

Photonic Solutions: Empowering Innovations from Concept to Manufacturing

Seamless Design Flow from Concept to Manufacture

- Improve quality and turnaround time of design iterations for photonic ICs with schematic-driven layout in Synopsys OptoCompiler™
- Simulate photonic ICs and optical communication systems with Synopsys OptSim™
- Design and optimize passive and active photonic devices with the RSoft™ Photonic Device Tools
- Create PDKs and add custom photonic devices with Synopsys Photonic Device Compiler

Overview

Photonics enable low footprint, high bandwidth, and energy-efficient devices, systems, and integrated circuits (ICs). This is driving the expansion of photonic technologies in a broad range of industries and technologies, including high-performance computing (HPC) and data centers, consumer wearables, automotive, sensing, AI, and quantum information science.

Synopsys is accelerating the adoption of photonic IC technologies with a seamless, unified design platform to help IC designers and photonic engineers innovate and succeed in a wide range of silicon photonic and fiber-optic applications. With Synopsys solutions, design teams have access to industry-leading electronic and photonic design software to achieve greater productivity, accuracy, and faster time to market.

Our design automation tools include Synopsys OptoCompiler, Synopsys OptSim, Synopsys Photonic Device Compiler and the RSoft Photonic Device Tools.

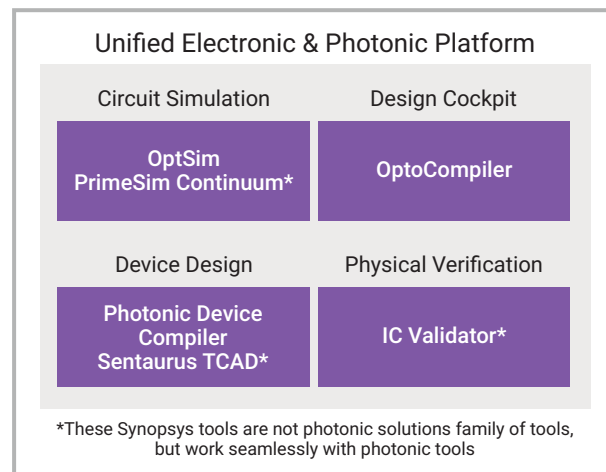


Figure 1: Synopsys' electronic-photonic design platform

Industries and Technologies Supported

- Integrated Photonics: Silicon photonics, III-V technologies such as InP and GaAs, SiN, PLC, and polymers
- Telecom and data center optics: High-speed transceivers with coherent and non-coherent modulation formats, single - and multimode fiber-optic interconnects, photonic systems with multipath interference (MPI), reflections, and resonances
- Computing: High-performance computing (HPC), quantum computing, and AI
- Aerospace and government: Free-space optics, 5G and radio-over-fiber systems, and microwave photonics
- Photonic components: Active and passive photonic devices, ring resonators, ring modulators, travelling-wave Mach-Zehnder modulators (TWMZM), lasers, VCSELs, filters, and more
- Sensing: Photonic and fiber-optic sensors for industrial, medical, and consumer applications
- Consumer and automotive: Wearables, AR/VR, and LiDAR

Unified Photonic and Electronic Design

Synopsys OptoCompiler is the industry's only unified electronic and photonic design platform that combines dedicated and mature photonic technology with Synopsys' industry-proven electronic design tools to enable engineers to produce and verify complex photonic IC designs quickly and accurately. By providing schematic-driven layout and advanced photonic layout synthesis in a single platform, Synopsys OptoCompiler bridges the gap between photonic experts and IC designers—shortening the learning curve, reducing turnaround times, and improving the quality of results.

