How to test the eye diagram of an optical module



Overview

Eye Diagram in Optical Transceivers: Analysis, Testing, and Signal. Learn how eye diagrams reveal signal integrity in optical transceivers. Explore analy.

Key Takeaways

Optical module eye diagram testing involves generating a repeatable test pattern, capturing the signal with a high-speed oscilloscope, and analyzing the eye opening to assess signal integrity and compliance. 1.

Test Setup and Equipment

To perform eye diagram testing, the following equipment and components are required: High-speed oscilloscope: Captures and overlays the signal waveform to form the eye diagram. Bit Error Rate Tester (BERT): Generates a known, repeatable test pattern, typically a Pseudo-Random Binary Sequence (PRBS), to ensure all possible bit sequences are represented. Differential probes: Connect the oscilloscope to the optical module or electrical interface, especially for differential signals.

Clock recovery unit: Synchronizes the oscilloscope to the data signal when a separate clock is unavailable. Module Compliance Boards (MCB) or Host Compliance Boards (HCB): Provide standardized electrical interfaces and reliable probing points for QSFP-DD, OSFP, or SFP modules. 2.

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Signal Generation

Generate a clean, stable digital signal using the BERT or equivalent pattern generator. Use a PRBS pattern to cover all possible bit transitions, ensuring the eye diagram captures worst-case scenarios. Ensure the signal amplitude and rise/fall times meet the module specifications.

3.

Triggering Methods

Eye diagrams can be constructed using different triggering techniques: Clock trigger: Uses a system clock to trigger the oscilloscope, producing a classical eye diagram with all bit transitions overlaid. Divided clock trigger: Useful when the oscilloscope's trigger bandwidth is lower than the data rate; divides the clock to capture a complete eye. Pattern trigger: Triggers on specific bit sequences to display individual bits or sections of the pattern.

Clock recovery from data: Extracts the embedded clock from the data signal when no external clock is available. 4.

Capturing the Eye Diagram

The oscilloscope repetitively samples the signal and overlays multiple bit sequences to form the eye diagram. The horizontal axis represents the bit period (Unit Interval, UI), and the vertical axis represents voltage or optical power. Thousands or millions of bits are superimposed to reveal cumulative effects of jitter, noise, inter-symbol interference, and signal distortion.

5.

Measurement Parameters

Key parameters to evaluate signal quality include: Eye height: Vertical distance between logic “1” and “0”, indicating noise tolerance and BER performance. Eye width: Horizontal opening of the eye, representing timing margin and jitter tolerance. Crossing point: Intersection of upper and lower edges, reflecting duty cycle and pulse broadening; typically adjusted to 40–45% on the transmitter side to achieve ~50% at the receiver.

Jitter analysis: Includes random jitter (RJ), deterministic jitter (DJ), and periodic jitter (PJ) to identify noise sources like EMI or crosstalk. Mask test: Overlay a standard eye mask to check if the signal violates prohibited regions, ensuring compliance with industry standards. 6.

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Analysis and Reporting

Evaluate the openness of the eye: A wide and tall eye indicates minimal distortion and high signal integrity. Compare measured parameters against module specifications and industry standards. Save results for documentation, often exporting data as CSV or text files for further analysis.

Repeat measurements under different conditions (temperature, voltage, or stress tests) to ensure robustness. 7.

Optional Enhancements

Use virtual bit pattern generators in oscilloscopes to simulate eye diagrams without hardware BERTs. Apply jitter injection or controlled stress to evaluate module tolerance to real-world impairments. By following this process, engineers can accurately assess optical module performance, identify signal integrity issues, and ensure compliance with high-speed communication standards.

Article Content

Eye Diagram in Optical Transceivers: Analysis, Testing, and Signal ...

Learn how eye diagrams reveal signal integrity in optical transceivers. Explore analysis methods, test standards, and performance optimization.

Understanding the Eye Diagram in Optical Transceiver Testing

The key parameters and criteria of eye diagram testing in optical transceivers, focusing on how metrics like eye height, eye width, jitter, and extinction ratio affect signal quality, and highlights the critical

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The Role of Eye Diagrams in High-Speed Optical Design | Cinch

Eye diagrams are commonly generated using high-speed oscilloscopes or bit error rate testers (BERTs). The equipment triggers on a known clock and overlays thousands of captured

Performing Eye Diagram Measurements

In the oscilloscope, an eye diagram is often used to analyze signal quality. You can diagnose problems, such as attenuation, noise, jitter, and dispersion that arise or characterize specific parts of the system

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Introduction To Key Parameters Of Optical Module Eye Diagrams

An eye diagram is a pattern displayed on an oscilloscope by accumulating a series of digital signals. It is vividly named so because its shape resembles an open eye.

How To Test A Optical Transceiver? | Complete Test Guide--ETU

All in all, testing a optical transceiver is a complex job, but it is an indispensable step to ensure its performance. Standard optical transceiver testing includes transmitter performance test

Eye Diagram and Digital Signal Testing

The eye diagram reflects that the digital signal is affected by the physical device and the channel. Engineer can quickly obtain the measured parameters of the signal in the product to be

Eye Mode

In Eye/Mask Mode, you can make eye diagram measurements and eye mask tests on NRZ (Non-Return to Zero) and PAM4 coded signals. Measurements are made using a database for multi-valued

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Eye Diagram in Optical Transceivers: Analysis, Testing, and Signal ...

The eye diagram test is an indispensable methodology for evaluating the signal integrity and performance of high-speed digital communication systems, particularly in the domain of optical

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