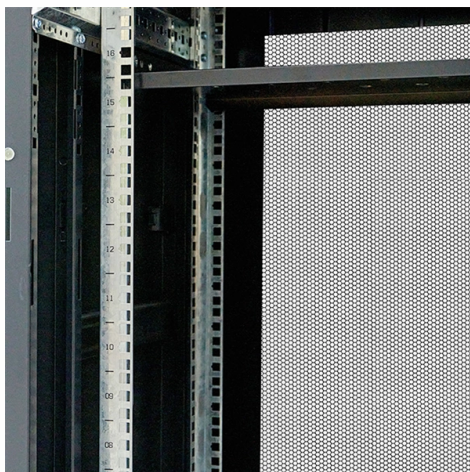


High Temperature Test Method for Optical Modules



Overview

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Key Takeaways

High-temperature testing of optical modules typically involves three-temperature cycling (-40°C , $+25^{\circ}\text{C}$, $+85^{\circ}\text{C}$) to verify electro-optical performance under extreme conditions. Overview of High-Temperature Testing

Optical modules, which include lasers (VCSEL/DFB), detectors (PIN/APD), driver ICs, and TIAs, are highly sensitive to temperature variations. High-temperature testing ensures that these modules maintain performance across their full operating range, which is critical for data centers, 5G front-haul, and co-packaged optics applications (SFF-8472, IEEE 802.3, ITU-T G.698). Key parameters evaluated include:

- Output power
- Receiver sensitivity
- Extinction ratio
- Eye diagram quality
- Center wavelength drift

- Dispersion tolerance

Three-Temperature Test Method

The three-temperature test is the standard method for high-temperature evaluation:

- Temperature Nodes: Modules are tested at -40°C (low), +25°C (room), and +85°C (high) .
- Test Procedure: Each module is cycled through these temperatures while monitoring electro-optical parameters.
- Challenges:
 - Conventional compressor-based chambers require 30-60 minutes to switch between extreme temperatures, limiting throughput.
 - DFB lasers have a center wavelength temperature coefficient of $\sim 0.1 \text{ nm/}^\circ\text{C}$, necessitating stable control within $\pm 0.1^\circ\text{C}$ for reproducible measurements.
 - Condensation after low-temperature tests can cause short circuits or contamination at optical interfaces.
 - Fiber routing in large chambers can introduce extra loss due to bending .

High-Temperature Optical Sensing Techniques

For precise temperature monitoring during testing, fiber-optic sensors are often used due to their immunity to electromagnetic interference and ability to operate in harsh environments . Common methods include:

- Blackbody Radiation Sensors: Measure thermal radiation emitted from a heated blackbody cavity coupled to an optical fiber. Suitable for temperatures above 500°C .
- Fiber Bragg Grating (FBG) Sensors: Detect wavelength shifts in reflected light due to temperature changes.
- Distributed Temperature Sensors (DTS): Use Brillouin or Raman scattering to measure temperature along the fiber length, enabling distributed high-temperature monitoring up to 1100°C with sapphire-based sensors .
- Sapphire Fabry-Perot Sensors: Employ a sapphire cavity to measure optical path differences, achieving stability $\pm 1^\circ\text{C}$ at 1100°C and resolution

Article Content

Optical Fiber Sensors for High-Temperature Monitoring: A Review

This paper reviews the sensing principle, structural design, and temperature measurement performance of fiber-optic

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High Temperature Testing

For oxide fibers, high-temperature testing is normally carried out in air. This allows the fiber to be fixed in the test frame using “cold”

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Reference Guide to Fiber Optic Testing

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