CMX500
RADIO COMMUNICATION TESTER

Rethinking 5G testing

Product Brochure
Version 07.00

The CMX500 combines incredible RF performance of up to 16 GHz instantaneous bandwidth with a revolutionary leap in processing power that enables 20 Gbps of IP data throughput. The modular hardware architecture can also flexibly adapt instruments to your requirements.

CONTENTS

AT A GLANCE

TheCMX500 is designed to make 5Gtesting simpler and more straightforward than ever before, even with complex test setupsfor all 5G NR deployments. Itcovers all 5G and WLAN signaling test applications, supports a large variety of present and future 3GPP band combinations and end-to-end data rates of up to 20 Gbps – all in a single box. Fully independent LTE/FR1 and FR2 RF chains reduce complexity for your test setup and speed up the whole process with parallel testing.

The combined multi-band capabilities of the CMX500 one-box tester enables LTE, FR1 and FR2 band combination testing to verify RF, signaling and applications in 5G devices. The RF unit frequency range scales up to 8 GHz and the CMX500 is designed to support any further FR1 3GPP band extensions. The advanced dynamic range of the RF unit makes RF and callbox testing much more stable and reliable.

The CMX500 offers unparalleled 5G testing flexibility. The modular CMX500 design can be easily customized to specific test requirements. Users can configure one RF unit to focus on IoT RedCap applications. The CMX500 can also come with additional RF units to support comprehensive testing of all 3GPP FR1 band combinations. FR2 capabilities can be integrated into most configurations for greater versatility in advanced 5G NR testing.

State-of-the-art R&S®CMsquares software guides users with a simple and intuitive web interface through any testing configuration. The web-based interface includes a Python scripting interface for automated remote testing.

The CMX500 comes with a wide range of accessories for MIMO and OTA testing in the FR1 and FR2 frequency ranges. Rohde & Schwarz has turnkey testing solutions, ranging from small shielded boxes to large OTA chambers with remote radio heads and active combiners.

KEY FACTS

- ▶LTE, FR1 and WLAN multi-band capabilities up to 8 GHz
- ▶FR2 multi-band remote radio support (24 GHz to 50 GHz)
- ▶20 Gbps and end-to-end IP data performance capability
- ▶Single web based GUI for RF, protocol and application tests
- ▶Extensive IP and application test feature set onboard
- ▶LTE Anchor support for massive LTE carrier aggregation scenarios

USE CASES

- ▶RF callbox measurements
- ▶RF preconformance testing
- ▶Signaling protocol verification
- ▶End-to-end data testing
- ▶3GPP conformance testing
- ▶Network operator acceptance tests

DIFFERENT CONFIGURATIONS OF THE CMX500

The CMX500 comes in five different configurations:
OBTlite, OBT, OBTplus, OBT FR1 specialist and OBT FR2 specialist.

CMX500, OBTlite

CMX500, OBT

CMX500, OBTplus

CMX500, OBT FR1 specialist

CMX500, OBT FR2 specialist

A TRUE ALLROUNDER

product lifecycle of a mobile communications device.

Supporting the entire product lifecycle

The CMX500 can handle allnon-signaling and signaling scenarios from early R&D design to final integration, verification and performance testing, final product validation in a test house as well as quality assurance and repair. The hardware modules are designed for versatile tasks and flexible enough to let users perform different measurement tasks with the same test station.

Covering all use cases for 5G NR device testing

The CMX500 platform can be used inR&D or test labs for signaling tests in the sub-8 GHz (FR1) and mmWave (FR2) frequency bands in chip development testing, module testing and device testing in regression stations. The CMX500 has RF units (R&S®CMX-B600B) that support the LTE, FR1 and WLAN frequency ranges and IF units (R&S®CMX-B500A) that support FR2 frequency ranges. The powerful processors can host LTE, 5G and WLAN technologies and the data application modules.

Ready for the future

Rohde& Schwarzpermanently implements all new standardization and test house requirements to make the CMX500 future-proof. The CMX500 is available in several specific use-case configurations to flexibly support future extensions.

Addressing all 3GPP bands in FR1

The CMX500product family supports a frequency range of up to sub-8 GHz. The CMX500 addresses all 3GPP bands in the FR1 frequency range. The R&S®CMX-B600B RF frontend supports existing LTE frequency ranges (licensed and unlicensed) along with existing 5G FR1 frequency ranges.

Countless CA and MIMO combinations

The R&S®CMX-B600B RF unit boasts an instantaneous bandwidth of 1 GHz per TX and can simultaneously host LTE and NR FR1 cells with a maximum carrier bandwidth of 200 MHz. Up to 32 layers can be configured per RF unit with end-to-end (E2E) IP throughput capabilities. Each RF unit provides four TX ports, two RX ports and two TRX ports that can be used to flexibly link RF connectors to DUTs.

Offering a whole test environment from one vendor

Rohde& Schwarzofferscomplimentary chambers for FR1 and FR2 over-the-air (OTA) testing for all 5G and WLAN OTA testing.

Customizable hardware

The modular hardware architecture can be configured for a range of different use cases such as IoT testing with RedCap devices, RF parameter measurements, measurements under fading conditions and performance measurements with maximum data rates. The front panels of the IF and RF interfaces can be fully customized to specific testing needs for all RF parametric and application tests for LTE, FR1, FR2 and WLAN. The CMX500 has unmatched flexibility thanks to its specialized hardware components.

- R&S®CMX-B600B RF unit supports up to 32 5G layers or up to 32 LTE layers
- R&S®CMX-B200A accelerator unit for baseband computing
- R&S®CMX-B300C processing unit for protocol stack computing and data application
- Optionally R&S®CMX-B500A IF unit for FR2

3GPP RF pre-/confor mance tests

Automated TX, RX and performance testing

End-to-end communications testing

Userexperience testing, including voice, video, IP data transfer and OTT

GCF, PTCRB and NetOp tests

Validated testing for specific network operators in compliance with 3GPP and operator test plans

5G NR test and measurements

Supports non-standalone (NSA) and standalone (SA)

WLAN (IEEE 802.11)

TX/RXverification, performance measurements, coexistence testing, audio analysis, traffic offloading

Inter-RAT, roaming and reject testing

Mobilitywithfading conditions and reject/error signaling scenarios

5G location-based testing

OMAsecure user plane location (OMA-SUPL), certification tests including network operator tests

Simplified service and repair testing

Easyand practicalsolutionfor 5G service and repair testing

Band combination testing

AutomatedMRDC andCA band combination testing for RF verification, signaling and end-to-end (E2E)

R&S®CMsquares – THE CMX500 CONTROL CENTER

A modern, web based user interface designed for remote and lab operation, R&S®CMsquares is the CMX500 control center for all measurement tasks. R&S®CMsquares simplifies device testing in all development stages from early prototyping, to form factor verification including RF callbox measurement tasks, protocol verification and data application testing.

- ▶Dashboard style, simple entry point for all users
- ▶Use case selection (e.g. NSA mode, SA mode)
- ▶User defined squares
- ▶Easy parameter outline with the help of favorites
- ▶Snippet access (sequencer based macros) via dedicated buttons

Common graphical user interface

All CMX500 services are integrated in R&S®CMsquares, the common graphical user interface. It has a dashboard where all types of applications can be accessed. This unique user interface is controlled via a web GUI. The standardized GUI provides a unified user experience for all Rohde & Schwarz 5G radio communication testers. All measurements can be operated manually in the workspace or built as test sequences in the integrated R&S®CMsequencer graphical scripting interface. Test routines can be remotely controlled via XLAPI and SCPI interfaces.

Browser based test software solution

R&S®CMsquares is a unified test software solution with browser based user experience that combines all that is needed for 5G NR testing. It provides everything from test configuration, parameterization, measurements as well as test execution in a single dashboard style environment with quick access to various applications. A standardized GUI can control all new 5G radio communication testers.

The interactive callbox mode helps rapidly connect to a device under test, alter network parameters on the fly, analyze real-time RF TX/RX measurements and trace protocol stack messages on all protocol layers. It also has a sequencer mode to run preconfigured 5G NR test scripts or simply create 5G NR test scripts from scratch with a simple drag and drop. Ultimately, an interactive mode and a sequencer mode can run in parallel to provide the same test results.

Squares concept

With R&S®CMsquares, users can access measurement tasks in separate measurement squares. The DUT is always in focus with R&S®CMsquares. With this DUT-centric approach, it is very easy to keep an overview of even complex test scenarios, test environments and measurement tasks. The next change is just one click away.

R&S®CMsquares includes as many squares as needed: for measurements, graphical outputs and statistical views, network layout and configuration, RF connection, message analyzer, test sequencer, scripting – you name it. The R&S®CMsquares layout can be configured for your personal preferences at any time.

