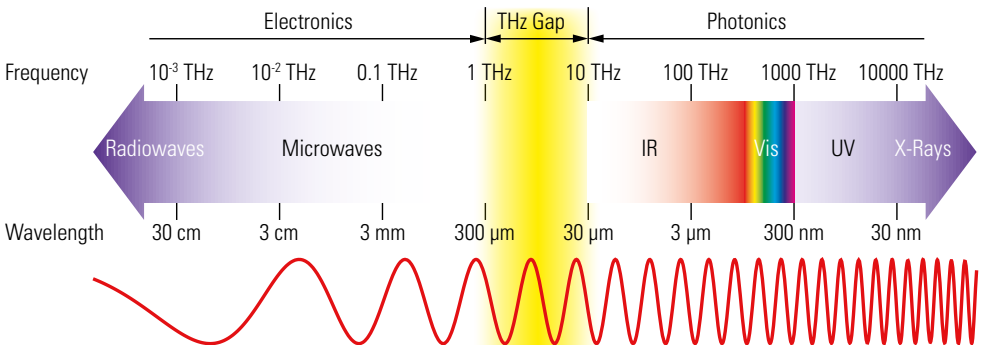
TERAHERTZ DETECTORS

Overview of the different models

WHAT IS TERAHERTZ RADIATION?

The THz portion of the electromagnetic spectrum fills the gap between the far infrared and the microwaves. More precisely, it is nestled between the high-frequency edge of the microwave band, 300 GHz (3×10^{11} Hz), and the long-wavelength edge of far-infrared light, 3000 GHz (3×10^{12} Hz or 3 THz). In wavelengths, this range corresponds to 0.1 mm (or 100 µm) infrared to 1.0 mm microwave. The THz band is set in the region where electromagnetic physics can best be described by its wave-like characteristics (microwave) and its particle-like characteristics (infrared).



WHAT IS IT USED FOR?

THz radiation is interesting because of the way it interacts with matter:

- It can penetrate things like wood, plastics, clothing, and other materials.
- It is also absorbed by water, or a material that contains water, like human skin.
- It is non-ionizing and therefore not harmful to humans like X-rays can be.

One of the first uses is the “full body scan” used at airports. It also has uses in medical applications for early detection of cancer cells.

HOW IS IT MEASURED?

THz sources range in power from nW to mW and in energy from nJ to mJ. Like most electromagnetic sources, they must be characterized for performance and/or control.

Older THz detection methods include:

- Golay cells
- Microbolometers
- Electronic antennas

Newer THz detection methods include:

- Pyroelectric detectors
- Schottky diode detectors
- Photoacoustic detectors

WHY ARE GENTEC-EO PRODUCTS BETTER?

Golay cells are large, fragile, costly and have a limited measurement range.

Pyroelectric detectors (like the ones used in our THZ detectors) are small, sensitive, durable and less costly. Some of their advantages are:

- High performance in a small package
- Broad spectral response (from 0.25 to 3000 µm)
- Wide dynamic range (from nW to mW)
- Rugged and durable
- Very cost-effective

TERAHERTZ DETECTORS

Overview of the different models

We have designed a unique line of thermal sensors and meters for measurements in the THz region. These products are used to measure power (radiant flux or irradiance) and energy of CW, pulsed and quasi-CW THz sources from 30 THz to 0.1 THz. Our product line includes the QS series of miniature pyroelectric detector hybrids that include an operational amplifier and can be easily integrated into THz instrumentation.

THZ-B DETECTORS, WITH T-RAD RADIOMETERS

- Large area: 5 mm and 9 mm Ø
- Wide dynamic range: 10 nW to 20 mW
- Broad spectral response with BL coating: 0.1 µm to 3000 µm
- Two output options:
  - "DZ" models used with our digital T-RAD lock-in radiometer, for USB output to PC. Includes a powerful standalone LabVIEW software.
  - "DA" models used with our T-RAD-ANALOG power supply, for analog BNC output to your oscilloscope or lock-in amplifier.

