

SITE TESTING AND TROUBLESHOOTING IN 5G MOBILE NETWORKS



Application Brochure
Version 02.00

ROHDE & SCHWARZ

Make ideas real



CONTENTS

- Your situation**.....3
- Your task**.....4
 - Installation/acceptance tasks.....4
 - Troubleshooting steps.....4
- Rohde & Schwarz solution**5
 - R&S®Cable Rider ZPH cable and antenna analyzer in combination with
 - Rohde & Schwarz spectrum analyzer5
 - Rohde & Schwarz 5G site testing solution (5G STS)5
 - 5G QualiPoc Android software on smartphone5
- Results**.....6
 - Cable/antenna tests.....6
 - Basic RF parameter OTA, frequency domain6
 - Basic RF parameter OTA, time domain6
 - Demodulation and decoding.....7
 - Measuring FR1 and FR2 in parallel with two antennas.....7
 - PCI and beam-centric measurements8
 - 5G NSA measurements.....8
 - Synchronization/timing measurements (ToA).....8
 - Synchronization/timing measurements (TAE).....9
 - EMF measurements.....9
 - Indoor measurements.....10
 - Functional tests10
- Key features**11
- Additional information**11
- Ordering information**11



Rohde & Schwarz 5G site testing solution (5G STS).

YOUR SITUATION

Commercial 5G rollout is happening now and more and more 5G non-standalone (NSA) sites are being deployed. Existing LTE infrastructure is being converted into dynamic spectrum sharing (DSS) hybrid sites supporting 5G. An increasing number of private regional 5G networks in standalone (SA) mode are going into trial phase.

Each new installation must be commissioned and verified to ensure correct network performance and end-user quality of service. The link to the anchor site (usually low-frequency LTE) needs to be checked in parallel for NSA mode. New latency and reliability requirements are becoming reality in campus networks and need to be verified.

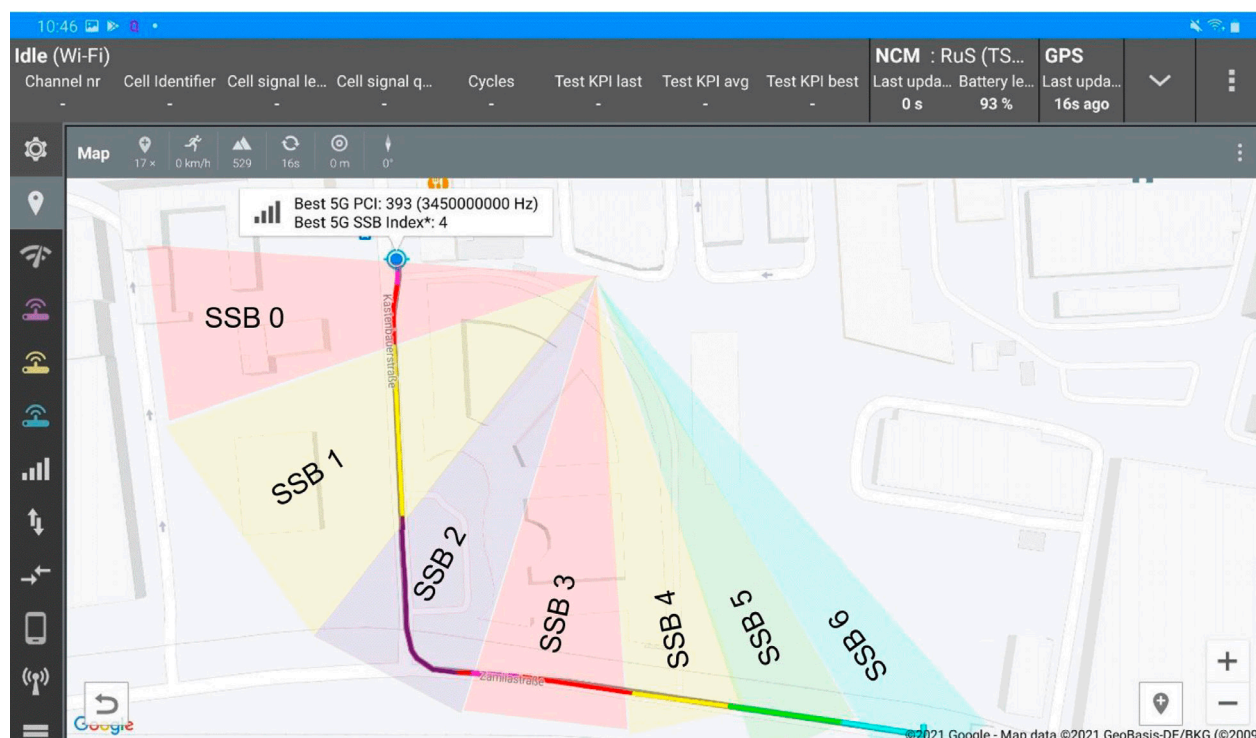
Over-the-air testing is moving into the front line of active antenna system (AAS) testing. The beams are produced directly in the antenna, by a varying number of antenna

