

RF/RRM DVT & Conformance Toolset Overview

The S8705A RF/RRM DVT & Conformance Toolset is an integrated solution that enables RF performance testing of 5G devices against the 3GPP-defined conformance test specifications across frequency range 1 (FR1, sub-6 GHz) and frequency range 2 (FR2, millimeter wave, or mmWave). The solution also supports test cases for cellular vehicle-to-everything (C-V2X) communication based on Long Term Evolution (LTE) and LTE sidelink formats.

The solution offers two configurations to adapt to different needs:

- The Design Verification Test (DVT) configuration provides unvalidated test cases based on the 3GPP test specifications. Their purpose is to allow the customization of the baseline test methodologies and test limits from 3GPP to test the device beyond industry requirements, explore its performance limits, and compare its performance against competitive devices to enhance the end user experience.
- The Conformance configuration provides test cases validated at relevant industry certification bodies, such as the Global Certification Forum (GCF) and the PCS Type Certification Review Board (PTCRB). This configuration also supports test plans from regulatory bodies that local authorities enforce before product deployment.

When testing 5G NR RF characteristics, the scope expands from in-band test cases to out-of-band measurements such as spurious emissions and blocking. In-band test cases focus on the radio's performance as a transmitter and 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 RRM and performance testing, which are essential for fully characterizing the RF performance of devices. 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 or impaired radio conditions, with special tests defined for channel state information (CSI) reporting.

To support 5G's diverse set of test requirements, the RF/RRM DVT & Conformance Toolset leverages the superior RF measurement and real-time processing capabilities of Keysight's **E7515B UXM 5G wireless test platform**. The platform also allows RF testing in adjacent bands (that is, adjacent channel leakage ratio), 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. Find more details about the hardware configurations in Table 1.

GCF and PTCRB Certification Process

3GPP is a collaboration between regional telecommunications standards associations and a wide range of commercial companies with an interest in mobile communications. The organization produces the technical specifications that chipset and device manufacturers must comply with to launch their products commercially. The 3GPP conformance specifications cover three main classes of test cases for ensuring that new 5G devices work correctly with the radio access network (RAN):

- protocol
- RF
- RRM

GCF and PTCRB mandate a selection of 3GPP test cases that chipset and device manufacturers must comply with to achieve certification. Once GCF or PTCRB select the test cases, Keysight implements the corresponding test specifications in the RF/RRM DVT & Conformance Toolset. Keysight collaborates with a range of chipset and device vendors to confirm that the 3GPP test specifications correctly verify the underlying 5G functionality and Keysight's interpretation. When all issues are resolved, Keysight requests an independent, accredited validation organization to validate the implementation of each test case against the 3GPP specifications and GCF/PTCRB requirements. If successful, the validation organization submits the test results to GCF and PTCRB, requesting approval for the test cases to be used for formal device certification testing.

Who benefits from using the S8705A RF/RRM DVT & Conformance Toolset?

A range of user types benefit from the RF/RRM DVT & Conformance Toolset solution, as follows:

- chipset makers that support the integration of their modems with a device RF front end
- device manufacturers that want to ensure that their devices offer superior performance and can pass required regulatory and industry certifications before market launch
- test houses and test labs that run tests for GCF/PTCRB certification or regional regulation compliance
- regulatory bodies that need reference equipment for the development of regulatory tests for devices that support 5G NR and C-V2X technology
- mobile network operators (MNOs) that mandate 3GPP test plans for their ecosystem

Core Hardware and Software Elements

The S8705A RF/RRM DVT and Conformance Toolset supports a wide range of test requirements for scalability and price optimization. The solution features core elements and options. Test systems can easily be upgraded during their operational life via the addition of new hardware and software options. The common elements of a test system are as follows:

- software application
- system core software
- hardware

The solution's common software components are the application and system core software. DVT and Conformance users can add specific applications, test packages, and band software assets.

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 common software parts also facilitate upgrades by enabling the addition of complementary solutions from Keysight's NES portfolio.

