

SIGNAL GENERATION AND ANALYSIS FOR 5G AND BEYOND

Application Brochure | Version 08.00

ROHDE & SCHWARZ

Make ideas real



Rohde & Schwarz has signal generation and analysis solutions that cover up to sub-THz frequencies. Our signal generation and analysis solution portfolio addresses the bandwidth and frequency requirements for 5G and beyond, offering a wide range of features and application software for any testing challenge.





CONTENTS

5G test and measurement challenges

► page 4

Vector signal generators

► page 6

Analog signal generators

► page 8

Signal and spectrum analyzers

► page 10

External frontends

► page 12

Performance vector tester

► page 14

Power sensors

► page 16

5G signal configuration and analysis at your fingertips

► page 18

Solutions for power amplifier development

► page 20

Compensating the effects of test fixtures

► page 22

5G NR base station conformance testing

► page 23

Solutions for high-volume tests and base station production

► page 24

Solution to explore beyond 5G

► page 26

Application software

► page 27

5G TEST AND MEASUREMENT CHALLENGES

Three things distinguish the 5G air interface from previous cellular generations: higher carrier frequencies, wider carrier bandwidths and flexible physical layer parameterization to support different requirements. The impact of these features on 5G product development and testing includes the following areas.



Millimeterwave signal generation and analysis

5G is the first cellular technology to tap into the bandwidth reserves in the centimeterwave and millimeterwave frequency bands. The unique radio properties in these bands make component manufacturing very challenging. To master these challenges, test solutions with excellent RF performance in the millimeterwave range are needed.

Wideband signal generation and analysis

5G supports single carrier bandwidths of up to 100 MHz for carrier frequencies below 7.125 GHz (FR1) and up to 2 GHz for carrier frequencies in the millimeterwave range (FR2). Carrier aggregation makes signal bandwidths in the GHz range relevant in FR1, meaning test solutions with wideband signal generation and analysis capabilities are a must.

Over-the-air testing

The short wavelength of millimeterwave frequencies and the higher circuit losses necessitate tight integration, making it impractical to supply connections for testing. At the same time, the effects of connectors and test fixtures are non-negligible, potentially affecting the validity of conducted measurements. As a result, over-the-air (OTA) testing plays an important role at higher carrier frequencies, which calls for innovative test solutions.

Signal configuration and analysis

The 5G physical layer offers a degree of flexibility never seen before, allowing a multitude of parameter options and combinations. As a result, configuring signals for testing can be complicated, time-consuming and prone to error. Dedicated solutions that simplify and speed up signal configuration for testing and subsequent analysis are needed.

Massive MIMO and beamforming/beam steering verification

5G employs massive MIMO and beamforming to combat the effects of higher attenuation at higher frequencies and improve capacity. Beam steering and beam sweeping are important techniques to cope with the dynamic nature of wireless channels. Test solutions must offer a simple way to verify the beamforming accuracy and the effectiveness of beam steering techniques.

Selected Rohde & Schwarz solutions

Vector signal generators

- ▶ Signal generation up to 72 GHz
- ▶ RF modulation bandwidth up to 10 GHz
- ▶ Base station receiver and performance testing
- ▶ MIMO and beamforming

Analog signal generators

- ▶ Signal generation up to 72 GHz with the highest signal quality and output power
- ▶ LO source, high-power intermodulation tests, blocking tests, test fixture calibration

Signal and spectrum analyzers

- ▶ Signal and spectrum analysis up to 90 GHz
- ▶ Signal analysis bandwidth up to 8.3 GHz
- ▶ Base station transmitter testing

External frontends

- ▶ Cost-effective and fully integrated external front-ends to cover mmWave and sub-THz frequencies
- ▶ OTA tests
- ▶ Beyond 5G/6G R&D

Performance vector testers

- ▶ Integrated vector signal generator and signal analyzer covering all FR1 bands
- ▶ Base station and small cell tests
- ▶ Characterization and production

Power sensors

- ▶ Over-the-air 2D/3D power level calibration and beamforming/beam steering verification up to 170 GHz

Dedicated application software

- ▶ Signal configuration and analysis for 5G NR, generic OFDM and custom parameterizations
- ▶ Amplifier development and characterization
- ▶ Compensating the effects of test fixtures

For more 5G test solutions, see
www.rohde-schwarz.com/5G

VECTOR SIGNAL GENERATORS



The R&S®SMW200A is the vector signal generator for the most demanding applications. Its flexibility, performance and intuitive operation make it ideal for generating high quality, complex, digitally modulated signals. Above is a setup for generating up to four RF output signals with one R&S®SMW200A and two R&S®SGT100A SGMA RF source modules.

R&S®SMW200A vector signal generator

The automatic internal amplitude correction in Rohde&Schwarz vector signal generators provides an extremely flat amplitude frequency response of modulated signals over the entire frequency range up to their maximum rated power (< 0.4 dB measured over 2 GHz bandwidth for the R&S®SMW200A). They also have excellent spectral characteristics, making them ideal for both conducted and over-the-air testing.

The outstanding amplitude and frequency characteristics ensure the generation of extremely clean 5G NR signals (measured error vector magnitude of less than 0.2% on the R&S®SMW200A for a 5G NR downlink signal with 100 MHz bandwidth) to test true DUT performance.

Advanced applications benefit from the full flexibility and scalability of the R&S®SMW200A. It can be configured as a single path instrument up to 67 GHz or as a dual path instrument up to 44 GHz. It allows other Rohde&Schwarz vector signal generators to be cost-effectively used as additional RF outputs. Up to six R&S®SGT100A SGMA vector RF sources can be connected to a single R&S®SMW200A for a compact setup with eight RF outputs, all controlled and configured from the R&S®SMW200A. The setup is scalable and easily duplicated if more RF outputs are required. This is especially useful for beamforming, MIMO, carrier aggregation and multistandard testing.

The R&S®SMW200A also has an optional real-time fading simulator and AWGN generator, making it an excellent one-box solution for base station performance testing and channel emulator for terminal and base station chipset testing.

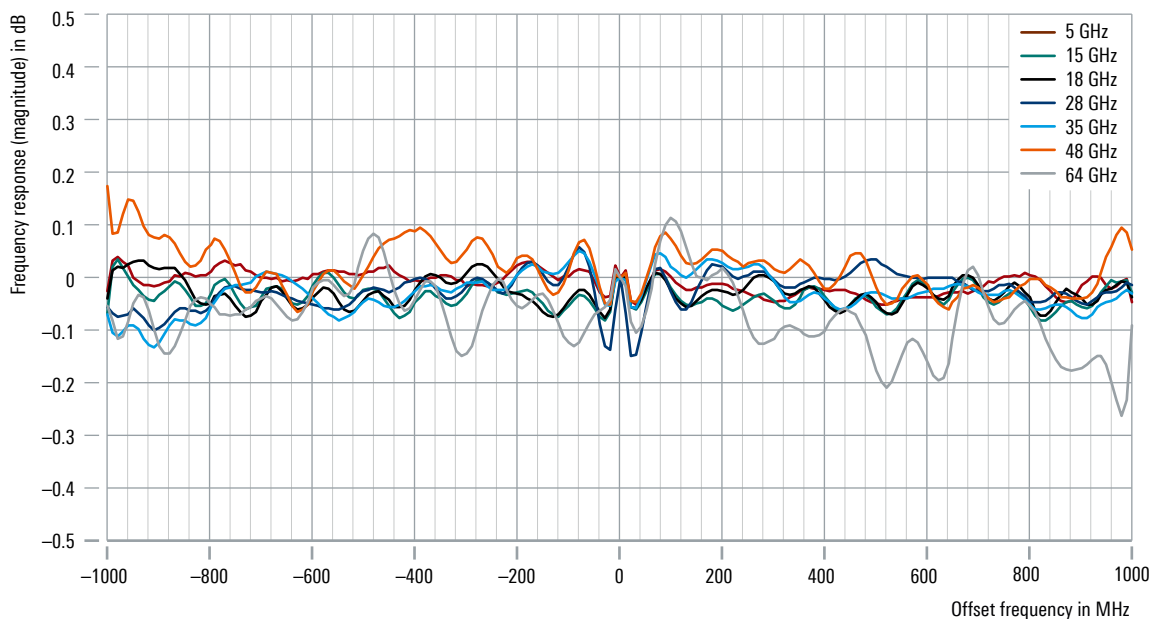
Rohde & Schwarz has a variety of solutions for wideband signal generation applications ranging from research and development to production testing. Our vector signal generators have excellent RF performance out of the box, intuitive user interfaces and a fully flexible hardware and software option concepts.



