USER MANUAL

QE Series | Pyroelectric Energy Detectors

gentec-eo
PARTNERS for ACCURACY

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.

<u>All customers</u>:

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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 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 monitor. They must be used with an oscilloscope or an OEM acquisition system.

All QE Serie are also available with the the INTEGRA USB Connector. This option only needs a Computer or tablet PC using the PC-GENTEC-EO. It also a Smart Interface programmed with the calibration sensitivity, the spectral correction factors at different wavelengths and other data relating to the specific QE series joulemeter head.

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 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.

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[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 $\leq$ 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.

QE -QED series

The QE-QED series are calibrated with QED installed, they can be used from 0.3 to 2.1µm, but cannot be used without attenuator.

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 monitor automatically adjust to the characteristics of the joulemeter, when the "Smart Interface" is connected to the monitor. The cable length is 3 feet.

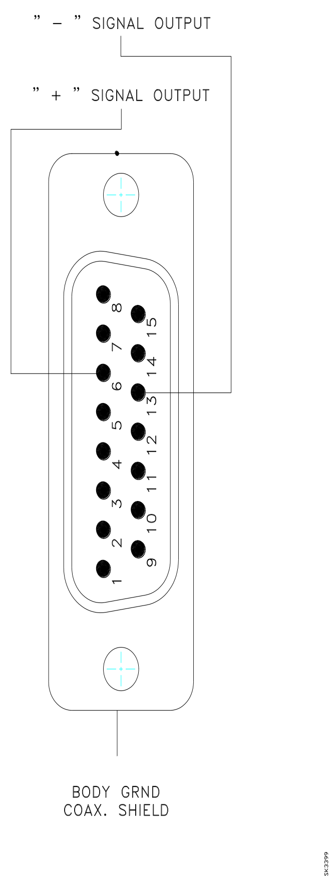
The DB-15 "Smart Interface" connector pin-out is (see Fig. 1-1):

1-	USED BY MONITORS
2-	" " " "
3-	" " " "
4-	" " " "
5-	" " " "
6-	"+" SIGNAL OUTPUT
7-	''-'' SUPPLY VOLTAGE QE8 ONLY
8-	USED BY MONITORS
9-	''+'' SUPPLY VOLTAGE QE8 ONLY
10-	USED BY MONITORS
11-	" " " "
12-	" " " "
13-	"-" SIGNAL OUTPUT
14-	USED BY MONITORS
15-	" " " "
SHELL-	COAX. SHIELD / BODY GRND

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

NOTE : Consult Gentec-EO for supply voltage requirements.

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



1.3 Integra USB connector

The Integra USB Connector is an integrated monitor that allows to plug the head directly into a computer. It has the same serial commands as the MAESTRO and a few extra ones (see the PC-Gentec-EO Manual) and uses the same PC-Gentec-EO software. All specifications are the same. The cable length is 6 feet.

1.4 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%.

Condensation must not be present at anytime on the detector in operation or storage.

FOOTNOTES SPECIFICATIONS:

1 See "Personal wavelength correction" certificate.
The calibrations from 2.1 to 2.5 µm and at 10.6 µm are on special request only. The traceability at 248 nm is obtained with the help of a traceable reference at 250 nm, since our spectrophotometer has a 4 nm spectral bandwidth at 248 nm.

2 Load capacitance must be ≤ 30 pF, excluding the supplied BNC to DB-15 "Smart Interface" coaxial cable (≤ 13 pF for QE4).

3 Assuming Max Energy density @ 1.064µm, 7ns laser beam; with a uniform energy distribution; energy applied to full aperture. Increasing the pulse width increases the maximum measurable energy.

4 At constant power.

5 Calibrated @ 1.064 µm, 10 Hz, semi-Gaussian beam profile, energy applied to 80% of aperture, loaded into 1 MΩ / 30 pfd, energy level and pulse width varies according to detector specification.

6 For calibrated wavelength only,
add ±1% from 0.3 µm to 2.1 µm
add ±2% from 0.248 µm to 0.3 µm
add ±1.5% for QE-QED series from 0.3 µm to 2.1 µm

7 Excludes non-linearities.

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

9 Loaded into 1 MΩ / 30 pfd (13 pF for QE4).

10 Maximum measurable energy, maximum energy density and maximum average power can be increased by using an optional QED attenuator / diffuser.

