TE cooling

Detector cooling reduces noise, increases responsivity and, in some devices, improves high frequency response. Two, three and four stage TE coolers are available TE cooler (TEC) is biased with DC power. All specifications are given for 300K heat sink temperature.

The coolers are characterized by:

Maximum temperature difference ΔT_{max}

ΔT_{max} rated at Q=0, at other Q the ΔT should be estimated as $\Delta T=\Delta T_{max}(1-Q/Q_{max})$

Optimum current: I_{opt}

Supply current giving the highest temperature difference (ΔT_{max}) at the specified conditions stated in detector test data sheet.

Maximum TEC voltage: V_{max}

Voltage drop at ΔT_{max}.

Maximum heat pumping capacity: Q_{max}

Q_{max} rated at $\Delta T=0$, at other ΔT cooling capacity should be estimated as $Q=Q_{max}(1-\Delta T/\Delta T_{max})$

Standard TE coolers parameters:

	2TE	3TE	4TE
$T_{detector}$, K	~230	~210	~195
V_{max}, V	1.3	3.6	8.3
I_{max}, A	1.2	0.45	0.5
Q_{max}, W	0.36	0.27	0.28
ΔT_{max}, K	92	114	125

Temperature Sensor

The built-in thermistor serves as a sensor of the detector operation temperature. The maximal power dissipated by the thermistor should not exceed 0.2 mW—and for accurate temperature measurement, the power should be reduced to <0.03 mW. TE-cooled detectors are equipped with thermistor type TB04-222 as a standard. Resistance – temperature characteristics of the sensors are shown in Table.

Resistance vs temperature for TB04-222 Thermistor

T [K]	R_{th}[Ω]	T [K]	R_{th}[Ω]	T [K]	R_{th}[Ω]	T [K]	R_{th}[Ω]
180	1146.9	**215**	81.8	**250**	12.2	**285**	2.9
181	1048.6	**216**	76.8	**251**	11.7	**286**	2.8
182	959.6	**217**	72.2	**252**	11.1	**287**	2.7
183	879.1	**218**	67.8	**253**	10.6	**288**	2.6
184	806.1	**219**	63.8	**254**	10.2	**289**	2.5
185	739.8	**220**	60.1	**255**	9.7	**290**	2.4
186	679.6	**221**	56.6	**256**	9.3	**291**	2.4
187	624.9	**222**	53.3	**257**	8.9	**292**	2.3
188	575.1	**223**	50.2	**258**	8.5	**293**	2.2
189	529.7	**224**	47.4	**259**	8.1	**294**	2.1
190	488.3	**225**	44.7	**260**	7.8	**295**	2.1
191	450.6	**226**	42.2	**261**	7.5	**296**	2
192	416.1	**227**	39.9	**262**	7.2	**297**	1.9
193	384.6	**228**	37.7	**263**	6.9	**298**	1.9
194	355.7	**229**	35.6	**264**	6.6	**299**	1.8
195	329.3	**230**	33.7	**265**	6.3	**300**	1.7
196	305.1	**231**	31.9	**266**	6	**301**	1.7
197	282.9	**232**	30.2	**267**	5.8	**302**	1.6
198	262.5	**233**	28.6	**268**	5.6	**303**	1.6
199	243.7	**234**	27.1	**269**	5.4	**304**	1.5
200	226.5	**235**	25.7	**270**	5.1	**305**	1.5
201	210.6	**236**	24.4	**271**	4.9	**306**	1.4
202	196	**237**	23.2	**272**	4.7	**307**	1.4
203	182.5	**238**	22	**273**	4.6	**308**	1.4
204	170.1	**239**	20.9	**274**	4.4	**309**	1.3
205	158.6	**240**	19.9	**275**	4.2	**310**	1.3
206	148	**241**	18.9	**276**	4.1	**311**	1.2
207	138.2	**242**	18	**277**	3.9	**312**	1.2
208	129.2	**243**	17.1	**278**	3.8	**313**	1.2
209	120.8	**244**	16.3	**279**	3.6	**314**	1.1
210	113	**245**	15.5	**280**	3.5	**315**	1.1
211	105.8	**246**	14.8	**281**	3.4	**316**	1.1
212	99.1	**247**	14.1	**282**	3.2	**317**	1
213	92.9	**248**	13.4	**283**	3.1	**318**	1
214	87.1	**249**	12.8	**284**	3	**319**	0.98

