SYNOPSYS®

DATASHEET

OptSim

Electro-Optic Co-Simulation of Photonic Integrated Circuits and Fiber-Optic Systems

Features at a Glance

- Electronic-photonic co-design via **Synopsys PrimeSim HSPICE** and **PrimeSim SPICE**
- Simulation of single and multimode fiber optic systems and photonic integrated circuits
- Seamless integration with **OptoCompiler** and **PrimeWave Design Environment**
- Extensive libraries of photonic and electronic components and analysis tools
- Support for numerous foundry process design kits (PDKs)
- Support for custom photonics (PDKs and devices) via **Photonic Device Compiler**
- Support for hierarchical design and bidirectional signal flow
- Design for manufacturing via Monte Carlo and corner analyses

Overview

The Synopsys OptSim tool 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 circuits and systems. OptSim can be used as a standalone solution with its own graphical user interface (Windows and Linux), or integrated into the OptoCompiler Photonic IC design platform (Linux). When used as an OptoCompiler-integrated simulator, OptSim:

- Supports electro-optic (E-O) co-simulation with Synopsys PrimeSim HSPICE and PrimeSim SPICE electrical circuit simulators
- Integrates seamlessly with the PrimeWave Design Environment for advanced simulation, analyses, and visualization including parametric scans, Monte Carlo and corner analyses
- 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.

Introduction

Photonic integration is an answer to the ever-increasing demands for more bandwidth, better energy efficiency, smaller footprint, and improved reliability. The adaptation of photonic ICs (PICs) is rapidly growing across industry segments such as telecom, data centers, optical interconnects, automotive, sensing, aerospace & defense, artificial intelligence (AI), and photonic computing. PICs are becoming complex and the component count is increasing at a rapid pace. Co-packaged optics (CPO) and xPU I/O are driving more complex trade-offs between electronics and photonics. Gone are the days when it was sufficient to model photonics on the back of an envelope, with some homegrown code, or as electronics in electrical circuit simulators. With OptSim, you use the most comprehensive optical simulator with the industry's best electrical circuit simulators on the respective portions of the design within the OptoCompiler platform.

Designing single- and multimode fiber-optic systems requires capabilities to support advanced intensity- and phase-modulation for both single- and multi-channel transmission with direct and coherent detection. The interplay of polarization-dependent transmission impairments with noise, crosstalk, and multi-path interference (MPI) can create challenges to the channel capacity. In addition to PIC modeling capabilities, OptSim provides rich libraries of components and powerful analyses options to facilitate the design of a diverse range of system applications such as coherent telecom systems, RF-over-fiber, high-speed Ethernet, passive-optical-networks, and free-space optics.

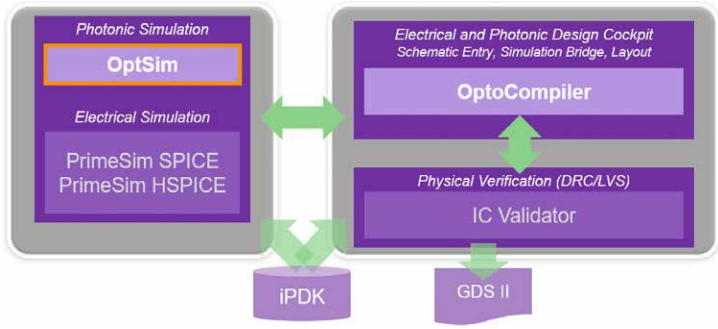

Figure 1: Photonic and electronic circuit and system simulation from the OptoCompiler cockpit

Features

- Works with foundry model libraries and provides a complete library of generic model templates of integrated photonics devices, enabling engineers to tailor models to measured behavior. In addition to supporting PIC design models and features, OptSim provides a rich library of single- and multimode fiber-optic system design models to support testing a PIC at the system level