11 Warning: Detector body can reach 60°C at maximum powers.

12 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.

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

14 A performant computer processor is required to run PC-M-LINK software at high repetition rates. The repetition rate specification is given using a sufficiently performant computer.

15 M-LINK can measure up to 6000 Hz pulses using the serial command set.

1.4.1 Specifications for MB series

	Footnotes	Model	
		QE12LP-S-MB QE12LP-H-MB	QE12HR-H-MB
Optical Absorber		MB	
Spectral Range (QE) (QE-QED)		0.19 – 20 µm 0.266 – 2.1 µm	
Calibrated Spectral Range (QE) (QE Optional) (QE-QED)	1	0.248 – 2.1 µm 2.1-2.5 µm, 10.6 µm 0.532 – 2.1 µm	
Typical Sensitivity	2, 9	60 V/J	
Calibration Uncertainty	2, 5, 6, 7, 9	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm 0.266 µm With QED @ 1.064 µm QED @ 0.266 µm	2, 3, 11	0.85 J 0.7 J 3.9 J 0.81 J	
Noise Equivalent Energy (NEE) (Typ)	2, 9	0.7 µJ	1.4 µJ
Max. Repetition Rate	2, 4, 9	300 Hz	1000 Hz
Typical Rise Time (0-100%)	2, 9	550 µsec	70 µsec
Max. Pulse Width (Typ)	2, 8, 9	400 µsec	40 µsec
Max. Energy Density	10	600 mJ/cm² @ 1.064µm, 7ns, 10 Hz 500 mJ/cm² @ 266nm, 7ns, 10 Hz	
Max. Energy Density with QED		16 J/cm² @1064nm, 7nsec, Single shot 8 J/cm² @1064nm, 7nsec, 10Hz 6 J/cm² @532nm, 7nsec, 10Hz 1 J/cm² @266nm, 7nsec, 10Hz	
Max. Average Power Detector Alone (QE12xP-S-MB): With Heatsink (QE12xP-H-MB):	11	3 W (7.5 W with QED) 5 W (12.5 W with QED)	
Max. Power Density Detector Alone (QE12xP-S-MB): With 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 Heatsink (QE12xP-H-MB):		36 x 36 x 14 mm 36 x 36 x 33 mm	
Weight : Detector Alone (QE12xP-S-MB): With 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 cm² 0.81 cm²	

	Footnotes	Model		
		QE25SP-S-MB QE25SP-H-MB	QE25LP-S-MB QE25LP-H-MB	QE25HR-H-MB
Optical Absorber		MB		
Spectral Range (QE) (QE-QED)		0.19 – 20 µm 0.266 – 2.1 µm		
Calibrated Spectral Range (QE) (QE Optional) (QE-QED)	1	0.248 – 2.1 µm 2.1-2.5 µm, 10.6 µm 0.308 – 2.1 µm		
Typical Sensitivity	2, 9	10 V/J		
Calibration Uncertainty	2, 5, 6, 7, 9	± 3%		
Repeatability		< 0.5 %		
Max. Pulse Energy 1.064 µm 0.266 µm With QED @ 1.064 µm QED @ 0.266 µm	2, 3, 11	3.75 J 3.1 J 23 J 4.8 J		
Noise Equivalent Energy (NEE) (Typ)	2, 9	4 µJ		10 µJ
Max. Repetition Rate	2, 4, 9	800 Hz	300 Hz	1000 Hz
Typical Rise Time (0-100%)	2, 9	200 µsec	550 µsec	70 µsec
Max. Pulse Width (Typ)	2, 8, 9	150 µsec	400 µsec	40 µsec
Max. Energy Density	10	600 mJ/cm² @ 1.064µm, 7ns, 10 Hz 500 mJ/cm² @ 266nm, 7ns, 10 Hz		
Max. Energy Density with QED		16 J/cm² @1064nm, 7nsec, Single shot 8 J/cm² @1064nm, 7nsec, 10Hz 6 J/cm² @532nm, 7nsec, 10Hz 1 J/cm² @266nm, 7nsec, 10Hz		
Max. Average Power Detector Alone (QE25xP-S-MB): With Heatsink (QE25xP-H-MB):	11	5 W (15 W with QED) 10 W (30 W with QED)		
Max. Power Density Detector Alone (QE25xP-S-MB): With 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 Heatsink (QE25xP-H-MB):		50 x 50 x 14 mm 50 x 50 x 52.5 mm		
Weight Detector Alone (QE25xP-S-MB): With 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 cm² 4.84 cm²		

