

TECHNICAL  
OVERVIEW

# PathWave RF Synthesis (Genesys)

PATHWAVE

Simulation and synthesis EDA software for  
RF/Microwave circuit board and subsystem designers

## Affordable, accurate, easy-to-use RF design tool

PathWave RF Synthesis (Genesys) is an affordable, accurate, easy-to-use RF and microwave circuit synthesis and simulation software created for the circuit board and subsystem designer. Providing the optimal balance of capabilities with ease-of-use, designers can quickly attain the skills necessary to operate the tool while realizing unbeatable engineering productivity through multiple powerful automatic RF circuit synthesis technologies.

## Safe investment

Genesys is endorsed by an installed base of over 5,000 satisfied RF and microwave designers worldwide, many of whom have been loyal repeat customers over the past 30 years. Genesys incorporates breakthrough RF simulation and synthesis technologies backed by Keysight's extensive industry-wide expertise in RF/ microwave design, instrumentation, and support.

As a proven safe investment, Genesys literally pays for itself through cost savings within its first year of deployment as a design productivity tool. As your requirements expand to include enterprise level design of RF/high speed boards, MMICs or multi-technology RF system-in-package (SIP) modules, Keysight Technologies, Inc. protects your Genesys investment by providing full trade-up credit towards the even more capable Advanced Design System (ADS).



## Genesys Configuration Overview

The core capabilities of Genesys can be extended with additional simulation and synthesis building blocks into powerful and affordable bundles.

Genesys offers the highest design productivity by providing:

- Industry's widest coverage of RF and microwave automatic circuit synthesis
- Comprehensive RF system architecture and frequency planning tools
- Modulated RF analysis of circuits and systems for EVM, BER and ACPR with WLAN and LTE-3GPP verification
- Time- and frequency-domain circuit simulation with optimization
- Fast, memory-efficient 3D-planar electromagnetic (EM) simulation
- Accurate and convenient X-parameter nonlinear circuit and system simulation
- Accurate frequency, temperature, and bias dependent Sys-parameters models of vendor system blocks

## Genesys Core Environment

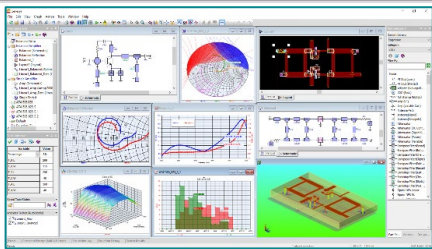
All Genesys configurations start with the prerequisite Genesys core environment, which is itself a full-featured design bundle. Extended capabilities are added to other affordable bundles to include:

- Filter, match and 10 other automatic RF circuit synthesis
- RF system architecture and frequency planning
- Modulated RF system analysis (dataflow- and frequency-domains)
- Nonlinear circuit simulation (DC, time- and frequency-domains)
- 3D-planar EM simulation

## Key building blocks

Genesys bundles are comprised of one or more of these building blocks		
	Core	Schematic, Layout, Linear Analysis, Optimization, MATLAB script, Instrument links
	Synthesis	Filters (active, passive, distributed, custom response), Match, Oscillator, Mixer, Signal Control, Equalizer, Transmission Lines, PLL, Vendor Parts Selection
	System	System simulation, Budget analysis & Frequency Planning synthesis
	Modulated RF	Modulated RF system analysis of EVM, BER and ACPR with WLAN & LTE verification
	Circuit	Harmonic Balance & Transient circuit simulation
	EM	3D Planar Electromagnetic simulation of printed circuits and antennas

