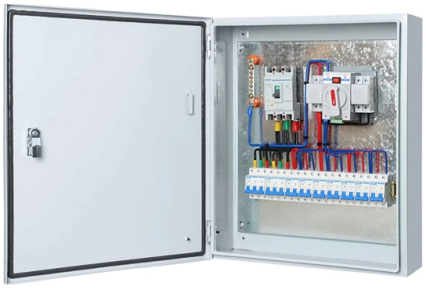
Functions of the Dual-Rate 400G Optical Module



Overview

400 Gigabit Ethernet (400G) transceivers are optical modules capable of handling data rates of 400 Gbps.

Key Takeaways

A Dual-Rate 400G Optical Module supports both 400G and lower-speed configurations, enabling flexible deployment through multi-rate operation, lane aggregation, and breakout modes.Multi-Rate Operation

Dual-Rate 400G modules are designed to operate at multiple transmission rates, typically supporting 400G as the maximum rate while also allowing operation at 200G or 100G per port through electrical or optical lane conversion. This flexibility ensures compatibility with various network devices and transport requirements, allowing a single module to adapt to different deployment scenarios without replacing hardware ( ).

Lane Architecture and Modulation

These modules commonly use an eight-lane architecture, with each lane transmitting at 50 Gbps using PAM4 modulation. PAM4 doubles the data rate per lane compared to traditional NRZ signaling, enabling 400G transmission with fewer fibers. A Digital Signal Processor (DSP) and gearbox circuitry manage the conversion between lane rates, such as combining 8x50G lanes into 4x100G lanes or 2x200G lanes, depending on the selected mode ( ).

Breakout Capabilities

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Dual-Rate 400G modules support breakout modes, allowing the module to be logically divided into multiple lower-speed ports:

• 1x400G: All lanes combined for a single 400G port.

• 2x200G: Two separate 200G ports.

• 4x100G: Four 100G ports for flexible connectivity in data centers ( ).

Coherent and Adaptive Features

Some dual-rate 400G modules, particularly coherent optics variants, can dynamically adjust modulation formats and data rates based on fiber conditions. This allows operation over varying distances, from short intra-data center links to ultra-long-haul networks, while maintaining high spectral efficiency and signal integrity ( ).

Applications

• Data Centers: High-density 400G connectivity with flexible breakout for 100G or 200G links.

• Metro and Long-Haul Networks: Coherent dual-rate modules extend reach and optimize bandwidth over single-mode fiber.

• Service Providers: Multi-rate support reduces inventory complexity and enables seamless upgrades from lower-speed networks to 400G ( ).

Summary

The Dual-Rate 400G Optical Module functions as a versatile, high-speed transceiver capable of:

• Supporting multiple data rates (400G, 200G, 100G)

• Aggregating and converting lanes via DSP and gearboxes

• Providing breakout options for flexible network deployment

• Adapting to fiber conditions in coherent optics applications This combination of features ensures efficient, scalable, and cost-effective deployment in modern high-performance networks.

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400G DCO QSFP56-DD ZR and ZR+ Optical Module In our last newsletter, we shared about 400G PAM4 Ethernet and 400G

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