	Footnotes	Model QE50SP-S-MB QE50SP-H-MB	Model QE50LP-S-MB QE50LP-H-MB
Optical Absorber		MB	
Spectral Range (QE) (QE-QED)		0.19 – 20 µm 0.266 – 2.1 µm	
Calibrated Spectral Range (QE) (QE Optional) (QE-QED)	1	0.248 – 2.1 µm 2.1-2.5 µm, 10.6 µm 0.308 – 2.1 µm	
Typical Sensitivity	2, 9	3 V/J	
Calibration Uncertainty	2, 5, 6, 7, 9	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm 0.266 µm With QED @ 1.064 µm QED @ 0.266 µm	2, 3, 11	15 J 12.5 J 85 J 22 J	
Noise Equivalent Energy (NEE) (Typ)	2, 9	10 µJ	
Max. Repetition Rate	2, 4, 9	500 Hz	200 Hz
Typical Rise Time (0-100%)	2, 9	300 µsec	900 µsec
Max. Pulse Width (Typ)	2, 8, 9	225 µsec	675 µsec
Max. Energy Density	10	600 mJ/cm² @ 1.064µm, 7ns, 10 Hz 500 mJ/cm² @ 266nm, 7ns, 10 Hz	
Max. Energy Density with QED	10	16 J/cm² @1064nm, 7nsec, Single shot 8 J/cm² @1064nm, 7nsec, 10Hz 6 J/cm² @532nm, 7nsec, 10Hz 1 J/cm² @266nm, 7nsec, 10Hz	
Max. Average Power Detector Alone (QE50xP-S-MB): With Heatsink (QE50xP-H-MB):	11	10 W (25 W with QED) 20 W (45 W with QED)	
Max. Power Density Detector Alone (QE50xP-S-MB): With 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 Heatsink (QE50xP-H-MB):		75 x 75 x 15 mm 75 x 75 x 44 mm	
Weight Detector Alone (QE50xP-S-MB): With 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 cm² 22.09 cm²	

	Footnotes	Model	
		QE65LP-S-MB QE65LP-H-MB	QE65ELP-S-MB QE65ELP-H-MB
Optical Absorber		MB	
Spectral Range (QE) (QE-QED)		0.19 – 20 µm 0.266 – 2.1 µm	
Calibrated Spectral Range (QE) (QE Optional) (QE-QED)	1	0.248 – 2.1 µm 2.1-2.5 µm, 10.6 µm 0.308 – 2.1 µm	
Typical Sensitivity	2, 9	4 V/J	1.5 V/J
Calibration Uncertainty	2, 5, 6, 7, 9	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm 0.266 µm With QED @ 1.064 µm QED @ 0.266 µm	2, 3, 11	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, 9	10 µJ	20 µJ
Max. Repetition Rate	2, 4, 9	100 Hz	20 Hz
Typical Rise Time (0-100%)	2, 9	1000 µsec	6000 µsec
Max. Pulse Width (Typ)	2, 8, 9	700 µsec	5000 µsec
Max. Energy Density	10	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 Heatsink (QE65xP-H-MB):	11	12 W (30 W with QED) 40 W (90 W with QED)	
Max. Power Density Detector Alone (QE65xP-S-MB): With 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 Heatsink (QE65xP-H-MB):		90 x 90 x 20 mm 90 x 90 x 94 mm	
Weight Detector Alone (QE65xP-S-MB): With 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 (QE) (QE-QED)		0.19 – 20 µm 0.266 – 2.1 µm	
Calibrated Spectral Range (QE) (QE Optional) (QE-QED)	1	0.248 – 2.1 µm 2.1-2.5 µm, 10.6 µm 0.308 – 2.1 µm	
Typical Sensitivity	2, 9	2 V/J	0.6 V/J
Calibration Uncertainty	2, 5, 6, 7, 9	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm 0.266 µm With QED @ 1.064 µm QED @ 0.266 µm	2, 3, 11	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, 9	15 µJ	30 µJ
Max. Repetition Rate	2, 4, 9	40 Hz	10 Hz
Typical Rise Time (0-100%)	2, 9	2000 µsec	6000 µsec
Max. Pulse Width (Typ)	2, 8, 9	1500 µsec	5000 µsec
Max. Energy Density	10	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 (QE95xP-S-MB): With Heatsink (QE95xP-H-MB):	11	20 W (45 W with QED) 40 W (90 W with QED)	
Max. Power Density Detector Alone (QE95xP-S-MB): With 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 Heatsink (QE95xP-H-MB):		122 x 122 x 20 mm 122 x 122 x 98 mm	
Weight Detector Alone (QE95xP-S-MB): With 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 cm² 64 cm²	

