Signal generation

with the R&S®SMU 200A/R&S®SMATE 200A/R&S®SMJ 100A and software option R&S®SMx-K49

Features of vector signal generators

- Frequency range 100 kHz to 6 GHz
- Internal I/Q modulation bandwidth 80 MHz (in RF)
- Up to two signal generators in one box (R&S®SMU 200A or R&S®SMATE 200A), e.g. for simulation of useful signal and interferer
- Fading simulator (option) with up to 40 fading paths (R&S®SMU 200A)
- Extremely fast setting times and addressable hardware list mode for high throughput in production (R&S®SMATE 200A)
- AWGN simulation (option)
- WiMAX fading profile planned (option for R&S®SMU 200A)

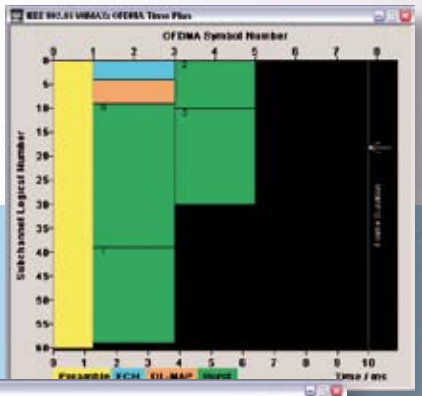
Features of R&S®SMx-K49

- Signal generation in line with IEEE 802.16-2004 and IEEE 802.16e (incl. WiBro)
- Symbol rate and bandwidth in line with ETSI, MMDS, WCS, U-NII (or user-defined)
- Physical layer modes OFDM + OFDMA
- Generic MAC header generation
- Signals for packet error ratio measurement
- Variable FFT size: 128, 512, 1024, 2048
- Channel coding
- Subchannelization
- Easy setup of frame structure
- Automatic DL-MAP generation or user-defined DL-MAP file for OFDMA
- Automatic FCH generation
- Graphical display of frame structure
- Multiple zones for IEEE 802.16e
- Ranging (IEEE 802.16e)
- Space/time coding (IEEE 802.16e)

R&S®SMU 200A

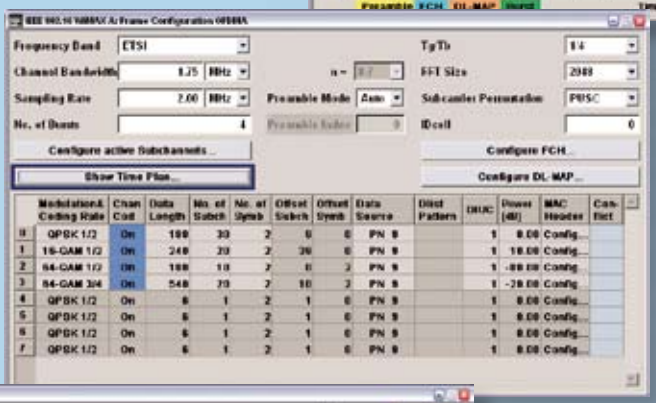
The internal fading simulator option of the R&S®SMU 200A makes it easy to simulate multipath propagation conditions in the lab.
It is not only possible to simulate the fading profiles required for the most common mobile radio standards such as 3GPP FDD. This option also allows customized configuration to meet special test requirements.
For WiMAX IEEE 802.16-2004, SUI[1] fading profiles are recommended.
For WiMAX IEEE 802.16e, 3GPP FDD fading profiles are being discussed.
The R&S®SMU 200A fading option supports 3GPP FDD fading.

