

Article Overview

Optical modules convert electrical signals into light to enable high-speed, low-latency, and energy-efficient data transfer in AI chips and clusters.

Role in AI Systems

Optical modules are critical for AI computing infrastructure, particularly in GPU/XPU clusters and large-scale AI data centers. They facilitate high-speed data exchange both within a single rack (scale-up) and across multiple racks (scale-out), supporting massive AI workloads such as training large neural networks and inference tasks . By converting electrical signals to optical signals and back, these modules allow AI systems to handle terabytes to petabytes of data efficiently, minimizing latency and improving throughput .

Technical Components

A typical optical module includes:

- o Digital Signal Processor (DSP): Equalizes signal impairments.
- o Linear Driver (LD): Amplifies signals for transmission.
- o Transmit Optical Sub-Assembly (TOSA): Contains the laser and modulator.
- o Receive Optical Sub-Assembly (ROSA): Includes a photodiode (PD) and transimpedance amplifier (TIA) to convert optical signals back to electrical signals . Different laser and modulator technologies influence the module's speed, power consumption, and reliability. Modules commonly support 100 Gbps PAM4 and 200 Gbps PAM4 signaling, with next-generation platforms reaching 400G, 800G, 1.6T, and beyond .

Emerging Technologies

- o Co-Packaged Optics (CPO): Integrates optics directly with the switch and AI chip, reducing latency by ~50% and power consumption by ~40% compared to traditional pluggable modules .
- o Silicon Photonics: Combines lasers, modulators, and detectors on silicon chips using CMOS processes, reducing size and cost while enabling higher bandwidth .
- o Near-Package Optics (NPO) and Optical I/O: Focus on reliability, manufacturability, and serviceability, moving optical interconnects closer to the chip for optimized AI cluster performance .

Market and Future Trends

The demand for optical modules is driven by AI compute growth, with large models like GPT-4 requiring multi-terabit bandwidth per rack, often necessitating hundreds of optical modules . The market is shifting toward CPO and silicon photonics, with projections showing silicon photonic modules capturing over 60% of



AI Optical Module Chip

the market by 2030 . Optical interconnects are essential for scale-out networks, where copper cannot span long distances, and they are central to the evolving AI system architecture .

Benefits

- o High Bandwidth: Supports massive AI datasets and multi-GPU/TPU communication.
- o Low Latency: Critical for distributed training and inference.
- o Energy Efficiency: Reduces power consumption in AI data centers.
- o Scalability: Enables both scale-up and scale-out AI cluster designs . Optical modules are thus foundational to modern AI chips and infrastructure, enabling faster, more efficient, and scalable AI computation.

Top 10 AI Optical Chips Companies to Watch in 2025 and Beyond Explore the evolving AI Optical Chips market as we profile ten

Huagong Tech, an optical module manufacturer based in central China's Wuhan, launched the world's first 12.8-terabit

BEIJING -- With the global push for AI computing power unleashing an unprecedented wave of infrastructure buildout,

This market research report provides a comprehensive analysis of the global and regional Optical Module Chip markets, covering the

MCU chips for optical modules emerge as a critical semiconductor segment as AI data center buildout drives

Using light dramatically cuts the power needed to perform these tasks, with efficiency 10 or

PCB Design for AI Optical Interconnect Modules Engineering guide to PCB substrate requirements for co-packaged

Celestial AI has a new Photonic Fabric Module that frees chip designers to place high

Optical will change the data center architecture and the architecture of CMOS chips in the

The number of venture-backed optical component startups has exploded - the Optical

By 2029, the global AI optical module market is projected to reach USD 22.4 billion, with a CAGR of 30.1% from 2024 to 2029. This



AI Optical Module Chip

Chinese researchers have developed a new all-optical interconnect system linking standard electronic chips, boosting

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

Neurophos is taking a crack at solving the AI industry's power efficiency problem with an optical chip that uses a

SCALE CPO solution is the industry's first OCI MSA capable platform and built with GF's proven silicon photonics

Khare and his colleagues have developed an optics module that would enable chipmakers to add six times as many

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