elements. This renders some traditional quality metrics, such as EVM (conducted measurements) unreliable indicators of proper working sites. Instead, beam-centric measurements (SINR/RSRP) measured over the air in front of the cell site are now vital. Deployment will be in the FR1 (sub6 GHz) band and in FR2 (microwave, usually 28 GHz and higher). The LTE anchor cell uses the same antenna or even a different tower, making new test tools and procedures necessary.

Site acceptance is by no means trivial. Well-defined test procedures and proper test tools create reliable and efficient results.

This application brochure gives an overview of the required RF tests, groups them into different deployment scenarios and lists the required test equipment.

Best SSB (based on RSRP, number of SSB color coded); 5G site with three sectors and 7 beams per sector.



YOUR TASK

After a 5G site is installed, fundamental cell site performance must be secured, all parameters must be inside a specified range and additional 5G capacity needs to be advertised in the related LTE anchor cells.

Installation/acceptance tasks

- ▶ Check VSWR reflections via OSS counters
- ▶ Ensure PCI and beams are visible in the expected location (SS-RSRP, SS-SINR)
- ▶ Conduct power measurements on the allocated LTE anchor cell (RSRP, SINR, etc.)
- ▶ Make sure timing is correct (synchronization relative to UTC)
- ▶ Perform functional tests for proper integration of 5G cell into complete network
- ▶ Measure the field strength radiated by 5G station (EMF)

Troubleshooting steps

- ▶ If reflection counters indicate problems, measure reflection/DTF with a cable and antenna tester
- ▶ If beams/PCI are not visible, check and correct 5G site configuration file. Check cable and antenna
- ▶ If the 5G cell is not used or throughput is too low, check on LTE-SIB 2 whether 5G cell is advertised
- ▶ If SINR is not as expected, check for internal interference (sidelobes) and external interference
- ▶ When timing is not within limits, check distributed grandmaster clock timing. Make sure no other delays from broken parts are in the chain generating the RF signal

Depending on deployment, some tests cannot be performed or make no sense. OSS can check reflections without a detached antenna but they cannot be verified by an on-site reflection/DTF test.

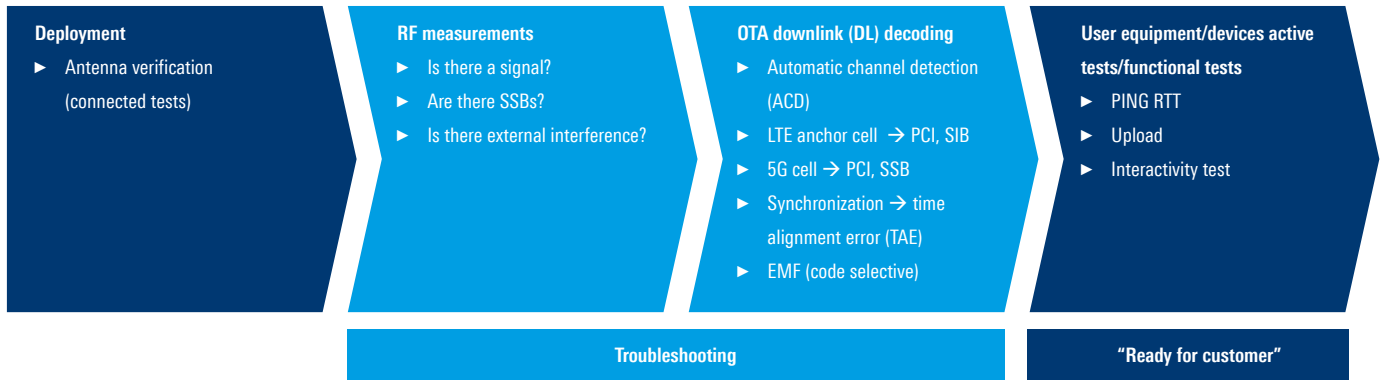
Beam distribution can be very complex in FR2. We have measured cells that distribute 64 beams and can change from one beam to another in just one step.