DUT-centric operating concept

5Gis taking mobile communications by storm. But since most use cases expand on existing cellular technologies such as LTE, device testing has become even more complex and time-consuming. A simple and efficient solution is needed to keep the transition to 5G as smooth as possible. Rohde & Schwarz puts the DUT in the center of the test environment.

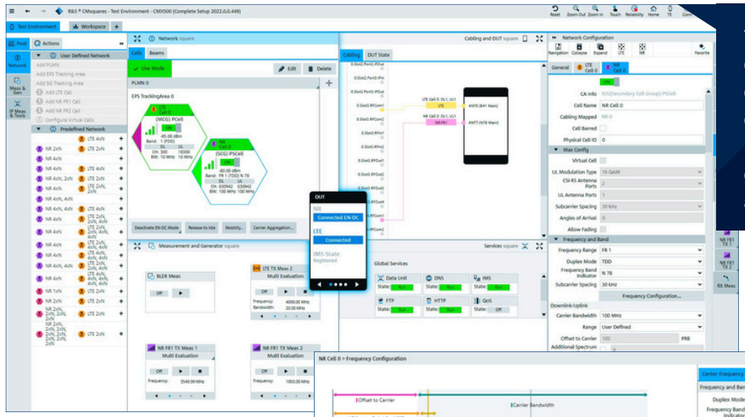
In the test environment, the DUT is placed in the center of the four squares. Simply configure your device and network parameters to create your preferred 5G network for non-standalone or standalone mode, data services for throughput tests, RF connector cabling of the device as well as required RF measurements.

Easy measurement setup with R&S®CMsquares; shown here: configuration of RF non-standalone measurements

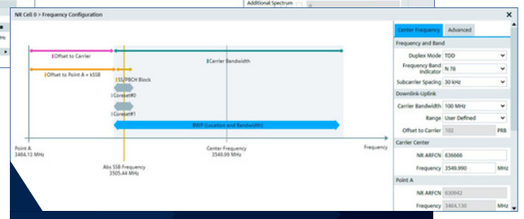
R&D TEST SUITE WITH ALL UTILITIES UNIFIED IN ONE PLACE

TheR&S®CMsquarestest softwareplatformhasan intuitive controlarchitecturebasedontest environment, measurementworkspace, sequencerandmessage analyzer.

TEST ENVIRONMENT

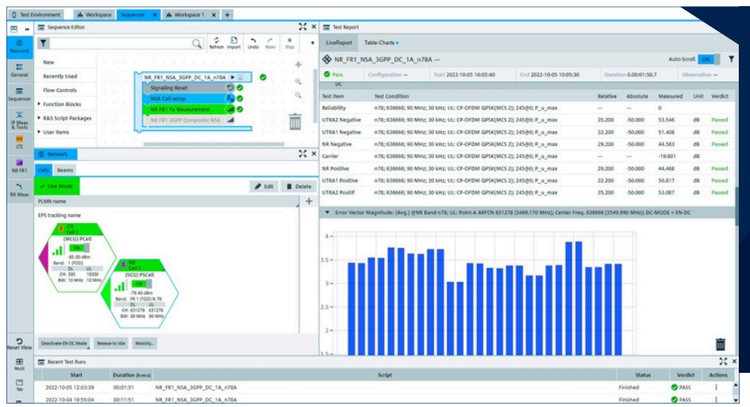


The test environment provides a comprehensive overview of all configurations and measurements with customized settings adapted to DUT needs. It is the control hub for network creation, parametrization, DUT control and cabling.



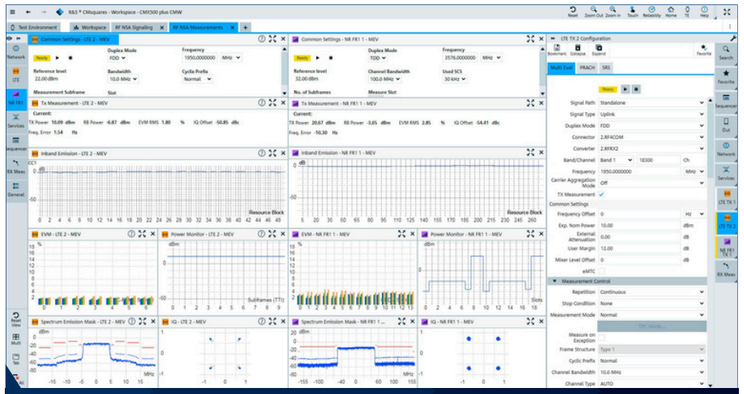
Utilities like the graphical frequency configura tion dialog guide users to a valid network configuration, no matter how complex specifications may seem.

SEQUENCER



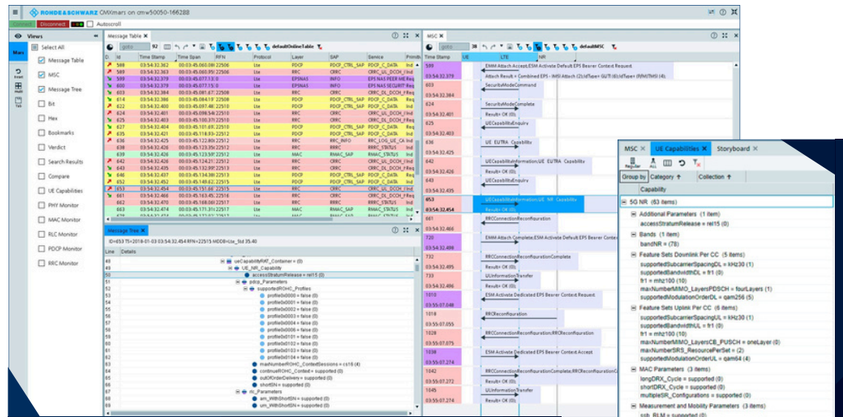
The R&S®CMsequencer features a unique graphical user interface and simplified workflows for creating and execut-ing test scripts and complete test plans/ campaigns. The built-in campaign man-ager offers all tools required for automated testing, parametrization and result report-ing. Users are free to add other measurement squares in the sequencer for a seamless user experience with all kinds of RF, protocol and application tests.

MEASUREMENT WORKSPACE



Measurements are performed in the workspace. It combines several squares for all technologies including LTE, FR1, FR2, WLAN, TX and RX live measurements, data testing, monitoring, DUT control and through-put charts. The layout can be arranged to suit any use case. Users have immediate access to all signaling and measurement parameters within the workspace without leaving the measurement.

MESSAGE ANALYZER



The entire message exchange between the network and end device can be traced in real time and analyzed in detail using the message analyzer. The message analyzer is integrated into R&S®CMsquares and allows quick access to all signaling communications layers between the DUT and the simulated network. Users can quickly narrow down DUTs protocol stack issues in the event of errors.

UE capabilities: The message analyzer combines several auxiliary tools to investigate the DUT protocol stack. Users get instant access to UE capabilities and band combinations reported by the DUT.

TEST SEQUENCE AUTOMATION WITH R&S®CMsequencer

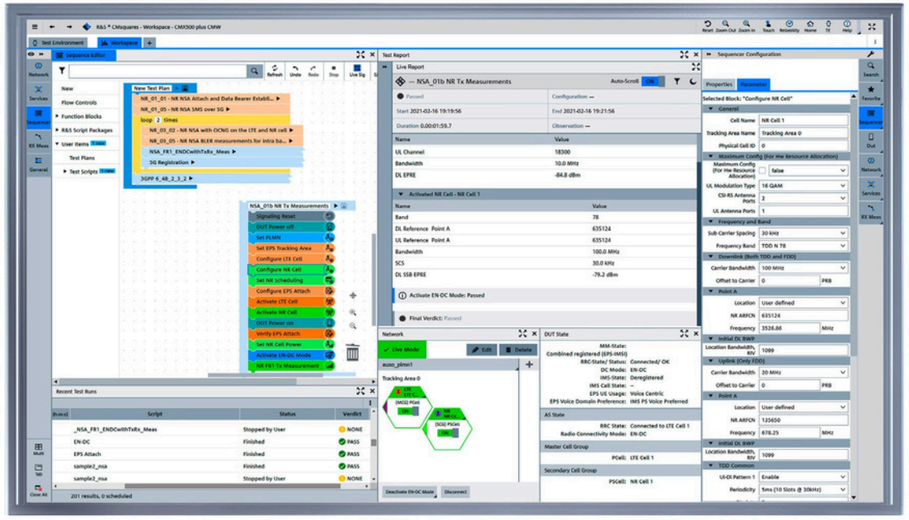
The R&S®CMsequencergraphicalscripting interfacecreates,configuresandexecutestestscripts on theCMX500.TheR&S®CMsequenceris partofR&S®CMsquares.

