Module Testing Silicon Photonics



Overview

We describe the design of silicon photonic circuits and components that comprise the proposed DFT architecture.

Key Takeaways

Module silicon photonics testing involves comprehensive optical and electrical characterization of photonic integrated circuits (PICs) and co-packaged modules to ensure performance, reliability, and manufacturability.

Overview of Silicon Photonics Testing

Silicon photonics modules integrate optical and electrical components on a single chip or multi-die assembly, enabling high-speed data transmission for applications such as AI, cloud data centers, telecom, 5G, LIDAR, and sensing. Testing these modules is critical across the entire product lifecycle, from early lab development to high-volume manufacturing, to ensure device performance, yield, and reliability. Key Testing ApproachesWafer-Level TestingAutomated wafer probers and test systems, such as Keysight's NX5402A, enable high-throughput testing of PICs before packaging.

Measurements include insertion loss (IL), return loss (RL), polarization-dependent loss (PDL), phase response, group delay (GD), chromatic dispersion (CD), and polarization mode dispersion (PMD). Wafer-level testing helps identify known-good dies for integration into multi-die modules.

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Module and Co-

Packaged Optics TestingTeradyne's Photon 100 platform integrates optical and electrical instrumentation for automated testing of optical engines and co-packaged modules. EXFO's OPAL automated test stations provide precise optical alignment and repeatable measurements for single-die, multi-die, and wafer-level modules. Typical module-level tests include optical switching, attenuation control, tunable laser measurements, and passive component characterization.

Optical Characterization Techniques

Transmission and reflection mode measurements with micrometer-level spatial resolution allow detailed analysis of PICs. Polarization performance, phase ripple, and polarization crosstalk are measured to ensure signal integrity in high-speed optical links. Tunable laser sources combined with optical power meters are used to determine wavelength-dependent insertion loss and transmission characteristics.

Automation and High-

Throughput Testing

Automation software, such as EXFO Pilot or Keysight PathWave TAP, orchestrates test sequences, instrument control, and data analysis. High-density parallel testing architectures, including PXI and benchtop systems, support scalable, cost-effective volume manufacturing. Automated testing reduces human error, accelerates time-to-market, and ensures consistent quality across large production volumes.

Industry Solutions

Teradyne: Offers modular test solutions for wafer, optical engine, and co-packaged module stages, integrating optical and electrical testing for high-throughput manufacturing. Luna: Provides high-resolution optical measurement instruments for detailed PIC characterization, including IL, RL, PDL, GD, CD, and PMD. Keysight: Delivers wafer-level and RF-test solutions for integrated photonics, supporting high-frequency O/E and E/O measurements up to 67 GHz.

EXF

O: Offers automated PIC testing platforms combining OPAL probe stations, optical testers, and Pilot software for scalable lab and production testing.

Conclusion

Module silicon photonics testing is a multi-stage, highly automated process that combines electrical and optical measurements to ensure the performance and reliability of PICs and co-packaged modules. By leveraging wafer-level testing, module characterization, and advanced automation, manufacturers can achieve high-throughput, cost-effective, and precise testing, which is essential for next-generation applications in data centers, telecom, and emerging technologies like quantum computing and autonomous vehicles.

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Article Content

Silicon Photonics Test

As silicon photonics and co-packaged optics become foundational to advanced semiconductor architectures, Teradyne is leading the way with innovative, modular test solutions that span the entire

First Silicon Photonics High Speed (up to 67GHz)

– A Must for Silicon Photonics Integration – High Complexity of Silicon Photonics Modules (112Gbd, 224Gbd application) – Integration of photonics + electronics (e.g., lasers, modulators, drivers, TIAs)

Integrated Photonics Test Products

Photonic Integrated Circuits enable the co-packaging of optical and electrical components, creating new testing challenges that Keysight addresses with

Design-for-Test for Silicon Photonic Circuits

We describe the design of silicon photonic circuits and components that comprise the proposed DFT architecture. The designs are extensively simulated and vali-dated as test-access and fault-detection

Photonic and Optical Test

Designed for precision, accuracy, and flexibility, these solutions help you uncover critical insights into optical performance, ensuring your designs meet today''s demanding requirements. Explore our wide

Automated photonic integrated circuit (PIC) testing

A scalable, automated approach to testing photonic integrated circuits. Testing is critical across the photonics lifecycle—from design and validation to manufacturing. EXFO delivers a complete, flexible

Integrated Photonics

Functional and final performance testing of module include testing according to customer specifications or standards (e.g. transmitter eye mask, TDECQ, wavelength or receiver sensitivity)

Silicon Photonics and PIC Testing

The industry''s most comprehensive range of polarization control solutions provide your automated test systems with the flexibility and speed required for modern PIC testing.

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Silicon Photonics Testing

The system supports wafer-level (8″–12″), multi-chip, and single-chip testing, with reserved interfaces for RF and electrical testing modules, accommodating full optoelectronic testing needs (OO/OE/EO/RF).

Testing at the Speed of Light: Enabling Scalable Optical Testing for ...

By combining deep electrical test expertise with cutting-edge optical capabilities, Teradyne is accelerating the adoption of silicon photonics and co-packaged optics in AI and HPC—at

Design-for-Test for Silicon Photonic Circuits

Abstract—This paper proposes a design-for-test (DFT) method-ology and architecture for testing and validation of silicon photonic integrated circuits. We describe the design of silicon photonic circuits

Silicon Photonics and PIC Testing

Silicon Photonics and PIC Testing Fast and Complete Component Characterization Luna''s unique test systems, based on optical frequency-domain reflectometry (OFDR), deliver accuracy and speed for

Motion Control for Photonics Devices Test & Assembly | PI

Early in the Silicon Photonics saga, they pioneered custom SiPh change-kits: briefcase-sized personalization modules that accommodate each chip design''s I/O configuration within a multi

Silicon Photonics Test

Modular Test Solutions for Next-Generation Silicon Photonics and Co-Packaged Optics As silicon photonics and co-packaged optics become foundational to advanced semiconductor architectures,

Integrated Photonics

Integrated Photonics Test Silicon Photonics - Efficient Wafer Level Test Integrated Photonics, often called Silicon Photonics, promises additional benefits for

Production Testing For Silicon Photonics Wafers

For effective heterogeneous integration and packaging of these silicon-based optical transceivers, individual functional chips such as logic, photonics, and laser must all be tested prior to

Silicon Photonics – Challenges & Solutions for Wafer-Level Production Tests

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SiP-based Optical Transceiver Chipset for QSFP28 module Source: Luxtera''s website, Luxtera acquired by CISCO in Dec 2018 for US$660M. Integrated Wafer-Level Photonics Test Solution

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