gentec-eo

Laser Beam Measurement

USER MANUAL

Energy Detectors

QE Series
Pyroelectric Detectors

121-200243

WARRANTY

First Year Warranty

The Gentec-EO thermal power and energy detectors carry a one-year warranty (from date of shipment) against material and /or workmanship defects when used under normal operating conditions. The warranty does not cover recalibration or damages related to misuse.

Gentec-EO will repair or replace at its option any wattmeter or joulemeter which proves to be defective during the warranty period, except in the case of product misuse.

Any unauthorized alteration or repair of the product is also not covered by the warranty.

The manufacturer is not liable for consequential damages of any kind.

In the case of a malfunction, contact the local Gentec-EO distributor or nearest Gentec-EO office to obtain a return authorization number. Return the material to the address below.

All customers:

Gentec-EO, Inc.
445 St-Jean-Baptiste, Suite 160
Quebec, QC, G2E 5N7
Canada

Tel: (418) 651-8003
Fax: (418) 651-1174
Email: info@gentec-eo.com
Web: www.gentec-eo.com

Lifetime Warranty

Gentec-EO will warranty any thermal power and energy detector head for its lifetime as long as it has been returned for recalibration annually from the date of shipment. This warranty includes parts and labor for all routine repairs including normal wear under normal operating conditions.

Gentec-EO will inspect and repair the detector during the annual recalibration. Exceptions to repair at other times will be at Gentec-EO's option.

Not included is the cost of annual recalibration or consequential damages from using the detector.

The only condition is that the detector head must not have been subject to unauthorized service or damaged by misuse. Misuse would include, but is not limited to; laser exposure outside Gentec-EO's published specifications, physical damage due to improper handling, and exposure to hostile environments. Hostile environments would include, but are not limited to excessive temperature, vibration, humidity (>80%), or surface contaminants; exposure to flame, solvents or water; and connection to improper electrical voltage.

TABLE OF CONTENTS

WARRANTY 2

TABLE OF CONTENTS 3

LIST OF ILLUSTRATIONS 4

1 GENERAL INFORMATION **5**

1.1. INTRODUCTION 5
1.2. QE SERIES “SMART INTERFACE” CONNECTOR 6
1.3. QE4, QE12, QE25, QE50 AND QE65 SERIES SPECIFICATIONS 8
1.3.1 .. Specifications for the QE12, QE 25, QE50, QE65 and QE 95 MB 8
1.3.2 .. Specifications for QE4, QE12, QE 25 and QE 50 MT 14
1.3.3 .. Specifications for QE4 BL 19
1.3.4 .. Specifications for XLE4 20
1.4. When used with SOLO monitor 21
1.4.1 .. General Instructions 21
1.4.2 .. Working at other wavelengths than 1.064µm (except with QED attenuator / diffuser) 22
1.4.3 .. Working with QED attenuator / diffuser. 23
1.5. When using an oscilloscope: 23
1.5.1 .. General Instructions 23
1.5.2 .. Working at other wavelengths than 1.064µm 24

2 DAMAGE TO THE OPTICAL ABSORBER MATERIALS 27

3 OPTIONAL ACCESSORIES 28

3.1. QED ATTENUATOR / DIFFUSER 28

4 Appendix A (Joulemeter) 30

4.1. Recycling and separation procedure for WEEE directive 2002/96/EC. 30
4.2. Separation: 30

LIST OF ILLUSTRATIONS

Fig. 1-1 DB-15 "Smart Interface" connector Pin-out 7

Fig. 2-1 Joulemeter setup 25

Fig. 4-1 QED ATTENUATOR SPECIFICATIONS 28

1 GENERAL INFORMATION

1.1 INTRODUCTION

The Gentec-EO QE Series is a robust line of high performance and high accuracy pyroelectric joulemeters. Each modular unit is built for durability, compactness and ease of operation.

The QE optical absorber exhibits high damage thresholds and can operate at high rep-rates. The QE series can be used to even higher energy levels with QED attenuator / diffuser.

The QE Series benefits from the use of a DB-15 male, “Smart Interface” connector, containing an EEPROM (Erasable Electrical Programmable Read-Only Memory) programmed with the calibration sensitivity, the spectral correction factors at different wavelengths and other data relating to the specific QE Series joulemeter head. This connector permits the SOLO monitor to automatically adjust to the characteristics of the joulemeter being connected.

The C0 version of the QE series (with BNC connector) does not have the “Smart Interface” function. These joulemeters cannot be used with SOLO monitor. They must be used with an oscilloscope or an OEM acquisition system

Every QE Series joulemeter features high intrinsic responsivity and high insensitivity to electromagnetic interference.

The QE Series also offers an exceptionally wide dynamic range and permits energy measurement from UV to far IR.

QE Series joulemeters are designed for user-friendly energy measurement of pulsed lasers with SOLO monitor.

QE Series joulemeters require no power source. They can also be used with 1 MΩ[1] input impedance oscilloscopes[2] (or fast chart recorders). The calibrated V/J sensitivity is documented in the calibration certificate of each unit. The spectral correction of this sensitivity is also documented in the “Personal wavelength correction” certificate.

Each probe[3] also includes a standard optical stand and post. An appropriate damage test target is provided, as a safety precaution, for all QE models.

---

[1] The capacitance of the cable linking the joulemeter to the electronic readout and the readout input impedance (capacitance and resistance) constitute the total impedance load seen by the detector. The total load capacitance, excluding the integral cable should be ≤ 30 pfd.

[2] A DB-15 to BNC adaptor is required.

[3] For the CO version, the post and stand are optional.

QE - series

The QE series are modular low-profile heads, designed for ease of installation in tight optical setups.
These detectors have square apertures, providing better compatibility with rectangular beam profiles, such as pulsed gas lasers.
A corner mounting thread permits diagonal mounting of the heads to accommodate longer rectangular beams.
These heads can be used with an optional finned heatsink to extend the power range.
The QE Series can also be used with QED optional attenuator / diffuser[4] for improved compatibility with high-energy lasers.