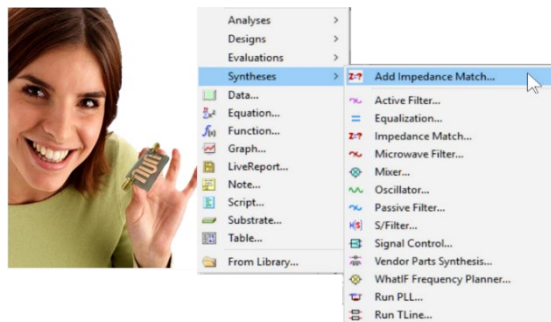
## Genesys Core Building Block

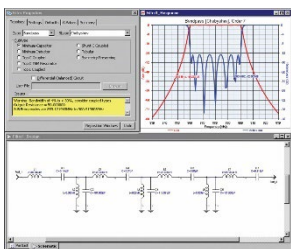
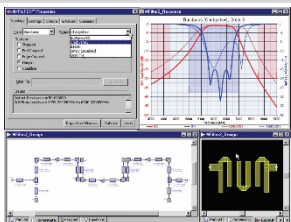
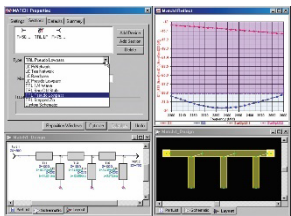
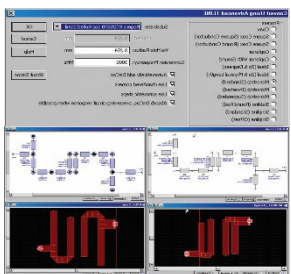
Capability module	Description
	<p><b>Design Environment</b></p> <ul style="list-style-type: none"> <li>• Integrated, easy-to-use Windows-based graphical user environment for hierarchical design creation and management; available in six major languages worldwide</li> <li>• Scripting from Matlab script, Visual Basic, C++, VBScript or JScript for automation of Genesys to perform custom or repetitive tasks</li> <li>• LiveReport for creating auto-updating and interactive design documentation</li> <li>• Export Genesys designs for use in Keysight ADS in design collaboration</li> </ul> <p><b>Linear Circuit Simulation, Tuning and Optimization</b></p> <ul style="list-style-type: none"> <li>• Fast linear simulation and powerful optimization</li> <li>• Interactive tuning for quick insights</li> <li>• Fast and robust design optimizer</li> <li>• Linearizes nonlinear components at their DC bias before linear simulation.</li> </ul> <p><i>NOTE: Full DC analysis requires Harbec/Cayenne nonlinear circuit simulators</i></p> <p><b>Statistical Simulation</b></p> <ul style="list-style-type: none"> <li>• Monte Carlo yield analysis</li> <li>• Graphical and spreadsheet statistical report</li> </ul> <p><b>Data Processing and Display</b></p> <ul style="list-style-type: none"> <li>• Data sets for persistent storage of simulation and measurement data for post-processing and display to eliminate wasteful re-simulation</li> <li>• Matlab scripting with 100% compatibility with Matlab for custom equations, functions and data processing</li> <li>• Flexible data display and analysis with rectangular, polar, Y/Z Smith, histogram, 3D-parametric plots, and instrument-style marker readouts</li> <li>• Interactive 3D viewer for EM surface currents and antenna far-field patterns</li> </ul>

Capability module	Description
	<p><b>RF/microwave Layout and Artwork Translators</b></p> <ul style="list-style-type: none"> <li>• Create layout from schematic, imported artwork, or direct drawing for EM simulation and board fabrication</li> <li>• 3D viewer for layout with interactive rotation, zoom, vertical stretching, and cut planes to verify correct geometry before fabrication</li> <li>• Export Python script of layout, materials and ports to Keysight EMPro for full 3D EM simulation</li> <li>• Full library of pad/package layout footprints</li> <li>• Import /export masks and drill files in popular printed circuit board (PCB) formats (e.g., Gerber, DXF/DWG, and GDSII) for PCB board realization on fast prototyping machines or chemical etching</li> </ul> <p><b>Libraries of Simulation Models and Parts</b></p> <ul style="list-style-type: none"> <li>• Full libraries of accurate high-frequency physical transmission line, transition and discontinuity models</li> <li>• Over 30,000 linear, nonlinear and system parts</li> </ul> <p><b>Instrument Testlink</b></p> <ul style="list-style-type: none"> <li>• Captures measured data directly into Genesys for simulation and display on network analyzers, impedance analyzers, oscilloscopes, vector/spectrum analyzers, semi-conductor analyzers, and power meters</li> <li>• Supports over 140 instruments from more than 14 equipment manufacturers</li> </ul>

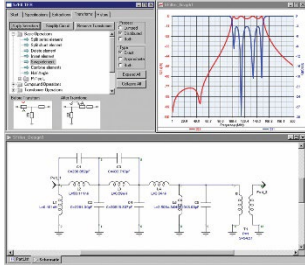
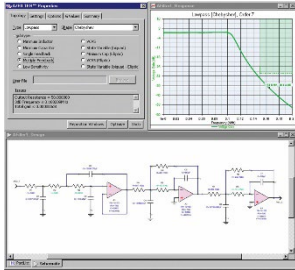
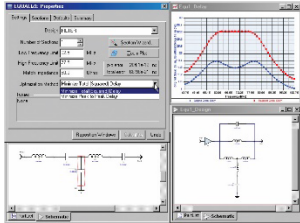
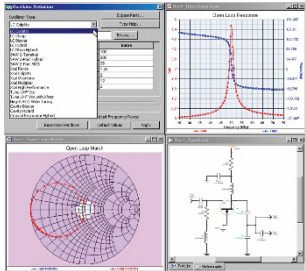
## Genesys Circuit Synthesis

Genesys provides the industry's widest coverage of passive and active circuit synthesis capabilities. The synthesis modules create high-performance circuits, accelerate routine design tasks from hours to minutes, and enable fast make-or-buy decisions on RF components. All 12 synthesis modules are included in the Genesys Synthesis building block.