	R&S®SMW200A	R&S®SMM100A	R&S®SMBV100B	R&S®SMCV100B	R&S®SGT100A
Applications	R&D, integration and verification, conformance testing	R&D, production, integration and verification	R&D, production, integration and verification	Production, automated use, RF extension for R&S®SMW200A	Production, automated use, RF extension for R&S®SMW200A
Frequency	100 kHz to 67 GHz (up to 72 GHz in overrange)	100 kHz to 44 GHz	8 kHz to 6 GHz	4 kHz to 7.125 GHz	1 MHz to 6 GHz
Modulation bandwidth	2 GHz (4 GHz with bandwidth extension)	2 GHz	1 GHz	240 MHz	240 MHz
Channel emulation	optional	–	–	–	–
RF outputs	1 or 2	1	1	1	1
RF output power (1 GHz)	+18 dBm	+18 dBm	+25 dBm (with option)	+20 dBm	+17 dBm

Measured I/Q modulation frequency response of the R&S®SMW200A vector signal generator

The R&S®SMW200A generates extremely flat amplitude frequency response of modulated signals over the entire bandwidth, making it possible to test the true performance of a DUT in both conducted and over-the-air measurements.



ANALOG SIGNAL GENERATORS



The R&S®SMA100B RF and microwave signal generator offers uncompromising performance leadership, delivering the purest signals with the highest output power up to 72 GHz for demanding 5G applications that require extremely clean analog signals. It comes in two form factors for flexible test setups.

R&S®SMA100B RF and microwave signal generator

The R&S®SMA100B RF and microwave signal generator is ideal for all 5G applications that require extremely clean analog signals, such as in component testing, receiver testing and amplifier characterization. When testing analog-to-digital converters (ADC), the R&S®SMA100B generates signals with extremely low jitter and highest available spurious-free dynamic range (SFDR). Specifically for ADC tests with clock signals up to 6 GHz, the R&S®SMA100B has an optional independent clock output with exceptionally low wideband noise for extremely clean clock signals. This eliminates the need for two separate generators, greatly simplifying the test setup.

The combination of high output power, low wideband noise and excellent phase noise performance ensures simple setups for base station receiver blocking tests that bring out the true performance of the receivers under test. In automated production environments, the ultra high output power capabilities of the R&S®SMA100B make additional amplifiers unnecessary and keep harmonics extremely low.

R&S®SMB100B RF signal generator

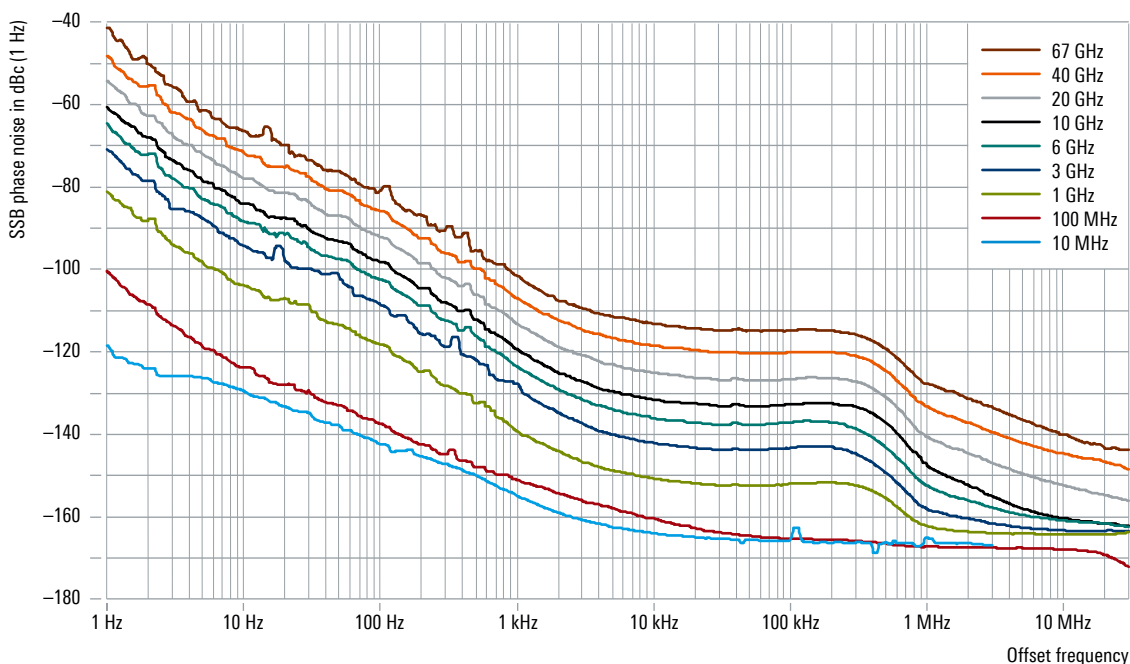
The R&S®SMB100B is an ideal choice for a wide range of applications in R&D, production, service and maintenance where a good price/performance ratio is key. It sets new standards in spectral purity and output power in the mid-range segment.

Rohde & Schwarz industry-leading analog signal generators are specifically designed for uncompromising high performance and cover research and development, production, service and maintenance applications. As the world's leading signal generator, the R&S®SMA100B can handle the most demanding component, module and system testing and measurements, while covering frequencies up to 72 GHz and delivering ultra-high output power up to +38 dBm with outstanding SSB phase noise performance.



	R&S®SMA100B	R&S®SMB100B (RF signal generator)	R&S®SMB100B (microwave signal generator)	R&S®SGS100A
Applications	R&D, integration and verification, conformance testing	R&D, integration and verification, production	R&D, integration and verification, production	Production, automated use
Frequency	8 kHz to 67 GHz (up to 72 GHz in overrange)	8 kHz to 6 GHz	8 kHz to 40 GHz	1 MHz to 12.75 GHz
SSB phase noise (1 GHz, 20 kHz offset)	< -147 dBc (with option)	< -126 dBc	< -126 dBc	< -126 dBc
Harmonics (1 GHz)	< -60 dBc	< -30 dBc	< -30 dBc	< -30 dBc
Nonharmonics (1 GHz)	< -94 dBc (with option)	< -70 dBc	< -70 dBc	< -76 dBc
RF output power (1 GHz)	+30 dBm (with option)	+26 dBm (with option)	+21 dBm (with option)	+15 dBm

Measured SSB phase noise performance of the R&S®SMA100B with the R&S®SMAB-B711(N) option



SIGNAL AND SPECTRUM ANALYZERS



The FSW signal and spectrum analyzer redefines top of the line signal and spectrum analyzers, offering superior phase noise, displayed average noise level, intermodulation suppression and dynamic range RF performance for ACLR and harmonic measurements.

FSW signal and spectrum analyzer

The FSW with up to 8.3 GHz internal bandwidth enables research and development for next generation mobile standards in the 5G millimeterwave frequency bands and characterization of wideband signals. It has a high dynamic range and low input signal distortion. A spurious-free dynamic range (SFDR) of 65 dBc allows users to precisely determine signal modulation quality.

The FSW error vector magnitude (EVM) is excellent for reliable measurements of signals with very good inherent EVM. The bandwidth extension and the R&S®VSE-K96 OFDM vector signal analysis software allow the FSW to measure EVM values in the order of < 1 %, even for 800 MHz signals in the 28 GHz range. The FSW has an industry-leading 8.3 GHz of internal demodulation bandwidth in the RF and over 8 GHz in the analog baseband for analyzing signals between chipsets.

R&S®FSV3000, R&S®FSVA3000 and R&S®FPS signal and spectrum analyzers

The R&S®FSV3000 and R&S®FSVA3000 general-purpose analyzers are a cost-efficient alternative for many applications.

The R&S®FPS was developed especially for automated test systems and is an exceptionally fast and compact spectrum analyzer with excellent RF performance.

