R&S®TS8996
RSE TEST SYSTEM

Radiated spurious emission measurements on wireless devices

Product Brochure
Version 01.00

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AT A GLANCE

All wireless devices must be tested for radiated spurious emissions (RSE) to verify compliance with national and international standards such as ITU, ETSI and FCC. The configuration required is similar to an EMI measurement setup, with the additional challenging task of measuring the low level spurious emissions in presence of the carrier frequency of a wireless device. The R&S®TS8996 RSE test system handles these tasks with a single setup and covers all relevant carrier frequencies and bandwidths used in wireless communications.

In general a RSE test system is very similar to a commercial EMI testing system in a fully anechoic room (FAR) or a semi-anechoic chamber (SAC). However, RSE standards typically require measurements from 30 MHz up to 12.75 GHz, 26 GHz or 40 GHz. Another difference is the capability to use a spectrum analyzer. Nevertheless, most RSE systems include an EMI test receiver because they combine RSE and EMC tests.

RSE measurements require high sensitivity for emissions in the presence of the DUT's carrier frequency. Active transmitting DUTs can easily cause overload and saturation effects in the receive path due to the high sensitivity required. The standards define an exclusion range around the carrier, typically 250 % of the signal bandwidth. Modern communications technologies utilize many carrier frequencies and bandwidths. This results in a multitude of exclusion bands that have to be covered by state-of-the-art RSE test systems without extensive retuning and recalibration. For this reason, physical carrier suppression using notch filters has become impractical.

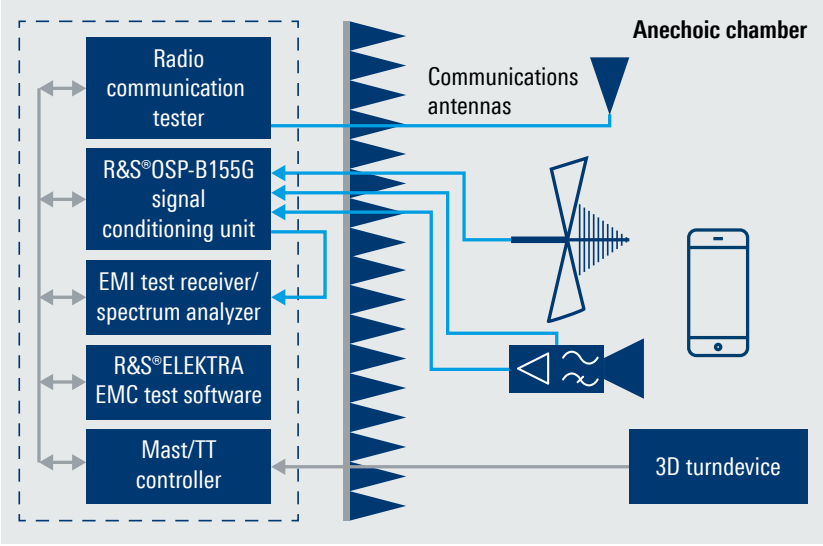
The R&S®TS8996 RSE test system is equipped with an R&S®OSP-B155G signal conditioning unit within the rack and an R&S®TS-PRE2 signal conditioning unit at the antenna mast which can handle carriers up to 26 dBm EIRP without notch filters, covering all carrier bands and bandwidths up to 7.125 GHz with a single setup.

The system can also support multiple carrier configurations and the measurement of emissions in direct proximity of the carrier, out-of-band (OOB) emissions and radiated-band edge (RBE) emissions. Notch filters are only required in the test system when testing high-power carriers.

In addition to an EMI test receiver or a spectrum analyzer, a radio communication tester is also an integral part of the R&S®TS8996 to establish, configure and monitor the communications link via the R&S®ELEKTRA EMC test software and provide a stable over-the-air link for a complete 3D measurement.

As a turnkey solution including installation and training, the R&S®TS8996 has already proven its performance in numerous installations for RSE measurements according to national and international standards such as ITU, ETSI and FCC.