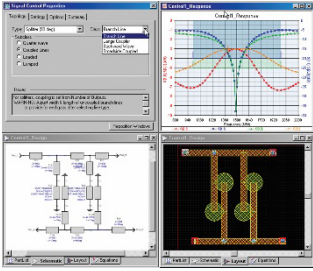
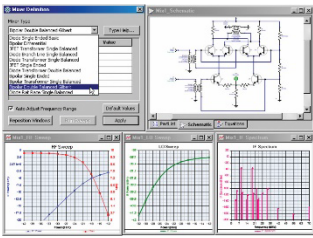
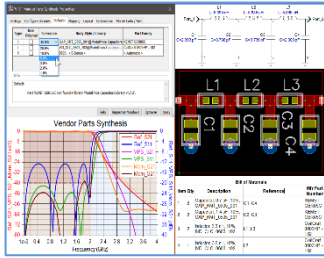


Capability module	Description
<b>Filter Synthesis</b>	
	Lumped filter synthesis. Automatically creates multiple lumped LC filter circuit topologies that satisfy user input specifications such as filter type, response shape, minimum inductor (to minimize cost), single ended or differential terminations.
<b>M/Filter Synthesis</b>	
	Microwave filter synthesis. Automatically creates distributed and hybrid lumped-distributed microwave wave filters with physical layout for over 60 types of topologies to satisfy user input specifications for filter type, response shape, order, transmission line resonator impedance and types of physical implementation. Useful for designing embedded printed filters on PCB boards.
<b>Match Synthesis</b>	
	Matching network synthesis. Synthesizes impedance-matching networks over narrow/broad frequency bands with lumped/distributed components and complex frequency-dependent loads. Creates simultaneous input, output and inter-stage matching for cascaded non-unilateral devices. Accepts measured S-parameters of impedances to be matched.
<b>Advanced Transmission Line Synthesis</b>	
	Synthesizes 13 types of transmission lines with lump-distributed circuit conversion and automatic discontinuity insertion. Converts ideal electrical designs to physical implementation such as microstrips and striplines on your choice of substrate.

# Circuit Synthesis

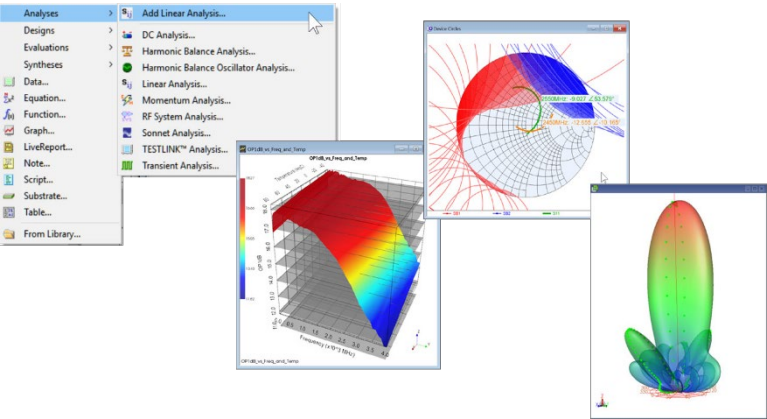
Capability module	Description
<b>S/Filter Synthesis</b>	
	Direct filter synthesis technology enables custom shaping of filter response with transmission zeros to automatically create custom lumped and distributed filter topologies. Comes with over 200 interactive lumped and distributed topological transforms to design filters that are practically realizable with lumped and/or distributed elements.
<b>A/Filter Synthesis</b>	
	Active op-amp filter synthesis with over 30 active topologies. Use for IF, video, baseband frequencies, and control applications such as power control and AGC circuits.
<b>Equalize Synthesis</b>	
	Synthesizes equalization networks to compensate for linear phase distortions in the circuit or system that impacts modulation fidelity such as error vector magnitude (EVM), video, and audio fidelity.
<b>Oscillator Synthesis</b>	
	Explore 19 RF oscillator topologies from classical L-C, transmission line, SAW, crystal, cavity, and coaxial hybrid. Recommended companion to the Harbec harmonic balance or Cayenne transient circuit simulators.



