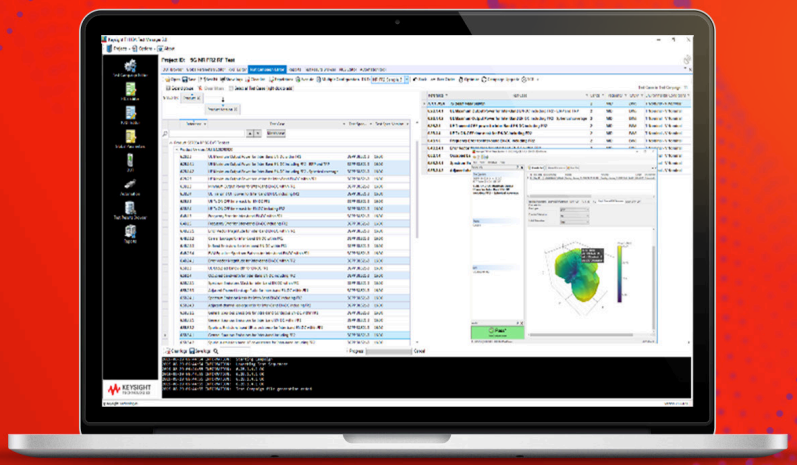

TECHNICAL OVERVIEW

S8707A RF/RRM Carrier Acceptance Toolset

Features and Capabilities

Around the world, commercial development and deployment of 5G technology is accelerating to address a wide range of use cases for consumers and industry verticals. As mobile network operators (MNOs) across the globe deploy their 5G network, the number of 5G-enabled devices is increasing. According to GSA, the number of 5G devices exceeded 200 for the first time in January 2020. By May 2020, 296 5G devices had been announced including 112 commercially available.

Before launch, device manufacturers must achieve certification for their 5G New Radio (NR) devices. Manufacturers must follow the 3rd Generation Partnership Project (3GPP) specifications for radio frequency (RF), radio resource management (RRM), and protocol as required by the Global Certification Forum (GCF), the PCS Type Certification Review Board (PTCRB), and regulatory bodies in many countries. Carrier acceptance is a set of additional tests required by most MNOs to ensure device interoperability and performance with their network configuration. Carrier acceptance tests are supplemental to regulatory and conformance tests and validated by subject matter experts at MNOs.

The Keysight S8707A RF/RRM Carrier Acceptance Toolset is part of Keysight's Network Emulation Solutions (NES) portfolio. The portfolio addresses the entire device development workflow — from initial design to acceptance (Figure 1).

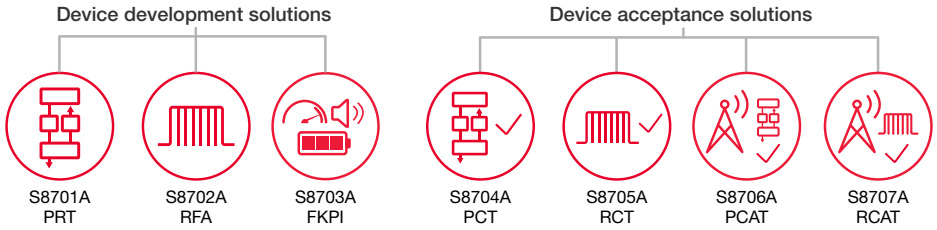

Figure 1. Keysight's network emulation solutions

KEYSIGHT TECHNOLOGIES

RF/RRM Carrier Acceptance Toolset Overview

The S8707A RF/RRM Carrier Acceptance Toolset is an integrated solution that enables RF performance testing of 5G devices against MNO-defined test specifications across frequency range 1 (FR1, sub-6 GHz) and frequency range 2 (FR2, millimeter-wave, or mmWave).

Testing 5G NR RF characteristics includes in-band test cases and out-of-band measurements such as spurious emissions and blocking. In-band test cases focus on radio performance as a transmitter and a receiver. Out-of-band measurements help determine how the device's radio impacts other devices operating in the same or adjacent bands. Out-of-band measurements also assess resistance to interference from nearby radio devices.

The toolset also covers radio resource management (RRM) and performance testing to characterize the RF performance of 5G devices fully. RRM helps confirm that the device can keep a robust and reliable connection to the network in stationary and mobility scenarios, with handovers between cells using the same or different radio access technologies. Performance testing checks that the device can successfully demodulate downlink signals under ideal and impaired radio conditions, with special tests defined for channel state information (CSI) reporting.