Block diagram of an RSE test system up to 18 GHz in a FAR



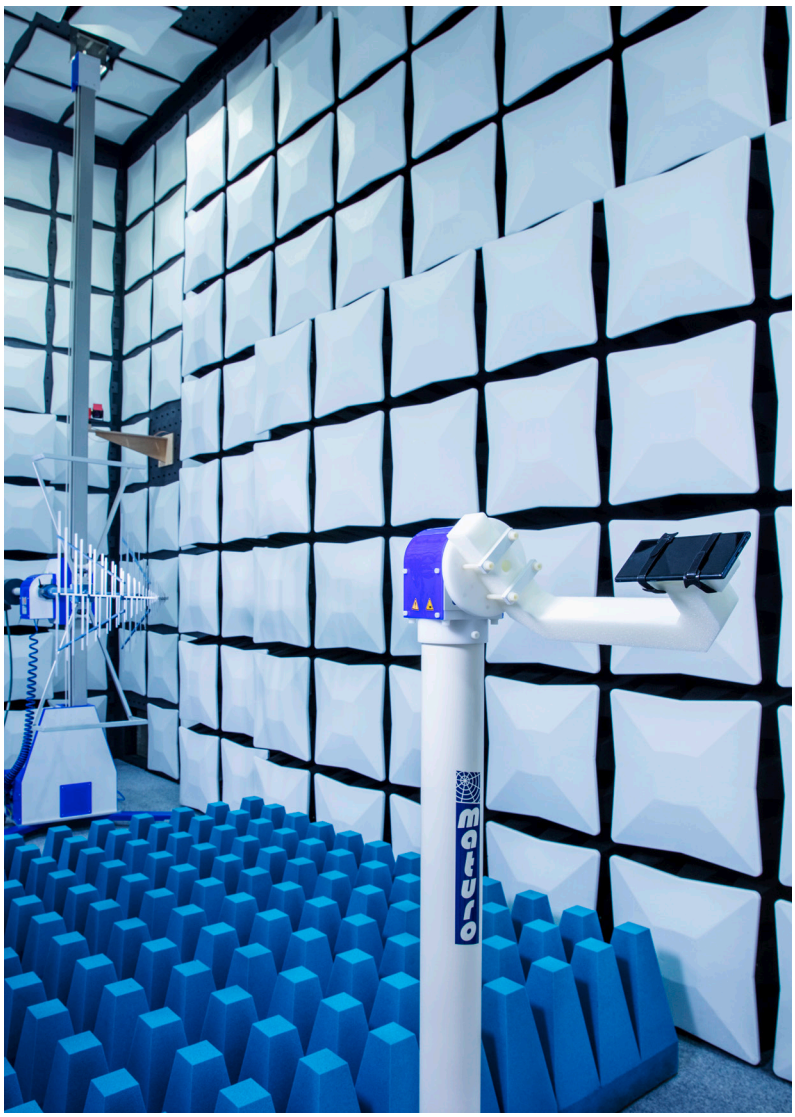
KEY FACTS

- Frequency range from 30 MHz to 18 GHz, 26 GHz or 40 GHz, extendable to 325 GHz
- Handles carriers up to 26 dBm without notch filters
- Compact solution for all DUT bands and bandwidths
- No retuning and recalibration required for band and bandwidth change
- Supports multiple carriers, e.g. 5G NSA mode
- Additional notch filters for high-power carriers
- Integrated signaling for 2G/3G/4G/5G FR1/5G FR2/Wi-Fi®/Bluetooth®
  – easy link configuration and monitoring with R&S®ELEKTRA EMC test software
- Turnkey solution
- Modular design, supports upgrade of existing R&S®TS8996 RSE test systems

BENEFITS AND KEY FEATURES

ONE COMPACT SIGNAL CONDITIONING UNIT FOR ALL CARRIERS

R&S®TS8996 RSE test system covering 2G/3G/4G/5G/Wi-Fi®/Bluetooth®.



Unique technique shifts the signal into the ideal dynamic range of the receiver

The compact 2 HU R&S®OSP-B155G signal conditioning unit in combination with a leveling procedure in the R&S®ELEKTRA EMC test software and the EMI test receiver or a spectrum analyzer shifts the whole signal around the carrier in the ideal dynamic range of the receiver. For frequency ranges up to 1 GHz, the signal can be routed directly from the antenna through the R&S®OSP-B155G to the receiver. The 1 GHz to 18 GHz frequency range uses an additional R&S®TS-PRE2 signal conditioning unit directly at the antenna mast, which either routes the signal to the R&S®OSP-B155G for measurement around the carrier, or at higher frequencies above the carrier. The integrated high pass filters, in combination with a low-noise amplifier directly at the mast, result in excellent sensitivity up to 18 GHz. This covers most common communications technologies such as 3G, 4G, Wi-Fi® and Bluetooth®, as well as Wi-Fi 6E and 5G FR1 with carriers up to 7.125 GHz. The frequency range from 18 GHz to 40 GHz is covered by the R&S®TS-LNA1840 preamplifier unit with included horn antenna in combination with the receiver located in the anechoic chamber.

