

Application Brief

Audio Amplifier Drives Thermoelectric Cooler For OC-48 Laser Module

Application Brief 118

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A common problem faced by designers of laser-based fiber optic communication systems is maintaining the laser's characteristics over temperature. As the temperature drifts, the center frequency of the laser will also drift. To prevent this unwanted frequency drift, modern solid state laser modules incorporate a Thermoelectric Cooler (TEC) that can both pump heat out of and into the module, thus regulating its temperature. Thermoelectric coolers work on the Peltier effect. When DC current flows through the TEC device, heat is transferred from one side of the TEC to the other. This creates a "hot" and "cold" side to the device. If the DC current is reversed, the hot and cold sides reverse. This provides an ideal method of heating or cooling the laser module. However, the TEC must be driven in a differential manner to allow the unit to heat or cool the laser.

To provide a method of first order feedback, an integral thermistor is used to monitor the temperature of the laser. The manufacturer of the laser module typically trims the value of the thermistor to a specific value at the correct temperature of operation providing a simple method of controlling the thermoelectric cooler. Typically, a closed-loop control system and power amplifier is used to drive current through

the TEC. Other methods use pulse width modulation and an H-Bridge, however the noise generated by this method may not be acceptable.

To find out how much power is required to drive the TEC, measurements were taken at room temperature (about 20°C) while driving different values of current through the TEC. *Figure 1* shows the relationship of the TEC current versus voltage across the cooler terminals (pins 6 and 7 in *Figure 3*). Measurements were also taken of the thermistor while driving the TEC. *Figure 2* shows the absolute power values derived from *Figure 1*. It can be seen that the cooler requires about 1W of power to maintain the temperature of the laser. Also, *Figure 2* shows the range of the onboard thermistor versus the power being applied (as the internal temperature changes). The laser used in this application (a 1.3 μm 246-type laser) uses a thermistor that is trimmed to 10 K Ω at the correct temperature of 25°C.

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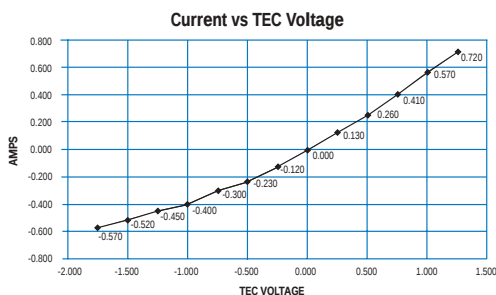


Figure 1: Current vs. Voltage of Thermoelectric Cooler

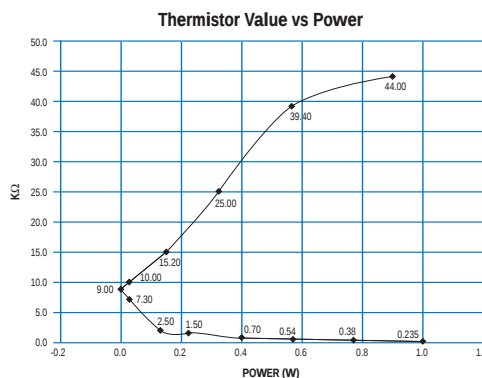


Figure 2: Power vs. Thermistor Value

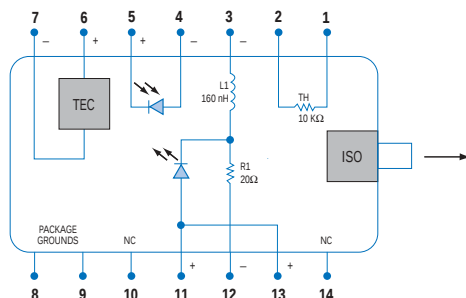


Figure 3: Laser Schematic

The system objective is to drive the temperature up or down using the TEC to hold the thermistor's value at 10 K Ω . The control circuit used to accomplish this uses a National Semiconductor LM4860 power amplifier normally used in audio applications to drive the TEC, as referred to in Figure 4. The LM4860 is part of the Boomer[®] power amplifier series of devices which are normally used in single-supply low-power applications such as CD players, cell phones, and other portable audio devices. R1 is selected to match the value of the internal thermistor (in this case 10 K Ω). The amplifier's gain is set to one and the internal bias is set to 1/2 V_{CC} by the device. An optional small capacitor (33 pf ceramic) can be used to compensate the amplifier if larger gains (e.g. faster response time) are required. The system drives the temperature up or down (using the differential output drive of the amplifier) causing the value of the thermistor to change accordingly. Once the temperature

reaches 25°C, the input matches the bias voltage and the loop closes on the TEC. Since there is a thermal mass to the laser module, the loop response time of this circuit is measured in seconds, so the system is very forgiving. The 1 watt output drive also limits the power than can be pumped into the TEC and the LM4860 includes thermal shutdown in case of problems – which protects both the laser and the control circuitry. A great advantage of this design is that it works from a single +5V supply, thus no differential supplies are required.

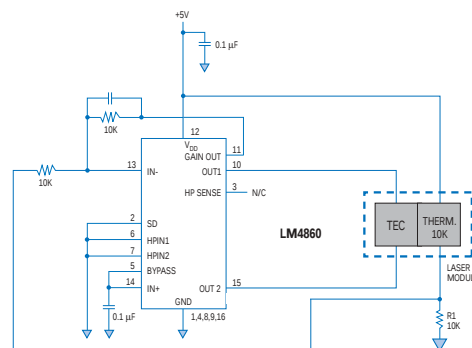


Figure 4: Application Circuit

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