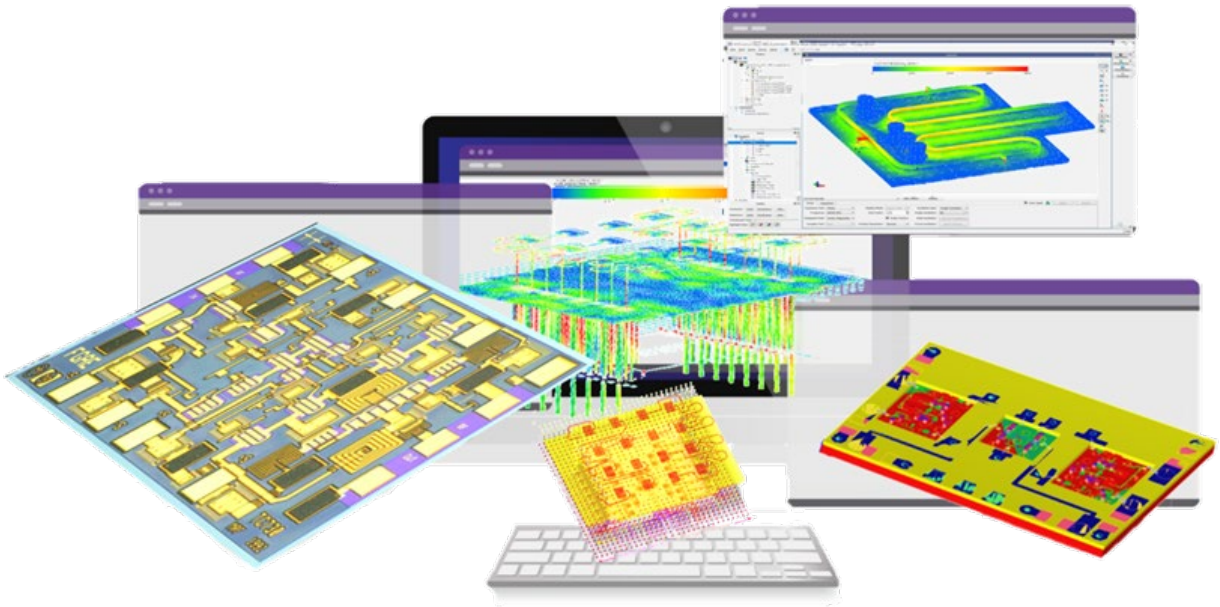
Keysight EDA Electronic Design Automation Software

The next generation EDA for designing High-Frequency Analog and High-Speed Digital products.

Introduction

Keysight EDA software is a comprehensive suite of design and simulation tools for the development of high-frequency analog and high-speed digital products to meet current and future requirements such as 5G, 6G, automotive radars, high data rate wired/wireless channels for AI machine learning in commercial/military applications and quantum electronics.

Keysight EDA is the leading high-frequency (up to 300GHz sub-terahertz) and high-speed digital physical layer design tool used by circuit and system designers to develop components for the RF-microwave (RFMW), high-speed digital (HSD), electronic system level (ESL), power electronics (PE) and quantum electronics (QE) industries. These powerful capabilities are proven in Keysight's state-of-the-art, high-performance instruments that serve these industries because the cutting-edge components inside are designed with Keysight EDA tools. Keysight EDA also enables you to develop superior products to meet tight competitive market windows.



KEYSIGHT

Table of Contents

Advanced Design System (ADS)
EDA Platform for Multi-Technology Simulation

Keysight ADS is the premier EDA platform for the design of high-frequency and high-speed digital physical layer components from single purpose amplifiers to complex RF modules and high-speed digital boards. The ADS platform forms the basis for RF/microwave, Signal/Power Integrity, Power electronics and Quantum electronics design software bundles that contain the powerful capabilities to accomplish challenging design tasks for these applications.

The ADS EDA platform is chosen by leading companies after careful evaluation of its unique capabilities not found in other design tools:

- 3D integration of multi-technology including chips, packaging, interconnects, shielding, boards, and input/output connectors. This represents the most realistic assembly of the product to be designed and electrically simulated. Other design tools can only design chips, packaging, or boards separately but not together as the assembled product, requiring subsequent tedious, error prone manual integration of separate design databases to obtain the required composite simulation results.
- Superior simulation accuracy with instrument grade signal generation, simulation algorithms and data processing, leveraged from Keysight's rich history of developing state-of-the-art test instruments and sponsoring university research. ADS simulation flexibly duplicates measurements on the test bench, except it is done on the product that is yet to be built, so that the design can be optimized for performance, yield, and spec compliance before hardware prototyping to eliminate wasteful iterations.
- Flexible deployment into your design process with Python scripting support to automate integration with external applications such as AI and machine learning to generate simulation models from measured or published data. The ADS design database itself is architected on the OpenAccess standard, the world's most widely used, open reference database for IC and electronic design, for 3rd party tool interoperability without lossy database translation.

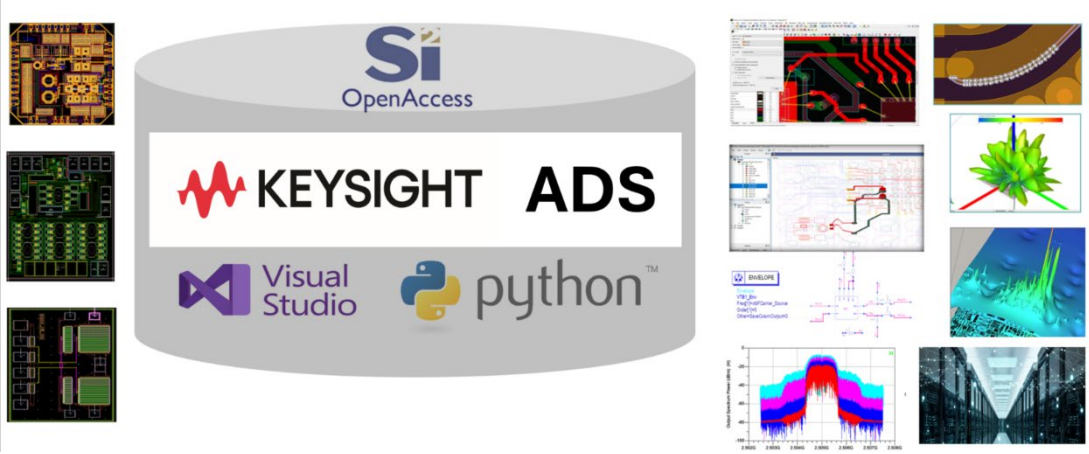


Figure 1. ADS multi-technology simulation platform is customizable with Python to smoothly integrate into your design flow and provides easy access to the most accurate RF and high-speed simulation in the industry for single pass design success.