Having individual applications for specific testing areas is a thing of the past. In the future a more unified approach will be needed, where all necessary test functions are available in a single graphical user interface. The R&S®CMsequencer helps uniquely and intuitively create test sequences for a wide range of use cases, including RF parametric testing, protocol verification and E2E IP testing. By working seamlessly with R&S®CMsquares interactive mode, R&S®CMsequencer makes it simple to create and execute test scripts and test plans in an automated environment. Users configure tests by simply arranging color-coded functional blocks one after another, a very straightforward process. Testing has never been easier.

Key facts

- ▶ Automated environment to execute test scripts or test campaigns created with graphics or the Python scripting interface
- ▶ 3GPP RF TX/RX tests in line with IEEE 38.521
- ▶ R&D RF signaling measurements including multi-evaluation measurements, BLER search, maximum power (both for FR1 and FR2)
- ▶ End-to-end throughput testing including IMS, VoLTE, VoNR and VoWLAN
- ▶ Signaling feature capabilities (for e.g. carrier aggregation, mobility) with flexible configuration possibilities
- ▶ Automatic iteration over DUT-capable band combinations and result summary for each combination
- ▶ Online and offline measurement reports including charts and graphs in various data formats (e.g. csv, pdf)
- ▶ Seamless context switching to and from R&S®CMsquares interactive mode for unlimited testing flexibility

R&S®CMsequencer workspace within R&S®CMsquares web user interface



SNIPPETS – MORE THAN SAVE AND RECALL

R&S®CMsquaresSnippetsminimizefrequentactionsintosingleclickbuttonsforrapidtestuse case verification.

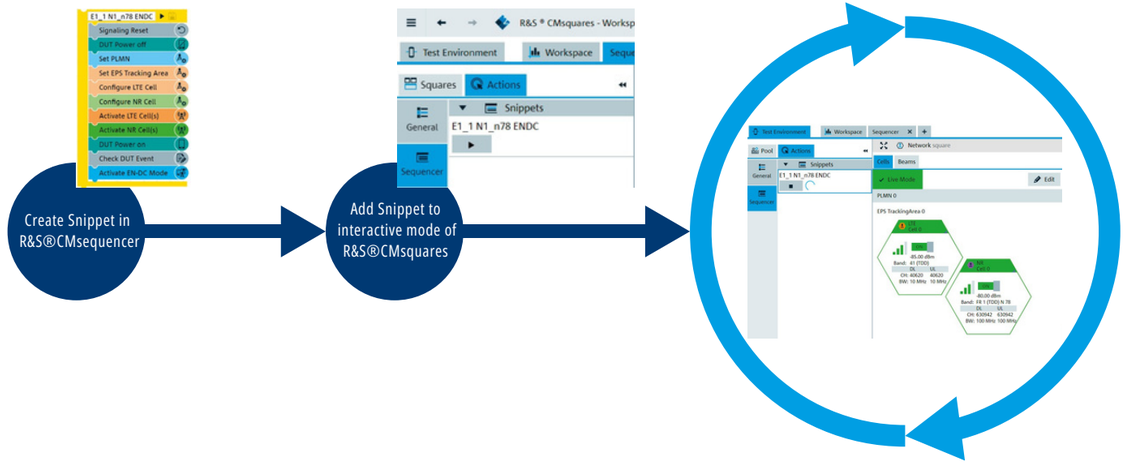
Never before has it been easier to seamlessly switching from interactive testing to scripting and vice versa. R&S®CMsquares Snippets can do this and more. R&S®CMsquares Snippets is a one-click pre-defined system configuration solution that guides a DUT into a certain state. Afterwards, users can continue testing in interactive mode. R&S®CMsquares Snippets saves time and effort by avoiding monotonous actions in interactive operation mode. Simply place your test sequence in a customized button and run it whenever needed.

Key facts

- ▶ Avoid monotonous steps and bring DUT to a desired state with just one-click
- ▶ Many use cases possible, e.g.:
  - — One-click EN-DC connection
  - — One-click maximum throughput
  - — One-click maximum power configuration
- ▶ Utilize user created and verified test scripts in interactive mode

User workflow on creating and using R&S®CMsquares Snippets

Save/recall feature has a similar function in Callbox, but only for configuration data that can be saved and retrieved. R&S®CMsquares Snippets help configure cells and settings and change the DUT to the desired state without manual intervention.



SHUFFLER – AUTOMATED BAND COMBINATION TESTING

R&S®CMsequencerShuffler automaticallytestsallsupportedbandcombinationstoverifysignaling, RFandE2Efunctionswith CMX500.

3GPP stipulates a combination of LTE and NR band combinations that far exceed 10 000 s. In functional or RF verification, verifying a device against all supported band combinations would result in huge testing times with a lot of manual work.

The R&S®CMsequencer Shuffler easily performs automatic iteration across the bands and band combinations reported by the DUT, drastically reducing the time and effort needed to test RF, signaling and IP throughput performance for all supported combinations.

Any combination of LTE, NR FR1, NR FR2, EN-DC, NR-DC, NR-CA can be tested as long as the necessary resources are supported by CMX500 hardware. These combinations can be extracted directly from user equipment or the band combinations can be fed in a file.

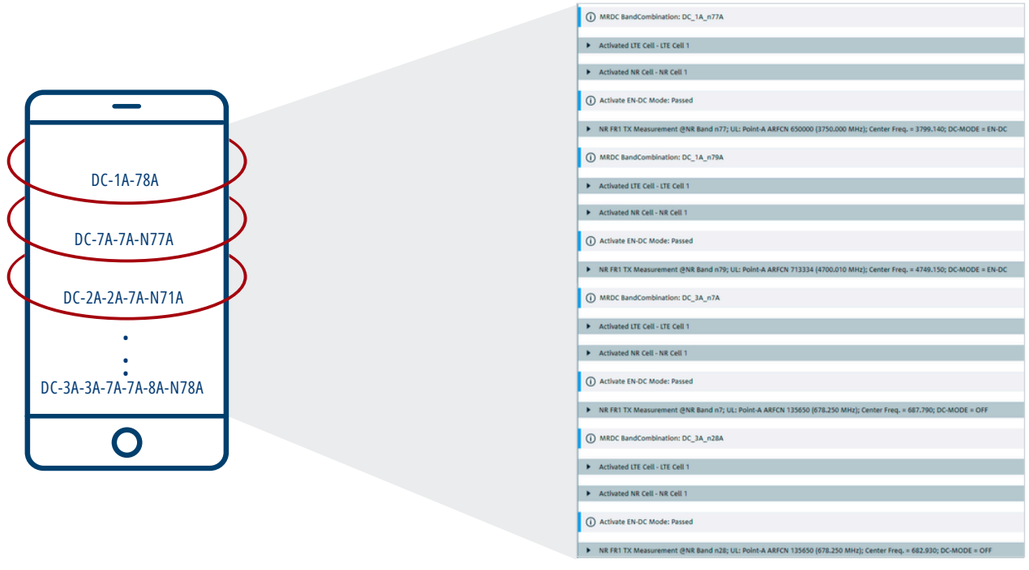
Predefined and verified test scripts from Rohde & Schwarz mean not having to start from scratch and tests can be adapted to user needs with minimal changes. This automation and flexibility makes iterating band combination testing quicker and easier than ever before.

Key facts

- Single click solution to iterate through all band combinations reported in user equipment capabilities
- Highly flexible testing of various device functions (TX/RX measurements, throughput, VoLTE/VoNR, etc.)
- All band combination results in one test report
- Users can enter band combinations from various input sources (e.g. csv file)

R&S®CMsequencer Shuffler

TheR&S®CMsequencerShuffleriteratesthrough device MRDC band combinations for fully automated DUT health checks.



PYTHON INTERFACE FOR WRITING REPEATABLE ROUTINES

Pythonisthe mostcommonscripting languageand an industrystandardfor testing andautomation frameworks. Toconfigure andcontrol theCMX500 and verifyDUTbehavior, Rohde & Schwarzprovides the scripting interface in Python.

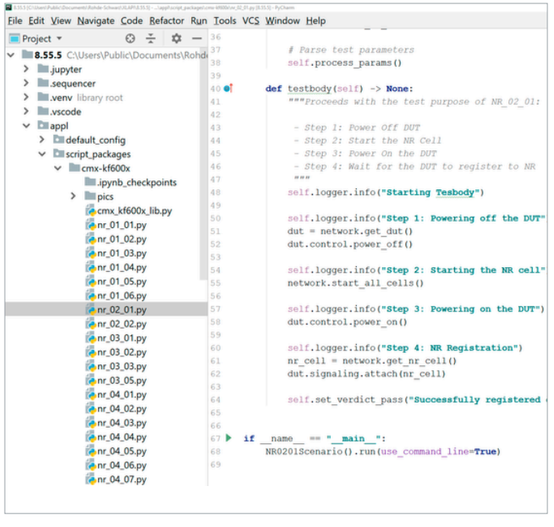
The simple and abstract interface enables users to spend their precious time testing rather than programming. For users who want to go deeper into configuration and peer message content, XLAPI also has a flexible configuration mode. Python test script packages created and maintained by Rohde & Schwarz provide a user-friendly starting point for device verification, whether for FR1, FR2, non-standalone or standalone modes.

