
Version
01.00

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# R&S®AMU200A Baseband Signal Generator and Fading Simulator

Specifications

ROHDE&SCHWARZ

Specifications apply under the following conditions: 30 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and all internal adjustments performed. Data designated "overrange" or "underrange" and data without tolerance limits is not binding.

EMC specifications are tested with sufficiently shielded cables and accessories (e.g. mouse and keypad). To prevent degradation of these specifications, the user is responsible for using appropriate equipment.

In compliance with the 3GPP standard, chip rates are specified in Mcps (million chips per second), whereas bit rates and symbol rates are specified in kbps (thousand bits per second) or ksps (thousand symbols per second). Mcps, kbps, and ksps are not SI units.

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# Introduction

The R&S®AMU200A baseband signal generator and fading simulator has been designed to meet all requirements encountered in the research and development of modern communications systems as well as in their production. The R&S®AMU200A not only combines up to two independent baseband signal generators in one cabinet of only four height units, but also offers unrivaled channel simulation capabilities.

Due to its modular design, the R&S®AMU200A can be optimally adapted to the requirements of different applications. Up to two generators can be installed. They generate complex signals in realtime and are equipped with an arbitrary waveform generator with 16 Msample, 64 Msample, or 128 Msample memory for I and Q and four marker bits per sample. The signals generated in the different basebands can be added, even with frequency, phase, and level offset.

The modern, intuitive concept of the R&S®AMU200A ensures fast and easy operation.

# Key features

**Scalable platform**

- Up to two complete baseband paths
- Configuration as a fading simulator, I/Q source, or all-in-one instrument with fading and signal generation
- Baseband generators with universal coder for realtime signal generation
- Arbitrary waveform generators with 16 Msample, 64 Msample, or 128 Msample memory
- Analog single-ended, analog differential, and digital baseband outputs
- Up to two baseband inputs (analog/digital)
- Lossless combination of up to four baseband signals in the digital domain (e.g. for testing multistandard base stations)

**High signal quality**

- 40 MHz I/Q bandwidth with flat frequency response of typ. 0.03 dB
- Excellent ACLR performance of typ. +78 dB with 3GPP FDD (test model 1, 64 DPCH)
- Wideband noise of typ. –155 dBc
- Low inherent EVM

**Unmatched flexibility**

- Support of a multitude of digital standards, including GSM/EDGE, 3GPP FDD, HSPA, CDMA2000®[1], TD-SCDMA, WLAN, WiMAX, DVB-H, GPS, EUTRA/LTE
- Four code channels in realtime for 3GPP FDD
- Change of modulation from slot to slot for GSM/EDGE
- Multisegment waveform mode for fast signal switching
- Arbitrary waveform generator supported by R&S®WinIQSIM2™ simulation software
- Pulse generation with the pulse sequencer option from Rohde & Schwarz
- Direct waveform transmission via MATLAB®
- Internal 40 Gbyte hard disk as standard for storing waveforms and modulation data

**Fading and interference simulation**

- Dual-channel realtime fading simulator
- Up to 20 taps per channel
- Time resolution down to 0.01 ns
- Profiles for static and dynamic fading scenarios
- Additional noise simulation
- Optimal suitability for diversity tests

**Intuitive operation**

- Color display with 800 × 600 pixels (SVGA format)
- Intuitive user interface with graphical display of signal flow (block diagram)
- Graphical display of baseband signals through built-in transient recorder
- Context-sensitive help system

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[1] CDMA2000® is a registered trademark of the Telecommunications Industry Association (TIA – USA).

**Connectivity**

- Remote control via GPIB and LAN
- USB connectors for keyboard, mouse, and memory stick
- VGA connector
- User-selectable trigger and marker signals

# Baseband and enhancement options

## One-path unit

| | |
|---|---|
| R&S®AMU-B13 | Baseband Main Module (mandatory) |

## Two-path unit

| | |
|---|---|
| 2 × R&S®AMU-B13 | Baseband Main Module (mandatory) |

Additionally, one of the following baseband source options must be installed in path A (one-path unit) or path A and B (two-path unit).

| | |
|---|---|
| R&S®AMU-B9 | Baseband Generator with ARB (128 Msample) and Digital Modulation (realtime) |
| R&S®AMU-B10 | Baseband Generator with ARB (64 Msample) and Digital Modulation (realtime) |
| R&S®AMU-B11 | Baseband Generator with ARB (16 Msample) and Digital Modulation (realtime) |
| R&S®AMU-B17 | Baseband Input (digital/analog) |

The following options can be installed in path A or B.

| | |
|---|---|
| R&S®AMU-B9 | Baseband Generator with ARB (128 Msample) and Digital Modulation (realtime) |
| R&S®AMU-B10 | Baseband Generator with ARB (64 Msample) and Digital Modulation (realtime) |
| R&S®AMU-B11 | Baseband Generator with ARB (16 Msample) and Digital Modulation (realtime) |
| R&S®AMU-B16 | Differential I/Q Output |
| R&S®AMU-B17 | Baseband I/Q Input (digital/analog) |
| R&S®AMU-B18 | Baseband Digital I/Q Output |
| R&S®AMU-B14 | Fading Simulator |
| R&S®AMU-B15 | Fading Simulator Extension |

# Reference frequency

| | | |
|---|---|---|
| Aging | after 14 days of uninterrupted operation | typ. 1 × $10^{-6}$/year |
| Temperature effect | in operating temperature range | <1 × $10^{-6}$ |
| Output for internal reference signal | frequency (approx. sinewave) | 10 MHz or external input frequency |
| | level | typ. 5 dBm |
| | source impedance | 50 Ω |
| Input for external reference | frequency | 5 MHz, 10 MHz, or 13 MHz |
| | maximum deviation | 5 × $10^{-6}$ |
| | input level | ≥–6 dBm to ≤19 dBm |
| | input impedance | 50 Ω |

# Baseband outputs

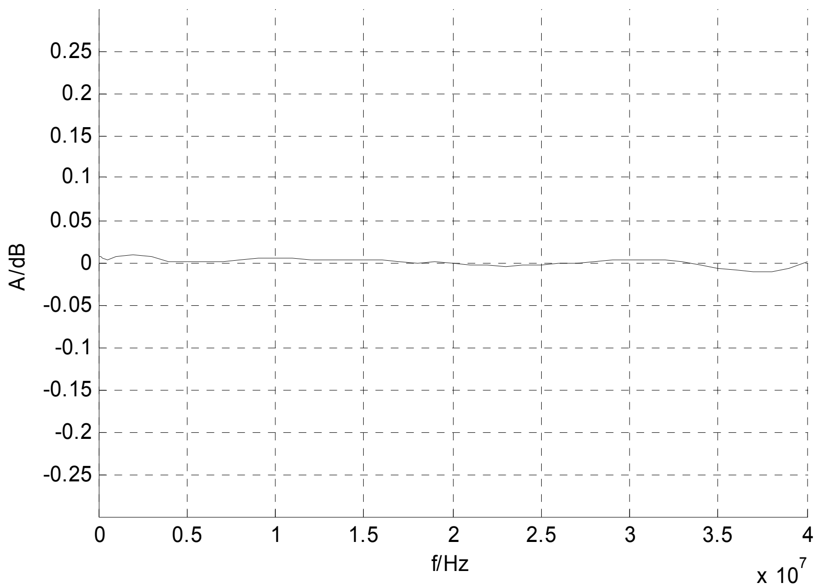
There are three kinds of baseband outputs available for the R&S®AMU200A: analog single-ended, analog differential (R&S®AMU-B16), and/or digital baseband outputs (R&S®AMU-B18). For each type of baseband output, the RMS level or PEP value can be set. The main level display can be configured to show the output level of the analog (single-ended/differential) or the digital baseband output.

## Analog I/Q outputs

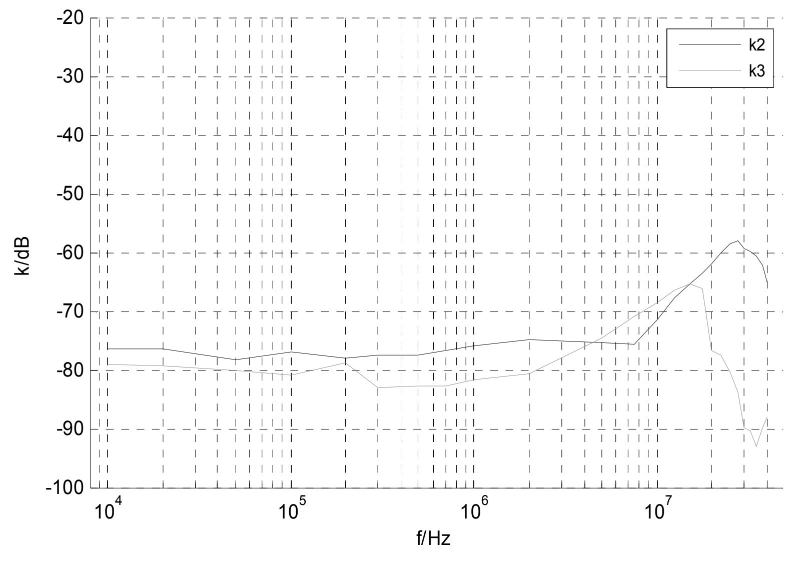
A DA board (R&S®AMU-B13) converts the internal digital baseband signals into analog I/Q output signals.

| | | |
|---|---|---|
| Output impedance | | 50 Ω |
| Output voltage | EMF | 0.02 V to 2 V ($V_p$) |
| | output load type | EMF, 50 Ω |
| Offset | EMF | <1 mV |
| D/A converter | data rate | 100 MHz |
| | resolution | 16 bit |
| | sampling rate | 400 MHz (internal interpolation × 4) |
| Aliasing filter | with amplitude, group-delay, and Si correction | |
| | bandwidth, roll-off to –0.1 dB | 40 MHz |
| | D/A converter interpolation spectra | |
| | up to 10 MHz | <–80 dBc |
| | up to 40 MHz | <–73 dBc |
| I/Q impairment | carrier leakage I, Q | |
| | setting range | –10 % to +10 % |
| | resolution | 0.01 % |
| | I ≠ Q (imbalance) | |
| | setting range | –1 dB to +1 dB |
| | resolution | 0.001 dB |
| | quadrature offset | |
| | setting range | –10° to +10° |
| | resolution | 0.01° |
| Frequency response | at $R_L$ = 50 Ω, output voltage > 0.5 V ($V_p$) | |
| | magnitude | |
| | up to 10 MHz | typ. 0.02 dB |
| | up to 40 MHz | typ. 0.03 dB |
| | nonlinear phase | |
| | up to 10 MHz | typ. 0.1° |
| | up to 30 MHz | typ. 0.3° |
| I/Q balance | at $R_L$ = 50 Ω | |
| | magnitude | |
| | up to 10 MHz | typ. 0.01 dB |
| | up to 40 MHz | typ. 0.02 dB |
| | nonlinear phase | |
| | up to 10 MHz | typ. 0.1° |
| | up to 30 MHz | typ. 0.2° |

| | | |
|---|---|---|
| Spectral purity | at $R_L$ = 50 Ω | |
| | SFDR (sine) | |
| | up to 2 MHz | >70 dB |
| | up to 20 MHz | typ. 60 dB |
| | phase noise | |
| | 10 MHz sinewave at 20 kHz offset | typ. –150 dBc |
| | wideband noise | |
| | 10 MHz sinewave at 1 MHz offset | typ. –155 dBc |