Configuration

Advanced Design System (ADS)

https://www.keysight.com/find/ads

https://www.keysight.com/find/ads-config

Learn more about:

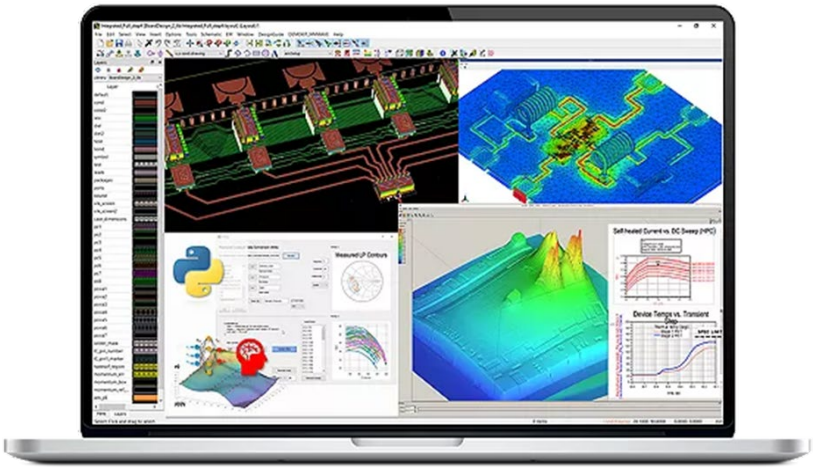
- Circuit Design and Simulation
- Python customization in ADS
- Artificial Intelligence (AI) and Machine Learning (ML)

RF and Microwave Design

ADS is the trusted design and simulation tool used by 70% of the world's RF and Microwave component designers according to a recent Pedestal Research EDA industry report.

This is because it is uniquely able to easily integrate 3D mixed technologies, such as RFICs, chip packaging, boards, interconnects, antennas, and input/output connectors to accurately represent and simulate what will eventually be built. This is also known as 3D Heterogeneous Integration (3DHI).

All simulation technologies, including time-frequency-envelope domain circuit, electromagnetic (EM), electrothermal (ETH), system and statistical, are seamlessly integrated for accurate analysis and automated optimization of performance to meet specs.



These are the unique capabilities offered by ADS for RF and Microwave component design:

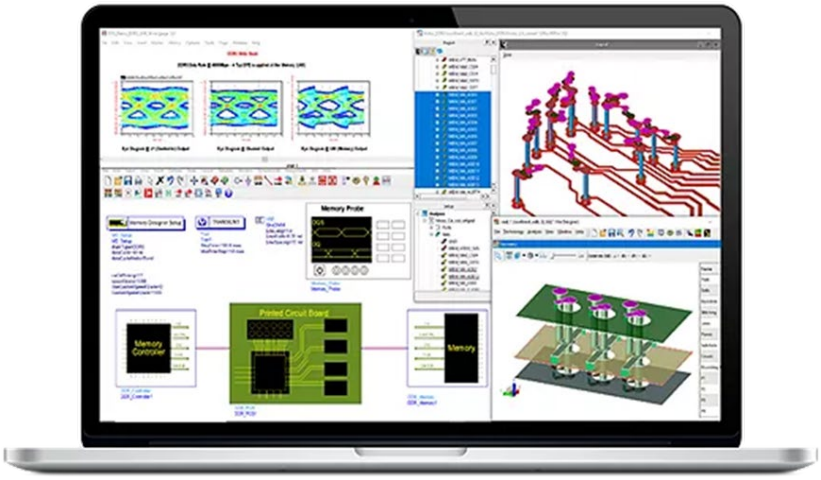
- 3DHI multi-technology assembly and simulation
- Circuit-Electromagnetic (EM)-Electrothermal (ETH) cosimulation for optimal accuracy.
- RFIC, MMIC, RF Module, RF Board, 3D Packaging, Passive component design.
- Error Vector Magnitude (EVM) optimization for meeting digitally modulated RF signal specs.
- Modulated Signals Virtual Test Bench (VTB) libraries for evaluating circuit design compliance to system wireless, radar, and networking industry standards specs.
- Nonlinear stability to guarantee stable amplifier design.
- Electrothermal for optimal circuit performance and reliability simulation accuracy under actual deployment conditions.
- Statistical design for robust production yield.
- Python support for AI/Machine Learning model training and workflow deployment customization.

Recommended ADS Bundles for RF and Microwave (RF/MW) Circuit Design

ADS Core, EM Design, Layout, RF Ckt Sim	W3603B
ADS Core, EM Design, Layout, RFPro, RF Ckt Sim	W3606B
ADS Core, EM Design, Layout, RFPro, RF Ckt Sim, Sys-Ckt Verification, Complete VTBs	W3608B
Learn more: https://www.keysight.com/find/whats-new-in-rf-microwave	

High Speed Digital Design

ADS high-frequency simulation expertise is also ideally suited for High-Speed Digital design of components and circuit boards for high datarate multi-gigabit applications such as High Performance Computing (HPC), data center servers, memory systems, chiplets, and AI/ML systems in robotics and autonomous vehicles. Libraries of industry digital standards enables convenient compliance verification.