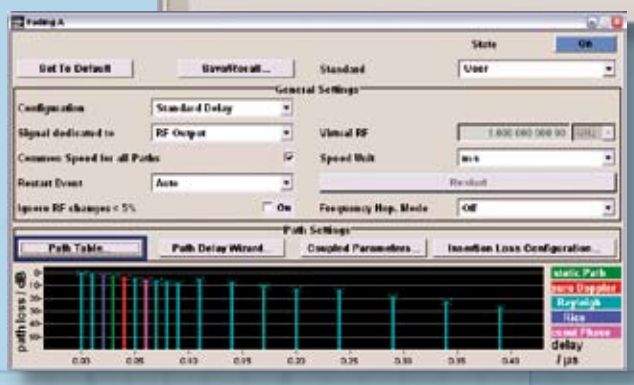
[1] Stanford University Interim.



Direct graphical view of OFDMA time frame.

Easy setup of WiMAX frame structure.





Extremely easy setting of different fading scenarios using the fading option for the R&S®SMU 200A.

Signal analysis

with the R&S®FSQ + Application Firmware R&S®FSQ-K92 or R&S®FSQ-K93

General features of the R&S®FSQ

- Combination of high-end spectrum analyzer and signal analyzer
- Maximum frequency range up to 40 GHz
- Up to 120 MHz demodulation bandwidth (28 MHz standard)
- Additional inputs for signal analysis directly in the baseband and analysis of low-IF designs
- Full range of RF measurement routines

R&S®FSQ

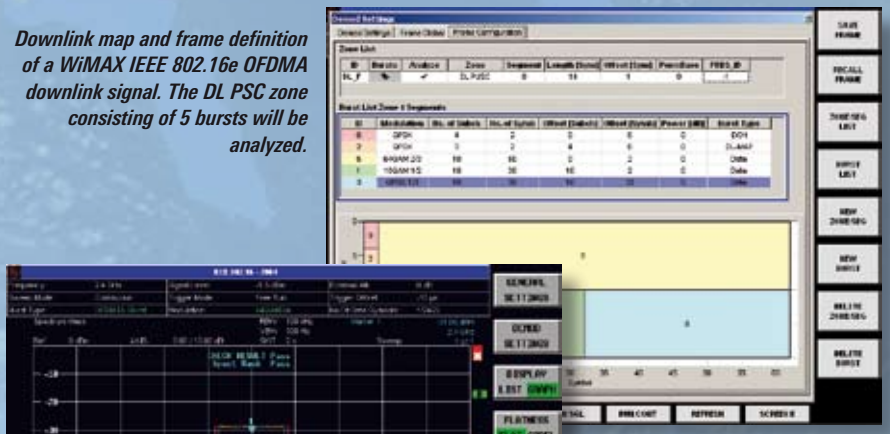
Features of R&S®FSQ-K92/93

- Result list of all important parameters
- Burst list summary
- Bit stream
- Graphical results:
  - EVM vs. carrier and vs. symbol
  - Frequency and phase error vs. preamble
  - Spectrum flatness (difference)
  - Group delay
  - Constellation diagram
  - CCDF
  - Spectrum emission mask
  - ACP
  - FFT spectrum

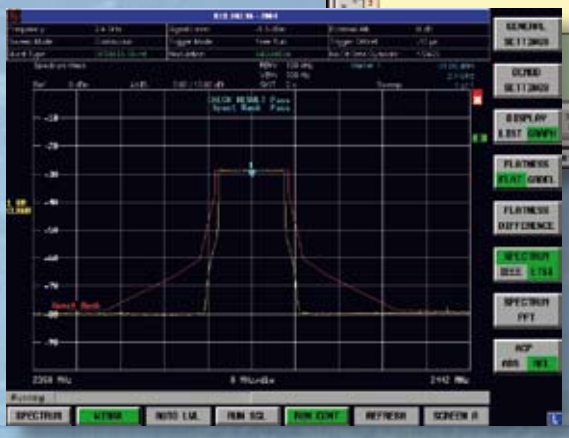
The list shows all important parameters of a WiMAX signal at a glance: EVM of all carriers, of data carriers and of pilots only, I/Q impairments, burst power, crest factor, RSSI and CINR.

