

Optical Module Bandwidth Selection



Overview

Selecting high-quality optical modules ensures reliable and predictable network operation in high-speed, high-bandwidth environments.

Key Takeaways

Optical module bandwidth is determined by the combination of data rate, modulation format, wavelength, and photodetector response, which together define the module's performance and transmission capabilities.

Key Bandwidth-

Related Parameters1. Data Rate and Modulation Format The data rate specifies the maximum speed at which an optical module can transmit information, typically ranging from 1G to 1.6T in modern systems.

Modulation format (e.g., NRZ, PAM4) affects bandwidth efficiency, determining how much data can be transmitted per optical carrier and influencing the required per-lane speed for system architecture. 2. Optical Bandwidth vs.

Modulation Bandwidth Optical bandwidth refers to the spectral width of the light source (in THz or nm), while modulation bandwidth is the maximum frequency at which the optical signal can be varied or detected (in MHz or GHz). The achievable data rate depends on both the optical bandwidth and the system's spectral efficiency. 3.

Wavelength and Center Wavelength The center wavelength (e.g., 850nm, 1310nm, 1550nm) determines fiber type compatibility and transmission distance. Multimode fibers typically use 850nm for short distances, while single-mode fibers use 1310nm or 1550nm for longer distances, with 1550nm supporting up to 120km without amplification. 4.

Transmit Power and Receiver Sensitivity Transmit optical power and receiver sensitivity define the effective link budget. High sensitivity and appropriate transmit power ensure reliable signal detection over the intended distance, accounting for fiber loss and dispersion. 5.

Photodetector Bandwidth (3-dB Bandwidth) The 3-dB bandwidth of a photodetector is the frequency at which the detected signal power drops to 50% of its low-frequency value. It is inversely related to the detector's rise and fall time and directly impacts the maximum modulation frequency the module can support. 6.

Transmission Distance and Dispersion Transmission distance is limited by fiber loss and chromatic dispersion. For example, 1310nm single-mode modules have higher loss but lower dispersion, suitable for distances up to 40km, while 1550nm modules have lower loss but higher dispersion, supporting longer links. 7.

Power Consumption and Thermal Design High-speed modules require careful thermal management.

DS

Ps, TIAs, and laser drivers contribute to power consumption, which affects module reliability and maximum achievable bandwidth.

Summary

Optical module bandwidth is a function of data rate, modulation format, optical spectrum, photodetector response, and link design. Understanding these parameters ensures proper module selection for network performance, distance requirements, and system reliability. High-speed modules, such as 400G or 800G transceivers, rely on advanced DSPs, low-loss fibers, and optimized photodetectors to achieve maximum bandwidth while maintaining power efficiency and signal integrity.

Article Content

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Bandwidth – optical spectrum, telecom fiber

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