ADS offers the following powerful capabilities for HSD design:

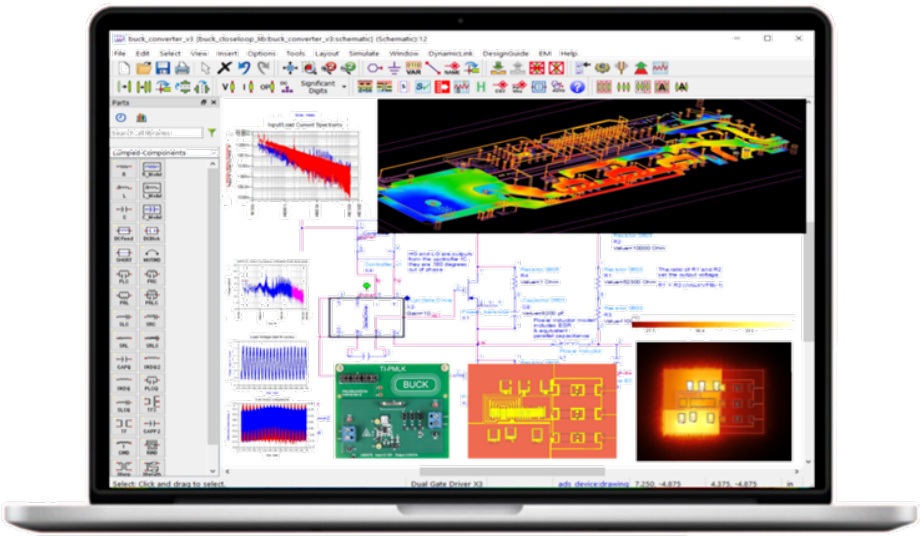
- Signal Integrity (SI) for simulating digital data channels, such as PCB traces and interconnects, for eye-diagram opening margin requirements in both pre-layout exploration and post-layout verification. It includes channel simulation for pulsed amplitude modulation (PAM-4/3/N) high data rate signaling and rapid scanning of trace impedance to avoid SI issues in HSD boards.
- Power Integrity (PI) for verifying and optimizing power delivery network in HSD systems to ensure stable, noise free voltages and currents are delivered to ICs on PCBs to maintain reliable operations. PI issues such as voltage droops, noise and signal distortions are simulated to avoid wasteful hardware iterations.
- Memory design in modules or memory systems on server boards to ensure compliance with industry standards such as DDR, GDDR and multi-level modulation PAM-N and NRZ signaling. Pre- and post-layout analysis of memory bus channels ensures reliable memory hardware downstream.
- Chiplet design for integrating modular specific function ICs, called chiplets, in a package to deliver multi-function System-on-Chip (SoC) with higher yields and cost savings up to 50% compared to custom SoC chips. Communication between chiplets, called die-to-die (D2D) UCIe, is simulated to ensure chiplet interconnects are reliable and interoperable.
- PCIe design for high data rate multi-lane communication channels in high performance computing (HPC), datacenter infrastructure, AI/ML system, automotive, mobile and desktop computing applications. Analyze PCIe performance and address issues before build-out to avoid iterations.

Recommended ADS Bundles for High-Speed Digital (HSD) Design

ADS Core, EM Design, Layout, HSD Ckt Sim, SIPro	W3624B
ADS Core, EM Design, Layout, HSD Ckt Sim, SIPro, PIPro	W3625B
ADS Core, EM Design, HSD Ckt Sim, Memory Designer	W3622B
Chiplet PHY Designer Bundle	W3650B
PCIe Designer Bundle	W3651B
Learn more: https://www.keysight.com/find/whats-new-in-high-speed-digital	

Power Electronics Design

Designing compact, high power density and reliable Switched Mode Power Supply (SMPS) requires high switching speed, suppression of electromagnetic interference (EMI) emissions and thermal reliability. Accurate models required for SMPS design and simulation, such as Gallium Nitride (GaN) transistors, can be created with Python based AI/ML automated training from published datasheet information.



ADS offers the following unique capabilities for Power Electronics (PE) design:

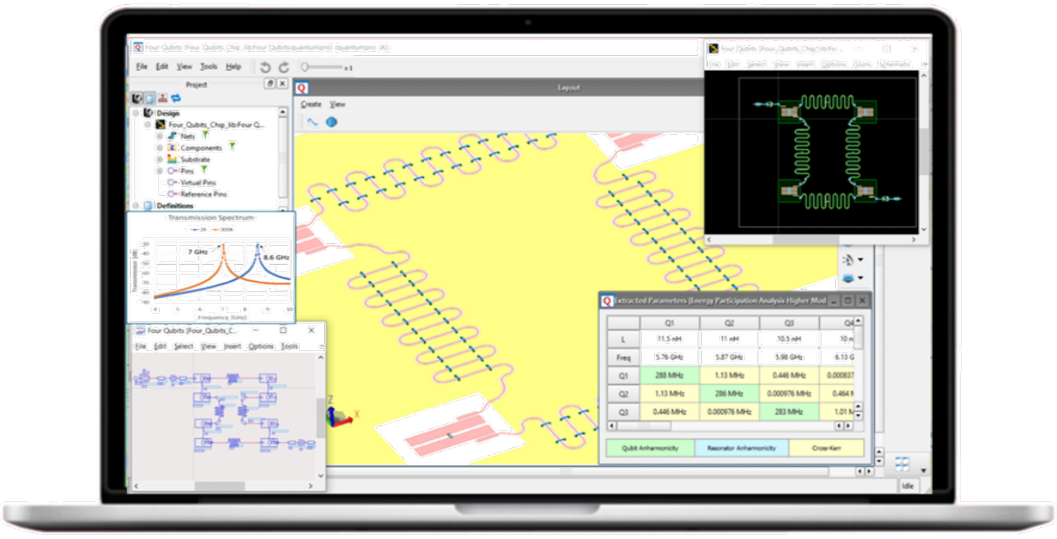
- Design compact, high-power density SMPS with EMI emission compliance.
- Thermal simulation to identify hotspot locations that degrades reliability.
- GaN transistor model creation with automated AI/ML training from published datasheet information for use in accurate PE simulations.