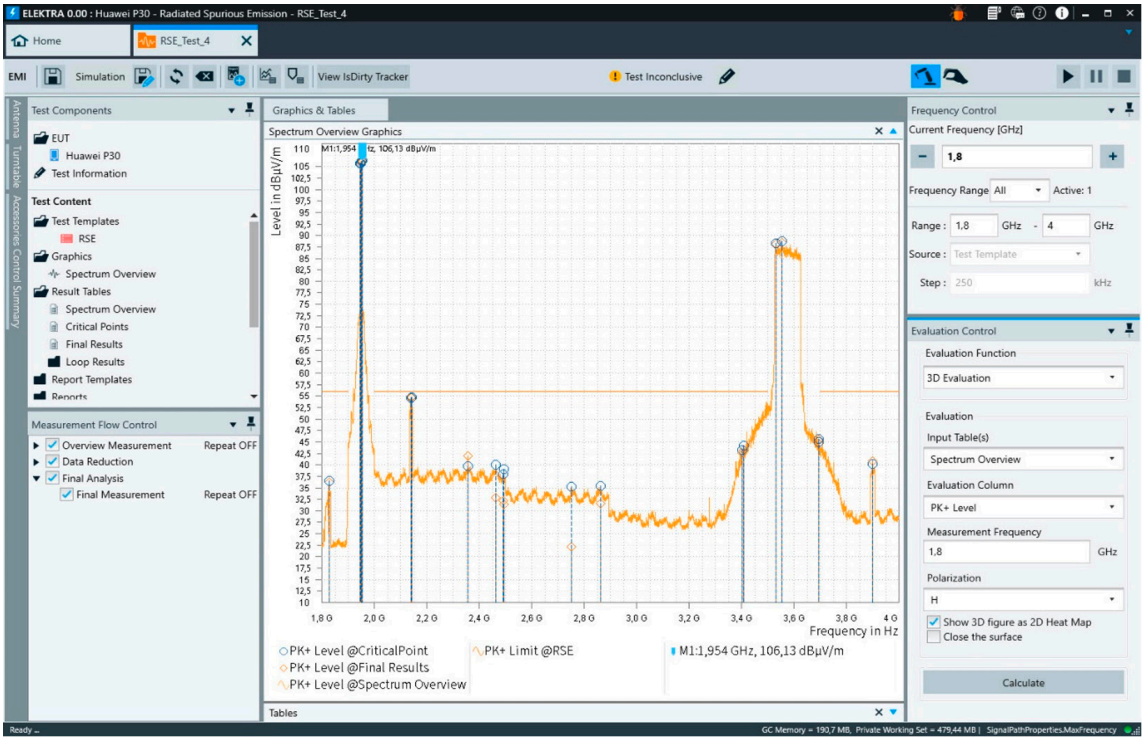
Another advantage of this technique is that it enables RSE measurement of devices with multiple active carriers. This is required, e.g. for 5G FR1 NSA (NSA: non-standalone), with signaling via a 4G link and simultaneous data transmission via 5G (see screenshot below).

High sensitivity measurement mode

When measuring devices in idle mode (without the presence of a carrier signal), the limits specified by ETSI can be even lower than those required for typical EMI tests. For these tests, a high sensitivity measurement mode can be enabled in the R&S®TS-PRE2, using amplifiers with high gain and low noise directly at the antenna.

Leveling with the R&S®OSP-B155G supports carriers in the 400 MHz to 7.125 GHz frequency range and a maximum power of 26 dBm EIRP. For high-power devices, such as 2G, the R&S®OSP-B155G supports additional notch filters, which are integrated into the system rack and switched by the R&S®OSP-B155G or additional R&S®OSP modules. Typically, this option is used for GSM (2G), but high-power devices using other technologies can also be supported.

RSE measurement of a 5G FR1 NSA device with the 4G and 5G carrier present.



COVERS ALL RELEVANT TECHNOLOGIES

Measurement range from 30 MHz to 12.75 GHz/26 GHz/40 GHz

Depending on the carrier frequency, the measurement range required by the different standards varies from 30 MHz up to 12.75 GHz, 26 GHz or a multiple of the carrier frequency to a maximum of 40 GHz.

Frequency ranges up to 18 GHz, covered by the R&S®OSP-B155G and R&S®TS-PRE2 signal conditioning units can be extended to 40 GHz with the R&S®TS-LNA1840 preamplifier unit in combination with the included R&S®TC-HORN40 horn antenna. The frequency, above which the receiver has to be operated in the anechoic chamber and remote controlled via fiber optic link, depends on the RF cable length. This is part of the system design for an R&S®TS8996 RSE test system.