Software application

Test Manager is the core of the RF/RRM DVT & Conformance Toolset application, for both the DVT and Conformance configurations. It provides the following main functions:

- support for protocol implementation conformance statement/extra information for testing (PICS/PIXIT)
- test campaign creation
- test campaign execution and management
- logging and reporting tools
- device-under-test (DUT) automation
- climatic chamber/power supply automation
- integration with Keysight compact antenna test range (CATR) portfolio

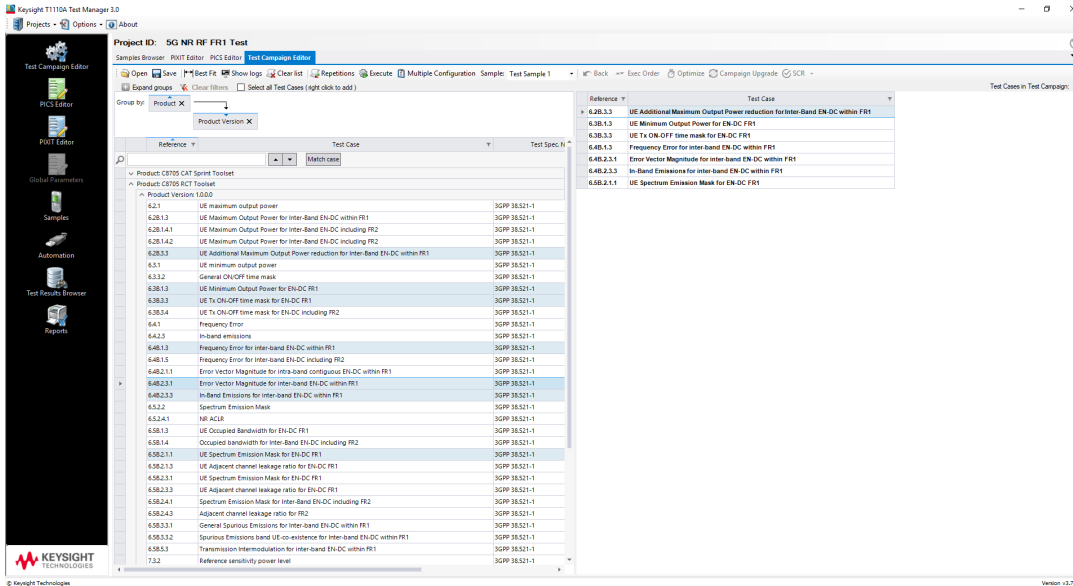


Figure 2. Test Manager software interface

System core software

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

- signaling: NR non-standalone (NSA), NR standalone (SA), LTE, C-V2X (Rel.14)
- RF measurements analysis for supported 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

Conformance

Specific features extend Test Manager’s core functionality to streamline conformance testing operations. These features are either integrated into the application or available for the user to configure.

Test Manager for conformance provides the following key features:

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

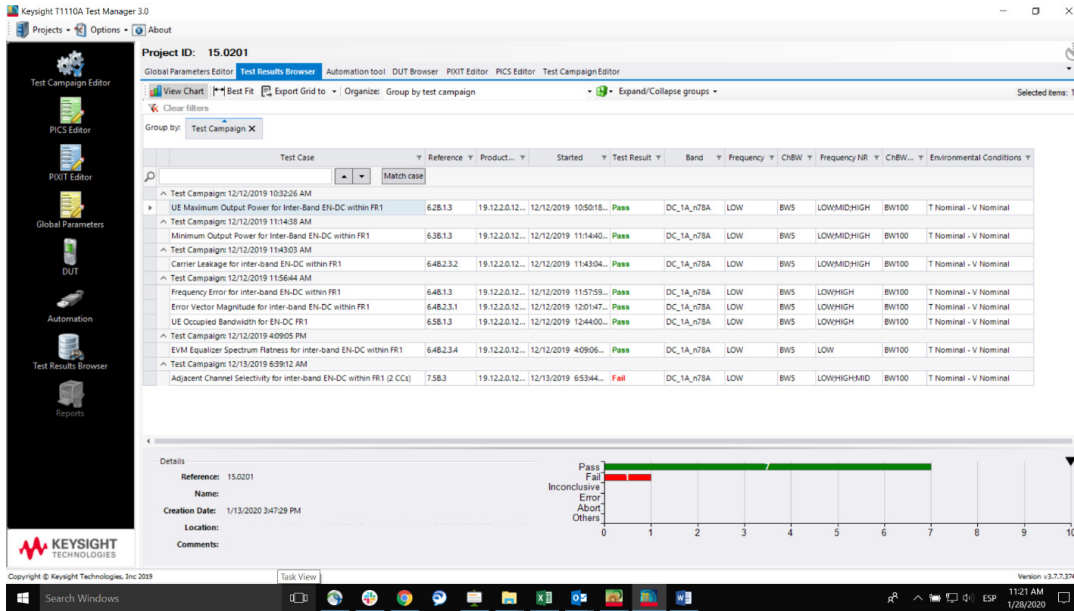


Figure 3. Quick access to test campaign results and retry to test with fail results

