Nextreme Application Note: Cold-Side Temperature Sensing on Thin-Film TE Coolers

Whether you need to cool a hot spot, maintain operating temperature ranges for optimal performance or channel heat away from sensitive electronics, Nextreme's thin film thermoelectric coolers (TFTECs) technology enables micro-scale thermal management products for precision temperature control. By cooling as close to the heat source as possible and with the smallest devices on the market, Nextreme provides a new approach to solving thermal challenges in a variety of markets and applications.

Integrated temperature sensing of the cold-side of thin-film thermoelectric coolers is a challenge due to small surface area of the coolers' top header. Micro-scale thermistors can be mounted either directly onto the top surface of the header or on the side of the top header to enable closed-loop temperature control.

TEMPERATURE SENSING

The precise measurement of temperature is not always required. For some applications where thermal boundary conditions are known, closed-loop temperature control is not required and it is adequate to simply apply a specific current to the TEC. However, for applications that do require tight control of temperature, it is necessary to measure the temperature on the cold side of the TEC during operation. This has traditionally been done by using thermistors. Thermistors have the benefit of being highly temperature sensitive and while their resistance is non-linear with temperature, they are extremely repeatable. In addition, thermistors have reasonably high impedance (typically 10kΩ) and are generally easier to integrate than thermocouples. Finally, many commercially available TEC drivers include thermistor connections making them the preferred measurement method for precise temperature control.

The integration of these devices onto a TE device is relatively straightforward if there is adequate working space. Conventional thermistors tend to be on the order of 2-3 mm^2. Unfortunately, this precludes the use of these devices on TFTECs since they are as large or larger than the TFTEC itself. Several manufacturers have begun offering small scale thermistors that provide a pathway to direct temperature sensing on TFTECs. Three examples of these micro-scale thermistors are listed in Table 1 along with their size and electrical resistance.

***Table 1**: Micro-scale Thermistor Products*

Manufacturer	Model Number	L x W (mm)	Resistance (kΩ)	Comments
AdSem	GE-N-CHIP-103	0.1 x 0.1	10	Leadless device
BetaTHERM	GR10KM3499J15	0.4 bead	10	Glass encapsulated with leads
Cornerstone Sensors	T021D103	0.43 x 0.43	10	Leadless device

INTEGRATION EXAMPLES

Several potential integration methods are shown below for attaching thermistors to a Nextreme HV14 thermoelectric cooler. The HV14 has a top header that is only 1 mm x 1.5 mm in size. Placing the thermistor on the top surface of the TEC is the most straightforward method of integration but uses valuable (and limited) area on the header.

Figure 1 shows the packaging scheme in which a laser diode was mounted on the cold side of an HV14 in a TO-8 package. Figure 2 shows a side profile of the same package. The HV14 is thermally coupled to the chip and TO base.

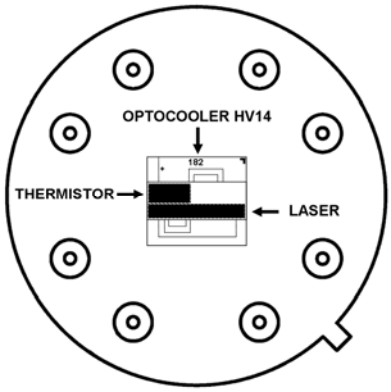

***Figure 1**. Illustration of a laser diode TO package with embedded OptoCooler HV14 TEC*

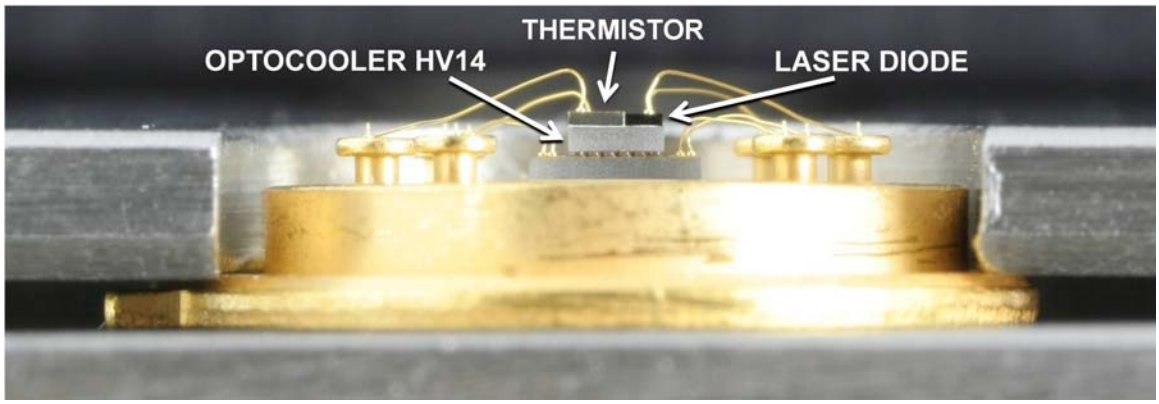

***Figure 2**. Side profile of a laser diode TO package (cap removed) with embedded OptoCooler HV14 TEC and thermistor*

Figure 3 illustrates placement of an AdSem thermistor to the top header of the HV14 TEC. The AdSem is a leadless device and so the leads must be attached by the integrator.

