

PAM4 Laser Diode Test Report



Overview

A 15 Gbps-NRZ, 30 Gbps-PAM4, 120 mA laser diode driverThis paper reports on the design, fabrication, and testing of a 15 Gbps-NRZ, 30 Gbps-PAM4 high current.

Key Takeaways

PAM4 laser diodes have been successfully tested at speeds up to 106GBaud, showing clear eye diagrams, high extinction ratios, and efficient power performance suitable for 800G and 1.6T optical networks.Overview of PAM4 Laser Diode Testing

PAM4 (4-level pulse amplitude modulation) doubles the bit rate compared to NRZ at the same bandwidth, but it is more sensitive to amplitude noise and inter-symbol interference (ISI) due to its multiple signal levels . Testing PAM4 laser diodes involves evaluating eye diagrams, output current levels, bandwidth, and power consumption to ensure reliable high-speed optical transmission.

Driver and Modulation Performance

A 30 Gbps PAM4 laser diode driver (LDD) was implemented using 0.15- μm GaAs E-mode pHEMT technology. The driver combines two 15 Gbps NRZ paths to generate PAM4 output currents of 0, 40, 80, and 120 mA when driving 25- Ω lasers.

Measurement results show clear eye diagrams at 30 Gbps, with a maximum output current of 120 mA and power consumption of 1.228 W from a single -5.2 V supply. The design includes cross-coupled neutralization capacitors and on-chip 50- Ω resistors for bandwidth enhancement and reflection absorption .

Electro-Absorption Modulated Laser (EML) Testing

High-speed 106GBaud EMLs were tested for 800G and 1.6T optical networks. The EML structure combines a distributed feedback laser diode (DFB-LD) for DC bias and an electro-absorption modulator (EAM) for RF modulation. Testing over 2 km of fiber showed high bandwidth, high extinction ratio, low threshold current, and high output power, confirming suitability for AI and data center applications. Using 106GBaud EMLs reduces the number of lasers required compared to 53GBaud devices, improving power efficiency and cost-effectiveness .

Key Test Metrics

- Eye Diagram Clarity: Clear separation of PAM4 levels at target speeds (30–106 Gbps)
 - Output Current Levels: Configurable multi-level currents (0–120 mA) for precise modulation
 - Bandwidth: Sufficient to support 106GBaud operation with minimal ISI
 - Power Consumption: Optimized for high-speed operation (e.g., 1.228 W at 30 Gbps)
 - Extinction Ratio: High ER ensures signal integrity over fiber links
 - Reach: Tested over 2 km for CWDM EMLs, suitable for short-reach data center links
- Conclusion

The PAM4 laser diode tests demonstrate that high-speed, multi-level modulation is feasible for next-generation optical networks, including 800G and 1.6T systems. The combination of advanced driver circuits and EMLs provides high spectral efficiency, low power consumption, and reliable signal integrity, making these devices suitable for AI, cloud computing, and high-bandwidth data center applications .

Article Content

PAM4 Design Challenges and the Implications on Test

The multi-level PAM4 signaling has changed what has been expected in Ethernet test. Learn more about Keysight solutions for

Laser Reliability and Defects

Therefore, high reliability, low power consumption and high speed laser diodes are required for optical interconnects. Vertical cavity

Aging and reliability testing of lasers

Compared to other electronic devices, laser diode testing is more complex as it requires precise measurement of optical and

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