Design Verification Test (DVT)

As for conformance, Test Manager's functionality can increase with specific features. These features provide greater user control over test definition and execution. Starting from reference 3GPP specifications, the design verification testing mode allows users to explore device performance beyond industry-accepted reference metrics or test conditions.

Test Manager for conformance provides the following key features:

- usability
 - redefine test scope from the 3GPP default configuration
 - remove or add test points with control over frequency ranges, bandwidths, subcarrier spacing, uplink resource block configuration, etc.
- alter test case limits and tolerances
 - work with new bands defined in RAN4, before addition by RAN5 test specs
 - individual test cases for total radiated power (TRP) and Tx/Rx beam peak search
 - fine-tune grid algorithm for beam peak search

Hardware

The core of the S8705A RF/RRM DVT & Conformance Toolset is the E7515B UXM 5G wireless test platform. It is a highly 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 users 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 allows users to perform tests for device RF characteristics, protocol compliance, and functional key performance indicators. It also supports LTE and C-V2X signaling formats.



Figure 6. E7515B UXM 5G wireless test platform

For RF in-band test cases for transmitter, receiver, RRM, demodulation, and CSI, and reporting performance described in different chapters of 3GPP TS 38.521-1/2/3/4 and TS 38.533, a single UXM 5G unit is enough, if the test is conducted in FR1. Certain carrier aggregation (CA) levels or the need for extra RF ports for multiple-input/multiple-output (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 M1740A mmWave transceivers. The Keysight CATR over-the-air chamber completes the test setup.

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

The following table lists the hardware configurations supported by the S8705A RF/ RRM DVT & Conformance Toolset solution, the test case types supported by each hardware configuration, and the hardware units that make up each configuration, where • represents the quantity of units required.

Table 1. S8705A-Supported Hardware Configurations

Configuration	Supported Test Case Types	E7515B UXM 5G	C8880A NGSU FR1	NGSU FR2	N9040B UXA	E8257D PSG	E7770A CIU	M1740A RRH	F9650A (CATR)
H51-s	RF transmitter and receiver, RF demod/CSI reporting and RRM, FR1	•							
H52-s	Same as H51-s; supports greater CA ¹	••							
H51-sm	Same as H51-s, plus FR2 coverage	•					•	••	•
H52-sm	Same as H51-sm; supports greater CA ¹	••					•	••	•
H53-s	Same as H51-s, plus FR1 spurious tests	•	•		•				
H55-s	Same as H53-s, plus FR1 blocking tests	•	•		•	•			
H56-s	Same as H55-s; supports greater CA ¹	••	•		•	•			
H55-m	RF transmitter and receiver, including spurious and blocking tests, RF demod/ CSI reporting, and RRM 1 angle of arrival (AoA) tests, FR2	•		•	•	•	•	••••	•
H56-m	Same as H55-m; supports greater CA ¹	••		•	•	•	•	••••	•
H56-sm	RF transmitter and receiver, including spurious and blocking tests, RF demod/CSI reporting, and RRM tests, greater CA ¹ ; FR1 and FR2 (1 AoA)	••	•	•	•	•	•	••••	•

1. Carrier aggregation.

C-V2X testing requires one additional MXG unit. 3GPP Extreme Temperature Condition testing (-10 °C to +55 °C) requires Temp control unit (F9631A)