Beam distribution in a 5G FR2 site.



ROHDE & SCHWARZ SOLUTION

Rohde & Schwarz process



R&S®Cable Rider ZPH cable and antenna analyzer in combination with Rohde & Schwarz spectrum analyzer

This combination is the FR1 solution. (FR2 solution: R&S®Spectrum Rider FPH handheld spectrum analyzer, without cable tests)

- ▶ Occupied bandwidth
- ▶ Spectrum emission mask
- ▶ ACLR
- ▶ Channel power
- ▶ Interference hunting
- ▶ VSWR
- ▶ Distance to fault
- ▶ Optional optical power measurement



R&S®Cable Rider ZPH cable and antenna analyzer.

Rohde & Schwarz 5G site testing solution (5G STS)

- ▶ Automatic channel detection (ACD)
- ▶ PCI and beam-centric:
 - SSS/PSS/PBCH/DM-RS – RSRP
 - RSSI
 - SSS/PSS/PBCH/DM-RS – SINR
 - SSS/PSS/PBCH/DM-RS – RSRO
- ▶ Parallel measurements for LTE and 5GNR
- ▶ Parallel measurements of FR1 and FR2 (FR2 via downconverter up to 44 GHz)
- ▶ Code selective electromagnetic field strength (EMF)
- ▶ Indoor and outdoor distribution of RSRP and SINR
- ▶ Time alignment error (TAE)



Rohde & Schwarz 5G site testing solution.

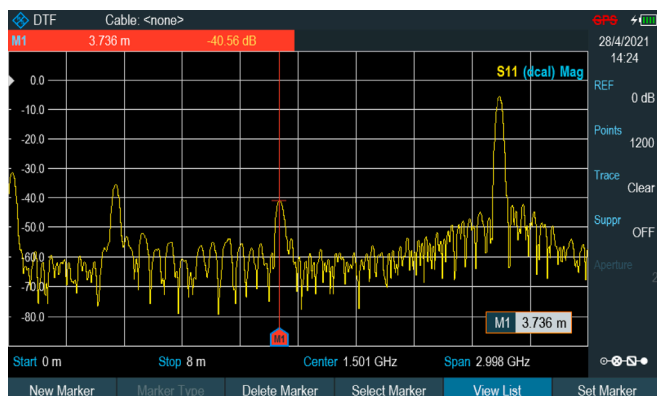
5G QualiPoc Android software on smartphone

- ▶ Uplink parameter
- ▶ Layer one parameters of anchor cell (LTE)
- ▶ Layer one parameters of secondary cell (5G)
- ▶ Scheduled and net throughput (LTE and 5G cell)
- ▶ BLER block error rate (LTE and 5G cell)
- ▶ Layer 3 signaling, MIB and SIB
- ▶ Functional tests (ping, data DL/UL)
- ▶ Dropbox transfer
- ▶ Facebook test
- ▶ Trace route (UDP only)

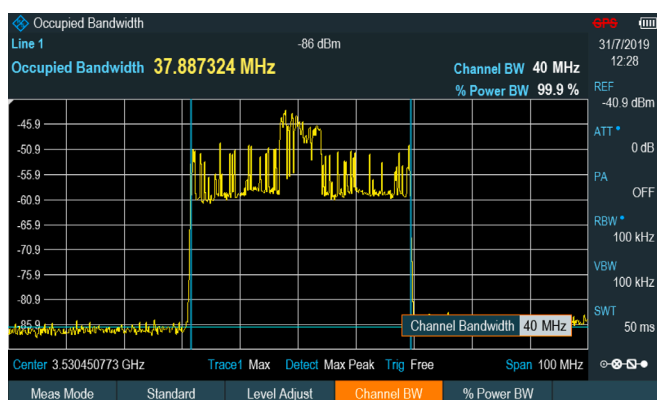


5G QualiPoc Android software on smartphone.