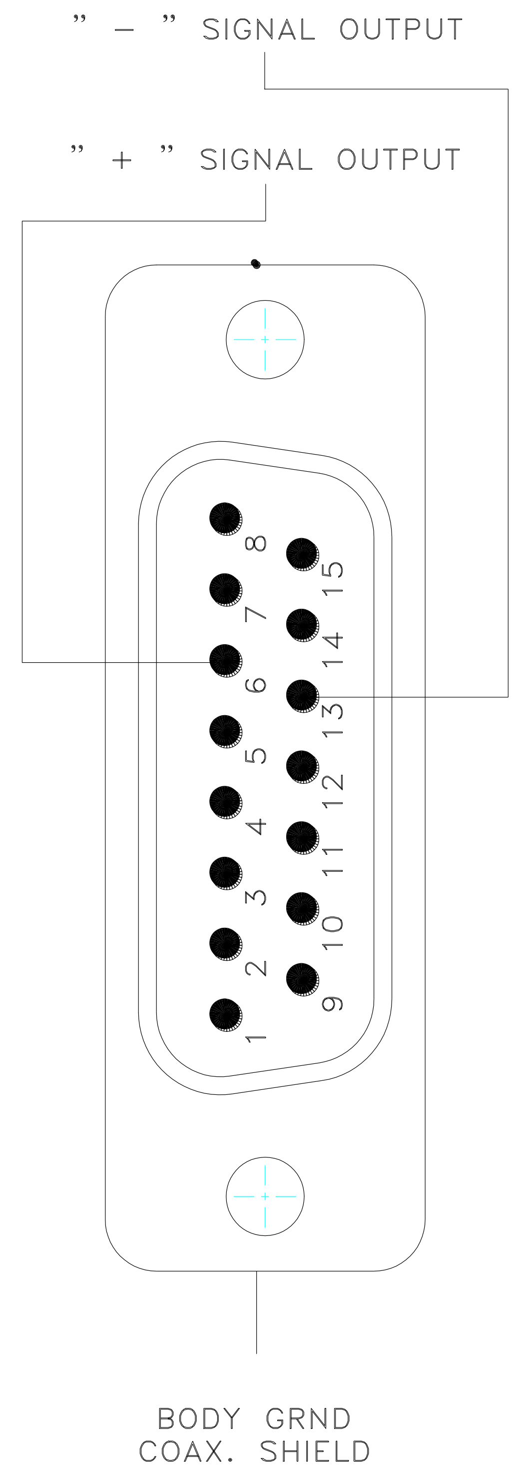
1.2 QE SERIES "SMART INTERFACE" CONNECTOR [5]

The DB-15 male "Smart Interface" connector contains an EEPROM (Erasable Electrical Programmable Read-Only Memory) programmed with the calibration sensitivity and other data relating to the specific QE joulemeter in use. Faster set-ups are obtained because the SOLO monitor automatically adjust to the characteristics of the joulemeter, when the "Smart Interface" is connected to the monitor.

The DB-15 "Smart Interface" connector pin-out is (see Fig. 1-1):

1-	USED BY SOLO
2-	" " " "
3-	" " " "
4-	" " " "
5-	" " " "
6-	"+" SIGNAL OUTPUT
7-	USED BY SOLO
8-	" " " "
9-	" " " "
10-	" " " "
11-	" " " "
12-	" " " "
13-	"-" SIGNAL OUTPUT
14-	USED BY SOLO
15-	" " " "
SHELL-	COAX. SHIELD / BODY GRND

[4] See optional accessories section.
[5] Does not apply to the C0 version.



DB-15 "Smart Interface" connector Pin-out Fig. 1-1

SK3399

1.3 QE4, QE12, QE25, QE50 AND QE65 SERIES SPECIFICATIONS

The following specifications are based on a one-year calibration cycle, an operating temperature of 15 to 28ºC and a relative humidity not exceeding 80%. Storage 5 to 45 ºC and relative humidity not exceeding 80%.

1.3.1 Specifications for the QE12, QE 25, QE50, QE65 and QE 95 MB

	Footnotes	Model
		QE12LP-S-MB **QE12LP-H-MB**
Optical Absorber		**MB**
Spectral Range	**1, 8**	0.19 – 20 µm
Typical Sensitivity	**2, 7**	60 V/J
Calibration Uncertainty	**7, 2, 8, 9, 11**	± 3%
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm **0.266 µm** **With QED @ 1.064 µm** **QED @ 0.266 µm**	**3, 12**	0.85 J 0.7 J 3.9 J 0.81 J
Noise Equivalent Energy (NEJ) (Typ)	**2, 11**	0.7 µJ
Max. Repetition Rate	**2, 5, 11**	300 Hz
Typical Rise Time (0-100%)	**2, 11**	550 µsec
Max. Pulse Width (Typ)	**2, 6, 10, 11**	400 µsec
Max. Energy Density	**12**	600 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 500 mJ/cm^2 @ 266nm, 7ns, 10 Hz
Max. Energy Density with QED		16 J/cm^2 @1064nm, 7nsec, Single shot 8 J/cm^2 @1064nm, 7nsec, 10Hz 6 J/cm^2 @532nm, 7nsec, 10Hz 1 J/cm^2 @266nm, 7nsec, 10Hz
Max. Average Power **Detector Alone (QE12xP-S-MB):** **With optional Heatsink (QE12xP-H-MB):**	**12, 13**	3 W (7.5 W with QED) 5 W (12.5 W with QED)
Max. Power Density **Detector Alone (QE12xP-S-MB):** **With optional Heatsink (QE12xP-H-MB):** **With QED :**		10 W/cm² @ 3 W 10 W/cm² @ 5 W 600 W/cm²
Dimensions (H x W x D) **Detector Alone (QE12xP-S-MB):** **With optional Heatsink (QE12xP-H-MB):**		36 x 36 x 14 mm 36 x 36 x 33 mm
Weight **Detector Alone (QE12xP-S-MB):** **With Optional Heatsink (QE12xP-H-MB):**		87 g 117 g
Aperture Size **QE 12:** **QED 12:**		12 x 12 mm 9 x 9 mm

Aperture Area Size **QE 12:** **QED 12:**		1.4 cm^2 0.81 cm^2

	Footnotes	Model	
		QE25SP-S-MB **QE25SP-H-MB**	**QE25LP-S-MB** **QE25LP-H-MB**
Optical Absorber		**MB**	
Spectral Range	1, 8	0.19 – 20 µm	
Typical Sensitivity	2, 7	10 V/J	
Calibration Uncertainty	7, 2, 8, 9, 11	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm **0.266 µm** **With QED @ 1.064 µm** **QED @ 0.266 µm**	3, 12	3.75 J 3.1 J 23 J 4.8 J	
Noise Equivalent Energy (NEJ) (Typ)	2, 11	4 µJ	
Max. Repetition Rate	2, 5, 11	800 Hz	300 Hz
Typical Rise Time (0-100%)	2, 11	200 µsec	550 µsec
Max. Pulse Width (Typ)	2, 6, 10, 11	150 µsec	400 µsec
Max. Energy Density	12	600 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 500 mJ/cm^2 @ 266nm, 7ns, 10 Hz	
Max. Energy Density with QED		16 J/cm^2 @1064nm, 7nsec, Single shot 8 J/cm^2 @1064nm, 7nsec, 10Hz 6 J/cm^2 @532nm, 7nsec, 10Hz 1 J/cm^2 @266nm, 7nsec, 10Hz	
Max. Average Power **Detector Alone (QE25xP-S-MB):** **With optional Heatsink (QE25xP-H-MB):**	12, 13	5 W (15 W with QED) 10 W (30 W with QED)	
Max. Power Density **Detector Alone (QE25xP-S-MB):** **With optional Heatsink (QE25xP-H-MB):** **With QED :**		10 W/cm² @ 5 W 10 W/cm² @ 10 W 600 W/cm²	
Dimensions (H x W x D) **Detector Alone (QE25xP-S-MB):** **With optional Heatsink (QE25xP-H-MB):**		50 x 50 x 14 mm 50 x 50 x 52.5 mm	
Weight **Detector Alone (QE25xP-S-MB):** **With Optional Heatsink (QE25xP-H-MB):**		120 g 187 g	
Aperture Size **QE 25:** **QED 25:**		25 x 25 mm 22 x 22 mm	
Aperture Area Size **QE 25:** **QED 25:**		6.25 cm^2 4.84 cm^2	

