

Data Center Optical Module Requirements



Overview

The four requirements for optical modules in data centers-ETU-LINK. ETU-link will talk about the four requirements for optical modules in the next genera.

Key Takeaways

Data centers require a range of optical modules, from 1G SFPs to high-density 400G OSFP or XPO modules, depending on network layer, bandwidth, and architecture. Common Optical Modules

- 1G SFP (Small Form-Factor Pluggable)
 - Used for basic Ethernet connections and legacy systems.
 - Supports short-range (SR) and long-range (LR) fiber transmission.
 - Suitable for low-bandwidth server-to-switch connections or access layers .
- 10G SFP+ and 25G SFP28
 - Widely used in top-of-rack (TOR) switches.
 - SFP28 supports 25Gbps per lane, enabling higher density and future-proofing .
- 40G QSFP+ and 100G QSFP28
 - Common in aggregation and core layers.
 - QSFP28 supports 100Gbps using four 25Gbps lanes; QSFP+ supports 40Gbps using four 10Gbps lanes .

- 200G and 400G QSFP-DD / OSFP
- High-speed modules for hyperscale and AI-driven data centers.
- QSFP-DD and OSFP support 400Gbps and beyond, often used in leaf-spine or high-bandwidth fabrics .
- eXtra-dense Pluggable Optics (XPO)
- Designed for AI and high-performance workloads.
- Each module delivers 12.8Tbps using 64 electrical lanes and supports multiple optical architectures (DR, FR, LR, SR, ZR).
- Enables extremely high front-panel density and pay-as-you-grow deployment .
- DWDM and BiDi Modules
- Dense Wavelength Division Multiplexing (DWDM) modules allow multiple wavelengths over a single fiber, ideal for long-distance or high-capacity interconnects.
- BiDi (bidirectional) SFPs reduce fiber usage by transmitting and receiving on a single fiber strand .

Considerations for Module Selection

- Network Layer: TOR switches typically use 10G–25G modules, aggregation layers use 40G–100G, and core layers may require 200G–400G or XPO modules .
- Distance: Single-mode fibers for long distances, multimode fibers for short distances.
- Power and Cooling: High-density modules like XPO may require liquid cooling due to high power consumption .
- Scalability: Modular, pluggable optics allow upgrades without replacing entire switches, supporting future growth .
- Data Center Architecture: Traditional three-tier, leaf-spine, or AI-focused architectures influence the number and type of modules needed per rack .

Emerging Trends

- Optical Circuit Switching (OCS): Reduces latency and power consumption by establishing direct optical paths, minimizing OEO conversions .
- Co-packaged and On-board Optics: Increase bandwidth density but present challenges in serviceability and manufacturability .
- AI and Hyperscale Workloads: Require higher bandwidth per module and denser optical interconnects, driving adoption of XPO and 400G+ modules . In summary, a modern data center typically deploys a mix of 1G–400G optical modules, with advanced options like XPO for AI workloads, selected based on network layer, distance, bandwidth, and scalability requirements. Proper planning ensures high performance, low latency, and future-proof network growth.

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