1.4.2 Specifications for MT series

	Footnotes	Model
		QE4 MT
Optical Absorber		MT
Spectral Range	12	0.19 – 20 µm
Calibrated Spectral Range	1	0.248 – 2.1 µm
Typical Sensitivity	2, 9	200 V/J
Calibration Uncertainty	2, 5, 6, 7, 9, 13	± 4%
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm 0.266 µm	2, 3, 11	43 mJ 7.6 mJ
Noise Equivalent Energy (NEE) (Typ)	2, 9	1 µJ
Max. Repetition Rate	2, 4, 9	MAESTRO,S-LINK, U-LINK: 6000 Hz INTEGRA: 5200Hz M-LINK: 1000Hz[14,15]
Typical Rise Time (0-100%)	2, 9	20 µsec
Max. Pulse Width (Typ)	2, 5, 8, 9	10 µsec
Max. Energy Density	10	400 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 70 mJ/cm^2 @ 266nm, 7ns, 10 Hz
Max. Average Power		0.3 W
Dimensions (H x W x D)	11	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	QE12HR-H-MT
Optical Absorber		MT	
Spectral Range (QE) (QE-QED)	12	0.19 – 20 µm 0.266 – 2.1 µm	
Calibrated Spectral Range (QE) (QE Optional) (QE-QED)	1	0.248 – 2.1 µm 2.1-2.5 µm 0.532 or 1.064 µm	
Typical Sensitivity	2, 9	100 V/J	
Calibration Uncertainty	2, 5, 6, 7, 9	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm 0.266 µm With QED @ 1.064 µm QED @ 0.266 µm	2, 3, 11	0.70 J 0.10 J 1.6 J 0.25 J	
Noise Equivalent Energy (NEE) (Typ)	2, 9	0.8 µJ	1.0 µJ
Max. Repetition Rate	2, 4, 9	MAESTRO,S-LINK, U-LINK: 6000 Hz INTEGRA: 5200 Hz M-LINK: 1000 Hz[14,15]	MAESTRO U-LINK: 10 000 Hz
Typical Rise Time (0-100%)	2, 9	20 µsec	7 µsec
Max. Pulse Width (Typ)	2, 5, 8, 9	10 µsec	4 µsec
Max. Energy Density	10	500 mJ/cm² @ 1.064µm, 7ns, 10 Hz 70 mJ/cm² @ 532nm, 7ns, 10 Hz 70 mJ/cm² @ 266nm, 7ns, 10 Hz	
Max. Energy Density with QED	10	4 J/cm² @1064nm, 7nsec, Single shot 2 J/cm² @1064nm, 7nsec, 10Hz 0.35 J/cm² @532nm, 7nsec, 10Hz 0.3 J/cm² @266nm, 7nsec, 10Hz	
Max. Average Power Detector Alone (QE12SP-S-MT): With Heatsink (QE12SP-H-MT):	11	3 W (7.5 W with QED) 5 W (12.5 W with QED)	
Max. Power Density Detector Alone (QE12SP-S-MT): With 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 Heatsink (QE12SP-H-MT):		36 x 36 x 14 mm 36 x 36 x 33 mm	
Weight Detector Alone (QE12SP-S-MT): With 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 cm² 0.81 cm²	