	Footnotes	Model	
		QE50SP-S-MB QE50SP-H-MB	QE50LP-S-MB QE50LP-H-MB
Optical Absorber		MB	
Spectral Range	1, 8	0.19 – 20 µm	
Typical Sensitivity	2, 7	3 V/J	
Calibration Uncertainty	7, 2, 8, 9, 11	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm **0.266 µm** **With QED @ 1.064 µm** **QED @ 0.266 µm**	3, 12	15 J 12.5 J 85 J 22 J	
Noise Equivalent Energy (NEJ) (Typ)	2, 11	10 µJ	
Max. Repetition Rate	2, 5, 11	500 Hz	200 Hz
Typical Rise Time (0-100%)	2, 11	300 µsec	900 µsec
Max. Pulse Width (Typ)	2, 6, 10, 11	225 µsec	675 µsec
Max. Energy Density	12	600 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 500 mJ/cm^2 @ 266nm, 7ns, 10 Hz	
Max. Energy Density with QED	12	16 J/cm^2 @1064nm, 7nsec, Single shot 8 J/cm^2 @1064nm, 7nsec, 10Hz 6 J/cm^2 @532nm, 7nsec, 10Hz 1 J/cm^2 @266nm, 7nsec, 10Hz	
Max. Average Power **Detector Alone (QE50xP-S-MB):** **With optional Heatsink (QE50xP-H-MB):**	12, 13	10 W (25 W with QED) 20 W (45 W with QED)	
Max. Power Density **Detector Alone (QE50xP-S-MB):** **With optional Heatsink (QE50xP-H-MB):** **With QED :**		10 W/cm² @ 10 W 5 W/cm² @ 20 W 600 W/cm²	
Dimensions (H x W x D) **Detector Alone (QE50xP-S-MB):** **With optional Heatsink (QE50xP-H-MB):**		75 x 75 x 15 mm 75 x 75 x 44 mm	
Weight **Detector Alone (QE50xP-S-MB):** **With Optional Heatsink (QE50xP-H-MB):**		209 g 338 g	
Aperture Size **QE 50:** **QED 50:**		50 x 50 mm 47 x 47 mm	
Aperture Area Size **QE 50:** **QED 50:**		25 cm^2 22.09 cm^2	

	Footnotes	Model	
		QE65LP-S-MB **QE65LP-H-MB**	**QE65ELP-S-MB** **QE65ELP-H-MB**
Optical Absorber		**MB**	
Spectral Range	**1, 8**	0.19 – 20 µm	
Typical Sensitivity	**2, 7**	4 V/J	1.5 V/J
Calibration Uncertainty	**7, 2, 8, 9, 11**	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm **0.266 µm** **With QED @ 1.064 µm** **QED @ 0.266 µm**	**3, 12**	25 J 20 J 125 J 35 J	50 J (µs pulse, single shot) 200 J (µs pulse, single shot)
Noise Equivalent Energy (NEE) (Typ)	**2, 11**	10 µJ	20 µJ
Max. Repetition Rate	**2, 5, 11**	100 Hz	20 Hz
Typical Rise Time (0-100%)	**2, 11**	1000 µsec	6000 µsec
Max. Pulse Width (Typ)	**2, 6, 10, 11**	700 µsec	5000 µsec
Max. Energy Density	**12**	1200 mJ/cm² @ 1064nm, 150µs, 10 Hz 600 mJ/cm² @ 1064nm, 7ns, 10 Hz 500 mJ/cm² @ 266nm, 7ns, 10 Hz	
Max. Energy Density with QED		14 J/cm² @1064nm, 150µs, 10Hz 16 J/cm² @1064nm, 7ns, Single shot 8 J/cm² @1064nm, 7ns, 10Hz 6 J/cm² @532nm, 7ns, 10Hz 1 J/cm² @266nm, 7ns, 10Hz	
Max. Average Power **Detector Alone (QE65xP-S-MB):** **With optional Heatsink (QE65xP-H-MB):**	**12, 13**	12 W (30 W with QED) 40 W (90 W with QED)	
Max. Power Density **Detector Alone (QE65xP-S-MB):** **With optional Heatsink (QE65xP-H-MB):** **With QED :**		10 W/cm² @ 12 W 5 W/cm² @ 40 W 600 W/cm²	
Dimensions (H x W x D) **Detector Alone (QE65xP-S-MB):** **With optional Heatsink (QE65xP-H-MB):**		90 x 90 x 20 mm 90 x 90 x 94 mm	
Weight **Detector Alone (QE65xP-S-MB):** **With optional Heatsink (QE65xP-H-MB):**		440 g 900 g	
Aperture Size **QE 65:** **QED 65:**		65 x 65 mm 62 x 62 mm	
Aperture Area Size **QE 65:** **QED 65:**		42 cm² 38 cm²	