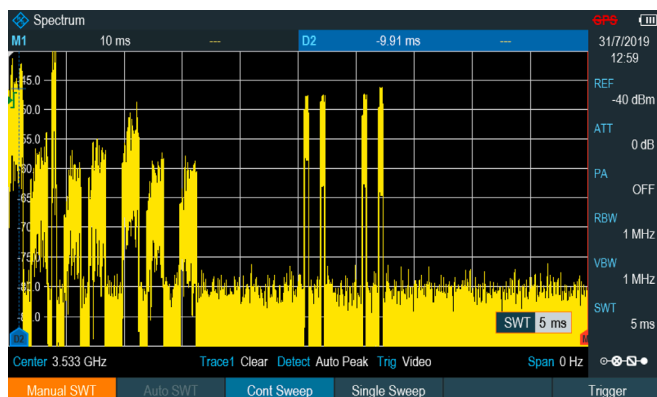
RESULTS



Distance-to-fault measurement with the R&S®Cable Rider ZPH cable and antenna analyzer.



Occupied bandwidth of a 40 MHz 5G NR signal measured over the air with the R&S®Cable Rider ZPH cable and antenna analyzer.



SSB measured over the air in zero span with the R&S®Cable Rider ZPH (additional shorter data/control signals are visible as well).

Cable/antenna tests

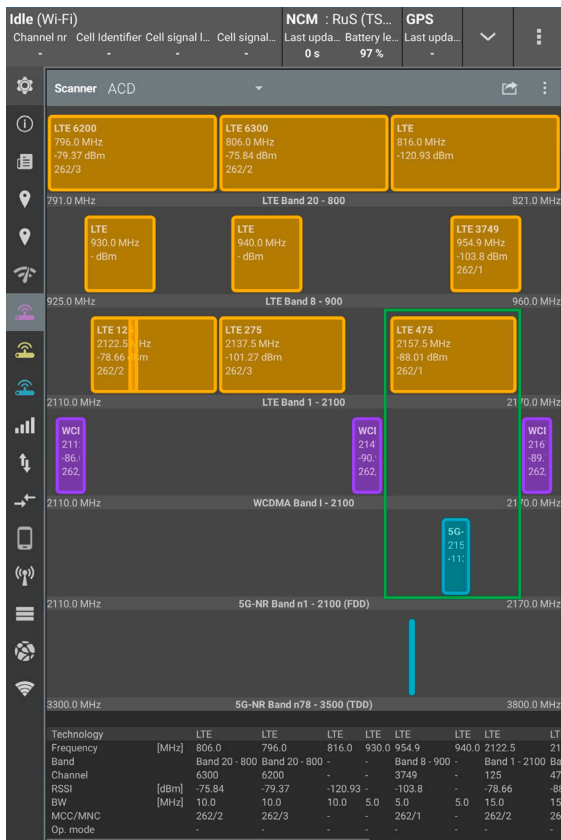
Making sure antenna systems are working smoothly is ever more important in 5G. Since 5G deployment started in older LTE sites with dynamic spectrum sharing (DSS), distance-to-fault and reflection tests are crucial to 5G and LTE network performance.

Basic RF parameter OTA, frequency domain

A spectrum analyzer detects the initial indications of whether a 5G signal is present in the air. A directional antenna pointed to the sector antenna can be used to measure the occupied bandwidth with the maximum hold function. The SSB section is visible in the middle of the spectrum.

Basic RF parameter OTA, time domain

SSBs can be seen in the time domain by going into zero span and using the video trigger. In this example, you can see repeated transmissions of seven beams and some control data. Since this is a non-decoding spectrum measurement, no PCI or SSB indications can be seen.



ACD, showing UMTS, LTE and 5G signals in various bands.

Demodulation and decoding

Rohde & Schwarz 5G STS adds demodulation and decoding to spectrum measurements. Automated channel detection (ACD) displays all legacy and 5G signals. No channel, frequency or SSB position settings are needed. Further information about the signal content can be obtained by reading relevant broadcasting data (MIB and SIB). Even DSS sites (green rectangular) can be detected (band 1 LTE over 5G at same frequency, within a UMTS gap).

