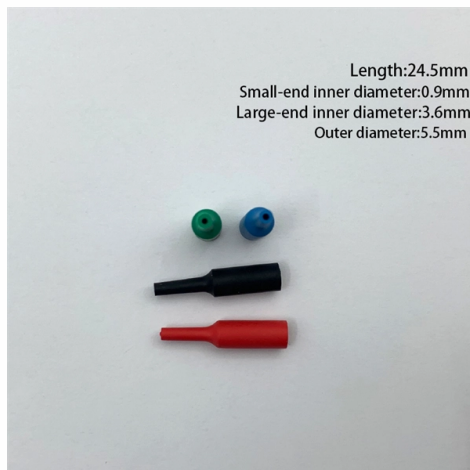


RIVO MULTITRADE OPTICAL SYSTEMS

Why is CDR needed in optical modules



Overview

In high-speed fiber-optic communication, data centers, and long-haul transmission systems, signal integrity is critical.

Key Takeaways

Clock Data Recovery (CDR) is essential in optical modules for accurately extracting the clock from high-speed data signals and restoring the transmitted data, ensuring reliable and high-speed optical communication. Core Function of CDR

In optical modules, data and clock signals are often transmitted together over optical fibers. During transmission, signals can become distorted due to attenuation, dispersion, noise, and jitter. CDR technology separates and recovers the original clock and data signals from the distorted input, providing a precise timing reference for data sampling and processing. This ensures that the receiving end accurately reconstructs the transmitted information, maintaining signal integrity and minimizing bit errors .

Working Principle

CDR typically employs a Phase-Locked Loop (PLL) or Delay-Locked Loop (DLL) system. The process involves:

- Phase Detection: Comparing the phase of the incoming signal with the internally generated clock.
- Loop Filtering: Smoothing the control voltage to remove high-frequency noise.

- **Voltage-Controlled Oscillator (VCO):** Adjusting the clock frequency and phase to synchronize with the input signal. Once the clock is recovered, the data is sampled at optimal points, reducing errors caused by signal distortion and jitter .

Importance in Optical Modules

CDR is critical for:

- **High-Speed Data Transmission:** Essential for 100G, 400G, and higher-speed modules where precise timing is required to decode data correctly .
- **Signal Integrity:** Retimes data to eliminate jitter and reshapes signals, reducing bit error rates (BER) and improving reliability .
- **Long-Haul and Data Center Applications:** Supports 400G ZR, 800G modules, and backbone networks by maintaining stable communication over long distances .
- **Integration with DSPs:** In modern high-speed modules, CDR functions are often integrated into the DSP, handling complex modulation schemes like PAM4 or coherent optics, and performing advanced equalization and error correction .

Practical Considerations

- **Configuration:** Traditional discrete CDR chips may require basic configuration, while DSP-integrated CDRs in 100G+ systems are typically self-contained and do not need independent setup .
- **Latency:** While CDR improves signal quality, it introduces minimal latency. For ultra-low latency applications, CDR bypass can be used to reduce processing time .
- **Analogy:** CDR acts like a "signal metronome" or intelligent dispatcher, ensuring that data is correctly aligned and decoded at the receiving end, similar to unloading train carriages in order according to a rhythm . In summary, CDR is a fundamental technology in optical modules, enabling high-speed, accurate, and reliable data transmission by recovering clock signals, retiming data, and mitigating transmission impairments. Its integration into modern DSPs further enhances performance in complex, high-bandwidth optical networks.

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25Gbps results (TIA w/o CDR, TIA w/I CDR Wirebond and SFP+ EVB, completed ESD Jitter 19ps p2p => 9.8ps p2p Recent ramp-up

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Clock and Data Recovery (CDR) circuits perform the function of recovering clock and re-timing received data in optical links. These

Clock Data Recovery (CDR): The Invisible Guardian Behind Optical Modules

At the same time, as the integration of optical modules becomes higher and higher, CDR circuits also need to be

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