	Footnotes	Model	
		QE25SP-S-MT QE25SP-H-MT	QE25HR-H-MT
Optical Absorber		MT	
Spectral Range (QE) (QE-QED)	12	0.19 – 20 µm 0.266 – 2.1 µm	
Calibrated Spectral Range (QE) (QE Optional) (QE-QED)	1	0.248 – 2.1 µm 2.1-2.5 µm 0.308 – 2.1 µm	
Typical Sensitivity	2, 9	20 V/J	
Calibration Uncertainty	2, 5, 6, 7, 9	± 3%	
Repeatability		< 0.5 %	
Max. Pulse Energy 1.064 µm 0.266 µm With QED @ 1.064 µm QED @ 0.266 µm	2, 3, 11	3.0 J 0.44 J 10 J 1.45 J	
Noise Equivalent Energy (NEE) (Typ)	2, 9	2 µJ	3 µJ
Max. Repetition Rate	2, 4, 9	MAESTRO,S-LINK, U-LINK: 6000 Hz INTEGRA: 5200 Hz M-LINK: 1000 Hz[14,15]	MAESTRO, U-LINK: 10 000 Hz
Typical Rise Time (0-100%)	2, 9	20 µsec	7 µsec
Max. Pulse Width (Typ)	2, 5, 8, 9	10 µsec	4 µsec
Max. Energy Density	10	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 Heatsink (QE25SP-H-MT):	11	5 W (15 W with QED) 10 W (30 W with QED)	
Max. Power Density Detector Alone (QE25SP-S-MT): With Heatsink (QE25SP-H-MT): With QED :		10 W/cm^2 @ 5 W 10 W/cm^2 @ 10 W 600 W/cm^2	
Dimensions (H x W x D) Detector Alone (QE25SP-S-MT): With Heatsink (QE25SP-H-MT):		50 x 50 x 14 mm 50 x 50 x 52.5 mm	
Weight Detector Alone (QE25SP-S-MT): With 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 QE50SP-S-MT QE50SP-H-MT
Optical Absorber		MT
Spectral Range (QE) (QE-QED)	12	0.19 – 20 µm 0.266 – 2.1 µm
Calibrated Spectral Range (QE) (QE Optional) (QE-QED)	1	0.248 – 2.1 µm 2.1-2.5 µm 0.308 – 2.1 µm
Typical Sensitivity	2, 9	4 V/J
Calibration Uncertainty	2, 5, 6, 7, 9	± 3%
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm 0.266 µm and QED @ 1.064 µm QED @ 0.266 µm	2, 3, 11	13 J 1.8 J 44 J 6.5 J
Noise Equivalent Energy (NEE) (Typ)	2, 9	10 µJ
Max. Repetition Rate	2, 4, 9	4000 Hz
Typical Rise Time (0-100%)	2, 9	20 µsec
Max. Pulse Width (Typ)	2, 5, 8, 9	10 µsec
Max. Energy Density	10	500 mJ/cm² @ 1.064µm, 7ns, 10 Hz 70 mJ/cm² @ 532nm, 7ns, 10 Hz 70 mJ/cm² @ 266nm, 7ns, 10 Hz
Max. Energy Density with QED		4 J/cm² @1064nm, 7nsec, Single shot 2 J/cm² @1064nm, 7nsec, 10Hz 0.35 J/cm² @532nm, 7nsec, 10Hz 0.3 J/cm² @266nm, 7nsec, 10Hz
Max. Average Power Detector Alone (QE50SP-S-MT): With Heatsink (QE50SP-H-MT):	11	10 W (25 W with QED) 20 W (45 W with QED)
Max. Power Density Detector Alone (QE50SP-S-MT): With Heatsink (QE50SP-H-MT): With QED :		10 W/cm² @ 10 W 5 W/cm² @ 20 W 600 W/cm²
Dimensions (H x W x D) Detector Alone (QE50SP-S-MT): With Heatsink (QE50SP-H-MT):		75 x 75 x 15 mm 75 x 75 x 44 mm
Weight Detector Alone (QE50SP-S-MT): With 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 cm² 22.09 cm²

