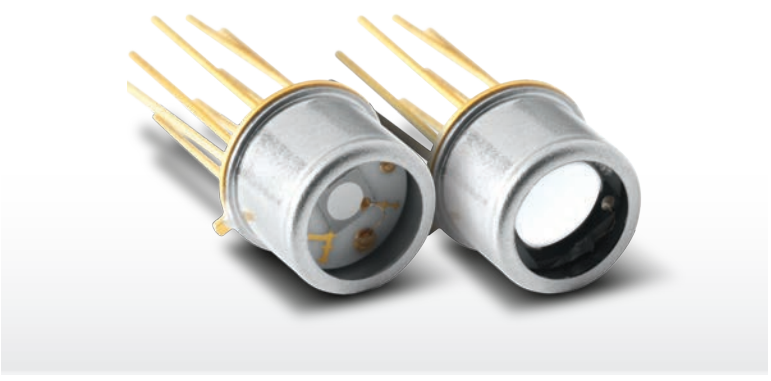
APPLICATION NOTE

THERMAL SATURATION IN LARGE AREA, HIGH RESPONSIVITY HYBRID PYROELECTRIC DETECTORS: QS-IF AND QS-IL



High voltage response Hybrid Pyroelectric Detectors are extremely sensitive thermal detectors. When a thin, $LiTaO_3$ pyroelectric element is mated to a low noise transimpedance amplifier with a 100 GΩ feedback resistor, the Voltage Responsivity can be as high as 40,000 V/W.

When you handle the Pyroelectric Hybrid - plugging it into our QS-I-TEST box for instance - heat will conduct from your hands into the TO package and, subsequently, into the Pyroelectric crystal. As the crystal heats up, it generates a large charge that changes with time, (current) which drops across the 100 GΩ resistor, generating a very large positive voltage. Once the handling has stopped, the pyroelectric begins to cool, returning to "room temperature" and generating a negative voltage of equal size, which could saturate the transimpedance amplifier circuit.

HERE ARE THE EQUATIONS THAT GOVERN THIS PHENOMENON:

$$I = P(T)\cdot A\cdot \frac{dT}{dt} \quad \text{Current Output from Pyro Crystal}$$

$$V = I\cdot R_f = \left(P(T)\cdot A\cdot \frac{dT}{dt}\right)\cdot R_f \quad \text{Amplifier Voltage Output}$$

Where:
I = Current ; V = Voltage
$P(T)$ = Pyroelectric Coefficient
A = Detector Area
$\frac{dT}{dt}$ = Rate of Temperature Change

Let's walk through a practical example and calculate the potential voltage output from a 5 mm element (area 0.2 cm^2) mated to a high gain amplifier (i.e. QS5-IL) when the crystal heats up at a rate of 2°C per minute (0.03°C/sec):

$$V = \left(\left(1.8\cdot 10^{-8}\right)\cdot\left(0.2\right)\cdot\left(0.033\right)\right)\cdot 10^{11} \text{ Volts}$$

$$V = 11.9 \text{ Volts}$$

The larger the element, the greater the voltage output and chance of amplifier saturation. So what to you do about it? Be patient, once the Pyroelectric is inserted into your circuit and/or our test box, you must allow it to return to a stable temperature (i.e. room temp). At this point, the output will be zero, and you can go on with your measurement. Air currents in the lab? If your Pyroelectric device is windowless, the detector will respond to air currents moving past it. This imparts a temperature change that will generate a voltage based on the equations reviewed above. We highly recommend you use the appropriate IR window, one that fits your needs, to isolate the detector from such air currents.

Note: One way to avoid thermal saturation of the amplifier is to tie header pins 2 and 8 together during handling as this effectively shorts the charge generated. However, this is not always practical. Should you have any concerns about this phenomenon or want more guidance before setting up your Pyroelectric Detector, please give us a call.

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