The RF/RRM Carrier Acceptance Toolset leverages the superior RF measurement and real-time processing capabilities of Keysight's E7515B UXM 5G wireless test platform to support 5G's diverse set of test requirements. The platform also enables RF testing in adjacent bands, generates interferers for blocking test cases, including additive white Gaussian noise (AWGN), and provides fading without the need for additional instruments in the test system. Table 1 on page 9 of this document has the details for the hardware configurations.

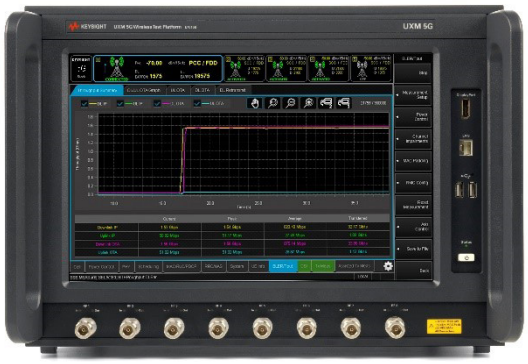

Figure 2. E7515B UXM 5G wireless test platform

Who benefits from using the S8707A RF/RRM Carrier Acceptance Toolset?

The companies that benefit from the RF/RRM Carrier Acceptance Toolset solution are:

- Device manufacturers to get their devices approved for commercial launch by MNOs.
- Test houses and test labs requiring approval by the MNOs to execute their carrier acceptance tests.
- MNOs to approve tests for their ecosystem and verify that devices comply with their network deployment.
- Chipset makers to ensure radio performance after integrating their modems with device RF frontends.

Carrier acceptance process

MNOs define the scope of carrier acceptance tests based on multiple factors:

- type of device (smartphone, tablet, mobile broadband, fixed wireless access, and more)
- technologies supported by the device (5G NR, LTE, UMTS, IMS, Wi-Fi, GNSS, and more)
- stocked or non-stocked devices
- MNO or MVNO

MNOs produce the technical specifications that chipset and device manufacturers must comply with to commercially launch their products. Subject matter experts are responsible for defining the test requirements for new features and technologies the MNO wants to deploy, as well as the approval of the implemented tests. A collection of test requirements for a technology or feature makes a test plan. Figure 3 shows one or more test plans that fall under these categories. The S8707A RF/RRM Carrier Acceptance Test Toolset covers RF, RRM, and demodulation test cases:

- RF: Tx/Rx in-band, Tx/Rx spurious and blocking
- RRM
- signaling: mobility, carrier aggregation
- IMS: VoLTE, VoNR, RCS
- Wi-Fi
- performance: demodulation, data throughput, battery, audio quality

MNOs periodically conduct a technical alignment with Keysight and their chosen chipset and device suppliers for them to plan the necessary features in their products. Their network technology roadmap dictates the deployment of new features. MNOs' subject matter experts define the new test requirements to cover all the functionalities and performance of new features. Keysight implements the new features and test cases and verifies their performance with market-leading chipsets Subject matter experts validate Keysight test cases to ensure the tests fit the MNOs' deployed features. Chipset and device makers execute the test cases to ensure their products can perform as per the validated tests. MNOs approve the devices for deployment on their network.

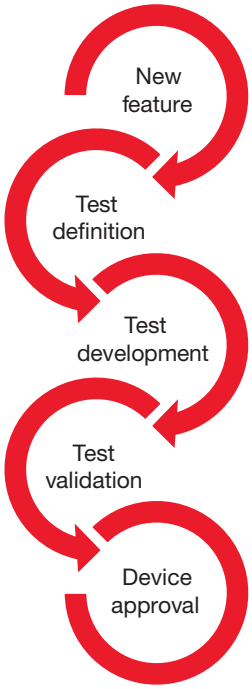

Figure 3. Carrier acceptance process flow

Core Hardware and Software Elements

The S8707A RF/RRM Carrier Acceptance Toolset supports a wide range of test requirements for scalability and price optimization. You can easily upgrade the test system during its operational life by adding new hardware and software options. The test system contains the following elements:

- software application
- core system software
- hardware

The solution's common software components are the application and core system software. Carrier acceptance users can add a specific application and test packages.