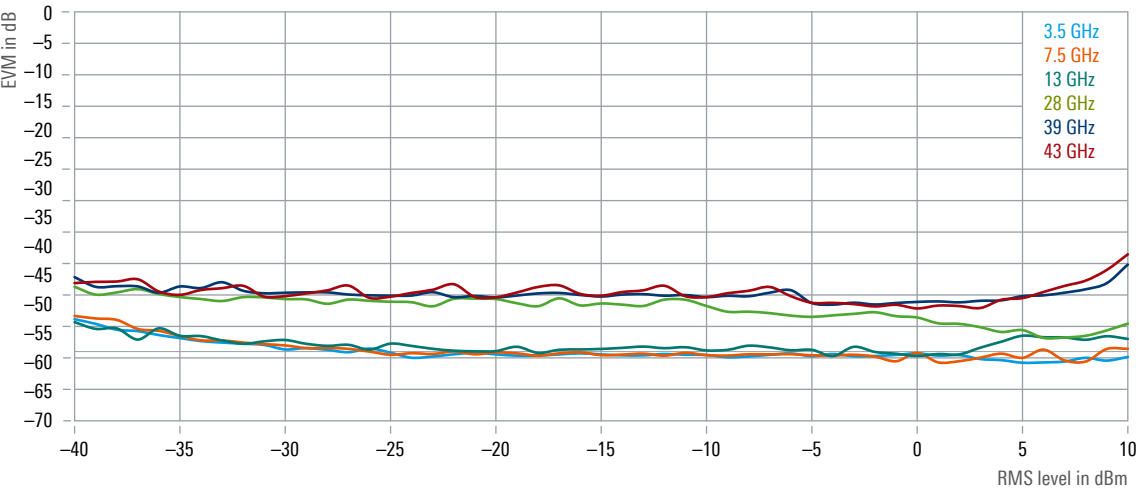
Rohde & Schwarz offers the widest range of spectrum analyzers in the industry for all phases of 5G development. The FSW covers frequencies up to 90 GHz, with a built-in demodulation bandwidth of up to 8.3 GHz, making it an ideal R&D tool with the highest dynamic range.



	FSW	R&S®FSVA3000	R&S®FSV3000	R&S®FPS
Applications	R&D, integration and verification	R&D, production	R&D, production	Production, automated use
Frequency	2 Hz to 90 GHz	10 Hz to 54 GHz	10 Hz to 50 GHz	10 Hz to 40 GHz
Internal analysis bandwidth	8.3 GHz	1 GHz	200 MHz	160 MHz

Measured error vector magnitude (EVM) of a 100 MHz 5G NR signal

The R&S®SMW200A vector signal generator with active R&S®SMW-K575 linearize RF option and the FSW vector signal analyzer with R&S®FSW-K575 I/Q noise cancellation (IQNC) option were used. A setup with an FSW in combination with an R&S®SMW200A vector signal generator is easy to operate and provides industry-leading performance and bandwidth for in-depth amplifier and predistortion measurements. The EVM remains below -40 dB over a wide power range.



EXTERNAL FRONTENDS



The R&S®FE50DTR external frontend extends the usable range from the 3GPP FR1 to the 3GPP FR2 frequency bands for existing R&S®FSA3000/R&S®FSV3000 signal and spectrum analyzers and R&S®SMM100A/R&S®SMW200A vector signal generators for increased flexibility. The frontend targets 5G frequency bands from 36 GHz to 50 GHz for a measurement solution close to the DUT with signal generation and analysis bandwidth up to 1 GHz and excellent RF performance.

Frequency extension with Rohde & Schwarz external frontends

Over-the-air (OTA) testing is standard for 3GPP FR2 frequency ranges. Cable loss and costs increase significantly at these frequencies. An external frontend enables upconversion and downconversion directly at the DUT with better test setup performance and lower costs. External frontends from Rohde & Schwarz help simplify test setups for excellent signal quality. They have a very compact form factor, allowing them to be very close to the DUT. An integrated local oscillator (LO) with low phase noise eliminates the need for an analog signal generator for upconversion or downconversion or an additional LO interconnection to the vector signal generator base unit for a clear and simplified test setup.

Easy to use

For full transparency, the base instrument directly controls the frontends, automatically taking into account the internal frontend calibration data for proper RF frequency and level settings on the measurement plane. The external frontend is connected to the base instrument at a lower IF. The impact of frequency and amplitude on the IF are automatically compensated in the base instrument firmware, reducing measurement uncertainty for the test setup. Smart accessories such as filters and power amplifiers complement the setup. The base unit accounts for smart accessory calibration data to accurately calibrate the measurement plane for signal level and frequency response.

The banded external frontends extend the frequency range up to 170 GHz for Rohde & Schwarz signal and spectrum analyzers and signal generators. They enable signal upconversion and downconversion directly at the device under test (DUT), lowering cable losses, increasing sensitivity and delivering more power at the antenna in an OTA environment.



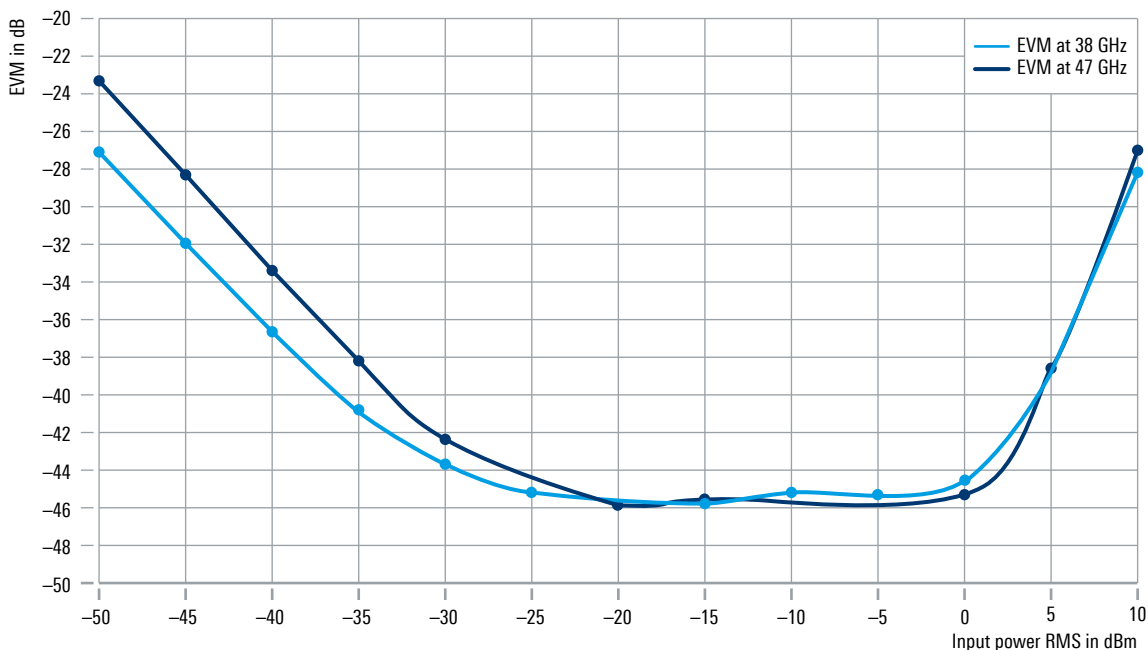
Rohde & Schwarz has a portfolio of external frontends to extend vector signal generator frequency ranges as well as signal and spectrum analyzer base instruments up to 170 GHz. These frontends have integrated local oscillators and are fully integrated in the base instrument firmware. Base instruments, such as the FSW and R&S®FSVA3000 signal and spectrum analyzers and the R&S®SMW200A and R&S®SMM100A vector signal generators, fully control the external frontend for fully transparent frequency extensions to measurement setups.