Test campaigns and regression tests with Python test scripts can be created and executed in R&S®CMsequencer. Integration in user automation frameworks is easy, whether via R&S®CMsequencer or Python scripts executed directly from the user automation framework.

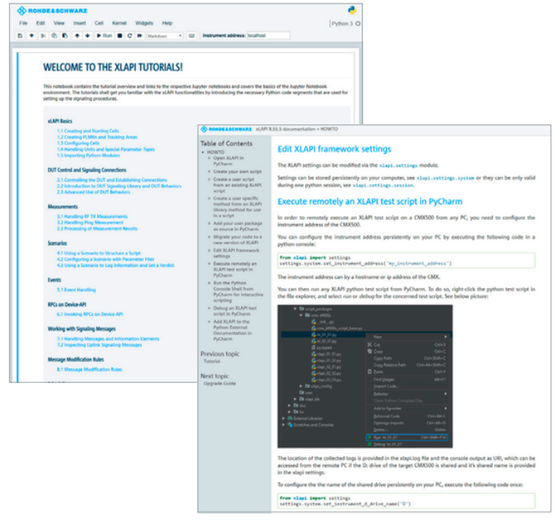
Key facts

- Self-sufficient installation (no effect on existing Python installations)
- Configure only what is needed (only necessary parameters are configured; the rest will be adjusted or default values used)
- Comprehensive help with extensive documentation on version upgrades
- Any other Python modules can be used
- Covers all functional tests including RF, throughput, mobility and multi-SIM

The scripts written in the integrated Python development environment can communicate with all device functions.



The integrated tutorials and information texts make it easy to use Python scripting interface.



RF AND 3GPP PRECONFORMANCE TESTING

RFmeasurements ormeasurements ofthetransmitandreceive characteristics,are the basisfor device testing.The CMX500offers a user-friendlytestsolution forlabapplications that delivers reliable and reproducible results.

Flexible scheduling

Achipsetmanufacturer has different RF measurement requirements than a network operator. The CMX500 with the R&S®CMsquares user interface takes into account the differences between the various applications. Details for many test scenarios can be flexibly and interactively set. R&S®CMsquares and the integrated R&S®CMsequencer offer everything needed to successfully perform RF measurements: the necessary flexibility and large predefined libraries. Test solutions needed for specific RF measurements are easy to create. RF measurements are possible in the FR1 and FR2 frequency ranges, in chambers and with remote radio heads (RRH). Users have access to all parameters, can flexibly adjust them and reproduce results at any time.

Automated 3GPP preconformance tests

R&S®CMsequenceroffers3GPP RF test cases in line with TS 38.521 (preconformance) as a simple and automated one-click test execution solution. Special 3GPP blocks that comply with the configuration and test points in 3GPP TS 38.521 offer a ready-made way to test device RF functions. R&S®CMsequencer 3GPP blocks also allow modification of default configurations and the flexibility to test non-compliant configurations.

The flexibility of R&S®CMsquares allow setups for interactive RF tests. Different technologies can be created with R&S®CMsequencer, LTE measurements are on the left and 5G FR1 measurements on the right.

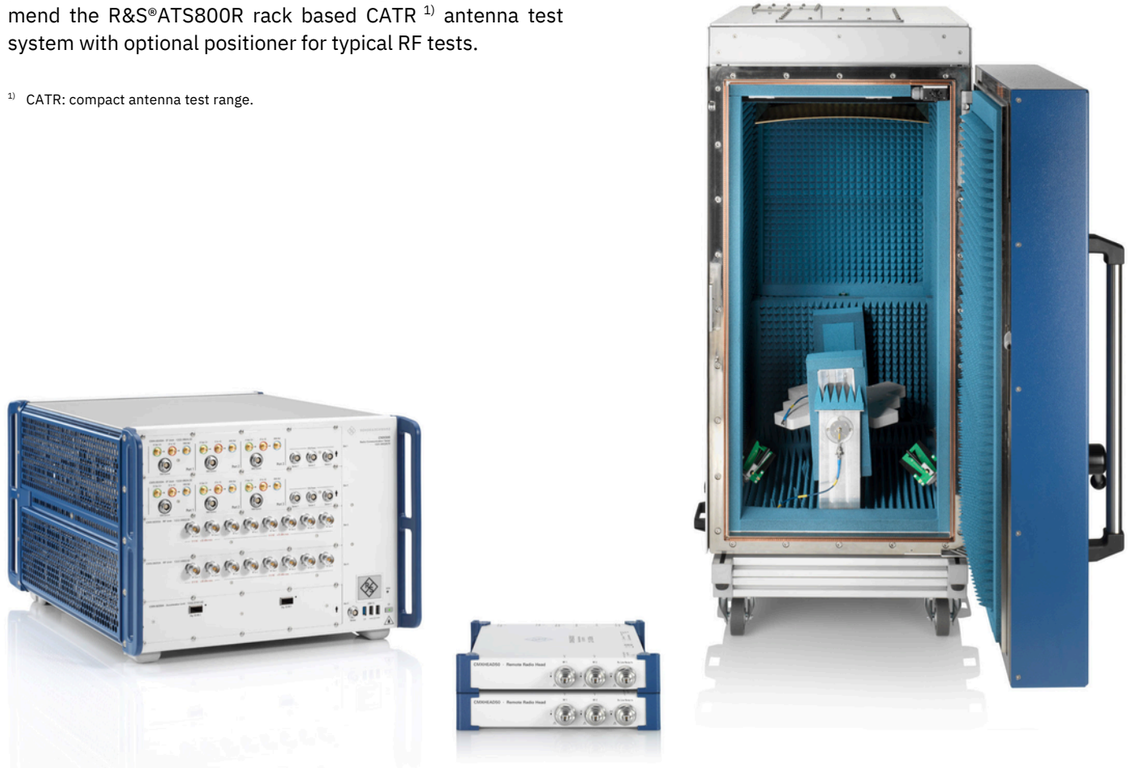
Extendable for mmWave measurements

The standard CMX500 in theFR1 range can be upgraded into an mmWave setup by adding R&S®CMXHEAD50 remote radio heads and additional internal IF modules (R&S®CMX-B500A).

The R&S®CMXHEAD50 devices upconvert or downconvert from the IF signal into the required mmWave RF spectrum to support TX and RX signals at the dual polarized antenna inside the over-the-air (OTA) chamber. Depending on the test requirements, the setup can be connected to one of the Rohde & Schwarz OTA chambers (see Complementary products from Rohde & Schwarz on page 28). We rec- om mend the R&S®ATS800R rack based CATR [1] antenna test system with optional positioner for typical RF tests.

[1] CATR: compact antenna test range.

To boost the output power or increase the signal-to-noise ratio (SNR) or for bandwidth extensions, we offer the R&S®CMX-RF42 RF frontend, an active combiner. In line with 3GPP requirements, EIRP, CDF or TRP measurements can be reliably performed within the OTA chamber.



RF over-the-air testing for FR1 and FR2 using CMX500, R&S®ATS800R and R&S®CMXHEAD50

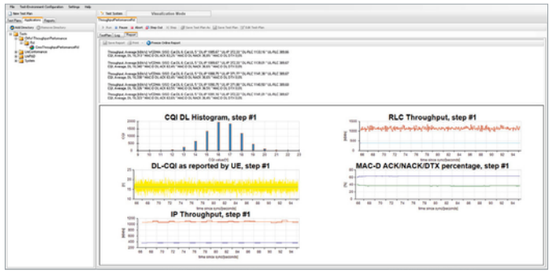
R&S®CONTEST – SOPHISTICATED TOOLS FOR ALL PREDEFINED TESTS

R&S®CONTEST is testsystemsoftware withversatile automatedtestproperties,forbothnetworkoperator testscenarios and conformancetesting inlinewith 3GPP.

