5G New Radio Solutions for Chipset and Device Designers

Master the complexities of 5G New Radio and accelerate your 5G designs
5G New Radio Solutions for Chipset and Device Designers

5G New Radio (NR) initial standards are approved by 3GPP and first chipsets are released, setting the stage for large-scale trials and commercial deployments as early as 2019. 5G requires new technologies and performance improvements that challenge the way you design, test, and optimize 5G devices.

Keysight is helping solve 5G design and test challenges ahead of the technology wave, providing solutions that span the device ecosystem, enabling designers to accelerate development and bring 5G innovations to market faster.

Keysight 5G Solutions

- Components & RFICs
  - Circuit Design & Simulation Software
  - Baseband Development
  - RF Development

- High-Speed Digital Interfaces
  - Advanced Design Software
  - MIPI® Verification

- Modems & Devices
  - RF & Protocol Development
  - Battery Optimization

Solutions and Services Spanning the Device Ecosystem

- 5G Over-the-Air-Test
  - OTA test solutions span the 5G product development workflow

- Manufacturing Test
  - Automated test of multiple devices across extended frequencies and wide bandwidths

- Service & Support
  - Improve asset utilization, maximize engineer productivity, and eliminate sources of error
Overview: Solutions That Accelerate 5G Innovation

Overcoming 5G NR Design & Test Challenges

5G is rapidly approaching, promising a future where everything is connected, all the time, with faster, reliable, and near-instant connectivity.

There are aggressive design goals across all three priority 5G use cases. In enhanced mobile broadband (eMBB), target peak data rates of 20 Gbps in the downlink and 10 Gbps in the uplink are specified, sufficient to support streaming of 4K or 8K UHD videos. In ultra-reliable low-latency communications (URLLC), < 1 ms latency is required to support demanding applications such as self-driving automobiles and mission-critical drones. And in massive machine type communication (mMTC), support for up to 200,000 devices per square kilometer is necessary to support high-density IoT sensor networks. Achieving these goals requires new test methodologies and techniques for 5G NR chipsets, components, and devices.

Enhanced Mobile Broadband

Gigabytes In a Second

Smart Home Building

Voice

Smart City

Massive Machine Type Communications

Ultra-Reliable and Low Latency Communications

3D Video, UHD Screens

Work and Play in the Cloud

Augmented Reality

Industry Automation

Mission Critical Applications

Self Driving Cars

5G NR introduces a new flexible numerology, more complex waveforms and channel coding techniques, frequencies that extend into millimeter-wave (mmWave), wider channel bandwidths, and advanced multi-antenna access schemes, which together significantly increase complexity in design and test. As 5G standards are phased in, toolsets must also evolve to support designing and testing to the most recent specifications.
Different tests are needed at different stages of the 5G product workflow. Early in design, simulation tools reduce design cycle times by providing insight into how chipsets and components will perform when integrated in a wireless device, and how that simulated device will interact with the environment around it. Later in design, tests of the design's RF performance in real-world environments confirm the device will operate as expected in the radio channel it is designed for, and how it will perform when connected to the network across both RF and mmWave spectrum.

Keysight partnered early with industry leaders to understand the complexities of 5G and to develop test cases for many different use scenarios. Keysight’s 5G NR design and test solutions span the entire workflow, from simulation, development, and design verification, to conformance and acceptance test, and ultimately to manufacturing and deployment.

Keysight solutions leverage the same measurement techniques throughout the workflow to ensure consistent results, guiding you to the appropriate test cases specified by chipset vendors and operators. This enables teams to leverage measurements and get to market faster. Keysight solutions address sub-6 GHz to mmWave frequency bands, using hardware and software with up to 5 GHz bandwidth.

Keysight’s PathWave design and test software platform accelerates product development workflows from concept to design, through manufacturing test, via an integrated software platform that connects every step in your product development path.