	Footnotes	Model	
		QE95LP-S-MB QE95LP-H-MB	QE95ELP-S-MB QE95ELP-H-MB
Optical Absorber		MB	
Spectral Range	1, 8	0.19 – 20 µm	
Typical Sensitivity	2, 7	2 V/J	0.6 V/J
Calibration Uncertainty	7, 2, 8, 9, 11	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm 0.266 µm With QED @ 1.064 µm QED @ 0.266 µm	3, 12	35 J 30 J 150 J 50 J	70 J (µs pulse, single shot) 250 J (µs pulse, single shot)
Noise Equivalent Energy (NEE) (Typ)	2, 11	15 µJ	30 µJ
Max. Repetition Rate	2, 5, 11	40 Hz	10 Hz
Typical Rise Time (0-100%)	2, 11	1500 µsec	6000 µsec
Max. Pulse Width (Typ)	2, 6, 10, 11	2000 µsec	5000 µsec
Max. Energy Density	12	1200 mJ/cm^2 @ 1064nm, 150µs, 10 Hz 600 mJ/cm^2 @ 1064nm, 7ns, 10 Hz 500 mJ/cm^2 @ 266nm, 7ns, 10 Hz	
Max. Energy Density with QED	12	14 J/cm^2 @1064nm, 150µs, 10Hz 16 J/cm^2 @1064nm, 7ns, Single shot 8 J/cm^2 @1064nm, 7ns, 10Hz 6 J/cm^2 @532nm, 7ns, 10Hz 1 J/cm^2 @266nm, 7ns, 10Hz	
Max. Average Power Detector Alone (QE95xP-S-MB): With optional Heatsink (QE95xP-H-MB):	12, 13	20 W (45 W with QED) 40 W (90 W with QED)	
Max. Power Density Detector Alone (QE95xP-S-MB): With optional Heatsink (QE95xP-H-MB): With QED :		10 W/cm² @ 12 W 5 W/cm² @ 40 W 600 W/cm²	
Dimensions (H x W x D) Detector Alone (QE95xP-S-MB): With optional Heatsink (QE95xP-H-MB):		122 x 122 x 20 mm 122 x 122 x 98 mm	
Weight Detector Alone (QE95xP-S-MB): With optional Heatsink (QE95xP-H-MB):		780 g 1200 g	
Aperture Size QE 95: QED 95:		95 mm in diameter 90 mm in diameter	
Aperture Area Size QE 95: QED 95:		71 cm^2 64 cm^2	

FOOTNOTES FOR QE/12/25/50/65/95 MB SERIES SPECIFICATIONS:

1 See “Personal wavelength correction” certificate
2 Load capacitance must be ≤ 30 pF, excluding the supplied BNC to DB-15 “Smart Interface” coaxial cable.
3 Assuming 0.6 J/cm^2 @ 1.064µm, 7ns laser beam; with a uniform energy distribution; energy applied to full aperture. Increasing the pulse width increases the maximum measurable energy.
5 At constant power.
6 To maintain indicated calibration, sensitivity must be de-rated for longer pulses.
7 Calibrated at: 100 mJ, 10 Hz, @1.064 µm, 150 µsec pulse (FWHM), semi-Gaussian beam profile, energy applied to 80% of aperture, loaded into 1 MΩ / 30 pfd.
8 For values other than calibration wavelength and outside the range of 248 to 2500 nm, a typical value is recommended but not traceable to NIST.
9 Excludes non-linearities.
10 Duration at base of pulse. Divide by 2 for FWHM (Full Width at Half Maximum) duration.
11 Loaded into 1 MΩ / 30 pfd.
12 Maximum measurable energy, maximum energy density and maximum average power can be increased by using an optional QED attenuator / diffuser.
13 **Warning:** Detector body can reach 60°C at maximum powers.
14 @1.064µm, CW

1.3.2 Specifications for QE4, QE12, QE 25 and QE 50 MT

	Footnotes	Model
		QE4 MT
Optical Absorber		**MT**
Spectral Range	**1, 8, 15**	0.19 – 20 µm
Typical Sensitivity	**2, 14**	200 V/J
Calibration Uncertainty	**2, 8, 9, 11, 14**	± 3%
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm 0.266 µm	**3**	43 mJ 7.6 mJ
Noise Equivalent Energy (NEJ) (Typ)	**2, 11**	1 µJ
Max. Repetition Rate	**2, 5, 11**	6000 Hz
Typical Rise Time (0-100%)	**2, 11**	20 µsec
Max. Pulse Width (Typ)	**2, 6, 10, 11**	10 µsec
Max. Energy Density		400 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 70 mJ/cm^2 @ 266nm, 7ns, 10 Hz
Max. Average Power	**13**	0.3 W
Dimensions (H x W x D)		20 x 17.5 x 30 mm
Weight		20 g
Aperture Size		3.7 mm diameter
Aperture Area Size :		0.108 cm^2

	Footnotes	Model
		QE12SP-S-MT QE12SP-H-MT
Optical Absorber		**MT**
Spectral Range	1, 8, 15	0.19 – 20 µm
Typical Sensitivity	2, 14	100 V/J
Calibration Uncertainty	2, 8, 9, 11, 14	± 3%
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm 0.266 µm With QED @ 1.064 µm QED @ 0.266 µm	3, 12	0.70 J 0.10 J 1.6 J 0.25 J
Noise Equivalent Energy (NEJ) (Typ)	2, 11	0.8 µJ
Max. Repetition Rate	2, 5, 11	6000 Hz
Typical Rise Time (0-100%)	2, 11	20 µsec
Max. Pulse Width (Typ)	2, 6, 10, 11	10 µsec
Max. Energy Density	12	500 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 70 mJ/cm^2 @ 532nm, 7ns, 10 Hz 70 mJ/cm^2 @ 266nm, 7ns, 10 Hz
Max. Energy Density with QED		4 J/cm^2 @1064nm, 7nsec, Single shot 2 J/cm^2 @1064nm, 7nsec, 10Hz 0.35 J/cm^2 @532nm, 7nsec, 10Hz 0.3 J/cm^2 @266nm, 7nsec, 10Hz
Max. Average Power Detector Alone (QE12SP-S-MT): With optional Heatsink (QE12SP-H-MT):	12, 13	3 W (7.5 W with QED) 5 W (12.5 W with QED)
Max. Power Density Detector Alone (QE12SP-S-MT): With optional Heatsink (QE12SP-H-MT): With QED :		10 W/cm² @ 3 W 10 W/cm² @ 5 W 600 W/cm²
Dimensions (H x W x D) Detector Alone (QE12SP-S-MT): With optional Heatsink (QE12SP-H-MT):		36 x 36 x 14 mm 36 x 36 x 33 mm
Weight Detector Alone (QE12SP-S-MT): With Optional Heatsink (QE12SP-H-MT):		87 g 117 g
Aperture Size QE 12: QED 12:		12 x 12 mm 9 x 9 mm
Aperture Area Size QE 12: QED 12:		1.4 cm^2 0.81 cm^2