Key features include:

- Comprehensive features for hierarchical design to enable multiple designers to work closely together to shorten product development cycle times
- Seamless design and simulation of custom photonic components for inclusion in design alongside process design kit (PDK) components
- Ease-of-use features such as native optical port and net support, assisted waveguide routing, auto-alignment of photonic circuits, and curvilinear layout synthesis

Exclusive Features	Ease Design Effort And Maximize Productivity	Avoid Errors	Ease of Use	E-O Enabling
Electronic-photonic co-design (schematic, layout and analysis)				✓
Native optical port and net support		✓		
Native curvilinear shape engine			✓	✓
Seamless abutment at any angle		✓	✓	
Auto-align of photonic circuits			✓	
Waveguide connectors (single and bus)		✓	✓	
Assisted waveguide routing			✓	
Back-annotation of routing contents back to schematic and simulator		✓		
Integrated native photonic simulator		✓		✓
Optimized photonic DRC		✓		
Photonic + electronic LVS		✓		✓
Seamless design and simulation of custom photonic components for inclusion in design alongside PDK components			✓	
Photonic synthesis of optically-defined components such as filters		✓	✓	
Electrical auto-routing				✓

Table 1: Synopsys OptoCompiler key capabilities

Photonic Integrated Circuit Simulation

Use Synopsys OptSim to model and optimize photonic ICs at the circuit level, including coupling and feedback of optical and electrical signals. Synopsys OptSim can be used as a standalone solution with its own graphical user interface (supported on both Windows and Linux) or integrated with Synopsys OptoCompiler (supported on Linux).

When used as an OptoCompiler-integrated simulator, OptSim: (i) supports electro-optic co-simulation with Synopsys PrimeSim™ HSPICE and PrimeSim SPICE electrical circuit simulators; (ii) integrates seamlessly with Synopsys PrimeWave for advanced simulation, analyses and visualization; and (iii) provides single- and multimode fiber-optic system modeling capabilities. When used as a standalone simulator, Synopsys OptSim supports schematic entry, simulation setup, and visualization.

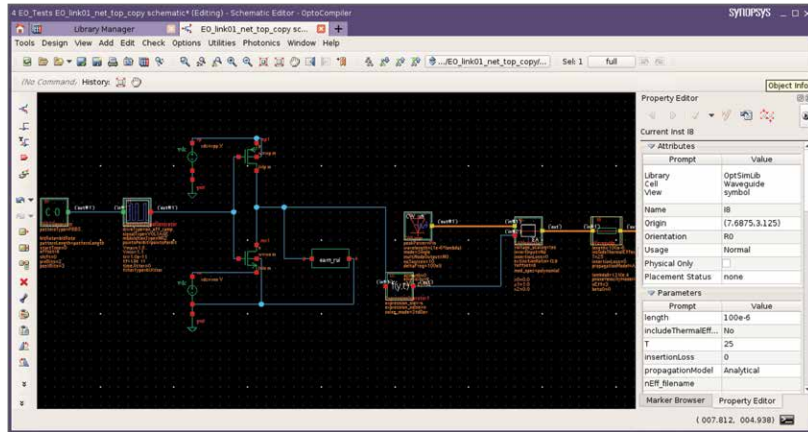


Figure 2: Synopsys OptSim supports co-simulation of electronic and photonic circuits

Key features include:

- Enables pre- and post-layout simulation and back-annotation of photonic parasitics
- Supports foundry model libraries and comes with a complete library of generic model templates of integrated photonic devices
- Supports custom design with foundry models and custom devices
- Models bidirectional signal flow for both optical (single- and multi-wavelength) and electrical signals
- Supports Monte Carlo and corner analyses
- Simulates design hierarchies
- Supports electro-optic co-simulations with Synopsys PrimeSim HSPICE and PrimeSim SPICE

Fiber-Optic Communication System Simulation

In addition to modeling photonic ICs at the circuit level, Synopsys OptSim can help you design spectrally efficient fiber-optic communication systems. With state-of-the-art time- and frequency-domain split-step algorithms, Synopsys OptSim's simulation engines facilitate rigorous analyses of linear, non-linear, and polarization-dependent transmission impairments.

You can perform system simulations within the Synopsys OptoCompiler platform or in a standalone version of Synopsys OptSim. Using OptSim as part of OptoCompiler gives you a seamless electro-optical co-design experience, since the Synopsys PrimeSim family of electrical circuit simulators can also be integrated within OptoCompiler.

