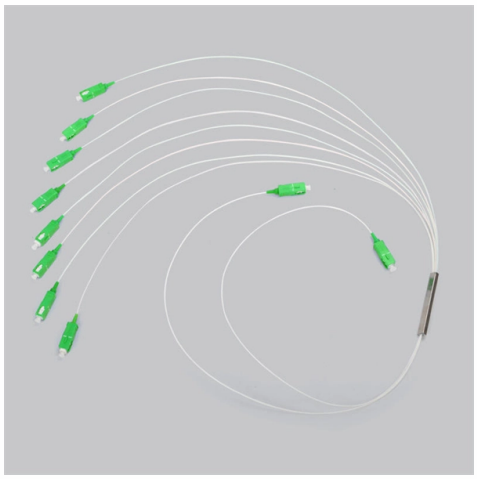
Reducing power consumption of optical modules



Overview

How to Reduce Power Consumption of Optical Transceivers in This guide will provide actionable strategies to significantly reduce optical transceiver power.

Key Takeaways

Power consumption in optical modules can be reduced through DSP optimization, linear drive schemes, efficient modulators, improved electro-optic efficiency, and advanced packaging techniques.

DSP and Signal Processing Optimization

Reducing the power used by digital signal processors (DSPs) and clock-data recovery (CDR) circuits is a key method. Techniques include adopting a linear drive interface or eliminating DSP/CDR functions entirely for short-reach links, which significantly lowers energy usage. Dynamic voltage scaling (DVS) can also be applied to DSPs, adjusting the supply voltage in real time based on signal quality and temperature, saving substantial power without compromising performance.

Modulator and Laser Efficiency

Selecting low-power modulators and reducing the drive voltage can decrease the power consumption of the optical modulator, as power scales with the square of the voltage. Improving the electro-optic efficiency of the laser and enhancing coupling efficiency ensures that less energy is wasted in converting electrical signals to optical signals.

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Electrical Interface and Packaging

Shortening the electrical interface length and using super-dense or co-packaged optics (CPO) packaging reduces losses and lowers the energy required for signal transmission. High-performance silicon photonics integration can further reduce power by combining multiple optical functions on a single chip, minimizing interconnect losses and improving overall efficiency.

Capacitor and Power Supply Design

Using ultra broadband (UBB) silicon capacitors for AC-coupling and power supply decoupling improves signal integrity and reduces parasitic losses, which can lower total energy consumption by up to 30% in high-speed optical modules. Efficient filtering of power lines reduces noise and enhances the signal-to-noise ratio (SNR), indirectly reducing the power needed for reliable transmission.

Optical Module Architecture

Choosing linear receive optics (LRO) or linear pluggable optics (LPO) instead of fully retimed optics (FRO) can cut module power consumption by up to 70% for short-reach links, as these designs reduce or eliminate internal retiming and forward error correction, shifting some processing to the host ASIC.

Reducing the Ser

Des lane count or length also lowers DSP energy requirements.

Summary

To minimize optical module power consumption: Optimize DSP/CDR usage and apply dynamic voltage scaling. Use low-power modulators and reduce drive voltage. Improve laser electro-optic and coupling efficiency.

Shorten electrical interfaces and adopt dense or co-packaged designs. Integrate silicon photonics and use UBB silicon capacitors for power decoupling. Consider linear optics architectures for short-reach applications.

These strategies collectively enhance energy efficiency, reduce thermal load, and support higher-density deployments in modern data centers.

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How to reduce power consumption of optical modules

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