PathWave System Design

One environment for system architecture, design, and verification

RF system design challenges include mmWave frequencies, multiple antennas, complex modulation, beam steering, and sophisticated algorithms. Rough estimates, figures and formulas on spreadsheets, and internal or custom tools have trouble keeping pace.

PathWave System Design (formerly SystemVue) brings teams multi-domain modeling and simulation in one collaborative design environment for complex RF systems. It goes beyond math-based modeling with a complete RF-aware design workflow, plus decades of Keysight measurement science in RF instrumentation, ready for any system architect.

Why RF system design teams choose PathWave System Design

- Most advanced virtual prototyping and design platform for complex RF systems
- Faster simulation speed in time and frequency domains with near-circuit-level fidelity
- Real-world libraries for radar, EW, satellite, phased array, 5G NR, Wi-Fi 6, and more
- Integrations with MATLAB®, STK, Wireless InSite®, HFSS, and CST Studio Suite®

Faster prototyping, better RF designs

Teams are turning to PathWave System Design for faster, more accurate digital prototyping and design of RF systems. See how PathWave System Design fits in your system engineering workflow with a free, 30-day trial:

www.keysight.com/find/system-design-evaluation
Prototype complex RF systems, create new breakthroughs

Physical prototyping, especially for large, complex systems, is expensive and time-consuming. However, even if an organization has an outstanding track record of RF system design, investors and government agencies are less and less willing to fund development without seeing a prototype. In a major shift, the United States Department of Defense (DoD) has outlined its Digital Engineering Strategy. Calling for digital system representations in its acquisition and procurement processes, DoD looks to encourage prototype repeatability, capture proof-of-performance sooner, and speed up communication across stakeholders.

How do system engineering teams quickly demonstrate concepts and show ways to address challenges without too much speculative spending?

PathWave System Design is the most advanced virtual prototyping and design platform available for RF system architects, array antenna designers, RF module designers, DSP engineers, and system test engineers. It shares data with many enterprise tools for modeling and analysis of coverage scenarios, RF propagation and channels, antenna design, and baseband signal processing. Teams can drill down into part of a design reducing complexity, simulate with higher fidelity, and bring results back into the system model.

Figure 1. PathWave System Design shares data with many RF system engineering tools

Adding PathWave System Design to a system engineering workflow can get virtual RF system prototypes up and running faster, with improved accuracy. Teams can explore ideas and have answers for risks earlier. System architects proficient in PathWave System Design see new ways to solve difficult design challenges, opening doors to development breakthroughs in future technologies for complex RF systems.
Verify hardware faster with RF-aware tools

High fidelity RF characterization built in
- Non-linearity, spurs, phase noise, impedance, and more
- X-parameters, fast circuit envelope models
- Verified waveforms and vector modulation analysis
- Shared measurement science with decades of Keysight instrumentation designs
- Flows directly into chip- and circuit-level RF design

Multi-domain modeling and simulation
- Everything needed for physical layer (layer 1) analysis
- Behavioral model libraries in intuitive workflow
- Simulation in both time- and frequency-domain
- Open interfaces for third party RF component models

Phased array analysis
- Powerful frequency, time, and cross-domain simulation of complete phased array systems
- ‘Best in class’ simulation speed for phased arrays and other complex RF designs
- Intuitive array configuration and links to antenna design software
- Beam measurement and visualization tools
- 5G, Radar, EW, and Satellite applications

Libraries for real-world RF systems
- MilCom & SatCom data links and SDR
- Electronic warfare, SIGINT, and EMSO
- Space vehicle communication links
- 5G NR and 3GPP specifications
- Wi-Fi 6 and connectivity specifications
- Automotive radar systems

Direct connections with enterprise design and verification tools
- Baseband algorithm design and modeling (MATLAB, Python)
- RF and mmWave circuit design (PathWave ADS, PathWave RFIC Design)
- Scenario and channel modeling (STK, Wireless InSite)
- Instrument software (PathWave Vector Signal Analysis (VSA))
- Open APIs for modeling and additional workflow customization

Figure 2. Multi-beam phased array antenna pattern

Figure 3. 5G NR carrier aggregation (CA)
Save time with built-in RF modeling excellence

Simulation with RF effects captured

**Time-domain simulation** in PathWave System Design captures modulation and time-varying behavior:

- Dataflow simulation addresses complex RF system scenarios such as adaptive modulation, system agility, and dynamic resource allocation.
- Multiple envelope dataflow handles higher-order harmonics and distortion for wideband designs.

