

## Two-Optics-Three-Electrical Module



### Overview

1.1. Scope This document defines the technical specifications for a 3.2 Tb/s Copackaged Optic (CPO) transceiver module.

### Key Takeaways

A Two-Optics-Three-Electrical Module integrates two photonic interface chiplets with three electrical interface chiplets using hybrid 2.5D/3D integration to achieve high-bandwidth, energy-efficient optical interconnects.

A Two-Optics-Three-Electrical Module is a type of co-packaged optical module designed to combine multiple optical and electrical interfaces in a compact, high-performance package. These modules are increasingly used in data centers and high-performance computing to overcome bandwidth and energy bottlenecks associated with traditional pluggable optical transceivers and board-level electrical interconnects. The module typically integrates:

- Two photonic interface chiplets (PICs) for optical signal generation and reception.
- Three electrical interface chiplets (EICs) for high-speed electrical signal processing.
- A compute chiplet (e.g., FPGA or switch ASIC) for data routing and processing.

### Integration Technology

The module uses hybrid 2.5D/3D integration, which allows stacking and side-by-side placement of chiplets on an interposer or embedded multi-die interconnect bridge (EMIB). Key features include:

- 3D stacking of EICs on PICs using micro-bumps (e.g., 55  $\mu\text{m}$  pitch) to minimize signal path length and reduce power consumption.
- 2.5D integration to connect the stacked chiplets to the main compute chiplet using high-density interposers (e.g., 45  $\mu\text{m}$  pitch) for high aggregate bandwidth.
- Wavelength-division multiplexing (WDM) to combine multiple optical channels onto a single fiber, enabling extremely high optical throughput .

#### Performance Characteristics

- Each EIC/PIC stack can support 1,024 optical channels per direction, with 64 channels WDM per fiber.
- Designed to operate at up to 16 Gb/s per channel, achieving a peak bi-directional optical bandwidth of 32 Tb/s per stack and 96 Tb/s aggregated across the module .
- Co-packaging reduces electrical path lengths, lowering power consumption and cooling requirements compared to traditional pluggable transceivers .
- Integration of optical engines and switch ASICs on the same board facilitates higher bandwidth density and supports future scaling to multi-terabit Ethernet switches .

#### Applications

- Data center Ethernet switches requiring high-speed interconnects for AI and machine learning workloads.
- High-performance computing clusters where inter-node communication is a limiting factor.
- Next-generation optical networking where energy efficiency and compact form factor are critical.

#### Summary

The Two-Optics-Three-Electrical Module represents a state-of-the-art co-packaged optical solution, combining multiple optical and electrical chiplets using hybrid 2.5D/3D integration. This design enables ultra-high bandwidth, energy-efficient, and compact interconnects, addressing the growing demands of modern data centers and HPC systems .

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Introduction Optical modules are critical components in fiber optic communications, enabling the conversion between

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Small Form-factor Pluggable Small Form-factor Pluggable connected to a pair of fiber-optic cables Small Form-factor Pluggable

### Co-Packaged Optic Assembly Guidance Document

1.3. Introduction The CPO JDF plans to release three documents focused on different elements of Co-Packaged Optics (CPO): the

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Fiber-optic communication is a form of optical communication for transmitting information from one place to another by sending

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An optical link module is a compact device that converts electrical signals into light signals and transmits them through fiber optic

Designing a Module for High-Speed Optical Communication

For the 400G/200G/100G optical modules that are widely used in data communication and fiber-optic backbone infrastructures, MPS

Five Key Trends of Co-Packaged Optics (CPO) in 2026

To address the energy demand from AI, co-packaged optics (CPO) brings optical engines directly adjacent to switch

Wave Optics Software for Analyzing Micro

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

Unlike a conventional pluggable optical transceiver that slots into a front panel, a CPO optical module (often called an

What Is an Optical Module and Its FAQs (V200)

Fundamentals of an Optical Module As an important part of fiber-optic communication, an optical module is a photoelectric converter

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