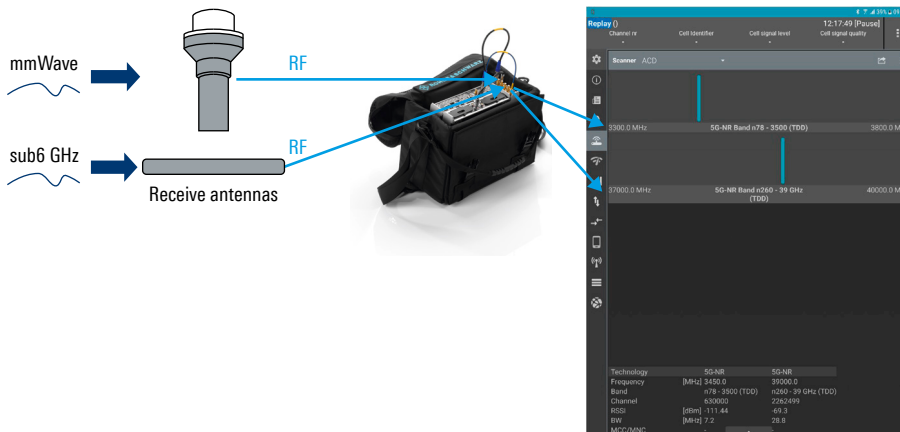
Measuring FR1 and FR2 in parallel, using two antennas



Measuring FR1 and FR2 in parallel with two antennas

By extending the 5G STS with a downconverter, parallel measurements of legacy/5G sub6 GHz signals and 5G FR2 are possible. This retrofit function enables measurement of the sub6 LTE anchor cell in parallel with the 5G FR2 cell.

ACD, showing 5G signals in FR1 and FR2





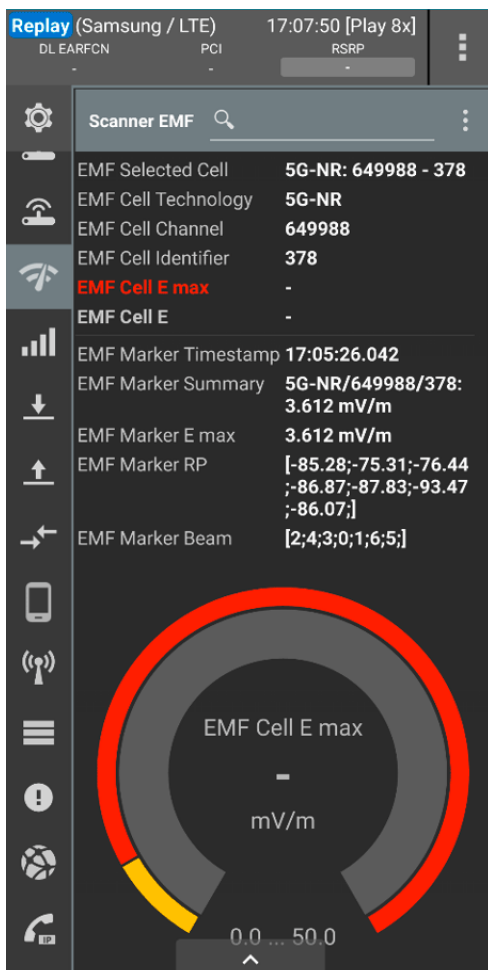
5G signal with time alignment error absolute in relation to UTC.

Synchronization/timing measurements (TAE)

One difference between ToA and time alignment error (TAE) is accuracy. TAE measurements are stationary and have an uncertainty of 50 ns or less, depending on the GNSS quality. TAE is also compared with UTC, meaning it is an absolute time error.

The TAE is determined by measuring when an SSB is received and comparing it with the timing in 3GPP. In the picture, the "Ref. time err. [ns]" is the reference time error in nanoseconds. A typical maximum value is 1500 ns, depending on local agreements between mobile operators and regulators. The frequency error is also measured, showing exact site transmission frequency (Avg. rel. freq. error [ppm]).

The measurements need very good reception conditions for 5G signals and GNSS signals because 10 m uncertainty in the position translates to a 30 ns timing error.

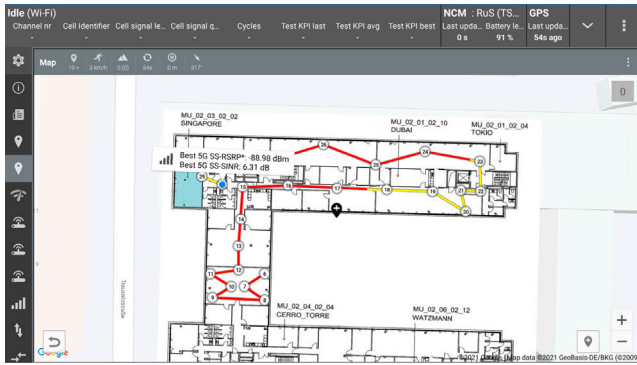


EMF cell (PCI) summary and detail values per SSB.