■ CHOICE OF ANALOG OR DIGITAL OUTPUT

THZ5I-BNC: ANALOG RADIOMETER & JOULEMETER

- Very sensitive pyroelectric radiometer and joulemeter
- 5 mm Ø detector with BL broadband absorber
- Wide dynamic range: 10 nW to 63 µW and 10 nJ to 2 µJ
- Analog BNC output to your oscilloscope or lock-in amplifier

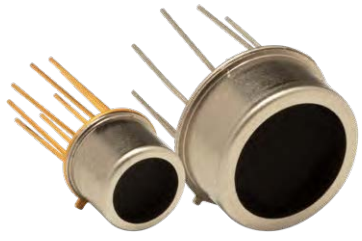
■ CAN BE USED BOTH FOR POWER AND ENERGY MEASUREMENTS

Available with integra

THZ-D: POWER DETECTORS FOR USE WITH GENTEC-EO METERS

- THZ12D-3S-VP:
  - Large area: 12 mm Ø
  - Wide dynamic range: 0.1 mW to 3 W
  - Spectrally flat (± 5%) from 30 THz to 0.7 THz
- THZ9D-20mS-BL:
  - Large area: 9 mm Ø
  - High sensitivity: 500 nW to 20 mW
  - Spectral correction factors provided from 0.25 µm to 3000 µm

■ COMPATIBLE WITH OUR STANDARD DISPLAYS & PC INTERFACES



QS-THZ: MINIATURE HYBRID PYROELECTRIC DETECTORS

- Standard sizes: 5 and 9 mm Ø active area (other sizes available)
- Wide dynamic range: nW to mW and nJ to mJ
- Broad spectral response with BL coating: 0.1 µm to 3000 µm
- Small packages: TO5 & TO8
- Includes integrated operational amplifier

■ TRY THEM WITH OUR EVALUATION TEST BOX QS-I-TEST

THZ-B

THz-B detectors and T-Rad modules

T-Rad Module

KEY FEATURES

COVERS THE ENTIRE THZ SPECTRUM
Get the best precision across the entire wavelength range and relative measurements from 30 THz to 0.1 THz.

ROOM TEMPERATURE OPERATION
Easier to use and less expensive than a Golay cell.

MEASURE POWER FROM nW TO mW
With state of the art pyroelectric sensors, measure down to 10 nW with 1 nW NEP

USE WITH T-RAD THZ MODULE OR T-RAD-ANALOG POWER MODULE
Each head can be connected to an oscilloscope using the analog power module (T-Rad-Analog) or directly to a PC with the digital power module (T-Rad)

SEVERAL SENSOR SIZES AVAILABLE
Choice of 5 mm and 9 mm diameter

CALIBRATED AT 0.63 µm
All THz detectors are calibrated at a single wavelength (0.63 µm) and include a typical wavelength correction data from 0.25 to 440 µm. They are used for relative measurements outside that range.

SDC-500 OPTICAL CHOPPER
All THZ-B detectors require the use of an optical chopper, like our SDC-500, to sync the signal at either 5 Hz (DA models) or 25 Hz (DZ models)

OUTPUT OPTIONS

SMART DB15 CONNECTOR
Contains all the calibration data

TWO DETECTOR TYPES AVAILABLE:

- "DZ": digital output, used with T-RAD digital power module
- "DA": analog output, used with T-RAD-ANALOG analog power module

COMPATIBLE DISPLAYS & PC INTERFACES

T-RAD
(for "-DZ" models only)

T-RAD-ANALOG
(for "-DA" models only)

ACCESSORIES

Stand with delrin post

Removable IR windows
(Various types available)