PathWave’s open and flexible development environment provides a consistent user experience, common data formats, open control interfaces, and open APIs. With PathWave, you have an open, scalable, and predictive platform that can accelerate your design and test workflow.
Scenario: Flexible numerologies and expansion into mmWave frequencies introduce new challenges in component and RFIC designs. Complex waveform structures require testing of more use cases. Keysight’s solutions provide accurate 5G NR waveforms so you can simulate, prototype, and validate physical layer implementations with greater insight and confidence.

“Keysight’s strong local and worldwide support combined with its industry-leading capabilities in demodulation and vector signal analysis helps us address 5G NR design and test challenges, quickly and effectively.

— Dr. Victor Kwan, Senior Manager, Wireless Systems Communications Technologies at ASTRI.
Circuit Design & Simulation Software Solutions

Keysight’s design and simulation solutions integrate 5G NR waveform generation and analysis with simulation. This enables advanced system level modelling so you can fully characterize components prior to developing hardware.

SystemVue 5G NR Libraries

Keysight SystemVue electronic design automation software is used to model and simulate system designs early in the development process. It enables physical layer design of wireless communications systems, and provides unique value to RF, digital signal processing, FPGA/ASIC, and MIMO implementers.

- **W1906EP 5G Baseband Verification Library** provides ready-to-use 5G reference baseband models and multi-antenna signal processing blocks for full link-level studies.
- **W1906BEL 5G Baseband Exploration Library** provides ready-to-use reference signal processing IPs (Intellectual Property) for 5G technology research, which can accelerate 5G baseband physical layer design.
- **W1720 Phased Array Beamforming Kit** provides tools to evaluate phased array and beamforming subsystems, including RF, digital, and hybrid beamforming architectures.
Advanced Design System

Advanced Design System (ADS) electronic design automation software for RF, microwave, and high-speed digital applications offers technologies such as X-parameters and 3D electromagnetic (EM) simulators for standards-based design and verification in an integrated platform. The **W2383EP 5G Modem Library for ADS** enables design and verification for emerging 5G wireless standards.

**ADS Benefits**

- Achieve first-pass design success with powerful desktop simulation tools and workflows
- Ensure 5G compliance early in the design
- Accelerate designs with application-specific Design Guides that encapsulate years of expertise in an easy-to-use interface
Baseband Development Solutions

Keysight’s multichannel arbitrary waveform generators (AWGs) can create baseband IQ signals with extremely wide RF/microwave signals from DC to 25 GHz using Keysight’s Signal Studio for 5G NR Software. Keysight AWGs provide reliable and repeatable high-fidelity signals, delivering both high resolution and wide bandwidth simultaneously. Keysight’s digitizers provide multiple phase coherent channels for evaluating MIMO or multiple baseband IQ channels using the Keysight 89600 VSA Software with 5 NR Modulation Analysis (Option BHN).

Wideband Arbitrary Waveform Generators

- The **M8190A** is a 12 GSa/s AXIe AWG that ensures accuracy and repeatability with 12-bit resolution, or 14-bit resolution up to 8 GSa/s sampling rate, and up to 90 dBc SFDR (spurious free dynamic range). High dynamic range and excellent vertical resolution provides confidence that you are testing your device and not the signal source.

- The **M8195A** addresses wideband wireless applications where extremely wide instantaneous bandwidth (DC to 25 GHz) is a critical parameter. With up to 65 GSa/s and built-in frequency and phase calibration, it generates wideband signals with a flat frequency response up to 25 GHz.

- The **M9336A** PXI AWG delivers exceptional resolution for creation of complex wideband waveforms. Multiple 540 MHz bandwidth channels with 16-bit resolution and up to 1.28 GSa/s sampling rate enables wide bandwidth signal generation with low error vector magnitude (EVM), making it ideal for creating baseband waveforms.

Powered by the leading test solutions from Keysight, Spreadtrum can accelerate the R&D process of 5G chipsets, and strengthen our 5G global deployment.