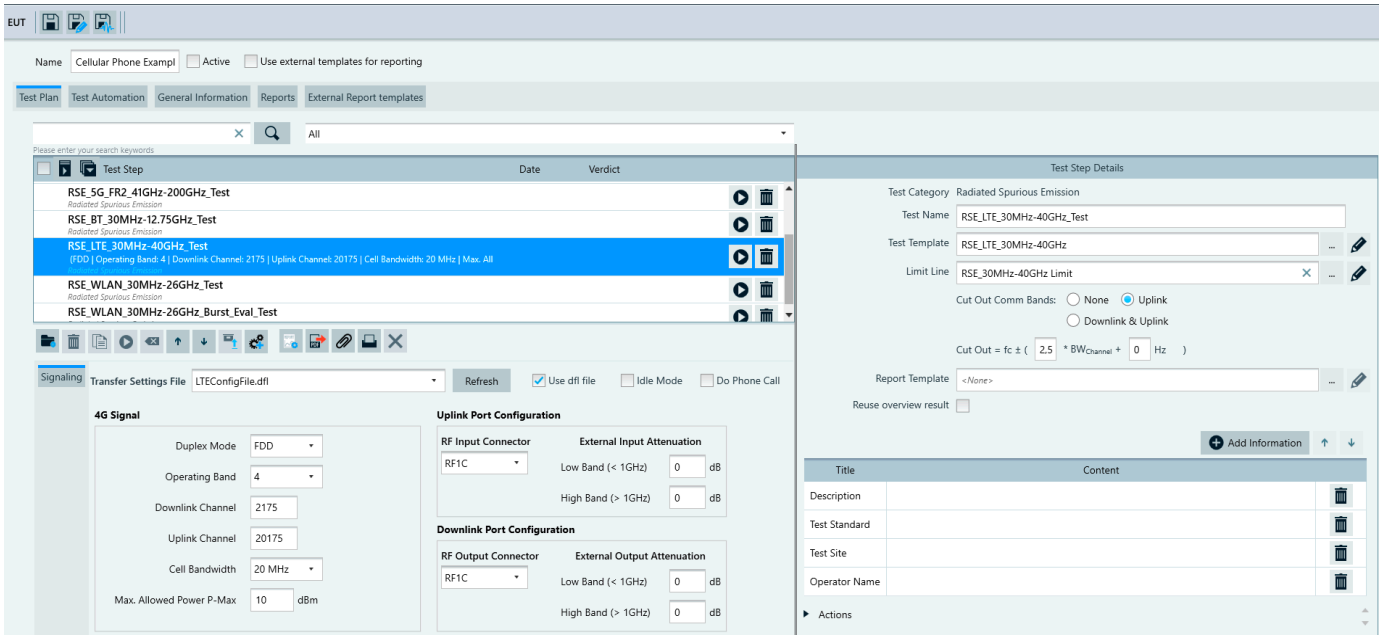
Integrated signaling for 2G/3G/4G/5G/Wi-Fi®/Bluetooth®

Wireless devices that are not in a special test mode require a counterpart to establish a link and transmit data. For user equipment (UE) using the most common technologies, such as 2G, 3G, 4G, 5G FR1, 5G FR2, Wi-Fi®, Wi-Fi 6E and Bluetooth®, radio communication testers such as the R&S®CMX500, R&S®CMW500 and R&S®CMW270 are used to establish, configure and monitor the communications link via the R&S®ELEKTRA EMC test software.

Advantages of integrated signaling:

- The GUI is limited to the configuration parameters relevant for RSE, making configuration easier
- Special configurations, such as those used for prototypes, can be manually defined at the radio communication tester and imported via DFL file
- Automatic cutout of exclusion band in the limit line depending on the selected band, channel and bandwidth. This test configuration for different bands, channels and bandwidths makes it easy to create test plans for a DUT.

Configuration of link parameters in R&S®ELEKTRA.



For 5G, the signaling configuration supports standalone (SA) and non-standalone (NSA) modes with additional 4G carrier as well as FDD and TDD.

In R&S®ELEKTRA, the same signaling for all technologies can be used not only for RSE, but also for other EMI and EMS tests on wireless devices in accordance with ETSI EN 301 489, for example. This includes monitoring the link quality by throughput, error rate or audio breakthrough, in the case of EMS testing.

For other technologies, users can define and set up the link control using the generic DUT monitoring interface in R&S®ELEKTRA.

Stable over-the-air link

The DUT is moved in azimuth and in many cases also elevation. Due to the radiation pattern of the DUT, large variations in the communications link level in uplink and downlink are common. In addition, the tolerable uplink and downlink levels depend on the technology and have to be adopted accordingly.

A stable over-the-air link is important for efficient RSE measurements, as every loss of link causes interruption of the measurement and may require manual interaction.

The R&S®TS8996 achieves a stable communications link with separate low gain spiral antennas for the uplink and downlink and the configurable, remote controlled R&S®TS-LINK amplifier. It allows gain to be adapted separately for the uplink and downlink, depending on the technology in several gain steps so that the different wireless standards can be covered.

FREQUENCY RANGE EXTENSION UP TO 325 GHz FOR RSE OF MICROWAVE DEVICES

Measurements up to the 5th harmonic

Devices transmitting in the microwave range require RSE measurements beyond 40 GHz. Examples are 5G FR2 which requires measurements up to the 5th harmonic at a maximum of 200 GHz according to the FCC, or UWB devices requiring measurements up to 260 GHz. ERC Recommendation 74-01 for "Unwanted emissions in the spurious domain" defines measurement ranges with upper frequencies as high as 300 GHz.