SDC-500 digital
optical chopper

Winston cone

Pelican carrying case

THZ-B
Specifications

*Also traceable to NRC-CNRC




	THZ5B-BL-DZ	THZ5B-BL-DA	THZ9B-BL-DZ	THZ9B-BL-DA
MAX AVERAGE POWER	20 mW	25 µW	20 mW	125 µW
EFFECTIVE APERTURE	5 mm Ø	5 mm Ø	9 mm Ø	9 mm Ø
COMPATIBLE MODULES	T-Rad	T-RAD-ANALOG	T-Rad	T-RAD-ANALOG
MEASUREMENT CAPABILITY				
Spectral range [a]				
Frequency	0.1 - 30 THz	0.1 - 30 THz	0.1 - 30 THz	0.1 - 30 THz
Wavelength	3000 - 10 µm	3000 - 10 µm	3000 - 10 µm	3000 - 10 µm
Max measurable power	20 mW	25 µW	20 mW	125 µW
Noise equivalent power (NEP)	5 nW	1 nW	50 nW	3 nW
Rise time (0-95%)	≤ 0.2s	≤ 0.2s	≤ 0.2s	≤ 0.2s
Sensitivity (Typical)	N/A	140 kV/W	N/A	20 kV/W
Chopping frequency [b]	25 Hz	5 Hz	25 Hz	5 Hz
DAMAGE THRESHOLDS				
Max average power density (at 1064 nm)	10 mW/cm²	10 mW/cm²	10 mW/cm²	10 mW/cm²
PHYSICAL CHARACTERISTICS				
Effective aperture	5 mm Ø	5 mm Ø	9 mm Ø	9 mm Ø
Sensor	Pyroelectric	Pyroelectric	Pyroelectric	Pyroelectric
Absorber	BL	BL	BL	BL
Dimensions	66.0Ø x 46.5D mm	66.0Ø x 46.5D mm	66.0Ø x 46.5D mm	66.0Ø x 46.5D mm
Weight	227 g	227 g	227 g	227 g
ORDERING INFORMATION				
Compatible stand	STAND-D-233	STAND-D-233	STAND-D-233	STAND-D-233
Product page				

a. Projected spectral range.
From 10 to 440 µm, spectrometer measurement.
From 440 to 3000 µm, relative measurement only.
This spectral range is subject to change.
b. SDC-500 digital optical chopper sold separately.

THZ-B
Specifications

T-Rad

The T-Rad is a microprocessor-based digital radiometer that includes a 12-bit ADC and unique DSP Lock-In Software. It is powered by a USB connection, which also acts as a Virtual COM port. When a THZ-B Terahertz Pyroelectric detector is plugged into the T-Rad module, the module reads the content of the head's EEPROM, which identifies the detector and provides calibration and wavelength correction data. The LabVIEW Software supplied with the device makes it very easy to set up the radiometer, measure a THz or broadband source and record data. The software is compatible with Windows 7, 8 & 10.

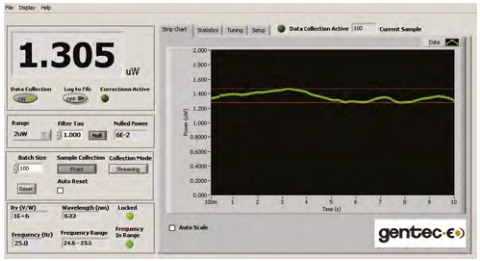
T-Rad
(rear view)

T-Rad-Analog
(front view)

SPECIFICATIONS & FEATURES

	T-RAD	T-RAD-ANALOG
Compatible detector heads	THZ-B-DZ	THZ-B-DA
Full scale ranges	200 nW - 200 mW*	N/A
Power on light	Green	Green
Analog output	0 to 3.6V, BNC	± 4.88 V, BNC
PC connection	USB 2.0	None
Trigger input (TTL)	BNC connector	None
Power supply	USB 2.0	External, 100/240 VAC 50 - 60 Hz, and 9V battery (both included)
Product number	201849	202306

** Actual ranges vary based on the THZ-B detector selected*



INSTRUMENT CONTROL AND STRIP CHART

Instrument controls and the radiant power measurement are always visible, making it easy to change the radiometer settings, no matter which display tab is selected. Instrument controls include: Range, Filter Tau, Batch Size, Data Collection Mode, Reset Options, and a Null button for background cancellation. In addition, there are more set up and operation status indicators including: detector Rv, Wavelength, Frequency (actual), Locked and Frequency in Range lights. The Strip Chart displays the Radiant Power measurement in Watts, either continuously or by the batch. Select full scale, auto scale or use our manual scaling option.

