Thermoelectrically Cooled Detectors

A thermoelectric cooler (**TEC**) is a small heat pump which provides proper infrared detector operating temperature. Heat dissipation is very important in the IR detector/preamplifier modules.

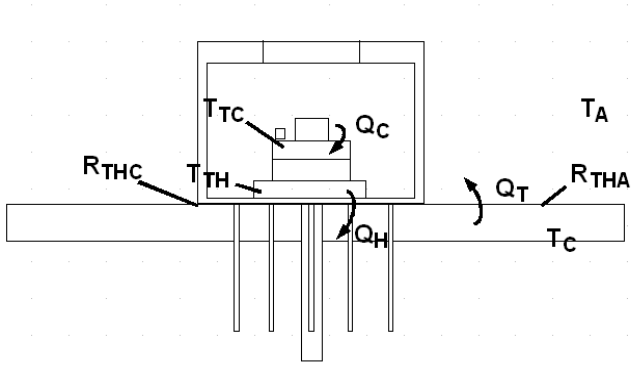

Fig.1. Cooling elements location, heat transfers and thermal resistances

Ambient Temperature

Heat sink and max. ambient temperature depends on:

$$T_C=T_{TH}+Q_H*R_{THC}$$

$$T_A=T_C+Q_T*R_{THA}$$

where:

Q_H- Heat disapated from the TEC hot-side to heat sink

Q_C- Heat transfered from the cold-side to hot-side of the TEC

Q_T- Heat disapated to ambient

T_C-Temperature of the heat sink

T_A-Ambient temperature

T_{TH}- Temperature of the TEC hot-side

T_{TC}- Temperature of the TEC cold-side

R_{THC}-Thermal resistance between detector case and heat sink

R_{THA}-Thermal resistance between heat sink and ambient

From above equations we could get desirable data. F.e. if we have heat sink thermal resistance and desirable ambient temperature, we may to get max. cooling temperature of the detector.

Mechanical Shocks

The TEC incorporated in the package is very sensitive to excessive mechanical shocks and vibrations. Great care is recommended during all manipulations (including normal exploitation) to avoid the mentioned hazards. Drop impacts against a hard base may be particularly dangerous.

Heat Sinking

TE-cooler requires a suitable heatsink of a proper thermal resistance to maintain the detector's temperature within the determined limits. Improperly designed heatsink or its lack usually leads to poor heat dissipation and overheating of the package. It results in degradation of the detector's parameters and may even lead to damage of the detector and/or the TE- cooler. Recommended thermal resistance of heatsinks for our TE-cooled detectors should be **max. 2K/W** for two-stage cooler and **1.5K/W** when three-stage cooler is used (see table).

The base of the package must be safely attached to the heatsink and possibly low thermal resistance between these two elements should be provided. This can be achieved either by using a thin layer (< 5 μm) of heat conductive epoxy glue or silicone grease between the mentioned elements. The latter requires carefully made clamping of the elements to assure thin layer of the grease.

Heat Sink Thermal Resistance	
No. of TEC stages	**Max. Rth [K/W]**
2TE	2
3TE	1.5
4TE	1

Temperature Control

IR detector structure has to operate at stabilized temperature. For proper temperature stabilization Vigo recomends thermoelectric Cooler Controllers.

Peltier's Cooling Element (TEC)

Be careful not to misconnect the plus and minus leads of the TE cooler. Polarity reversal of the cooler leads to rapid increase of the temperature inside the package what results in damage of the detector and (usually) the remaining elements.

For the recommended thermal conditions (i.e. proper thermal resistance between the package and the ambient), there is the optimal value of the current supplying the cooler, when the detector's temperature attains its minimal value. Any current lower then Iopt will degrade the cooling effect. Exceeding the maximal permissible value of Imax (always given by the manufacturer) by **approx. 20%** usually results in damage of the cooler.

To ensure a stable and long-term operation it is recommended to supply the cooler with the current of value **0.8Imax**. The value of the maximal permissible current varies d`epending on the type of TE cooler.

Thermistor

Built-in thermistor serves as a sensor of the detector's temperature. The maximal power dissipated by the thermistor should not exceed **0.2 mW**, so it's bias must be carefully chosen. To provide accurate temperature measurement, this power should not exceed **0.03 mW**. The detectors and detector/modules are supplied with data including the thermistor type and specifications.

Heatsinks for TE-Cooled Detectors

2TE and 3TE -cooled detectors are assembled in TO-8 packages. The package, which also includes TE-cooler, should be mounted on a suitable heatsink. The DR-1 heatsink developed and offered by our company provides optimal detector cooling and stabilization of its temperature. The heatsink plays also a role of the preamplifier's housing. Such construction provides a significant improvement of screening and reducing the influence of the EMI on the performance of the detection system. The DR-1 can be easily attached to all typical blocks of optical measuring systems. The DR-10 type with increased length has been designed for preamplifiers of bandwidth 50MHz – 250 MHz. When equipped with DRB-1 stand, the detecting unit can be used on any flat surface and its vertical position can be easily adjusted. The complete unit incorporating DR-1 or DR-10 heatsink and DRB-1 stand is marked as DR-1B or DR-10B set respectively. The MIPxC housing has been designed for operation with 2TE and 3TE cooled detectors. To provide sufficient heat dissapation the MIPxC MUST be atached to a cold plate.

The MIPxC-F and VPAC-1000F packages have been designed for operation with both 2TE & 3TE cooled detectors. They are equipped with a miniature fan.

VIGO System Heat Sinks	
Name/Code	**Destination**
MIPxC-F	2TE, 3TE Cooled detectors
MIPxC	2TE, 3TE Cooled detectors
MIPAC-1000F	2TE, 3TE Cooled detectors
DR-1;DR-10	2TE Cooled detectors