EMF measurements

Electromagnetic field strength (EMF) measurements are an important tool for increasing public 5G acceptance. The 5G STS offers the most precise EMF measurements. Code selective EMF results can be used to display the contribution of every network component (PCI, SSB).

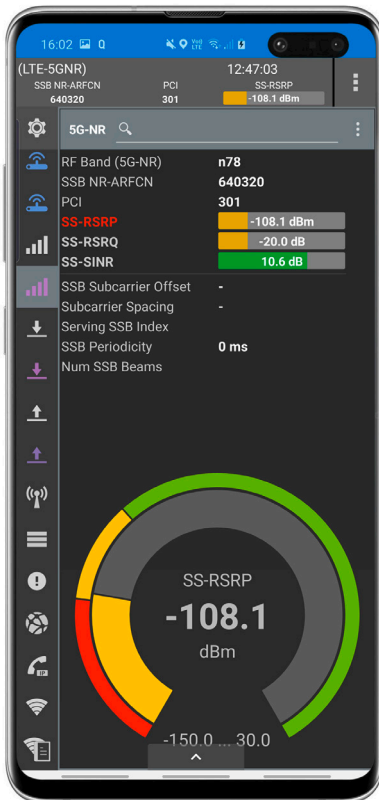
ACD supports the measurements and shows all 5G signals present in an area. One by one the maximum value per component is measured and added to the field strength budget. Once completed, results can be exported and a country-specific extrapolation applied to match the regional limits.



Indoor 5G SS-RSRP.

Indoor measurements

All important measurement values can be displayed/ measured using the indoor feature. Predefined routes or on-the-fly waypoints are distributing the measurements along a path while walking from one waypoint to another. Support of the iBwave file format enables 5G STS to share the results and to import iBwave floor plans.



Phone monitor showing 5G parameters.

Functional tests

Adding a smartphone to the 5G STS allows functional tests such as data uplink or downlink and throughput measurements. Layer 1 parameters and layer 3 signaling can be measured and recorded for further troubleshooting.

KEY FEATURES

The unique test solution from Rohde & Schwarz offers the following features:

- ▶ Automated RF parameter settings via automated channel detection
- ▶ Most sensitive scanner, fast and easy detection of signals even without directional antenna
- ▶ Parallel measurement of LTE anchor cell and 5G cell, no switching time
- ▶ Parallel FR1 and FR2 measurements with two antennas
- ▶ Synchronization measurements for 5G TAE and ToA
- ▶ Code selective 5G EMF measurements
- ▶ Support of legacy technologies (GSM, UMTS, LTE, LTE-M, NB-IoT)
- ▶ Extendable to functional test via 5G phone attached to GUI
- ▶ Spectrum and cable tests with lightweight handheld analyzer
- ▶ Searching for external interference by using the gated trigger of the handheld device

ADDITIONAL INFORMATION

For more information about test and measurement solutions and products (such as the R&S®TSMA6, R&S®TSME30DC, QualiPoc, R&S®Cable Rider ZPH, R&S®Spectrum Rider FPH) discussed in this application brochure, please contact your local Rohde & Schwarz sales office or visit the Rohde & Schwarz website:

www.rohde-schwarz.com/mnt

ORDERING INFORMATION

Designation	Type	Order No.
Autonomous mobile network scanner	R&S®TSMA6	4900.0004.02
Downconverter, up to 30 GHz	R&S®TSME30DC	4901.1004.02
Downconverter, up to 44 GHz	R&S®TSME44DC	4901.2600.02
Smartphone based network optimizer	QualiPoc Android	Please contact your local Rohde & Schwarz sales office.
Handheld cable and antenna analyzer	R&S®Cable Rider ZPH	1321.1211.12
Handheld spectrum analyzer	R&S®Spectrum Rider FPH	1321.1111.26

Service that adds value

- ▶ Worldwide
- ▶ Local and personalized
- ▶ Customized and flexible
- ▶ Uncompromising quality
- ▶ Long-term dependability

Rohde & Schwarz

The Rohde & Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test and measurement, technology systems, and networks and cybersecurity. Founded more than 85 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.

www.rohde-schwarz.com

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

Rohde & Schwarz training

www.training.rohde-schwarz.com

Rohde & Schwarz customer support

www.rohde-schwarz.com/support