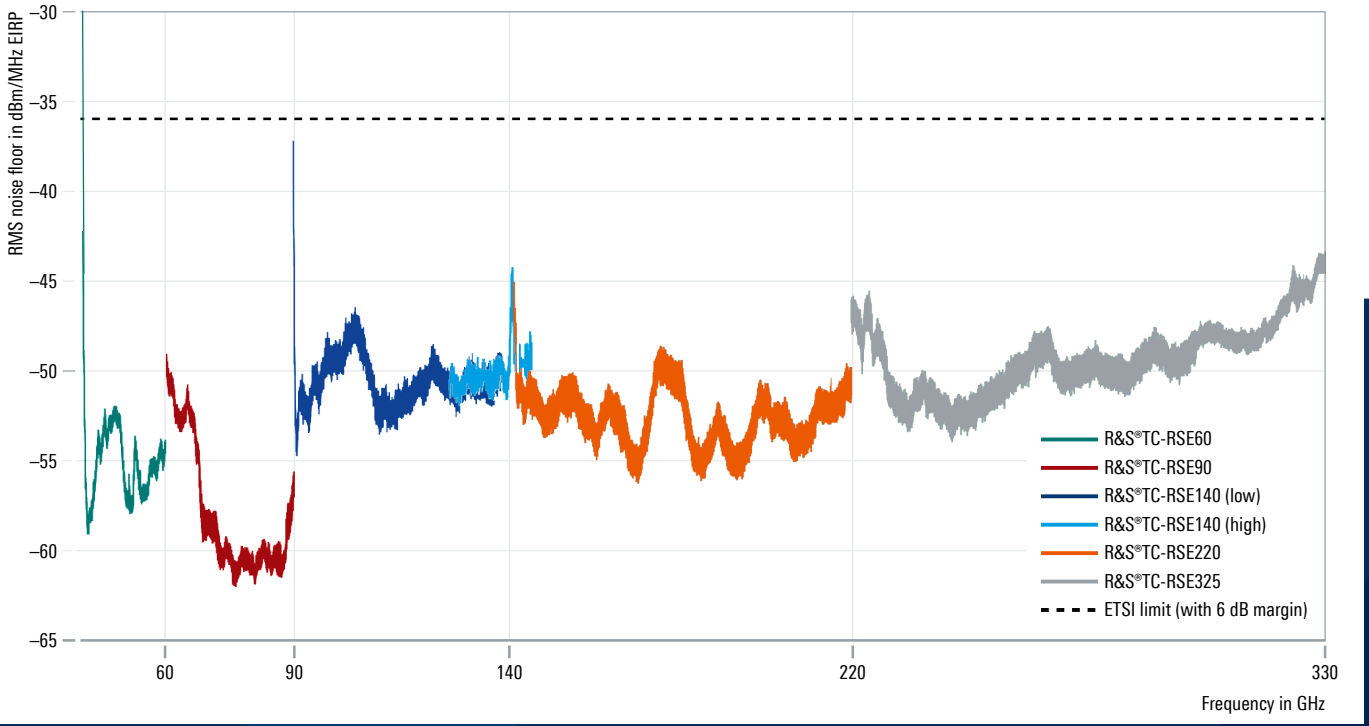
To meet this requirement, the frequency range of the R&S®TS8996 can be extended to 325 GHz using R&S®TC-RSE receive units and R&S®TC-MX multiplier units. The conversion units are connected to the R&S®ESW EMI test receiver or a Rohde&Schwarz spectrum analyzer through an R&S®ESW-B21 or R&S®FSx-B21 LO/IF port for connection to an external mixer and controlled via an R&S®OSP-B153B module. When combined with the R&S®SMB100A microwave signal generator, the multiplier units make it easy to perform a system check and calibrate the receive level of the system.

A very high sensitivity of better than –40 dBm/MHz at 1 m test distance ensures that the RSE limits are met with a sufficient signal-to-noise ratio and supports early pass/fail criteria, which speeds the measurement process (see figure below). R&S®ELEKTRA supports dedicated measurement routines for this frequency range, e.g. total radiated power (TRP) with two and three orthogonal cuts and full TRP for spurious emissions. The frequency range starts at 41 GHz to suppress carriers up to 40 GHz using the 30 MHz to 40 GHz setup for the R&S®TS8996.

