Sensors:

- TP5-BL: 5 mm \varnothing pyroelectric sensor with organic black coating
- TP9-BL: 9 mm \varnothing pyroelectric sensor with organic black coating



CUSTOM PRODUCTS



PULSE BURST ENERGY METER

This pulse burst energy meter was developed for Candela Corporation for a new 2-Color Medical Laser System that required measuring the power in multiple pulses and displaying total and sub-pulse energy and pulse width of a laser running in a burst mode.

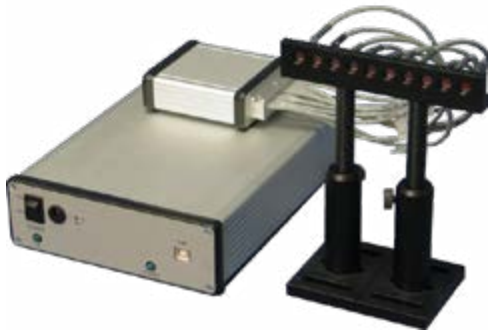
It was designed to measure a single pulse or up to eight pulses in a burst. The spectral range was 0.5 μm to 3.0 μm .

- MEASURES INDIVIDUAL PULSE ENERGIES IN A PULSE BURST

10-CHANNEL ENERGY METER

This Energy Meter was designed for use with Mid-IR and Far-IR lasers and could be used in pairs to create a 10-Channel Digital Joulemeter. The energy sensors were based on fast Pyroelectric Detectors outfitted with KRS5 windows. The microprocessor instrument featured a full speed USB2.0 output, LabView application software and USB Drivers. It also included a multiplexed analog output for use with an oscilloscope that allowed viewing of the relative energy of each channel.

- COMBINES 10 ENERGY MEASUREMENTS IN ONE APPLICATION



“HOLLOW” DETECTOR

This special calorimeter demonstrates the extent of Gentec-EO's customization capabilities. This product fulfills the requirements for the newest lasers for high energetic beam experimentation.

- High energy at low repetition rate for continuous measurement
- Femtosecond pulse
- Very large diameter with different shapes & sizes available
- Offers the flexibility to measure both power or energy
- Center hole option to let an electron beam through

- SHORT PULSES, HIGH ENERGIES
- VARIOUS SHAPES & SIZES



CALORIMETERS



Photo courtesy of Lawrence Livermore National Laboratory

A Gentec-EO calorimeter is the only reliable solution available for the largest and highest energy laser beams. Through cooperation with several leading research facilities around the world, Gentec-EO has become the expert in manufacturing, calibrating and servicing calorimeters for use in high energy inertial confinement fusion calorimetric measurement.

PRESENTATION



STATE-OF-THE-ART

We work with a wide range of materials from surface coatings to the most robust volume absorbers to provide the best solution for your specific application.

- OUTSTANDING SIGNAL TO NOISE RATIOS
- HIGH SENSITIVITY
- VACUUM COMPATIBILITY
- ATTENTION TO DETAIL AND WORKMANSHIP

With over 45 years of experience in thermal-based energy measurement, Gentec-EO is the ideal choice for all your high energy measurement needs.

ACCURATE

Using NIST traceable sources and proven calibration techniques, your Gentec-EO calorimeter is always the most accurate large aperture measurement device on the market.

With calibration uncertainties of $\pm 3\%$, and repeatabilities better than $\pm 2\%$ for very large beams, Gentec-EO offers the very best solution for extreme energy measurement and for balancing in multi laser systems.



CUSTOMIZED

We have designed calorimeters for 16 kJ beams. We have built them for beams as large as 420 x 427 mm in aperture size, to withstand pulse energy densities of more than 15 J/cm².

We have also provided highly sensitive, large-aperture size calorimeters for beam energies as low as 50 mJ for the most delicate applications.

Our calorimeters span the band from 190 nm to 25 microns. Moreover, we are happy to push these limits even further. We work with a wide range of materials from surface coatings to the most robust volume absorbers to provide the best solution for your specific application.



APPLICATIONS

LASER FUSION EXPERIMENTS

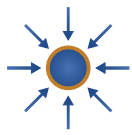
Inertial confinement fusion (ICF) is a process where nuclear fusion reactions are initiated by heating and compressing a fuel target, typically in the form of a pellet that most often contains a mixture of deuterium and tritium. To compress and heat the fuel, energy is delivered to the outer layer of the target using high-energy beams of laser light.* ICF is said to reproduce the energy generation process taking place in the core of the sun.

