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Recommended Long-Distance Optical Modules



Overview

Discover everything you need to know about SFP optical transceiver modules for long-distance fiber transmission.

Key Takeaways

For long-distance transmission over single-mode fiber, modules such as LR, ER, ZR/ZR+, and 400G coherent pluggables (DR4, FR4, LR8) are recommended depending on distance and data rate requirements.Key Long-Distance Module Types

1. LR (Long Reach) Modules

• Distance: Typically up to 10 km over single-mode fiber (SMF)

• Wavelength: 1310 nm

• Use Case: Inter-building or campus connections

• Notes: Standardized under IEEE 802.3 standards; suitable for 10G, 25G, or 400G LR4 modules 2. ER (Extended Reach) Modules

• Distance: Up to 40 km

• Wavelength: 1550 nm

• Use Case: Metro networks or inter-campus links

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• Notes: Higher optical power and sensitive receivers; often used in 10GBASE-ER or 400G LR8 deployments 3. ZR/ZR+ Modules

• Distance: 80–120 km (ZR) and beyond for ZR+

• Wavelength: 1550 nm with coherent DSP technology

• Use Case: Carrier-grade long-haul and metro networks

• Notes: Coherent pluggable modules with probabilistic shaping (PCS) can reach 2,500 km at 400G and 1,200 km at 600G, making them ideal for geographically distributed networks 4. 400G Modules (DR4, FR4, LR8)

• DR4: Medium distance (up to 500 m), single-mode fiber, PAM4 modulation

• FR4: Uses CWDM to multiplex 4 wavelengths over a single LC duplex fiber pair, suitable for metro networks

• LR8: Long-distance 400G module, optimized for single-mode fiber links up to 10 km or more, compatible with 800G migration strategies
Selection Considerations
• Distance and Power Budget: Ensure Tx/Rx power levels match fiber attenuation and connector/splice losses. Use an optical power meter to verify link budget

• Fiber Type: Long-distance modules require single-mode fiber (OS2); multimode fiber is unsuitable beyond short distances due to modal dispersion

• Compatibility: Verify module support for your switch/router brand and DDM functionality to avoid vendor lock-in

• Environmental Conditions: For outdoor or industrial deployments, choose industrial-grade modules with extended temperature ranges (-40°C to +85°C)

• Future-Proofing: Consider LPO-ready 400G optics for energy efficiency and 800G readiness in data center or backbone deployments
Practical Recommendations
• Campus/Metro Links (10–40 km): 10G/25G LR or 400G LR8 modules

• Extended Metro/Carrier Links (40–120 km): ER or ZR/ZR+ coherent modules

• Ultra-Long-Haul (1000+ km): PCS-enabled coherent modules at 400G–800G for intercontinental or subsea links By matching the module type to your distance, data rate, and fiber infrastructure, you can ensure reliable, high-speed connectivity while optimizing cost, power consumption, and future scalability.

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Article Content

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This guide provides a technically accurate and standards-aligned explanation of long distance transceivers, including

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Long-range 10G optical modules enable high-speed data over distances up to 80km. Learn about types, specs,

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Systematic classification of optical modules by data rate, form factor, transmission distance, and fiber type.

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Selecting SFP modules for long-distance fiber links requires a combination of optical physics, system design, and procurement

How 10G SFP+ ER Modules Enable Long-Distance Optical Link

Long-distance optical links are vital for enabling the spread of high-speed networking, but they come with unique

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Learn how to select the ideal optical transceiver module based on speed, fiber type, compatibility, and real deployment

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This article presents a comparison of modulation techniques applicable to deep-space optical communication. We assume a gamma

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What Are the Key Parameters of Optical Modules

Understand the key parameters of optical modules, including transmission rate, distance, wavelength, and fiber

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Understanding Single-mode and Multi-mode Optical Modules and Optical ...

Single-mode optical modules are optimized for long-distance transmission, thanks to their ability to minimize signal loss and

Fiber Optic Cable Distance: A Comprehensive Guide

How far is single mode fiber distance? Optical Transmission of Single-mode Fiber SMF,

Designing a Module for High-Speed Optical Communication

The ultimate goal for all-optical connectivity with an ultra-high F5G bandwidth is to increase transmission rates. Optical modules —

Things You Need to Know About Optical Modules and Wavelengths

Multi-mode optical modules are used for short-range (SR) transmission, whereas single-mode optical modules are

Key Differences Between Single-Mode and Multimode Optical Modules

Compare single-mode and multimode optical modules by core size, distance, speed, and cost. Choose the right

Going the Distance: The Tech Behind Long-Haul Fiber Optic

Long-distance fiber optic transmission is a fascinating field where physics, engineering, and innovation converge to

Common 400G QSFP-DD Transceiver Types in the Market

The 400G QSFP-DD optical modules offer a cost-effective and low-power solution for next-generation data centers,

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However, fiber optic cable performance over distance varies depending on factors such as cable type, installation

The Complete Guide to the Best Choice of 10G SFP+ Optical Modules

Conclusion Selecting the best 10G SFP+ optical module for your network involves understanding your specific requirements and

Top Optical Transceiver Modules for Data Center Applications

Explore the best optical transceiver modules for modern data centers, including SFP+, QSFP28, QSFP-DD, and

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The transmission distance of optical modules can be estimated by analyzing factors like wavelength, fiber optic cable

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