– Adam Zeng, global executive vice president of Unigroup and chief executive officer of Unigroup Spreadtrum & RDA

Wideband Arbitrary Waveform Generator Benefits

- Generate clean, complex, real-world signals based on the latest 5G standards
- Create IF, RF, or mmWave signals with greater bandwidths and higher resolution
- Low-noise clocks ensure superior measurement fidelity
Wideband Digitizers

- The **M9703B** is an 8-channel, 12-bit AXIe digitizer/wideband digital receiver that captures signals from DC up to 2 GHz at 1.6 GS/s. Its channel interleaving capability allows waveform acquisition up to 3.2 GS/s with exceptional measurement accuracy. The M9703B also provides real-time data processing, large FPGA and customizable I/O interfaces.

- The **M9203A** is a 12-bit, 3.2 GS/s PXIe high-speed digitizer and wideband digital receiver with programmable on-board processing. With a wide analog bandwidth, this high-speed digitizer is ideal for applications requiring very high dynamic range.

**Wideband Digitizer Benefits**

- Superior measurement fidelity and signal integrity increases measurement repeatability
- Achieve the most accurate MIMO measurements with multiple, phase-coherent channels, and customizable FPGAs
- Increase test throughput with high channel density in a compact form factor
RF Development Solutions

Keysight’s portfolio of RF development solutions enable you to evaluate and characterize your designs into mmWave frequencies, with wide bandwidth and the fidelity needed to achieve 5G design goals at different stages of RF design.

Network Analyzers

Network analyzers allow you to fully characterize interconnects and active devices such as amplifiers, mixers, and frequency converters at sub-6 GHz and mmWave frequencies. With the physical layer test system (PLTS) software, you can calibrate, measure, and analyze linear passive interconnects, such as cables, connectors, backplanes, and printed circuit boards. The PNA-X is the most integrated microwave test engine for testing active devices.

Network Analyzer Benefits

- Attain unrivaled excellence with high precision solutions for component design
- Measure active components up to 120 GHz
- Improve throughput with faster measurements
5G Waveform Generation & Analysis Testbed

The 5G Waveform Generation and Analysis Testbed enables you to test devices against 5G NR compliant waveforms at RF to mmWave frequencies. With bandwidths up to 5 GHz, you can create 5G compliant waveforms for verifying 5G components with carrier aggregation, and you can validate multi-mode or coexistence test scenarios.

“Keysight has enabled us to validate the breakthrough data throughput performance of our Ball-built arrays at 26 GHz and gain visibility into our performance edges, using standard-compliant 5G NR waveforms and processing.

– Bob Donahue, chief executive officer, Anokiwave

5G Waveform Generation & Analysis Testbed Benefits

- Generate and analyze wide bandwidth 5G-compliant waveforms with superior EVM (error vector magnitude) at sub-6 GHz and mmWave frequencies
- Reduce time to market with solutions that scale in performance across the workflow
- Achieve lower cost of test with multi-channel, high speed solutions

5G Waveform Generation and Analysis Testbed Solution
Wideband RF/mmWave Signal Creation

The N7631C Signal Studio for 5G NR software allows you to quickly generate 5G NR waveforms for testing transmitters and receivers with channel coding and multi-antenna support. Download and playback 5G compliant signals with Keysight’s portfolio of wideband signal generators.

Wideband RF/mmWave Signal Analysis

Keysight’s 89600 VSA Software with 5G NR Modulation Analysis (Option BHN) provides a comprehensive and forward compatible toolset for demodulation and vector signal analysis. When combined with a Keysight signal analyzer, oscilloscope, or digitizer, you can demodulate and analyze 5G waveforms in different downlink, uplink, or coexistence scenarios.
**Infiniium Oscilloscopes**

With the emergence of technologies pushing hundreds of Gb/s, oscilloscopes must have higher bandwidth, lower noise and faster processing. The UXR-Series real-time oscilloscopes (up to 110 GHz) and the **DSOZ634A Infiniium Oscilloscope**, with 63 GHz of bandwidth, samples wideband signals directly at mmWave frequencies.

