General Introduction

Types of Power/Energy Sensors

Power and Single Shot Energy Sensors

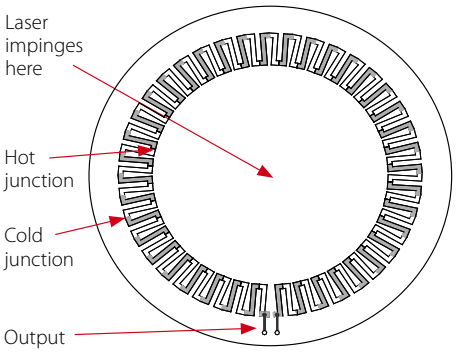
Ophir provides two types of power sensors: Photodiode sensors and Thermal sensors. Photodiode sensors are used for low powers from picowatts up to hundreds of milliwatts and as high as 3W. Thermal sensors are for use from fractions of a milliwatt up to thousands of watts. Thermal sensors can also measure single shot energy at pulse rates not exceeding one pulse every ~5s.

Repetitive Pulse Energy Sensors

For higher pulse rates, Ophir has pyroelectric energy sensors able to measure pulse rates up to tens of KHz. These are described in the energy sensor section, section 1.3.

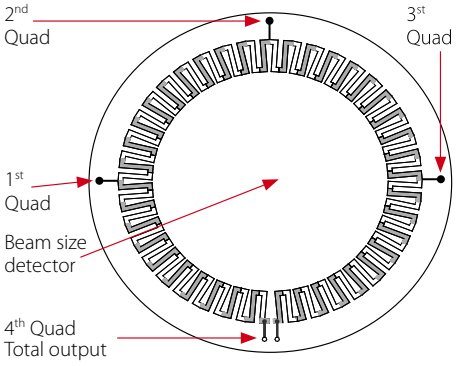
Thermal Sensors

The thermopile sensor has a series of bimetallic junctions. A temperature difference between any two junctions causes a voltage to be formed between the two junctions. Since the junctions are in series and the «hot» junctions are always on the inner, hotter side, and the «cold» junctions are on the outer, cooler side, radial heat flow on the disc causes a voltage proportional to the power input. Laser power impinges on the center of the thermopile sensor disk (on the reverse side of the thermopile), flows radically and is cooled on the periphery. The array of thermocouples measures the temperature gradient, which is proportional to the incident or absorbed power. In principle, the reading is not dependent on the ambient temperature since only the temperature difference affects the voltage generated and the voltage difference depends only on the heat flow, not on the ambient temperature. Since all the heat absorbed flows through the thermocouples (as long as the laser beam is inside the inner circle of hot junctions), the response of the detector is almost independent of beam size and position. If the beam is close to the edge of the inner circle, some thermocouples become hotter than others but since the sum of all of them is measured, the reading remains the same. Generally, Ophir specifies ±2% uniformity of reading over the surface or better.



BeamTrack Power / Position / Size sensors

Ophir now has the new BeamTrack thermal sensor that can measure beam position and beam size as well as power. This innovative device provides an additional wealth of information on your laser beam – centering, beam position and wander, beam size as well as power and single shot energy. The BeamTrack sensor is illustrated schematically here and works as follows: the signal coming from the sensor is now divided into 4 quadrants so by measuring and comparing the output from the 4 sections we can determine the position of the center of the beam to a high degree of accuracy. In addition to the 4 quadrants, there is now a special proprietary beam size detector. After processing outputs from these various detectors, the user is presented with the beam position as well as beam size. Note that the beam size is calibrated only for a Gaussian beam of >3mm but for other beams it will give relative size information and will indicate if the beam is changing size. For more information on the BeamTrack sensors, please see section 1.2.

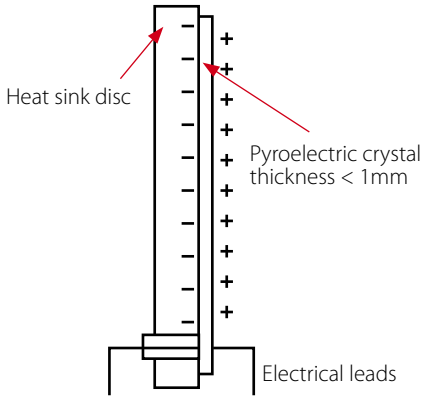


Using Power Sensors to Measure Single Shot Energy

Although Ophir thermal power sensors are used primarily to measure power, they can measure single shot energy as well where they integrate the power over time flowing through the disc and thus measure energy. Since the typical time it takes for the disc to heat up and cool down is several seconds, these thermal sensors can only measure one pulse every several seconds at most. Thus they are suitable for what is called "single shot" measurement. Although the response time of the sensor discs is slow, there is no limit to how short the pulses measured are since the measurement is of the heat flowing through the disc after the pulse.

Pyroelectric Sensors

Pyroelectric type sensors are useful for measuring the energy of repetitively pulsed lasers at up to 25,000Hz and are sensitive to low energies.
They are less durable than thermal types and therefore should not be used whenever it is not necessary to measure the energy of each pulse and average power measurement is sufficient.
Pyroelectric sensors use a pyroelectric crystal that generates an electric charge proportional to the heat absorbed. Since the two surfaces of the crystal are metalized, the total charge generated is collected and therefore the response is not dependent on beam size or position. This charge then charges a capacitor in parallel with the crystal and the voltage difference thus generated is proportional to the pulse energy. After the energy is read by the electronic circuit, the charge on the crystal is discharged to be ready for the next pulse.



Photodiode Sensors for Lower Powers

In addition to the thermal sensors described above, Photodiode sensors are used for low powers from picowatts up to hundreds of milliwatts and as high as 3W.
A photodiode sensor is a semiconductor device that produces a current proportional to light intensity and has a high degree of linearity over a large range of light power levels - from fractions of a nanowatt to about 2 mW. Above that light level, corresponding to a current of about 1mA, the electron density in the photodiode becomes too great and its efficiency is reduced causing saturation and a lower reading. Most Ophir PD sensors have a built-in filter that reduces the light level on the detector and allows measurement up to 3W without saturation.