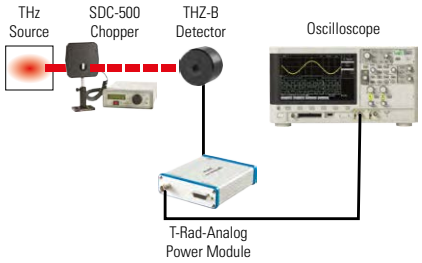
INSTRUMENT CONTROL AND TUNING NEEDLE

The "TUNE" tab selects the very useful "Tuning Needle" display. This is a simulated analog meter whose speed is determined by the "filter tau" setting. It is expected to be used during the set-up of a radiometer with a source. The "tau" value is usually set to a small value when aligning the probe to the source (i.e. when peaking the reading). There is a button control to select "full scale", "min-max" or "reset". In the "min-max" mode, the indicators are "blue" for the minimum power and "red" for the maximum power.

THZ-B
Specifications

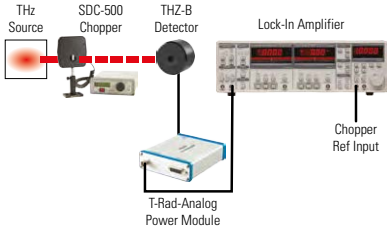
INSTRUMENT CONTROL AND STATISTICS

In the "Statistics" tab there are 4 large windows that contain the statistics for the selected batch, including: Minimum, Maximum, Standard Deviation and Mean, expressed in Engineering Notation. Standard Deviation can be displayed in Watts or as a % that is user-selectable. There is also a window that shows the bandwidth of the Digital Band Pass Filter based on the user selected "Filter Tau" (0.100 to 100 seconds). A lower time constant is helpful when setting up, and a longer one when making measurements, especially on the lower ranges of the instrument.



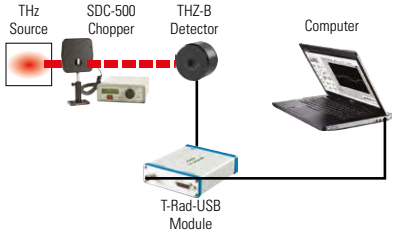
THZ-B-DA DETECTOR AND OSCILLOSCOPE

Here is a basic analog set up that would be useful if the optical power of the source was about 5 µW or greater. The output of the THZ5B-BL-DA detector would be approximately 600 mV at 5 Hz chopping frequency, giving plenty of signal for an oscilloscope. Simply read the voltage output and divide by the Rv factor (V/W) of the detector to measure the intensity of the source in Watts. Also consider applying a wavelength correction factor under certain circumstances.



THZ-B-DA DETECTOR AND LOCK-IN AMPLIFIER

This is another analog set-up option that we recommend if you have to measure very low power levels (i.e. less than 5 µW) where the signal may be buried in the broadband noise. The voltage output of the analog THZ-B-DA detector, powered by our T-Rad-Analog, is routed to the Lock-In Amplifier input, and the Sync Output of our SDC-500 Chopper is connected to the reference input. The Lock-In Amplifier will lock on the chopping frequency and you can dial in a long integrating time and measure a very low RMS voltage. The voltage divided by our Voltage Responsivity (V/W) equals the power of the source.



THZ-B-DZ DETECTOR AND T-Rad MODULE

Although analog solutions are available, for simplicity, convenience and sensitivity, we recommend you choose our THZ-B-DZ detectors and the T-Rad Digital Radiometer. Our unique DSP Lock-In Amplifier software provides a function much like the Analog Lock-In, but is so much easier to use. It also addresses thermal drift of the sensor and allows you to display the power measurement and complete statistics directly in digital and graphic formats. Set the range, null the background, set the filter tau (bandwidth) and make the measurement. It's that easy!