	Footnotes	Model OEM
		QE25SP-S-MT QE25SP-H-MT
Optical Absorber		**MT**
Spectral Range	**1, 8, 15**	0.19 – 20 µm
Typical Sensitivity	**2, 14**	20 V/J
Calibration Uncertainty	**2, 8, 9, 11, 14**	± 3%
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm **0.266 µm** **With QED @ 1.064 µm** **QED @ 0.266 µm**	**3, 12**	3.0 J 0.44 J 10 J 1.45 J
Noise Equivalent Energy (NEJ) (Typ)	**2, 11**	2 µJ
Max. Repetition Rate	**2, 5, 11**	6000 Hz
Typical Rise Time (0-100%)	**2, 11**	20 µsec
Max. Pulse Width (Typ)	**2, 6, 10, 11**	10 µsec
Max. Energy Density	**12**	500 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 70 mJ/cm^2 @ 532nm, 7ns, 10 Hz 70 mJ/cm^2 @ 266nm, 7ns, 10 Hz
Max. Energy Density with QED		4 J/cm^2 @1064nm, 7nsec, Single shot 2 J/cm^2 @1064nm, 7nsec, 10Hz 0.35 J/cm^2 @532nm, 7nsec, 10Hz 0.3 J/cm^2 @266nm, 7nsec, 10Hz
Max. Average Power **Detector Alone (QE25SP-S-MT):** **With optional Heatsink (QE25SP-H-MT):**	**12, 13**	5 W (15 W with QED) 10 W (30 W with QED)
Max. Power Density **Detector Alone (QE25SP-S-MT):** **With optional Heatsink (QE25SP-H-MT):** **With QED :**		10 W/cm² @ 5 W 10 W/cm² @ 10 W 600 W/cm²
Dimensions (H x W x D) **Detector Alone (QE25SP-S-MT):** **With optional Heatsink (QE25SP-H-MT):**		50 x 50 x 14 mm 50 x 50 x 52.5 mm
Weight **Detector Alone (QE25SP-S-MT):** **With Optional Heatsink (QE25SP-H-MT):**		120 g 187 g
Aperture Size **QE 25:** **QED 25:**		25 x 25 mm 22 x 22 mm
Aperture Area Size **QE 25:** **QED 25:**		6.25 cm^2 4.84 cm^2

	Footnotes	Model OEM QE50SP-S-MT QE50SP-H-MT
Optical Absorber		**MT**
Spectral Range	1, 8, 15	0.19 – 20 µm
Typical Sensitivity	2, 14	4 V/J
Calibration Uncertainty	2, 8, 9, 11, 14	± 3%
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm 0.266 µm and QED @ 1.064 µm QED @ 0.266 µm	3, 12	13 J 1.8 J 44 J 6.5 J
Noise Equivalent Energy (NEJ) (Typ)	2, 11	10 µJ
Max. Repetition Rate	2, 5, 11	4000 Hz
Typical Rise Time (0-100%)	2, 11	20 µsec
Max. Pulse Width (Typ)	2, 6, 10, 11	10 µsec
Max. Energy Density	12	500 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 70 mJ/cm^2 @ 532nm, 7ns, 10 Hz 70 mJ/cm^2 @ 266nm, 7ns, 10 Hz
Max. Energy Density with QED		4 J/cm^2 @1064nm, 7nsec, Single shot 2 J/cm^2 @1064nm, 7nsec, 10Hz 0.35 J/cm^2 @532nm, 7nsec, 10Hz 0.3 J/cm^2 @266nm, 7nsec, 10Hz
Max. Average Power Detector Alone (QE50SP-S-MT): With optional Heatsink (QE50SP-H-MT):	12, 13	10 W (25 W with QED) 20 W (45 W with QED)
Max. Power Density Detector Alone (QE50SP-S-MT): With optional Heatsink (QE50SP-H-MT): With QED :		10 W/cm^2 @ 10 W 5 W/cm^2 @ 20 W 600 W/cm^2
Dimensions (H x W x D) Detector Alone (QE50SP-S-MT): With optional Heatsink (QE50SP-H-MT):		75 x 75 x 15 mm 75 x 75 x 44 mm
Weight Detector Alone (QE50SP-S-MT): With Optional Heatsink (QE50SP-H-MT):		209 g 338 g
Aperture Size QE 50: QED 50:		50 x 50 mm 47 x 47 mm
Aperture Area Size QE 50: QED 50:		25 cm^2 22.09 cm^2

FOOTNOTES FOR QE4/12/25/50 MT SERIES SPECIFICATIONS:

1 See "Personal wavelength correction" certificate
2 Load capacitance must be ≤ 30 pF, excluding the supplied BNC to DB-15 "Smart Interface" coaxial cable (≤ 13 pF for QE4).
3 Assuming 0.05 J/cm^2 @ 1.064µm, 7ns laser beam; with a uniform energy distribution; energy applied to full aperture. Increasing the pulse width increases the maximum measurable energy.
5 At constant power.
6 To maintain indicated calibration, sensitivity must be de-rated for longer pulses.
7 Calibrated at: 100 mJ, 10 Hz, @1.064 µm, 7 ns pulse (FWHM), semi-Gaussian beam profile, energy applied to 80% of aperture, loaded into 1 MΩ / 13 pfd.
8 For values other than calibration wavelength and outside the range of 248 to 2500 nm, a typical value is recommended but not traceable to NIST.
9 Excludes non-linearities.
10 Duration at base of pulse. Divide by 2 for FWHM (Full Width at Half Maximum) duration.
11 Loaded into 1 MΩ / 30 pfd (13 pF for QE4).
12 Maximum measurable energy, maximum energy density and maximum average power can be increased by using an optional QED attenuator / diffuser.
13 **Warning:** Detector body can reach 60°C at maximum power.
14 Calibrated at: 2 mJ, 5 Hz, @1.064 µm, 7 ns pulse (FWHM), semi-Gaussian beam profile, energy applied to 80% of aperture, loaded into 1 MΩ / 30 pfd (13 pF for QE4).
15 Detectors with the MT coating can be used within the range 0.19 to 20 µm, however the absorption in the IR wavelengths decreases significantly. This, in turn, reduces the sensitivity and increases the noise level.

1.3.3 Specifications for QE4 BL

	Footnotes	Model
		QE4 BL
Optical Absorber		**BL**
Spectral Range	**1, 8**	0.19 – 20 µm
Typical Sensitivity	**2, 7**	150 V/J
Calibration Uncertainty	**2, 7, 8, 9, 11**	± 3%
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm **0.266 µm**	**3**	16 mJ 0.7 mJ
Noise Equivalent Energy (NEJ) (Typ)	**2, 11**	1 µJ with amplifier 15 µJ with Solo/Duo alone
Max. Repetition Rate	**2, 5, 11**	1200 Hz
Typical Rise Time (0-100%)	**2, 11**	200 µsec
Max. Pulse Width (Typ)	**2, 6, 10, 11**	100 µsec
Max. Energy Density		150 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 6 mJ/cm^2 @ 266nm, 7ns, 10 Hz
Max. Average Power	**13**	0.3 W
Dimensions (H x W x D)		20 x 17.5 x 30 mm
Weight		20 g
Aperture Size		3.7 mm diameter
Aperture Area Size :		0.108 cm^2

FOOTNOTES FOR QE4 BL SERIES SPECIFICATIONS:

1 See "Personal wavelength correction" certificate

2 Load capacitance must be ≤ 13 pF, excluding the supplied BNC to DB-15 "Smart Interface" coaxial cable.

3 Assuming 0.15 J/cm^2 @ 1.064µm,7ns laser beam; with a uniform energy distribution; energy applied to full aperture. Increasing the pulse width increases the maximum measurable energy.