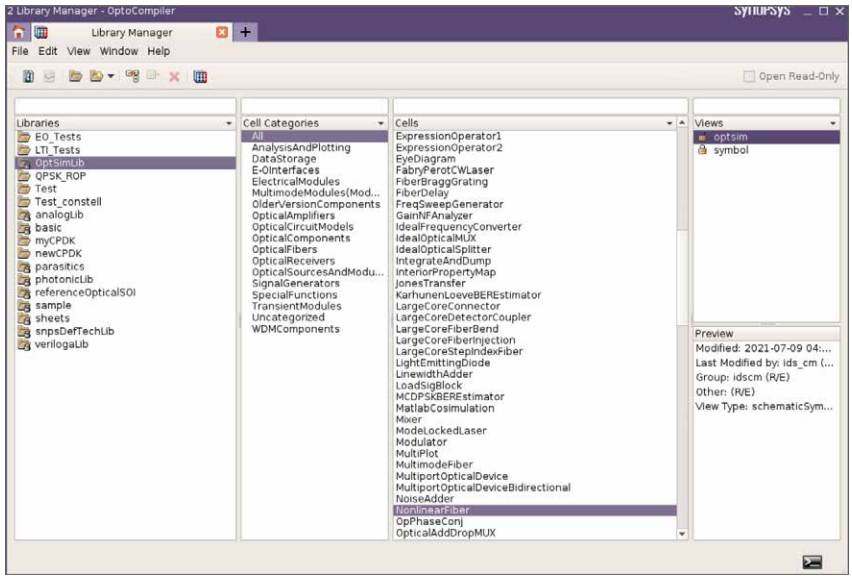

Figure 2: The OptSim library includes electrical and photonic models to simulate circuits and systems

- Models bidirectional signal flow for both optical (single- and multi-wavelength) and electrical signals
- Models multipath interference (MPI), reflections, and resonances from network and PIC devices
- Supports Monte Carlo and corner analyses
- Supports simulation of design hierarchies
- Supports measurement- and datafile-driven modeling of active and passive photonic components, electronic components, and circuits
- Supports custom design, combining foundry models and custom devices

- 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

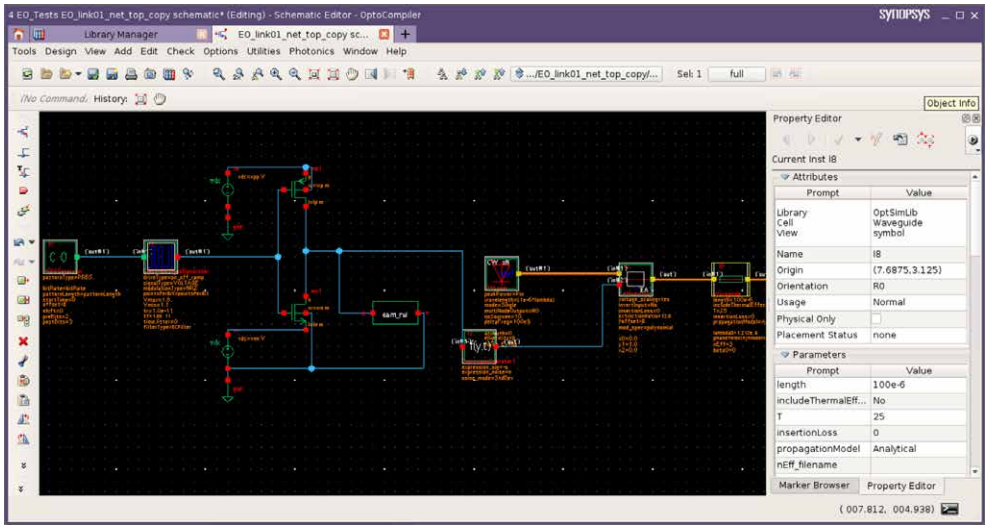

Figure 3: Co-simulating electronic and photonic circuits in OptSim

- OptSim is integrated with the Synopsys PrimeWave Design Environment, for both electrical and photonic netlists allowing setup of test benches, specifying simulation engine and parameters, performing scans and analyses for both electrical, photonic, and combined schematics