THZ-I-BNC

THz detectors with integrated analog module

KEY FEATURES

- **COVERS THE ENTIRE THZ SPECTRUM**
  Measure accurately from 0.25 to 15 µm and from 30 THz to 0.1 THz in relative terms
- **MEASURE POWER FROM nW TO µW**
  Make low-level measurements with an NEP of 1.0 nW
- **MEASURE ENERGY FROM nJ TO µJ**
  Can be used with low repetition rate pulsed THz sources to measure pulse energy up to 40 Hz
- **INTEGRATED ANALOG MODULE**
  Plug the device directly into your oscilloscope or Lock-In Amplifier
- **BATTERY OR EXTERNAL POWER**
  Includes 9V battery and an external power supply
- **CALIBRATED AT 0.63 µm**
  All THz detectors are calibrated at a single wavelength (0.63 µm) and include typical wavelength correction data from 0.25 to 440 µm. They are used for relative measurements outside that range.
- **SDC-500 OPTICAL CHOPPER**
  The THZ-I-BNC models require the use of an optical chopper, like our SDC-500, running at 5 Hz.

OUTPUT OPTIONS

- **ANALOG OUTPUT**
  Plug the device directly into your oscilloscope or lock-in amplifier with the BNC output

ACCESSORIES

Stand with delrin post

Removable IR Windows (Various types available)

SDC-500 digital optical chopper

Pelican carrying case

THZ-I-BNC

Specifications

*Also traceable to NRC-CNRC

	THZ5I-BL-BNC
MAX AVERAGE POWER	62.5 µW
EFFECTIVE APERTURE	5 mm Ø
INTEGRATED MODULE	Analog (BNC)
MEASUREMENT CAPABILITY	
Spectral range [a]	
Frequency	0.1 - 30 THz
Wavelength	3000 - 10 µm
Max measurable power	62.5 µW
Noise equivalent power [b]	1.0 nW
Rise time (0-100%)	≤ 0.2s
Sensitivity (Typical)	140 kV/W
Chopping frequency	5 Hz (Required)
Calibration uncertainty	Contact us
Energy mode	
Maximum measurable energy	2 µJ
Noise equivalent energy	1.0 nJ
Minimum pulse width	1.0 µs
Maximum repetition rate	40 Hz
DAMAGE THRESHOLDS	
Maximum average power density (1064 nm)	50 mW/cm²
PHYSICAL CHARACTERISTICS	
Effective aperture	5 mm Ø
Sensor	Pyroelectric
Absorber	BL
Analog output	0-10 V
Dimensions	81.3Ø X 99.3D mm
Weight	500 g
ORDERING INFORMATION	
Compatible stand	STAND-D-233
Product page	

a. Projected spectral range.
From 10 to 440 µm, spectrometer measurement.
From 440 to 3000 µm, relative measurement only.
This spectral range is subject to change.

b. At 632 nm and a chopping frequency of 5Hz.

THZ-D

THz detectors for use with our universal displays & PC interfaces

KEY FEATURES

- **COVERS THE ENTIRE THZ SPECTRUM**
  Get the best precision across the entire wavelength range and relative measurements from 30 THz to 0.1 THz.
- **ROOM TEMPERATURE OPERATION**
  Easier to use and less expensive than a Golay cell.
- **CALIBRATED AT 10.6 µm**
  THZ-D detectors are calibrated at a single wavelength 10.6 um (30 THz) and at 10 Hz chopping frequency for the THZ9D. Both include typical wavelength correction data from 10.6 to 440 µm. They are used for relative measurements outside that range.
- **LARGE AREA**
  Models range from 9 mm Ø for the THZ9D and 12 mm Ø for the THZ12D.
- **WIDE RANGE OF MEASUREMENTS**
  Measure from 100 uW to 3 W of continuous power with the THZ12D model, the highest in our terahertz range of products, and down to 5 uW to 25 mW with the THZ9D model.
- **USE WITH A UNIVERSAL DISPLAYS & PC INTERFACE**
  No need for an exclusive monitor. These unique THz detectors work with our display & PC interface.
- **SDC-500 OPTICAL CHOPPER**
  The THZ9D model requires the use of an optical chopper, like our SDC-500, running at 10 Hz.