Several laser fusion projects are underway around the world right now, their main goal is to produce a clean, reliable and nearly unlimited source of energy. All these laser fusion experiments use very high energy lasers of several kJ per pulse for which a Gentec-EO calorimeter is the ONLY reliable measuring device available on the market. Over the years, we have been presented with increasingly large and energetic laser pulses to be measured and we have kept pace with the world's most demanding lasers.

* Source: Wikipedia.

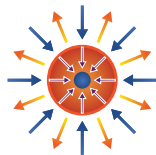
LASER FUSION MECHANISM

Schematic of the stages of inertial confinement fusion using lasers. The blue arrows represent radiation; orange is blowoff; purple is inwardly transported thermal energy.



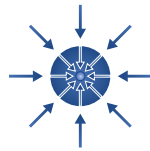
1.

Laser beams or laser-produced X-rays rapidly heat the surface of the fusion target, forming a surrounding plasma envelope.



2.

Fuel is compressed by the rocket-like blowoff of the hot surface material.



3.

During the final part of the capsule implosion, the fuel core reaches 20 times the density of lead and ignites at 100,000,000 °C.



4.

Thermonuclear burn spreads rapidly through the compressed fuel, yielding many times the input energy.

Typical pulse values for these lasers are in the range:

Aperture Sizes:
Up to 420 x 427 mm

Energy Range:
Up to 16 kJ

Pulse Widths:
Nanoseconds

Wavelengths:
From UV to NIR

FEMTOSECOND LASERS

Femtosecond lasers are developing at a very fast pace. Some lasers now feature peak powers in the Petawatts (10^{15} W). Furthermore, the beam sizes can be fairly small, which results in peak power densities too high for a standard detector. Typically, pulse values for these lasers are in the range:

Beam Sizes: Up to 160 mm Ø

Energy range: 1 J to 100 J

Pulse Widths: Femto & picosecond

Wavelengths: UV to NIR

For these, a Gentec-EO calorimeter is the only reliable solution. Furthermore, it can sometimes be used in power meter mode.

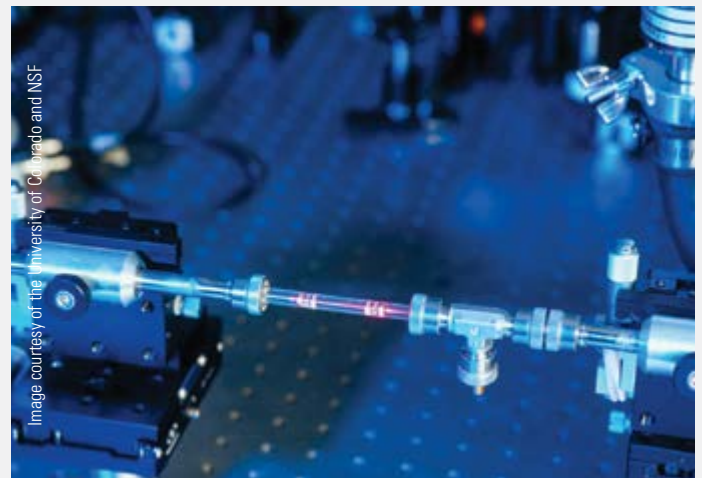


Image courtesy of the University of Colorado and NSF

TECHNICAL ASPECTS

EXAMPLES OF CUSTOM CALORIMETERS

MAIN SPECIFICATIONS	SPECTRAL RANGE	MINIMUM ENERGY	MAXIMUM ENERGY
RECTANGULAR APERTURES			
420 x 427 mm	1053 nm	500 J	16 000 J
420 x 427 mm	351/532/1053 nm	200 J	5 000 J
110 x 110 mm	351/532/1053 nm	1 J	50 J
400 x 400 mm	351/532/1053 nm	200 J	5 000 J
230 x 230 mm	532/1064 nm	100 J	1 500 J
ROUND APERTURES			
310 mm Ø	351 nm	20 J	500 J
310 mm Ø	0.35 - 1.1 µm	200 J	1 500 J
150 mm Ø	0.3 - 1.1 µm	1 J	500 J
50 mm Ø	0.19 - 10 µm	15 mJ	200 J
19 mm Ø	0.19 - 25 µm	1 mJ	2.3 J
17 mm Ø	0.19 - 10 µm	1 mJ	23 J

