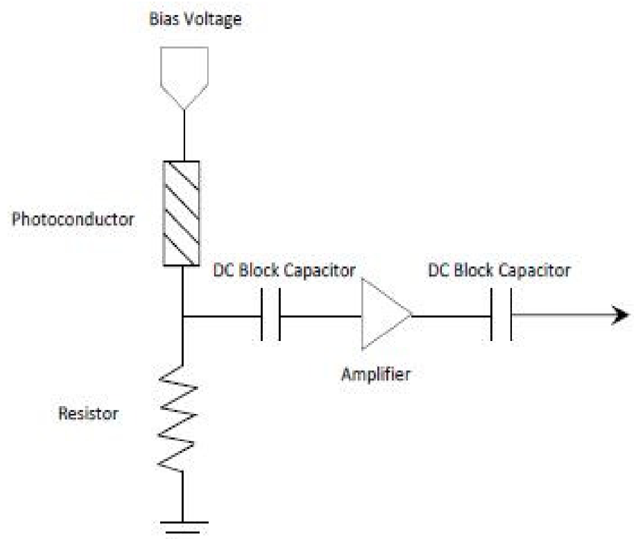
ET-6000 Application Note

The ET-6000 consists of a lead selenide (PbSe) photoconductor and an amplifier with selectable gain. A photoconductor (PC) increases in conductance with an increase in optical power. Because the photoconductor does not generate an output current like our PIN photodiodes, it is placed in a voltage divider to generate a voltage output: a change in PC conductance will produce a change in the divider's output voltage. This voltage is then amplified as shown in the figure.

Photoconductors use a figure of merit called Detectivity (D*):

$$Detectivity\left(cm\cdot\frac{\sqrt{Hz}}{W}\right) = xx\frac{\sqrt{Active\ Area}}{NEP}$$

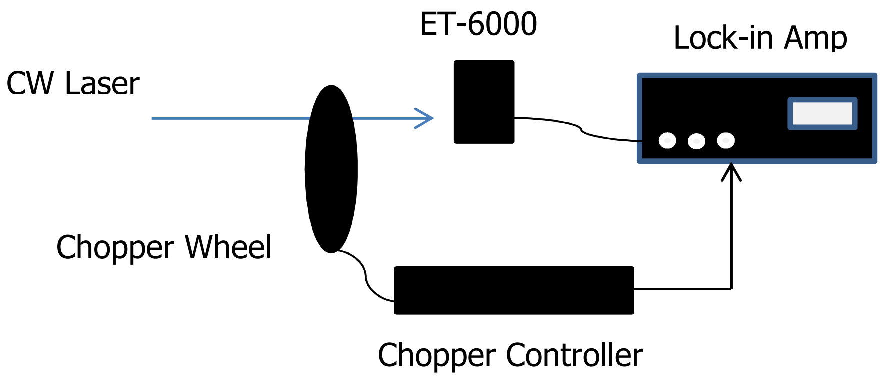
Active Area: active area of the PC in cm²
NEP (Noise Equivalent Power): optical input power that produces a signal-to-noise ratio of 1 at the output of the PC with a bandwidth of 1 Hertz.



Detectivity is used to compare the sensitivity of photoconductors for a given wavelength range and temperature in order to select the appropriate device for an application; the higher the detectivity the more sensitive the device. The above equation normalizes active area and NEP so different size device can be compared. For example, a larger sensor has the advantage of potentially improved photon collection, but this advantage may be offset by a larger NEP – it might not be the best device for the application.

The ET-6000 output incorporates the photoconductor and amplifier parameters into an overall responsivity in volts per watts. The data sheet contains a graph of responsivity vs. wavelength for each gain setting. For example, if 10µW is incident on the detector at 4.0um, the output of the ET-6000 will be 10µW x 6,400V/W = 64mV for a gain of 2 and 10µW x 320,000V/W = 3.2V for a gain of 100. The maximum optical input power density is 10µW/mm².

In order to overcome the thermal noise inherent in mid-IR sensors an optical chopper and lock-in amplifier are recommended. This system helps reduce flicker noise and noise proportional to the square root of the measurement bandwidth. Flicker noise is low frequency noise proportional to the inverse of frequency (1/f): the higher the chopping frequency the lower the effect of flicker noise; EOT recommends a chopping frequency around 1,000 Hz. The chopping frequency is synchronized with the lock-in amplifier, so the amplifier "locks in" on the chopping frequency and filters out noise not at 1,000 Hz and within the lock-in amplifier's measurement bandwidth; as noise is proportional to the square root of the measurement bandwidth, the bandwidth should be kept as small as possible. The lock-in amplifier will output put a value on a display, or a voltage, proportional to the optical input multiplied by the responsivity of the detector, multiplied by the gain of the lock-in amplifier.



Recommended chopper systems:

- Dual phase
- 60 dB or greater dynamic range
- Manufacturers: Scitec, Stanford Research Systems