Key features include:

- Optimizes data communication performance to meet or exceed design goals
- Supports brownfield and greenfield deployments
- Includes an extensive library of photonic, opto-electronic, electronic and microwave/RF components
- Provides hundreds of pre-supplied designs for rapid prototyping
- Offers easy-to-use options to account for component tolerances and estimate Monte Carlo performance bounds
- Provides powerful insights into the role of electrical and optical noise in systems and their interplay with transmission impairments
- Supports testing and optimization of photonic components and PICs in the context of system performance and compliance with industry standards

Applications include data center and automotive optical interconnects, aerospace and defense radio-over-fiber communication systems, long-haul and passive optical networks, sensor systems such as VCSEL-based 3D sensing, time-of-flight, LiDAR, biometric OCT, and iFoG.

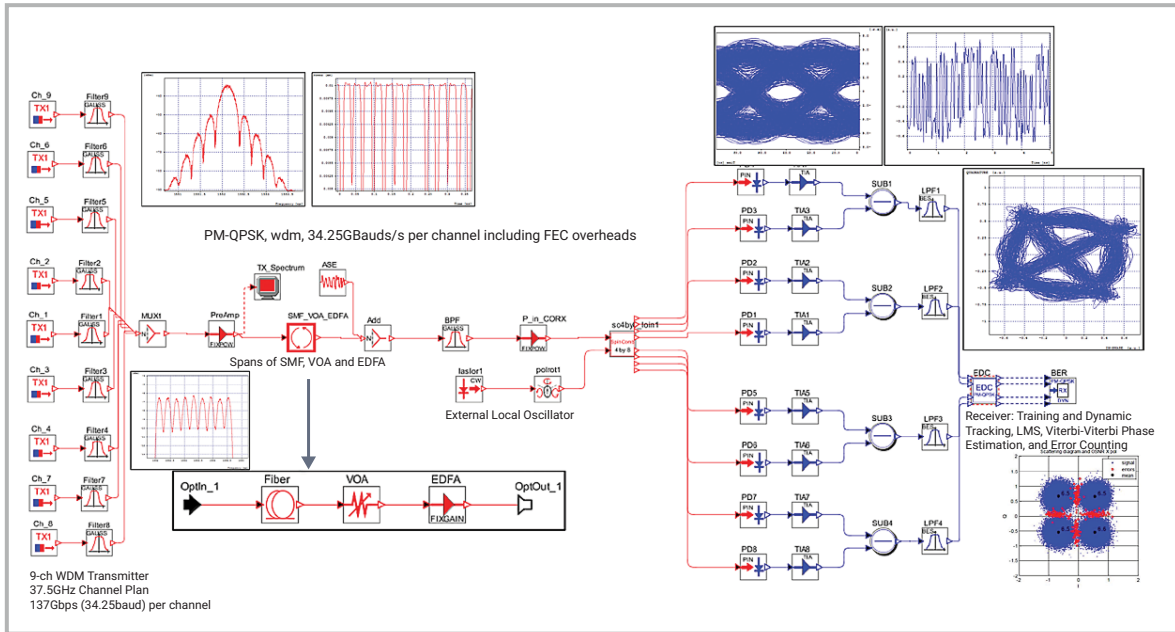


Figure 3: Synopsys OptSim provides comprehensive simulations optical communication systems

Photonic Device Design

The RSoft Photonic Device Tools provide the industry's largest portfolio of simulators and optimizers to design passive and active photonic and optoelectronic devices. You can design any type of photonic device, including lasers, VCSELs, integrated photonic devices such as MMI, gratings, splitters and couplers, modulators, photo diodes, and nanostructures.

The RSoft Photonic Device Tools bring together Synopsys optical and semiconductor design tools to enable streamlined, multi-domain co-simulations. The tools are integrated with CODE V and LightTools products for rigorous modeling of nano-textured optical structures and diffraction analysis in imaging and illumination applications.