General settings for analyzing WiMAX signals. In addition, baseband inputs can be activated.

Constellation diagram of all symbols in a frame consisting of bursts with different modulation.



Downlink map and frame definition of a WiMAX IEEE 802.16e OFDMA downlink signal. The DL PSC zone consisting of 5 bursts will be analyzed.



Measurement for checking whether the transmitted spectrum is in line with the specified mask.

Preconformance test system

for WiMAX radio tests in accordance with IEEE 802.16-2004 and IEEE 802.16e

Targeting early R&D applications up to WiMAX Forum defined test procedures, the modular concept is based on the following:

- Market-leading 2G/3G conformance test system architecture incl. selftest and RF path compensation
- Top of their class Rohde&Schwarz vector signal analyzers and generators
- Worldwide established flexible R&S®RS-Pass software concept
- State-of-the-art TTCN-3 interface

This future-proof test setup is ready for the following:

- Intersystem interoperability (RRM, handover scenario)
- Predefined and user-configurable fading scenario
- STC (space time coding)
- MIMO (multi-antenna systems)
- AAS (advanced antenna systems)
- Out-of-band measurements

The lower part of the screen shows the burst summary list. All bursts of all captured frames are listed with optional preambles, showing modulation, power and EVM results.

The lower part of the screen shows the spectrum flatness difference. The red lines show the limits as specified in the standard. A limit line check is applied automatically.

General-purpose instruments

In addition to the measuring equipment that provides standard-specific or standard-compliant functions, a large number of general-purpose measuring instruments is needed – in development labs, in production and in service. A small selection from our wide range of products is presented here. Due to their unique characteristics, each of these instruments soon becomes indispensable for the user.

Selected products

R&S®SMA 100A

The Signal Generator R&S®SMA 100A is not only a versatile laboratory tool but also a fast and reliable signal source with very low SSB phase noise.

R&S®FSL

The R&S®FSL is a high-quality RF laboratory that combines a variety of functions ranging from spectrum and network analysis to power measurement, FM demodulator and WLAN tester. It provides a demodulation bandwidth of 20 MHz and is capable of capturing WiMAX signals with $f_0 < 20$ MHz

R&S®NRP

When the task at hand is high-precision measurement of RF power, the R&S®NRP and its sensors can't be beat. The sensors feature a USB interface and can thus be operated on any computer.

R&S®ZVA

The R&S®ZVA shows how convenient high-end network analysis can be. Its helpful wizards also enable fast, reliable measurements on multiport and balanced DUTs.