*Frequency response of I/Q outputs*




*Harmonic distortion of I/Q outputs*

## Differential I/Q output (R&S®AMU-B16 option)

One or two R&S®AMU-B16 can be installed.

| **Additional specifications for I/Q outputs with R&S®AMU-B16 option** | | |
|---|---|---|
| Output impedance | | |
| Single-ended | | 50 Ω |
| Differential | | 100 Ω |
| Output voltage | output voltage depends on set modulation signal | |
| Single-ended | EMF | 0.02 V to 2 V ($V_p$) |
| Resolution | | 1 mV |
| Differential | EMF | 0.04 V to 4 V ($V_{pp}$) |
| Resolution | | 2 mV |
| Bias voltage (single-ended and differential) | EMF | –3.6 V to 3.6 V |
| Resolution | | 2 mV |
| Uncertainty | | 1 % + 4 mV |
| Offset voltage | | |
| Differential | EMF | –300 mV to 300 mV |
| Resolution | | 0.2 mV |
| Uncertainty | | 1 % + 0.1 % × bias voltage + 1 mV |
| Differential signal balance | at $R_L$ = 50 Ω, output voltage >0.5 V ($V_p$) | |
| | magnitude | |
| | up to 10 MHz | <0.2 dB, typ. 0.05 dB |
| | up to 40 MHz | typ. 0.2 dB |
| Frequency response | at $R_L$ = 50 Ω, output voltage >0.5 V ($V_p$) | |
| | magnitude | |
| | up to 10 MHz | typ. 0.02 dB |
| | up to 40 MHz | typ. 0.03 dB |
| | nonlinear phase | |
| | up to 10 MHz | typ. 0.1° |
| | up to 30 MHz | typ. 0.2° |

## Digital I/Q outputs (R&S®AMU-B18 option)

With the R&S®AMU-B18, digital I/Q signals are available on the rear of the instrument. The digital I/Q output can be used for losslessly connecting the R&S®AMU200A to the digital I/Q input of other Rohde & Schwarz instruments (e.g. R&S®SMU200A vector signal generator). One or two R&S®AMU-B18 can be installed.

| | | |
|---|---|---|
| Interface | standard | in line with Rohde & Schwarz TVR290, I/Q data and control signals, data and interface clock |
| | level | LVDS |
| | connector | 26-pin MDR |
| | data rate | 100 MHz, 87.5 MHz |
| I/Q sample rate | With source 'user defined', the sample rate must be entered via the parameter 'sample rate'; no I/Q data clock is necessary. With source 'digital I/Q out', 'digital I/Q in', the sample rate will be estimated by the applied I/Q data clock. | |
| | source | user-defined, digital I/Q out, digital I/Q in |
| | sample rate | |
| | resolution (user-defined) | 1 kHz to 100 MHz |
| | frequency uncertainty (user-defined) | 0.001 Hz<br>$<5 \times 10^{-14}$<br>max. sample rate depends on interface data rate |
| I/Q data | resolution | 18 bit |
| | logic format | 2s complement |
| | physical signal level | |
| | setting range | 0 dBFS to –60 dBFS |
| | resolution | 0.01 dBFS |
| | bandwidth | |
| | sample rate = 100 MHz (no interpolation, user-defined) | 40 MHz |
| | sample rate <100 MHz (interpolation) | 0.31 × sample rate |
| Control signals | markers | 4 |
| | data valid | valid samples are marked in the data stream |

# Baseband input (analog/digital) (R&S®AMU-B17 option)

With the R&S®AMU-B17, external analog or digital signals can be fed to the baseband section of the R&S®AMU200A. The frequency of the signals can be shifted, and the signals can be added to the internally generated signal with variable level ratio. If the R&S®AMU200A is equipped with a fading simulator, the input signals can also be faded. One or two R&S®AMU-B17 can be installed.

| | | |
|---|---|---|
| Mode | | analog input<br>digital input |
| Input level | peak level | |
| | setting range | –10 dB to 0 dB referenced to full scale |
| | resolution | 0.01 dB |
| | crest factor | |
| | setting range | 0 dB to 30 dB |
| | resolution | 0.01 dB |
| | The adjust level function automatically determines the peak level and crest factor of the input signal. | |
| Frequency offset | With the aid of the frequency offset, the center frequency of the input signal can be shifted in the baseband. The restrictions caused by the modulation bandwidth apply. | |
| | setting range | –40 MHz to +40 MHz |
| | resolution | 0.01 Hz |
| | frequency accuracy | $<5 \times 10^{-10}$ × frequency offset + reference frequency error |
| I/Q swap | I and Q signals swapped | ON/OFF |
| **Analog I/Q inputs**<br>All specifications apply to a peak level of 0 dB. | | |
| I/Q inputs | input impedance | 50 Ω |
| | VSWR up to 30 MHz | < 1.1, typ. 1.03 |
| | input voltage for full-scale input | $\sqrt{V_i^2 + V_q^2} = 0.5\ \text{V}$ |
| I/Q impairment | carrier leakage I, Q | |
| | setting range | –10 % to +10 % |
| | resolution | 0.01 % |
| | I ≠ Q (imbalance) | |
| | setting range | –3 dB to +3 dB |
| | resolution | 0.001 dB |
| | I/Q skew | |
| | setting range | –1 ns to 1 ns |
| | resolution | 1 ps |
| A/D converter | sampling rate | 100 MHz |
| | resolution | 14 bit |
| Aliasing filter | with amplitude and group-delay correction | |
| | bandwidth, roll-off to –0.1dB | 30 MHz |
| | stopband rejection, f ≥ 70 MHz | typ. 80 dB |
| Carrier leakage | referenced to full scale | <–55 dBc, typ. <–65 dBc |
| Spectral purity | wideband noise, with full-scale DC input | typ. –150 dBc |
| | ACLR with an ideal input signal 3GPP, test model 1, 64 DPCHs | |
| | offset 5 MHz | typ. 70 dB |
| | offset 10 MHz | typ. 72 dB |
| Digital I/Q inputs | | |
| Interface | standard | in line with Rohde & Schwarz TVR290, I/Q data and control signals, data and interface clock |
| | level | LVDS |
| | connector | 26-pin MDR |
| | data rate | 66 MHz to 100 MHz |

| | | |
|---|---|---|
| I/Q sample rate | With source 'user defined', the sample rate must be entered via the parameter 'sample rate'; no I/Q data clock is necessary. With source 'digital I/Q in', the sample rate will be estimated by the applied I/Q data clock.<br>Max. sample rate depends on interface data rate. | |
| | source | user-defined, digital I/Q in |
| | sample rate | 1 kHz to 100 MHz |
| | resolution (user-defined) | 0.001 Hz |
| | frequency uncertainty (user-defined) | $<5 \times 10^{-14}$ |
| I/Q data | resolution | 18 bit |
| | logic format | 2s complement |
| | bandwidth | |
| | sample rate = 100 MHz<br>(no interpolation, user-defined) | 40 MHz |
| | sample rate <100 MHz (interpolation) | 0.31 × sample rate |
| Control signals | markers | 4 |
| | data valid | valid samples are marked in the data stream |

# I/Q baseband generator (R&S®AMU-B9/B10/B11 option) – arbitrary waveform mode

One or two R&S®AMU-B9/B10/B11 can be installed. Their I/Q signals can be assigned a frequency offset and/or be added in the digital domain.

| | | |
|---|---|---|
| Waveform memory | output memory | |
| | waveform length R&S®AMU-B9 | 128 sample to 128 Msample in one-sample steps |
| | waveform length R&S®AMU-B10 | 128 sample to 64 Msample in one-sample steps |
| | waveform length R&S®AMU-B11 | 128 sample to 16 Msample in one-sample steps |
| | resolution | 16 bit |
| | loading time 10 Msample | 15 s |
| | nonvolatile memory | hard disk |
| Multisegment waveform | number of segments | max. 100 segments |
| | changeover modes | GUI, remote control, external trigger |
| | extended trigger modes | same segment, next segment, next segment seamless |
| | changeover time (external trigger, without clock change) | <= ($84*t_{clk}$+6 µs) |
| | seamless changeover | output up to end of current segment before changeover to next segment |
| Clock generation | clock rate | 400 Hz to 100 MHz |
| | resolution | 0.001 Hz |
| | operating mode | internal, external |
| | frequency uncertainty (internal) | $<5 \times 10^{-14}$ × clock rate + uncertainty of reference frequency |
| Interpolation | The sampling rate of the waveform is automatically interpolated to the internal 100 MHz data rate. | |
| | bandwidth | |
| | clock rate = 100 MHz (no interpolation), roll-off to –0.1 dB | 40 MHz |
| | clock rate ≤100 MHz, drop to –0.1 dB | 0.31 × clock rate |
| Frequency offset | With the aid of the frequency offset, the center frequency of the wanted baseband signal can be shifted. The restrictions caused by the modulation bandwidth still apply. | |
| | range | –40 MHz to +40 MHz |
| | resolution | 0.01 Hz |
| | frequency uncertainty | $<5 \times 10^{-10}$ × frequency offset + uncertainty of reference frequency |

| | | |
|---|---|---|
| Triggering | In clock mode internal, a trigger event restarts the clock generation. The clock phase is then synchronous with the trigger (with a certain timing uncertainty). In external clock mode, the trigger event is synchronized to the symbol clock. | |
| | operating mode | internal, external |
| | modes | Auto, Retrig, Armed Auto, Armed Retrig |
| | setting accuracy for clock phase related to the trigger in internal clock mode | <18 ns |
| | external trigger delay | |
| | setting range | 0 to $2^{16}$ sample |
| | resolution | |
| | internal clock mode | 0.01 sample |
| | external clock mode | 1 sample |
| | setting accuracy | <5 ns |
| | external trigger inhibit | |
| | setting range | 0 to $2^{26}$ sample |
| | resolution | 1 sample |
| | external trigger pulse width | >15 ns |
| | external trigger frequency | <0.02 × sampling rate |
| Marker outputs | number | 4 |
| | level | LVTTL |
| | operating modes | unchanged, restart, pulse, pattern, ratio |
| | marker delay | |
| | setting range | 0 sample to (waveform length – 1) sample |
| | setting range without recalculation | 0 sample to 2000 sample |
| | resolution of setting | 0.001 sample |
| | setting accuracy | <10 ns |
| Operation with R&S®WinIQSIM2™: As of version 2.04, the software supports download of I/Q data and control of the R&S®AMU-B9/-B10/-B11. | | |

