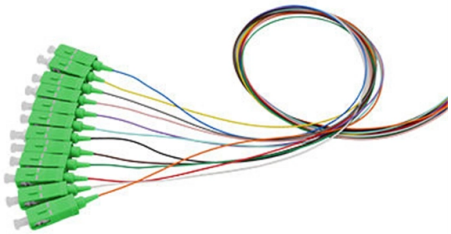
Optical module CPO heat dissipation



Overview

For the unique architecture of CPO, this study analyzes its heat dissipation needs in detail, and a thermal management scheme is designed.

Key Takeaways

CPO optical modules face significant heat dissipation challenges due to high-density integration, concentrated thermal loads, and the need for precise temperature control of optical components.

Thermal Challenges in CP

O ModulesCo-Packaged Optics (CPO) integrates electronic ICs and photonic ICs on a single substrate, creating a high-density thermal environment. Unlike traditional pluggable optical modules, CPO modules have multiple heat sources—switch ASICs, acceleration chips, and optical engines—closely packed on a small substrate, often only tens of millimeters in size. This results in thermal crosstalk, where local heating can create micro-scale temperature gradients of 5–8°C, exceeding the 2–3°C tolerance of traditional optical devices.

Such gradients can cause resonant wavelength drift, modulation contrast loss, and channel interference, directly impacting system bit error rates.

Heat Dissipation Mechanisms

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Effective thermal management in CPO modules requires addressing conduction, convection, and radiation simultaneously. Heat from high-power electronic components (up to 500–1000 W/cm²) must be efficiently conducted away while maintaining temperature stability for sensitive optical elements like microring modulators and laser diodes. Optical devices typically require operating temperatures below 85°C to prevent wavelength drift and power degradation.

Thermal Management Solutions

Several strategies are employed to manage heat in CPO modules: Dedicated heat dissipation components: Heat sinks or thermal interfaces are placed between the optical assemblies and the module housing to extract heat efficiently. Liquid cooling and hybrid architectures: Liquid-cooling channels or combined air-liquid cooling systems can remove heat from high-flux switch chips while maintaining uniform temperatures across optical modules. Substrate and packaging design: Using high-thermal-conductivity substrates and optimizing the layout of optical and electronic components reduces thermal gradients and crosstalk.

System-level thermal collaboration: Coordinating the thermal behavior of multiple components ensures that local heating does not compromise multi-channel wavelength consistency or signal integrity.

Practical Implications

Proper heat dissipation in CPO modules is critical for maintaining optical performance, reliability, and system bandwidth. Advanced thermal management allows CPO technology to achieve ultra-high-speed, low-power optical connections while preventing performance degradation due to thermal effects. Simulation and experimental studies have demonstrated that these solutions can support high-bandwidth CPO systems, such as 51.

2 Tbit/s configurations, without compromising temperature homogeneity. In summary, CPO optical modules require integrated, multi-dimensional thermal management strategies that combine material selection, component layout, and active cooling to ensure both electronic and optical components operate within safe and stable temperature ranges.

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Article Content

Simulation and experimental investigation of liquid-cooling thermal ...

For the unique architecture of CPO, this study analyzes its heat dissipation needs in detail, and a thermal management scheme is designed. The thermal management scheme is simulated and

Thermal solution for Co-Packaged Optics (CPO) modules

Abstract: In Co-Packaged Optics (CPO) where optical devices and ICs are attached to a common base substrate, there are requirements to keep the temperature of high-heat-dissipating ICs as low as

US20250284076A1

The present disclosure provides an optical module with CPO configuration which includes a housing, a substrate, a plurality of optical communication assemblies, and a plurality of heat...

Heat dissipation difficulties of co-packaged optics (CPO) limit its ...

In this paper, a series of research studies have been conducted on the thermal management of the CPO, and a corresponding thermal management scheme has been designed

Thermal Design for CPO Microring Modulators

This diagram illustrates the core structure of TSMC''s Co-Packaged Optics (CPO) technology, which integrates an electronic chip and a silicon photonic chip into a single package,

Liquid-Cooled Heat Dissipation Technology for Co-Packaged Optics

This article explores the liquid-cooling heat dissipation technology for CPO systems over 12.8 Tbps. We designed a heat dissipation structure to address the special heat dissipation needs of CPO systems

What is Co-Packaged Optics (CPO) Technology? | Corning

Co-Packaged Optics (CPO) is a technology and design approach where optical components, such as lasers and photodetectors, are integrated alongside electrical components, like Application-Specific

Electronic Chip Package and Co-Packaged Optics

Meanwhile, the optical module, enabled by silicon photonics, is now treated similarly to electronic chips, and advanced co-packaged optics (CPO) is

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The Complete Guide to Optical Module Thermal Management

Mastering heat dissipation, cooling techniques & design strategies for reliable optical transceivers. Optical modules are the backbone of high-speed networks — from data centers to 5G

Coherent''s $23B Opportunity Lifted by NVIDIA''s Optical

Coherent''s market on track to reach $23 billion as NVIDIA''s Spectrum-6 and Kyber drive structural demand for co-packaged optics components.

Co-Packaged Optics — a deep dive | APNIC Blog

Thermal Management: Integrating heat-sensitive optical components inside ASIC packages poses significant thermal challenges, and liquid cooling is a must. Given these challenges

WO/2026/143866 OPTICAL MODULE HAVING INTEGRATED HEAT DISSIPATION ...

An optical module having an integrated heat dissipation structure (2) and having high power consumption. The optical module comprises a base for mounting a circuit board, the circuit

CPO will soon replace pluggable optical modules, and Rubin will

Introduction Nvidia announced its first CPO solution, which will be deployed in its scale-out switches. CPO packages silicon photonics devices with ASICs, and is about to replace traditional pluggable

Everything You Need to Know About 800G/1.6T Optical Transceiver

Explore 800G/1.6T pluggable optics: key architecture, applications, challenges, and future co-package trends.

Optical Module Liquid Cooling Plate – Solution for High-Power Data ...

Name: Optical Module Liquid Cooling PlateHeat Source: 4015mm Optical ModuleHeat Dissipation:25W16=40 0WMaterials: Cold plate -copper, liquid distributor -stainless steelProcess:

Air-Cooling CPO Module Market Report 2034

The global Air-Cooling CPO Module market stands at USD 1.50 billion in 2025, growing at 17.8% CAGR through 2034, driven by data center expansion.

4-3-5 Ultimate Combination —— CPO (Co-Packaged Optics) and

This is relatively friendly for heat dissipation and maintenance and is a solution that Broadcom is currently strongly promoting and has already commercialized (such as the predecessor

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Wavelength Compression Mechanism, High-Speed Routing

The ultra-fine and high-density electrical layout of 224G+ high-speed optical modules greatly improves signal transmission performance but also brings two prominent thermal problems:

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Technical inquiry: https://fdsoluciones.es/project-enquiry.html

This document is for preliminary research. Verify specifications against current standards, product documentation and project requirements.

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