On the hardware side, the platform scales with the complexity of test requirements. It ranges from a simple configuration based on a single E7515B UXM 5G wireless test platform and test PC to a full-rack test system providing complete coverage of all test cases, including instruments for spurious emissions measurements.

The solution's architecture supports future requirements as they become available. The software components also facilitate upgrades by enabling the addition of complementary solutions from Keysight's Network Emulation Solutions portfolio.

Software application

Keysight Test Manager hosts the tests available from MNO ecosystems and provides the following main functions:

- test campaign creation
- test campaign execution and management
- parameterization of band and band combinations
- logging and reporting tools
- device-under-test (DUT) automation
- climatic chamber/power supply automation
- integration with Keysight compact antenna test range (CATR) portfolio

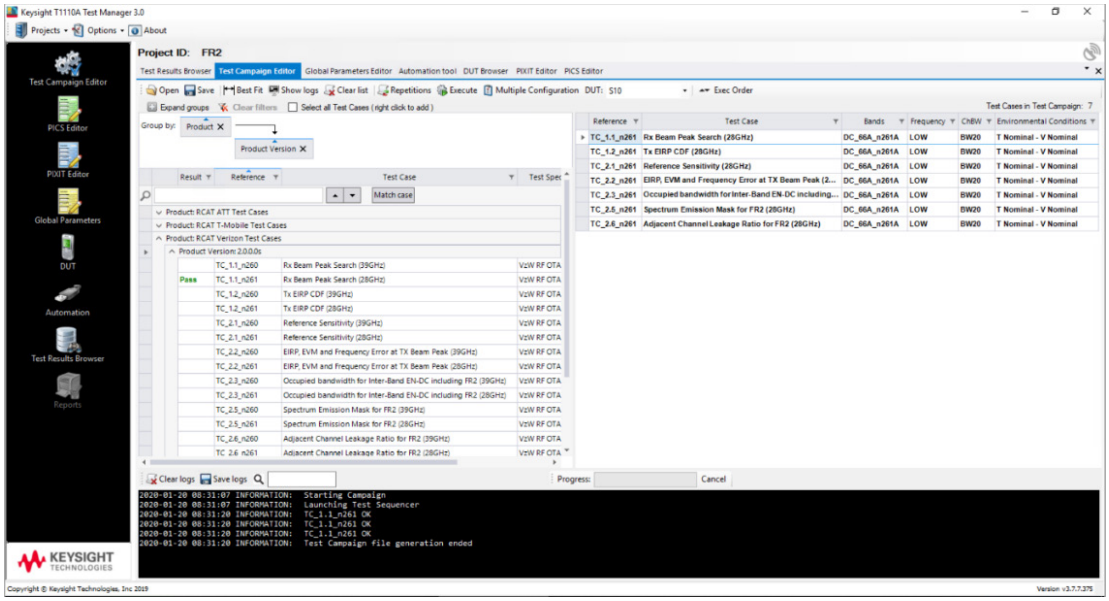

Figure 4. Test Manager software interface

Carrier Acceptance Toolset

Specific features extend Test Manager's core functionality to streamline carrier acceptance testing operations. These features are either integrated into the application or available for you to configure.

Key features

- test time optimization
  - smart execution planning based on selected test cases and test points
  - test case grouping
  - remote file input-output (RFIO) to map bands supported in each DUT antenna port, avoiding recabling in FR1 test
- usability
  - parameterization of bands and band combinations
  - control of power supply
  - integrated view of 3D result plots in reports
  - rapid creation of test campaigns based on existing results
  - comprehensive test campaign reports