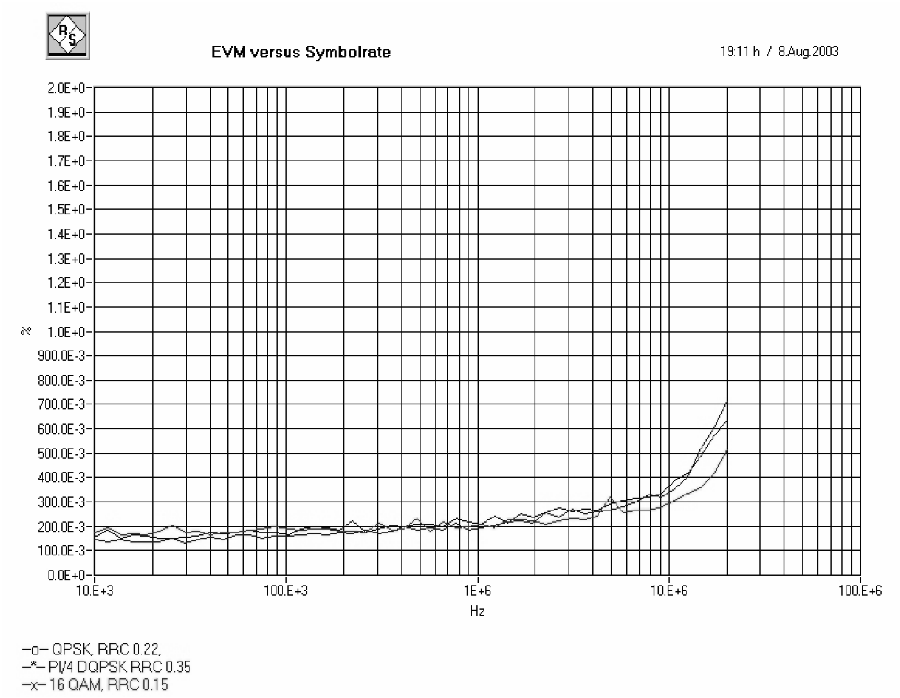
# I/Q baseband generator (R&S®AMU-B9/B10/B11 option) – realtime operation

One or two R&S®AMU-B9/B10/B11 can be installed. Their I/Q signals can be assigned a frequency offset and/or be added.

| | | |
|---|---|---|
| Types of modulation | ASK | |
| | modulation index | 0 % to 100 % |
| | resolution | 0.1 % |
| | FSK | 2FSK, 4FSK, MSK |
| | deviation | 0.1 to 1.5 × $f_{Sym}$ |
| | maximum | 10 MHz |
| | resolution | <0.1 Hz |
| | setting uncertainty | <0.5 % |
| | variable FSK | 4FSK, 8FSK, 16FSK |
| | deviations | –1.5 × $f_{sym}$ to +1.5 × $f_{sym}$ |
| | maximum | 10 MHz |
| | resolution | <0.1 Hz |
| | PSK | BPSK, QPSK, QPSK 45° offset, OQPSK, π/4-QPSK, π/2-DBPSK, π/4-DQPSK, π/8-D8PSK, 8PSK, 8PSK EDGE |
| | QAM | 16QAM, 32QAM, 64QAM, 256QAM, 1024QAM |
| Coding | Not all coding methods can be used with every type of modulation. | OFF, Differential, Diff. Phase, Diff. + Gray, Gray, GSM, NADC, PDC, PHS, TETRA, APCO25 (PSK), PWT, TFTS, INMARSAT, VDL, EDGE, APCO25(FSK), ICO, CDMA2000®, WCDMA |
| Baseband filter | Any filter can be used with any type of modulation. The bandwidth of the modulation signal is max. 25 MHz; the signal is clipped when the bandwidth is exceeded. | |
| | cosine, root cosine | |
| | filter parameter α | 0.05 to 1.00 |
| | Gaussian | |
| | filter parameter B × T | 0.15 to 2.50 |
| | cdmaOne, cdmaOne + equalizer | |
| | cdmaOne 705 kHz | |
| | cdmaOne 705 kHz + equalizer, | |
| | CDMA2000® 3X, APCO25 C4FM | |
| | rectangular | |
| | split phase | |
| | filter parameter B×T | 0.15 to 2.5 |
| | resolution of filter parameter | 0.01 |
| Symbol rate | If an external clock is used, the applied data rate may deviate from the set clock rate by ±2 %. The external clock can be used for internal and external data. | |
| | operating mode | internal, external |
| | setting range | |
| | ASK, PSK, and QAM | 400 Hz to 25 MHz |
| | FSK | 400 Hz to 15 MHz |
| | resolution | 0.001 Hz |
| | frequency uncertainty (internal) | <5 × $10^{-14}$ × symbol rate + reference frequency uncertainty |
| | external clock | symbol , K × symbol and bit clock |
| | clock divider K | 1 to 64 |
| | external clock rate | max. 100 MHz |

| | | |
|---|---|---|
| Frequency offset | With the aid of the frequency offset, the center frequency of the modulation signal in the baseband can be shifted. The restrictions caused by the modulation bandwidth apply. | |
| | setting range | –40 MHz to +40 MHz |
| | resolution | 0.01 Hz |
| | frequency uncertainty | <5 × $10^{-10}$ × frequency offset + reference frequency uncertainty |
| Data sources | **internal** | |
| | all 0, all 1 | |
| | PRBS | |
| | sequence length | 9, 11, 15, 16, 20, 21, 23 |
| | pattern | |
| | length | 1 bit to 64 bit |
| | data lists | |
| | output memory | |
| | R&S®AMU-B9 | 8 bit to 1 Gbit |
| | R&S®AMU-B10 | 8 bit to 2 Gbit |
| | R&S®AMU-B11 | 8 bit to 4 Gbit |
| | nonvolatile memory | hard disk |
| | **external** | |
| | In the case of serial transmission, the symbol strobe marks the LSB of the symbol, and the maximum symbol rate is limited by the data rate of the interface. | |
| | serial | |
| | word width | 1 bit to 10 bit |
| | bit rate | max. 60 MHz |
| | parallel | |
| | word width | 1 bit to 10 bit |
| | symbol rate | max. 25 MHz |
| Triggering | In internal clock mode, a trigger event restarts the clock generation. The clock phase is then synchronous with the trigger (with a certain timing uncertainty). In external clock mode, the trigger event is synchronized to the symbol clock. | |
| | operating mode | internal, external |
| | modes | Auto, Retrig, Armed Auto, Armed Retrig |
| | setting accuracy for clock phase related to the trigger in internal clock mode | <18 ns |
| | external trigger delay | |
| | setting range | 0 sample to $2^{16}$ sample |
| | resolution | |
| | internal clock mode | 0.01 sample |
| | external clock mode | 1 sample |
| | setting accuracy | <5 ns |
| | external trigger inhibit | |
| | setting range | 0 sample to $2^{26}$ sample |
| | resolution | 1 sample |
| | external trigger pulse width | >15 ns |
| | external trigger frequency | <0.02 × sampling rate |
| Marker outputs | number | 4 |
| | level | LVTTL |
| | operating modes | control list, restart, pulse, pattern, ratio |
| | marker delay (in sample) | |
| | setting range | 0 to ($2^{24}$ –1) |
| | setting range without recalculation | 0 to 2000 |
| | resolution of setting | 0.001 |
| | setting uncertainty | <10 ns |

| | | |
|---|---|---|
| Level reduction | Internal or external via LEVATT input. The signal switches between nominal and reduced level (without edge shaping). When an internal LEVATT signal is used, the connector is used as an output. | |
| | setting range | 0 dB to 60 dB |
| | additional level error in case of reduction | |
| | up to 30 dB | <1 dB |
| | up to 50 dB | <3 dB |
| Burst | Internal or external via BURST input. The signal triggers the beginning of a power ramp. The positive edge starts power ramping from blank to full level; the negative edge ramping in the opposite direction from full level to blanking. When an internal BURST GATE signal is applied, the connector is used as an output. | |
| | operating range | max. 5 MHz |
| | rise/fall time | |
| | setting range | 0.5 symbol to 16 symbol |
| | resolution | 0.1 symbol |
| | ramp shape | cosine, linear |
| Trigger/clock/data inputs | Input impedance and trigger threshold can be set separately for the trigger and the clock/data inputs. | |
| | input impedance | 1 kΩ, 50 Ω |
| | trigger threshold | |
| | setting range | 0 V to 2.50 V |
| | resolution | 0.01 V |
| Clock/data outputs | level | LVTTL |
| Predefined settings | modulation, filter, symbol rate, and coding in line with standard | |
| | standards | Bluetooth®, DECT, ETC, GSM, GSM EDGE, NADC, PDC, PHS, TETRA, WCDMA 3GPP, TD-SCDMA, CDMA2000® Forward, CDMA2000® Reverse, Worldspace |
| **Modulation errors** | | |
| Deviation error with 2FSK, 4FSK | deviation 0.2 to 0.7 × symbol rate | |
| | Gaussian filter with B × T = 0.2 to 0.7 | |
| | symbol rate up to 2 MHz | 1.2 %, typ. 0.25 % |
| | symbol rate up to 10 MHz | typ. 0.75 % |
| Phase error with MSK | Gaussian filter with B × T = 0.2 to 0.7 | |
| | bit rate up to 2 MHz | 0.4°, typ. 0.15° |
| | bit rate up to 10 MHz | typ. 0.3° |
| EVM with QPSK, OQPSK, π/4-DQPSK, 8PSK, 16QAM, 32QAM, 64QAM | cosine, root cosine filter with α = 0.2 to 0.7 | |
| | symbol rate up to 5 MHz | 0.8 %, typ. 0.2 % |
| | symbol rate up to 20 MHz | typ. 0.7 % |




*Typical EVM versus symbol rate*

## Modulation accuracy for main standards

Typical values

| **Standard** | **GSM** | **EDGE** | **WCDMA 3GPP (1DPCH)** | **CDMA2000® forward (9 channels)** | **DECT** | **TETRA** | **NADC** | **PDC** | **IEEE 802.11a** |
|---|---|---|---|---|---|---|---|---|---|
| EVM in % | – | 0.2 | 0.25 | 0.2 | – | 0.2 | 0.2 | 0.2 | 0.4 |
| Phase error in ° | 0.15 | – | – | – | – | – | – | – | – |
| Dev. error in kHz | – | – | – | – | 0.5 | – | – | – | – |
| Channel spacing | 200 kHz | 200 kHz | 5 MHz | 1.25 MHz | 1.728 MHz | 25 kHz | 30 kHz | 25 kHz | – |
| Adjacent channel power ratio (ACPR) in dB | | | | | | | | | |
| In adjacent channel | –37 | –41 | –82 | –86[2] | – | –78[3] | –34 | –74 | –56 at 11 MHz |
| In alternate channel | –71 | –71 | –84 | –89[4] | – | –86[8] | –86 | –82 | –65 at 20 MHz |
| In 2nd alternate channel | –90 | –86 | – | –90[5] | – | – | – | – | –66 at 30 MHz |

[2] 885 kHz offset and 30 kHz bandwidth.

