Laser Diode Temperature Measurement



Overview

Key to the validation of any thermal design is the ability to measure junction temperature. This same ability is also applicable to and necessary for the high-yield manufacture of these devices.

Key Takeaways

Laser diodes can be used for precise temperature measurement either as part of optical sensing systems or in combination with thermistors for controlling diode temperature.

Diode-

Based Electrical Temperature Sensing

Semiconductor diodes, including diode-connected BJTs, are widely used as temperature sensors due to their predictable forward voltage drop that varies linearly with temperature, typically around −2 mV/°C. In practice, a diode or BJT is excited with a small current, and the resulting voltage is measured. The voltage is then converted to temperature using calibration curves.

This method is low-cost, compact, and suitable for moderate-precision applications in automotive, industrial, and consumer electronics. For laser diodes, temperature control is critical because the emission wavelength shifts with temperature, affecting performance in optical communication and LiDAR systems.

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C thermistors are often integrated near the laser diode to provide highly accurate temperature feedback, with tolerances as tight as ±1% and operating ranges from −40 to 125 °C. These thermistors can be wire-bonded inside the laser package for precise monitoring.

Optical Temperature Measurement Using Laser Diodes

Laser diodes can also be used in non-contact optical temperature measurement through tunable diode laser absorption spectroscopy (TDLAS). In this approach, a diode laser is tuned to a specific absorption line of a target gas, such as H_2O, and the absorbance is measured. The temperature is then inferred from the ratio of integrated absorbances of lines with different lower energy levels.

This method is non-intrusive, fast, and highly sensitive, making it suitable for combustion diagnostics, aerospace, and industrial applications. Accuracy can reach a few percent over a wide temperature range, even under strong laser intensity fluctuations.

Laser Diode Thermal Characterization

For research and development, the temperature of the laser diode's active region can be determined by comparing current-voltage characteristics under continuous and pulsed operation. This allows calculation of the thermal resistance and the operating temperature at peak power, which is essential for preventing overheating and optimizing performance.

Summary

Electrical sensing: Uses diode or BJT forward voltage; simple, low-cost, moderate precision. Thermistor-assisted control: NTC thermistors near laser diodes provide precise temperature feedback for wavelength stabilization. Optical sensing (TDLAS): Non-contact, high-accuracy measurement of gas or surface temperature using laser absorption; suitable for high-temperature and industrial environments.

Thermal characterization: Current-voltage analysis allows determination of active region temperature and thermal resistance for laser diode design optimization. These methods ensure accurate temperature monitoring and control, which is critical for maintaining laser diode performance, wavelength stability, and device longevity.

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Article Content

Determination of the Temperature and Thermal

A technique is proposed for determining the temperature of a laser diode operating in a continuous mode, as well as thermal resistance of the

PhoPack ''02 Template

Key to the validation of any thermal design is the ability to measure junction temperature. This same ability is also applicable to and necessary for the high-yield manufacture of these devices. This paper

NTC thermistors for laser diode temperature measurement

These bondable NTC thermistors can be mounted with Au wire bonding inside the package for highly accurate temperature detection of laser diodes (LDs) used for optical

Diode-Based Temperature Measurements (Rev. A)

The circuitry can be quite simple, but making a temperature measurement system with a diode will require excitation, offsetting, and amplification. This application report contains a collection of circuits

Laser Diode Testing

Laser diodes are operated at significantly increased temperatures, causing aging processes to occur much faster. This allows for a quicker assessment of long

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Abstract—A technique is proposed for determining the temperature of a laser diode operating in a continuous mode, as well as thermal resistance of the device by comparing its current-voltage

Temperature distribution and thermal resistance analysis of high

A hybrid experimental/numerical method was developed to calculate multiple unknown interface thermal resistances and improve the prediction of the temperature distribution of high-power

Measurement of junction temperature confirms package thermal design

There are basically three different methods for making laser-diode junction-temperature measurements. All three methods have been in use for more than two decades by various manufacturers and

Measuring High Power Laser Diode Junction Temperature and

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A simple, accurate method for measuring junction temperature and heat sink-to-chip thermal impedance is needed to enable the development and production of high power laser diodes. This article

Temperature measurement with photodiodes: Application to laser diode ...

Abstract The temperature feedback of solid state laser diodes and various photovoltaic devices is critical for stable and reliable usage. We demonstrate that with a simple and passive

AMETEK PROCESS INSTRUMENTS

Tunable Diode Laser Absorption Spectoscopy (TDLAS) - What is it and how does it work? Tunable diode laser absorption spectroscopy (TDLAS) is a technique that offers a high level of sensitivity and

LI-COR LI-7700 Open-Path CH_4/CO_2/H_2O Eddy Covariance Flux

The LI-7700 specifically addresses the long-standing technical challenge of open-path methane (CH_4) measurement by integrating single-mode near-infrared tunable diode laser absorption spectroscopy

Determination of the Temperature and Thermal Resistance of a

Abstract A technique is proposed for determining the temperature of a laser diode operating in a continuous mode, as well as thermal resistance of the device by comparing its current

Measurement of junction temperature of a semiconductor laser diode ...

Normally, laser diodes (LDs) are mounted on heat sinks to dissipate the heat energy to avoid overheating. But even when a laser-diode is mounted on a heat sink; the active layer temperature or

Laser diode optical output dependence on junction temperature for

Abstract Laser diode optical output is studied and modeled. Four major diode parameters (threshold current, slope efficiency, central wavelength of output, and full-width half maximum of

Temperature distribution and thermal resistance analysis of high

Abstract The accurate temperature measurement of high-power laser diode arrays is a considerable challenge due to their large temperature gradient and package structure. In this study,

Parameter Overview of Laser Diodes by Dr. Kamran S. Mobarhan

The characteristic temperature of the laser diode, which is commonly referred to as T o (pronounced T-zero) is a measure of the temperature sensitivity of the device.

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