LM4860

Audio Amplifier Drives Thermoelectric Cooler For OC-48 Laser Module

Literature Number: SNAA092

Application Brief

Audio Amplifier Drives Thermoelectric Cooler For OC-48 Laser Module

Application Brief 118

Richard Zarr

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.

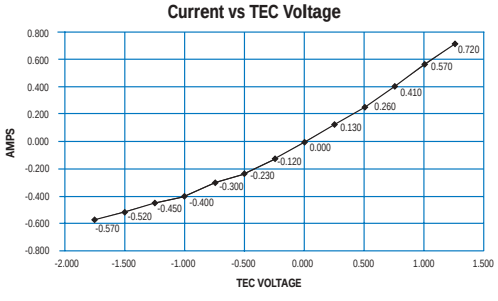

Figure 1: Current vs. Voltage of Thermoelectric Cooler

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 verses 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 KΩ at the correct temperature of 25˚C.

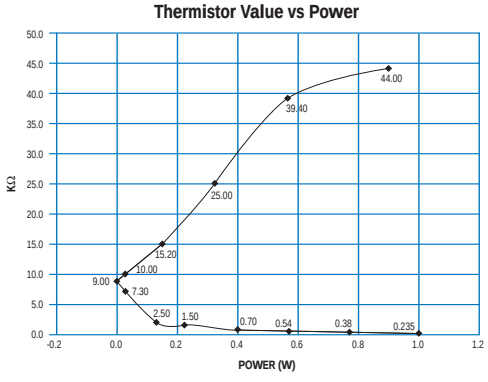

Figure 2: Power vs. Thermistor Value

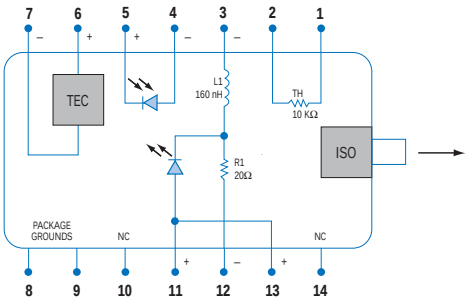

Figure 3: Laser Schematic

The system objective is to drive the temperature up or down using the TEC to hold the thermistor's value at 10 KΩ. 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 KΩ). 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.

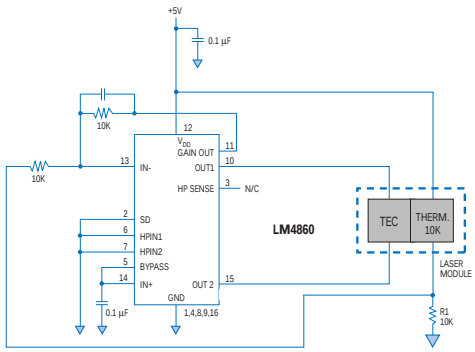

Figure 4: Application Circuit

National Semiconductor
2900 Semiconductor Dr.
PO Box 58090
Santa Clara, CA 95052
1-800-272-9959

Visit our Web site at:
www.national.com

For more information,
send email to:
newfeedback@nsc.com

Additional Information

www.national.com/pf/LM/LM4860.html
www.national.com/appinfo/audio

Visit The National Edge, our online technical journal for an archive of Application Briefs and other interesting information.
edge.national.com

National Semiconductor
The Sight & Sound of Information

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap		
Wireless Connectivity	www.ti.com/wirelessconnectivity		
	TI E2E Community Home Page		e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265