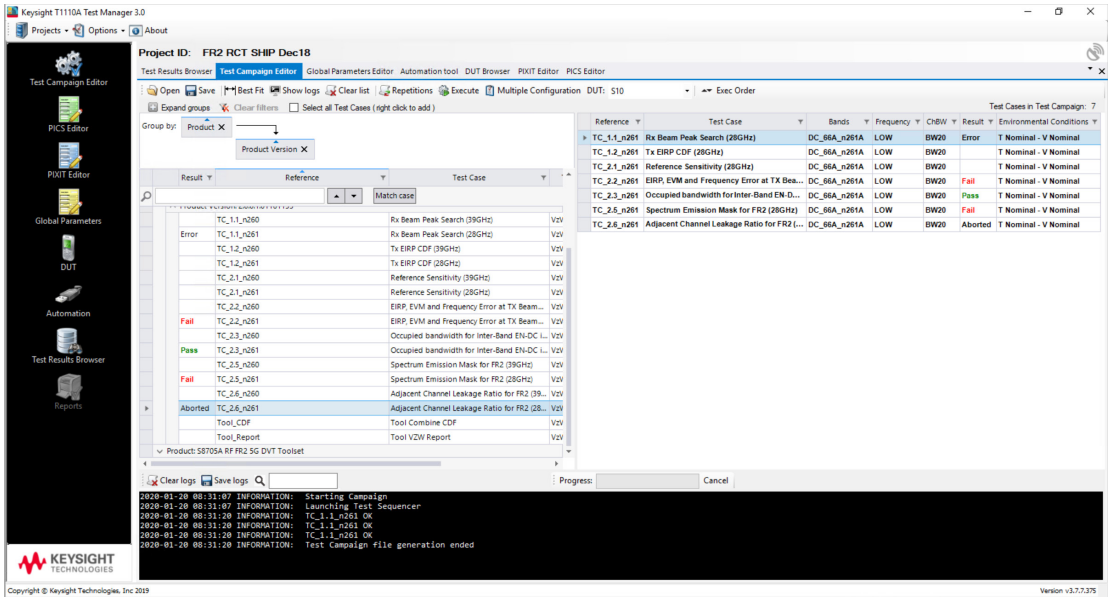

Figure 5. Quick access to test campaign results and retry in case of failures

Core system software

The core system software runs in the UXM 5G's main unit, which may act alone or with a second UXM 5G unit in an array configuration.

Software options

- signaling: NR non-standalone (NSA), NR standalone (SA)
- RF measurements analysis for supported radio access network (RAN) formats
- arbitrary waveform generation for noise and modulated interferers generation
- fading profiles required by 3GPP for both 5G NR and LTE radio access formats

Results and analysis

The RF/RRM Carrier Acceptance Toolset includes Keysight Trace Studio. You can launch it standalone or directly from Test Manager by clicking on any test result in the test campaign results summary.

Test Manager generates a .tcres report for each executed test case, from which Trace Studio can present information on both test case conditions and measurement results, including verdict. It provides results in different formats, such as tables and graphs as shown in Figure 6.

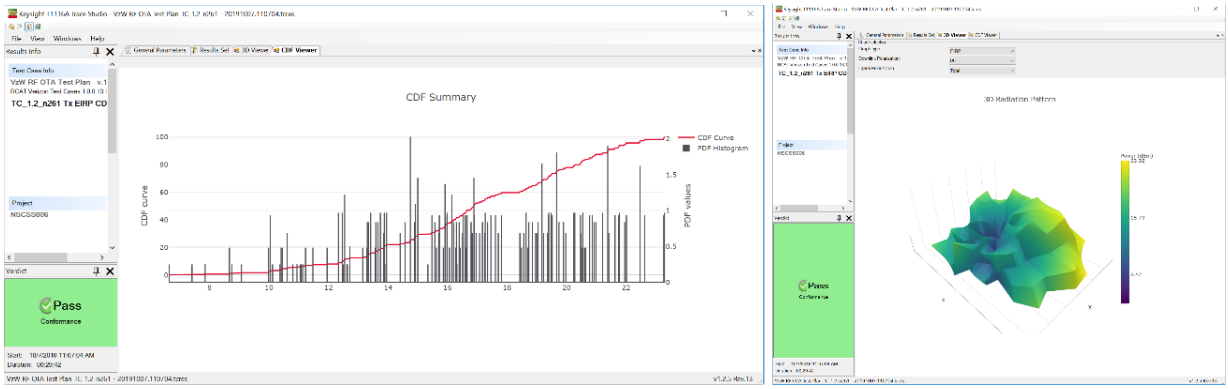

Figure 6. Rich report formats for quick results analysis and post-processing

Hardware

The core of the S8707A RF/RRM Carrier Acceptance Toolset is the E7515B UXM 5G wireless test platform. It is an integrated signaling test platform with multiformat stack support, rich processing power, and abundant RF resources. Supporting the latest 3GPP Release 15 and beyond, the UXM 5G enables you to establish a 5G call with a DUT in different 5G NR deployment modes (NSA and SA) and frequency bands (FR1 and FR2). The platform performs tests for device RF characteristics, protocol compliance, and functional key performance indicators.