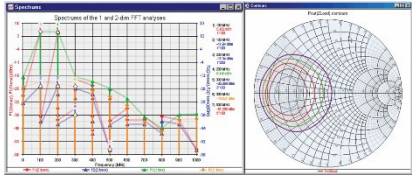
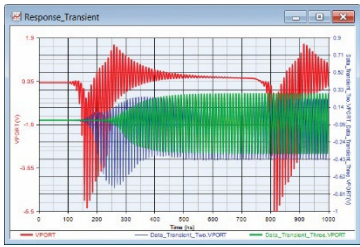
Capability module	Description
<b>PLL Synthesis</b>	
	Phase-locked loop (PLL) synthesis of analog loop filters and 5 setup wizards to design frequency synthesizers and phase/frequency modulators/demodulators.
<b>Signal Control Synthesis</b>	
	Synthesizes a variety of lumped and distributed couplers (10 types), splitters (10 types), Baluns (5 types), and attenuator (2 types) circuits that control RF signal flow.
<b>Mixer Synthesis</b>	
	Explore a range of performance trade-offs between 11 RF mixer topologies based on BJTs, FETs and diodes from diode rings to Gilbert cells. Design companion to the Harbec harmonic balance circuit simulator.
<b>Vendor Parts Synthesis</b>	
	<p>Automatically replace real-valued RLC parts in any design with purchasable discrete vendor RLC with accurate parasitic models from Modelithics and performs a grid optimization of available values so that your actual RF-PCB meets original specs.</p> <p>Automatically inserts solder pads for SMT RLC components and sets up EM analysis to account for their effects during grid optimization.</p>

# Genesys RF Simulation

Genesys offers comprehensive circuit, system and electromagnetic simulation capabilities that are provided in the following 4 building blocks. They are used to construct powerful and economical Genesys RF and microwave board design bundles.



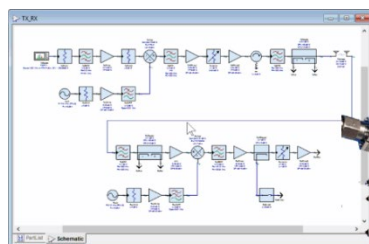
## Circuit Simulation

Capability module	Description
Harbec Harmonic Balance	
	Harmonic balance, nonlinear frequency-domain circuit simulation and optimization that calculates the harmonic spectrum at any circuit node, IP3, compression, efficiency, conversion gain, phase noise, load pull contour, large-signal oscillator, amplifier, or mixer. Indispensable tool for RF/microwave and DC bias designs with active transistors, diodes, and components. Harbec now incorporates Keysight's breakthrough nonlinear X-parameters simulation technology for convenient and accurate nonlinear circuit designs with X-parameter models of transistors and RFICs.
Cayenne Transient	
	Transient simulation for RF circuits that works from the same schematic and RF physical models as Harbec. Includes convolution algorithm to use S-parameters and frequency-domain transmission-line models in accurate time-domain transient simulations of RF and high-speed signal paths. Includes full DC analysis and optimization of DC voltages and currents.

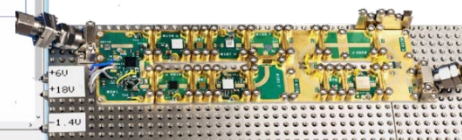



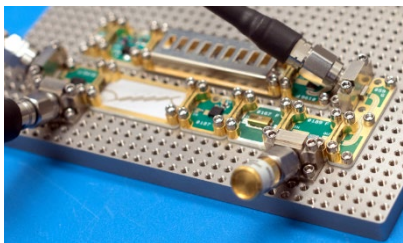
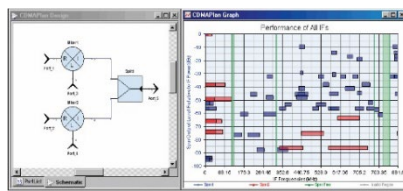
## Genesys RF System Simulation

The Genesys system building block includes Spectrasys, a powerful RF system architecture and diagnostic simulator, and WhatIF, an innovative frequency planning synthesis that instantly identifies spurious-free bands when designing frequency conversion systems.



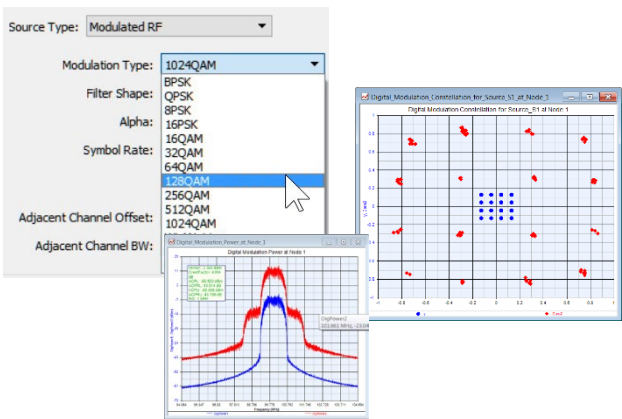
Simulate and build RF systems with real parts

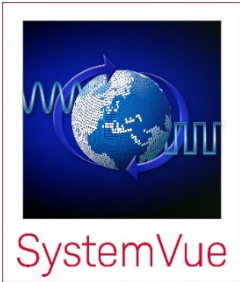
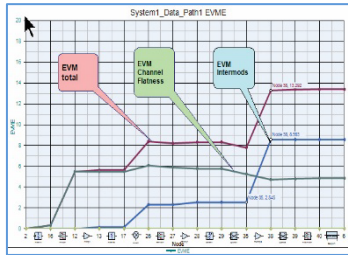



