Overview

Photonics, or the manipulation and movement of light waves, represents a growing opportunity for designing and manufacturing devices, systems and integrated circuits for applications in high-speed data communications, advanced sensing, and imaging. Photonic technologies promise orders-of-magnitude speed improvements with reduced power consumption for data transmission and ultra-sensitive sensing capabilities in multiple domains.

Synopsys is accelerating the adoption of photonic IC technologies with the industry’s first unified solution, which includes the OptoCompiler electro-optical IC design solutions, the OptSim simulation solution, and Photonic Device Compiler for photonic device design and PDK development. Synopsys Photonic Solutions offer a seamless and unified design platform to help IC designers and photonic engineers innovate consumer, health, and industrial applications. With Synopsys software solutions, design teams have access to widely used, high-quality electronic and photonic design solutions to improve results and reduce time to market.

Markets, Applications, and Technologies

- Communication systems
- 5G
- Radio-over-fiber networks
- Microwave photonics
- AR/VR
- Quantum computing
- Photonic components: passive and active
- LiDAR
- Chemical sensing
- Metamaterials and metalenses
- Spectroscopy
- Integrated Photonics: Silicon photonics, III-V like InP and GaAs, SiN, PLC, polymers and more
- Transceivers for coherent and non-coherent fiber optic communication systems
- Photonic systems with multipath interference (MPI), reflections and resonances
- Ring resonators, ring modulators, traveling-wave Mach-Zehnder modulators (TWMZM), optical filters
- Biophotonic sensors
Access a Complete Portfolio of Photonic Device Simulators and Optimizers

The RSoft Photonic Device Tools provide the industry’s widest 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 like MMI’s, 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. Our tools are integrated with:

- Synopsys CODE V and LightTools products for rigorous modeling of nano-textured optical structures and diffraction analysis in imaging and illumination applications
- Synopsys Sentaurus TCAD products for the design and simulation of complex optoelectronic devices

Complete Platform of Photonic Integrated Circuit (PIC) Design Solutions

Our PIC design tools empower photonic innovations from concept to manufacturing:

- OptoCompiler supports electronic-photonic co-design to ensure scalable design processes
- Tools include: OptSim, Photonic Device Compiler, IC Validator, PrimeSim, StarRC, and OptoDesigner tools
- Supports photonic-aware physical layout capabilities enabled by foundry PDKs

OptoCompiler: Unified Photonic & Electronic Design

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 PIC designs quickly and accurately. By providing schematic-driven layout and advanced photonic layout synthesis in a single platform, 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

<table>
<thead>
<tr>
<th>Exclusive Features to Ease Design Effort and Maximize Productivity</th>
<th>Avoid Errors</th>
<th>Reduce Size of Use</th>
<th>Enable E-O Interfacing</th>
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</thead>
<tbody>
<tr>
<td>Electronic-photonic co-design (schematic, layout and analysis)</td>
<td>✔</td>
<td>✔</td>
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<td>Native optical port and net support</td>
<td>✔</td>
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<td>Native curvilinear shape engine</td>
<td>✔</td>
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<td>Seamless abutment at any angle</td>
<td>✔</td>
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<td>Auto-align of photonic circuits</td>
<td>✔</td>
<td>✔</td>
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<td>Waveguide connectors (single and bus)</td>
<td>✔</td>
<td>✔</td>
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<td>Assisted waveguide routing</td>
<td>✔</td>
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<tr>
<td>Back annotation of routing contents back to schematic and simulator</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Integrated native photonic simulator</td>
<td>✔</td>
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<td>Optimized photonic DRC</td>
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<td>Photonic + electronic LVS</td>
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<td>✔</td>
<td>✔</td>
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<tr>
<td>Seamless design and simulation of custom photonic components for inclusion in design alongside PDK components</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Photonic synthesis of optically-defined components such as filters</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Electrical auto-routing</td>
<td>✔</td>
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Photonic Integrated Circuit Simulation with OptSim

Use OptSim to model and optimize PICs at the circuit level, including coupling and feedback of optical and electrical signals. OptSim can be used as a standalone solution with its own GUI (Windows, Linux), or integrated with the OptoCompiler Photonic IC design platform (Linux). When used as an OptoCompiler-integrated simulator, OptSim (i) supports electro-optic (E-O) co-simulation with Synopsys PrimeSim HSPICE and PrimeSim SPICE electrical circuit simulators, (ii) integrates seamlessly with the PrimeWave Design Environment for advanced simulation, analyses and visualization including parametric scans, Monte Carlo and corner analyses, and (iii) provides single- and multimode fiber-optic system modeling capabilities. When used as a standalone simulator, OptSim’s GUI provides functionalities of schematic entry, simulation setup and visualization.

Features and benefits of OptSim for PIC design include:

• Enables pre- and post-layout simulation and back-annotation of photonic parasitics
• Supports foundry provided model libraries and comes with a complete library of generic model templates of integrated photonics devices
• Supports custom design, combining foundry provided models and custom devices
• Models bidirectional signal flow for both optical (single- and multi-wavelength) and electrical signals
• Supports Monte Carlo and Corner analyses
• Supports simulation of design hierarchies
• Co-simulation with PrimeSim HSPICE and PrimeSim SPICE enables simulation of electronics in the PIC using industry-leading electrical circuit simulators together with the simulation of photonic circuits in OptSim

Custom Design and PDK Development with Photonic Device Compiler

Photonic Device Compiler utilizes RSoft Photonic Device Tools and the Custom PDK Utility to provide the PIC designers and PDK developers with a powerful solution to generate foundry-specific building blocks as well as the ability to augment existing PDKs with your own custom components. This allows PIC designers to automate the process of generating symbols, analytical models, and parametric layouts for 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 1500 tapeouts.

Our solutions support all technologies:

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

We work together 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 eco-system to accelerate the adoption of Photonic IC technology.

Setting Up Your Own PDK

PDKs are available as a plug-in library for our PIC 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 kick-start teams with setting up foundry-specific compact models, building block definitions, layouts, and physical verification rules.

Obtaining PIC Foundry PDKs

Our solutions are used by many designers around the world to access MPW services and to work directly with R&D facilities and commercial foundries. Our Customer Support Portal (https://opticsportal.synopsys.com), provides an overview with the contact details to obtain a PDK for your foundry of choice. If you do not already have a customer portal account, please email photonics_support@synopsys.com for information about how to sign up.

Foundry Not Listed?

If you don’t see the technology or foundry you want to work with, don’t worry. We have relationships with many more facilities than listed above. Contact our team to request more information or support.
Design Spectrally Efficient Fiber-Optic Communication Systems

OptSim is an award-winning photonic integrated circuit and fiber-optic system simulator. With state-of-the-art time- and frequency-domain split-step algorithms. OptSim provides engineers around the globe with a native photonic-domain environment to design, and optimize photonic integrated circuits and systems. OptSim provides a virtual testbed where you can design single- and multi-mode, fiber-based high-speed data communication systems. The powerful time- and frequency-domain split-step simulation engines facilitate rigorous analyses of linear, non-linear, and polarization-dependent transmission impairments. The tools offer the following features and benefits:

- Optimize data communication performance to meet or exceed design goals
- Support brownfield and greenfield deployments
- Include a rich library of photonic, opto-electronic, electronic and microwave/RF components
- Include hundreds of pre-supplied designs for rapid prototyping
- Offer easy-to-use options to account for component tolerances and estimate Monte Carlo performance bounds
- Provide powerful insights into the role of electrical and optical noise in systems and their interplay with transmission impairments
- Support 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.

Experts in Electronic and Photonic Design Automation

Synopsys has 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.

To Get Started

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