

Test/Validation

"Scaling Electro-Optical Test and Reliability Validation of Silicon Photonics for AI and Hyperscale Data Centers"

The explosive growth of generative AI is driving unprecedented demands on bandwidth, power efficiency, and system scalability, exposing fundamental limitations of conventional electrical interconnects. Ayar Labs is addressing these challenges with a leading-edge silicon photonics (SiPh) co-packaged optical (CPO) platform that enables high-bandwidth, energy-efficient data movement for next-generation AI infrastructure. By integrating photonics and electronics within a unified package, optical I/O overcomes the power and bandwidth-density constraints of electrical interconnects, enabling continued scaling of AI training and inference systems. With technologies such as dense wavelength division multiplexing (DWDM), micro ring-based optical modulation, and ultra-high-density optical port density, optical I/O represents a foundational technology for future hyperscale AI systems. However, widespread deployment of CPO technology requires more than device-level innovation; it demands manufacturing-ready solutions that deliver high yield, reliability, testability, and scalability at volume. The tightly coupled nature of electro-optical devices, advanced packaging, and system integration introduces new challenges in process control, test coverage, automation, and reliability qualification. Rapid design iterations further require scalable development methodologies capable of bridging the gap between R&D laboratory demonstrations and high-volume manufacturing. This paper presents a comprehensive high volume manufacturing test technology and reliability framework. It includes automated test architectures, high-throughput reliability testing methodologies, mixed-control electro-optical wafer sort (EOWS), packaged part qualification strategies, and data-driven process monitoring for volume production. Experimental results demonstrate how automation, scalable test infrastructure, and reliability hardware development improve repeatability, accelerate product qualification, reduce operational complexity, and establish the foundation required for hyperscale deployment of optical I/O. The work provides a practical roadmap for transitioning co-packaged optics from emerging technology to production-ready infrastructure capable of supporting the next generation of AI computing systems.

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