Optical module with SERDES



Overview

448G SerDes Explained: The Key Technology Behind The maturity of 448G SerDes will directly usher in the era of 3.2T optical modules. Doubling Port Density.

Key Takeaways

Optical modules with SERDES use high-speed serial interfaces to convert electrical signals into optical signals, enabling ultra-high bandwidth data transmission in modern data centers.

Overview of SERDE

S in Optical ModulesSERDES (Serializer/Deserializer) is a critical technology in optical modules that converts parallel data from a host ASIC into a high-speed serial stream for optical transmission, and vice versa on reception. This allows optical modules to achieve extremely high data rates while minimizing the number of physical connections and pins required. Linear Pluggable Optics (LPO) vs Co-Packaged Optics (CPO)Linear Pluggable Optics (LPO): LPO modules retain a linear, analog signal path without internal DSP regeneration.

The host ASIC's SerDes handles both electrical and optical link performance. This approach reduces module power consumption by up to 40% and lowers latency, making it suitable for AI/ML workloads where speed is critical.

LP

Os are commonly used in OSFP, QSFP-DD, and QSFP112 form factors.

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Co-

Packaged Optics (CPO): CPO integrates optical engines directly with the switching ASIC, minimizing electrical path length and improving signal integrity at extremely high speeds. This approach is essential for next-generation 448G SerDes and 3. 2T optical modules, where per-lane bandwidth requirements exceed 400 Gbps.

High-

Speed SERDE

S and Modulation448G SerDes: Represents a major leap in per-lane bandwidth, transmitting 448 Gbps per lane. It enables 3. 2T optical modules by combining eight lanes, effectively doubling port density in data center racks.

Modulation Schemes: PAM4 remains standard, encoding 2 bits per symbol, but higher-order schemes like PAM6 and PAM8 are being explored to reduce symbol rates and ease bandwidth pressure on channels, though at the cost of increased DSP complexity and power consumption.

Design Considerations

Signal Integrity: At 448 Gbps, electrical signals approach the physical limits of copper, requiring advanced PCB materials and precise channel design. Power and Latency: LPO modules reduce module power and latency compared to DSP-based optics, while CPO offers higher integration and performance for ultra-high-speed links. Integration: Modern optical modules often include laser drivers, photodiode sensing, and precise biasing circuits to maintain signal quality and thermal stability.

Applications

Optical modules with SERDES are essential for AI data centers, high-performance computing (HPC), and hyperscale cloud networks, where massive bandwidth and low latency are critical. They enable seamless GPU cluster interconnects, support next-generation Ethernet speeds, and facilitate the transition from copper to optical interconnects for longer reach and higher throughput. In summary, SERDES-enabled optical modules are the backbone of modern high-speed data communication, with LPO and CPO approaches providing trade-offs between power, latency, and integration, while advanced modulation schemes and high-speed SerDes IP drive the evolution toward 3.

2T and beyond.

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Article Content

448G SerDes Explained: The Key Technology Behind

The maturity of 448G SerDes will directly usher in the era of 3.2T optical modules. Doubling Port Density: By utilizing eight 448G lanes, a single

448G SerDes Explained: The Key Technology Behind 3.2T Optical

Learn how 448G SerDes enables 3.2T optical modules and transforms AI data center interconnects. Explore PAM4, CPO/LPO, and next-gen networking trends.

Optical module design resources | TI

View the TI Optical module block diagram, product recommendations, reference designs and start designing.

448G SerDes Explained: The Key Technology Behind 3.2T Optical

Q: What is 448G SerDes? A: 448G SerDes is a high-speed electrical interface technology that transmits data at 448Gbps per lane, enabling next-generation optical modules such

Linear Drive Pluggable Optics

Link using optical modules, Host SerDes equalizes the entire link On the transmit side a modulator driver and the optical transmitter is used for the electrical-to-optical conversion.

224G SerDes IP: Enabling Linear Drive Optics in Data Centers

This technical article provides an overview of the transition from copper to optical interconnects, focusing on key performance metrics for SerDes IP, latency considerations, power

Linear Pluggable Optics – An Overview

Comparison to CPO g the need for a standalone module. Although CPO is becoming increasingly popular, LPO is seen as a natural evolutionary path for pluggables, offering lower risk compared to

Understanding SERDES: How Serializer/Deserializer Interfaces Work

By enabling efficient high-speed serial transmission, it serves as the backbone of Ethernet optical modules, data center switching fabrics, chip-to-chip links, and next-generation

400G, 800G, and Terabit Pluggable Optics:

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Equipment and electrical serdes can evolve through 3 generations (25 Gb/s, 50 Gb/s or 100 Gb/s) without changing the optical interface that interconnects your equipment.

From Custom SRAM to Optical SerDes: How Marvell Builds the Data ...

Leveraging chiplet-based design and 2.5D/3D advanced packaging, Marvell can integrate compute dies with high-speed SerDes, HBM stacks, and optical modules within a single package.

Co-Packaged Optics — a deep dive | APNIC Blog

The optical engine of a transceiver — whether co-packaged or part of a pluggable module — typically includes an electronic integrated circuit (EIC) and photonic integrated circuits (PICs).

Optical Transceiver Market Price Trends 2026: TCO & Risks

LPO (Linear Drive Pluggable Optics) requires the host ASIC SerDes to perform the equalization. If you put an LPO module on one end and a standard DSP-retimed module on the

AI infrastructure accelerates the shift to scalable optical systems ...

CPO and soldered optical integration were another major focus. The OCI MSA promoted optics over copper for AI scale-up networks, aiming to reduce power consumption by eliminating high

Nvidia Unveils Silicon Photonics Cpo Technology For Ai Data Centers ...

With AI computing rapidly advancing, data center network infrastructures are under increasing pressure. At GTC 2025 on March 18, 2025, NVIDIA unveiled its revolutionary silicon

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

Optics Primer, Part 3: Co-Packaged Optics (CPO) From EML lasers and DSPs to silicon photonics and external CW lasers. How CPO works and the impact on the optical supply chain.

Huawei Optical Module Part Number Decoder

EXECUTIVE SUMMARYThis document provides a comprehensive technical overview of the Huawei Optical Module Part Number Decoder, an essential framework for understanding the nomenclature,

Optical Modules in Intelligent Computing Scenarios

Huawei provides a full series of pluggable optical modules. A wide variety of modules give you flexible plug-and-play options for all types of interfaces.

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Marvell Optical DSPs | Powering the Future of AI Infrastructure

Discover how Marvell''s Optical DSPs enable high-speed, energy-efficient connectivity for AI workloads, data center interconnects, and cloud infrastructure.

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