[3] Measured with root cosine filter.

[4] 1.25 MHz offset and 30 kHz bandwidth.

[5] 1.98 MHz offset and 30 kHz bandwidth.

# Digital modulation systems

At least one I/Q baseband generator (R&S®AMU-B9/-B10/-B11 option) must be installed. If two I/Q baseband generators are installed and two signals of the same standard (e.g. GSM/EDGE) are to be output simultaneously, two corresponding software options must also be installed (in this case R&S®AMU-K40). If only one R&S®AMU-K40 is installed and GSM/EDGE is selected in one I/Q baseband generator, the other I/Q baseband generator is disabled for GSM/EDGE. However, a software option is not tied to a specific I/Q baseband generator.

The data specified applies together with the parameters of the respective standard.

## GSM/EDGE digital standard (R&S®AMU-K40 option)

| | | |
|---|---|---|
| GSM/EDGE digital standard | | in line with GSM standard |
| Modes | unframed | generation of a signal without slot and frame structure and power ramping, with symbol rate and filtering in line with GSM standard; MSK or 8PSK EDGE modulation can be selected |
| | framed (single) | configuration of a signal via frame structure (see frame structure below) |
| | framed (double)<br>application: simulation of modulation change in a slot versus time | configuration of simple multiframe scenarios by combining two frames (frame structure see below); a repetition factor can be specified for each of the two frames |
| Modulation | | MSK,<br>switchable to FSK with settable deviation for simulating frequency deviation errors<br>8PSK EDGE |
| Symbol rate | standard | 270.833 kHz |
| | range | 400 Hz to 300 kHz |
| Baseband filter | GSM, standard | Gaussian with B × T = 0.3 |
| | range | B × T = 0.15 to 2.5 |
| | EDGE, standard | Gaussian linearized (EDGE) |
| Frame structure | Change between GSM and EDGE possible from slot to slot and frame to frame; half rate and GPRS at the physical layer. Slots 0 to 7 of the frames are user-defined for uplink and downlink. In the normal burst half-rate mode, the burst parameters can be defined independently for two users that alternate from frame to frame. | |
| | burst types | normal (full rate)<br>normal (half rate)<br>EDGE<br>synchronization<br>frequency correction (normal + compact)<br>dummy<br>access<br>all data (GSM)<br>all data (EDGE) |
| Burst rise/fall time | standard | in line with GSM power time template |
| | selectable | |
| | ramp time | 0.3 symbol to 4 symbol |
| | ramp delay | –1.0 symbol to 1.0 symbol |
| | rise delay | –9 symbol to 9 symbol |
| | fall delay | –9 symbol to 9 symbol |
| Settable slot attenuation | | 0.0 dB to 60.0 dB, 8 different levels simultaneously possible (full level and 7 attenuated levels) |
| Burst ON/OFF ratio | | >100 dB |

| | | |
|---|---|---|
| Data sources | For data source characteristic, see section "I/Q baseband generator (R&S®AMU-B9/B10B11 option) – realtime operation". | |
| | internal data sources | all 0<br>all 1<br>PRBS 9, 11, 15, 16, 20, 21, 23<br>pattern (length 1 bit to 64 bit)<br>data list |
| Training sequence | for normal burst (full rate), normal burst (half rate), EDGE burst | TSC0 to TSC7, user TSC |
| | for sync burst | standard, CTS, compact, user |
| | for access burst | TS0 to TS2 |
| Triggering | | see I/Q baseband generator |
| Markers | | convenient graphics editor for defining marker signals, and in addition:<br>frame, multiple frame<br>slot, multiple slot<br>pulse<br>pattern<br>ON/OFF ratio |
| Phase error | MSK, Gaussian filter B × T = 0.3 | |
| | rms | ≤0.4°, typ. 0.15° |
| | peak | ≤1.2°, typ. 0.4° |
| Error vector magnitude | 8PSK EDGE, Gaussian linearized filter | |
| | rms | ≤0.5 %, typ. 0.2 % |
| Power density spectrum | values measured with 30 kHz resolution bandwidth, referenced to level in band center without power ramping | |
| | 200 kHz offset | typ. –37 dB |
| | 400 kHz offset | typ. –71 dB |
| | 600 kHz offset | typ. –90 dB |

# 3GPP FDD digital standard (R&S®AMU-K42 option)

| | | |
|---|---|---|
| WCDMA 3GPP FDD digital standard | | in line with 3GPP standard, release 6 |
| Signal generation modes/sequence length | Combination of realtime operation (enhanced channels) and arbitrary waveform mode. In downlink mode, the P-CCPCH (BCCH with running SFN) and up to three DPCHs can be generated in realtime. All other channels (frame-cycle control channels such as SCH, OCNS simulation, other base stations, etc) can be added via the ARB. In uplink mode, one mobile station can be simulated in realtime (PRACH, PCPCH, or DPCCH and up to 6 DPDCHs); further mobile stations (three user-configured and up to 64 of identical mode) can be simulated via the ARB and added to the realtime signal.<br><br>The sequence length of the ARB component can be entered in frames (10 ms each); the max. length depends on chip rate, mode, and in some cases on oversampling. | |
| Enhanced channels | special capabilities in up to 4 channels of base station 1 on downlink and in all channels of mobile station 1 on uplink:<br>realtime calculation, optional channel coding, simulation of bit and block errors, data lists as sources for data and TPC fields | |
| Modulation | | BPSK (uplink)<br>QPSK (downlink)<br>16QAM (downlink HSDPA) |
| Test models | downlink (in line with TS 25.141) | test model 1 with 16/32/64 channels<br>test model 2<br>test model 3 with 16/32 channels<br>test model 4<br>test model 5 with 8/4/2 HS-PDSCH channels |
| | uplink (not standardized) | DPCCH + 1 DPDCH at 60 ksps<br>DPCCH + 1 DPDCH at 960 ksps |
| Generate waveform file | | filtering of data generated in ARB mode and saving it as waveform file |
| **Realtime component** | | |
| WCDMA signal in realtime | generation of WCDMA signals with up to 4 active enhanced channels | |
| Applications | continuous measurement of BER and BLER (with channel coding) in a code channel with any (PN) data without wrap-around problems<br>use of user data (data lists) with externally processed long data sequences for enhanced channels | |
| Data lists for data and TPC field | The data fields and the transmit power control (TPC) field of the slots of enhanced channels can be filled from data lists. Externally generated data can thus be fed into the signal generation process of the R&S®AMU200A, e.g. with payload information from higher layers, on transport or physical layer. Long power control profiles for power control of the DUT can also be generated. | |
| Applications | measurement of power control steps of a mobile station (UE power control steps)<br>measurement of maximum output power of a mobile station (UE max. output power) | |

| | | |
|---|---|---|
| Channel coding | coding of up to 4 enhanced channels in line with the definition of reference measurement channels in TS 25.101, TS 25.104 and TS 25.141; in addition, user-configurable channel coding for each enhanced channel station | |
| | predefined channel coding schemes for uplink and downlink | RMC 12.2 kbps<br>AMR 12.2 kbps<br>RMC 64 kbps<br>RMC 144 kbps<br>RMC 384 kbps |
| | possible settings of user-configurable channel coding | |
| | transport channels | 1 DCCH<br>up to 6 DTCHs |
| | transport block size | 1 to 4096 |
| | transport blocks | 1 to 16 |
| | rate matching attribute | 16 to 1024 |
| | transport time interval | 10 ms, 20 ms, 40 ms, 80 ms |
| | CRC size | none, 8, 12, 16, 24 |
| | error protection | none, convolutional coding rate 1/3, convolutional coding rate 1/2, turbo coding rate 1/3 |
| | interleaver 1/2 state | ON/OFF |
| Applications | BER measurements in line with TS 25.101/104/141 (radio transmission and reception), e.g.<br>adjacent channel selectivity<br>blocking characteristics<br>intermodulation characteristics | |
| | BLER measurements in line with TS 25.101/104 (radio transmission and reception) e.g.<br>demodulation of dedicated channel under static propagation conditions<br>(AWGN generation together with R&S®AMU-K62)<br>test of decoder in receiver | |
| Bit error insertion | deliberate generation of bit errors by impairing the data stream prior to channel coding or at the physical layer | |
| | bit error ratio | 0.5 to $10^{-7}$ |
| Application | verification of internal BER calculation in line with TS 25.141 (BS conformance testing) | |
| Block error insertion | deliberate generation of block errors by impairing the CRC during coding of enhanced channels | |
| | block error ratio | 0.5 to $10^{-4}$ |
| Application | verification of internal BLER calculation in line with TS 25.141 (BS conformance testing) | |
| Add OCNS | Simulation of orthogonal background and interfering channels of a base station in line with TS 25.101.<br>The power of the OCNS channels is configured automatically so that the total power of the BS is 1. | |
| Applications | testing the receiver of the mobile station under real conditions;<br>measuring the maximum input level in line with TS 25.101 | |
| Additional mobile stations | Simulation of up to 64 mobile stations in addition to the 4 user-configurable mobile stations; the additional mobile stations use different scrambling codes. | |
| Parameters | number of additional mobile stations | 1 to 50 |
| | scrambling code step | 1 to 1000 hex |
| | power offset | –20 dB to 20 dB |
| Applications | base station tests under real receive conditions | |