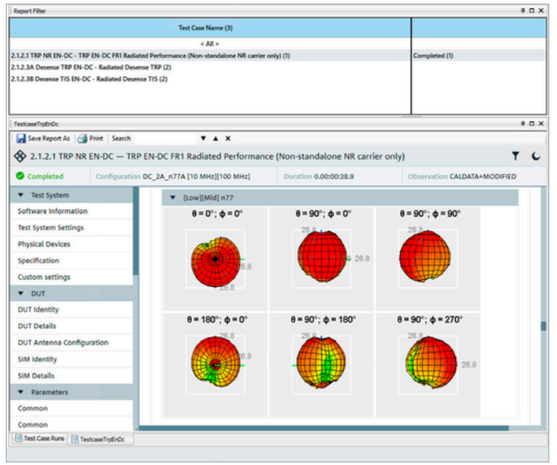
Automated testing

R&S®CONTESTis proven test system software for 24/7 automated testing of network operator testing scenarios and conformance testing in line with 3GPP. R&S®CONTEST provides comprehensive analysis for evaluating test campaigns, generates easy-to-understand reports and has many useful tools.

Even complex test plans can be quickly defined with drag-and-drop and any needed intuitive parameter applications, such as frequency band combinations.



Performing carrier acceptance tests with R&S®CONTEST test software: R&S®CONTEST enables fully automated performance of test cases and provides extensive summary reports along with powerful analysis tools to evaluate test reports.



R&S®CONTEST provides 3GPP RF testing for FR2 and spherical coverage reports, where applicable.

User-friendly operation

Cabling and antenna scenarios can be visually edited and system operators easily guided through the test system calibration process. User-friendly remote access and web-based test system monitoring are also available.

Wide range of applications

R&S®CONTESTcoversawide range of applications and system configurations, from a single CMX500 to a full-blown R&S®TS8980FTA conformance test system.

System operators benefit from one sequencer platform for the entire range of pre-defined test applications, such as location based services (LBS), RF, radio resource management (RRM), protocol conformance testing and specific test solutions for network operators (NetOp test solutions).

Test solution for 3GPP protocol and minimum performance tests (both for FR1 and FR2) with an R&S®CMQ500 shielding cube, the CMX500, two R&S®CMXHEAD50 remote radio heads, an R&S®SMBV100B vector signal generator and a notebook.

TESTING USE CASES FOR APPLICATION TESTING

TheCMX500 has aunique andfully integratedapplicationtesting solution. A pre-optimized IPv4/IPv6 test environment provides the CMX500 with maximum reproducibility and stability, dramatically shortening test setup preparation and configuration times for application and connectivity testing of the most common internet transport protocols.

The server functions and IP level applications allow users to verify IP functions on DUTs ranging from basic to advanced. The CMX500 one-box solution addresses the following use cases:

IP throughput testing
The CMX500 allows traffic generation and monitoring of high 5G data rates and the different layers, including the physical and IP layers.

IMS audio and video testing
The integrated IMS server enables voice, video and SMS testing over NR, LTE and WLAN.

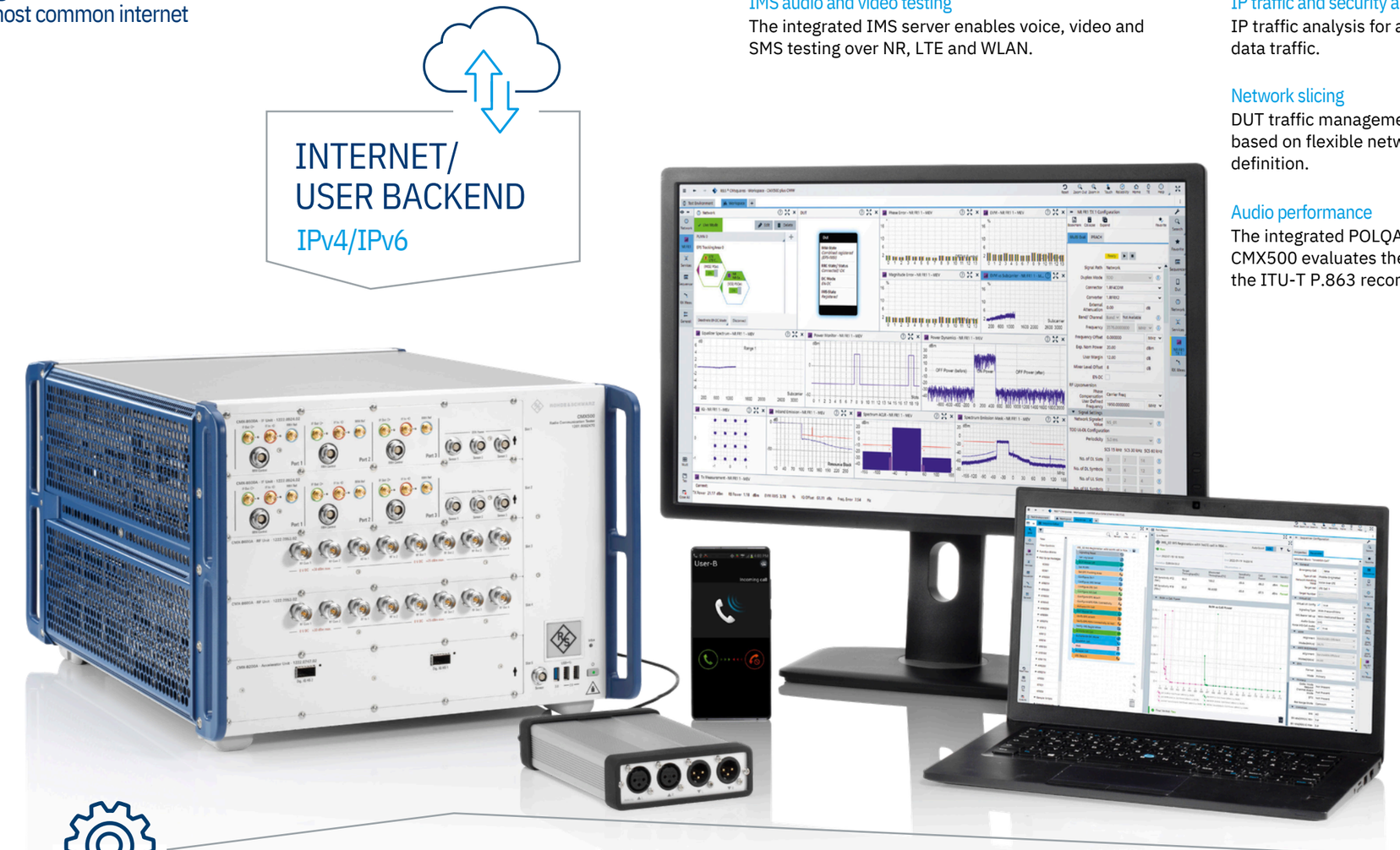
Battery life testing
The seamless integration of power consumption measurements for unique insights together with RF, protocol and application testing.

WLAN offloading and VoWLAN
5G and WLAN are expected to seamlessly intermingle in future networks. WLAN offloading is vital to ubiquitous network availability.

IP traffic and security analysis
IP traffic analysis for a detailed look at 5G mobile device data traffic.

Network slicing
DUT traffic management and service isolation testing based on flexible network slicing and URSP traffic rule definition.

Audio performance
The integrated POLQA audio measurements option for CMX500 evaluates the subjective voice quality in line with the ITU-T P.863 recommendation.



CERTIFICATION AND CARRIER ACCEPTANCE TESTS

3GPP protocol conformance testing

Protocolconformancetestingis akeyelementinthe development of modern mobile devices.

The CMX500 provides excellent coverage of test cases defined in 3GPP TS 38.523-1, supporting both FR1 and FR2 frequency ranges. The CMX500 is a powerful tool for validating the protocol conformance of 5G and 5G-Advanced devices.

The ongoing enhancements for the CMX500 already support features beyond the current state of the art for a future-proof solution that meets demanding test requirements, including next generation eCall over New Radio (NG eCall over NR), non-terrestrial networks (NTN) and mission critical services (MCX).

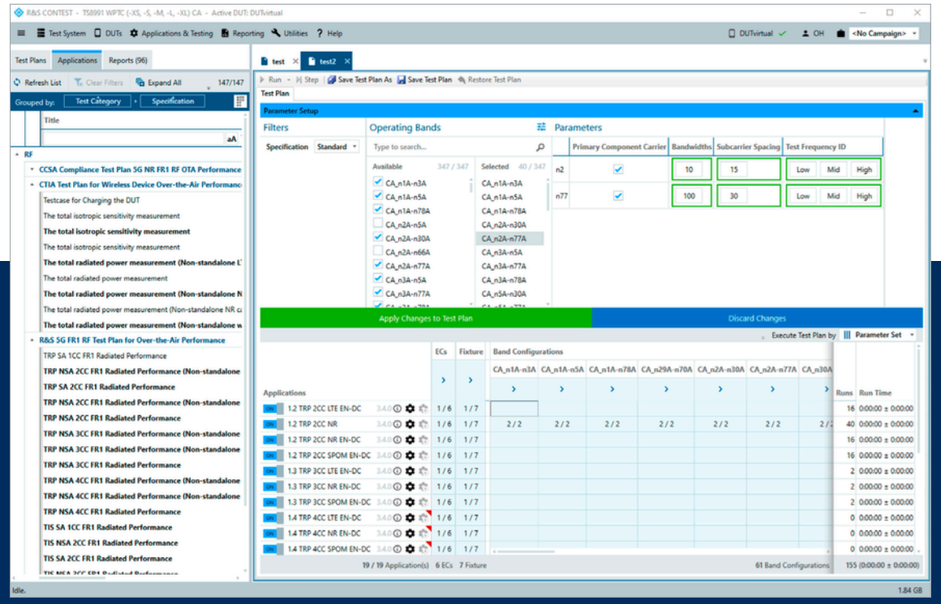
3GPPLBSprotocolandminimumperformance tests

3GPP hasdefined location based services(LBS)standards that are essential for the effective deployment and operation of location services in mobile networks.