Capability module	Description
Spectrasys RF System Simulator	
  <p>RF system rapid prototyping with system blocks from X-Microwave.com accurately modeled with Keysight Sys-parameters or X-parameters for simulation in Spectrasys</p>	<p>RF system architecture design with accurate behavioral and data-based system blocks to analyze system block diagram performance far more accurately than traditional spreadsheets. Unique root-cause diagnostics identify culprit components that impair system performance such as origins of nonlinear spurious mixing intermods ignored by traditional spreadsheet calculations. Especially useful for establishing confidence in system design reviews before hardware realization to avoid costly implementation mistakes downstream.</p> <p>Spectrasys uses Keysight Sys-Parameters which are frequency, temperature and bias dependent nonlinear system component models that directly use datasheet specs supplied by component vendors such as Mini Circuits and Analog Devices. You can also create spreadsheets of P1dB, IP3, IP2, NF, etc. for use by these models to accurately simulate off-the-shelf components in your system before purchase. Sys-parameter libraries representing popular system blocks from ADI, MiniCircuits, MACOM, DLI, IDT, Custom MMIC and others are downloadable from <a href="http://www.xmicrowave.com">www.xmicrowave.com</a> for rapid system prototyping.</p> <p>X-parameters from nonlinear network measurements or ADS circuit simulation are also convenient and accurate models of system blocks used in Spectrasys.</p> <p>DC power estimator summarizes the different voltage and current drain required by each system component to enable the proper sizing of the system power supply. This is an important aspect of RF system design that other tools neglect.</p>
WhatIF Frequency Planner	
	<p>Unique, graphical frequency-planning synthesis tool that quickly identifies spurious-free bands across a wide bandwidth involving multiband conversions to a common IF, using realistic mixers. Useful for designing multiband down-converters with high- and low-side LO's. A natural companion to Spectrasys RF system architecture design tool.</p>

# Genesys Modulated RF

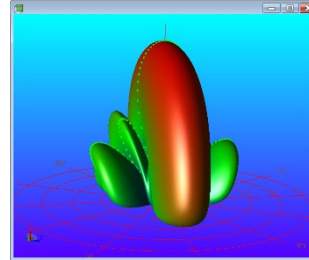
The Genesys Modulated RF capability extends the prerequisite System building block by adding the SystemVue dataflow simulator. It enables RF designers to easily specify digitally modulated RF signals to analyze circuits and systems for digital modulation metrics such as EVM, BER and ACPR. Included WLAN and LTE verification libraries assure design compliance with the latest wireless standards.



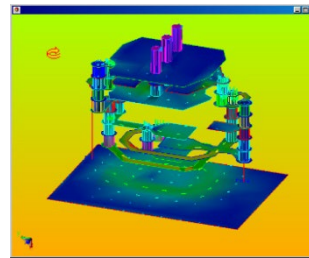
Capability module	Description
<b>SystemVue Dataflow Simulator</b>	
	<p>The SystemVue dataflow simulator enables digitally modulated RF signals to be used for simulating circuits and systems to calculate key digital RF figure of merits such as EVM and ACPR.</p> <p>It comes with more than 40 digital modulation schemes, selectable through a pull-down menu on the signal source. Once the digital modulation source is selected, all dataflow parameters, including data sinks are automatically set up correctly for the analysis; thus relieving the RF engineer from having to deal with unfamiliar digital signal processing (DSP) dataflow parameters before starting the simulation.</p>
<b>Modulated RF Budget Analysis</b>	
	<p>The modulated RF budget analysis of EVM, BER and ACPR on the level diagram is a breakthrough capability in the industry that enables the RF system designer to pinpoint which components in the system architecture are contributing to EVM, BER or ACPR failures.</p> <p>Unlike a single pass/fail simulation, the level diagram indicates stage-by-stage the relative contribution of each component in the system chain to the overall system performance. Based on patented fast estimation algorithms, modulated RF budget analysis also allows interactive tuning of individual component specs to see their relative impact on EVM, BER or ACPR during design.</p>
<b>Verification library LTE-3GPP and WLAN 802.11ac</b>	
	<p>Instead of going through volumes of LTE-3GPP or WLAN802.11ac test and compliance specifications in trying to set up complicated simulations for verifying your circuit or system design, Genesys has already done that for you.</p> <p>The included LTE-3GPP and WLAN 802.11ac verification libraries comes ready set up with correct default dataflow parameters for the RF engineers to begin the verification simulations with zero learning curve. This follows the tradition of ease-of-use and instant productivity that Genesys is always sought after for.</p>