| | | |
|---|---|---|
| **General settings** | | |
| Triggering | | see I/Q baseband generator |
| Chip rate | standard | 3.840 Mcps (15 slots/frame) |
| | range | 1 Mcps to 5 Mcps |
| Link direction | | uplink (reverse link) and<br>downlink (forward link) |
| Baseband filter | standard | $\sqrt{\cos}$ , $\alpha$ = 0.22 |
| | other filters | $\sqrt{\cos}$ , cos, user filters |
| Clipping | Setting of clipping value relative to highest peak in percent. Clipping takes place prior to baseband filtering. Clipping reduces the crest factor. | |
| | modes | vector \|i + j q\|<br>scalar \|i\|, \|q\| |
| | clipping level | 1 % to 100 % |
| Code channels | downlink | up to 512 data channels (plus special channels) divided among up to 4 base stations (BS) of 128 code channels each |
| | uplink | up to four user-configurable mobile stations (MS) and 64 additional MS of identical configuration in each of the modes PRACH only, PCPCH only, DPCCH + DPDCHs |
| **Parameters of every BS** | | |
| State | | ON/OFF |
| Scrambling code | | 0 to 5FFF hex |
| 2nd search code group | | 0 to 63 |
| Page indicators per frame | | 18, 36, 72, 144 |
| Time delay | The signals of the various base stations are delayed against each other. | 0 chips to 38400 chips |
| Transmit diversity | The output signal can be generated either for antenna 1 or 2, as defined in the standard. | OFF/antenna 1/antenna 2 |
| **Physical channels in downlink** | | |
| | primary common pilot channel (P-CPICH) | |
| | secondary common pilot channel (S-CPICH) | |
| | primary sync channel (P-SCH) | |
| | secondary sync channel (S-SCH) | |
| | primary common control physical channel (P-CCPCH) | |
| | secondary common control physical channel (S-CCPCH) | |
| | page indication channel (PICH) | |
| | access preamble acquisition indication channel (AP-AICH) | |
| | collision detection acquisition indication channel (AICH) | |
| | physical downlink shared channel (PDSCH) | |
| | dedicated physical control channel (DL-DPCCH) | |
| | dedicated physical channel (DPCH) | |
| | high-speed shared control channel (HS-SCCH) | |
| | high-speed physical downlink shared channel (HS-PDSCH),<br>modulation QPSK or 16QAM | |
| **Parameters of every downlink code channel that can be set independently** | | |
| State | | ON/OFF |
| Slot format | depending on physical channel type | 0 to 16 |
| Symbol rate | depending on physical channel type | 7.5 ksps to 960 ksps |
| Channelization code | value range depending on physical channel type and symbol rate | 0 to 511 |
| Power | | –80 dB to 0 dB |
| Payload data | | PRBS: 9, 11, 15, 16, 20, 21, 23<br>all 0, all 1, pattern (length 1 bit to 64 bit)<br>data lists |
| Multicode state | | ON/OFF |
| Timing offset | time offset that can be separately set for each code channel | 0 to 150 (in units of 256 chips) |
| Pilot length | depending on symbol rate | 2 bit, 4 bit, 8 bit, 16 bit |
| Pilot power offset | power offset of pilot field against data fields | –10 dB to 10 dB |

| | | |
|---|---|---|
| TPC pattern | | all 0, all 1, pattern (length 1 bit to 32 bit), data lists |
| TPC pattern readout mode | application mode for TPC pattern | continuous, single + all 0, single + all 1, single + alt. 01, single + alt. 10 |
| Use of TPC for dynamic output power control | If this function is active, the TPC pattern is used to vary the transmit power of the code channels versus time. | |
| | state | ON/OFF |
| | output power control step | –10 dB to +10 dB |
| TPC power offset | power offset of TPC field relative to data fields | –10 dB to +10 dB |
| TFCI state | | ON/OFF |
| TFCI | | 0 dB to 1023 dB |
| TFCI power offset | power offset of TFCI field relative to data fields | –10 dB to +10 dB |
| **Parameters of every MS** | | |
| State | | ON/OFF |
| Mode | | PRACH only, PCPCH only, DPCCH + DPDCHs |
| Scrambling code | | 0 to FF FFFF hex |
| Scrambling code mode | | long, short |
| Time delay | The signals of the various mobile stations are delayed against each other. | 0 chips to 38400 chips |
| **Physical channels in uplink** | | |
| | physical random access channel (PRACH) | |
| | physical common packet channel (PCPCH) | |
| | dedicated physical control channel (DPCCH) | |
| | dedicated physical data channel (DPDCH) | |
| **PRACH Only mode** | | |
| Submodes | Preamble only: Only preambles are generated.<br>Application: Detection of RACH preamble in line with TS 25.141. | |
| | Standard: The message part of the PRACH is generated in addition to a settable number of preambles. It can also be channel-coded.<br>Application: Demodulation of RACH message part in line with TS 25.141. | |
| Frame structure | | preamble(s), message part consisting of data and control component |
| Slot format | | 0 to 3 |
| Symbol rate | | 15 ksps, 30 ksps, 60 ksps, 120 ksps |
| Preamble part power | | –80 dB to 0 dB |
| Preamble power step | | 0 dB to 10 dB |
| Preamble repetition | | 1 to 10 |
| Data part power | | –80 dB to 0 dB |
| Control part power | | –80 dB to 0 dB |
| Signature | | 0 to 15 |
| Access slot | | 0 to 14 |
| AICH transmission timing | | 0 (3 access slots) or<br>1 (4 access slots) |
| Message part length | | 1 frame, 2 frames |
| TFCI | | 0 to 1023 |
| Payload data | | PRBS: 9, 11, 15, 16, 20, 21, 23<br>all 0,all 1, pattern (length 1 bit to 64 bit), data lists |
| Channel coding | reference measurement channel for UL RACH in line with TS 25.141 | |
| | state | ON/OFF |
| | transport block size | 168, 360 |
| **PCPCH Only mode** | | |
| Submodes | Preamble only: Only preambles are generated.<br>Application: Detection of CPCH preamble in line with TS 25.141. | |
| | Standard: The message part of the PCPCH is generated in addition to a settable number of preambles. It can also be channel-coded.<br>Application: Demodulation of CPCH message part in line with TS 25.141. | |
| Frame structure | | access preamble(s), collision detection preamble, power control preamble, message part consisting of data and control component |

| | | |
|---|---|---|
| Slot format control part | | 0 to 2 |
| Symbol rate | | 15 ksps, 30 ksps, 60 ksps, 120 ksps, 240 ksps, 480 ksps, 960 ksps |
| Preamble part power | | –80 dB to 0 dB |
| Preamble power step | | 0 dB to 10 dB |
| Preamble repetition | | 1 to 10 |
| Data part power | | –80 dB to 0 dB |
| Control part power | | –80 dB to 0 dB |
| Signature | | 0 to 15 |
| Access slot | | 0 to 14 |
| AICH transmission timing | | 0 (3 access slots) or 1 (4 access slots) |
| Message part length | | 1 to 10 frames |
| Power control preamble length | | 0 slots, 8 slots |
| FBI state | | OFF/1 bit/2 bit |
| FBI pattern | | pattern (length 1 bit to 32 bit) |
| Payload data | | PRBS: 9, 11, 15, 16, 20, 21, 23<br>all 0, all 1, pattern (length 1 bit to 64 bit)<br>data lists |
| Channel coding | reference measurement channel for UL CPCH in line with TS 25.141 | |
| | state | ON/OFF |
| | transport block size | 168, 360 |
| **DPCCH + DPDCH Only mode** | | |
| DPCCH<br>(dedicated physical control channel) | symbol rate | 15 ksps |
| | power | –80 dB to 0 dB |
| | channelization code | 0, fixed |
| | FBI state | OFF/1 bit/2 bit |
| | FBI pattern | pattern (length 1 bit to 32 bit) |
| | TFCI state | ON/OFF |
| | TFCI | 0 to 1023 |
| | TPC pattern | all 0, all 1, pattern (length 1 bit to 32 bit), data lists |
| | TPC pattern readout mode (application mode for TPC pattern) | continuous, single + all 1, single + all 1, single + alt. 01, single + alt. 10 |
| | TPC for dynamic output power control; if this function is active, the TPC pattern is used to vary the transmit power of the code channels of the MS versus time | |
| | state | ON/OFF |
| | output power control step | –10 dB to +10 dB |
| DPDCH<br>(dedicated physical data channel) | overall symbol rate (total symbol rate of all uplink DPDCHs) | 15 ksps, 30 ksps, 60 ksps, 120 ksps, 240 ksps, 480 ksps, 960 ksps, 2 × 960 ksps, 3 × 960 ksps, 4 × 960 ksps, 5 × 960 ksps, 6 × 960 ksps |
| | depending on overall symbol rate: | |
| | active DPDCHs | 1 to 6 |
| | symbol rate | fixed for active DPDCHs |
| | channelization code | fixed for active DPDCHs |
| | channel power | –80 dB to 0 dB |
| | payload data | PRBS: 9, 11, 15, 16, 20, 21, 23<br>all 0, all 1, pattern (length 1 bit to 64 bit)<br>data lists |
| Graphical display | | domain conflicts, code domain, channel graph, slot structure, and formats offered in graphics block |
| Error vector magnitude | 1 DPCH, rms | <0.8 %, typ. 0.3 % |
| Adjacent-channel leakage ratio (ACLR) | test model 1, 64 DPCHs | |
| | offset 5 MHz | typ. 78 dB |
| | offset 10 MHz | typ. 79 dB |

## 3GPP FDD enhanced BS/MS test including HSDPA (R&S®AMU-K43 option)

At least one R&S®AMU-K42 option must be installed.

