

CPO is not the same as optical module



Overview

Optical Interconnect Technology Analysis: LPO, NPO, CPONPO, or Near-Packaged Optics, is a highly integrated optical interconnect solution that falls between

Key Takeaways

CPO (Co-Packaged Optics) is a highly integrated optical solution where the optical engine is packaged directly with the switching ASIC, unlike traditional pluggable optical modules which are separate, hot-swappable units.

Key Differences

Integration Level: CPO integrates the optical engine (lasers, modulators, photodetectors, drivers, TIAs) directly with the switch ASIC on the same substrate or interposer, creating a single co-packaged assembly. In contrast, conventional optical modules are discrete, pluggable units that connect to the switch via front-panel ports and PCB traces, remaining physically separate from the ASIC. **Signal Path and Latency:** Because CPO places the optical engine adjacent to the ASIC, the high-speed electrical lanes are reduced from centimeters to millimeters, significantly lowering latency and signal loss.

Traditional optical modules require longer PCB traces, which increases latency and power consumption. **Power Efficiency:** CPO reduces I/O power consumption by shortening the electrical path and minimizing the need for high-power DSPs or retimers. Conventional pluggable modules rely on DSPs within the module to handle signal integrity, consuming more power per bit.



Maintenance and Replaceability: CPO assemblies are not hot-swappable. If a component fails, the entire co-packaged unit or switch board may need replacement. Traditional optical modules can be easily replaced from the front panel without affecting the switch ASIC.

Use Cases: CPO is designed for high-density, high-speed environments such as AI/ML clusters, hyperscale data centers, and HPC systems where bandwidth density, low latency, and energy efficiency are critical. Conventional optical modules are still widely used for standard deployments where ease of maintenance and modularity are prioritized. **Related Technologies**
NPO (Near-Packaged Optics): Optical engine is placed near the ASIC on the same PCB but not fully co-packaged, offering a compromise between CPO efficiency and modularity.

LPO/LRO (Linear Pluggable/Linear Receive Optics): Optimized pluggable modules that reduce DSP usage to lower power and latency but remain separate from the ASIC.

Summary

While both CPO and conventional optical modules perform optical-electrical signal conversion, CPO represents a deeper integration with the switch ASIC, offering lower latency, higher power efficiency, and greater bandwidth density at the cost of reduced modularity and more complex maintenance. Conventional optical modules remain modular, easier to replace, and suitable for less demanding deployments.

Article Content

Optical Interconnect Technology Analysis: LPO, NPO, CPO

NPO, or Near-Packaged Optics, is a highly integrated optical interconnect solution that falls between traditional pluggable optical modules and CPO.

Next-Gen Optical Modules: A Technical Comparison of CPO, NPO,

While CPO, NPO, and XPO represent different ways to optimize the electrical-to-optical conversion process, they do not resolve the fundamental bottlenecks inherent in electrical switching.

LPO vs LRO vs CPO vs NPO Optics: Understanding The Difference

Although LPO vs LRO vs CPO vs NPO all belong to high-speed optical interconnect technologies, each module and optical architecture has its own unique role. Understanding their

Optics Primer, Part 3: Co-Packaged Optics (CPO)

NPO Near package optics (NPO) brings the optics module on the same substrate or very close to the switch package, but not inside it: It's close enough to reduce most copper impairments.

LPO vs CPO vs NPO: The Future of AI Optical Interconnects

A deep technical comparison of LPO, NPO, and CPO architectures, exploring how next-generation optical interconnects will power AI and HPC infrastructure.

LPO vs NPO vs CPO: A Practical Guide to Optical Interconnects

No. Silicon photonics is a foundational integration technology that underpins CPO, LPO and even traditional pluggable modules — it is an enabler, not a competitor.

CPO vs LPO: A Comprehensive Comparison for Next-Generation

While both technologies aim to overcome the limitations of traditional pluggable optical modules, they differ fundamentally in architecture, implementation, and application scenarios.

Understanding CPO, LPO, NPO, and OCS

In the field of high-speed optical interconnect, CPO, NPO, LPO, and OCS represent different technologies or packaging forms. The following is a detailed introduction to each of them:

LPO vs CPO: Understanding the Future of Data Center Optical ...

This has driven the emergence of two major approaches: Co-Packaged Optics (CPO) and Linear Pluggable Optics (LPO). Understanding the technical differences, advantages, and

Co-Packaged Optics Is Not Delayed. SemiAnalysis Is Just Wrong

On June 9, SemiAnalysis published “Powered Down, Lights Off” and told investors that co-packaged optics is going to be late — scale-out CPO shipments revised down through 2027,

Evaluating Co-Packaged Optics (CPO) Performance

At the same time, to achieve larger capacity and higher integration, development of optical interfaces using Co-Packaged Optics (CPO) technology, which are fundamentally different from current

Co-Packaged Optics — a deep dive | APNIC Blog

Cost: At present, CPO does not have a significant cost advantage over high-volume pluggable optics. As the volumes pick up, this equation should change. Thermal Management:

Co-Packaged Optics Race: Strategic Approaches from NVIDIA and

Co-packaged optics addresses this limitation by placing the optical engines in the same package as the switch ASIC, drastically shortening the electrical path between the switch die and the

SemiAnalysis report cited delays in two key technologies, triggering a ...

SemiAnalysis reported that the mass production of 800VDC and CPO has been delayed to beyond 2028, triggering a sharp sell-off in U.S. optical communication stocks. Meanwhile, in an interview, an

CPO Technology Nvidia: Death of Optical Modules and the Future of

Analysis of Nvidia's announcement from June 3, 2026: why CPO is killing optical module suppliers, who the beneficiaries are (TSMC, Marvell) and what awaits InnoLight.

CPO Is Extending The Limits Of What's Possible In AI...

Additional challenges involve promoting the standardization of CPO module form factors, improving the automation of testing and validation, and ensuring the serviceability of the optical

A SemiAnalysis report alleging delays in two key technologies

SemiAnalysis' report emphasizes that in the CPO architecture, the optical engine and a large ASIC worth tens of thousands of dollars are co-packaged on the same substrate. Once the

Can VCSEL CPO Shake Up the InP Optical Order?

It is not CPO, where the optical engine is integrated into the same package as the ASIC. AI data centers are racing from 800G to 1.6T and on to 3.2T, pushing per-lane speed from 100G to

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