OUTPUT OPTIONS

- **SMART DB15 CONNECTOR**
  Contains all the calibration data
- **ANALOG OUTPUT**
  When used with APM (D) analog power supply module
- *integra* **ALL-IN-ONE-METER** (for THZ12D only)
  Connects directly to a PC
  Two models available:
  - USB output (-INT)
  - RS-232 output (-IDR)

COMPATIBLE DISPLAYS & PC INTERFACES

MAESTRO

U-LINK

M-LINK
(for THZ12D)

APM (D)
analog power module
(for THZ9D)

ACCESSORIES

Stand with steel post
(for THZ12D)

Stand with delrin
(for THZ9D)

SDC-500 digital
optical chopper

Pelican carrying case

Extension cables
(4, 15, 20 or 25 m)

Extra isolation tube

Fiber adaptors & connectors
(FC, ST and SMA)

THZ-D
Specifications

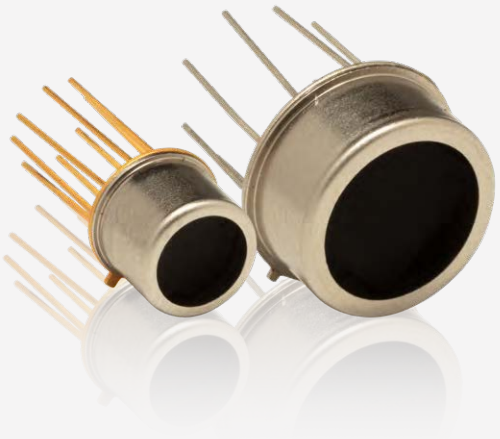
*Also traceable to NRC-CNRC

	THZ9D-20mS-BL	THZI2D-3S-VP
MAX AVERAGE POWER	25 mW	3 W
EFFECTIVE APERTURE	9 mm Ø	12 mm Ø
COMPATIBLE DISPLAYS & PC INTERFACES	MAESTRO, U-LINK & APM (D)	MAESTRO, U-LINK & M-LINK
MEASUREMENT CAPABILITY		
Spectral range [a]		
Frequency	0.1 - 30 THz	0.1 - 30 THz
Wavelength	3000 - 10 µm	3000 - 10 µm
Maximum average power		
with MAESTRO	20 mW	3 W
with U-LINK	25 mW	3 W
Noise equivalent power [b]	300 nW	0.5 µW
Minimum measurable power [c]	N/A	50 - 100 µW
Thermal drift	N/A	12 µW/°C
Rise time (nominal) [d]	< 0.2 s	3 s
Minimum repetition rate [f]	1000 Hz	7 Hz
Chopping frequency	10 Hz (required)	N/A
Calibration uncertainty [g]	± 5.0% at 10.6 µm; ± 15% at 10.6 - 440 µm [a]	± 3.0% at 10.6 µm ± 8.0% at 10.6 - 300 µm ± 15% at 300 - 440 µm
Repeatability	±0.5%	±0.5%
DAMAGE THRESHOLDS		
Maximum average power density [h]	50 mW/cm²	30 W/cm²
Maximum energy density	< 0.1 J/cm²	< 1 J/cm²
PHYSICAL CHARACTERISTICS		
Effective aperture	9 mm Ø	12 mm Ø
Absorber	BL (Black Absorber)	VP (Volume Absorber)
Dimensions	38.1Ø x 79 mm	73H x 73W x 20D mm (72D mm with tube)
Weight (head only)	91 g	320 g
ORDERING INFORMATION		
Compatible stand	STAND-D-233 or STAND-D-233-M	STAND-D-233
Product page		