## Genesys EM Simulation

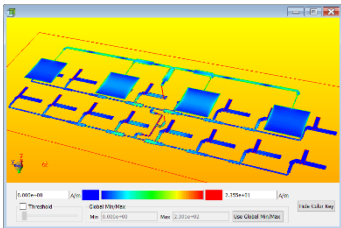
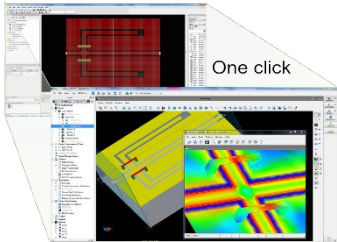

The Genesys EM block includes Momentum, the most advanced 3D-planar electromagnetic simulator in the industry that is also used by Keysight PathWave Advanced Design System flagship EDA tool. Momentum enables you to analyze the EM effects of physical circuit layout components that were not in your original design schematic, such as microstrip interconnects for SMT components, solder pads, vias, proximity ground planes and covers. Tightly integrated circuit-EM cosimulation allows you to optimize circuit parameters to compensate for these parasitic effects before you construct hardware, thereby eliminating wasteful delaying iterations. Links to Keysight EMPro full 3DEM simulator and Sonnet provides automatic setup of ports, materials and structure for additional EM corroboration if needed.



Visualize and measure planar antenna far field patterns



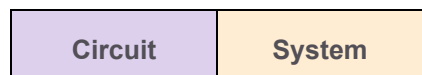
Compute and visualize Surface current flow in 3D to troubleshoot EM coupling and leakage effects

Capability module	Description
<b>Momentum 3D Planar EM Simulator</b>	
	Highest-performance, integrated 3D-planar EM simulator in the industry. Includes fast multi-threaded simulation on multicore processors, polygonal mesher and highly memory efficient NlogN solvers. Offers the highest speed and capacity for 3D-planar EM simulation to analyze complex multilayer layouts or large planar-antenna arrays. Interactive 3D viewer for surface currents and antenna far-field reveals design insights for troubleshooting and fixing undesired EM effects.
<b>Keysight PathWave EMPro Link</b>	
	Keysight EMPro analyzes non-planar 3-D electromagnetic effects such as packaging, shielding and integration of circuit with waveguides or coax connectors. In a single click, Genesys exports its planar RF/microwave layout, along with ports and substrate material properties to EMPro for immediate simulation. Eliminates tedious manual re-entering of 3D structures, EM port locations and material properties.
<b>Sonnet Link</b>	
	Enables users of Sonnet planar EM simulator to take advantage of Genesys circuit/system synthesis and simulation by performing circuit-EM co-simulation.

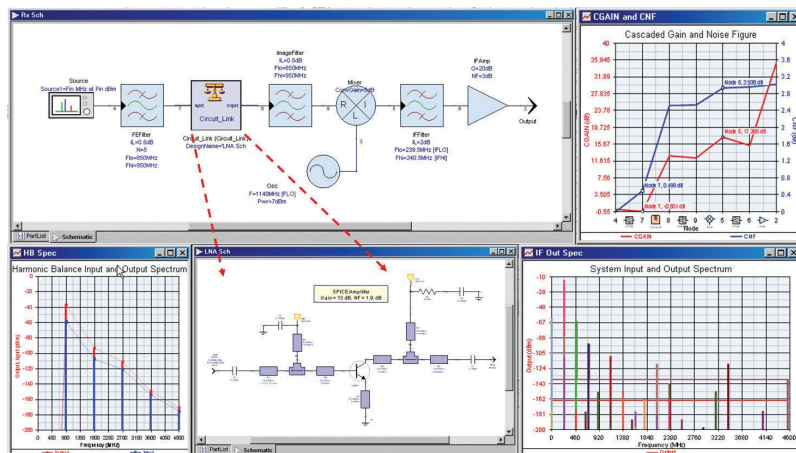
## Genesys Co-Simulation

The already powerful system, circuit and electromagnetic simulators can also be used together to analyze, tune and optimize your designs in a single pass. This eliminates tedious and error-prone manual translation of data between simulators.

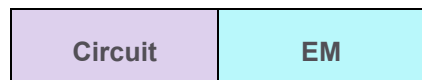
### Circuit-system co-simulation



Enables nonlinear circuit parameters to be tuned and optimized to system specs in one pass. It eliminates tedious, non-interactive and error-prone creation of inaccurate system behavioral models from circuits to perform circuit-system verification.