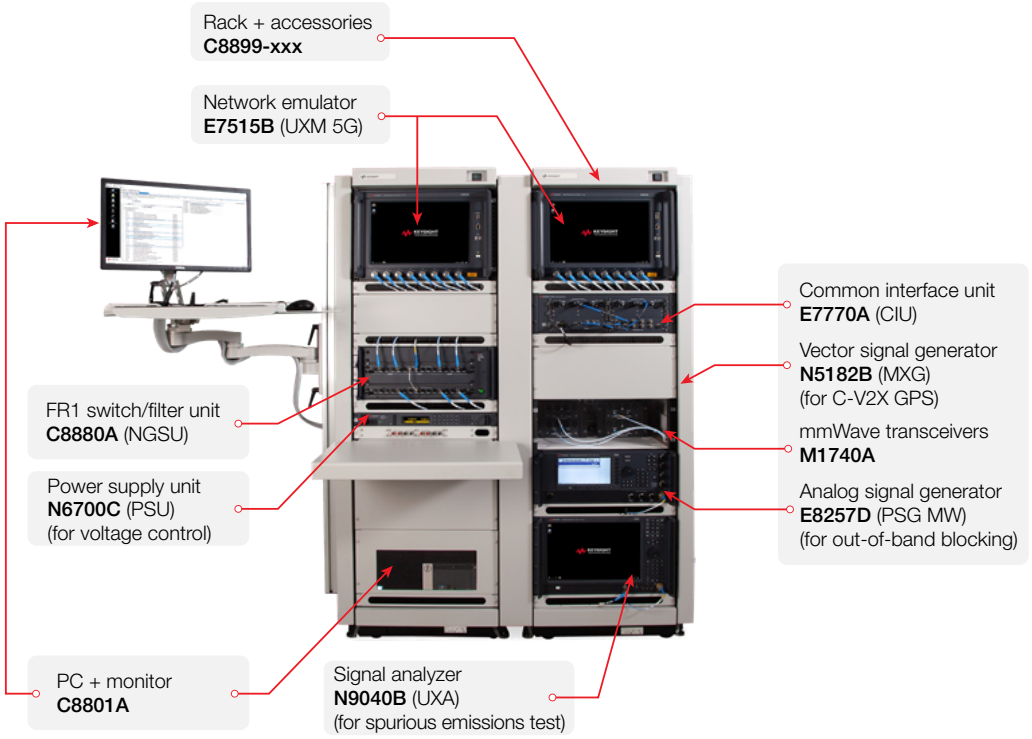

Figure 7. H56-s hardware configuration

For RF in-band transmitter and receiver test cases and RRM described in different test plans of MNOs — a single UXM 5G unit is enough if the test involves a single carrier. Certain carrier aggregation (CA) levels or the need for extra RF ports for MIMO require a dual E7515B configuration. Connecting two UXM 5G units achieves that configuration easily.

The E7515B supports testing up to 6 GHz. FR2 testing between 24.25 and 44 GHz requires the Keysight E7770A common interface unit and two or more Keysight M1740A mmWave transceivers. The Keysight CATR OTA chamber completes the test setup.

Spurious emissions testing and out-of-band blocking require other equipment, such as the Keysight E8267D PSG vector signal generator, the Keysight UXA signal analyzer, and next-generation switching units (NGSU). The setup also requires a power system for the DUT.

Figure 8. Keysight H51-sm hardware configuration

Table 1 lists the hardware configurations supported by the S8707A RF/RRM Carrier Acceptance Toolset solution, the MNO test case types supported by each hardware configuration, and the number of Keysight hardware units required for each configuration.