1.4.3 Specifications for the QE8 series

	Footnotes	Model	
		QE8SP-B-MT-D0	QE8SP-B-BL-D0/DA
Optical Absorber		MT	BL
Spectral Range	12	0.19 – 20 µm	
Calibrated Spectral Range (QE) (Optional)	1	0.248 – 2.1 µm 2.1-2.5 µm	
Typical Sensitivity	2, 9	2400 V/J	900 V/J
Calibration Uncertainty	2, 5, 6, 7, 9	± 4%	
Repeatability		< 0.5 %	
Max. Pulse Energy @ 1.064 µm • M-Link • S-Link-2 • U-LINK and Maestro	2, 3, 11	 1.3 mJ 1.1 mJ 0.93 mJ	 3.6 mJ 2.9 mJ 2.5 mJ
Noise Equivalent Energy (Typ. NEE) • M-Link • S-Link-2 • U-Link and Maestro	2, 9	 50 nJ 50 nJ 80 nJ	 100 nJ 100 nJ 150 nJ
Max. Repetition Rate	2, 4, 9	1000 Hz	400 Hz
Typical Rise Time (0-100%)	2, 9	30 µsec	30 µsec
Max. Pulse Width (Typ)	2, 5, 8, 9	10 µsec	10 µsec
Max. Energy Density	10	50 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz	
Max. Average Power Density		1W/cm^2	
Max. Average Power	11	0.5 W	
Dimensions		Ø38.1 x 27.4D mm	
Weight		91 g	
Aperture Size		7.8 x 7.8 mm	
Aperture Area Size		0.608 cm^2	

1.4.4 Specifications for QE4-BL and XLE4

	Footnotes	Model
		QE4-BL
Optical Absorber		BL
Spectral Range		0.19 – 20 µm
Calibrated Spectral Range (QE) (Optional)	1	0.248 – 2.1 µm 2.1-2.5 µm
Typical Sensitivity	2, 9	150 V/J
Calibration Uncertainty	2, 5, 6, 7, 9	± 4%
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm 0.266 µm	2, 3, 11	16 mJ 0.7 mJ
Noise Equivalent Energy (NEE) (Typ)	2, 9	1 µJ with amplifier 15 µJ with Monitor
Max. Repetition Rate	2, 4, 9	1200 Hz
Typical Rise Time (0-100%)	2, 9	200 µsec
Max. Pulse Width (Typ)	2, 5, 8, 9	100 µsec
Max. Energy Density	10	150 mJ/cm^2 @ 1.064µm, 7ns, 10 Hz 6 mJ/cm^2 @ 266nm, 7ns, 10 Hz
Max. Average Power		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
		XLE4
Optical Absorber		XT : Metallic
Spectral Range	12	0.19 – 20 µm
Calibrated Spectral Range	1, 13	0.35 – 2.1 µm
Typical Sensitivity	2, 9	1100 V/J
Calibration Uncertainty	2, 5, 6, 7, 9	± 4% at 1064nm ± 9% for other wavelengths
Repeatability		< 0.5 %
Max. Pulse Energy 1.064 µm	2, 3, 11	4 mJ
Noise Equivalent Energy (NEE) (Typ)	2, 9	150 nJ
Max. Repetition Rate	2, 4, 9	2000 Hz
Typical Rise Time (0-100%)	2, 9	10 µsec
Max. Pulse Width (Typ)	2, 5, 8, 9	5 µsec
Max. Energy Density	10	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

2 OPERATING INSTRUCTIONS

2.1 When used with compatible monitor

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

2.1.1 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.

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

The 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 wavelength 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 %

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

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

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

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

8 Refer to the monitor manuals for instructions.

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

2.1.3 Working with QED attenuator / diffuser.

- STANDARD CALIBRATION
  - QE Detector Alone: Fully calibrated, from 0.25 - 2.5 µm
  - With QED Attenuator: Not calibrated (Calibrated by the user, refer to Appendix A)

- CALIBRATED AS A PAIR (-QED EXTENSION)
  - QE Detector Alone: Not calibrated
  - With QED Attenuator: Fully calibrated, from 0.3 - 2.1 µm

- EXTRA QED CALIBRATION
  - QE Detector Alone: Fully calibrated, from 0.25 - 2.5 µm
  - With QED Attenuator: Calibrated at one wavelength (532 nm or 1064 nm)

2.2 When using an oscilloscope:

2.2.1 General Instructions

1- Install tall 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

[9] See optional accessories section.

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.

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.

