

CPO Printed Circuit Board Optical Module



Overview

CPO (Co-Packaged Optics) Technology: Co-Packaged Optics (CPO) represents a paradigm shift in data center connectivity, moving The Rise of Co-Packaged Optic.

Key Takeaways

A CPO optical module integrates optical and electronic components directly on the same PCB or interposer as the switch ASIC, enabling higher data rates, lower power consumption, and reduced latency. Overview of CPO Technology

Co-Packaged Optics (CPO) represents a paradigm shift in data center connectivity, moving optical engines from traditional pluggable modules to direct integration with switch ASICs on a common substrate or PCB . Unlike conventional optical transceivers that are hot-swappable and mounted on the front panel, CPO modules are tightly integrated assemblies of photonic components—such as lasers, modulators, photodetectors, drivers, and TIAs—co-located with the ASIC . This integration shortens electrical paths from centimeters to millimeters, significantly improving signal integrity and reducing power consumption by up to 50% .

Key Benefits

- **Power Efficiency:** Reduced electrical trace lengths lower energy loss and minimize the need for power-hungry retimers or DSPs .
- **High Bandwidth:** Supports ultra-high data rates of 800G, 1.6T, and beyond, enabling next-generation data center throughput .
- **Low Latency:** Shorter signal paths and direct integration reduce latency, critical for AI, machine learning, and HPC workloads .

- Compact Design: Co-location of optics and electronics allows higher density and scalability within the same PCB footprint .

PCB and Module Design Considerations

CPO optical modules introduce new challenges for PCB design:

- Advanced Materials: High-speed signal integrity requires low-loss substrates and careful material selection .
- Thermal Management: Concentrated heat from ASICs and optical engines necessitates innovative cooling solutions .
- Layout Strategies: Designers must optimize trace routing, power delivery, and component placement to maintain performance .
- Integration Techniques: 2.5D/3D packaging, silicon interposers, and silicon photonics are commonly used to achieve functional co-packaging .

Comparison with Traditional Optical Modules

Traditional pluggable optical modules are separate from the switch ASIC, connected via PCB traces that can degrade signals at high speeds . In contrast, CPO modules:

- Eliminate front-panel pluggable interfaces
- Reduce electrical trace lengths dramatically
- Integrate photonics and electronics at the package level
- Require updated manufacturing and maintenance approaches due to non-swappable design

Applications

CPO optical modules are primarily used in data centers, cloud infrastructure, and high-performance computing environments, where high bandwidth, low latency, and energy efficiency are critical . They are particularly valuable for AI workloads and large-scale networking, enabling scalable, high-speed interconnects while reducing operational costs. In summary, CPO printed circuit board optical modules represent a transformative approach to optical networking, combining high-speed performance, energy efficiency, and compact integration on a single PCB or interposer, while requiring advanced design and thermal management strategies to fully realize their potential .

Article Content

The Rise of Co-Packaged Optics: A Deep Dive into CPO Optical

This article provides a comprehensive overview of CPO optical modules, exploring their technology, benefits,

Co-Packaged Optic Assembly Guidance Document

The CPO JDF plans to release three documents focused on different elements of Co-Packaged Optics (CPO): the optical module,

CPO (Co-Packaged Optics) Technology: Revolutionizing Data Center ...

Co-Packaged Optics (CPO) represents a paradigm shift in data center connectivity, moving optical engines from

NPO and CPO: What is the Difference□

The optical engine can be a packaged module or a complete chip packaged in multi-Die 3D (silicon photonics)

The Rise of Co-Packaged Optics: A Deep Dive into CPO Optical

A CPO optical module integrates optical and electronic components to boost data center speed, efficiency, and

What is Co-Packaged Optics (CPO) Technology?

Co-Packaged Optics (CPO) is a technology and design approach where optical components, such as

Comprehensive Overview of CPO (Co-Packaged Optics)

It integrates the CPO optical module with the ASIC (Application-Specific Integrated Circuit) chip in the switch, thereby

Tutorial: The Emergence of Co-Packaged Optics

The next evolution was the concept of "co-packaged optics," where the optical module is integrated directly onto the

Understanding Co-Packaged Optics: Revolutionizing Data Center ...

CPO achieves a compact form factor by co-packaging optical and electronic components in a single, space-saving

Co-Packaged Optics (CPO) Solutions for Fiber Interconnect in Module ...

NKO board-to-board connector Senko's CPO module internal schematic using board-to-board connectors Optical

Electronic Chip Package and Co-Packaged Optics (CPO) Technology

Meanwhile, the optical module, enabled by silicon photonics, is now treated similarly to electronic chips, and advanced

(PDF) Progress in Research on Co-Packaged Optics

This technology has evolved from traditional board-edge optical modules to smaller and more integrated solutions.

Co-Packaged Optics—the Next Evolutionary Step in Data

Co-packaged optics CPO seeks to mitigate power consumption issues in data centers by placing the optical engine

Co-Packaged Optics Move Toward Reality as High Speed Solutions

An alternative approach is the use of an off-module laser source. An externally mounted laser could drive multiple on

What is Co-Packaged Optics (CPO) Technology?

Instead of relying on traditional pluggable optics, CPO uses tightly integrated optical and electrical

What is CPO (Co-Packaged Optics): The Complete Guide of CPO in

Co-packaged Optics (CPO) is a heterogeneous optoelectronic integration technology that integrates optical

Co-Packaged Optics: Architecture, Status, and the Path to 1.6T Switches

In Nvidia's CPO implementation, a replaceable module containing three co-packaged optical engines (4.8 Tb/s total), designed to

Optical PCB Waveguide Embedded System Overview

This article presents a waveguide embedded system (WES) based on optical printed circuit board technology for AI

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