Temperature Sensor

The built-in thermistor serves as a sensor of the active element temperature. The maximal power dissipated by the thermistor should not exceed 0.2 mW and for accurate temperature measurement, the power should be <0.03 mW.

Heat Sinking

Suitable heat sinking is necessary to dissipate heat generated by the Peltier cooler or excessive optical irradiation. Since heat is almost 100% dissipated at the base of the detector housing, it must be firmly attached to the heat sink (Figs. 1 a and b). Heat sinking via the mounting screw or via the detector housing cylindrical walls is not sufficient (Figs. 1 c and d). A thin layer of heat conductive epoxy or silicone grease should be applied to improve thermal contact between detector housing and heat sink.

A heat sink thermal resistivity of ~2 K/W is typically required for the most two-stage and three-stage Peltier coolers. Four stage cooler require ~1 K/W.

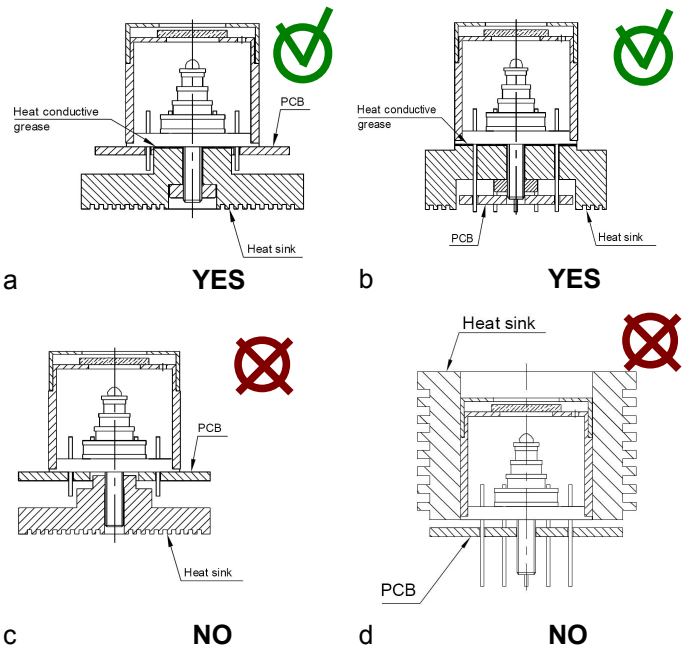

Fig. 1: Heat dissipation from TE cooled detector

TEC Controllers

VIGO System offers the standard thermoelectric cooler controller STCC-04 and the miniature thermoelectric cooler controller MTCC-01.

Temperature sensor inputs

Temperature sensor pins – might be connected with any polarity.

TEC supply input (+) and (-)

Supply polarity for the TEC. Those pins are floating, which means they are not connected to the GND.

Maximum TEC controller output current: I_{tec}

Maximum current that is provided by the controller to the TEC.

Maximum TEC controller output voltage: V_{tec}

Maximum voltage that is provided by the controller to the TEC.

Ripple of output current

It is a small unwanted residual periodic variation of the direct current (dc) output of a power supply (or other device) which has been derived from an alternating current (ac) source. This ripple is due to incomplete suppression of the rectified (dc) waveform within the power supply.

Output current of the built-in power supply

maximum current that can be delivered by power supply to the preamplifier, usually +/-100mA.

Series resistance of the connecting cable

material parameter - resistance of the supply cable. It depends on cable length.

Settling time of the set detector temperature

the time taken by the cooling system to reach appropriate temperature of the detector

Maximum voltage across TEC element

maximum voltage for TEC supplying.