2.2.2 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 %

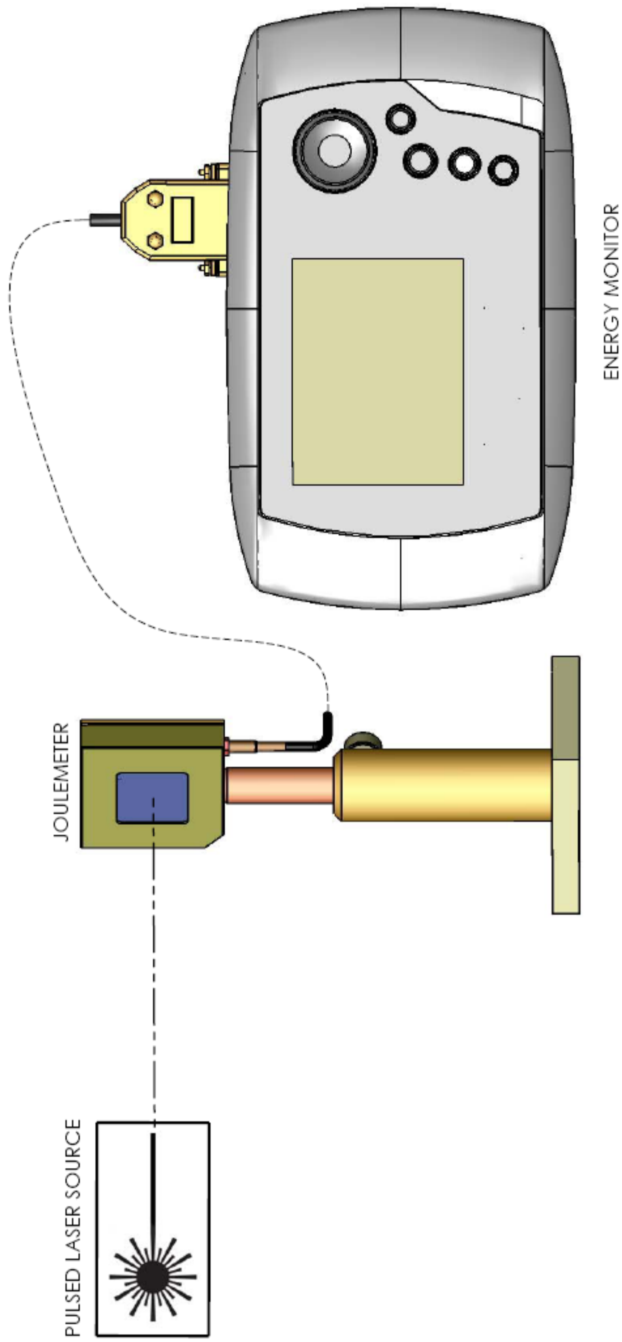
$$K = \frac{\mathbf{A}(\lambda 1)}{\mathbf{A}(@1.064\,\mu m)} \times 100$$

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

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**

3 DAMAGE TO THE OPTICAL ABSORBER MATERIALS

In any time, the beam's incident area should not be less than 10% of the detector's aperture. Please contact Gentec-EO to make measurements with such smaller beams.

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 aperture[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:

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

Where Io is the total beam power or energy
W is the beam radius at $1/e^2$ and $\pi = 3.1416$

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)

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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.

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

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

4 OPTIONAL ACCESSORIES

4.1 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 30-50% 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		0.266 to 2.5 µm				
Optional Calibration Spectral Range	Optical Absorber MB	0.532 to 2.1 µm	0.3 to 2.1 µm			
	Optical Absorber MT	0.532 or 1.064 µm [13]	0.3 to 2.1 µm		NA	
Typical Reflectance		40 - 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

4.2 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).
- Maestro monitor
- Carrying case

[13] Either 1064 nm or 532 nm (not the range between)

5 APPENDIX A

5.1 QED-12, QED-25, QED-50, QED-65, QED-95

Attenuator/Diffuser Calibration Procedure

Introduction;

These “Attenuator/Diffusers” must be user calibrated. The calibration procedure is relatively simple. First make measurement without the attenuator, then with the attenuator. The ratio of these measurements will be your correction. This procedure is suitable at any wavelength.

When using an oscilloscope;

Divide the joulemeter voltage output by the calibration sensitivity we provide to calculate the energy reading (see joulemeter manual).
To use this procedure at a wavelength other than the wavelength stated on the calibration certificate, you must first manually adjust the sensitivity value (of the cal. certificate) with the wavelength correction multiplier from the Personal Wavelength Correction certificate. Use this wavelength-adjusted sensitivity to calculate the energy readings used in the procedure that follows.