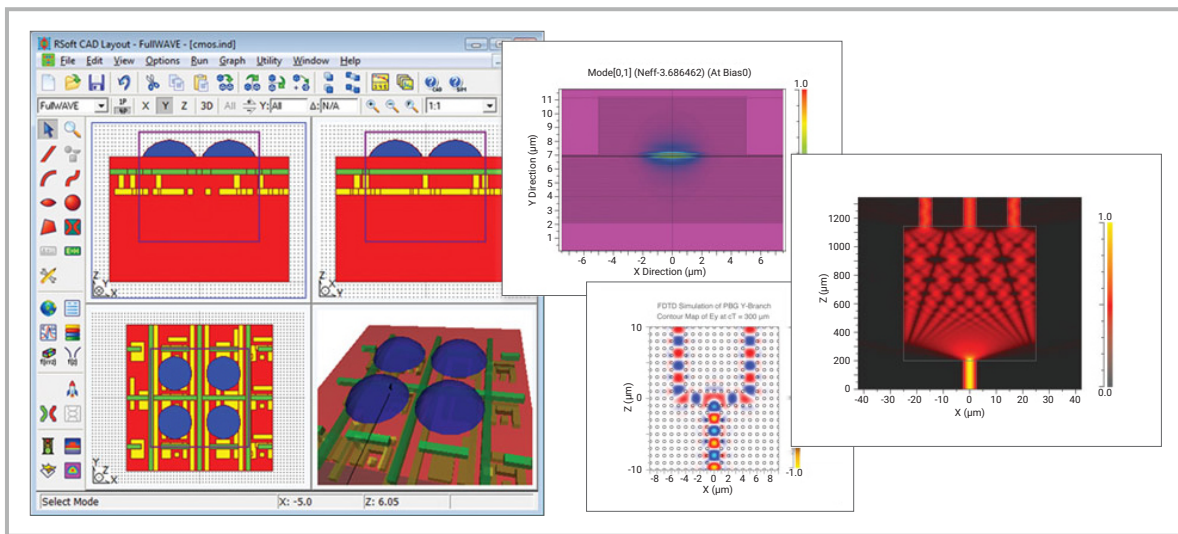


Figure 4: RSoft Photonic Device Tools provide the industry's largest portfolio of simulators and optimizers

Custom Design and PDK Development

Synopsys Photonic Device Compiler, which is part of the Synopsys OptoCompiler platform, uses RSoft Photonic Device Tools and the Custom PDK Utility to provide photonic IC designers and PDK developers with a powerful solution to generate foundry-specific building blocks as well as augment existing PDKs with your own custom components. This allows designers to automate the process of generating symbols, analytical models, and parametric layouts for Synopsys OptoCompiler and OptSim.

Process Design Kits

Synopsys has the most comprehensive photonic IC foundry support in the industry, with process design kits (PDKs) available from foundries around the world for photonic processes such as silicon, silicon nitride, indium phosphide, polymers, and silica-on-glass. Our solutions have supported more than 1,500 tapeouts.

Our solutions support all technologies:

- Silicon photonics
- InP/III-V
- TriPleX
- SiO2/SiN technologies, including polymers and silica

We work with AIM Photonics, amf, CEA-Leti, ePIXfab, Fraunhofer-HHI, GF, imec, JePPIX, LIGENTEC, LioniX International, SMART Photonics, Tower Semiconductor, and others to enable mutual customers and develop the ecosystem to accelerate the adoption of photonic IC technologies.

