

Optical Module Types Explanation



Overview

Many different forms of optical modulation and multiplexing have been employed in optical modules. The most common modulation technique historically has been on-off keying or NRZ. Pulse-amplitude modulation (PAM-4) has also been extensively used. In the 2010s, coherent optical modulation has been used. Techniques include Dual Polarization Quadrature Phase Shift Keying (DP-QPSK) and QAM-16.

Key Takeaways

An optical module is a physical-layer device in fiber-optic communication, generally classified as an optical transceiver, transmitter, or receiver, and further categorized by packaging, data rate, and wavelength. Functional Category

Optical modules operate at the physical layer of the OSI model and serve as photoelectric converters, transforming electrical signals into optical signals and vice versa during fiber-optic transmission. Functionally, they can be divided into:

- Optical Transceivers: Combine both transmitting and receiving functions in a single module.
- Optical Transmitters: Only send optical signals.
- Optical Receivers: Only receive and convert optical signals to electrical signals.
- Optical Forwarding Modules: Specialized modules for signal forwarding in certain network architectures.

Classification by Packaging

Optical modules are also categorized based on their physical form factor, which affects compatibility and port density. Common package types include:

- SFP (Small Form-factor Pluggable)
- SFP+ and SFP28
- QSFP, QSFP+, QSFP28, QSFP-DD
- OSFP, CFP, CXP, XFP, X2/XPAK, XENPAK These packages differ in size, channel count, and supported data rates, with smaller modules like SFP allowing higher port density on switches .

Classification by Data Rate

Optical modules are often classified according to their transmission speed, such as:

- FE (Fast Ethernet)
- GE (Gigabit Ethernet)
- 10GE, 25GE, 40GE, 100GE, 400GE, 800GE, 1.6T Higher data rates typically require more advanced packaging and tighter tolerances .

Classification by Wavelength

Another important classification is based on the central wavelength of the optical signal:

- 850 nm: Short-wavelength modules, typically for short-distance transmission.
- 1310 nm and 1550 nm: Long-wavelength modules, suitable for longer distances.
- Color-coded modules: Used in CWDM (Coarse Wavelength Division Multiplexing) and DWDM (Dense Wavelength Division Multiplexing) systems for multiplexing multiple wavelengths on a single fiber .

Summary

In essence, an optical module falls under the physical-layer networking hardware category and is primarily an optical transceiver. Its subcategories are defined by function (transmit, receive, transceive), packaging (SFP, QSFP, CFP, etc.), data rate (10GE, 100GE, 400GE, etc.), and wavelength (850 nm, 1310 nm, 1550 nm, CWDM/DWDM), allowing network designers to select modules based on performance, distance, and application requirements .

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