S8702A 5G RF Automation Toolset

Keysight’s 5G RF Automation Toolset leverages the E7515B or the E7515E UXM 5G Wireless Test Platforms to provide users with a comprehensive range of tests to quickly verify the transmitter (Tx) and receiver (Rx) performance of 5G new radio (NR) devices in accordance with the 3GPP specifications. The toolset forms part of Keysight’s suite of 5G network emulation solutions and offers a flexible and easy-to-use software environment.

3GPP NR Specs

The first version of the 5G New Radio (NR) industry reference standards were completed by 3GPP in July 2018, when Rel.15 was officially released.

The 38.521 test specifications cover the RF requirements for two main 5G NR deployment options:

- Non-Standalone (NSA Opt. 3) makes use of an LTE core network controlling a 5G NR Radio Access Network (RAN)
- Standalone (SA Opt. 2) introduces a new 5G core network and is the first step towards pure 5G NR networks
Accelerating the transition from prototypes to commercial 5G products

Mobile operators around the world are taking the first steps to turn on their 5G networks using a new Radio Access Technology (RAT). 5G NR devices in different form factors are now available for industry and consumers.

The new RAT fundamentally supports three service categories:

- Enhanced mobile broadband (eMBB)
- Massive machine-type communications (mMTC)
- Ultra-reliable, low-latency communications (UR-LLC)

The radio unit is a critical component in wireless communication systems. It determines what type of services or applications a network can support. 5G offers a wide range of spectral options to address the above use cases to deliver an optimized combination of high capacity, high data rates, ubiquitous coverage and ultra-reliability.

The main spectrum options for 5G, at least in the early deployment phases, exist in sub-6 GHz bands (3.5 GHz and 4.5 GHz) and in mmWave spectrum at 24 to 28 GHz and 39 GHz using TDD technology. Sub-6 GHz frequency spectrum allows mobile operators to support wide-area coverage and services, while higher frequencies provide access to a vast amount of spectrum necessary to achieve very high data rates. The introduction of mmWave bands poses new challenges to RF engineers, as 5G NR devices with phased-arrays and connector-less antennas need to be tested over-the-air.

Early access to 5G RF test tools that allow inspection of RF performance during the design verification phase is key to accelerating the transition from prototypes to commercial 5G products.

Be ready to test now and to scale with an evolving 5G technology

Testing 5G today requires a very high degree of flexibility to adapt to on-going changes in both the requirements and test methodologies. However, this evolution should have minimum impact on overall test costs and schedule. A versatile 5G RF design verification test solution adapts to evolving 5G standards, scales to address sub-6 GHz and mmWave frequencies, and provides optimized testing times to quickly verify a device’s RF performance or identify issues.
Keysight’s 5G RF Automation Toolset is a comprehensive RF design verification solution that supports Transceiver and Receiver tests based on the latest 3GPP 38.521 test specifications. The toolset relies on the Keysight E7515B UXM 5G Wireless Test Platform or E7515E UXM 5G Base Test Platform and uses its built-in Test Application Framework software environment. Keysight’s E7770A Common Interface Unit, M1740A mmWave Transceivers, and test chamber extend the test range to mmWave frequencies.

Based on the Test Application Framework

Keysight’s 5G Test Application (TA) Framework allows both touch-based and remote control of the UXM 5G network emulator. Its different operation modes support a wide range of tests, from non-signaling for UE Calibration to full signaling tests, providing a comprehensive set of features for engineers designing RF components and devices. The framework supports both 5G deployment modes, Non-Standalone (NSA) and Standalone (SA), and its full signaling test mode enables users to perform RF measurements while a call is in progress.

The RF Automation Toolset uses this underlying Test Application Framework to control the UXM 5G network emulator and provide a suite of fully-automated Transmitter and Receiver tests that are based on the 3GPP TS 38.521 test specifications.

Figure 1: Screen capture illustrating a completed 5G NR NSA Random Access procedure using Keysight’s 5G Test Application Framework
5G RF Automation Toolset – Key Features

Keysight’s 5G RF Automation Toolset extends the capabilities of the 5G Test Application by providing:

- An intuitive and easy-to-use graphical user interface for creating, configuring and running test campaigns
- A suite of fully-automated RF Transmitter and Receiver tests, based on the 3GPP TS 38.521 test specifications
- Optimized test execution times, enabling quick inspection of the RF performance of 5G NR devices
- A report generator to summarize the results of test campaigns
- Support for both NSA and SA 5G modes in the same network emulator, providing a small footprint benchtop solution
- State-of-the-art logging, visualization and debugging tools
- Flexible licensing options and tools

Campaign Creation

The RF Automation Toolset user interface allows users to easily create test campaigns by simply adding one or more test modes (e.g. NSA FR1, NSA FR2, SA FR1). This is followed by selecting the target tests and specifying the key network parameters for each test mode, e.g. duplex mode, frequency band, channel bandwidth, high/mid/low band channels, and sub-carrier spacing (SCS).

![Figure 2: Campaign created by selecting available tests and configuring the Test Mode](image-url)
Test Configuration

Each test in the campaign may be executed over a range of test conditions specified by the user, resulting in a test generated for each individual test condition. Test conditions provide access to a range of test-specific parameters, including bandwidth, modulation scheme, power levels, and the limits/measurement values against which the pass/fail verdict is assessed. This provides users with the flexibility to focus campaigns on specific conditions requiring further debugging, in order to quickly complete the verification of a device’s RF performance.

Figure 3: Screen capture illustrating a selection of test conditions

Campaign Management

The RF Automation Toolset also supports a range of test campaign configuration options, including the ability to repeat tests, retry failed tests and stop/pause execution when errors are found.
Result Analysis

The Result List area provides real-time information about the test campaign execution progress with relevant information about each individual test result, including a pass/fail verdict for each test based on the user-defined verdict conditions.
**Report Generation**

For post-campaign analysis, the RF Automaton Toolset allows the generation of summary reports in .csv and .xlsx formats.

![Example test campaign report](image)

**Tests Supported**

5G RF Automation Toolset supports a range of test packages. The initial package of RF Transmitter and Receiver tests, which covers both NSA and SA modes for in FR1 and FR2, includes the following test scenarios:

a. UE maximum output power  

b. Maximum power reduction  

c. Minimum output power  

d. Transmit off  

e. Frequency error  

f. Error Vector Magnitude (EVM)  

g. Carrier leakage  

h. EVM equalizer spectrum flatness  

i. In-band emissions  

j. Occupied Bandwidth (OB)  

k. ACLR (both NR and UTRA)  

l. Spectrum Emission Mask (SEM)  

m. Reference sensitivity power level  

n. Maximum input level
Ordering Information

The following table lists the RF Automation Toolset software licenses that may be ordered. In addition to these, a UXM 5G Wireless Test Platform and associated software licenses are also required (not listed here).

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<thead>
<tr>
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<th>Description</th>
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<tr>
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<td>RF Automation Toolset Application</td>
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<tr>
<td>C870250AA</td>
<td>RFA 5G NR T-0A: RF Tx and Rx tests (FR1/FR2)</td>
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Keysight’s 5G RF Solutions

Keysight’s Network Emulation Solutions (NES) portfolio offers a range of RF test solutions, covering the entire device development workflow.

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<th>Keysight Solution</th>
<th>Chipset development</th>
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<th>Carrier acceptance testing</th>
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