5 At constant power.

6 To maintain indicated calibration, sensitivity must be de-rated for longer pulses.

7 Calibrated at: 2 mJ, 5 Hz, @1.064 µm, 150 µsec pulse (FWHM), semi-Gaussian beam profile, energy applied to 80% of aperture, loaded into 1 MΩ / 13 pfd.

8 For values other than calibration wavelength and outside the range of 248 to 2500 nm, a typical value is recommended but not traceable to NIST.

9 Excludes non-linearities.

10 Duration at base of pulse. Divide by 2 for FWHM (Full Width at Half Maximum) duration.

11 Loaded into 1 MΩ / 13 pfd.

13 **Warning:** Detector body can reach 60°C at maximum power.

1.3.4 Specifications for XLE4

	Footnotes	Model
		XLE4
Optical Absorber		XT : Metallic
Spectral Range	1, 8	0.35 – 2.5 µm
Typical Sensitivity	2, 7	1100 V/J
Calibration Uncertainty	2, 7, 8, 9, 11	± 4% at 1064nm ± 9% for other wavelengths
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm	3	4 mJ
Noise Equivalent Energy (NEJ) (Typ)	2, 11	150 nJ
Max. Repetition Rate	2, 5, 11	2000 Hz
Typical Rise Time (0-100%)	2, 11	10 µsec
Max. Pulse Width (Typ)	2, 6, 10, 11	5 µsec
Max. Energy Density		90 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz
Max. Average Power		0.4 W
Dimensions (H x W x D)		26.5 x 36.0 mm diam
Weight		130 g
Aperture Size		4.0 mm diameter
Aperture Area Size :		0.16 cm^2

FOOTNOTES FOR XLE4 SERIES SPECIFICATIONS:

2 Load capacitance must be ≤ 13 pF, excluding the supplied BNC to DB-15 “Smart Interface” coaxial cable.

3 Assuming 90 mJ/cm^2 @ 1.064µm,7ns laser beam; with a uniform energy distribution; energy applied to full aperture. Increasing the pulse width increases the maximum measurable energy.

5 At constant power.

6 To maintain indicated calibration, sensitivity must be de-rated for longer pulses.

7 Calibrated at: 400 µJ, 10 Hz, @1.064 µm, 7 ns pulse (FWHM), semi-Gaussian beam profile, energy applied to 80% of aperture, loaded into 1 MΩ / 13 pfd.

8 For values other than calibration wavelength a typical value is recommended but not traceable to NIST.

9 Excludes non-linearities.

10 Duration at base of pulse. Divide by 2 for FWHM (Full Width at Half Maximum) duration.

11 Loaded into 1 MΩ / 13 pfd.

1.4 When used with SOLO monitor

Refer to the respective monitor's instruction manual for further information.

1.4.1 General Instructions

1- Install the joulemeter on its optical stand.

2- Connect the joulemeter to the Gentec-EO laser energy monitor (see Fig. 2-1).

NOTE: The parameters programmed in the DB-15 "Smart Interface" are for a 1 MΩ / 30 pfd load impedance.

3- Remove the detector's protective cover, when applicable.

4- Put the joulemeter head into the laser beam path (laser beam must be contained within the aperture).

CAUTION: Be careful not to exceed the maximum levels and densities of, energy, peak power and average power, stated in the specifications pages. The use of a damage test target is strongly recommended.

WARNING: 1- At maximum average powers QE Series joulemeter bodies can reach 60°C and can represent a burn hazard if handled with bare hands.
2- A diffuse back reflection of ~ 30% is present from the joulemeter's optical absorber.

NOTE: As with all large aperture pyroelectric devices, these detectors have some position and beam size sensitivity. For the most accurate measurements, the beam should normally be centered on the sensor surface and the beam diameter should ideally be close to that of the original calibration conditions, which is 100% encircled energy (of a semi-Gaussian beam stopped at $1/e^2$) applied to a diameter equal to 80% of the detector aperture. The use of a QED Attenuator/Diffuser[6], a divergent lens, a Lambertian diffuser such as opal glass, or any other method of beam spreading, is recommended for this purpose. Please take note that all of the laser light must be directed within the detector aperture and that the transmission loss through the optical component must be known.

---

[6] See optional accessories section.

1.4.2 Working at other wavelengths than 1.064µm (except with QED attenuator / diffuser)

The SOLO monitor will automatically configure himself using the data stored in the EEPROM of the DB-15 “Smart Interface”. This includes the calibration sensitivity and wavelengths corrections for 20 current wavelengths[7] [8].

For more precise measurements with a QE Series joulemeter at wavelengths other than those already corrected by the “Personal wavelenght correction ™” [7] data programmed into the “Smart Interface”, a correction factor[8] must be set in the monitor to compensate for the change in sensitivity of the joulemeter caused by the change in absorption of the optical absorber at different wavelengths.

To correct for the change in absorption refer to the spectral curve of the “ Personal Wavelength Correction ™ “ certificate supplied for the joulemeter and calculate **K** by taking the percentage difference between the absorption @1.064µm and that at the desired wavelength.

$$\mathbf{K} = \frac{\mathbf{A}(\lambda 1)}{\mathbf{A}(@1.064\mu m)}$$

Here $\mathbf{A}(\lambda 1)$ = Absorption of the QE @ the desired wavelength.

$\mathbf{A}(@1.064\mu m)$ = Absorption of the QE @ 1.064µm

A sample calculation follows:

$\mathbf{A}(\lambda 1)$ = 92 %.
$\mathbf{A}(@1.064\mu m)$ = 94 %

$$\mathbf{K} = \frac{\mathbf{A}(\lambda 1)}{\mathbf{A}(@1.064\mu m)} \times 100$$

$$\mathbf{K} = \frac{92\%}{94\%} \times 100 = 0.9787 \times 100 = \mathbf{97.87\ \%}$$

and is the Correction Factor to be set in the monitor[8].