When using a Gentec-EO Monitor:

The *Attenuator* setting in the *Measure mode* must not be check marked. That is, it must be off, otherwise you cannot access the wavelength menu window. You need this window to input the wavelength that you are calibrating at (see monitor manual). The *Attenuator* setting should also be checked off if you are redoing a calibration at the same wavelength as stated on joulemeter calibration certificate.

Procedure:

Step 1: Setup your joulemeter to measure the energy of your pulsed laser. If you are working at a wavelength other than the calibrated spectral range, adjust the sensitivity of your joulemeter for that wavelength; see *When using an oscilloscope or When using a Gentec-EO MAESTRO,* above. Make sure that the energy level is below the detector’s damage threshold and your laser still has good stability.

Step 2: Apply energy for a few minutes to warm up the detector. This will reduce any thermal bias.

Step 3: Measure the energy level without the attenuator. To reduce random uncertainty, you should average a number of shots. We recommend at least one hundred shots. This should reduce random errors by a factor of 10. (Square root of “n” assuming Gaussian distribution).

Step 4: Install the attenuator. Without changing the laser settings, measure the energy level by averaging the same number of shots. All laser settings must be the same as Step 3 (including beam size and position on the detector).

Step 5: Repeat the first measurement (Step 3) to make sure that nothing changed during the procedure to invalidate the calibration. A change larger than the uncertainty of your measurements means that something in the laser or environment changed. You can add this to your ± uncertainty when you use the attenuator or try to stabilize the laser and environment and begin again with Step 3.
The correction multiplier for the MAESTRO and an Oscilloscope will be given by:

$$T_f = \frac{\text{Reading without attenuator}}{\text{Reading with attenuator}} \qquad \text{(No unit)}$$

Now use this calibration factor in the correction menu for the “Attenuator/Diffuser” when using it at the wavelength established in Step 1.

6 APPENDIX B

6.1 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
- 1 Electronic PCB (Integra option)
- 1 Plastic enclosure (Integra option)

6.2 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). Inside the integra enclosure, no need to separate (less then 10 cm^2).
Aluminum: Detector casing.
Plastic: Integra enclosure.

7 DECLARATION OF CONFORMITY

Application of Council Directive(s): 2014/30/EU The EMC Directive

Manufacturer's Name: **Gentec Electro Optics, Inc.**
Manufacturer's Address: **445 St-Jean Baptiste, suite 160**
(Québec), Canada G2E 5N7

European Representative Name: **Laser Components S.A.S.**
Representative's Address: **45 bis Route des Gardes**
92190 Meudon (France)

Type of Equipment: **Optical Energy head's**
Model No.: **QE series**
Year of test & manufacture: **2016**

Standard(s) to which Conformity is declared:
EN 61326-1: 2006 Emission generic standard

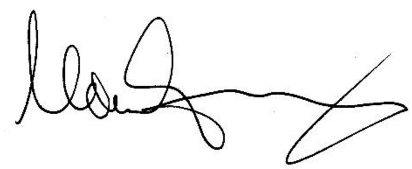
Standard	Description	Performance Criteria
CISPR 11 :2009 A1 :2010	Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement	Class A
EN 61000-4-2 2009	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques- Electrostatic discharge.	Class B
EN61000-4-3 2006+A2:2010	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques- Radiated, Radio Frequency, electromagnetic field immunity test.	Class A
EN61000-4-4 2012	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques- Electrical fast transient/burst immunity test.	Class B
EN 61000-4-5 2006	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques- Surge immunity test.	Class B
EN 61000-4-6 2013	Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurements techniques- Immunity to conducted Radio Frequency.	Class A
EN 61000-4-11 2004	Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques- Voltage dips, short interruptions and voltage variations immunity tests. Voltage dips: 0% during 1 cycle 40% during 10 cycles 70% during 25 cycles Short interruptions: 0% during 250 cycles	 Class B Class B Class C Class C

N 61000-3-2:2006 +A1:2009	Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase)	Class A

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place: Québec (Québec)

Date : July 15, 2016



(President)

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