	R&S®FE44S	R&S®FE50DTR	R&S®FE110ST	R&S®FE110SR	R&S®FE170ST	R&S®FE170SR
Applications	Production	Production	R&D	R&D	R&D	R&D
Frequency	24 GHz to 44 GHz	36 GHz to 50 GHz	70 GHz to 110 GHz	70 GHz to 110 GHz	110 GHz to 170 GHz	110 GHz to 170 GHz
Mode	transmit or receive	transmit and receive	transmit	receive	transmit	receive
Modulation bandwidth	1 GHz	1 GHz	10 GHz	–	10 GHz	–
Analysis bandwidth	1 GHz	1 GHz	–	10 GHz	–	10 GHz
RF outputs	1	1	1	–	1	–
RF inputs	1	1	–	1	–	1
RF output power	+14 dBm	+10 dBm	+5 dBm	–	0 dBm (with option)	–

Measured error vector magnitude (EVM) for a 5G NR downlink signal

The R&S®FE50DTR external frontend in transmit mode and the R&S®FSVA3000 signal and spectrum analyzer



PERFORMANCE VECTOR TESTER



The PVT360A performance vector tester integrates signal generation and analysis in a compact form factor for a wide range of FR1 testing needs where speed is critical. Innovative features such as an integrated switch matrix and hardware-accelerated test sequencing provide unparalleled flexibility for extremely fast measurements. The PVT360A comes either in the multiport configuration with an integrated switch matrix (R&S®PVT-B106H) or with a high power option providing +20 dBm peak envelope power (R&S®PVT-B306I).

PVT360A performance vector tester

The PVT360A performance vector tester covers a frequency range from 400 MHz to 8 GHz, a maximum signal bandwidth of 500 MHz and supports standard-compliant 5G NR signal generation and analysis in all FR1 frequency bands. Hardware-accelerated test sequencing enables extremely fast measurements and an integrated switch matrix allows parallelized and sequential testing for multiple DUTs and multiport devices.

Designed for remote operation, the PVT360A performance vector tester has automation capabilities for easy integration into test beds. Preconfigured test routines in line with 3GPP requirements simplify testing. For manual configuration, the intuitive web user interface has an overview of all signal generation and measurement parameters and capabilities.

PVT360A in combination with R&S®WinIQSIM2 or R&S®VSE software

The PVT360A has a variety of signal generation and analysis features. R&S®WinIQSIM2 external PC software supports ARB signal configuration and generation for multiple cellular and wireless standards. Direct waveform transfer to PVT360A is integrated into R&S®WinIQSIM2 for the easy replay of waveforms on the PVT360A.

R&S®VSE vector signal explorer software extends the range of measurement applications with various component or generic modulation analysis features. The PVT360A captures signals and provides the I/Q data to the R&S®VSE for signal analysis.

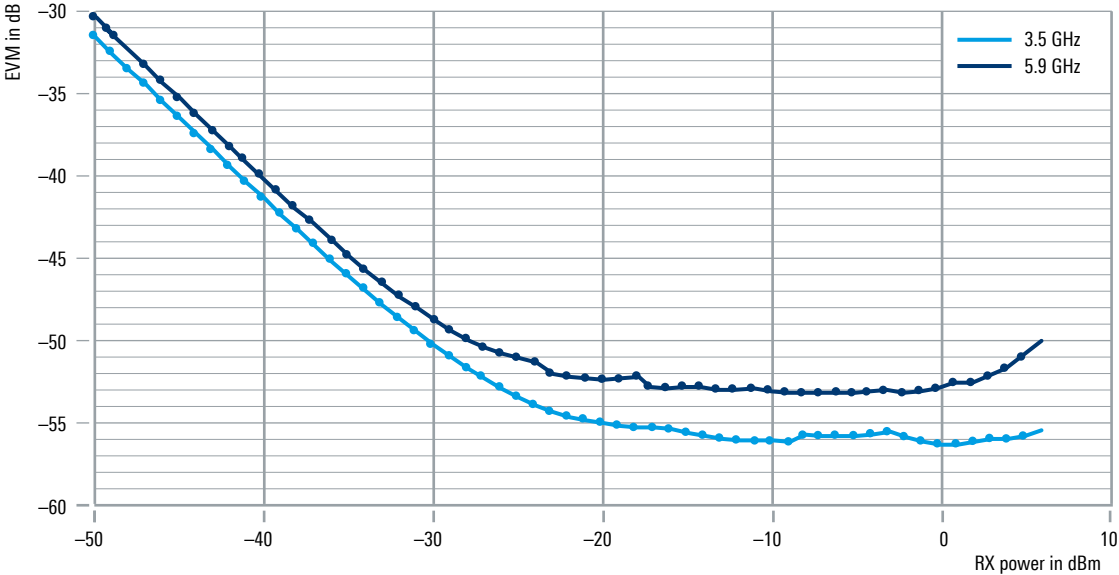
The PVT360A is a single box tester that integrates both vector signal generation and analysis. It is optimized for many FR1 applications such as base stations, small cells and RF component testing in production and characterization environments. Two independent signal generators and analyzers enable fast parallelized measurements, while the frequency range up to 8 GHz, flexible bandwidth configuration and an optional second TRX channel provide performance and flexibility in a small form factor.



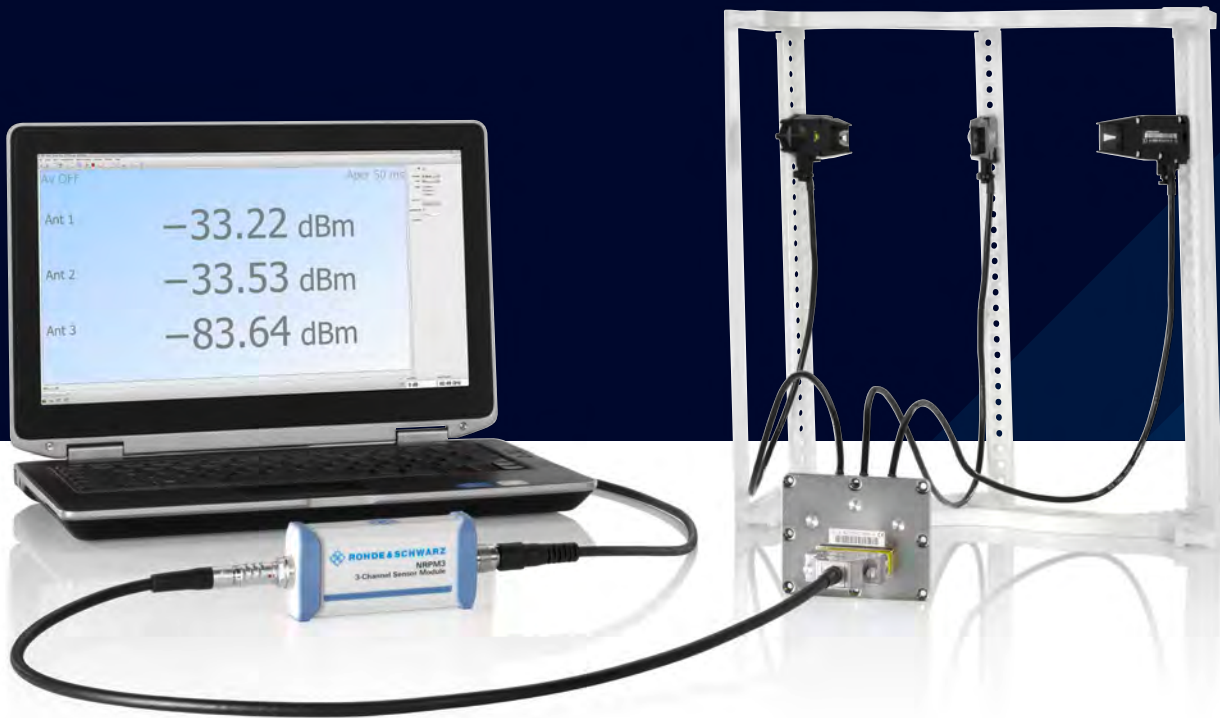
	PVT360A (with multiport option)	PVT360A (with high power option)
Applications	Base station and small cell production testing, component production testing, characterization, base station software regression testing, R&D	Base station and small cell production testing, component production testing, characterization, base station software regression testing, R&D
Frequency	400 MHz to 8 GHz	400 MHz to 8 GHz
Modulation bandwidth	500 MHz	500 MHz
Analysis bandwidth	500 MHz	500 MHz
RF outputs	8	2
RF inputs	8	2
RF output power	+8 dBm	+20 dBm

Measured error vector magnitude (EVM) of a 5G NR downlink TM 3.1 100 MHz signal

Subcarrier spacing: 30 kHz, modulation: 64QAM. Used: the PVT360A and the R&S®SMW200A vector signal generator as a signal source



POWER SENSORS



The R&S®NRPM OTA power measurement solution is unique. It uses single-polarized or dual-polarized Vivaldi antennas with integrated power sensors for over-the-air power measurements up to 90 GHz. The compact setup can be used on a benchtop and in a shielded box.