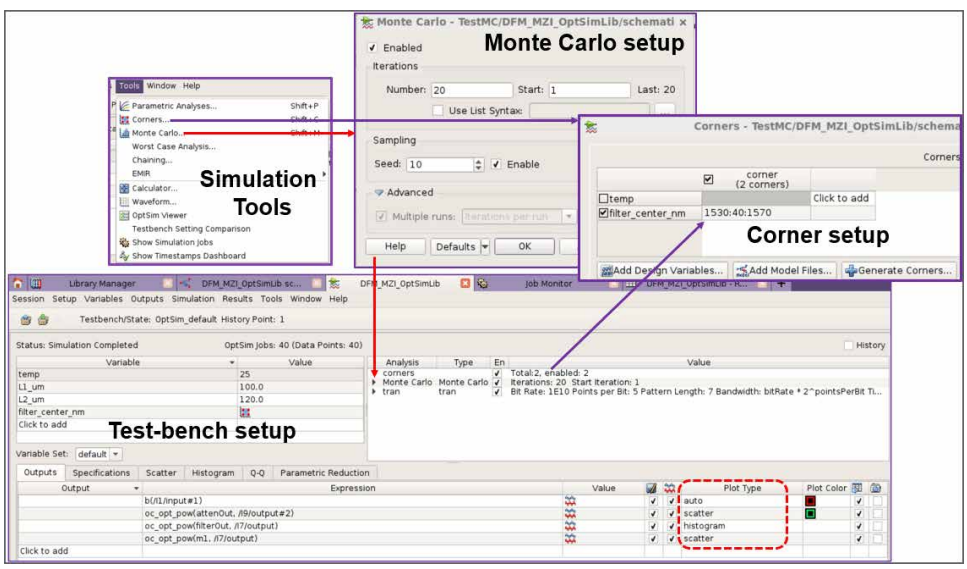

Figure 4: Setting up a testbench and simulation in PrimeWave Design Environment

- OptSim results and waveforms (logical, electrical, and optical) can be viewed in both the PrimeWave Design Environment WaveView and OptSim Viewer

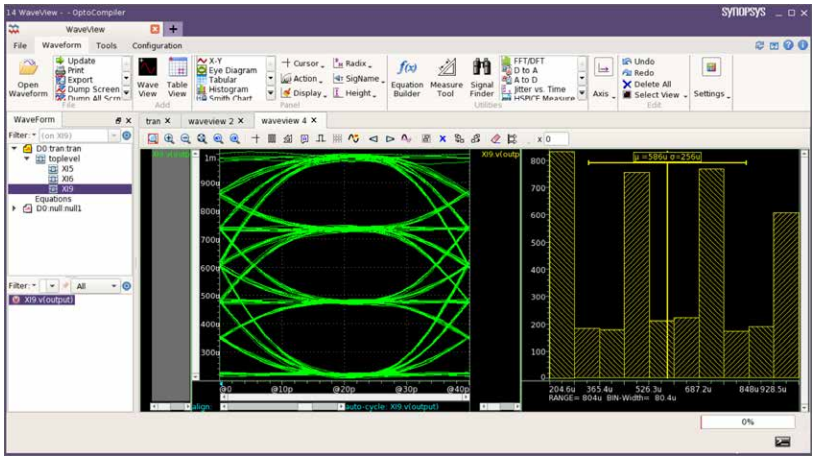

Figure 5: OptSim: Viewing simulation waveforms in PrimeWave Design Environment WaveView

- Standalone OptSim (Windows, Linux) has its own graphical user interface and provides an intuitive simulation experience

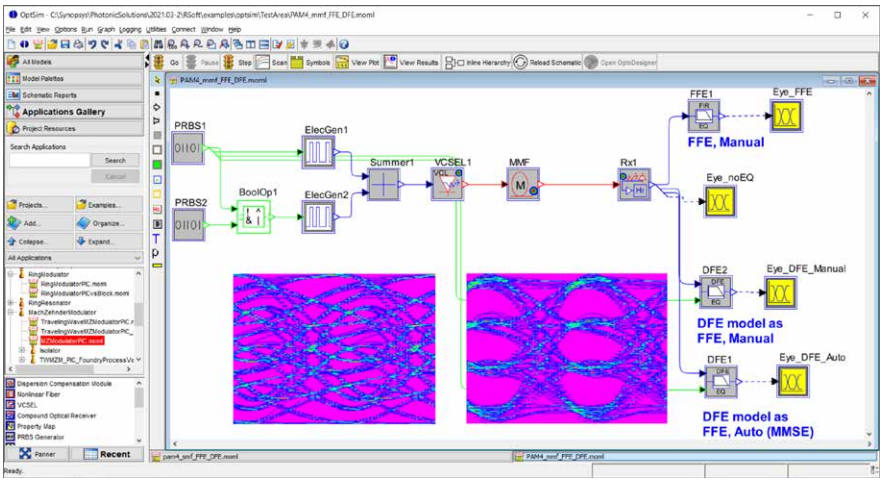

Figure 6: OptSim GUI: Simulation of a PAM4 fiber-optic system

Applications:

- Single- and multi-stage PICs for photonic computing, optical neural networks, life sciences, photonic sensor PICs
- Segmented-electrode (SE) and traveling-wave Mach-Zehnder modulators (TW-MZM), optical filters, ring resonators, ring modulators
- Transceivers for coherent and non-coherent fiber optic communication systems (such as NRZ, RZ, m-PAM, BPSK, QPSK, m-QAM, and OFDM)
- Single- and multimode fiber-optic systems and circuits
- Free-space optics, RF-over-fiber: Intermodulation distortion (IMD), dynamic range, sensitivity
- Datacenter and automotive interconnects
- Photonic systems with multipath interference (MPI), reflections, and resonances

Platform Support

- Linux: Red Hat Enterprise (64-bit), CentOS (64-bit)
- Windows (64-bit): Standalone OptSim