**Frequency-domain simulation** brings more RF critical measurements and accurate modeling:

- Spectrasys, a block-level RF simulator with unique technology for analyzing how harmonics and intermodulation propagate through systems.
- WhatIF frequency planning helps pinpoint optimum intermediate frequencies.
- EM Link captures layout and enclosure coupling effects starting early in the system design process, sharing data with layout tools, and highlighting parasitic issues automatically. Teams can explore system and physical design simultaneously with higher RF fidelity.

**Cross-domain simulation** extends PathWave System Design capability with unique analyses:

- RF Link allows time-domain simulations to use frequency-domain blocks with RF impairments directly from Spectrasys.
- With RF Link, simulations can capture stages of up- or down-conversion, spectral inversion, thermal and phase noise, frequency/power dependence, and more.

**Off-the-shelf and extensible behavioral models**

- **Over 300 simulation blocks** are available in the PathWave System Design core, all with behaviors and RF effects modeled. Optional libraries are available from Keysight, as well as vendor-specific libraries from Analog Devices, Mini-Circuits, X-Microwave, Qorvo, and others.
- Open interfaces allow building models from datasheets using Sys-parameters, S- and X-parameters.
Innovate faster with PathWave System Design libraries

PathWave System Design excels with elements like high-density antenna arrays, complex modulation and waveforms, and state-of-the-art signal processing. Design teams can use built-in libraries of generic and specification-compliant processing blocks, or they can bring their own MATLAB, C++, or HDL code into PathWave System Design for simulation with RF system models. Complete PathWave System Design library descriptions are available online at:

www.keysight.com/find/system-design-libraries

Figure 5. Plots from PathWave System Design libraries and application examples

Aerospace and Defense

- Pulsed and pulsed-doppler (PD) radar architectures for telemetry and EW applications
- Multi-static radars with multiple TX and RX locations, including motion (vehicle/ship/air/space-borne)
- MIMO radars for increased range resolution and robustness
- Advanced mission planning and analysis through links to STK from AGI, an Ansys Company
- Frequency modulated continuous-wave (FMCW) radars for automotive applications
- Signal generation for embedded simulators and test & measurement applications
- Numerous other radar examples such as ultra-wideband, synthetic aperture, and digital array radars

5G NR

- Supporting 5G NR physical layer channels and signals reference DSP models for:
  - 3GPP TS 38.211 Physical Channels and Modulation
  - 3GPP TS 38.212 Multiplexing and Channel Coding
- 3D MIMO channel based on 3GPP TR 38.901
- Over-the-air (OTA) simulation for 5G NR mmWave
- Multi-antenna system architectures, including baseband, RF and hybrid beamforming structures
- Link level performance evaluation by incorporating user antenna element pattern as well as beam pattern files from PathWave EM Design (EMPro), HFSS, or CST Studio Suite

Wireless connectivity

- Wi-Fi 6 (802.11ax)
- Bluetooth 5.2 with BLE
- Zigbee and 802.15.4
- GNSS data links

Digital modem

- Software-defined radio (SDR) and cognitive radio designs
- Over 40 digital modulation formats for MilCom and SatCom
- 25 reference transmitter and receiver designs
- Custom OFDM and DNSS sources
Capture world-class measurement science

PathWave System Design pairs accurate simulation with real-world data. Decades of measurement science – the same knowledge that Keysight uses to design its instrumentation – are available for system architects, designers, and verification teams. Complex waveforms from RF system simulation can be used in actual hardware testing as well. PathWave System Design connects to a wide range of Keysight instrumentation, allowing designers to use the same stimulus they used during simulation in their lab testing. Results from measurement can also be brought back into PathWave System Design for further analysis, enabling a true hardware-in-the-loop capability.