Frequency selective power sensor

Rohde & Schwarz has the unique R&S®NRQ6 frequency selective power sensor for high accuracy power measurements, even at low power levels. The compact device, has a receiver-based architecture and can perform frequency selective power measurements up to 6 GHz and capture I/Q data simultaneously thanks to its 100 MHz analysis bandwidth, making it ideal for calibration and functional software regression testing. Integration with the R&S®VSE vector signal explorer PC software simplifies I/Q capture and analysis. The R&S®NRQ6 is also a cost-effective solution for calibrating multiple active antenna modules for beamforming. Multiple R&S®NRQ6 devices can be set up in a primary-secondary configuration to measure and calibrate phase differences between multiple sources.

Power level calibration and beamforming/beam steering verification

Over-the-air power level calibration and beamforming/beam steering verification have never been easier, thanks to the unique R&S®NRPM OTA power measurement solution. The R&S®NRPM-A90/R&S®NRPM-A90D antenna modules are at its core. The modules are composed of a single- or dual-polarized Vivaldi antenna with an integrated diode power detector and a frequency limit of

up to 90 GHz. Up to three detectors can connect to the R&S®NRPM3 sensor module for signal processing. The entire system is calibrated ex-factory, for extremely straightforward, fast and accurate OTA power level measurements. The flexibility and scalability of the R&S®NRPM OTA power measurement solution makes it ideal for multidimensional power level calibration and verification of beamforming and beam steering.

Accurate and uncomplicated power measurements

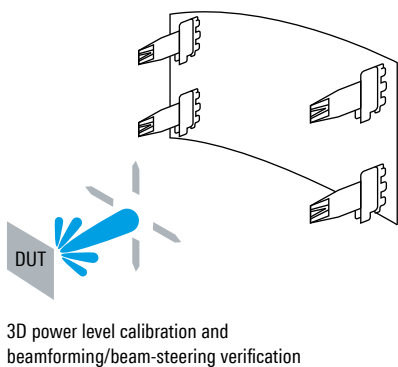
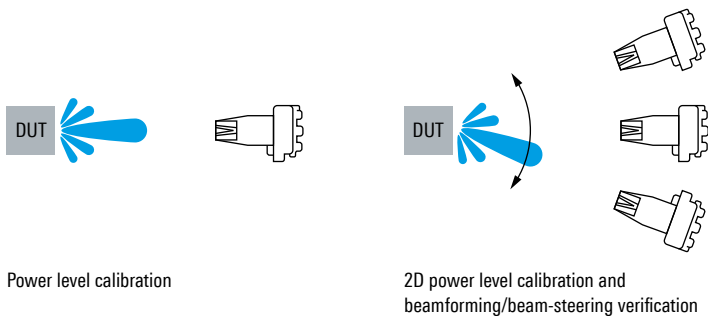
Top measurement accuracy and speed along with simple operation from a base unit or a laptop/PC make for accurate and uncomplicated power measurements. The R&S®NRP power meter family combines it all in the R&S®NRX base unit, R&S®NRPV virtual power meter PC software and a comprehensive portfolio of LAN and USB power sensors. The R&S®NRP family is ideal for production, R&D and calibration as well as for installation and maintenance.

Rohde & Schwarz offers a comprehensive portfolio of power sensors covering DC up to 170 GHz and a measurement range from -130 dBm to $+45\text{ dBm}$. Ongoing additions to the portfolio bring features to simplify power level calibration for conducted and over-the-air measurements for 5G and beyond.



	R&S®NRQ6 (frequency selective power sensor)	R&S®NRPM (OTA power sensor)	R&S®NRPxxS/SN (three-path diode power sensor)	R&S®NRPxxxTWG/TWGN (thermal waveguide power sensor)
Applications	Frequency selective power measurements, phase coherent measurements, I/Q capture	Over-the-air power level calibration, beamforming verification	R&D, production	Calibration
Frequency	50 MHz to 6 GHz	18 GHz to 90 GHz	10 MHz to 90 GHz	DC to 170 GHz
Power measurement range	-130 dBm to $+20\text{ dBm}$	-76 dBm to -19 dBm	-70 dBm to $+45\text{ dBm}$	-35 dBm to $+20\text{ dBm}$

The R&S®NRPM OTA power measurement solution



The R&S®NRQ6 frequency selective power sensor is a power sensor and an I/Q data capturing device all in one, making it ideal for calibration and functional software regression testing. Multiple R&S®NRQ6 devices can be set up in a primary-secondary configuration to perform phase coherence measurements for low-power modulated signals.



5G SIGNAL CONFIGURATION AND ANALYSIS AT YOUR FINGERTIPS

Rohde & Schwarz has dedicated applications for generating and analyzing 5G signals. Standard-compliant 5G NR signals can be configured directly on a Rohde & Schwarz vector signal generator or with R&S®WinIQSIM2 simulation software. Powerful signal analysis applications run directly on Rohde & Schwarz signal and spectrum analyzers for deep insights and a wide array of performance metrics. The R&S®VSE vector signal explorer PC software brings these powerful signal analysis capabilities to your desktop.

Dedicated applications for generating and analyzing 5G signals

Rohde & Schwarz offers dedicated signal generation and analysis solutions for 3GPP 5G NR standard including sidelink and flexibility to explore non-standard conform signal configurations for beyond 5G applications. A generic OFDM solution is also available to generate and analyze user-defined OFDM signals.

The image displays the Rohde & Schwarz VSE (Vector Signal Explorer) software interface, which is used for configuring and analyzing 5G signals. The interface is divided into several sections:

- Top Section:** Displays signal parameters for two channels, A and B. Channel A is configured at 28.000 GHz with a PEP of 5.61 dBm and a Level of -7.00 dBm. Channel B is configured at 1.000 GHz with a PEP of -30.00 dBm and a Level of -30.00 dBm. The interface includes checkboxes for RF On/Off, Mod On/Off, and Int Ref.
- Block Diagram:** A central block diagram shows the signal flow from Baseband A through various processing blocks (Fading A, AWGN A, I/Q Mod A, RF A) to the output. A blue arrow points from the 'Baseband A' block to the 'OFDM Standards' menu.
- Baseband A Menu:** A dropdown menu titled 'Baseband A' lists several options: 'OFDM Standards', 'EUTRA/LTE/LoT ...', '5G NR/Sidelink ...', 'V5GTF ...', and 'OFDM Signal Generation ...'. A blue arrow points from '5G NR/Sidelink ...' to the '5G New Radio A' settings window.
- 5G New Radio A Settings:** A window titled '5G New Radio A' shows various configuration options. The 'State' is set to 'On'. Other options include 'Link Direction' (Uplink), 'Node' (Users/BWPs), 'Scheduling' (Output/Power), and 'Time Plan' (Simple Mode, Off).
- OFDM Signal Generation A: General Settings (OFDM):** A window titled 'OFDM Signal Generation A: General Settings (OFDM)' shows detailed physical layer parameters. The 'Physical' tab is selected, displaying a table of parameters:

Physical	
Total Number of Subcarriers	4 096
Subcarrier Spacing	120.000 0 kHz
Cyclic Prefix Length	320 Samples
Alt. Cyclic Prefix Length	288 Samples
Cyclic Suffix Length	0 Samples
DC Mode	Utilize
Zero Padding Repetition after Symbols	10
Sampling Rate	491.520 MHz
Number of Left Guard Subcarriers	
Occupied Number of Subcarriers	3 300
Sequence Length	112 Symbols
CP No. Symbols	1 Symbols
Alt. CP No. Symbols	6 Symbols
DFTS (skip non-data)	Off
Zero Padding Samples	0
Symbol Offset Zero Padding	0
Occupied Bandwidth	396.000 MHz
Number of Right Guard Subcarriers	

3GPP 5G New Radio (5G NR)

The 5G NR software options simplify uplink, downlink and sidelink 5G NR signal generation. They support all waveforms, channel bandwidths, modulation schemes and numerology options specified in the standards. The intuitive GUI allows users to configure these and many other parameters directly on the instrument. The quick settings features simplify 5G signal creation, so the user can focus on key parameters. Predefined settings are also available to quickly configure fixed reference channels (FRC) for uplink tests and test models (TM) for downlink tests. When equipped with the 5G NR software options, the FSW signal and spectrum analyzer automatically detects and sets many parameters, performs detailed signal analysis and displays many user-configurable performance metrics. Setting files can be automatically transferred between the signal generator and the signal analyzer for quick and easy signal setup and analysis.



