Basics

These types of pyroelectric detectors are optimized for application in THz region. The detectors are small, have a large active area and a short response time.

The basic principle of pyroelectric detection is that the radiation pulse coming from a pulsed laser or a chopped cw-laser is absorbed in an absorber sheet. From there the heat energy is transferred to the pyroelectric sensor material by heat conduction. For all types of THz detectors a broadband metallic absorber is used. For realizing broadband absorption a partial absorption of nearly 50 % is realized, whereas 25% are reflected and the 25% transmitted radiation is absorbed in a dump. A temperature change of the sensor material leads to a generation of a free charge at two opposite surfaces of the sensor. The thermal time constant (τ_{therm}) describes the relaxation of the sensor temperature to the ambient temperature.

There are two possibilities to detect this signal:

- Using a **voltage detection** with a high load resistor R fulfils the condition:

  $RC >> t_{imp}$

  R - input resistance of the amplifier
  C - capacity of the sensor element
  t_{imp} - pulse duration

  Furthermore the condition:

  $t_{imp} << t_{therm}$

  t_{imp} - pulse duration
  t_{therm} - thermal time constant

  must be fulfilled. In this case the output signal is proportional to the **energy of the pulse**. This is a typical principle for joule meters. Sensitivity is given in V/J.

- If the RC constant is smaller than the pulse duration, the **current** is measured. The output current is proportional to the **pulse power**. The condition:

  $t_{imp} << t_{therm}$

  must be fulfilled, too.

The THz detection system consists of a detector and a current preamplifier. It is optimized for application in connection with cw- lasers and a chopper.

The response of a pyroelectric detector can be very fast, but for a reduction of noise the bandwidth of the preamplifier is limited. A further reduction of noise is possible by using detectors with smaller active area. The actual bandwidth depends on the frequency limit and is given in the preamplifier datasheet. Two possibilities for a Signal/Noise improvement for continuously repeated signals are often used:

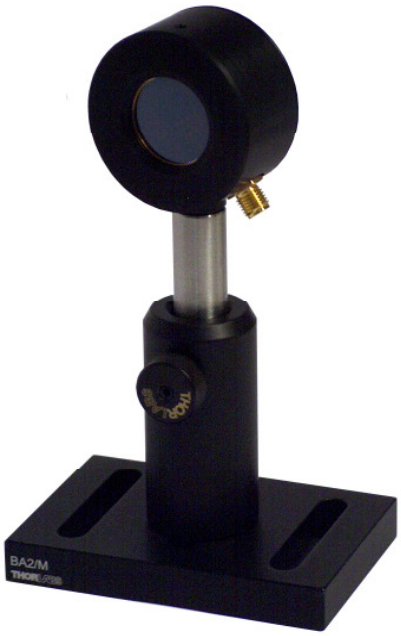
-Averaging

-Lock in amplification.

Single element detectors

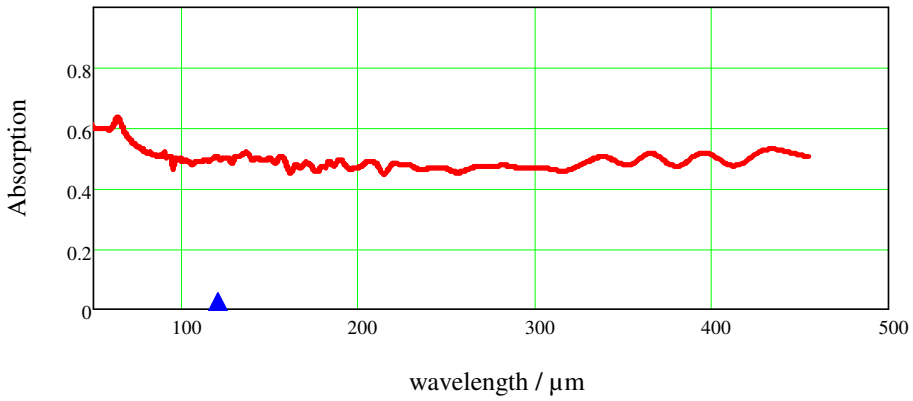
THz detectors for power measurement

	THz 10	THz 20	THz 30
Diam. of active area/mm	10	20	30
thermal time constant/ms	50	50	50
Max. power density mW/cm²	15	15	15
Typical current sensitivity µA/W	0.5 ...1	0.5 ...1	0.5 ...1
Rise time * µs	100	700	2000
Max. chopper rate* /Hz	>500	200	80
Amplifiers for high rep. rate application on request			



Detector THz 20

Absorption vs. wavelength/ metallic Absorber



Typical absorption vs. wavelength for a metallic absorber is shown. The blue triangle marks the calibration wavelength (PTB)

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Trap detector

It is prepared for application in combination with a chopper for different cw-lasers.

It consists of 3 detectors and 5 absorption processes are utilized. Consequently the total absorption is near to 100 % for a single absorption of >50%.

Diam. of active area	20 mm
Max. power density	15 mW/cm²
Max. power	50 mW
Thermal time constant	>50 ms
Rise time*	4.5 ms
Min. Detect. Power **	17 Hz: 15 µW; $f_{\text{chopper max.}}$: 15Hz 40 Hz: 25 µW; $f_{\text{chopper max.}}$: 25 Hz 70Hz: 100 µW; $f_{\text{chopper max.}}$: 50 Hz
Typ. Current sensitivity	0.5... 1 µA /W
Chopper frequencies*	8... 50 Hz

* only detector

**depends on parameters of the amplifier and detector

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Current Preamplifiers CPA

The current preamplifier is necessary to realize a power measurement of the incoming radiation. The amplifier consists of an IC as transimpedance amplifier at the input side and two further voltage amplifier stages. There are some additional components for a noise reduction and offset regulation. In praxis the maximum amplification is limited by the cut off-frequency. Highest amplification can only be realized for small frequency intervals. For THz detectors in combination with a chopper often the upper frequency is limited to values less than 50 Hz. For such amplifiers conversion factors between 10^{7} V/W and 10^{10} V/W can be realized.

The sensitivity of the combination detector and preamplifier is determined by multiplication of the current sensitivity of the detector and the amplification of the current amplifier (e.g. detector 10^{-6} A/W and CPA 10^{9} V/A leads to a total sensitivity : 10^{-6}A/W*10^{9} V/A=1000 V/W). The amplification can be set by a switch.

The CPA needs an operating voltage ±15 V from an included separate power supply.

Specifications:

Power supply: ±15 V

Input connector: SMA or BNC

Output connector BNC

The amplification can be set by a 3 step switch: e.g. 10^{7}... 10^{10} V/A ; the bandwidth is fixed* to e.g. 20Hz or 200 Hz. The detection limit depends on the amplification, the bandwidth and detector diameter.

*please ask if you need other parameters

CPA with BNC connectors for input and output

Calibration:

All detectors are calibrated from PTB Germany at a wavelength of 2.52 THz in combination with a preamplifier. Other conditions on request.

The calibration of the detector is done without any window. Under these conditions any movement of air must be avoided. We deliver the detector with a protection cap having a THz transparent insert. This cap can be used for avoiding any type of disturbance from moving air or fans. You have to check if this cap can be used for your wavelength and have in mind that the calibration is done without this cap. Furthermore it is advisable to tilt the detector a little bit against the optical axes for avoiding reflexions back to the source.

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