General RF measurements

	Recommended products	Features/measurements
Signal generation	• **Signal Generator R&S®SMA** • **Signal Generator R&S®SML** • **Vector Signal Generator R&S®SMV 03**	**R&S®SMA 100A** • Frequency range 9 kHz to 3 GHz • Very low SSB phase noise of typ. –135 dBc (20 kHz carrier offset, f = 1 GHz, 1 Hz measurement bandwidth); typ. –140 dBc with Enhanced Phase Noise Performance option R&S®SMA-B22 • Wideband noise of typ.–160 dBc (>10 MHz carrier offset, f = 1 GHz, 1 Hz measurement bandwidth) • High-stability reference oscillator as standard • Fast hopping mode offering flexibly addressable frequency level pairs, as fast as normal list mode • High output power up to +18 dBm, overrange +28 dBm • AM, broadband FM/φM (optional), pulse modulation • Optional multifunction generator up to 10 MHz • Optional clock synthesizer up to 1.5 GHz (low jitter) **R&S®SML/R&S®SMV 03** • Frequency range 9 kHz to 3.3 GHz • SSB phase noise <–122 dBc (1 Hz, at f = 1 GHz, offset 20 kHz) • High level accuracy (dev. <0.5 dB at levels >–120 dBm, f <2 GHz) • AM/FM/φM • Optional pulse modulator with integrated pulse generator • External I/Q modulation bandwidth 100 MHz in RF (R&S®SMV 03)
Signal analysis	• **Spectrum Analyzer R&S®FSL** • **Handheld Spectrum Analyzer R&S®FSH 3/6**	• Frequency range 100 kHz to 3 GHz / 6 GHz • Internal preamplifier • Displayed average noise level typ. –135 dBm (RBW 100 Hz) • Level accuracy typ. 0.5 dB • Resolution bandwidths 1 Hz to 20 MHz (R&S®FSL), 100 Hz to 1 MHz (R&S®FSH), one and three steps • Wide range of detectors: sample, max/min peak, auto peak, RMS
Power measure-ments	• **Power Meter R&S®NRP**	• Intelligent sensors – simply plug in and measure • High measurement speed • Up to 90 dB dynamic range • Accurate measurement of average power regardless of bandwidth and modulation • Measuring modes: continuous, burst average, timeslot, timegate, scope (dependent on sensor)
Network analysis	• **Vector Network Analyzer R&S®ZVA** • **Vector Network Analyzer R&S®ZVM** • **Vector Network Analyzer R&S®ZVK** • **Vector Network Analyzer R&S®ZVR/E** • **Vector Network Analyzer R&S®ZVC/E** • **Vector Network Analyzer R&S®ZVB** • **Vector Network Analyzer R&S®ZVT 8**	• Component measurements at physical layer • Very high dynamic range for high-blocking filters • All-round support in measuring active components • Unlimited measurements on frequency-converting DUTs such as mixer, amplifier, receiver and transceiver frontends • Measurements on multiport and balanced components • Optimized for R&D and for use in production
Power supply	• **Analyzer/Power Supply R&S®NGMO 1/2**	• Highly stable output voltage due to fast load regulation • High-resolution current measurement for detecting leakage currents when mobile device is in off state • Current-transient recorder with high time and magnitude resolution for isolating faults in mobile devices and for optimizing switching • Long-term power consumption analysis for determining and optimizing operation

Evolution

from OFDM to OFDMA

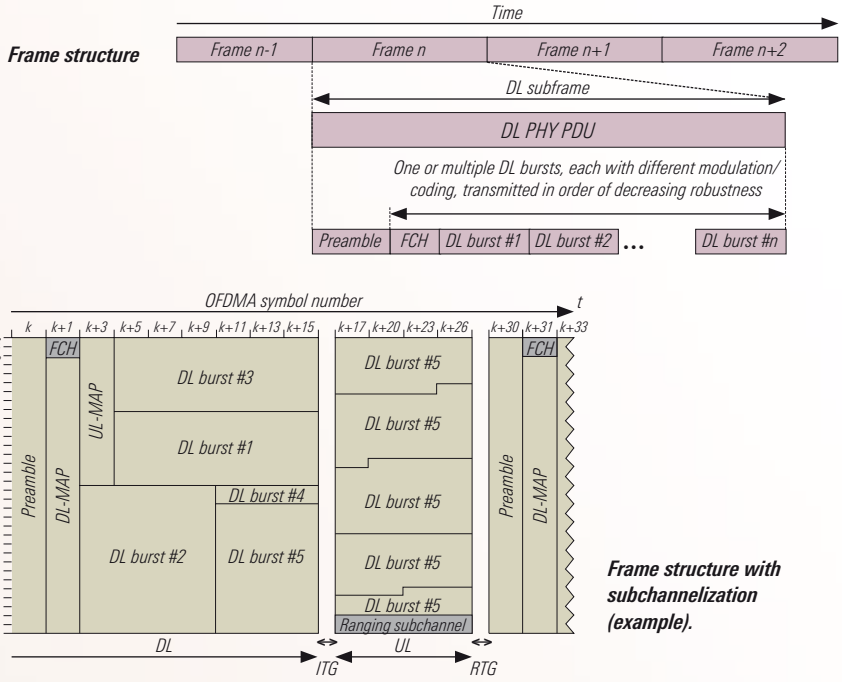
OFDM and OFDMA differ in the allocation of resources. With OFDM, users are handled sequentially. With OFDMA, however, users access resources simultaneously.