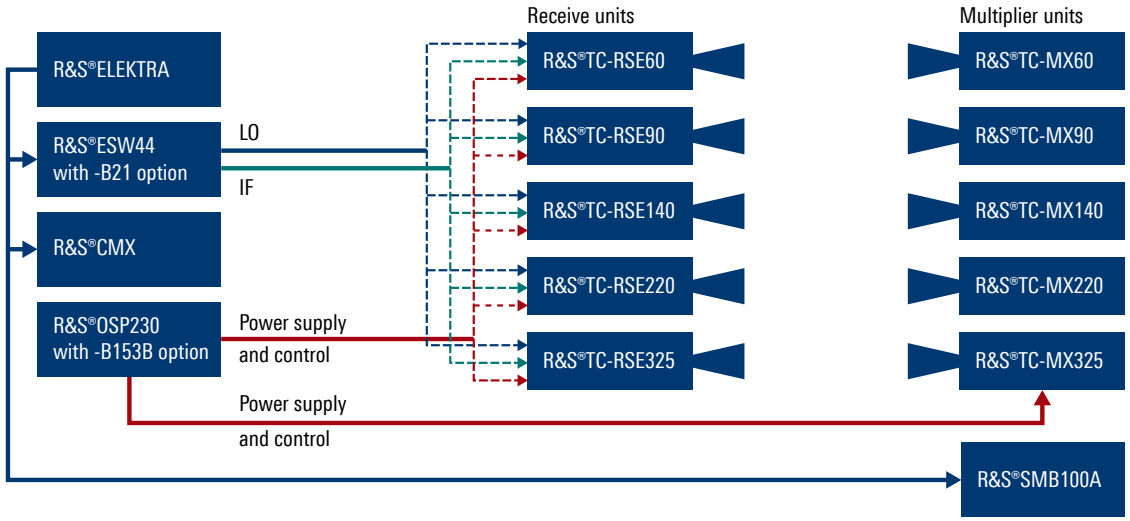
Automatic measurements with an electrical antenna positioner (EAP)

If an electrical antenna positioner is added, the frequency range from 41 GHz to 325 GHz can be measured automatically over all bands and polarizations, including an optimization of the x-y antenna position loop prior to the final measurement. Alternatively, the conversion units can be mounted on tripods or other masts.

Typical R&S®TS8996 sensitivity above 40 GHz



Receive and multiplier units to extend the frequency range of the R&S®TS8996 up to 325 GHz



R&S®TS8996 setup for frequencies above 41 GHz with automatic positioner for frequency and polarization change.

SUPPORTS ALL RSE RELATED TEST PROCEDURES WITH R&S®ELEKTRA EMC TEST SOFTWARE

Extensive software support, including different chamber configurations and interactive analysis tools enable a high degree of automation for all relevant test procedures.

RSE, OOB, RBE and substitution measurements

The R&S®TS8996 supports the test procedures relevant for measurements in connection with RSE:

- Substitution measurement, as described in RSE standards such as ETSI and FCC, is implemented as an additional, optional test step. As an alternative to substitution measurement, distance correction is applied to a height scan using a boresight mast in a precalibrated setup.
- Trigger on pulse as a final measurement for RLAN devices, as required by several ETSI standards, is supported
- Out-of-band (OOB) and radiated-band-edge (RBE) measurements directly around the carrier are supported by dedicated routines

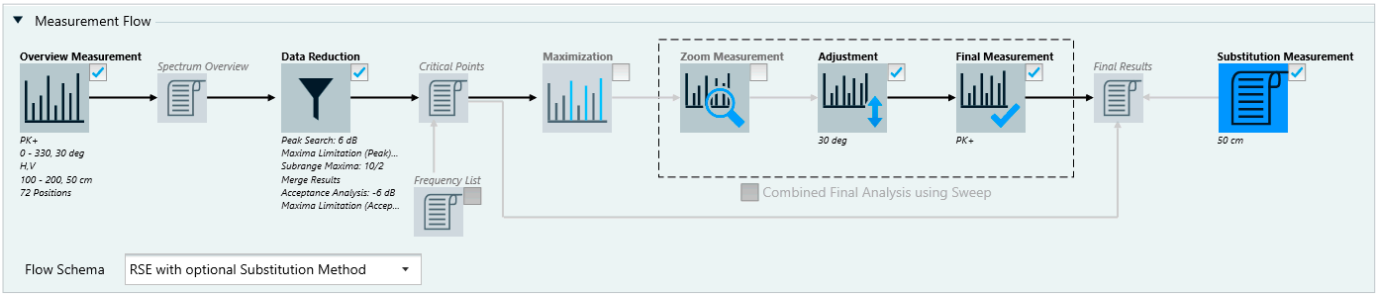
Different chamber configurations

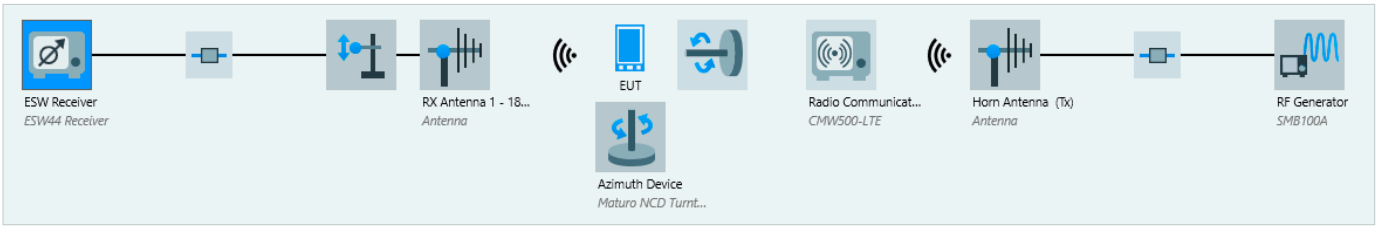
Different chamber configurations are supported, depending on the available chamber, DUTs and standards to be applied:

- Fully anechoic room (FAR) with 3D DUT positioner
- Semi-anechoic chamber (SAC) with height scan, with or without boresight mast
- Combinations of both configurations

In addition, the R&S®TS8996 supports positioning of more than one antenna around the turntable and simultaneous multiband or dual polarization measurement with up to four receivers, which speeds measurement times significantly.