The R&S®TS-LBS-NR conformance test solution is based on the CMX500 platform and covers:

- LBS protocol: Defines how location information is requested, processed and provided within mobile networks
- Minimum performance testing: Assesses the accuracy, latency and reliability of location services, including enhanced cell ID (eCID) and time difference of arrival (TDoA)
- OMA secure user plane location: Ensures secure transmission of location data and protects user privacy and data integrity

R&S®CONTEST provides conformance test case selection, configuration and execution possibilities.



Carrier acceptance tests

To ensure that devices function properly and to optimize the user experience in their networks, mobile network operators need additional testing beyond standard 3GPP compliance. The NetOp test solution is based on the CMX500 and implements device acceptance requirements for large network operators. It provides excellent support for network operator protocol testing (NPT) and covers key areas such as NR signaling and voice over NR as well as data throughput performance and quality acceptance test- ing (PQA). In addition to protocol and performance test- ing with the NetOp solution, Rohde & Schwarz provides comprehensive support for LBS and RF carrier accep- tance testing. LBS tests include network based position- ing technologies, while RF tests focus on operator-specific frequencies and band combinations.

3GPP RF and RRM conformance testing

RF conformance testingis a key component in develop- ing and certifying modern mobile devices. The testing ensures that user equipment radio performance complies with international specifications and meets regulatory requirements.

Test systems from the R&S®TS8980 series cover a wide range of test cases specified in 3GPP TS 38.521 (parts 1 to 4), supporting measurements in the FR1 frequency range as well as in FR2 (with additional hard- ware). This makes these test systems powerful tools for verifying the RF conformance of current and next- generation wireless device designs.

The R&S®TS8980S-4A test system offers a wide range of in-band test cases for RF and RRM certification tests.

The R&S®TS8980 series also supports radio resource man- agement (RRM) conformance testing in line with 3GPP TS 38.533. The tests validate a device's ability to manage radio resources efficiently – during handover procedures, frequency selection and evaluation – and maintaining con- nection quality under realistic network conditions.

Another key R&S®TS8980 series capability is its support for NTNs. Both RF and RRM conformance testing are avail- able for devices targeting satellite-based communications scenarios.

The R&S®TS8980 series is continuously evolving and now supports a wide range of validated 5G NR test cases based on Global Certification Forum (GCF) and PTCRB, regulatory and carrier acceptance test cases from leading network operators.

The R&S®TS8980FTA-3A test system is the most compact full type approval RF/RRM conformance test solution on the market.

WLAN MEASUREMENTS UNDER REALISTIC OPERATION CONDITIONS

TheIEEE802.11 – orwirelesslocal areanetwork(WLAN) – standard is vital tothe modern world of communications. Mobile phones, laptopsand printersall useit.Even refrigerators, cameras and cars communicate wirelessly nowadays. WLAN-capable devices undergo a wide range of tests in their creation – from development to production – to ensure they operate smoothly. The scope of testing increases when a device needs to operate parallel to other wireless cellular standards, such as LTE/5G.

RF TX and RX characteristics measurements

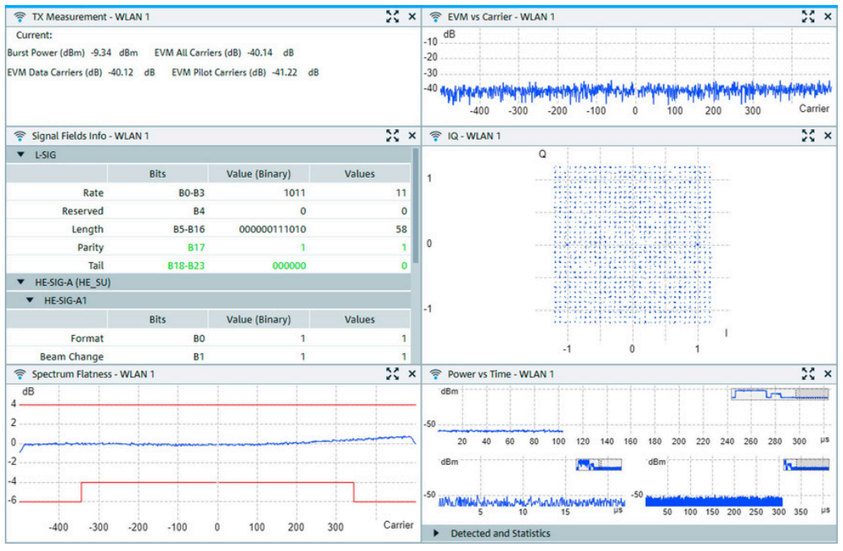
Measurements of RF TXand RXcharacteristics for a WLAN device tested under real-world conditions in signaling mode are vital. While measurements made in the non-signaling mode – an artificial operating mode – can be used to save time during production, development and quality control measurements need to be made in signaling mode.

Rohde & Schwarz: a reliable WLAN testing partner

Rohde & Schwarzisa leading supplierof T&M solutions for the wireless communications market and the CMX500 radio communication tester is a universal, flexible platform for testing the latest 5G, LTE and WLAN standards. The CMX500 measures the RF transmit and receive characteristics for the air interface of wireless devices in signaling mode. The CMX500 also evaluates applications, their performance and analyzes protocol stacks.

The powerful CMX500 can measure up to IEEE 802.11be (Wi-Fi 7) in all frequency bands and in various operation modes.

Measurements are performed in the workspace. It combines several squares for TX and RX live measurements, data testing, monitoring, DUT control and throughput charts. Users have immediate access to all signaling and measurement parameters within the workspace without leaving the measurement.



WLAN TRANSMITTER AND RECEIVER TESTS

Receivers and transmittersmust function properly and meetstandards. A broadrange of local regulations makethis even tougher.A wide rangeof testsmust be performed early in thedevelopment and design phases to determine receiver sensitivity and transmitter spectral purity.

Multi-evaluation of transmitter characteristics

Transmittercharacteristics must be verifiedto:

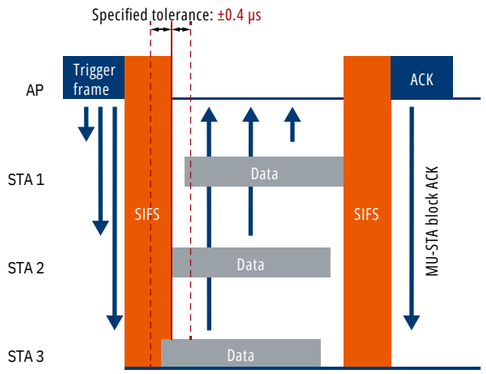
- Determine compliance with legal requirements, such as the maximum permissible transmit power
- Minimize interference with other radio transmissions
- Ensure high user satisfaction through reliable radiocommunications

To verify transmitter characteristics, the CMX500 offers a full range of power, modulation and spectrum RF measurements for IEEE 802.11a/b/g/n/ac/ax/be WLAN standards. The CMX500 platform system architecture helps perform different measurements simultaneously and quickly.

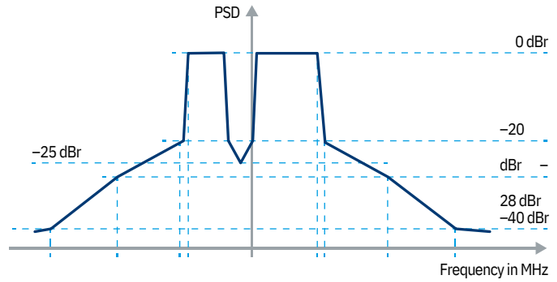
The orthogonal frequency division multiplexing access (OFDMA) method was introduced for WLAN in IEEE 802.11ax and uses the available radio channel much more efficiently. The available bandwidth is divided into resource units (RU) that the access point dynamically assigns to the allocated stations on demand. Multiple users can transmit at the same time. This is a big improvement over previous standards where only one user at a time could access the entire bandwidth.