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**Infiniium UXR- and Z-Series Oscilloscope Benefits**

- Use one scope to make a variety of FFT and wideband RF measurements
- Resolve issues quickly by viewing the entire bandwidth in one view
- Reduce time to market by testing across multiple frequency bands
- Achieve measurement confidence with industry’s lowest noise and jitter measurement floors
High-Speed Digital Interface Solutions

Scenario: Antennas, chipsets, and peripherals in a wireless device rely on digital standards to ensure high throughput, digital data transmissions without excess power consumption or electromagnetic interference (EMI), and compliance with standards. Keysight participates in standards committees to influence and understand requirements before standards are released. Our high-speed digital test solutions reduce risk by enabling you to test designs against current and future digital interconnect standards used in mobile devices.
Advanced Design System Software

Advanced Design System (ADS) Signal Integrity (SI) and Power Integrity (PI) tools leverage time and frequency domain simulation and analysis to quickly solve the underlying problems with high speed digital designs. The integrated schematic capture, layout, and data analysis environment with multiple simulators including IBIS-AMI channel, transient, S-parameters, and physical layer EM ensure compliant designs with the latest standards.

ADS Benefits
- Analyze complete chip-to-chip links by co-simulating individual components, each at its most appropriate level of abstraction: channel-, circuit- or physical-level
- Avoid causality and passivity issues by importing channel component S-parameter models into circuit and channel simulations
- Reduce design iterations through virtual prototyping which correlates measured and simulated data to verify design methods

MIPI® Verification

The M8000 Series Multi-Channel BERT test solutions enable physical layer characterization, validation, and compliance testing of digital interfaces. M8085A MIPI Receiver Test Solution is a software plug-in that adds controls for the M8190A/M8195A arbitrary waveform generators to create C-PHY or D-PHY standard compliant test signals.

MIPI Design & Test Benefits
- Save time and effort with test solutions that meet latest MIPI standards out of the box
- Natively test C-PHY and D-PHY receivers with purpose-built solutions
- Save time and money with automatic calibration
Modem & Device Solutions

Scenario: 5G NR brings advanced numerologies to handle a diverse global spectrum and deployment options. Testing with network protocols is critical to understanding how MIMO and beamforming technologies will affect network access including cell-site handovers, beam tracking and beam refinement. This becomes even more challenging in the presence of competing and complimentary 5G NR, 4G, Bluetooth, and Wi-Fi signals in close proximity. Keysight’s RF and protocol solutions deliver comprehensive 5G test cases so you can test for throughput and verify your designs for different network scenarios.

“...The technical support and expertise from Keysight in 5G channel sounding techniques for mobility helped us understand the channel behavior at mmWave frequencies, especially travelling at high speeds...”

– Yukihiko Okumura, Group leader of 5G Radio Access Network Research Group, Research Laboratories of NTT DOCOMO
RF & Protocol Development Solutions

Keysight’s portfolio of RF and protocol development solutions enable you to evaluate, characterize, and optimize your chipset and device designs for performance and compliance, enabling accelerated designs from prototype to fully functioning 5G devices.

5G Protocol R&D Toolset

The 5G Protocol R&D Toolset, based on the UXM 5G Wireless Test Platform, is a comprehensive solution that enables efficient prototyping of advanced 5G protocol features for both 5G TF (technical forum) and 5G NR, including beamforming at mmWave frequencies and standalone/non-standalone use cases.

5G Protocol R&D Toolset Benefits

- Validate and optimize device performance with purpose built 5G NR solutions that meet the latest standards
- Test 5G protocols early in the design process to discover and resolve defects early
5G RF DVT Toolset

The 5G RF DVT Toolset enables RF and radio resource management (RRM) measurements of a device on a call both for standards-ready 5G NR or pre-standard 5G TF (technical forum) specifications, including beamforming at mmWave frequencies and 5G NR standalone/non-standalone use cases. You can identify design defects early and ensure faster and more cost-effective development.