7 Refer to the spectral curve of the “ Personal Wavelength Correction ™ “ certificate supplied with the joulemeter

8 Refer to the SOLO monitor manuals for instructions.

Attention: when using QE series joulemeters with QED attenuator / DIFFUSER:

1.4.3 Working with QED attenuator / diffuser.

Except when purchased on special order with a double factory calibration @1.064µm (with and without attenuator), a so called V7 version, the data stored in the EEPROM of the DB-15 “Smart Interface”, includes the calibration sensitivity and wavelengths corrections for 20 current wavelengths without the QED attenuator installed.
When using a double factory calibrated (@1.064µm) QE series joulemeter combined with a When using a QE series joulemeter (@ any wavelength) with a QED attenuator, the user must calibrate the attenuator; refer to “Calibration Procedure” document # 420-190068, provided with the attenuator, for further details.

1.5 When using an oscilloscope:

1.5.1 General Instructions

1- Install the joulemeter on its optical stand

2- Connect the joulemeter to the oscilloscope.

NOTE: The required load impedance is 1 MΩ / 30 pfd.
An optional DB-15 to BNC adaptor may be required when used in conjunction with an oscilloscope. The C0 version is connected directly to oscilloscope.

3- Remove the detector's protective cover, when applicable.

4- Put the joulemeter head into the laser beam path (laser beam must be contained within the aperture).

CAUTION: Be careful not to exceed the maximum levels and densities of, energy, peak power and average power, stated in the specifications pages. The use of a damage test target is strongly recommended.

WARNING: 1- At maximum average powers QE Series joulemeter bodies can reach 60°C and can represent a burn hazard if handled with bare hands.
2- A diffuse back reflection of ~ 30% is present from the joulemeter’s optical absorber.

NOTE: As with all large aperture pyroelectric devices, these detectors have some position and beam size sensitivity. For the most accurate measurements, the beam should normally be centered on the sensor surface and the beam diameter should ideally be close to that of the original calibration conditions, which is 100% encircled energy (of a semi-Gaussian beam stopped at $1/e^2$) applied to a diameter equal to 80% of the detector aperture. The use of a QED Attenuator/Diffuser[9], a divergent lens, a Lambertian diffuser such as opal glass, or any other method of beam spreading, is recommended for this purpose. Please take note that all of the laser

[9] See optional accessories section.

light must be directed within the detector aperture and that the transmission loss through the optical component must be known.

5- Adjust the oscilloscope to trigger on the joulemeter pulse or on the laser sync. signal.

6- Measure the foot to crest peak voltage generated by the joulemeter.

7- Determine the joulemeter Volt/Joule sensitivity from the detector identification label or calibration certificate. Choose the value stated for the wavelength being used.

8- Calculate the optical energy using the following equation:

Energy = V_{peak} / Calibration sensitivity

Ex:

- V_{peak} = 1 volt
- Detector calibration sensitivity (10 Volts / Joule)

Energy = 1 Volt / 10 V/J = 100 mJ

NOTE: Exclude any DC offset from the pulse peak value measurement; this offset is a function of the repetition rate.

1.5.2 Working at other wavelengths than 1.064µm

For measurements with a QE Series joulemeter at wavelengths other than 1.064µm, a correction factor must be set to compensate for the change in sensitivity of the joulemeter caused by the change in absorption of the optical absorber at different wavelengths.

To correct for the change in absorption refer to the spectral curve of the " Personal Wavelength Correction ™ " certificate supplied for the joulemeter and calculate **K** by taking the percentage difference between the absorption @1.064µm and that at the desired wavelength.

$$\mathbf{K} = \frac{\mathbf{A}(\lambda 1)}{\mathbf{A}(@1.064\mu m)}$$

Energy = V_{peak} / Calibration sensitivity / K

Here $\mathbf{A}(\lambda 1)$ = Absorption of the QE @ the desired wavelength.
$\mathbf{A}(@1.064\mu m)$ = Absorption of the QE @ 1.064µm

A sample calculation follows:

$\mathbf{A}(\lambda 1)$ = 92 %.
$\mathbf{A}(@1.064\mu m)$ = 94 %

$$\mathbf{K} = \frac{\mathbf{A}(\lambda 1)}{\mathbf{A}(@1.064\mu m)} \text{ x } 100$$

$$\mathbf{K} = \frac{92\%}{94\%} \text{ x } 100 = 0.9787 \text{ x } 100 = \mathbf{97.87\ \%}$$

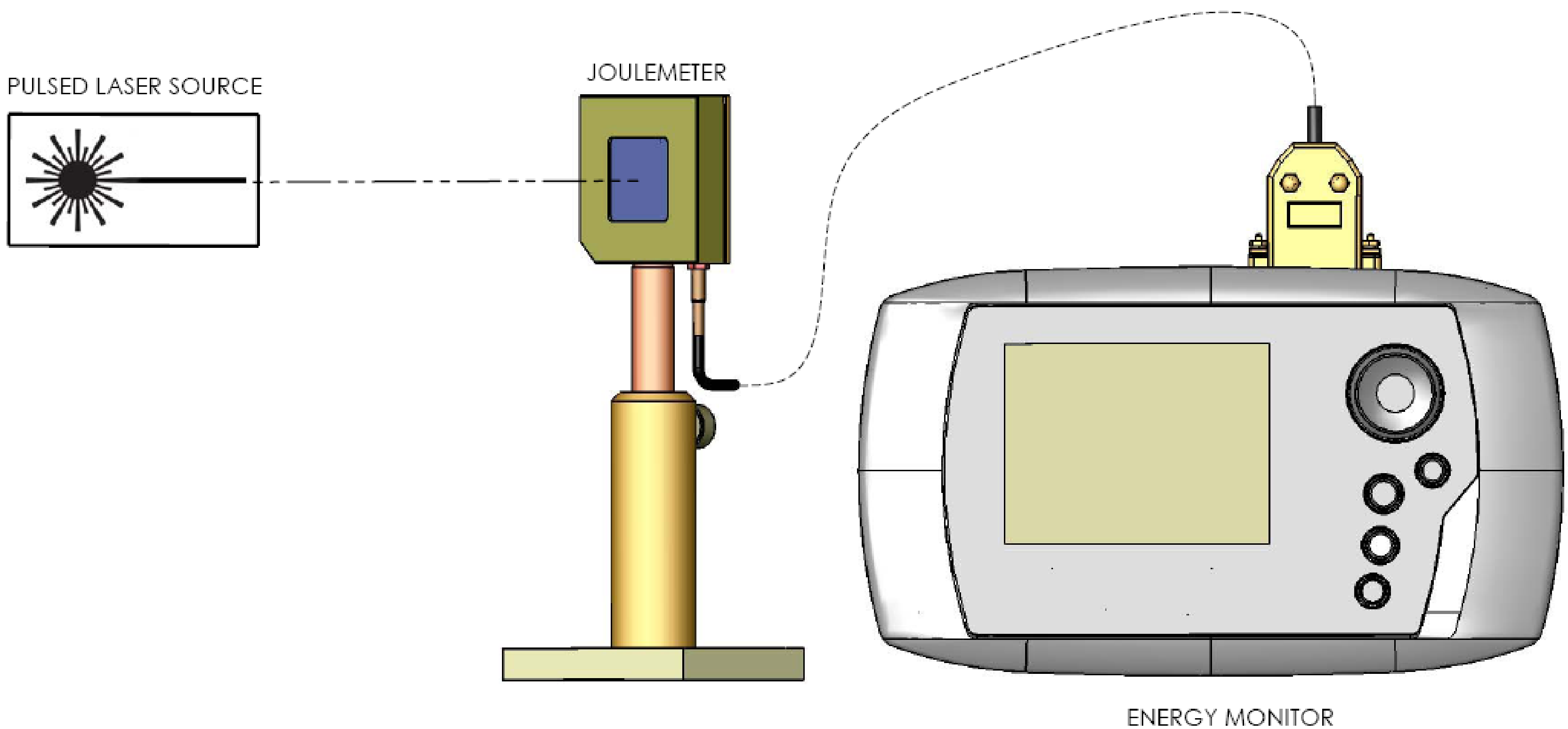
Ex:

