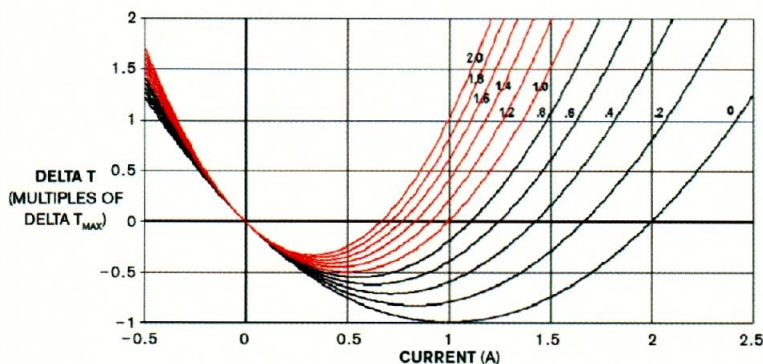# designideas

READERS SOLVE DESIGN PROBLEMS

Use thermoelectric coolers with real-world heat sinks

W Stephen Woodward, Chapel Hill, NC

Peltier devices, also known as solid-state refrigerators, or TECs (thermoelectric coolers), actively cool temperature-sensitive electronic components, such as optical detectors and solid-state lasers. A glance at any TEC data sheet reveals that some primary and fairly easily understood parameters characterize a TEC: The maximum current is the TEC's current drive for

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NOTE: HEAT-SINK IMPEDANCE IS NORMALIZED TO: 1.0=DELTA T_{MAX}/Q_{MAX}.

Figure 1 This family of curves shows that a thermoelectric cooler may actually heat rather than cool at the maximum drive current if the heat sink the cooler is mounted on is less than perfect.
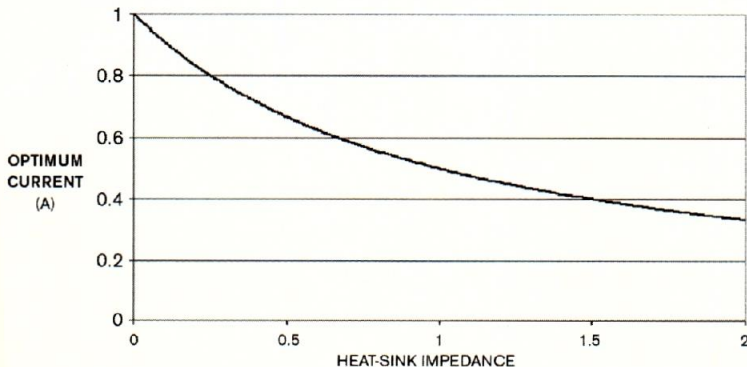

Figure 2 A derating factor for maximum voltage and current is based on the real-world thermal impedance of the TEC's heat sink.

maximum cooling, the maximum differential temperature is the no-load cooling temperature at maximum current and with no heat load. The maximum voltage is the TEC's voltage drop at the maximum-current drive, and the maximum heat transfer (Q_{MAX}) is the maximum cooling-heat load at a maximum current and differential temperature of zero.

However, one TEC data sheet proviso that designers sometimes miss is that you always measure these parameters with the TEC mounted on an effectively zero-thermal-impedance—that is, perfect—heat sink. This point is an important one and deserving of the designer's rapt attention because heat sinks always have at least some thermal impedance, and all the primary TEC parameters change—sometimes dramatically—when the TEC must make do with an imperfect sink.

The family of impedance-versus-current curves in **Figure 1** illustrates this effect. Each curve corresponds to a different heat-sink thermal impedance, normalized to one for 11 values from zero to two.

Although the maximum current is, by definition, the optimal current for

maximum cooling at a heat-sink impedance of zero, the situation changes radically with increasing impedance until there's no net cooling whatsoever. Further, for impedance greater than one, instead of cooling, the maximum TEC drive actually heats rather than cools. **Figure 2** shows the simple solution for this problem: You must replace the data sheet's maximum current and voltage values with new, lower maximum-drive values corresponding to the optimal numbers you need to achieve maximum cooling whenever impedance is greater than zero.**EDN**