OFDM

- Variable lengths of frames
- Different bursts with different modulation schemes
- Multiple users served sequentially

OFDMA

- User-definable burst configuration
- Multiple users served in parallel using subchannelization



Frame structure with subchannelization (example).

WiMAX IEEE 802.16-2004, IEEE 802.16e and WiBro parameters

	IEEE 802.16-2004	IEEE 802.16e	WiBro
Frequency range	2 GHz to 66 GHz	2 GHz to 11 GHz	2.3 GHz to 2.4 GHz
Modulation	BPSK (pilot), QPSK, 16QAM, 64QAM	BPSK, QPSK, 16QAM, 64QAM	QPSK (8PSK), 16QAM, 64QAM
Multiple access	TDMA, OFDM 256 FFT, OFDMA, SC	Scalable OFDMA 128 to 2048 FFT, TDMA, OFDM 256 FFT, SC	OFDMA 1024 FFT
Duplex	TDD/FDD	TDD/FDD	TDD
Sample frequency	1.0 MHz to 28 MHz (in line with local regulations)	1.0 MHz to 28 MHz (in line with local regulations)	10 MHz
Peak data rate	134 Mbit/s SC (28 MHz channel bandwidth) 75 Mbit/s OFDM	15 Mbit (in 5 MHz channel)	30 Mbit/s (60 Mbit/s with smart antenna/MIMO)
Mobility	–	60 km/h	60 km/h
Guard interval	1/4, 1/8, 1/16, 1/32	1/4, 1/8, 1/16, 1/32	1/8

WiMAX frequencies

Frequency	Band description	Licensed
2.305 GHz to 2.320 GHz	WCS (Wireless Communications Service)	Yes
2.345 GHz to 2.360 GHz	WCS (Wireless Communications Service)	Yes
2.495 GHz to 2.686 GHz	MMDS (Multichannel Multipoint Distribution System), BRS (Broadband Radio Service)	Yes
3.3 GHz to 3.8 GHz	BWA (Broadband Wireless Access), WLL (Wireless Local Loop)	Yes
5.150 GHz to 5.350 GHz	U-NII (Unlicensed National Information Structure)	No
5.750 GHz to 5.825 GHz	U-NII (Unlicensed National Information Structure)	No

For more information, see
www.wimax.rohde-schwarz.com

www.rohde-schwarz.com
Europe: +49 1805 12 4242, customersupport@rohde-schwarz.com
USA and Canada: 1-888-837-8772, customer.support@rsa.rohde-schwarz.com
Asia: +65 65 130 488, customersupport.asia@rohde-schwarz.com

PD 5213.6612.62 V 01.00

Printed in Germany 0206 (Bi bb/ab)

Test and measurement solutions for WiMAX / WiBro

An application-oriented product guide for

- IEEE 802.16-2004
- IEEE 802.16e
- WiBro

ROHDE&SCHWARZ

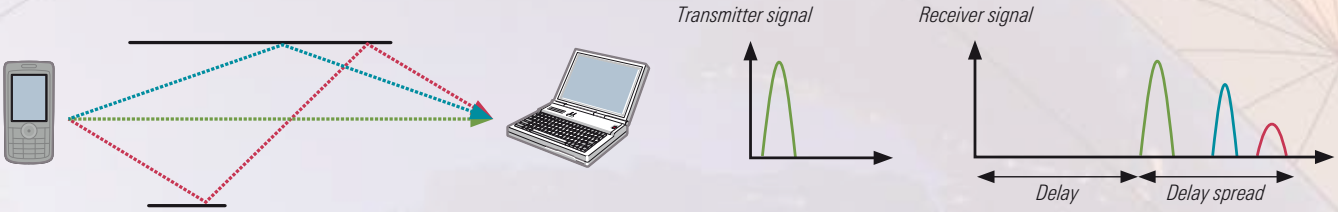
Background

Why OFDM?