Substitution measurement setup

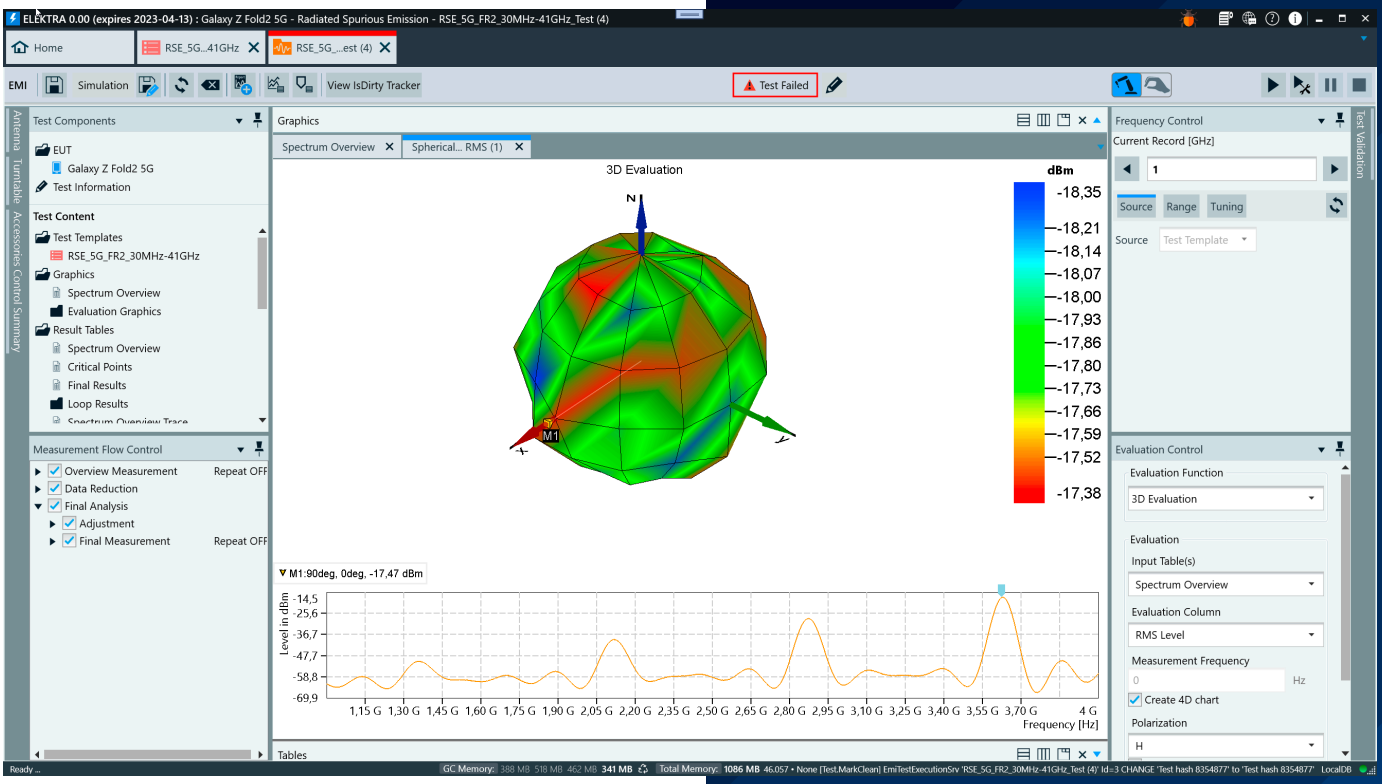




3D measurement and level visualization

For easy evaluation of measurement results, the 3D data of a spherical (FAR) or cylindrical (SAC) measurement can be saved. Graphical interactive analysis of these radiation patterns provides a quick overview of DUT behavior.

3D evaluation with level visualization



INSTALLATION AND TRAINING

Single point of contact ensures efficient testing and fast test readiness

With the R&S®TS8996, you get a system solution that includes consulting, planning, integration, acceptance and training – all from a single, reliable manufacturer. Not only the system design, but also the critical components such as signal conditioning, test software, test receiver or spectrum analyzer, antennas and radio communication tester are all genuine Rohde&Schwarz products. This ensures optimal performance and interfacing, enabling the best performance for complex measurements. Our system engineers ensure the correct and seamless on-site integration of your RSE test system and provide professional training.