| | | |
|---|---|---|
| General parameters | This option extends the R&S®AMU-K42 (3GPP FDD digital standard) to full HSDPA support and dynamic power control. Therefore, all general parameters of the R&S®AMU-K42 such as frequency range or modulation are also valid for the R&S®AMU-K43. | |
| **Downlink simulation** | | |
| HSDPA channels (HS-SCCH, HS-PDSCH, and F-DPCH) | | |
| Enhancements | The R&S®AMU-K42 supports simulation of HDSPA channels in a continuous mode needed for TX measurements in line with TS 25.141 (test model 5). The R&S®AMU-K43 now supports simulation of HS-SCCH (high speed shared control channel) and HS-PDSCH (high speed physical downlink shared channel) in line with TS 25.211. This implies the correct timing between these channels as well as the possibility to set start subframe and inter-TTI distance. In addition, several F-DPCHs (fractional dedicated physical channel) can be generated. | |
| Application | TX measurements on 3GPP FDD Node Bs with realistic statistics | |
| | RX measurements on 3GPP FDD UEs with correct timing | |
| Ranges (valid for HS-SCCH and HS-PDSCH) | HSDPA mode | continuous, subframe 0 to subframe 4 (where first packet is sent), H-Set |
| | inter-TTI distance | 1 to 16 |
| | burst mode | ON: DTX between two HS-PDSCH packets<br>OFF: transmission of dummy data between two HS-PDSCH packets |
| Fixed reference channel definition H-Set | | |
| Enhancements | The R&S®AMU-K43 allows HSDPA downlink channels with channel coding to be generated in line with the definition of the fixed reference channels (H-Set) in TS 25.101; in addition, user-configurable bit/block error insertion is possible. | |
| Ranges | H-Set | H-Set 1 to H-Set 5 |
| | slot format | QPSK, 16QAM (H-Set 1 to H-Set 3) |
| | RV parameter | 0 to 7 |
| | UEID | 0 to 65535 |
| | bit error insertion | 0.5 to $10^{-7}$ (insertion prior to channel coding or at the physical layer) |
| | block error insertion | 0.5 to $10^{-4}$ |
| Dynamic power control | | |
| Enhancements | The R&S®AMU-K42 provides a method to vary the output power of a code channel in arbitrary waveform mode by misusing its TPC pattern. The R&S®AMU-K43 now allows the variation of the output power in realtime mode for up to 3 DPCHs in three submodes: | |
| | external | UE provides TPC info to R&S®AMU200A by external connector (TTL level) |
| | by TPC pattern | TPC pattern is used to control the output power |
| | manual | the output power is changed incrementally by pressing buttons or sending the corresponding remote control commands |
| Application | RX measurements on 3GPP FDD UEs where closed loop power control is needed | |
| | RX measurements on 3GPP FDD UEs with varied code channel power without dropouts in the signal | |
| Ranges | mode | external, by TPC pattern, manual |
| | direction | up, down |
| | power step | 0.5 dB to 6 dB |
| | up range | 0 dB to 20 dB |
| | down range | 0 dB to 20 dB |

| | | |
|---|---|---|
| **Uplink simulation** | | |
| HS-DPCCH (high speed dedicated physical control channel) | | |
| Enhancements | The R&S®AMU-K42 does not support HSDPA for uplink. The R&S®AMU-K43 now allows the simulation of a HS-DPCCH (high speed dedicated physical control channel) in realtime operation (UE1) and arbitrary waveform mode (UE2 to UE4). | |
| Application | TX measurements on 3GPP FDD UEs supporting HSDPA | |
| | RX measurements on 3GPP FDD Node Bs supporting HDSPA | |
| Ranges | power | –80 dB to 0 dB |
| | start delay | 101 to 250 (in units of 256 chips) |
| | inter-TTI distance | 1 subframe to 16 subframes |
| | CQI pattern | up to 10 CQI values sent periodically, support of DTX |
| | ACK/NACK pattern | up to 32 ACK/NACK commands sent periodically, support of DTX |
| Dynamic power control | | |
| Enhancements | The R&S®AMU-K42 provides a method to vary the output power of a code channel in arbitrary waveform mode by misusing its TPC pattern. The R&S®AMU-K43 now allows the variation of the output power in realtime mode for UE1 in three submodes: | |
| | external | Node B provides TPC info to the R&S®AMU200A by external connector (TTL level) |
| | by TPC pattern | TPC pattern is used to control the output power |
| | manual | the output power is changed incrementally |
| Application | RX measurements on 3GPP FDD Node Bs where closed loop power control is needed | |
| | RX measurements on 3GPP FDD Node Bs with varied UE power without dropouts in the signal | |
| Ranges | mode | external, by TPC pattern, manual |
| | direction | up, down |
| | power step | 0.5 dB to 6 dB |
| | up range | 0 dB to 20 dB |
| | down range | 0 dB to 20 dB |

## GPS digital standard (R&S®AMU-K44 option)

| | | |
|---|---|---|
| GPS digital standard | | in line with ICD-GPS-200 revision C |
| **General settings** | | |
| Virtual RF frequency | | default L1 = 1575.42 MHz |
| Modulation | | BPSK (CDMA) |
| Symbol rate (chip rate) | | 1.023 MHz |
| Baseband filter | | Gaussian<br>filter parameter B × T = 1 |
| Simulation modes | | generic mode<br>localization mode |
| Marker | | navigation data bit (20460 chips)<br>navigation data word (30 data bits)<br>navigation data subframe (10 data words)<br>navigation page (5 data subframes)<br>complete navigation message (25 data pages)<br>pulse<br>pattern<br>ON/OFF ratio |
| Triggering | | see I/Q baseband generator |
| **Navigation data** | | |
| Navigation data | identical for each satellite | all 0<br>all 1<br>pattern (up to 64 bit)<br>PN 9 to PN 23<br>data lists<br>real navigation data |
| Real navigation data | | support of SEM-Almanac, any valid date and time (GMT) |
| Navigation data rate | | 50 bps |
| **Satellite configurations** | | |
| Number of channels | | 1 to 4 satellites |
| Use spreading code | identical for each satellite | ON/OFF |
| State | separately settable for each satellite | ON/OFF |
| Space vehicle ID | separately settable for each satellite | C/A codes: 37 Gold codes, 1023 chips each |
| Time shift | separately settable for each satellite | 0 to 10000000 (C/A code chip)/16 |
| Power | separately settable for each satellite | ±10 dB |
| Doppler shift | separately settable for each satellite | ±100 kHz (selectable in steps of 0.01 Hz) |
| **Localization mode** | | |
| Latitude | latitude of simulated location | ±90° (selectable in steps of 0.1 s) |
| Longitude | longitude of simulated location | ±180° (selectable in steps of 0.1 s) |
| Altitude | altitude of simulated location | ±10000 m<br>(selectable in steps of 0.1 m) |

## 3GPP FDD HSUPA (R&S®AMU-K45 option)

At least one R&S®AMU-K42 option must be installed.

| | | |
|---|---|---|
| General parameters | This option extends the R&S®AMU-K42 (3GPP FDD digital standard) to full HSUPA support. Therefore, all general parameters of the R&S®AMU-K42 such as frequency range or modulation are also valid for the R&S®AMU-K45. | |
| **Downlink simulation** | | |
| HSUPA channels (E-AGCH, E-RGCH, E-HICH) | | |
| Enhancements | The R&S®AMU-K45 in downlink supports simulation of HSUPA control channels E-AGCH (E-DCH absolute grant channel), E-RGCH (E-DCH relative grant channel), and E-HICH (E-DCH hybrid ARQ indicator channel) in line with TS 25.211. | |
| Application | RX measurements on 3GPP FDD UEs with correct timing | |
| Ranges (valid for E-RGCH and E-HICH) | type of cell | serving cell, non-serving cell |
| | E-DCH TTI | 2 ms, 10 ms |
| | signature sequence index | 0 to 39 (in line with TS 25.211) |
| | relative grant pattern | up to 32 UP/DOWN/HOLD commands sent periodically |
| | ACK/NACK pattern | up to 32 ACK/NACK commands sent periodically |
| **Uplink simulation** | | |
| E-DPCCH (E-DCH dedicated physical control channel), E-DPDCH (E-DCH dedicated physical data channel) | | |
| Enhancements | The R&S®AMU-K45 in uplink allows the simulation of an E-DPCCH and up to four E-DPDCHs with channel coding in line with the definition of the fixed reference channels in TS 25.104 and TS 25.141. | |
| Application | RX measurements on 3GPP FDD Node Bs supporting HSUPA | |
| E-DPCCH | power | –80 dB to 0 dB |
| | retransmission sequence number | 0 to 3 |
| | E-TFCI information | 0 to 127 |
| | happy bit | 0, 1 |
| | E-DCH TTI | 2 ms, 10 ms |
| | DTX pattern | up to 32 TX/DTX commands sent periodically |
| E-DPDCH | overall symbol rate (total symbol rate of all uplink E-DPDCHs) | 60 ksps, 120 ksps, 240 ksps, 480 ksps, 960 ksps, 2 × 960 ksps, 2 × 1920 ksps, 2 × 960 ksps, 2 × 1920 ksps |
| | depending on overall symbol rate | |
| | active E-DPDCHs | 1 to 4 |
| | symbol rate | fixed for active E-DPDCHs |
| | channelization code | fixed for active E-DPDCHs |
| | common for all E-DPDCHs | |
| | channel power | –80 dB to 0 dB |
| | payload data | PRBS: 9, 11, 15, 16, 20, 21, 23<br>all 0, all 1, pattern (length 1 bit to 64 bit)<br>data lists |
| | E-DCH TTI | 2 ms, 10 ms |
| | DTX pattern | up to 32 TX/DTX commands sent periodically |

| | | |
|---|---|---|
| HSUPA FRC | channel coding in line with the definition of fixed reference channels in TS 25.104 and TS 25.141; in addition, user-configurable Virtual HARQ mode and bit/block error insertion | |
| | fixed reference channel (FRC) (predefined channel coding schemes) | FRC 1 to FRC 7 |
| | DTX pattern | up to 32 TX/DTX commands sent periodically |
| | HARQ ACK/NACK pattern<br>(individual ACK/NACK pattern for each HARQ process) | up to 32 ACK/NACK commands sent periodically |
| | bit error insertion<br>(deliberate generation of bit errors by impairing the data stream prior to channel coding or at the physical layer) | |
| | bit error ratio | 0.5 to $10^{-7}$ |
| | application | verification of internal BER calculation in line with TS 25.141 (BS conformance testing) |
| | block error insertion (deliberate generation of block errors by impairing the CRC during coding of enhanced channels) | |
| | block error ratio | 0.5 to $10^{-4}$ |
| | application | verification of internal BLER calculation in line with TS 25.141 (BS conformance testing) |