5G RF DVT Toolset Benefits

- Quickly create and customize RF and RRM test cases with the highest degree of parametrization
- Accelerate test creation, execution, and analysis through an integrated environment
- Adapt and update tests to meet the latest changing 5G standards

“Keysight and Qualcomm work together to demonstrate multi-Gigabit 5G data connection at Mobile World Congress. “As we did in 3G and 4G, Qualcomm Technologies’ mobile expertise was fundamental in achieving this 5G milestone in a smartphone form factor. Our combined technical competency enabled both teams to overcome challenges as we work towards the commercial launch of 5G mobile devices expected in 2019.”

– Tony Schwarz, senior vice president, engineering, Qualcomm Technologies, Inc.
PROPSIM F64 5G Channel Emulation Solution

The PROPSIM 5G Channel Emulation Solution delivers end-to-end realistic and repeatable real-world performance testing of 5G multi-mode devices in the lab. It is scalable to verify MIMO capabilities at sub-6 GHz and mmWave frequencies.

PROPSIM F64 5G Channel Emulation Solution Benefits

- Gain early insights into a device’s real-world performance with protocol signaling and RF testing in a lab environment
- Test full range of 5G standards from sub-6 GHz to mmWave, MIMO, beamforming, and other beam management functions
- Integrate with Keysight’s 5G OTA test portfolio for end-to-end insights across the workflow
Battery Optimization Solution

Sub-6 GHz and mmWave implementations will put higher demands on mobile batteries. Optimizing your device’s power management to ensure accurate low-power events and fast powerdraw has never been more critical. Keysight’s battery power analysis solutions provide the highest precision for optimizing device power management and can emulate 4G/5G radio access networks and channels so you can simulate power consumption under real-world conditions.

Battery Current Drain Test

Battery Power Management Solutions Benefits

- Improve battery life in wireless devices with high precision current draw tests
- Achieve better performance by simulating real-world connectivity in a controlled test environment
- Characterize sub-circuits and battery independently and in combination with battery drain analysis
OTA Test Solutions

Scenario: Over-the-air testing is recommended for 5G components and devices using mmWave signals due to the highly integrated nature of the antennas and the propagation characteristic of mmWave signals. OTA testing should be used to characterize and validate radiated beam performance from your chipsets, components, and devices.

Keysight OTA solutions are purpose built and span the entire development workflow. They address a wide range of RF, demodulation, and functional performance test requirements across mmWave and sub-6 GHz 5G NR designs. Solutions integrate measurement science, application expertise, PathWave automation, and industry-leading test platforms, including:

- Network analyzers, signal generators and signal analyzers for RFICs, RF front ends, and antennas.
- UXM 5G network emulators and PROPSIM 5G channel emulators for modems and devices.

The Keysight compact antenna test range (CATR) methodology was accepted by 3GPP for RF performance measurements on mmWave devices. With Keysight’s OTA test solutions and expertise, system integrators can provide solutions that meet requirements set by industry bodies including CTIA, 3GPP and CCSA, as well as test plans mandated by major mobile operators.

Contact your local Keysight sales representative to explore OTA solution alternatives tailored to your needs. The complete list of Keysight services and offices is available at www.keysight.com/find/contactus.