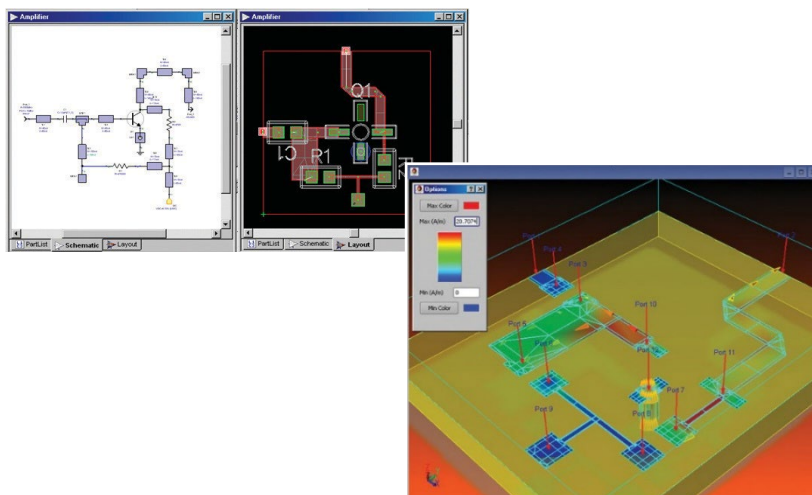
### Circuit-EM co-simulation



Automatically includes the physical effects of board layout in both linear and nonlinear circuit simulations.

It enables you to identify and fix circuit performance degradation caused by undesired parasitics, proximity coupling, resonance and reflection from your RF board layout.

3D interactive viewing of animated surface current flows help you pinpoint the location of these problems without guesswork.



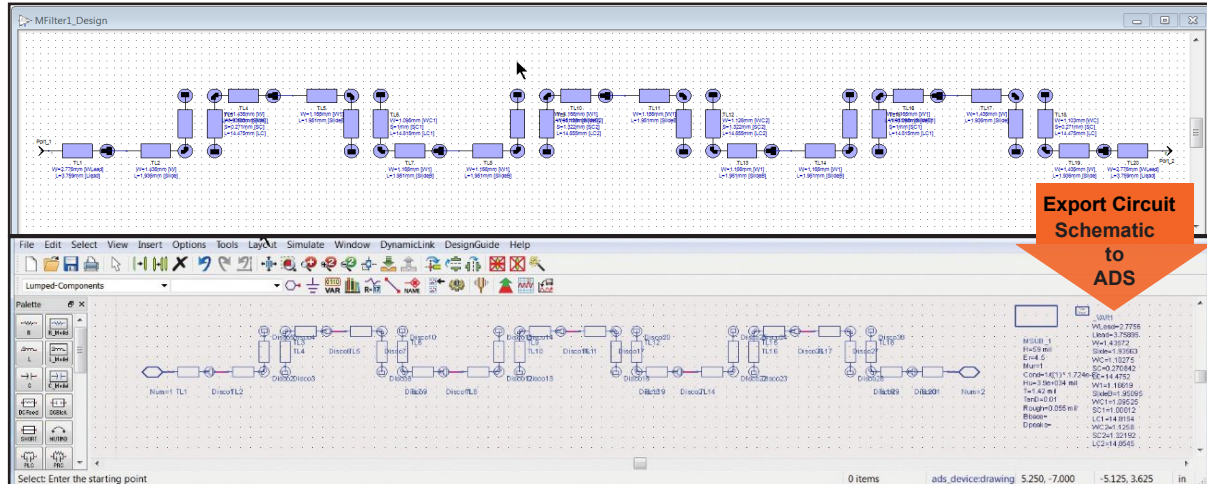


## Genesys For ADS Users

The automatic circuit synthesis and RF system architecture capabilities in Genesys are perfect complement to ADS users for enhancing personal design productivity at minimum cost.

### Genesys synthesis to ADS schematic transfer

Using Genesys synthesis for broadband impedance matching network design reduces hours of tedious work into a few minutes of mouse clicks as you watch your matching network being synthesized and optimized automatically.



Designing demanding custom notched filters or difficult multiplexers are efficiently tackled with automatic filter synthesis and network transforms to produce novel realizable topologies within minutes instead of days of looking up references. The Genesys synthesized circuit schematic can be transferred to ADS with one click for inclusion into a bigger design

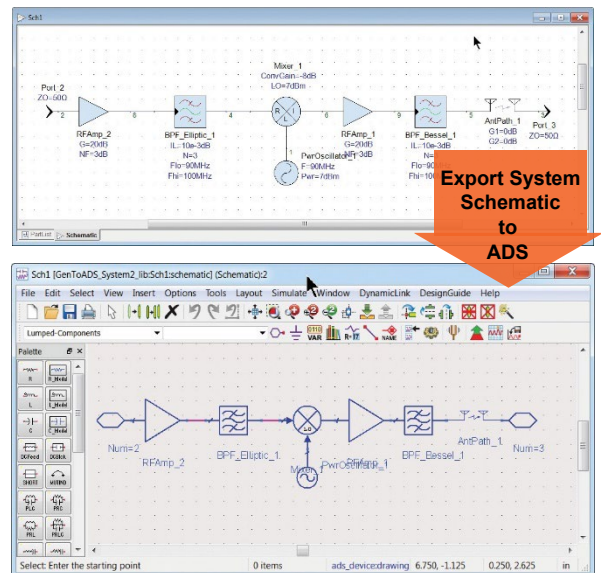
### Genesys system architecture to ADS schematic transfer

Quickly putting together a system block diagram and simulating it to pinpoint the components causing system impairments is one of the most valued capabilities in Genesys by all RF system designers. System schematic can be transferred to ADS with one click for simulation with its harmonic balance or circuit envelope simulators.