Uplink OFDMA synchronization

Startingwiththe AP trigger signal, all STAs must synchronously transmit their data packets to the AP within a time of departure accuracy of 0.4 µs.



Punctured spectrum mask (PDS)



Uplink OFDMA synchronization

Efficientparallel operationofmultiple WLAN IEEE 802.11ax and IEEE 802.11be stations requires proper synchronization. When triggered by the access point (AP), all stations (STA) must respond within a short interframe space (SIFS) of 16 µs and within a time tolerance of ±0.4 µs. The CMX500 can reliably measure compliance with this tolerance.

Receiver quality analysis

To check receiver sensitivity, several data packets with specific lengths, content, modulations and power levels are transmitted to the DUT to determine the packet error ratio (PER). As soon as the receiver can successfully decode a data packet, an acknowledgement (ACK) is delivered to the sender. The ACKs from the receiver indicate the quality of the receiver sensitivity.

Limits and their measurement methods are specified when analyzing transmitter and receiver quality. The measurements on the CMX500 platform are implemented in line with relevant specifications.

WLAN END-TO-END TESTING AND PERFORMANCE TESTING

State-of-the-artcommunications devices need topvoicequality,highdatathroughputandbatteriesthat staycharged.TheCMX500can measure allthis andmore.

The CMX500 can test, document and evaluate complex user scenarios under lab conditions. Quality-of-service parameters (delay and jitter), data throughput and other qualitative parameters can be adjusted to determine their impact on an application's quality.

Determining data throughput

As demand grows for moredata throughput, wire- less standards have been forced to evolve. Determining throughput under reproducible lab conditions is vital for development, quality assurance and other benchmarks. The CMX500 can help determine the best possible data throughput when transmitting and receiving, both separately and simultaneously.

Voice over WLAN (VoWLAN)

AllWLANapplications, including voice services, use the internet protocol (IP). Voice signals are converted into IP packets and transmitted with as little packet loss, jitter and delay as possible. Network operators worldwide have discovered the ease of WLAN calling solutions. Even though government authorities and standardization committees do not specify quality standards, users still expect good voice quality, with cellular technologies serving as the benchmark.

In VoWLAN, the voice packets are tunneled through the internet to a gateway provided by the network operator. This gateway links the mobile network to the WLAN connection. A VoWLAN call is based on an IP multimedia subsystem (IMS), an architectural framework for delivering IP multimedia services.

Voice over IP (VoIP)

Other VoIP services also provide voice or video calling but such services are mostly unmanaged and typically deliver best effort quality, in contrast to VoWLAN. Regardless of the speech codec or server, IP data packages are forwarded via the WLAN signaling implementations in the CMX500.

Automation tool

Inpractice,many measurements are automated to ensure that the procedure is always the same, saving lots of time during extensive testing. In end-to-end and performance testing, the setups need to control various devices, which can be complicated. The setups also have to precisely synchronize measurements, analytics and trigger events.

R&S®CMsequencer is an automation tool for simplifying test sequences, executing test scenarios and process- ing the results. The software meets the requirements for remote control test sequences on the CMX500. The convenient GUI allows automated tests to be generated and run without any special programming expertise.

Multifunctional logfile analyzer

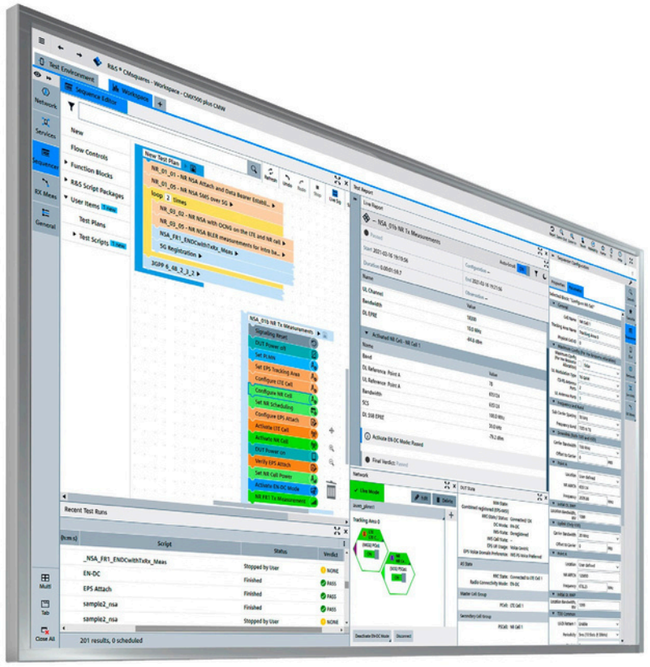
R&S®CMsquareshasa powerful message analyzer for all CMX500 signaling applications. Users can efficiently analyze recorded message logfiles and trace protocol information in real time while a test is running.

R&S®CMsquares also helps with troubleshooting. If the data throughput rate is lower than expected and evaluating the transmitter and receiver fails to provide any clues, the cause is most likely at the protocol level. Numerous views help users quickly find the root cause of problems in the signaling protocols and lower layers.

In-device coexistence interference testing

Modern communications equipment can use several standards in a very small space at the same time. This can generate interference or harmonics from working in the same or adjacent frequency bands. Standard compliant operations and minimal mutual interference are crucial to smooth operations.

Measurements of in-device coexistence determine desensitization (reduction of the RX sensitivity with and with- out strong internal interfering signals). The CMX500 sup- ports simultaneous signaling for LTE/5G and WLAN and can define relative RX sensitivity measurements, making it ideal for measuring coexistence.



R&S®CMsequencer is a graphical scripting interface that enables automated testing for a wide range of use cases. Test sequences can be in an intuitive easy way created, configured and executed.

The CMX500 supports internal speech quality tests with POLQA. The DUT can be connected to the R&S®CMX-ZG180A external media endpoint to evaluate sent and received analog audio signals and the R&S®CMX-KA181 POLQA measurement can analyze speech quality.

COMPLEMENTARY PRODUCTS FROM ROHDE & SCHWARZ

Rohde&Schwarz offers system components for5G NRsignaling testingin theFR2frequency range. In addition to the CMX500,these include antennas,cables, feedthroughs, power sensors, shielding chambers, antenna test systems and remote radio heads. Rohde & Schwarz manufactures all system components in its own plants for optimal system parameters. The following is a detailed overview of some of these products. See the Rohde & Schwarz website for other products.

R&S®CMXHEAD50 AND R&S®CMXHEAD50-Evo REMOTE RADIO HEADS, R&S®CMX-RF42E ACTIVE RF FRONTEND FOR NR FR2

R&S®CMXHEAD50

R&S®CMXHEAD50-Evo

R&S®CMX-RF42E

The R&S®CMXHEAD50 and R&S®CMXHEAD50-Evo are high-end remote radio heads with an exceptionally wide power range for demanding RF applications. Both are designed to extend the CMX500 across the frequency range of 21.84 GHz to 50.2 GHz. They support all key 5G FR2 bands and the Ka band, which is becoming ever more import for non-terrestrial networks. They offer excellent spectral purity and signal fidelity. The R&S®CMXHEAD50-Evo also has industry-leading EVM performance of up to 0.5 % across a wide RF power range, setting a new benchmark for high precision verification and design optimization in the mmWave range. The R&S®CMX-RF42E is the active frontend designed to aggregate signals from up to four remote radio heads in the 21.84 GHz to 50.2 GHz frequency range. By integrating high linearity, low noise amplifiers, R&S®CMX-RF42E significantly extends the system's dynamic range and enhances the signal-to-noise ratio (SNR) across the entire operating band.

R&S®CMQ500 SHIELDING CUBE

R&S®CMQ500 with open drawer

The R&S®CMQ500 shielding cube is a compact and fully integrated solution that covers most 5G devices in various applications. The robust mechanical design ensures reliable measurements in R&D environments. The flexible cube design covers applications for smart devices, CPEs, RFICs and prototypes. The R&S®CMQ500 is ready for 5G and other technologies in the frequency range from 0.7 GHz to 77 GHz. The R&S®CMQ500 can easily be scaled for different DUT sizes and requirements. Small antennas make it easy to test relatively large DUTs in the compact shielding cube. Flexible mounts allow antennas and probes to be mounted and aligned in any position. The mounts have a swivel head to cover various quiet zones.

R&S®CMX-Z25 RF PORT EXTENDER

R&S®CMX-Z25

The R&S®CMX-Z25 is a compact and rack-mountable port extender that doubles the number of CMX500 ports. The R&S®CMX-Z25 expands connectivity options without taking up additional space. It has user-friendly color coding to effectively enhance workflows and manage connections.