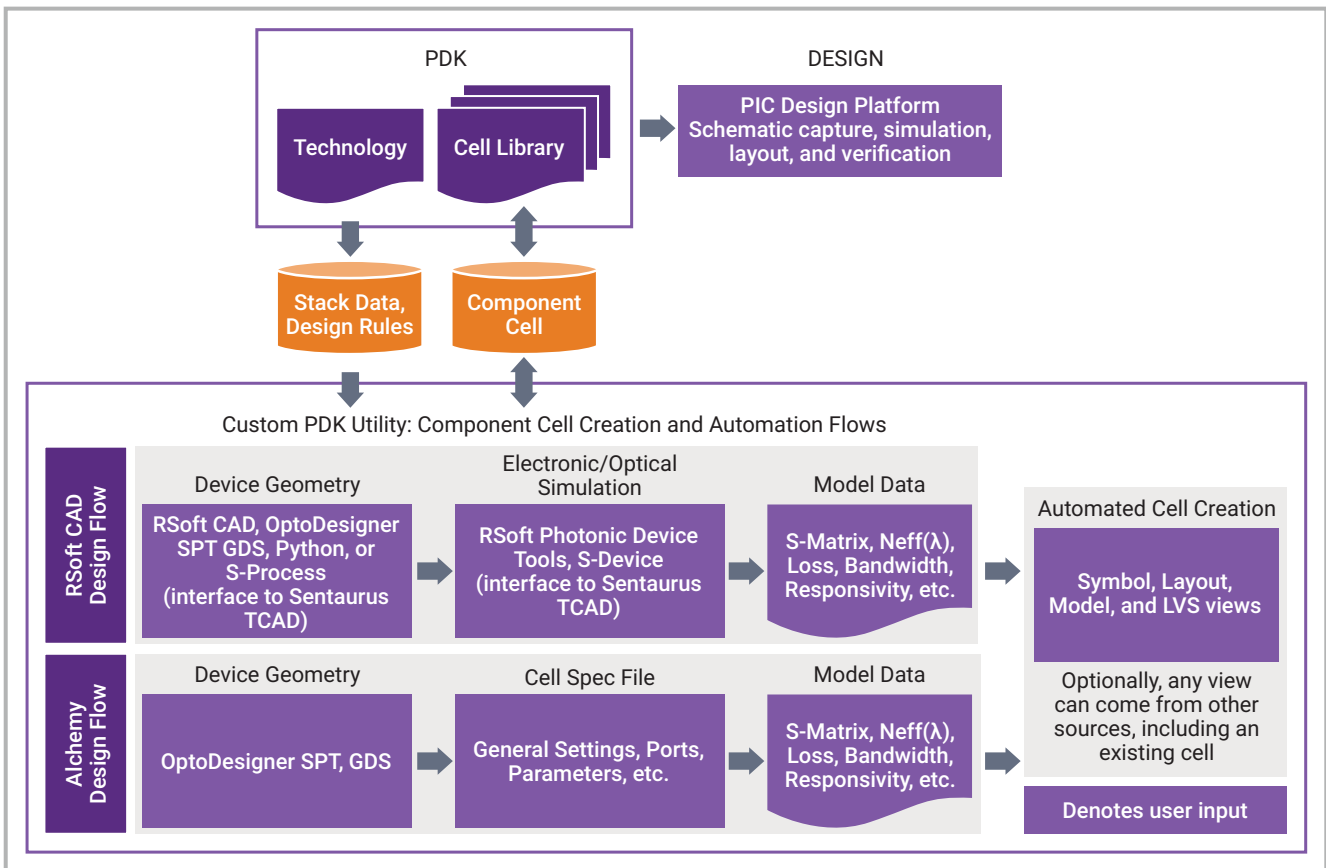


Figure 5: Synopsys supports a comprehensive set of foundry PDKs; you can also create custom PDKs

Setting Up Your Own PDK

PDKs are available as a plug-in library for our photonic IC design solutions. For vertically integrated organizations, foundries engaging in integrated photonics manufacturing, or customers using a foundry that is not yet supported, we offer engineering services to help teams with foundry-specific compact models, block definitions, layouts, and physical verification rules.

Obtaining Photonic IC Foundry PDKs

Our solutions are used by many designers around the world to access MPW services and work directly with R&D facilities and commercial foundries. Please contact us at photonics@synopsys.com for details about how to obtain a PDK for a specific foundry.

Experts in Electronic and Photonic Design Automation

Synopsys has over 30 years of leadership in electronic design automation, combined with a legacy of photonic innovations for over 25 years. We are uniquely positioned to provide best-in-class photonic design solutions and a scalable path towards full electric-photonic co-design. Visit us online at [synopsys.com/photonic-solutions](https://www.synopsys.com/photonic-solutions).

To Get Started

Contact us today at photonics@synopsys.com to request a demo and free 30-day evaluation.

For more information about Synopsys products, support services or training, visit us on the web at www.synopsys.com, contact your local sales representative or call 650.584.5000.