Analysis of a 5G NR downlink signal with R&S®FSW-K144

Beyond 5G

The beyond 5G signal generation and analysis options provide flexibility to explore non-standard conform 5G NR physical layer parameterizations, frequency domain spectrum shaping (FDSS) and neural receiver models. It allows to easily configure parameter combinations and parameters like channel bandwidth, SCS, modulation schemes and custom constellations that go beyond the standards for applications such as FR3 exploration, non-terrestrial networks (NTN) and sub-THz research.

Generic OFDM signal generation and analysis

The OFDM signal generation software options enable user-defined OFDM signal configurations beyond the standards for full parameterization flexibility in even the most sophisticated applications. R&S®VSE software, with its OFDM signal analysis option, offers a powerful, standard-independent and user-configurable OFDM signal analysis solution.



Analysis of a generic OFDM signal with R&S®VSE-K96

SOLUTIONS FOR POWER AMPLIFIER DEVELOPMENT

Power amplifiers need to deliver higher output power for 5G, and do so at higher carrier frequencies, over wider bandwidths and with greater efficiency. Effective digital predistortion (DPD) techniques are essential to meeting linearity requirements over wider bandwidths.

The R&S®SMW200A vector signal generator in combination with the FSW signal and spectrum analyzer

A dual-path R&S®SMW200A is an ideal platform for developing and testing advanced power amplifier architectures such as envelope tracking, Doherty, outphasing, load-modulated balanced amplifiers and their variants. Dedicated applications, such as the digital Doherty option, let power amplifier designers obtain unparalleled insights into their designs and shorten the design cycle.

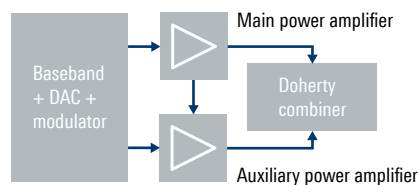
The FSW signal and spectrum analyzer with the amplifier measurements option provides the necessary measurements, capturing not only scalar quantities such as spectral regrowth and EVM, but also vectors such as AM/AM and AM/PM.

DPD solution

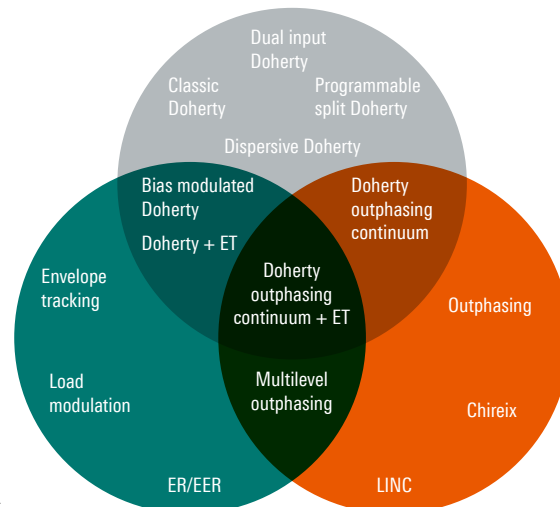
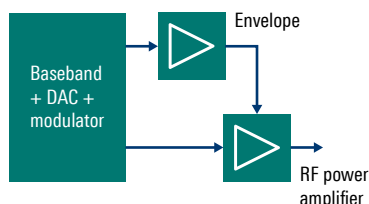
The digital predistortion option on the vector signal generators, together with the amplifier, direct DPD and memory DPD measurement options on the signal and spectrum analyzers, is a complete digital predistortion solution. Additional techniques such as crest factor reduction can also be applied to the signal to help push power amplifier design limits.

Ideal platform for power amplifier development

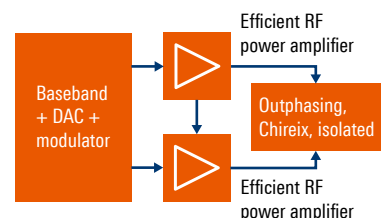
Doherty and its variants



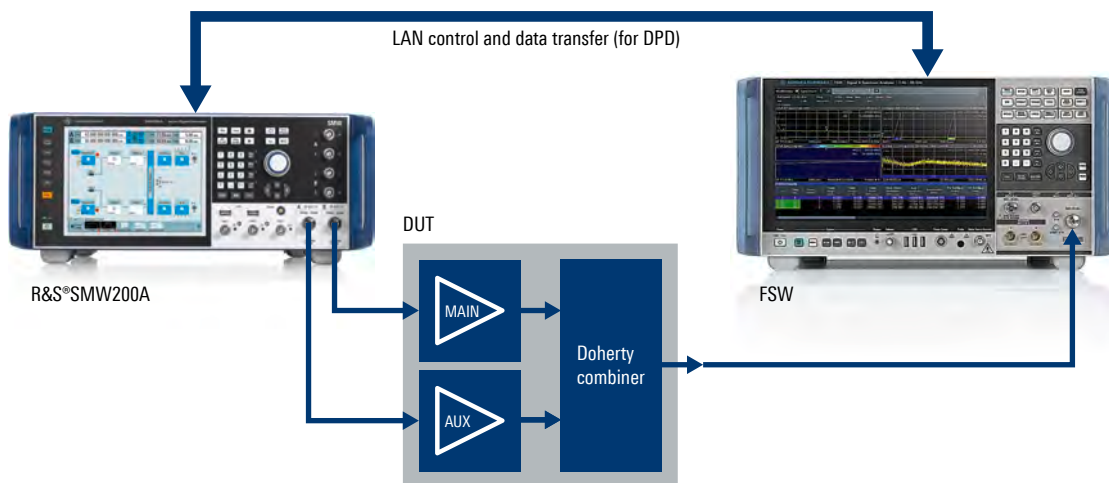
Envelope tracking and its variants



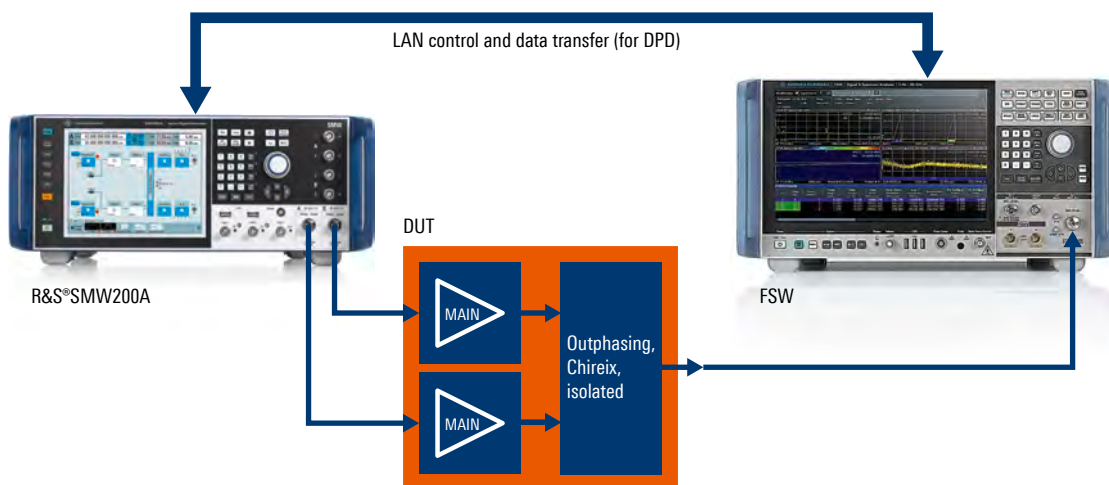
Outphasing and its variants



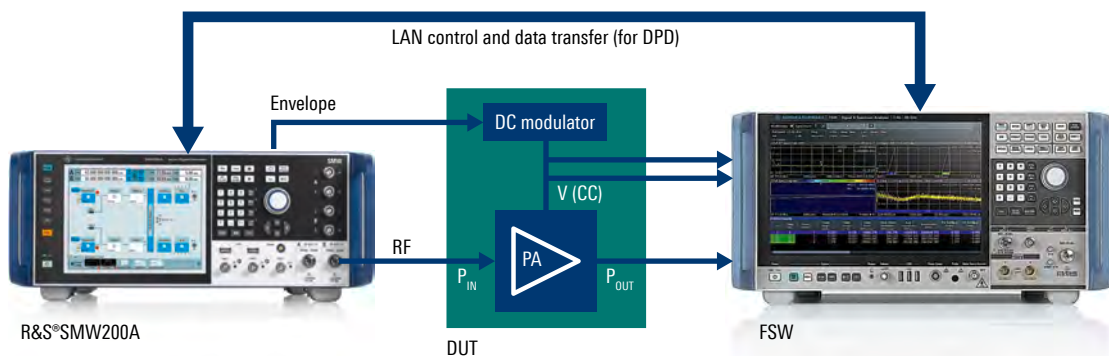
Doherty and its variants



Outphasing and its variants



Envelope tracking and its variants



The R&S®SMW200A dual-path capabilities make it a compact, powerful, easy-to-use platform for developing and characterizing advanced power amplifier architectures. The DPD option for vector signal generators (-K541), together with the amplifier and direct DPD measurement options on the signal and spectrum analyzers (-K18, -K18D, -K18M), offers a complete solution for digital predistortion and amplifier characterization.