MONITORING

MONITOR

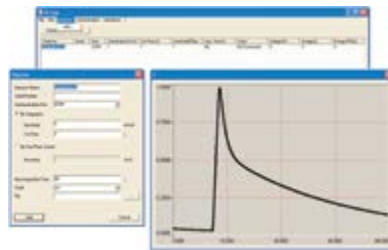


Single Channel (up to 4 on request)
Power & Energy PC-Based (USB or Ethernet)

P-LINK

The P-LINK is the perfect monitor to be integrated into your system and used remotely. You have the choice between USB, RS-232 or Ethernet connection and 1 or 4 channels. The P-LINK comes with a complete acquisition software (PC-CALO). S-LINK and MAESTRO are also available on special request as they require custom calibration and have limited features. See page 30.

ACQUISITION SOFTWARE



Can handle several calorimeters Saves Data to the PC Graphic Display

PC-CALO

The PC-Calo is a user-friendly PC interface that reads and controls several channels simultaneously via a USB or Ethernet connection. It reads the voltage outputs of the S-LINK, saves the data in a spreadsheet, displays the data graphically and analyzes the measured energy. The parameters are entered separately and the data can be treated individually or simultaneously.

REMOTE SYSTEM DIAGNOSTIC



Validation of the Calibration
Verification of the Signal Response

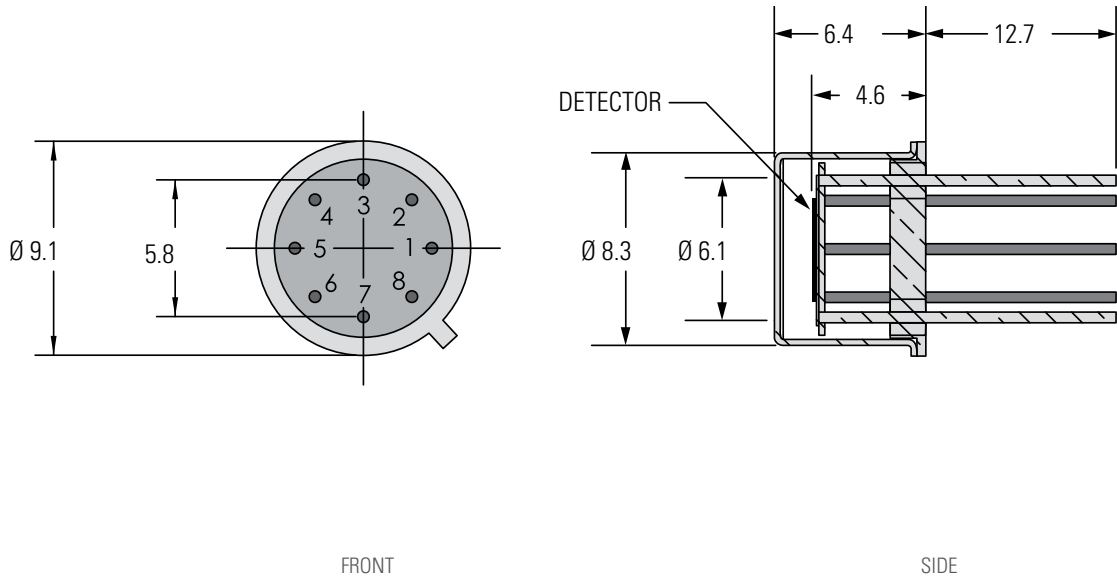
RSD

Do the on-site monitoring of your calorimeter using our special diagnostic tool. The verification is done remotely so you can control it from another location. The diagnostic includes the verification of the calorimeter's calibration and of the signal response and data acquisition.

