Types of pluggable optical modules

Article Overview

Pluggable optical modules are classified by form factor, data rate, transmission distance, fiber type, and emerging architectures like LPO, NPO, CPO, and XPO.

Form Factor Classification

Pluggable optical modules come in various physical sizes and interfaces, which determine compatibility with networking equipment:

o SFP (Small Form-Factor Pluggable): Standard module for 1 Gbps networks; supports monitoring of voltage, temperature, and optical power .
o SFP+: Enhanced SFP for 10 Gbps; more sensitive to EMI and requires tighter module cages .
o SFP28: Same size as SFP+ but supports 25 Gbps; compatible with 10G SFP+ ports .
o QSFP+ / QSFP28: Quad SFP modules for 40 Gbps and 100 Gbps, respectively; QSFP-DD extends this to 400 Gbps .
o XFP: 10 Gbps module, larger than SFP+ .
o CFP: Centum form-factor pluggable for high-speed telecom and data applications, supporting 100 Gbps and above .
o CXP: High-density parallel module with 12 channels per Tx/Rx, mainly for short-distance multimode links .
o CSFP: Compact SFP with dual 100 Mbps or 1 Gbps bidirectional transceivers, doubling port density .
o OSFP: Octal SFP for 400 Gbps and beyond .
o XPO: eXtra-dense pluggable module for AI data centers, supporting up to 12.8 Tbps per module with liquid cooling .

Data Rate Classification

Optical modules are also classified by transmission speed:

o 100 Mbps: Legacy systems.
o 1 Gbps: Standard enterprise networks.
o 10 Gbps: High-performance data centers.
o 25/40/100 Gbps: Modern high-throughput applications.
o 200/400 Gbps: Emerging ultra-high-speed networking .
o 800 Gbps to Tbps: Advanced AI and hyperscale data center modules like XPO .

Transmission Distance and Fiber Type

Modules are categorized by reach and fiber compatibility:

o Short Reach (SR): Typically multimode fiber, up to 100-150 meters.
o Long Reach (LR): Single-mode fiber, several kilometers.
o Extended Reach (ER/FR/ZR): Long-haul single-mode fiber, tens to hundreds of kilometers.
o CWDM/DWDM: Wavelength division multiplexing for multiple signals over a single fiber; CWDM is cost-effective for short to medium distances, DWDM for long-distance high-capacity networks .

Emerging Architectures

Advanced pluggable optical modules are evolving to meet high-bandwidth, low-latency, and energy-efficient requirements:

o LPO (Linear-drive Pluggable Optics): Removes DSPs and CDRs, using analog linear drivers and TIAs for lower power and latency, suitable for 800G+ systems .
o NPO (Near-Package Optics): Places optical engine near the processing chip (GPU/NPU) on the same PCB, reducing signal loss and improving bandwidth without exposing optics to high heat .
o CPO (Co-Packaged Optics): Integrates optics directly with the switch ASIC, improving data rate and power efficiency but increasing thermal and reliability challenges .
o XPO (eXtra-dense Pluggable Optics): Designed for AI data centers, delivering 12.8 Tbps per module with liquid cooling, enabling ultra-high front-panel density and field pluggability .

Summary

Pluggable optical modules are systematically classified by form factor, data rate, transmission distance, fiber type, and architecture. Selecting the appropriate module depends on network speed requirements, distance, fiber infrastructure, and emerging high-performance needs in AI and hyperscale data centers. Advanced architectures like LPO, NPO, CPO, and XPO are redefining module capabilities, balancing power efficiency, bandwidth density, and serviceability.

Pluggable optics can be used for both telecommunications and data communications purposes, making this solution useful in both

The rise of coherent pluggable transceivers addressed the critical network transport

GIGALIGHT provides 100G, 200G, 400G and 800G pluggable digital coherent optical transceiver modules (DCO) and non-coherent

Optical modules typically have an electrical interface on the side that connects to the inside of the system and an optical interface on

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Read the definitive 2026 guide on SFP modules. We explain Single Mode vs Multimode, DDM diagnostics, and how to choose the

According to the encapsulation type, optical modules are classified into SFP, eSFP, SFP+, XFP, SFP28, QSFP28, QSFP+, CXP,

QSFP+ optical modules support MPO fiber connectors and are larger than SFP+ modules. CXP: hot-pluggable high-density parallel

What Is an Optical Module and Its FAQs (V200) Describes what an optical module is and FAQs, including the fundamentals,

What"s Inside a Coherent Pluggable? Coherent pluggable transceivers have transformed optical communications,

There are various types of optical modules, including SFP (Small Form-factor Pluggable), SFP+, QSFP (Quad Small

Optical transceiver module (optical transceiver), referred to as optical module, is an important device in optical

Explore the ultimate guide to optical modules. Learn types, functions, performance metrics & how to choose the right

Learn what an SFP module is, how it works, its types, specifications, compatibility, and use cases in modern

This white paper focuses specifically on the trend toward building optical devices in silicon.

Optical modules are components used in optical communications and optical networks to convert optical signals into

Optical modules are available in various types to meet diversified requirements. Classified by transmission rates Depending on

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