COMPENSATING THE EFFECTS OF TEST FIXTURES

Since the effects of test fixtures become significant at higher carrier frequencies, simple and quick solutions are needed to compensate for these effects and measure the true DUT performance.

Frequency response correction option

The user-defined frequency response correction option is a simple and user-friendly way to compensate for these effects in vector signal generators and signal and spectrum analyzers. Simply load the n-port network parameter data for the test fixture once (e.g. from data sheets or directly measured with a vector network analyzer) and activate the correction parameters for the desired fixtures during testing.

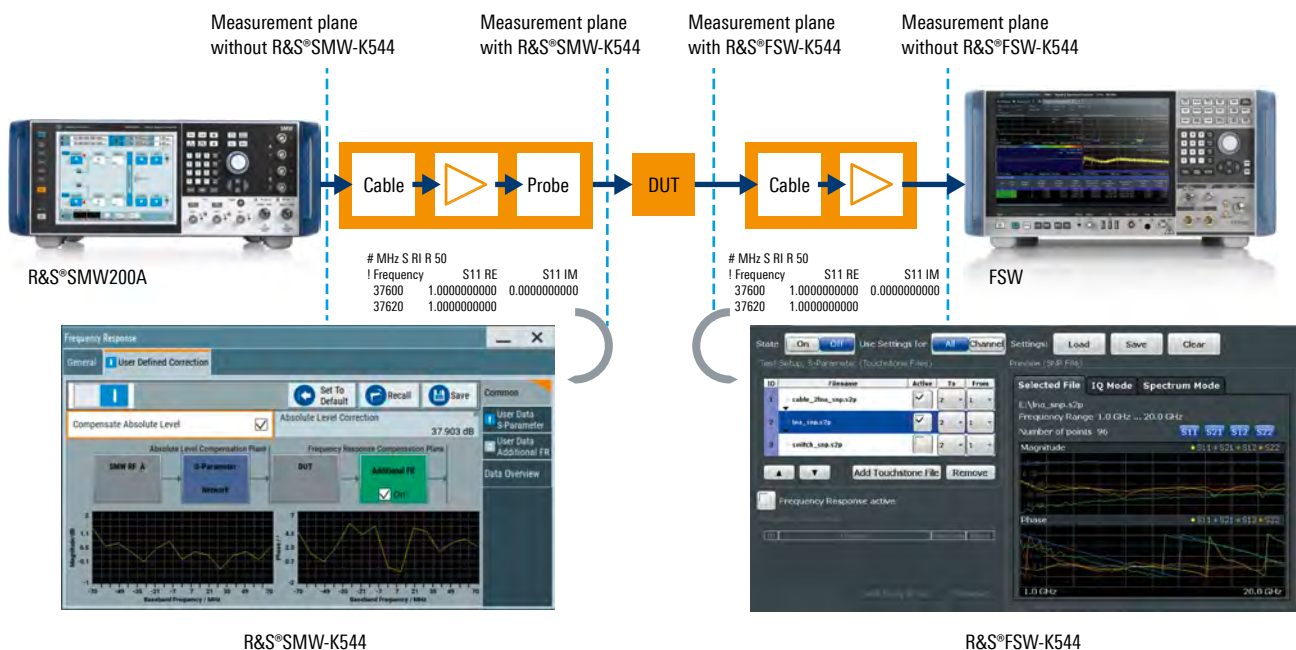
The instruments automatically and internally compensate for the effects of the activated fixtures in real time for calibrated measurements directly at the DUT plane, regardless of waveform, signal level, frequency and bandwidth.

Linearize RF

The R&S®SMW-K575 linearize RF option on the R&S®SMW200A extends the linear operating level range of the R&S®SMW200A with advanced on-board DPD techniques. This helps to ensure excellent signal quality and modulation performance even at high output levels required to overcome test fixture losses to drive a DUT with the optimal input level.

User-defined frequency response correction

The user-defined frequency response correction option (-K544) for the R&S®SMW200A, R&S®SMM100A, R&S®SMBV100B, R&S®FSVA3000, R&S®FSV3000 and FSW is easy to use, compensating the effects of test fixtures in real time, independent of waveform, signal level, frequency and bandwidth.



5G NR BASE STATION CONFORMANCE TESTING

The R&S®SMW200A vector signal generator has high output power and wideband signal generation capability, making it an excellent signal source for conducted and over-the-air receiver and antenna module testing. The FSW signal and spectrum analyzer has wide analysis bandwidth and powerful analysis capabilities and is an outstanding companion for testing transmitters and receiver spurious emissions.

Frequency response correction option

The user-defined frequency response correction option allows the measurement plane to be moved to the link and measurement antennas and the true DUT performance can be measured in both benchtop and shielded OTA measurement setups.

Test case wizard

The test case wizard in the 5G NR signal generation option helps quickly configure the relevant transmitter, receiver and performance test cases specified in 3GPP TS 38.141-1/-2 for conducted and OTA tests.

Optional channel emulator

When equipped with the optional channel emulator, the R&S®SMW200A becomes single-box performance testing solution. The R&S®SMW200A can generate the wanted and interference signals, perform fading with presets for the corresponding channel models, add AWGN and provide the real-time HARQ feedback signals required for 3GPP TS 38.141-1/-2 Chapter 8 testing.

5G NR test case wizard



Base station transmitter characteristics

Setup for testing base station transmitter characteristics with the FSW. The FSW signal and spectrum analyzer with its wide analysis bandwidth and powerful analysis capabilities is an outstanding tool for testing transmitters and receiver spurious emissions.



Base station receiver characteristics and performance

The R&S®SMW200A is the perfect platform for testing base station receiver characteristics and performance. When fully equipped, it is able to generate the wanted and interference signals, perform fading using predefined presets, add AWGN and generate real-time HARQ feedback all in a single box.



SOLUTIONS FOR HIGH-VOLUME TESTS AND BASE STATION PRODUCTION

R&S®SGMA vector signal generator family

The R&S®SGMA family of vector signal generators (the R&S®SGT100A and R&S®SGS100A) and the R&S®FSVA3000 signal and spectrum analyzer were developed with size and test speed in mind along with uncompromising performance. The result is a significant reduction in test times and floor space, making them ideal for production environments.

R&S®SMM100A vector signal generator and R&S®FSVA3000 signal and spectrum analyzer

The R&S®SMM100A vector signal generator and the R&S®FSVA3000 signal and spectrum analyzer provide a cost-effective solution for high volume and base station production FR2 testing needs, covering all important frequency bands in a single instrument. These solutions can be easily extended with external frontends, such as the R&S®FE50DTR for OTA testing in FR2. This ensures closer proximity to the DUT, minimal pathloss and excellent signal quality.

PVT360A performance vector tester

The PVT360A performance vector tester is ideal for production lines, thanks to reliable hardware and software and various features for maximum throughput. With frequencies up to 8 GHz and an optional bandwidth configuration of up to 500 MHz, the PVT360A covers all FR1 frequency bands. Multi-component carriers can be tested and the two optional pairs of vector signal generators and analyzers enable real MIMO measurements.

The cost-effective two channel TRX solution automates and sets new standards for speed. Packed in a small form factor, the PVT360A is easy to stack and brings robust feature density to the 19"/2 HU size. The PVT360A offers several possibilities for parallelized tests thanks to the smart channel features in combination with a 2 × 8 port switch matrix.

