

NRZ Solution for Optical Transceiver Modules



Overview

Optical Transceivers | Amphenol Active Optics Products 50 Gbps High-Speed Optical Module Card in an adapter card interface enabling two Amphenol Ruggedized.

Key Takeaways

NRZ (Non-Return-to-Zero) remains a simple, reliable, and cost-effective modulation scheme widely used in optical transceiver modules for high-speed data transmission. Understanding NRZ in Optical Transceivers

NRZ encoding represents digital data using two voltage levels: a high voltage for logic '1' and a low voltage for logic '0', without returning to zero between consecutive bits of the same value. This simplicity reduces spectral bandwidth requirements compared to Return-to-Zero (RZ) encoding, making NRZ highly efficient for optical transceivers. NRZ transmitters and receivers are easier to design, consume less power, and are cost-effective, which is critical for large-scale deployments like data centers.

Advantages of NRZ for Optical Modules

- **Reduced Bandwidth Usage:** NRZ avoids intermediate transitions, allowing higher data rates over the same optical channel.
- **Implementation Simplicity:** NRZ transceivers require less complex circuitry, reducing design and manufacturing costs.

- **Proven Reliability:** Decades of use in optical networks make NRZ a robust and well-understood solution.
- **Low-Latency Performance:** NRZ is suitable for time-sensitive applications such as radio access networks and industrial automation, where simpler modulation reduces DSP and equalization overheads .

NRZ-Compatible Optical Transceiver Examples

Several modern optical transceivers support NRZ signaling:

- **Amphenol LEAP® On-Board Transceiver:** A 12-channel duplex module capable of up to 25 Gbps per channel (300 Gbps cumulative) on multi-mode fiber, offering rugged and high-performance solutions for dense network architectures .
- **Quad Embedded Pluggable Transceiver (QEPT):** Aggregates 100 Gbps over 4 channels, supporting speeds up to 28 Gbps per channel and designed for extreme conditions. It can be upgraded to PAM4 while maintaining the same footprint, providing flexibility for NRZ-based deployments .
- **Low-Power NRZ Optical Receivers:** Research demonstrates 4x56 Gbps NRZ receivers with 1 pJ/bit energy efficiency using CMOS and Ge-on-Si photodetectors, optimized for one-hop optical switching in time-sensitive networks .

Applications

NRZ optical transceivers are ideal for:

- **Data Centers:** High-density, cost-effective interconnects.
- **Industrial Automation:** Low-latency, reliable communication.
- **Disaggregated Networks:** Supporting machine-type communications and optical switching with minimal DSP overhead .

Conclusion

NRZ remains a practical and efficient solution for optical transceiver modules, balancing simplicity, low power consumption, and reliable high-speed data transmission. Products like Amphenol's LEAP® and QEPT modules exemplify NRZ implementation in modern optical networks, making them suitable for both standard and time-sensitive applications .

Article Content

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