# Application Note 1002

## Thermal saturation in large area, high responsivity Pyroelectric Detector Hybrids

High voltage response Pyroelectric Hybrids are extremely sensitive, thermal detectors. When a thin, LiTaO3 pyroelectric element is mated to a low noise transimpeadance amplifier with a 100 Gigaohm feedback resistor the Voltage Responsivity can be as high as 40,000 V/W.

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

Here are the equations that govern this phenomena:

$\mathbf{I} = P(T).A.dT/dt$ Current ouput from Pyro Crystal

Where I = current
P(T) = Pyroelectric Coefficient
A = detector area
dT/dt = rate of temperature change

$\mathbf{V} = IR_f = ((P(T).A.dT/dt)).R_f$ Amplifier Voltage output

Lets walk through a practical example and calculate the potential voltage output from a 5mm element (area 0.2 $cm^2$) mated to a high gain amplifier (i.e. SPH-45) when the crystal heats up at a rate of 2 degrees C per minute (0.033 degrees per second):

$$\mathbf{V}=((1.8\text{x}10^{-8}).(0.2).(0.033)).(10^{11}) \text{ volts}$$

$$\mathbf{V} = 11.9 \text{ volts}$$

The larger the element, the greater the voltage output and chance of amplifier saturation…so what do you do about it?

Be patient …once the Pyroelectric is inserted into you 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 Pyroelectic 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 phenomena or want more guidance before setting up our Pyroelectric Detector please give us a call at…**

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