Recommended ADS Bundle for Power Electronics (PE) Design

ADS Core, EM Design, Layout, PEPro, PE Ckt Sim	W3631B
Learn more: https://www.keysight.com/find/whats-new-in-power-electronics	

Quantum Chip Design

Keysight EDA offers the first integrated design flow for superconducting qubit design to enable faster development of quantum chips with five unique capabilities in one platform:



- **Quantum Layout**: Library of commonly used quantum artwork -- fully parametrized for convenient optimization and quantum circuit buildup.
- **Electromagnetic**: Full EM solution in both frequency domain and eigenmode (with kinetic inductance) for quantum parameter analysis
- **Quantum Parameters Extraction**: Automatic extraction using the three standard methods, Blackbox Quantization, Energy Participation Ratio (EPR), and Quasi-Static.
- **Nonlinear Circuit Simulation**: Market-leading harmonic balance nonlinear circuit simulation with superior convergence for complex quantum amplifier design with 1000s of Josephson junctions.
- **EM-Nonlinear Circuit Co-Sim**: Ability to inspect the power dependence response of the quantum chip by combined EM and nonlinear circuit co-simulation.

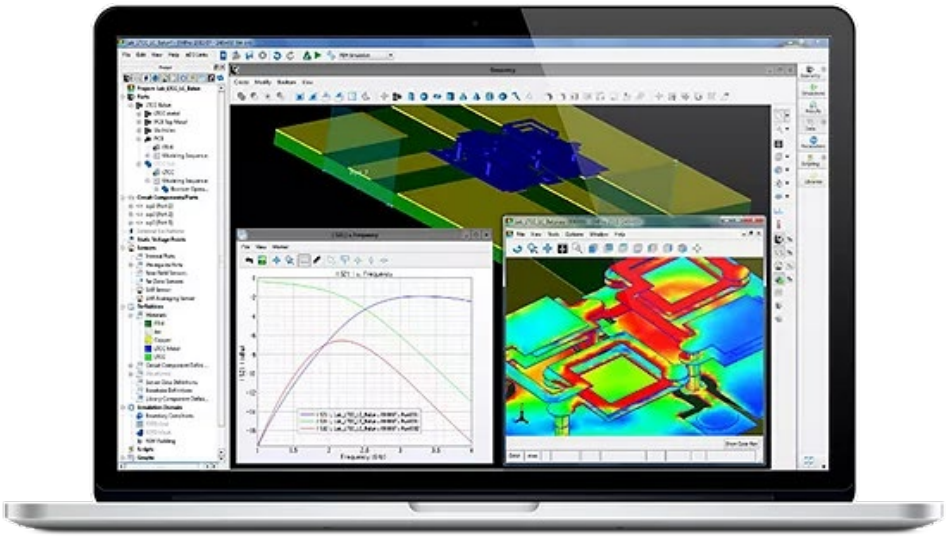
Recommended ADS Bundles for Quantum Design

ADS Core, EM Design, Layout, QuantumPro	W3704B
ADS Core, EM Design, Layout, QuantumPro, RF Ckt Sim	W3706B

Learn more: https://www.keysight.com/find/quantum-eda

Electromagnetic (EM) Design (EMPro)

Keysight EMPro is a dedicated 3D modeling and electromagnetic (3DEM) simulation environment for 3D components in electronic designs. It can also analyze radar cross sections of vehicles and aircrafts, and Specific Absorption Rate (SAR) of the human head and body from smartphone EM radiation.



EMPro offers the following capabilities:

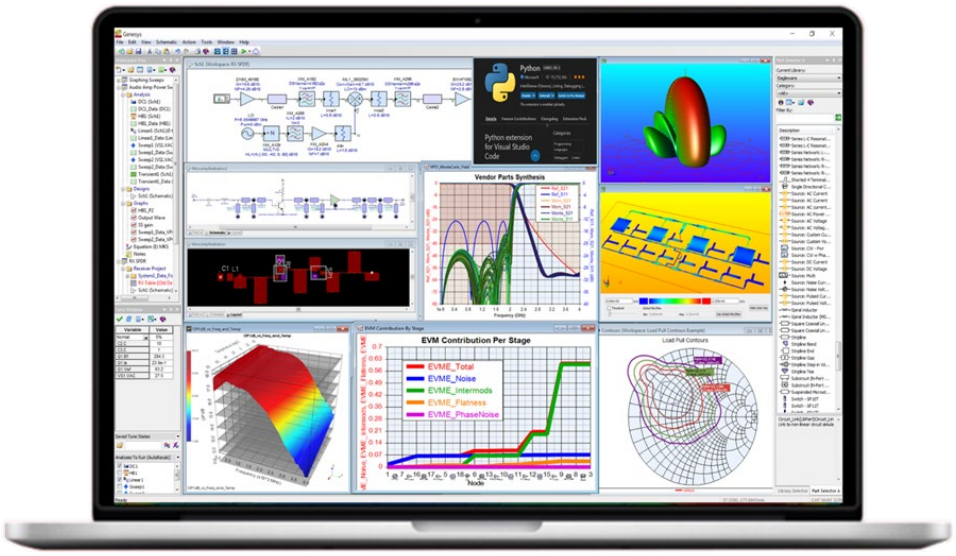
- 3D modeling environment to draw or import CAD files of complex 3D shapes such as packaging, antennas, connectors, vehicles, and the human body. Material properties and ports are then defined for running 3DEM simulation.
- Finite Element Method (FEM) simulator for electrically small structures such as packages, shields, and connectors to determine S-parameters, EM fields and cavity resonant frequencies.
- Finite Difference Time Domain (FDTD) simulator for electrically large structures such as vehicles, aircraft, and the human body to determine radar cross sections and biological EM field absorption.
- Output includes S-parameters, surface currents, EM fields, antenna patterns, and cavity resonant frequencies.
- Simulate smartphone antenna radiation with human body model for compliance with Hearing Aid Compatibility (HAC) and Specific Absorption Rate (SAR) standards.
- Export 3D components to ADS for Circuit-EM cosimulation to thoroughly analyze the interaction of active and passive components before building hardware to eliminate iterations.