R&S®ATS800R RACK BASED CATR ANTENNA TEST SYSTEM

R&S®ATS800R

The R&S®ATS800R rack based compact antenna test range (CATR) is a very compact environment for 5G antenna, module and device characterization in the frequency range from 20 GHz to 50 GHz. It is essential to R&D design verification for both active and passive devices. It has a gold-plated parabolic CATR reflector with rolled edges and a feed antenna. The DUT is placed on the device fixture on the bottom of the anechoic chamber for easy testing. The device fixture allows for flexible DUT mounting inside the 20 cm high quality quiet zone. This can be done using pin holes or threaded holes that match the mechanical interface of Rohde & Schwarz calibration antennas. In combination with the CMX500, it ensures fast and smooth characterization in the mmWave frequency range. The R&S®ATS800R can be expanded with a 3D positioner or a climate option for extreme temperature tests.

R&S®ATS1800C CATR BASED COMPACT 5G NR mmWAVE TEST CHAMBER

R&S®ATS1800C

The R&S®ATS1800C CATR based compact 5G NR mmWave test chamber is a turnkey chamber for far-field OTA RF measurements of 5G devices and components in the frequency range from 6 GHz to 90 GHz. The chamber itself is easily transportable with wheels and has a footprint small enough to pass through most doors, so it easily fits into R&D labs or test houses of all sizes. Inside the fully shielded chamber is a compact antenna test range (CATR) consisting of a feed antenna, a bidirectional parabolic reflector and a 3D positioner. The parabolic reflector is specially designed and manufactured with optimized rolled edges for well distributed collimated beam power after reflection. Moreover, the reflector has extremely high-precision surface roughness to minimize errors introduced by the reflection. This allows the reflector to be used in a very wide frequency range for accurate measurement results.

ORDERING INFORMATION

Designation	Type	Order No.
Base unit		
Radio communication tester; instrument with following accessories: power cords, operating manual (getting started), R&S®CMX-B300A cables, R&S®CMX-PB70B cables	CMX500	1201.0002K70
Hardware options		
CMX500 basic assembly	R&S®CMX-PB70H	1222.0676.0
CMX500 accelerator unit	R&S®CMX-B200A	9
CMX500 processing unit	R&S®CMX-B300C	1222.0747.0
CMX500 IF unit	R&S®CMX-B500A	2
CMX500 RF unit	R&S®CMX-B600B	1222.0801.0
Software options		4
WLAN signaling, IEEE 802.11a/b/g/n/ac	R&S®CMX-KS350B	1222.7064.0
WLAN signaling, IEEE 802.11ax, STA test	R&S®CMX-KS351B	2
WLAN signaling, IEEE 802.11be, STA test	R&S®CMX-KS352B	1222.7058.0
WLAN signaling, 2x2 MIMO	R&S®CMX-KS360B	3
WLAN TX measurements, IEEE 802.11a/b/g/n/ac	R&S®CMX-KM350	1222.7087.0
WLAN TX measurements, IEEE 802.11ax	R&S®CMX-KM351	2
WLAN TX measurements, IEEE 802.11be	R&S®CMX-KM352	1222.7112.0
WLAN TX measurements, True MIMO	R&S®CMX-KM360	2
LTE analyzer	R&S®CMX-KM500	1222.7135.0
5G NR analyzer	R&S®CMX-KM600	2
5G NR generator	R&S®CMX-KW601	1222.7141.0
NR signaling, NSA mode enabler Basic level, 2x2 MIMO and 4x4 DL (one CC only), 256QAM UL	R&S®CMX-KS600B	2 1222.7158.0
NR signaling, NSA mode enabler Medium level, 2x2 MIMO and 4x4 DL (one CC only), 256QAM UL	R&S®CMX-KS600M	1222.1650.02 2 1222.7164.0
NR signaling, NSA mode enabler Xpert level, 2x2 MIMO and 4x4 DL (one CC only), 256QAM UL	R&S®CMX-KS600X	1222.1695.02 2
NR SIG extension Basic, UL 2x2 MIMO, CA up to 8CC	R&S®CMX-KS610B	1222.3709.02
NR SIG extension Medium, UL 2x2 MIMO, CA up to 8CC	R&S®CMX-KS610M	2 1222.3717.02
NR SIG extension Xpert, UL 2x2 MIMO, CA up to 8CC	R&S®CMX-KS610X	1222.3723.02
NR signaling extension Basic, SUL and Rel. 16 features	R&S®CMX-KS611B	1222.4013.0 2 1222.3730.02
NR signaling extension Medium, SUL and Rel. 16 features	R&S®CMX-KS611M	1222.3746.02
NR signaling extension Xpert, SUL and Rel. 16 features	R&S®CMX-KS611X	1222.1720.0 2 1222.3752.02
NR signaling extension Basic, CA 9-16 CC	R&S®CMX-KS612B	1222.6574.02
NR signaling extension Medium, CA 9-16 CC	R&S®CMX-KS612M	1222.1672.0 1222.6580.02
NR signaling extension Xpert, CA 9-16 CC	R&S®CMX-KS612X	2 1222.6597.02
NR signaling extension Basic, Rel. 17	R&S®CMX-KS617B	1222.6600.02
NR signaling extension Medium, Rel. 17	R&S®CMX-KS617M	1222.6616.02
NR signaling extension Xpert, Rel. 17	R&S®CMX-KS617X	1222.6622.02
Application test feature set 1 (SL)	R&S®CMX-KA100	1222.1595.02
Application test feature set 2 (SL)	R&S®CMX-KA110	1222.4142.02
IP traffic analysis (SL)	R&S®CMX-KA150	1222.4159.02
Audio enabler	R&S®CMX-KA180	1222.4165.02
Audio POLQA measurements	R&S®CMX-KA181	1222.4936.02
NR LBS server, basic set 1	R&S®CMX-KA190B	1535.5874.02
NR LBS server, Rel. 16 feature	R&S®CMX-KA191	1222.5861.02
NR LBS OTA GNSS framework	R&S®CMX-KA195	1537.4198.02

Designation	Type	Order No.
Remote radio heads (RRH)		
Remote radio head for CMX500	R&S®CMXHEAD50	1201.0002K7
Hardware unit for R&S®CMXHEAD50	R&S®CMXH-B73B	6
Advanced TRX unit for signaling for R&S®CMXHEAD50-Evo	R&S®CMXH-B73C	1430.9106.03
High-class synthesizer for R&S®CMXHEAD50-Evo	R&S®CMXH-B74A	1430.9106.04
Housing for R&S®CMXH-B74A	R&S®CMXH-B76A	1430.7555.02
Extended frequency range up to 50 GHz	R&S®CMXH-K50G	1430.7710.02
Enable low noise RX input port (port label: "Rx Low Noise In")	R&S®CMXH-K51RX	1222.6568.02
Remote radio head connection cable, length: 3 m	R&S®CM-Z30A	1222.6551.02
Active RF frontend		1212.1040.02
Active RF frontend for NR FR2, extension	R&S®CMX-RF42E	1441.3004K02
Extras		
	R&S®CMX-Z01	1222.3917.0
5G NR UICC test SIM	R&S®CMX-ZG100A	2
Monitor	R&S®CMX-Z101A	1222.3100.0
Monitor mount	R&S®CMX-ZG501A	2
CMX500 transport case	R&S®CMX-ZG180A	1222.3098.0
External media endpoint (USB sound card)	R&S®CMX-Z25	2
RF port extender, 8 GHz, N connector		1222.3075.0
		2
		1222.4313.0
		2
		1230.0007.0
		2

Software maintenance contracts

Designation	Type	Order No.
Software maintenance for application test	R&S®CMX-PU100	1222.5690.81
Software maintenance for LBS server	R&S®CMX-PU190	1222.4488.81
Software maintenance for NR Basic and Medium level test scenarios	R&S®CMX-PU600	1222.4036.81
Software maintenance for NR Xpert level test scenarios and test cases	R&S®CMX-PU601	1222.4042.81
Software maintenance for NR signaling	R&S®CMX-PU610	1222.4059.81

Your local Rohde & Schwarz expert will help find the best solution for you.
Contact your local Rohde & Schwarz sales office for more information.

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- personalized Customized
- and flexible
- Uncompromising quality
- Long-term dependability

Rohde & Schwarz

TheRohde & Schwarz technology group is among the trail-blazers when it comes to paving the way for a safer and connected world with its leading solutions in test & measurement, technology systems and networks & cybersecurity. Founded more than 90 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

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- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

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ISO 9001

Certified Environmental Management
ISO 14001

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PD 5216.4127.12 | Version 07.00 | August 2025 (ch)
CMX500 Radio Communication Tester
Data without tolerance limits is not binding | Subject to change