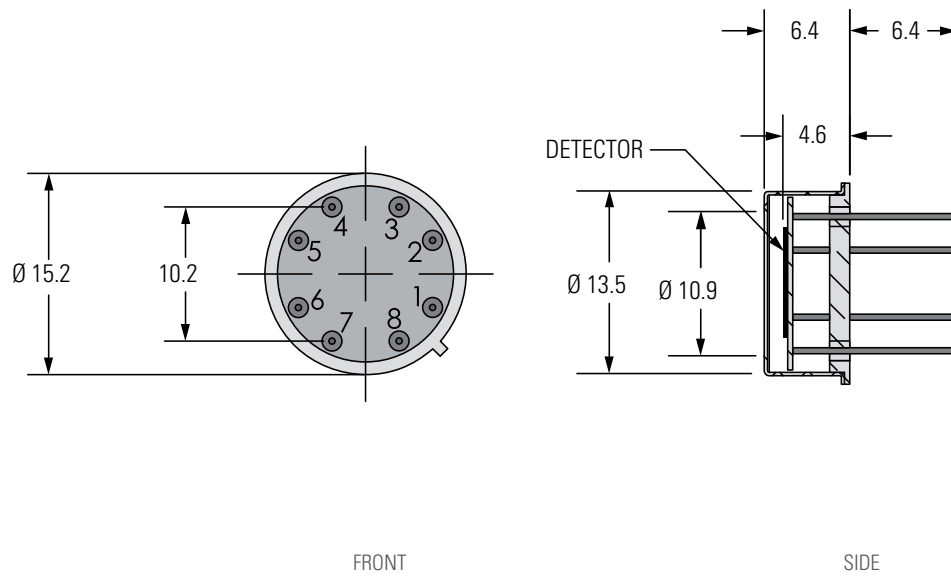
TECHNICAL DRAWINGS

All dimensions in mm

QS (TO5-BASED)



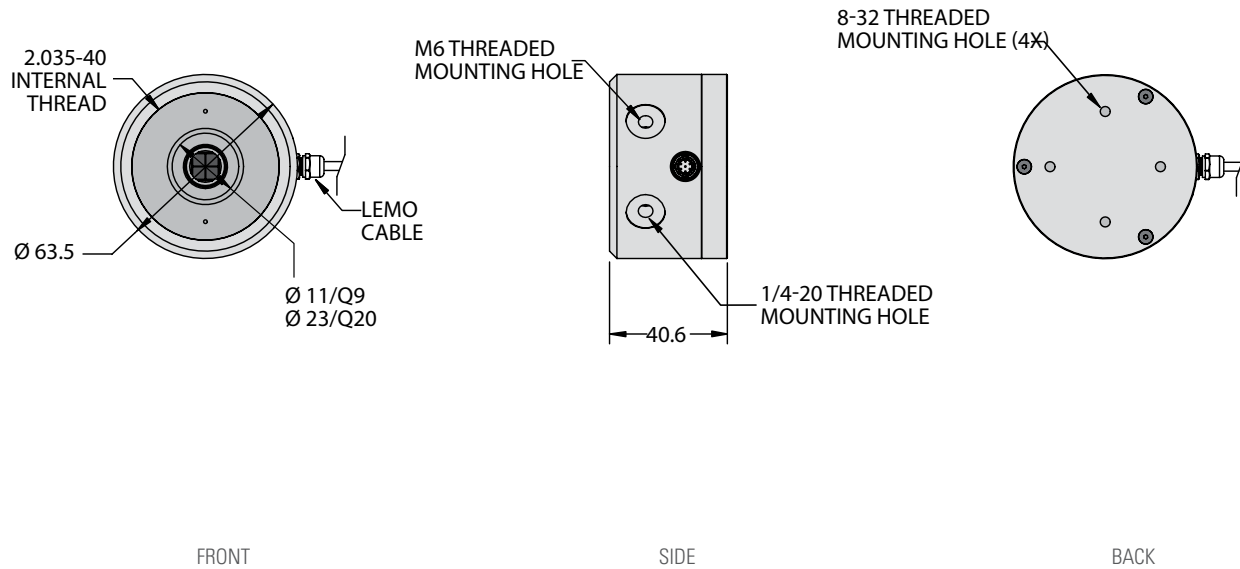
QS (TO8-BASED)



MONITORS
ENERGY DETECTORS
POWER DETECTORS
HIGH-POWER SOLUTIONS
PHOTO DETECTORS
THZ DETECTORS
OEM DETECTORS
SPECIAL PRODUCTS
BEAM DIAGNOSTICS

ABSORPTION CURVES

QUAD



TRAP