Multipath interference problems occur in fading environments if the symbol duration is shorter than the delay spread. In contrast to single carrier (SC) transmission, OFDM increases the symbol duration by distributing the symbols to multiple carriers. This reduces intersymbol interference (ISI) and thus ensures interference-free transmission.

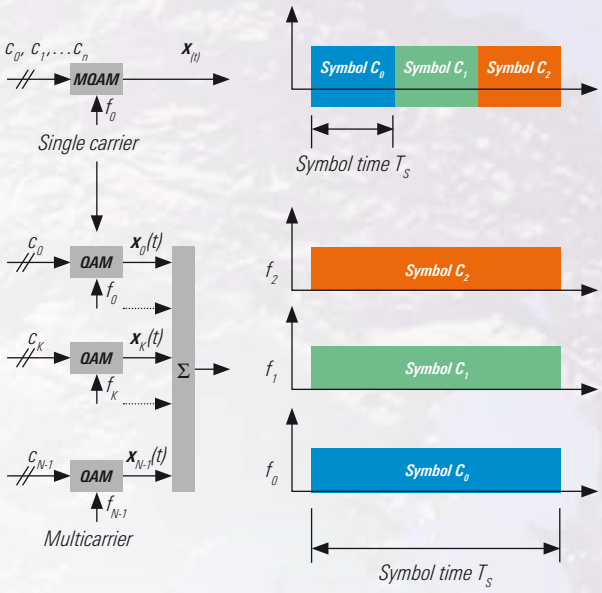
The WiMAX air interface standard (IEEE 802.16-2004 and IEEE 802.16e) is based on the latest transmission technologies. It makes use of OFDM[1] (or OFDMA[2]) and MIMO[3] to increase the data rate and robustness. However, the physical problems of the transmission channel such as fading or noise cannot be eliminated. Compared to WLAN, the system properties such as range and speed are considerably enhanced. The combination of these technologies places higher demands on developers and instruments alike. Besides integrating the new transmission models into T&M equipment, high accuracy, reliability, interoperability and ease of operation are more important than ever.

[1] OFDM = orthogonal frequency division multiplexing
[2] OFDMA = orthogonal frequency division multiple access
[3] MIMO = multiple input, multiple output

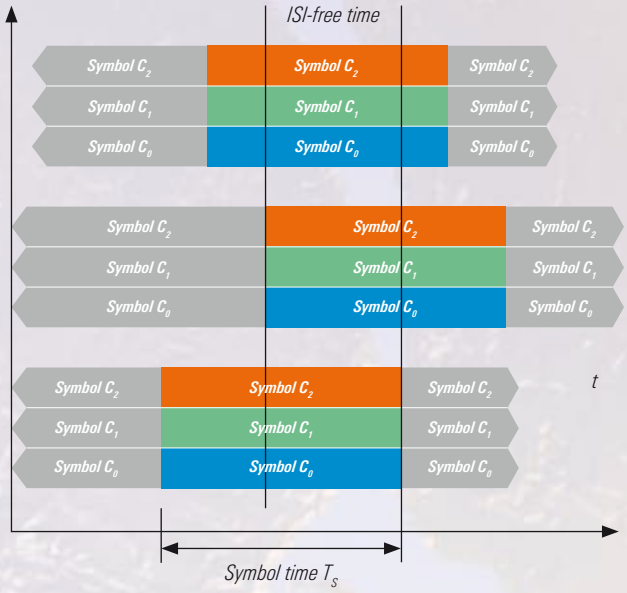


Problem of multipath interference with one carrier

The longer transmission time T_S with OFDM plus a guard interval reduce multipath interference, as the following graphics show.



Multicarrier system



Reducing ISI