Recommended EM Design (EMPro) Bundles

EM Design Core (EMPro) + FEM + ADS RFPro UI	W4301B
EM Design Core (EMPro) + FDTD + Compliance Module	W4302B
EM Design Core (EMPro) + FEM + FDTD + Compliance Module + ADS RFPro UI	W4303B
EM Design (EMPro) Configuration	https://www.keysight.com/find/em-design https://www.keysight.com/find/em-design-config

RF Circuit Synthesis (Genesys)

Keysight Genesys is an affordable and easy-to-use RF circuit and system design too. It offers 13 types of automatic RF circuit synthesis, such as filters and impedance matching networks, for RF engineers to quickly get a starting sub-circuit design for integrating into a bigger design. It also includes circuit, system, and EM simulators for designing single-technology RF boards.



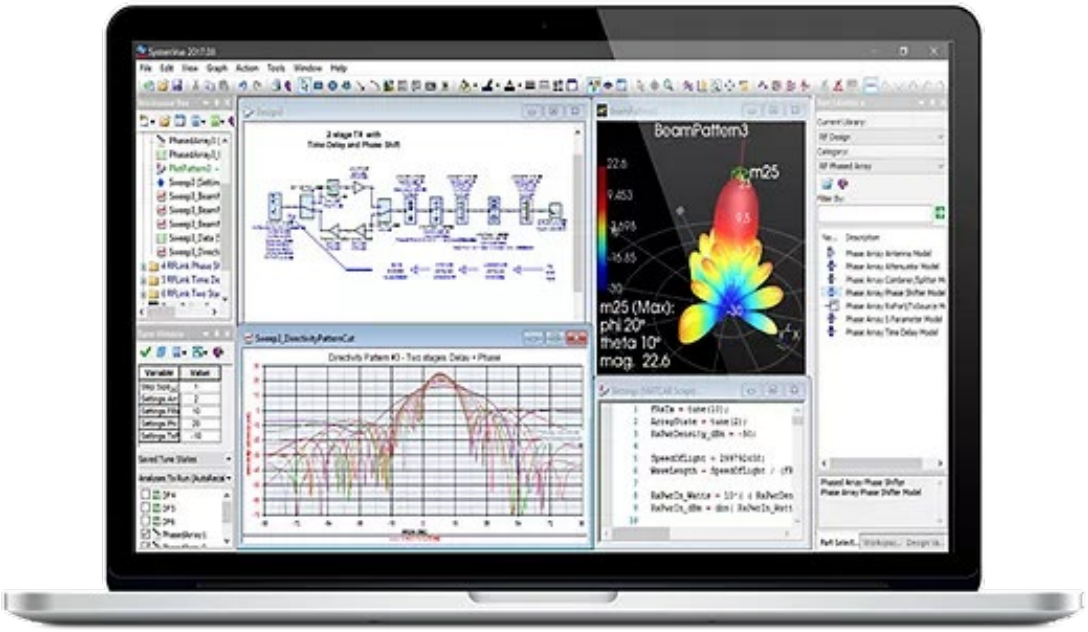
- Affordable, Accurate, Easy-to-Use RF circuit synthesis, Circuit, EM, System simulation integrated design tool.
- Widest coverage of 13 RF circuit synthesis categories in the industry. Ideal as personal RF toolbox for designing sub-circuits as part of a bigger design.
- Filter synthesis – passive, active, distributed, hybrid lumped-distributed, custom response direct synthesis.
- Impedance matching networks for measured complex, frequency dependent impedance (antennas) and multi-stage complex impedance broadband matching.
- Mixers, Oscillators, Transmission lines, transitions, signal control splitters, combiners, attenuators.
- RF System line up cascaded block budget analysis with root cause detective to pinpoint culprit block causing system degradation.
- RF System design for modulated RF signals with fast Error Vector Magnitude (EVM) analysis to select the optimal component line-up to meet system EVM specs.
- System Sys-Parameters modeling of published datasheet nonlinear amplifiers and passive components.
- Momentum 3D Planar EM simulator for microstrip and arbitrary planar layout.

Recommended RF Circuit Synthesis (Genesys) Bundles

RF Synthesis Core (Genesys) + Synthesis	W5301B
RF Synthesis Core (Genesys) + Synthesis + EM	W5304B
RF Synthesis Core (Genesys) + Synthesis + Circuit + System + Modulated-RF + EM	W5309B
RF Synthesis (Genesys) Configuration	https://www.keysight.com/find/rf-synthesis https://www.keysight.com/find/rf-synthesis-config

System Design (SystemVue)

Keysight SystemVue is an Electronic System Level (ESL) simulation platform for designing and verifying communication, defense/aerospace systems at the physical layer (PHY) where Digital Signal Processing (DSP) meets RF. SystemVue brings together baseband DSP algorithm modeling, accurate RF, trusted reference IP (such as 5G, WiFi, and radars), and measurement automation in a single environment for optimal baseband DSP and RF co-design to eliminate wasteful iterations.