a. From 10 to 440 µm, spectrometer measurement with multiple laser references validation.
From 440 to 600 µm, spectrometer measurement only.
From 600 to 3000 µm, relative measurement only.
This spectral range is subject to change.
b. Nominal value, actual value depends on electrical noise in the measurement system.
c. Actual value depends on ambient conditions and the measurement system.
d. With anticipation
e. Maximum output voltage = sensitivity x maximum power.
f. Minimum repetition rate for stable average power measurements.
g. Including linearity with power.
h. At 1064 nm, 1 W CW.

QS-THZ

Hybrid THz detectors



* Pictures for indicative purposes only

KEY FEATURES

- **RELATIVE MEASUREMENTS FROM 0.1 TO 30 THZ**
  Broadband, room temperature operation, easier to use and less expensive than a Golay cell
- **EASY TO INTEGRATE FORMAT**
  TO5 and TO8 packages make the QS-THZ detectors small and easy to integrate in an existing system
- **SEVERAL SENSOR SIZES AVAILABLE**
  Choice of 5 and 9 mm Ø
- **CALIBRATED AT 0.63 µm**
  All THz detectors are calibrated at a single wavelength (0.63 µm) and include a typical wavelength correction data from 0.25 to 440 µm. They are used for relative measurements outside that range.
- **TEST BOX AVAILABLE**
  Can be used with our QS-I-TEST test box which provides mounting and power supply

PERMANENT IR WINDOW OPTIONS

Every model can be fitted with a permanent IR window to narrow the wavelength range:

- S5/8: sapphire (0.3 - 4.5 and 100 - 1000 µm)
- Q5/8: quartz (0.25 - 3.0 and 50 - 1000 µm)
- Si5/8: silicon (1.2 - 8.0 and 50 - 1000 µm)

ACCESSORIES

QS-I-Test
evaluation test box

Permanent IR Windows
(Various types available)

SDC-500 digital
optical chopper

Pelican carrying case

QS-THZ
Specifications

*Also traceable to NRC-CNRC

	QS5-THZ-BL	QS9-THZ-BL
VOLTAGE RESPONSIVITY	120 kV/W	30 kV/W
EFFECTIVE APERTURE	5 mm Ø	9 mm Ø
PACKAGE	TO5	TO8
MEASUREMENT CAPABILITY		
Spectral range [a]		
Frequency	0.1 - 30 THz	0.1 - 30 THz
Wavelength	3000 - 10 µm	3000 - 10 µm
Max power density	50 mW/cm²	50 mW/cm²
Noise equivalent power	1 nW	3 nW
Detectivity [b]	4.10^8 cm(Hz)^{½} /W	$2.7.10^8$ cm(Hz)^{½} /W
Voltage responsivity [b]	120 kV/W	30 kV/W
PHYSICAL CHARACTERISTICS		
Effective aperture	5 mm Ø	9 mm Ø
Package	TO5	TO8
Sensor	Pyroelectric	Pyroelectric
Absorber	BL	BL
Dimensions (excluding pins)	9.1Ø x 6.4D mm	15.2Ø x 6.4D mm
Weight	45 g	45 g
ORDERING INFORMATION		
Product page		

a. Projected Spectral Range.
From 10 to 440 µm, spectrometer measurement.
From 440 to 3000 µm, relative measurement only.
This spectral range is subject to change.
b. 630 nm, 5 Hz

QS-I-TEST EVALUATION TEST BOX

	QS-I-TEST
Batteries	+9V/-9V
R_f resistors	105 - 1010 Ω
C_f compensating	YES
Package	101.6H x 127W x 58.4D
Optical mount	¼-20 threaded
Front bezel	SM1 (1.035-40)
Product number	201693