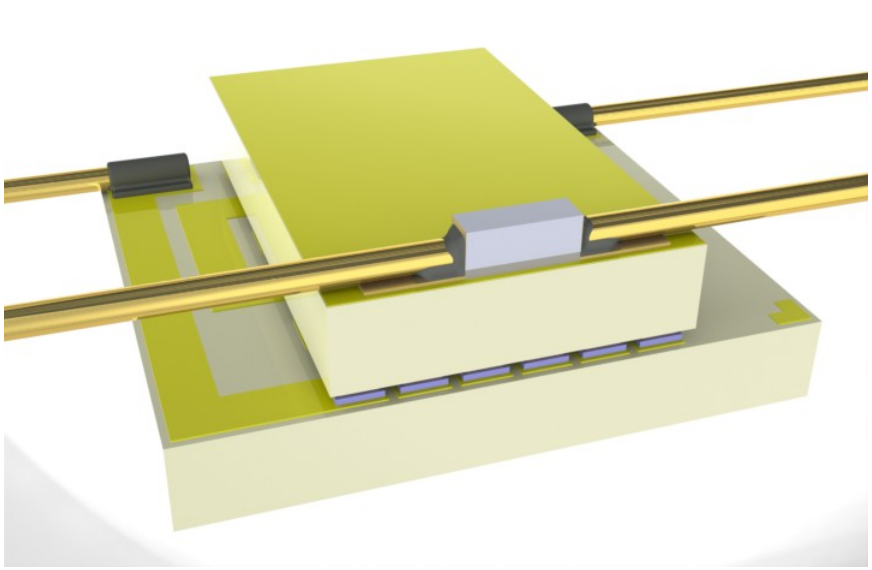

***Figure 3**: HV14 with AdSem thermistor attached to top header.*

Figure 4 shows the placement of a Cornerstone Sensors thermistor attached to the top header. In this case, the ground for the thermistor is connected through the metallization of the HV14 header. Wirebonds are used for the connection to the package posts.

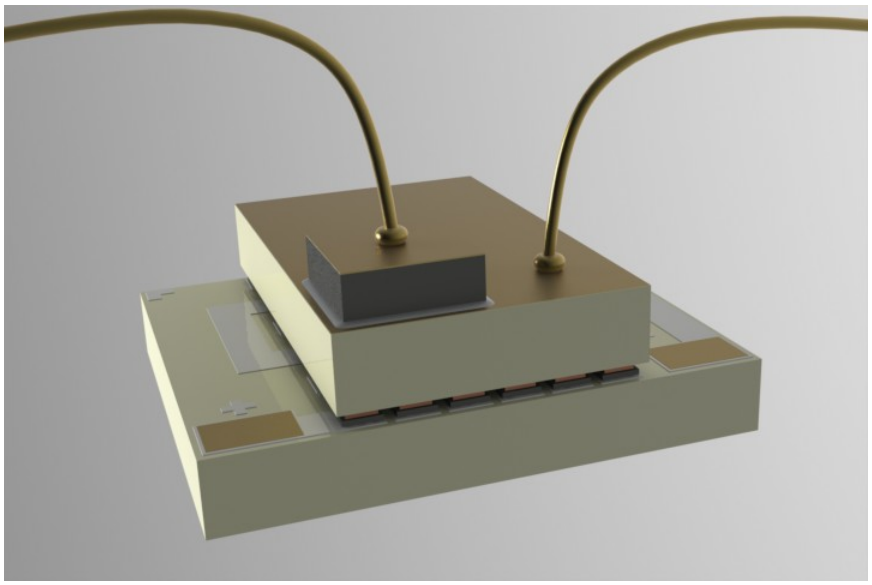

***Figure 4**: HV14 with Cornerstone Sensors thermistor attached to top header.*

Attaching the thermistor to the top surface may not be acceptable in cases where the all the top surface is reserved for the device (e.g., laser diode, ASIC, LED). In these cases, it is possible to place the thermistor on the side of the top header as shown in Figure 5.

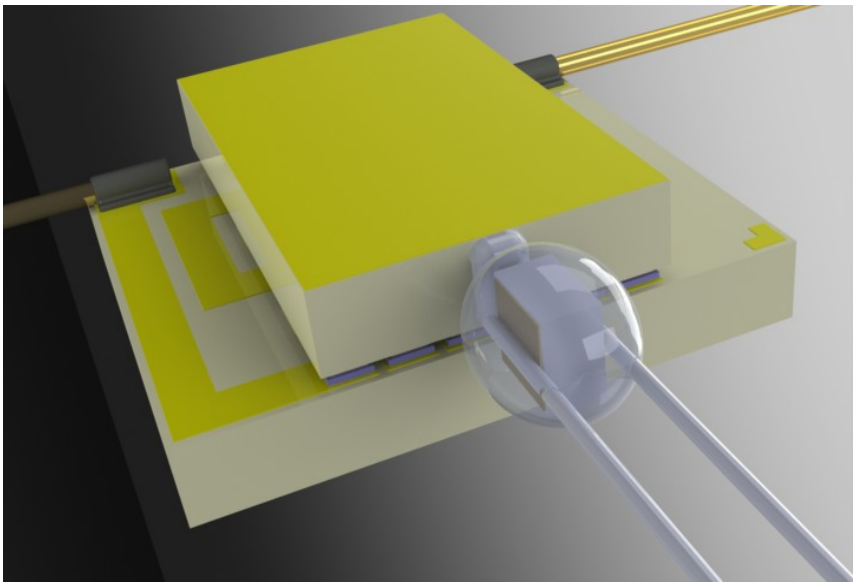

***Figure 5**: HV14 with BetaTHERM encapsulated thermistor attached to side of the top header.*