Together, these benefits ensure a system that is up and running quickly and ready to test without the risks associated with a solution cobbled together from different standalone components.

Proven solution

RSE turnkey solutions based on the R&S®TS8996 have been setting the market standard for more than ten years with a multitude of installations worldwide. It is the only system to offer its unique level-shifting technique and signaling pre-integrated into the test software.

Modular design allows upgrades

The modular system design not only allows flexible configuration to customer requirements, but also enables easy subsequent upgrades with options such as extended frequency range or additional technologies.

Existing EMC test systems can also be upgraded with an R&S®TS8996 to add wireless device testing capability.

Extending the R&S®TS8996 to cover EMS and conducted EMI testing for wireless devices creates a single solution for all RSE and EMC tests. When combined with the R&S®TS8997 wireless measurement system, it even covers all regulatory tests for RLAN devices (e.g. Wi-Fi® and Bluetooth®).

ORDERING INFORMATION

Designation	Type	Order No.
Radiated spurious emission (RSE) test system	R&S®TS8996	1119.4544.02
Main components		
Signal conditioning unit, 30 MHz to 8 GHz	R&S®OSP-B155G	1515.5640.06
Signal conditioning unit, 1 GHz to 18 GHz	R&S®TS-PRE2	1507.3287.32
Signal conditioning unit, 18 GHz to 40 GHz (extendable to 50 GHz with R&S®TS-PRE-B1)	R&S®TS-PRE1850	1538.5898.02
Preamplifier unit, 18 GHz to 40 GHz, R&S®TC-HORN40 horn antenna included (extendable to 50 GHz with R&S®TS-PRE-B1)	R&S®TS-LNA1840	1536.6100.04
Antenna, 40 GHz to 50 GHz, for R&S®TS-PRE1850	R&S®TS-PRE-B1	1538.5975.02
Receive units		
41 GHz to 60 GHz	R&S®TC-RSE60	1538.5700.02
60 GHz to 90 GHz	R&S®TC-RSE90	1538.5717.03
60 GHz to 93 GHz	R&S®TC-RSE90	1538.5717.02
90 GHz to 145 GHz	R&S®TC-RSE140	1538.5723.02
145 GHz to 220 GHz	R&S®TC-RSE220	1538.5930.02
220 GHz to 325 GHz	R&S®TC-RSE325	1538.5952.02
Multiplier units		
41 GHz to 60 GHz	R&S®TC-MX60	1538.5746.02
60 GHz to 90 GHz	R&S®TC-MX90	1538.5752.03
60 GHz to 93 GHz	R&S®TC-MX90	1538.5752.02
90 GHz to 138 GHz	R&S®TC-MX140	1538.5769.02
138 GHz to 220 GHz	R&S®TC-MX220	1538.5775.02
220 GHz to 325 GHz	R&S®TC-MX325	1538.5946.02
Adapter for up to four receive units, for Maturo EAP positioner	R&S®TC-RSEPOS	1538.5781.02
Tripod adapter, for R&S®TC-RSE receive units, with manual polarization control	R&S®TC-RSESGL	1538.5798.02
Tripod adapter, for R&S®TC-RSE receive units	R&S®TC-RSEADP	1538.5917.02
Laser kit, for adjustment of R&S®TC-RSE receive units and R&S®TC-MX multiplier units	R&S®TC-RSELAS	1538.5923.02
Software options		
EMI advanced system test software package	R&S®ELEMI-EAS	5601.0382.02
Radiated spurious emission measurements	R&S®ELEMI-RSE	5601.0253.02
3D results evaluation	R&S®ELEMI-3D	5601.0260.02
EMC extension for cellular signaling	R&S®ELEMS-CELS	5601.0699.02
EMC extension for wireless signaling	R&S®ELEMS-WRLS	5601.0701.02
5G signaling for R&S®CMX500	R&S®ELEMC-5GS	5601.0276.02
EMI extension 5G RSE measurements in line with FCC	R&S®ELEMI-5GFC	5601.0682.02
EMI out-of-band measurements	R&S®ELEMC-OOB	5601.0724.02
Documentation		
R&S®TC-RSE60 accredited calibration	R&S®ACATCRSE60	3599.0299.03
R&S®TC-RSE90 accredited calibration	R&S®ACATCRSE90	3599.0301.03
R&S®TC-MX60 accredited calibration	R&S®ACATCMX60	3599.0247.03
R&S®TC-MX90 accredited calibration	R&S®ACATCMX90	3599.0253.03

For more details on the components of the R&S®TS8996 refer to the R&S®TS8996 RSE test system components data sheet (PD 3609.9628.22).

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Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

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PD 3609.9628.12 | Version 01.00 | June 2023 (jr)
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Data without tolerance limits is not binding | Subject to change

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