

Article Overview

Clock Data Recovery (CDR) is a critical technology in optical modules that extracts and restores clock and data signals from high-speed optical transmissions, ensuring accurate and reliable communication.

What is CDR?

Clock Data Recovery (CDR) is a technology used in optical communication systems to recover the clock signal and the data signal from a received optical signal that may have been distorted during transmission . In optical modules, data and clock signals are often encoded together and transmitted over fiber, making it impossible to provide a separate clock line at the receiver. CDR acts like a "signal metronome," providing a timing reference to correctly sample and interpret the incoming data .

Working Principle

CDR typically uses a phase-locked loop (PLL) and data sampling techniques to restore signals . The PLL consists of a phase detector, loop filter, and voltage-controlled oscillator, which work together to align the recovered clock with the incoming data. The CDR circuit then re-times, reshapes, and re-amplifies the data, eliminating jitter and distortion caused by fiber loss, dispersion, or external noise . This ensures that the receiving end accurately reconstructs the transmitted information.

Importance in Optical Modules

CDR is essential for high-speed optical communication, including 10G, 25G, 100G, 400G, and beyond . Without a stable clock reference, high-speed signals cannot be correctly decoded, leading to errors and unreliable communication. CDR improves signal integrity, reduces bit error rate (BER), and supports long-haul transmission, data center interconnects, and backbone networks . In practical applications, CDR can significantly enhance performance; for example, in 400G ZR modules, it has been shown to reduce BER by 38% in cross-regional data transfers .

Configuration and Integration

Whether a CDR chip requires configuration depends on the module design and system architecture. Traditional 10G/25G modules often use discrete CDR chips that require manual configuration . In contrast, many next-generation optical modules integrate CDR functionality into digital signal processors (DSPs), eliminating the need for separate configuration . Some specialized applications, such as ultra-low latency systems, may use CDR bypass to reduce processing delay while still maintaining signal integrity .

Applications

CDR Standard Optical Module

- o High-speed long-haul transmission: Ensures accurate data recovery over long distances.
- o Data center interconnects (DCI): Maintains low BER and high reliability.
- o Ultra-low latency systems: CDR bypass can be used in high-frequency trading or AI clusters to minimize latency .
- o High-performance computing and storage networks: Supports Ethernet, OTN, and SAN infrastructures .

Summary

CDR is an indispensable component of optical modules, acting as the "invisible guardian" that ensures accurate, high-speed, and reliable data transmission. By recovering and synchronizing clock and data signals, it enables modern optical networks to operate efficiently, even at extremely high data rates and over long distances .

In short, CDR in optical modules is a key technical link to ensure high-speed and accurate optical communication data

We demonstrate 4-channel miniature solderable VCSEL-based optical modules with an integrated clock-data-recovery (CDR)

A pluggable optical module is best treated as a sealed sub-system: it terminates the host's high-speed electrical lanes on one side

The CDR (Clock Data Recovery) chip in optical modules is a core component in high-speed optical communication

Macom offers a series of high-performance, flexible, clock-and-data recovery (CDR) devices to remove the jitter from signals in high

Introduction Optical modules are critical components in fiber optic communications, enabling the conversion between

I am not sure what CDR means when I use optical cable module and want to program it in LabVIEW.

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

What is the use of CDR clock data recovery in optical modules? In high-speed fiber-optic communication, data centers,

The N1075A optical pick-off/converter provides an optical coupler that picks off optical energy to create an electrical

Tri-Edge is a CDR platform optimized for PAM4 optical interconnect in next-generation 200G and 400G data center module and AOC

Clock and data recovery (CDR) in retimers reduce noise and jitter in data signals, extend system link reaches and lower achievable

In this paper, a complete digital CDR is designed, implemented and evaluated on Spartan SP605 FPGA with SerDes circuits to

In high-speed optical communication systems, the optical module CDR chip (Clock and Data Recovery Chip) is one of

Behind the stable operation of optical modules, there is an "invisible guardian" - Clock Data Recovery (CDR)

As one of the core technologies for the stable operation of optical modules, the clock data recovery (CDR) technology

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