An ARB sequencer and hardware-accelerated test sequencing for pre-defined tests provide outstanding measurement speed. The integrated switch matrix minimizes recabling requirements. Receive tests can run in parallel thanks to the broadcast mode on the generation path, and for DUT transmit tests, the fast switching time of < 10 µs enables quick sequential measurements.



The R&S®SGMA compact vector signal generators are optimized for speed, without compromise on performance, making them ideal for production environments.



The R&S®SMM100A vector signal generator and the R&S®FSVA3000 signal and spectrum analyzer provide a versatile solution for base station production test. The instruments can be used standalone to address both FR1 and FR2 bands or can be extended with a fully-integrated frontend to cost-effectively address FR2 OTA testing requirements.

R&S®NRQ6 frequency selective power sensor

The R&S®NRQ6 frequency selective power sensor offers a compact power level calibration solution for fast, highly accurate frequency selective power sensing and I/Q data capturing in a single instrument.

The PVT360A offers ultimate performance in a minimal footprint for a cost-effective solution for FR1 base station and small cell production testing. It can be configured with up to two independent signal generators and analyzers. Thanks to the smart channel option in combination with the internal switch matrix, the PVT360A can be set up for use as up to eight virtual instruments.



SOLUTION TO EXPLORE BEYOND 5G



The R&S®SFI100A is the essential foundation for your sub-THz solution, enabling precision and innovation above expectations. It provides clean IF signals for the R&S®FE110ST and R&S®FE170ST external frontends. Full integration of the frontends in the R&S®SFI100A ensures unparalleled accuracy for wideband measurements.

R&S®SFI100A wideband IF vector signal generator

The R&S®SFI100A wideband IF vector signal generator offers a very wide RF modulation bandwidth up to 10 GHz in a compact form factor, enabling the generation of extreme wideband signals required for demanding applications such as early 6G research, high capacity wireless backhaul, fixed wireless access, sensing and automotive radar. The R&S®SFI100A offers flexibility for different test scenarios without compromising on performance or signal quality: baseband tests, IF tests and RF tests in the sub-THz frequency range in combination with the R&S®FE110ST/ R&S®FE170ST external frontends.

Designed for sub-THz applications, the R&S®SFI100A is the perfect IF source to drive a DUT or the R&S®FE110ST and R&S®FE170ST external frontends for upconversion. Thanks to the integrated operation of the R&S®FE110ST

and R&S®FE170ST frontends, the R&S®SFI100A covers the complete W and D band frequency range from 70 GHz to 175 GHz. Moreover, it ensures fully calibrated and accurate measurements out of the box without the need for time-consuming calibration routines.

In addition, the R&S®SFI100A offers wideband single-ended, differential and direct DAC analog I/Q signals for baseband tests with best signal quality up to 5 GHz and up to 2 V (V_{pp}). The internal ARB with up to 8 Gsample memory supports playback of waveforms generated with the R&S®WinIQSIM2 simulation software or other external tools. The intuitive touch-based GUI offers full monitoring along the signal path, ensuring that you are always in control.

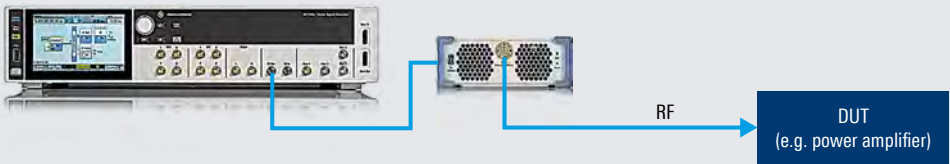


	R&S®SFI100A
Application	R&D
Frequency	11 GHz to 21 GHz (standalone), 70 GHz to 110 GHz with R&S®FE110ST, 110 GHz to 170 GHz with R&S®FE170ST
Modulation bandwidth	10 GHz
RF output	1
RF output power	0 dBm

Extensive flexibility to explore beyond 5G

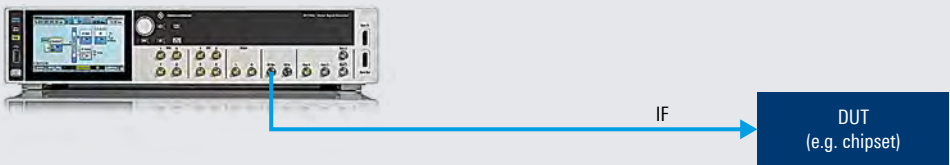
RF test in sub-THz range

70 GHz to 110 GHz with R&S®FE110ST,
110 GHz to 175 GHz with R&S®FE170ST,
220 GHz to 330 GHz with R&S®FC330ST



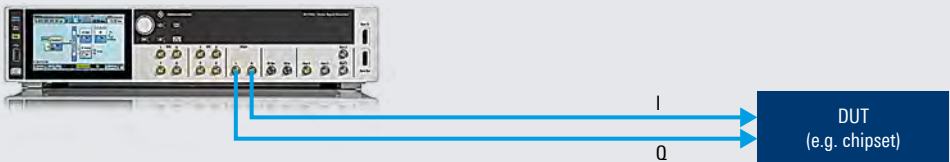
IF test

11 GHz to 21 GHz



Baseband test

Differential or single-ended,
up to 5 GHz and up to 2 V (V_{pp})



APPLICATION SOFTWARE

5G application software options

	5G NR Release 15	5G NR Release 16	5G NR Release 17/18	5G NR sidelink	Beyond 5G	Custom OFDM
Vector signal generators						
R&S®SMW200A	-K144, -K444 ¹⁾	-K148, -K448 ¹⁾	-K171, -K471 ¹⁾	-K170, -K470 ¹⁾	-K184, -K484	-K114, -K414 ¹⁾
R&S®SMM100A	-K144, -K444 ¹⁾	-K148, -K448 ¹⁾	-K171, -K471 ¹⁾	-K170, -K470 ¹⁾	-K184, -K484	-K114, -K414 ¹⁾
R&S®SMBV100B	-K144, -K444 ¹⁾	-K148, -K448 ¹⁾	-K171, -K471 ¹⁾	-K170, -K470	-K184, -K484	-K114, -K414 ¹⁾
R&S®SGT100A	-K444 ¹⁾	-K448 ¹⁾	-K471 ¹⁾	-K470 ¹⁾	-K484	-K414 ¹⁾
R&S®SMCV100B	-K444 ¹⁾	-K448 ¹⁾	-K471 ¹⁾	-K470 ¹⁾	-K484	-K414 ¹⁾
R&S®SFI100A	-K444 ¹⁾	-K448 ¹⁾	-K471 ¹⁾	-K470 ¹⁾	-K484	-K414 ¹⁾
Signal and spectrum analyzers						
FSW	-K144 (downlink), -K145 (uplink), R&S®VSE-K146 (MIMO measurements) ²⁾	-K148	-K171	–	-K184	R&S®VSE-K96 ²⁾
R&S®FSVA3000	-K144 (downlink), -K145 (uplink), R&S®VSE-K146 (MIMO measurements) ²⁾	-K148	-K171	–	-K184	R&S®VSE-K96 ²⁾
R&S®FPS	-K144 (downlink), R&S®VSE-K144 (uplink) ²⁾ , R&S®VSE-K146 (MIMO measurements) ²⁾	-K148	–	–	–	R&S®VSE-K96 ²⁾

¹⁾ Using R&S®WinIQSIM2 PC software.

²⁾ Using R&S®VSE vector signal explorer software.

Power amplifier development options

	Envelope tracking	Doherty	Digital predistortion	Crest factor reduction
Vector signal generators				
R&S®SMW200A	-K540	-K546	-K541	-K548
R&S®SMM100A	-K540	–	-K541	-K548
R&S®SMBV100B	-K540	–	-K541	-K548
R&S®SGT100A	-K540, -K543	–	-K541	-K548
R&S®SMCV100B	–	–	–	-K548
R&S®SFI100A	–	–	–	-K548
Signal and spectrum analyzers				
FSW	-K18	-K18	-K18, -K18D, -K18M	-K18
R&S®FSVA3000	-K18	-K18	-K18, -K18D, -K18M	-K18
R&S®FPS	-K18	-K18	-K18, -K18D, -K18M	-K18

Service at Rohde & Schwarz
You're in great hands

- ▶ 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 & 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.

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