## CDMA2000® digital standard (R&S®AMU-K46 option)

| | | |
|---|---|---|
| CDMA2000® digital standard | release C | in line with 3GPP2 C.S0002-C |
| Chip rates | standard | 1.2288 MHz (1X) |
| | range | 1 MHz to 5 MHz |
| Modes | | 1× direct spread (spreading rate 1) |
| Link direction | | forward link and reverse link |
| Signal generation modes/sequence length | sequence length of ARB component entered in frames (80 ms each), max. length 1022 frames with R&S®AMU-B9, 511 frames with R&S®AMU-B10, 160 frames with R&S®AMU-B11 | |
| Baseband filter | standard for reverse link | cdmaOne |
| | standard for forward link | cdmaOne + equalizer |
| | for enhanced ACLR: | |
| | reverse link | cdmaOne 705 kHz |
| | forward link | cdmaOne 705 kHz + equalizer |
| Code channels | forward link | 4 base stations with a maximum of 78 code channels each (depending on radio configuration) |
| | reverse link | 4 mobile stations with a maximum of 8 code channels each (depending on radio configuration) |
| Clipping level | setting of a limit value relative to the highest peak in percent; limitation is effected prior to baseband filtering and reduces the crest factor | 1 % to 100 % |
| Generate waveform file | | filtering of data generated in ARB mode and saving it as waveform file |
| **Parameters of every BS** | | |
| State | | OFF/ON |
| Time delay | timing offset of signals of individual base stations | |
| | BS1 | 0 chips (fixed) |
| | BS2 to BS4 | 0 chips to 98304 chips |
| PN offset | | 0 to 511 |
| Transmit diversity | If this function is activated, the output signal can be generated for either antenna 1 or 2, as defined in the standard. | OFF<br>antenna 1<br>antenna 2 |
| Diversity mode | | OTD/STS |
| Quasi-orthogonal Walsh sets | | set 1 to set 3 |
| **Parameters of every forward link code channel that can be set independently** | | |
| State | | OFF/ON |
| Channel types<br>Forward link | forward pilot (F-PICH) | |
| | transmit diversity pilot (F-TDPICH) | |
| | auxiliary pilot (F-APICH) | |
| | auxiliary transmit diversity pilot (F-ATDPCH) | |
| | sync (F-SYNC) | |
| | paging (F-PCH) | |
| | broadcast (F-BCH) | |
| | quick paging (F-QPCH) | |
| | common power control (F-CPCCH) | |
| | common assignment (F-CACH) | |
| | common control (F-CCCH) | |
| | packet data control (F-PDCCH) | |
| | packet data (F-PDCH) | |
| | traffic channel | |
| | fundamental (F-FCH) | |
| | supplemental (F-SCH) | |
| | dedicated control (F-DCCH) | |
| Radio configuration | chip rate 1.2288 Mcps (1X) | RC 1 to RC 5 and RC 10 |
| Frame length | depending on channel type and radio configuration | 5 ms, 10 ms, 20 ms, 40 ms, 80 ms, 160 ms |
| Data rate | depending on channel type and radio configuration | 1.2 kbps to 1036.8 kbps |

| | | |
|---|---|---|
| Walsh code | depending on channel type and radio configuration | 0 to 127 |
| Quasi-orthogonal code | | ON/OFF |
| Power | | –80 dB to 0 dB |
| Data | | all 0<br>all 1<br>pattern (up to 64 bit)<br>PN 9 to PN 23<br>data lists |
| Long code mask | | 0 to 3FF FFFF FFFF hex |
| Power control data source | | all 0<br>all 1<br>pattern (up to 64 bit)<br>data list |
| (Mis)use for output power control | If this function is active, the power control data is used to vary the transmit power of the code channels versus time. | |
| | state | ON/OFF |
| | output power control step | –10 dB to +10 dB |
| Channel coding | All stages of channel coding specified by IS-2000 (e.g. frame quality indicator, convolutional encoder/turbo coder, symbol puncture, and interleaver) are available.<br>All frame length and data rate combinations are supported.<br>Four options are available: | |
| | OFF | channel coding OFF |
| | complete | channel coding completely ON |
| | without interleaving | channel coding ON but without interleaver |
| | interleaving only | channel coding OFF, only interleaver is active |
| **Parameters of every MS** | | |
| State | | ON/OFF |
| Radio configuration | chip rate 1.2288 Mcps (1X) | RC 1 to RC 4 |
| Channel coding | All stages of channel coding specified by IS-2000 (e.g. frame quality indicator, convolutional encoder, symbol puncture, and interleaver) are available.<br>All frame length and data rate combinations are supported. | |
| | Four options are available: | |
| | OFF | channel coding OFF |
| | complete | channel coding completely ON |
| | without interleaving | channel coding ON but without interleaver |
| | interleaving only | channel coding OFF, only interleaver is active |
| Operating mode | simulates MS operating mode and defines available channels | traffic<br>access<br>enhanced access<br>common control |
| Long code mask | | 0 to 3FF FFFF FFFF hex |
| Power control data source | in reverse link, the power control data is used only for the misuse mode | all 0<br>all 1<br>pattern (up to 64 bit)<br>data list |
| (Mis)use for output power control | If this function is active, the power control data is used to vary the transmit power of the code channels versus time. | |
| | state | ON/OFF |
| | output power control step | –10 dB to +10 dB |

| **Parameters of every reverse link code channel that can be set independently** | | |
|---|---|---|
| State | | ON/OFF |
| Channel types<br>Reverse link | reverse pilot (R-PICH) | |
| | access (R-ACH) | |
| | enhanced access (R-EACH) | |
| | reverse common control (R-CCCH) | |
| | reverse dedicated control (R-DCCH) | |
| | traffic channel | |
| | fundamental (R-FCH) | |
| | supplemental code (R-SCCH) | |
| | supplemental (R-SCH) | |
| Frame length | depending on channel type and radio configuration | 5 ms, 10 ms, 20 ms, 40 ms, 80 ms |
| Data rate | depending on channel type and radio configuration | 1.2 kbps to 1036.8 kbps |
| Power | | –80 dB to 0 dB |
| Data | | all 0<br>all 1<br>pattern (up to 64 bit)<br>PN 9 to PN 23<br>data lists |
| Error vector magnitude (EVM) | F-PICH, F-SYNC, and one F-FCH, rms | <0.8 %, typ. 0.3 % |
| Adjacent-channel leakage ratio (ACLR) | F-PICH, F-SYNC, and one F-FCH | |
| | channel spacing 0.75 MHz (bandwidth 30 kHz) | typ. 79 dB |
| | channel spacing 1.98 MHz (bandwidth 30 kHz) | typ. 91 dB |

# IEEE 802.11 a/b/g digital standard (R&S®AMU-K48 option)

| | | |
|---|---|---|
| IEEE 802.11 a/b/g digital standard | | in line with IEEE 802.11a-1999, IEEE 802.11b-1999, IEEE 802.11g-2003 |
| **General settings** | | |
| Modes | unframed | generation of a non-packet-oriented signal without frame structure, with the modulation modes and data rates defined by the IEEE 802.11 standard |
| | framed | generation of a sequence of data packets with the frame structure defined by the standard, interrupted by an idle time |
| Sequence length | | 1 frame to 511 frames (depending on frame duration) |
| Clipping | | vector or scalar clipping, applied before filtering |
| Marker modes | | restart, frame start, frame active part, pulse, pattern, ON/OFF ratio |
| Triggering | | see I/Q baseband generator |
| **Parameters in framed mode** | | |
| Idle time | time between two successive packets (PPDUs) | |
| | range | 0 s to 10000 µs |
| MAC header | | activating and configuring the MAC header with the following parameters: frame control, duration/ID, addresses 1 to 4, and sequence control |
| Frame check sequence | | activating or deactivating a 32 bit (4 byte) check sum for protecting MAC header and user data (frame body) |
| **Settings for CCK (IEEE 802.11b/IEEE 802.11g)** | | |
| Chip rate | standard | 11 Mcps |
| | range | as R&S®AMU200A |
| Baseband filter | | spectral mask in line with IEEE 802.11b-1999 – Wireless LAN MAC and PHY specifications – chapter 18.4.7.3 |
| Parameters in framed mode | PLCP preamble and header format | long PLCP and short PLCP |
| | PSDU bit rate | 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps |
| | PSDU modulation (depending on PSDU bit rate) | DBPSK, DQPSK, CCK |
| | PSDU data length (length of user data field in bytes of the packet to be transferred) | |
| | range | 0 byte to 4095 byte |
| | scrambling | data scrambling can be activated or deactivated |
| Parameters in unframed mode | PSDU bit rate | 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps |
| | PSDU modulation (depending on PSDU bit rate) | DBPSK, DQPSK, CCK |
| | scrambling | data scrambling can be activated or deactivated |

| Settings for OFDM (IEEE 802.11a/IEEE 802.11g) | | |
|---|---|---|
| Kernel sample rate | standard | 20 Msample/s |
| | range | as R&S®AMU200A |
| Baseband filter | | spectral mask in line with IEEE 802.11b-1999 – Wireless LAN MAC and PHY specifications – chapter 17.3.9.6.2 |
| Parameters in framed mode | PLCP preamble and header format | long PLCP and short PLCP |
| | PLCP signal field | automatically calculated |
| | PSDU bit rate | 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, or 54 Mbps |
| | PSDU modulation (depending on PSDU bit rate) | BPSK, QPSK, 16QAM, 64QAM |
| | PSDU data length (length of user data field in bytes of the packet to be transferred) | |
| | range | 0 byte to 4095 byte |
| | number of data symbols (number of OFDM symbols in data portion of packet) | directly proportional to PSDU data length |
| | scrambling | data scrambling can be activated or deactivated; initial scrambler state can be set randomly or to a user-defined value |
| | interleaver | can be activated or deactivated |
| | time domain windowing (transition times) | 0 s to 1000 ns |
| | service field | user-defined service field value supported |
| Parameters in unframed mode | PSDU bit rate | 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, or 54 Mbps |
| | PSDU modulation (depending on PSDU bit rate) | BPSK, QPSK, 16QAM, 64QAM |
| | PSDU data length (length of user data field in bytes of the packet to be transferred) | |
| | range | 0 byte to 2312 byte |
| | number of data symbols (number of OFDM symbols to be generated) | directly proportional to PSDU data length |
| | scrambling | data scrambling can be activated or deactivated; initial scrambler state can be set randomly or to a user-defined value |
| | interleaver | can be activated or deactivated |
| | time domain windowing (transition times) | 0 s to 1000 ns |
| | service field | user-defined service field value supported |
| **Settings for PBCC (IEEE 802.11b/IEEE 802.11g)** | | |
| Chip rate | standard | 11 Mcps |
| | range | as R&S®AMU200A |
| Baseband filter | | spectral mask in line with IEEE 802.11b-1999 – Wireless LAN MAC and PHY specifications – chapter 18.4.7.3 |
| Parameters in framed mode | PLCP preamble and header format | long PLCP and short PLCP |
| | PSDU bit rate | 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps, 22 Mbps |
| | PSDU modulation (depending on PSDU bit rate) | DBPSK, DQPSK, PBCC |
| | PSDU data length (length of user data field in bytes of the packet to be transferred) | |
| | range | 0 byte to 4095 byte |
| | scrambling | data scrambling can be activated or deactivated |
| Parameters in unframed mode | PSDU bit rate | 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps, 22 Mbps |
| | PSDU modulation (depending on PSDU bit rate) | DBPSK, DQPSK, PBCC |
| | scrambling | data scrambling can be activated or deactivated |