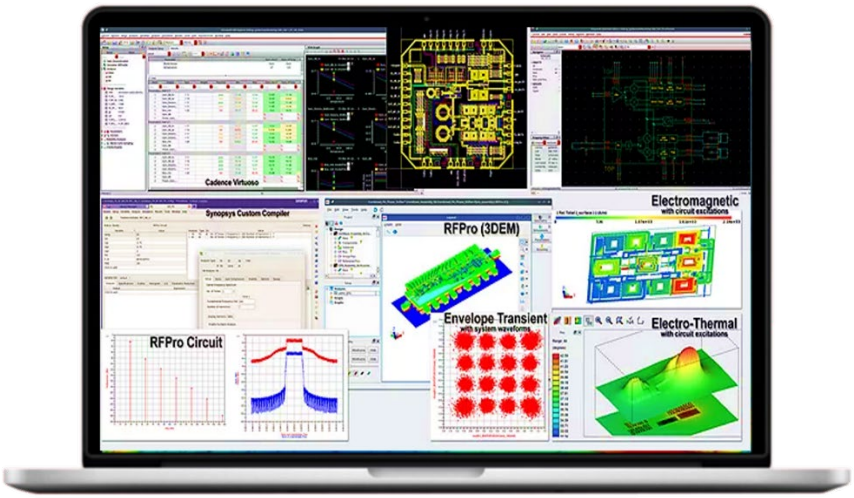
- Electronic System Level (ESL) design environment with integrated baseband DSP and RF simulators for designing physical layer (PHY) of communications and aerospace-defense systems.
- Industry first Phased Array Antenna system design with integrated RF system budget, antenna element-array configuration, and beamforming DSP algorithm co-simulation.
- Real-world libraries for Radar, EW, satellite, phased array, 5G NR-NTN, Wi-Fi, and automotive.
- Integration with ADS, Python, MATLAB and STK for complex, scenario-based ESL designs.
- Seamless AI ML integration for AI model import and training data generation for 6G and others.

Recommended System Design (SystemVue) Bundles

System Design Core + Comms/DSP	W4802B
System Design Core + RF + Comms/DSP + Phased Array	W4804B
System Design + Aerospace Defense	W4811B
System Design + 5G and Cellular	W4812B
System Design + Automotive	W4813B
System Design + WiFi and Connectivity	W4814B
System Design (SystemVue) Configuration	https://www.keysight.com/find/system-design https://www.keysight.com/find/system-design-config
Learn more	https://www.keysight.com/find/whats-new-in-system-design

RFIC Design (RFPro Circuit and GoldenGate)

RFPro Circuit is a next-generation simulation suite for robust RFIC circuit design. GoldenGate is a comprehensive RFIC Design and Verification solution. They seamlessly integrate within Cadence Virtuoso and Synopsys Custom Compiler design environments.



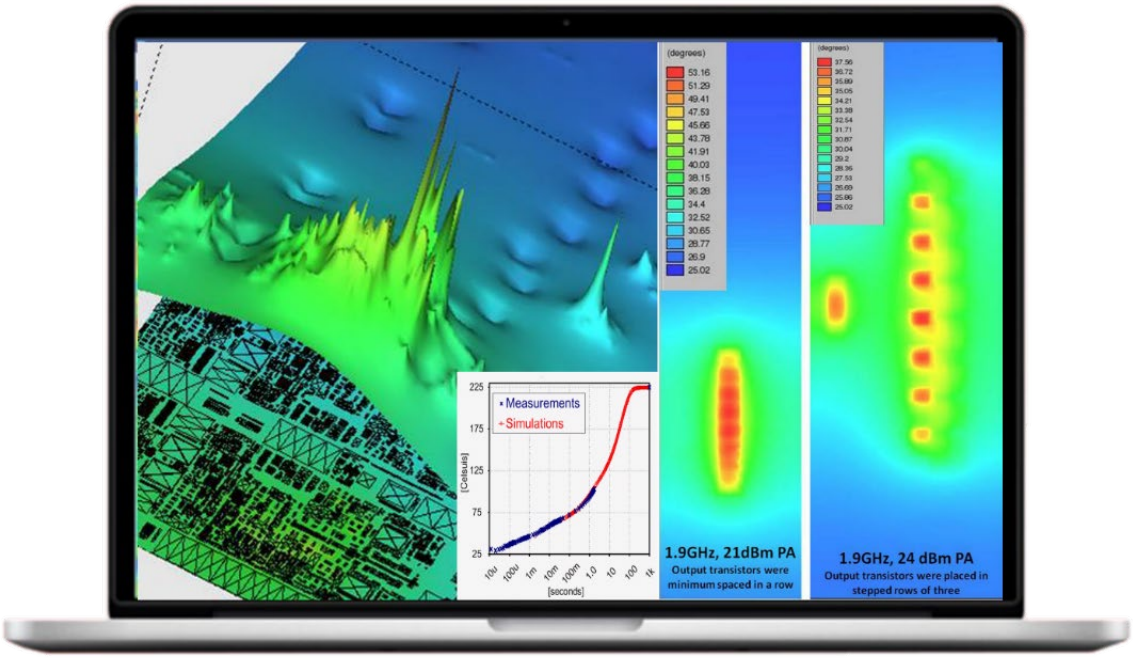
- Best in class RFIC circuit simulators in Cadence Virtuoso and Synopsys Design Compiler, offering Frequency, Time, and Envelope domain simulation for the most thorough characterization of complete RFIC transceivers before tape out.
- Optimization for performance with sweeps and load-pull analysis.
- Wireless Standards Libraries verify RFIC performance in target system applications (e.g., 5G/6G, WiFi, radars) before tapeout and to achieve early design wins with clients.
- Modulated Signal Error Vector Magnitude (EVM) performance assessment for the latest communication standards early in the design phase with fast EVM algorithms leveraged from Keysight instrumentation.
- Layout EM effects on RFIC performance from 3D IC layout, packaging, interconnects, transitions, and PCB evaluation boards are accounted for during design.
- Risk Reduction with thorough Circuit and Statistical verification toolkits eliminate costly re-spins and low yields.
- Worldwide Foundry Process Design Kit (PDK) support offers a wide choice of RFIC foundry process to tape out to.