- V_{peak} = 1 volt
- Detector calibration sensitivity @1.064µm (10 Volts / Joule)

Energy = 1 Volt / 10 V/J / 97.87% = 102.18 mJ

Joulemeter Setup

Fig. 2-1



2 DAMAGE TO THE OPTICAL ABSORBER MATERIALS

Damage is usually caused by exceeding the manufacturer's specified maximum incident:

- Average Power Density
- Peak Pulse Power Density
- Single Pulse Energy Density

Refer to the QE Series joulemeter specifications pages. This damage can also be caused when using a detector with a contaminated absorber or attenuator surface.

The quoted damage thresholds in the specifications section refer to a visible alteration of the absorber surface[10]. In practice a slight alteration will not affect the joulemeter response. Consider the joulemeter to be damaged and/or out of calibration when large-scale damage is evident or you can see the metal electrode beneath the coating[11].

For a QED Attenuator/Diffuser[12] mounted on a QE series joulemeter, consider the detector to be damaged and/or out of calibration **[11]**:

- In the presence of an optically eroded front optical component or in the presence of sparking at the front component, accompanied by a sharp snapping noise: this phenomenon is related to high single pulse energy density and high peak pulse power density.

- In the presence of shattered or molten optical components: this phenomenon is related to high average power density.

- In the presence of a damaged absorber (see above).

In the case of a TEMoo (Gaussian) beam, the maximum peak power and energy density can be calculated using the following equation:

$$\text{Density (power or energy)} \approx \frac{2Io}{\pi W^2}$$

Where Io is the total beam power or energy

W is the beam radius at $1/e^2$ and $\pi = 3.1416$

---

10 For QE Series detectors, the use of the appropriate "QE series Test Target " is suggested in order to insure that the laser beam will not damage the detector's absorber coating; contact Gentec-EO for further instructions.

11 Contact Gentec-EO for evaluation, repair, recalibration, or replacement (refer to the WARRANTY instructions).

12 See optional accessories section.

NOTE: The beam waist for a TEMoo beam is the radius of a circle centered on the beam axis and containing 86 % of the beam energy. Ref.: SIEGMAN, A.E., An Introduction to Lasers and Masers, p. 313 (Mcgraw-Hill Series in the Fundamentals of Electronic Science).

Example of energy density;

Io = 1 joule (total energy)
W = 1 cm

$$\text{Energy density} = \frac{2 \times 1 \text{ joule}}{\pi \times (1 \text{ cm})^2} = 0.64 \text{ joule/cm}^2$$

Example of power density calculation;

Io = 1 MegaWatt (total power)
W = 1 cm

$$\text{Power density} = \frac{2 \times 1 \text{ MegaWatt}}{\pi \times (1 \text{ cm})^2} = 0.64 \text{ MW/cm}^2$$

3 OPTIONAL ACCESSORIES

3.1 QED ATTENUATOR / DIFFUSER

The QED attenuators increase the energy, energy density, average power and average power density capabilities of the QE Series.

They are engineered to typically transmit 35% (@1.064µm) of the incident radiation to the detector in a near Lambertian pattern (very wide diffusion pattern).

They feature ease of installation and removal.
The QED attenuators can be optionally calibrated @1.064µm when purchased at the same time as a corresponding QE joulemeter.

See Fig. 4-1 for specifications table.

Fig. 4-1, QED ATTENUATOR SPECIFICATIONS

	Attenuator				
	QED12	QED25	QED50	QED65	QED95
Spectral Range	190 nm to 2.5 µm				
Typical Transmittance (@ 1.064 µm)	35%				
Typical Transmittance (@ 266nm)	30%				
Typical Reflectance (@ 1.064 µm)	45%				
Typical Reflectance (@ 266nm)	50%				
Max. Energy Density	16 J/cm^2 @1064nm, 7nsec, Single shot 8 J/cm^2 @1064nm, 7nsec, 10Hz 6 J/cm2 @532nm, 7nsec, 10Hz 1 J/cm^2 @266nm, 7nsec, 10Hz				
Dimensions (Lx W x D, mm)	30.5 x 41 x 12.5	44 x 55 x 12.5	69 x 80 x 12.5	85 x 97 x 12.5	115 x 127 x 12.5
For use with	QE12	QE25	QE50	QE65	QE95

4.3 Other Accessories:

Contact Gentec-EO for a complete list of accessories, their specifications and features. Partial list:

- DB-15 “Smart Interface“ to BNC adaptor (for connecting QE^+ Series to an oscilloscope).
- SOLO “Smart” monitor
- Carrying case

4 Appendix A (Joulemeter)

4.1 Recycling and separation procedure for WEEE directive 2002/96/EC.

This section is used by the recycling center when the detector reaches its end of life. Breaking the calibration seal or opening the monitor will void the detector warranty.

The complete detector contains

1 Detector with wires or DB-15.
1 instruction manual
1 calibration certificate

4.2 Separation:

Paper: Manual and certificate
Wires: Cable Detector.
Printed circuit board: inside the Detector (-C0 version only) or DB-15, no need to separate (less then 10 cm^2).
Aluminum: Detector casing.

gentec-eo

Laser Beam Measurement

Headquarters

445 St-Jean-Baptiste, Suite 160
Québec, QC, CANADA
G2E 5N7

T 418 651 8003
F 418 651 1174

@ info@gentec-eo.com

Calibration Centers

Québec City, CANADA
Olching (Munich), GERMANY