All the above are now available to ADS users as:

- PathWave Synthesis, SpectraSys & Modulated-RF W3060E element
- PathWave RF Synthesis Core (Genesys) + Synthesis + System + Modulated-RF W5307B bundle

They can also run as standalone Genesys bundles when available ADS licenses are depleted.



## Genesys Bundles

Genesys bundles are affordable combinations of useful capabilities that work seamlessly together at a fraction of the cost of any competing design tools. For ADS users, the W5307B bundle containing Genesys automatic synthesis and system capabilities is specially created for boosting personal design productivity with one click schematic transfer to ADS. The bestselling bundle is the all-inclusive W5309B because of its unbeatable price performance.

										EM
									Modulated RF	Modulated RF
								Modulated RF	System	System
				Circuit	EM	Circuit	Modulated RF	System	Circuit	Circuit
		Synthesis	System	Synthesis	Synthesis	Synthesis	System	Synthesis	Synthesis	Synthesis
	Core	Core	Core	Core	Core	Core	Core	Core	Core	Core
Model number	W5300B	W5301B	W5302B	W5303B	W5304B	W5305B	W5306B	W5307B	W5308B	W5309B
RF Pathwave Synthesis (Genesys) Bundle name	Core	Core + Synthesis	Core + System	Core + Synthesis + Circuit	Core + Synthesis + EM	Core + Synthesis + Circuit + EM	Core + System + Modulated RF	Core + Synthesis + System + Modulated RF	Core + Synthesis + Circuit + System + Modulated RF	Core + Synthesis + Circuit + System + Modulated RF + EM
Environment										
Genesys Core	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Testlink	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Synthesis										
Filter		Y		Y	Y	Y		Y	Y	Y
M/Filter		Y		Y	Y	Y		Y	Y	Y
Match		Y		Y	Y	Y		Y	Y	Y
Advanced Tline		Y		Y	Y	Y		Y	Y	Y
S/Filter		Y		Y	Y	Y		Y	Y	Y
A/Filter		Y		Y	Y	Y		Y	Y	Y
Equalize		Y		Y	Y	Y		Y	Y	Y
Oscillator		Y		Y	Y	Y		Y	Y	Y
PLL		Y		Y	Y	Y		Y	Y	Y
Signal control		Y		Y	Y	Y		Y	Y	Y
Mixer		Y		Y	Y	Y		Y	Y	Y
Vendor Parts		Y		Y	Y	Y		Y	Y	Y
Circuit Simulator										
Harbec				Y		Y			Y	Y
Cayenne				Y		Y			Y	Y
System Simulator										
Spectrasys			Y				Y	Y	Y	Y
WhatIF			Y				Y	Y	Y	Y
Modulated-RF										
Dataflow Simulator							Y	Y	Y	Y
EVM Budget Analysis							Y	Y	Y	Y
LTE, WLAN Verification							Y	Y	Y	Y
EM Simulator										
Momentum					Y	Y				Y
EMPro Link					Y	Y				Y
Sonnet Link					Y	Y				Y



## Genesys Licensing Options

PathWave RF Synthesis (Genesys) bundle licenses are purchased through an affordable annual subscription. In addition to preserving cash flows for your business, subscription purchase may also simplify accounting by treating it as an expense in tax reduction.

License Type	Node-locked	Networked
Subscription license	The node-locked subscription license is locked to a USB key or PC LAN physical address	The networked subscription license enables convenient sharing by users across a network
	Usage expires after the 12-months time-based license period	Suitable for larger companies who need to optimize cash flows by sharing a license amongst multiple users
	Lowest cost option to purchase a Genesys software license	Cost about 30% more than a node-locked license
		Requires network license server administration

## Securing your Genesys License

Genesys subscription licenses can be secured to your personal computer's (PC) local area network (LAN) physical address or a universal serial bus (USB) hardware key serial number.

- LAN Physical Address - When secured to your computer LAN physical address, the danger of losing the small USB hardware key is eliminated and your license enables you to start using Genesys just like any other software on your PC.
- USB Hardware Key - When secured to a USB hardware key, you have the convenience of license portability to run Genesys on different computers. However, you may risk losing the USB key which then prevents you from using Genesys.
- [www.keysight.com/find/eesof-usb-key](http://www.keysight.com/find/eesof-usb-key)



Learn more at: [www.keysight.com](http://www.keysight.com)

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