Recommended RFIC Design Bundles

RF Circuit Simulation Professional (RFPro Circuit)	W5600E
RFIC Design (GoldenGate) + VTB Engine + Complete VTBs	W5802B
RFIC Design (GoldenGate) + RFPro	W5803B
ADS Core, EM Design, RFIC Design Quad (GoldenGate), Layout, RFPro, RF Ckt Sim, Sys-Ckt Verif, VTBs	W3609B
RFPro Circuit Configuration	https://www.keysight.com/find/rfpro-circuit https://www.keysight.com/find/rfpro-circuit-config
RFIC Design (GoldenGate) Configuration	https://www.keysight.com/find/rfic-design https://www.keysight.com/find/rfic-design-config
Learn more about IC foundry support for Process Design Kits (PDKs)	https://www.keysight.com/find/design-software-foundries

Thermal Design for IC (ADS ETH and Heatwave)

ADS Electrothermal (ETH) simulation suite integrates with ADS transient, steady-state, and envelope circuit simulators to account for layout dependent localized ETH heating from active devices during operation. ETH heating effects alter device characteristics, degrade circuit performance, and reduce reliability. Heatwave is an IC ETH simulator for chips and stacked-die System-in-Package (SIP) designs and works with non-Keysight circuit simulators such as Cadence Spectre and Synopsys HSPICE.



- Most accurate Electrothermal (ETH) simulator and can resolve fine temperature variations on ICs across device spacing and between layers.
- Predicts reliability, electrical performance degradation from self-heating in amplifiers, packaged RF modules, and full chip operation.
- Steady state, transient and circuit envelope electrothermal simulation with HPC acceleration.
- Improves accuracy of circuit simulation by accounting for layout dependent ETH heating effects during operation in actual deployment conditions.

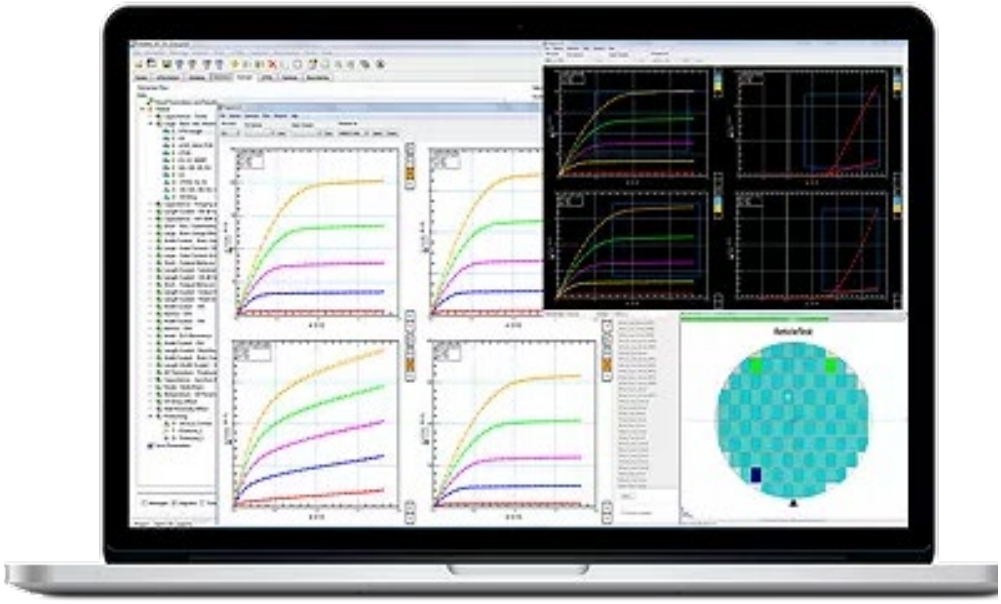
Recommended Thermal Design Bundles

Electrothermal RF (ADS Electrothermal ETH)	W3050E
Thermal Design Core (Heatwave)	W5900E
Thermal Design Steady-State Analog (Heatwave)	W5901E
Thermal Design (HeatWave) Configuration	https://www.keysight.com/find/thermal-design https://www.keysight.com/find/thermal-design-config

Device Modeling (ICCAP, MBP, MQA, WaferPro)

The accuracy of circuit simulation depends on the availability of accurate mathematical models to represent the active and passive devices in the circuit. Device modeling tools enable these models to be created by measuring the electrical characteristics of the devices; followed by mathematically adjusting the parameters in the model equations, until the simulated characteristics matches the measured data. These tools are typically used by semiconductor foundries to create a library of accurate models in their Process Design Kit (PDK) for use by their customers to design ICs with.

Keysight Device Modeling tools include:



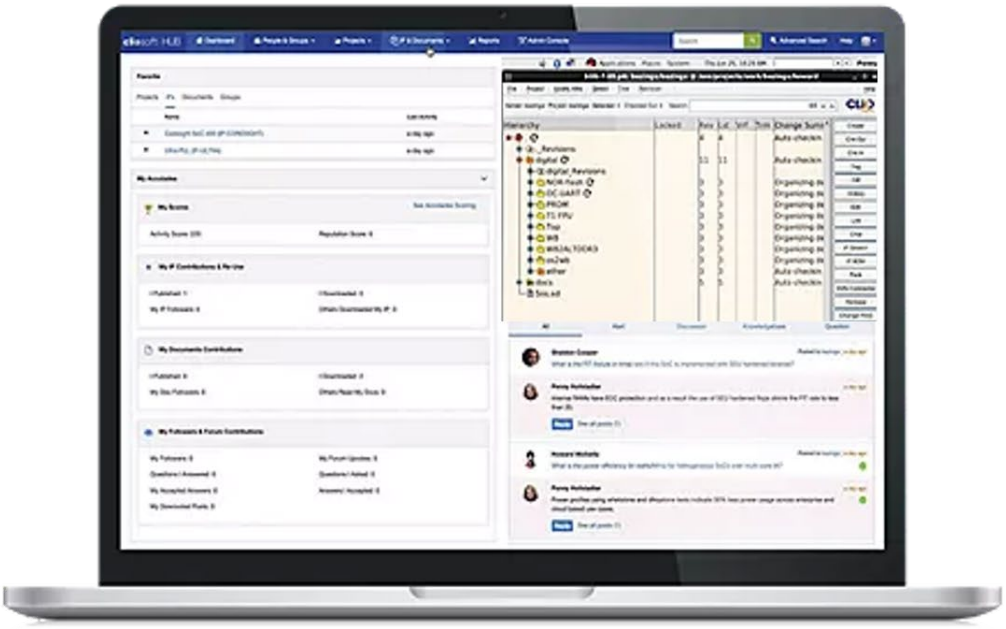
- **IC-CAP** (Integrated Circuit Characterization and Analysis Program) for modeling semiconductor devices built with Silicon CMOS, Bipolar, Gallium Arsenide (GaAs), Gallium Nitride (GaN), and other compound III-V foundry processes.
- **MBP** (Model Builder Program) for creating Silicon device models such as BSIM-BULK, BSIM-CMG, BSIM-IMG, UTSOI and others for logic, analog, and RF design applications. It features automated model extraction flow for high volume silicon device model extractions.
- **MQA** (Model Quality Assurance) automates device model validation by comparing the results from simulating the same model with multiple industry standard SPICE simulators. It reports model issues so that they can be corrected by the foundry before releasing it in their PDK.
- **WaferPro** performs automated wafer-level probing, measurements, and high-volume data analysis to validate that wafer electrical characteristics are uniform across the entire wafer and across batches of wafers. This wafer-level testing is critical for semiconductor yield monitoring.