PathWave VSA
- FM linear chirp frequency hopping, pulsed RF, and FMCW modulated signals
- Demodulation and error vector measurements of 5G NR signals
- Advanced capabilities including carrier aggregation and higher-order MIMO
- Signal quality analysis including MER, BER, constellations, and IQ error plots
- Custom OFDM formats with channel, stream, and cross-channel measurements
- Demodulation of signals with modulation from BPSK to 4096 QAM

Keysight PNA Vector Network Analyzers
- Efficient way to create behavioral models
- Two-tone X-parameter measurements
- Noise figure, gain compression
- Intermodulation and harmonic distortion
- Antenna and radar cross-section measurements
Step up hardware quality with near-circuit-level simulation accuracy

System architects aren’t the only ones who can harness the power of RF-aware system-level simulation. Connecting PathWave System Design with companion PathWave circuit-level RF design tools adds near-circuit-level simulation accuracy. Virtual Test Benches (VTBs) bring modulated waveform analysis to transistor-level simulation inside PathWave ADS and PathWave RFIC Design.

Hardware design benefits from tighter collaboration between system architects, RF module designers, and system test engineers. With PathWave ADS and PathWave RFIC Design connected to PathWave System Design, teams can co-simulate areas of interest with detailed RF effects. Designers gain crucial insight into hardware behavior with more real-world effects modeled accurately, and more advanced simulation techniques available for hardware exploration:

- **X-parameters** enhance system analysis with accurate non-linear models created from simulation or measurement,

- **Physical layout factors** such as PCB trace lengths, vias, and interconnects create effects impacting performance, with modeling connected by EM Link,

- **Fast circuit envelope** (FCE) algorithms speed up simulations with near-circuit-level accuracy, nonlinear behavior, and memory effects,

- **Load pull analysis** helps match impedance between RF stages. It evaluates an optimum point of impedance along with contours of constant degradation on a Smith chart,

- **Monte Carlo analysis** improves test coverage in RFIC simulations, using intelligent sampling to reduce the number of required trials by up to an order of magnitude.
PathWave System Design - Ordering Information and Licensing

For teams performing high-frequency RF design and simulation, PathWave System Design is licensed in two-part bundles with a design core license, and a simulator license. Enterprise installations can optimize licensing based on core access counts and specific simulation capability needs for team members.

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<tr>
<th>Model</th>
<th>Name</th>
<th>Description</th>
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<tbody>
<tr>
<td>W4800B</td>
<td>PathWave System Design Core</td>
<td>Schematic capture, data plotting, and MATLAB code support</td>
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<tr>
<td>W4801B</td>
<td>PathWave System Design Core + RF</td>
<td>Adds RF Analysis simulation elements with Spectrasys, WhatIF, linear simulation, and RF component model libraries</td>
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<tr>
<td>W4802B</td>
<td>PathWave System Design Core + Comms/DSP</td>
<td>Adds timed dataflow simulation, with libraries for DSP elements, digital modulation, SerDes, MIMO, and legacy cellular specifications</td>
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<tr>
<td>W4803B</td>
<td>PathWave System Design Core + RF + Comms/DSP</td>
<td>Allows RF Link to connect timed dataflow analysis with accurate, high-fidelity RF system models</td>
</tr>
<tr>
<td>W4804B</td>
<td>PathWave System Design Core + RF + Comms/DSP + Phased Array</td>
<td>Adds advanced Phased Array simulation for both RF and Comms/DSP applications using beamforming</td>
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For teams performing algorithm design in MATLAB, PathWave System Design simulation engines integrate with MATLAB and Simulink, letting algorithm designers call PathWave System Design workspaces and libraries directly within the MATLAB environment.

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<td>W4806B</td>
<td>PathWave System Design Algorithm Core</td>
<td>RF and Comms/DSP simulation engines for algorithm designers working in a MATLAB-centric environment (no PathWave System Design Core included)</td>
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PathWave System Design is available on a subscription basis with periods of 6, 12, 24, or 36 months. All bundles run on 64-bit versions of Windows 10.

Complete ordering details are available in the PathWave System Design Configuration Guide, online at: www.keysight.com/find/system-design-config
For More Information on PathWave System Design

Apply for a Free Trial:
www.keysight.com/find/system-design-evaluation

Or, visit these online resources:

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