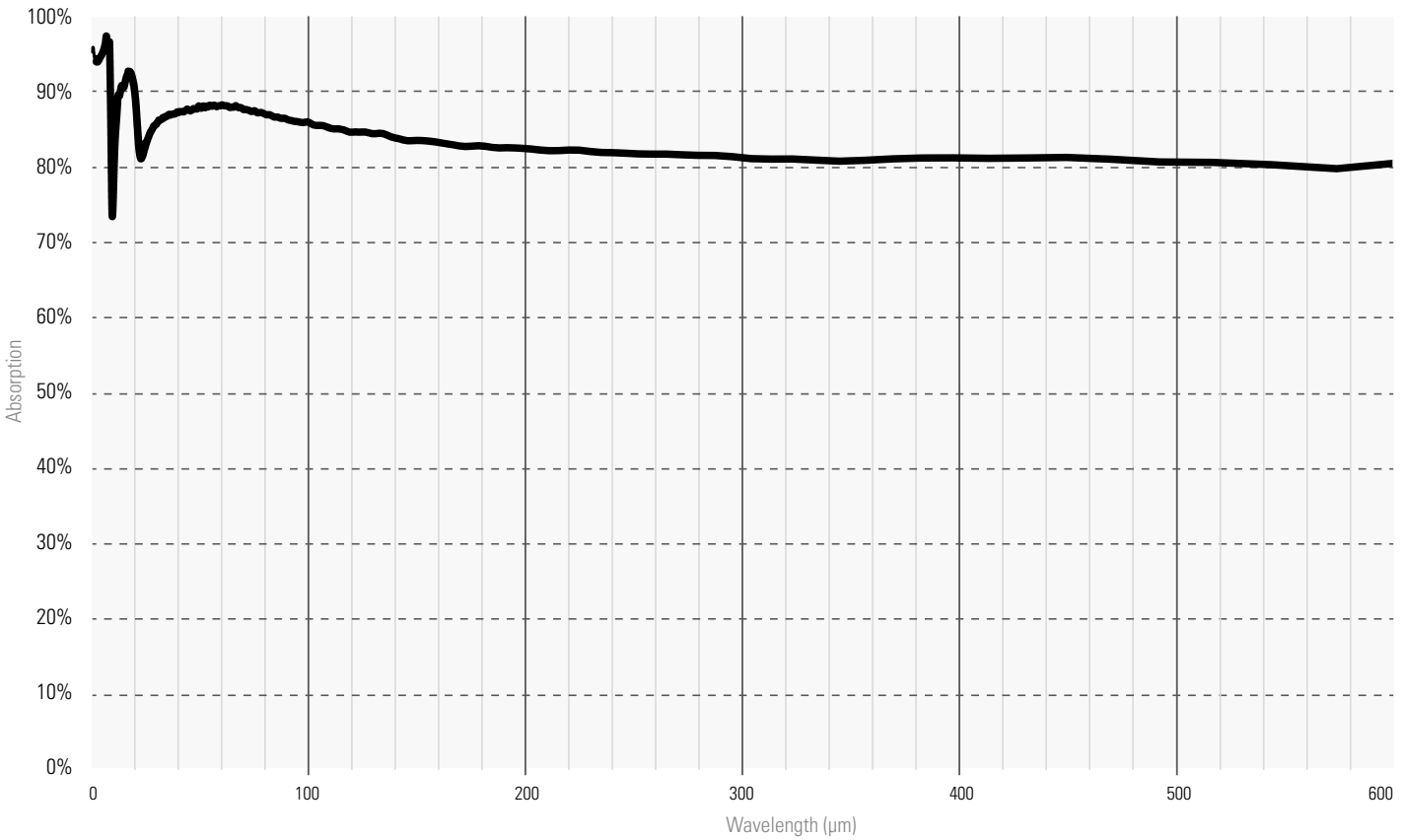
* *For details, contact your Gentec-EO representative*

T 418.651.8003 | info@gentec-eo.com

ABSORPTION CURVES

Specifications

VP ABSORBER



ABSORPTION CURVES

Specifications

THZ-BL, THZ-I-BL & QS-THZ-BL