Recommended Device Modeling Bundles

IC-CAP Device modeling platform bundle software license Plus	W7300B
MBP Model Builder Program core software license Plus	W6300B
MQA Model Quality Assurance core software license Plus	W6800B
WaferPro Express A-LFNA Measurement and Programming Bundle software license	W7802B
Advanced Low Frequency Noise Analyzer (A-LFNA)	W4727B
Device Modeling (IC-CAP) Configuration	https://www.keysight.com/find/device-modeling https://www.keysight.com/find/device-modeling-config
Model Builder (MBP) Configuration	https://www.keysight.com/find/model-builder https://www.keysight.com/find/model-builder-config
Model QA (MQA) Configuration	https://www.keysight.com/find/model-qa https://www.keysight.com/find/model-qa-config
WaferPro (WaferPro Express) Configuration	https://www.keysight.com/find/waferpro https://www.keysight.com/find/waferpro-config
Learn more about Device Modeling	https://www.keysight.com/find/whats-new-in-device-modeling
Learn more about Device Modeling Service	Global Device Modeling Services | Keysight
Contact Keysight about Device Modeling Service	eda.training@keysight.com

Design Data IP Management (Cliosoft SOS and HUB)

Design Data represents valuable time and resources invested by companies to create Intellectual Properties (IP) portfolios that can be monetized. The security and management of your Design Data and IP are critical to avoid costly unplanned business disruptions from data loss, salvage, and repair. Efficient IP management eliminates design resource inefficiency through systematic cataloging and retrieval of IPs for reuse and licensing, resulting in improved financial metrics.



- **Keysight Design Data Management (SOS)** optimizes design data archival with robust security and preservation of design integrity for global, dispersed team to collaborate with reliable retrieval and version control.

- **Keysight IP Management (HUB)** is ISO26262 certified for efficient IP cataloging, selection, reuse, publication and tracking across multiple sites and teams to streamline individual and collaborative design processes for optimal deployment of design resources.

Recommended Data and IP Management Bundles

SOS ADS: SOS Core + Interface to Keysight ADS	WW1503B
HUB Gold: HUB Core with IP + Document Management	WW2502B

Learn more about:	Links
Data and IP Management	https://www.keysight.com/find/design-data-and-ip-management
SOS	https://www.keysight.com/find/sos
HUB	https://www.keysight.com/find/hub

High Performance Computing (HPC)

High Performance Computing (HPC) enables simulation to be performed significantly faster with up to 80%-time savings by using parallel simulations and powerful cloud compute resources. Keysight EDA offers HPC license for accelerating circuit, EM, and system simulation. The number of HPC licenses can be scaled up to increase parallelism for attaining the achievable time savings.

- Accelerate analysis with parallel simulation for up to 80%-time savings.
- Scale up parallel simulation by adding HPC accelerators to the base simulator.

Base simulator	HPC accelerators	Part number
3DEM	EM HPC Accelerator	W3039E
Linear, Transient, Harmonic Balance	Circuit Sim HPC Accelerator	W3029E
Data Flow	System Analysis HPC Accelerator	W4509E
Heatwave	ETH HPC Accelerator	W3059E
Learn more about HPC	https://www.keysight.com/find/design-cloud	

Keysight EDA Learning, Training and Custom Solution Services

Keysight provides flexible learning, training, and custom solution services to ensure your investment in Keysight EDA products generate the fastest business returns. These include:

- eLearning: Web-based courses available 24x7 to enable learning at your own pace from any location to quickly acquire expertise in using Keysight solutions.
- Instructor-Led Training: Delivered on-site or through remote access for diverse teams to quickly deploy Keysight EDA solutions. Typical duration is two or more days with up to ten students.
- Custom Solutions: Keysight experts provide customized training, consulting, or measurement service for you to achieve optimal business results in the shortest time by providing expert industry proven knowledge to fast track the learning curve and deployment into your enterprise workflow.
    - One example is Keysight device modeling service where your device measurements are performed on Keysight instruments in sophisticated labs and Keysight device modeling experts fit the measured data to your requested device models.

Recommended Keysight EDA services:

eLearning 24/7 online access for up to 50 users	N3240F
Remote dedicated training by Keysight Experts online	N3249R
Custom Solution Service	R5000A
Learn more about Device Modeling Service	Global Device Modeling Services | Keysight
Contact Keysight about the above services	eda.training@keysight.com

Conclusion

This Keysight Electronic Design Automation (EDA) technical overview introduces the distinct categories of EDA solutions needed to accurately design physical hardware and components in today's high frequency and high data bandwidth applications such as 5G/6G wireless, data center for AI/ML training, and satellite networks.

Each EDA category contains recommended bundles for getting budgetary quotes. Please discuss with your Keysight EDA specialist to verify your product selection and optimize your investment with Keysight Technologies, like thousands of satisfied customers around the world for over three decades