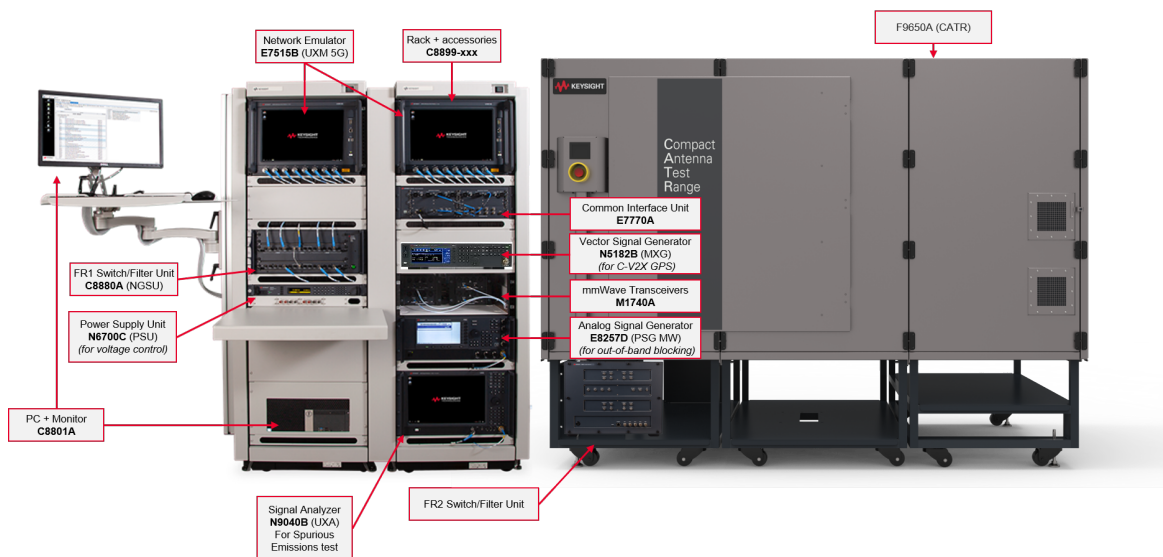


Figure 7. S8705A on H56-sm configuration

Flexible Licensing Options

Keysight offers a wide range of software license to address your testing needs and increase the cost-effective use of assets:

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	Perpetual licenses that do not expire
Subscription	Temporary licenses with limited duration of 6, 12, 24, or 36 months

As frequencies increase and solutions move to over-the-air, DVT, conformance, and carrier acceptance toolsets for 5G technology require trained and expert installation, alignment, and verification. Keysight has a worldwide team of trained 5G technical experts that will ensure your solution is integrated correctly, whether connected or over-the-air, with specific alignment and validation. We have standard services to validate the solution against a Keysight-provided device and test cases specific to the options ordered. We can go beyond these offerings and provide specialized measurement support, test case development, and user equipment support depending on your specific needs.

Keysight C8899A/AU Kits

Kits available to support your rack configuration include:

Part number	Description
C8899A-001	Provides a 2-bay rack with power supply adapted to countries working with 100-120 V
C8899A-002	Provides a 2-bay rack with power supply adapted to countries working with 200-240 V
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
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
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

Test System Technical Information

Configuration	Dimensions W x H x D	Weight (100-120 V configuration)	Weight (200-240 V configuration)
H53-s	1800 mm x 1620 mm x 1505 mm	380 kg	370 kg
H55-s		410 kg	390 kg
H55-m		420 kg	400 kg
H56-s		455 kg	435 kg
H56-m		465 kg	445 kg
H56-sm		490 kg	470 kg

Environmental conditions
Temperature
<ul style="list-style-type: none"> • Storage –10 to 50 °C • Operating 10 to 40 °C • Operating temperature after RF calibration 20 to 35 °C • 5 to 85% (non-condensing) Humidity
Altitude operating range Up to 2000 m
Electrical safety Complies with European Low Voltage Directive 2014/35/EU
Electrical safety Complies with IEC 61010-1, Edition 3.1 / EN 61010-1:2010+A1:2019
EMC Complies with European EMC directive 2014/30/EU
EMC Complies with IEC 61326-1:2012 / EN 61326-1:2013
This ISM device complies with Canadian CAN ICES/NMB-001(A)
KCC Number “R-R-Kst-1320675”
Frequency range Defined by 3GPP E-UTRA operating bands FDD and TDD
Input and output connector N-type 50 ohms
Supported bandwidths, see UXM 5G datasheet

Succeeding at Acceptance Testing

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

The S8705A RF/RRM DVT and Conformance 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 the following webpage:

- [Wireless Network Emulators](#)

You can also 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

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