OTA Test Solution Benefits

- Accelerate designs with integrated automated tests based on proven Keysight 5G solutions
- De-risk development with 3GPP approved OTA test methodologies for components and devices that operate at sub-6 GHz and mmWave frequencies
Manufacturing Test Solutions

**Scenario:** Testing 5G chipsets, components, and devices during manufacturing requires you to verify that devices meet new requirements at higher frequencies and with greater bandwidths. These challenges, combined with the introduction of new MIMO and mmWave beam steering technologies, require OTA testing solutions to ensure compliance with industry standards as well as test plans mandated by mobile operators. Keysight’s solutions easily scale from R&D to design verification to cost-effective manufacturing test. With automated, compact manufacturing solutions, multiple devices are verified across multiple RF and mmWave frequency bands in parallel.
KS8700A PathWave Test Environment

PathWave Test provides a portfolio of measurement, test automation, and data management tools that connect teams and test stations. Scalable from a single user to a global enterprise, PathWave Test accelerates your TestOps with an open and modular software architecture.

The Keysight PathWave software platform connects design and test. With PathWave Test, you can create, modify, and access test plans, results, and test stations all in a managed environment with access level policies. Engineers can develop, deploy, and manage test projects. PathWave breaks down the silos between design, validation test, and manufacturing, providing faster insights and rapid resolution when test data reveals a potential problem.

PathWave Test Environment

KS8700A PathWave Test Environment Benefits

- Powerful, fast test plan creation and execution with insightful visualization and analysis
- Customize your test processes with open APIs
- Scale your test plans to thousands of worldwide test stations
5G Non-signaling mmWave Test Solution

Keysight’s 5G mmWave Non-signaling mmWave Test Solution uses sequenced based, non-signaling test for calibration and verification to reduce test times and costs. The non-signaling test solution provides signal generation and analysis for testing up to three device transmitters and receivers simultaneously with multiple RF and IF ports, or add one mmWave transceiver with tunable access to the 28 GHz and 39 GHz frequency bands as defined by 3GPP.

**5G Non-signaling mmWave Test Solution Benefits**

- Verify multiple devices at IF and RF with compact, integrated wideband source and receiver
- Reduce cost of test with fast, automated measurements based on familiar platforms
- Test with confidence using proven measurement science in a streamlined form factor

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“We are delighted to collaborate with Keysight. Their leading test and measurement expertise and solutions for 5G will enable us to execute on our commercial deployment plans more efficiently and reliably.”

– Jeon Hongbeam, executive vice president, Infrastructure Laboratory - Institute of Convergence Technology at KT Corporation
Education Services 5G is creating real-world measurement challenges. With eLearning, you’ll gain the basic skills needed to make more accurate, repeatable measurements. Start-Up Assistance complements that skillset with private, customized hands-on instruction specifically designed to help you get your application measurement objectives met.

Process & Consulting Services The transformation in 5G technology brings new opportunities for growth, but also new challenges. Keysight provides expert analysis with quantifiable metrics so you can analyze current process and provide quantified evaluation of alternatives and accelerate time to market.

Technology Refresh Services Current test equipment will likely be unable to provide the increased levels of measurement capability required for 5G standards. Technology refresh offers an easy and cost-effective way to upgrade or trade-in existing assets to obtain the test equipment performance for your new requirements.
Test Asset Optimization Services  Mitigating the challenges that arise during the tough transition to 5G NR and making the right equipment choices to support that transition, requires access to real-time asset data and effective management of all assets. Keysight Test Asset Optimization services offer an ideal solution to this dilemma, delivering the asset tracking and control, utilization and health data, and loan pool management.

One-Stop Calibration Services  With increasingly complex multivendor 5G systems and test plans, it is more important than ever to ensure your equipment is calibrated, while maintaining maximum uptime. Keysight One-Stop calibration increases uptime, ensures ongoing accuracy, and reduces logistical complexity with one point of contact for all calibration services – regardless of manufacturer.

Financial Services  You need to make the most of your operational and capital budgets to design and produce new 5G solutions. Keysight financial options help you get the equipment you need to deliver on time and in-budget. Keysight Instant-Buy* gives you the flexibility to make monthly payments at 0% interest over 18 months. Or with Keysight Rent-to-own*, you can get the instrument that you need now and decide to purchase later. With Keysight Lease* you can access leading technologies while managing your budgets.

*Available in select countries.

Learn more at: www.keysight.com

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