Table 1. S8707A-supported hardware configurations

Configuration	MNO test case types	E7515B UXM 5G	C8880A NGSU FR1	N9040B UXA	E8257D PSG	E7770A CIU	M1740A RRH	CATR OTA chamber
H51-sm	FR1, FR2 RF transmitter and receiver plus RRM (1 angle of arrival (AoA))	1				1	2	1
H51-s	FR1 RF transmitter and receiver	1						
H52-s	FR1 RF transmitter and receiver	2						
H53-s	FR1 RF transmitter and receiver, plus spurious	1	1	1				
H55-s	FR1 RF transmitter and receiver, plus spurious and blocking	1	1	1	1			
H56-s	FR1 RF transmitter and receiver, plus spurious and blocking	2	1	1	1			

Flexible Licensing Options

Table 2 lists Keysight's wide range of software licenses and terms to address your testing needs and increase asset cost-effectiveness:

Table 2. Licensing options

License type	Description
Node-locked	License for one specific instrument
Transportable	License for one instrument at a time, manually transferable to another instrument via the Keysight Software Manager website
Floating:	License for one instrument at a time, transferable to another instrument via a USB dongle
• floating single site	License server within a 1-mile radius from the instrument/computer
• floating single region	License server in the same region as the instrument/computer (for example, Americas, Europe, and Asia)
• floating worldwide	License server anywhere in the world; export restrictions available in the end-user license agreement

License term	Description
Perpetual	Licenses that do not expire
Subscription-based	Temporary licenses with limited duration of 6, 12, 24, or 36 months

Keysight C8899A/AU Kits

Table 3. Kits available to support your rack configuration

Keysight part number	Description
C8899A-001	Provides a 2-bay rack with power supply adapted to countries working with 100-120V
C8899A-002	Provides a 2-bay rack with power supply adapted to countries working with 200-240V
C8899A-003	• Requires either C8899A-001 or C8899A-002 • Provides RF cables and adaptors; tray for keyboard/DUT needed to customize C8899A-001 or C8899A-002 in H53-s configuration
C8899A-005	• Requires either C8899A-001 or C8899A-002 • Provides RF cables and adaptors; tray for keyboard/DUT needed to customize C8899A-001 or C8899A-002 in H55-s configuration
C8899A-006	• Requires either C8899A-001 or C8899A-002 • Provides RF cables and adaptors; tray for keyboard/DUT needed to customize C8899A-001 or C8899A-002 in H56-s configuration
C8899A-007	• Requires either C8899A-001 or C8899A-002 • Provides RF cables and adaptors; tray for keyboard/DUT needed to customize C8899A-001 or C8899A-002 in H55-m configuration
C8899A-008	• Requires either C8899A-001 or C8899A-002 • Provides RF cables and adaptors; tray for keyboard/DUT needed to customize C8899A-001 or C8899A-002 in H56-m configuration
C8899A-010	• Requires either C8899A-001 or C8899A-002 • Provides RF cables and adaptors; tray for keyboard/DUT needed to customize C8899A-001 or C8899A-002 in H56-sm configuration
C8899A-011	• Required for S8705A when instruments are rack-mounted to support C-V2X test cases (test cases are available through different software options) • Includes 2 BNC cables, 1 LAN cable, and 1 power combiner
C8899A-012	• Required for S8707A Sprint test cases • Provides 1 RF coupler, 1 circulator, and RF cables
Z2160A-1A3	• Custom FR2 switching unit required for RF conformance or acceptance out-of-band spurious test cases • Supports spurious emissions measurements up to 67 GHz • More information about NGSU available in Keysight S8705A technical overview
Z2160A-1A4	• Custom FR2 switching unit required for RF conformance or acceptance out-of-band spurious test cases • Supports spurious emissions measurements up to 110 GHz • More information about NGSU available in Keysight S8705A technical overview
Z2160A-1R3	• Custom FR2 switching unit required for RF conformance or acceptance out-of-band test cases (spurious) • Supports spurious emissions measurements up to 67 GHz • RoHS compliant • More information about NGSU available in Keysight S8705A technical overview

Succeeding at Acceptance Testing

5G networks open doors to new business models and provide an edge for those who seize the opportunity. The E7515B UXM 5G wireless test platform supports a comprehensive portfolio of network emulation solutions. These solutions help the 5G mobile ecosystem accelerate the device development workflow, from initial design to acceptance, and increase confidence in hitting the target performance before market launch.

The S8707A RF/RRM Carrier Acceptance Toolset offers scalability while keeping costs in mind. It provides the necessary performance, flexibility, and features to effectively test the RF characteristics of 5G NR devices according to industry device certification requirements.

More Information

Learn more about Keysight's network emulation solutions by visiting 5G network emulation solutions.

Visit the following webpages to find out more about 5G challenges and solutions.

- 5G chipset manufacturers
- 5G device manufacturers
- 5G service providers

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

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