## IEEE 802.16 WiMAX digital standard including IEEE 802.16e (R&S®AMU-K49 option)

| | | |
|---|---|---|
| IEEE 802.16 digital standard | | in line with IEEE 802.16™-2004/Cor1/D5 and IEEE 802.16e-2005 |
| Link direction | | forward link and<br>reverse link |
| Physical layer modes | | OFDM, OFDMA, OFDMA/WiBro |
| Duplexing | | TDD, FDD |
| Frame durations | | 2 ms, 2.5 ms, 4 ms, 5 ms, 8 ms, 10 ms, 12.5 ms, 20 ms, continuous, user |
| Sequence length (frames) | depending on frame duration, sample rate, and available ARB memory | 1 to >2000 |
| Predefined frames | in OFDM mode | short, medium, and long test messages for BPSK, QPSK, 16QAM, and 64QAM modulation |
| | in OFDMA mode | predefined setups for all bandwidths and modulations specified in MRCT 1.0.0, appendix 2 |
| Level reference | in OFDM mode | FCH/burst or preamble |
| | in OFDMA/WiBro mode | preamble or subframe RMS power |
| Generate waveform file | filtering of data generated in ARB mode and saving it as waveform file | |
| **Parameters in OFDM mode** | | |
| Predefined frequency bands | | ETSI, MMDS, WCS, U-NII, user |
| Channel bandwidth | depending on selected frequency band | 1.25 MHz to 30 MHz |
| Sampling rate | depending on channel bandwidth | 1.5 MHz to 32 MHz |
| Tg/Tb settings | | 1/4, 1/8, 1/16, 1/32 |
| FFT size | | 256 (fixed) |
| Frame preamble | | long, short, OFF |
| Modulation and RS-CC rates | | BPSK 1/2, QPSK 1/2, QPSK 3/4,<br>16QAM 1/2, 16QAM 3/4, 64QAM 2/3,<br>64QAM 3/4 |
| Subchannelization (number of possible channels) | | 1, 2, 4, 8, 16 (all) |
| Number of bursts with different modulation formats per frame | | 64 |
| Burst types | | data, DL-MAP, UL-MAP, ranging |
| Data | | all 0<br>all 1<br>pattern (up to 64 bit)<br>PN 9 to PN 23<br>data lists |
| Midamble repetition | in uplink mode | OFF, 5, 9, 17 |
| **Parameters in OFDMA mode** | | |
| Predefined frequency bands | | ETSI, MMDS, WCS, U-NII, WiBro, user |
| Channel bandwidth | depending on selected frequency band | 1.25 MHz to 30 MHz |
| Sampling rate | depending on channel bandwidth | 1.5 MHz to 32 MHz |
| Tg/Tb settings | | 1/4, 1/8, 1/16, 1/32 |
| FFT size | | 128, 512, 1024, 2048 |
| Preamble modes | | Auto and User with index 0 to 113 |
| Number of zones/segments | | 8 |
| Space-time coding modes | | OFF<br>2 antennas matrix A<br>2 antennas matrix B |
| Modulation and coding rates | | QPSK 1/2, QPSK 3/4, 16QAM 1/2,<br>16QAM 3/4, 64QAM 1/2, 64QAM 2/3,<br>64QAM 3/4, 64QAM 5/6 |
| Channel coding modes | | OFF, CC, CTC |
| Channel coding parts | | scrambler, FEC, interleaver can be switched ON/OFF independently |
| Repetition coding | | 0, 2, 4, 6 |
| Subcarrier permutation | | FUSC, PUSC, AMC2x3 |
| Subchannel map | | user-definable for PUSC |
| Subchannel rotation | | ON/OFF (for uplink PUSC) |

| | | |
|---|---|---|
| Dedicated pilots | | ON/OFF (for downlink PUSC and AMC2x3) |
| Number of bursts with different modulation formats | | 64/zone |
| Burst types | | FCH, DL-MAP, UL-MAP, DCD, UCD, HARQ, ranging, fast feedback, data |
| Data | | all 0<br>all 1<br>pattern (up to 64 bit)<br>PN 9 to PN 23<br>data lists |

# TD-SCDMA digital standard (3GPP TDD LCR) (R&S®AMU-K50 option)

| | | |
|---|---|---|
| WCDMA 3GPP TDD LCR (TD-SCDMA) digital standard | | in line with 3GPP TDD standard for chip rate 1.28 Mcps (low chip rate mode) |
| Signal generation modes/sequence length | Simulation of up to 4 TD-SCDMA cells with variable switching point of uplink and downlink. User-configurable channel table for each slot and simulation of the downlink and uplink pilot timeslot. In uplink, a PRACH can also be generated. | |
| | The sequence length can be entered in frames (10 ms each). | |
| Modulation | | QPSK, 8PSK |
| Generate waveform file | | filtering of data generated in ARB mode and saving it as waveform file |
| | application | for multicarrier or multisegment scenarios |
| **General settings** | | |
| Triggering | | see I/Q baseband generator |
| Chip rate | standard | 1.28 Mcps (7 slots/subframe) |
| | range | 1 Mcps to 5 Mcps |
| Link direction | | uplink (reverse link) |
| | | downlink (forward link) |
| Baseband filter | standard | $\sqrt{\cos}$, $\alpha$ = 0.22 |
| | other filters | $\sqrt{\cos}$, cos, user filters |
| Clipping | Setting of clipping value relative to highest peak in percent. Clipping takes place prior to baseband filtering. Clipping reduces the crest factor. | |
| | modes | vector \|i + j q\|<br>scalar \|i\|, \|q\| |
| | clipping level | 1 % to 100 % |
| Code channels | downlink/uplink | up to 16 data channels (plus special channels) per slot, 7 slots per subframe, simulation of up to 4 cells |
| **Configure cell** | | |
| Reset all cells | | all channels are deactivated |
| Copy cell | | adopting a specific cell configuration to another cell to define multicell scenarios |
| | parameters | source and destination of copying |
| Predefined settings | | generation of complex signal scenarios with parameterizable default settings |
| | selectable parameters | use of P-CCPCH, number and spreading factors of data channels |
| | crest factor | minimal/average/worst |
| **Parameters of each cell** | | |
| State | | ON/OFF |
| Scrambling code | scrambling code can be disabled for testing | 0 to 127 |
| SYNC-DL code | automatic selection depending on scrambling code | 0 to 31 |
| SYNC-UL code | range depending on SYNC-DL Code | 0 to 255 |
| Number of users | | 2, 4, 6, 8, 10, 12, 14, 16 |
| Switching point | switchover between uplink and downlink slots | 1 to 6 |
| DwPTS power | | –80 dB to 10 dB |
| **Parameters for each downlink slot** | | |
| State | | ON/OFF |
| Slot mode | downlink dedicated: simulation of up to 16 DPCHs and max. 6 special channels | DPCH QPSK/8PSK: 0 to 24<br>DPCH PDSCH: 0 to 24<br>S-CCPCH: 0 to 9 |

| | | |
|---|---|---|
| **Parameters for each uplink slot** | | |
| State | | OFF/ON |
| Slot mode | uplink dedicated: simulation of up to 16 DPCHs and 1 PUSCH<br>PRACH: simulation of one physical random access channel | DPCH QPSK, PUSCH: 0 to 69<br>DPCH 8PSK: 0 to 24 |
| **Physical channels in downlink** | | |
| | primary common control physical channel 1 (P-CCPCH 1) | |
| | primary common control physical channel 2 (P-CCPCH 2) | |
| | secondary common control physical channel 1 (S-CCPCH 1) | |
| | secondary common control physical channel 2 (S-CCPCH 2) | |
| | fast physical access channel (FPACH) | |
| | physical downlink shared channel (PDSCH) | |
| | dedicated physical channel modulation QPSK (DPCH QPSK) | |
| | dedicated physical channel modulation 8PSK (DPCH 8PSK) | |
| **Physical channels in uplink** | | |
| | physical uplink shared channel (PUSCH) | |
| | dedicated physical channel modulation QPSK (DPCH QPSK) | |
| | dedicated physical channel modulation 8PSK (DPCH 8PSK) | |
| **Parameters of every code channel that can be set independently** | | |
| State | | ON/OFF |
| Midamble shift | time shift of midamble in chips: step width 8 chips | 0 to 120 |
| | controlled via the current user and the number of users | |
| Slot format | depending on physical channel type | 0 to 69 |
| Spreading factor | depending on physical channel type and link direction | 1, 2, 4, 8, 16 |
| Spreading code | depending on physical channel type and spreading factor | 1 to 16 |
| Power | | –80 dB to 0 dB |
| Payload data | PRBS | 9, 11, 15, 16, 20, 21, 23<br>all 0, all 1, pattern (length 1 bit to 64 bit), data lists |
| Number of TFCI bits | depending on modulation type | |
| | QPSK | 0, 4, 8, 16, 32 |
| | 8PSK | 0, 6, 12, 24, 48 |
| TFCI value | | 0 to 1023 |
| Number of sync shift & TPC bits | depending on modulation type | |
| | QPSK | 0 & 0, 3 & 3, 48 & 48 |
| | 8PSK | 0 & 0, 2 & 2, 32 & 32 |
| Sync shift pattern | up to 64 UP/DOWN/HOLD commands sent periodically | "1" → up: increase sync shift<br>"0" → down: decrease sync shift<br>"–" → do nothing |
| Sync shift repetition M | | 1 to 8 |
| TPC source | | all 0, all 1, pattern (length 1 bit to 64 bit), data lists |
| TPC readout mode | | continuous, single + all 0, single + all 1, single + alt. 01, single + alt. 10 |
| **Parameters in uplink PRACH mode** | | |
| UpPTS start subframe | selection of first frame in which UpPTS is sent | 1 subframe to 10 subframes |
| UpPTS power | | –80 dB to 0 dB |
| UpPTS power step | | 0 dB to 10 dB |
| Distance UpPTS | distance UpPTS to PRACH message part | 1 subframe to 4 subframes |
| UpPTS repetition | number of UpPTS repetitions | 1 to 10 |
| RACH message part state | | ON/OFF |
| Message part length | | 1 subframe, 2 subframes, 4 subframes |
| Spreading factor | | 4, 8, 16 |
| Spreading code | | 0 to (spreading factor – 1) |
| Message part power | | –80 dB to 0 dB |
| Payload data | | PRBS: 9, 11, 15, 16, 20, 21, 23<br>all 0, all 1, pattern (length 1 bit to 64 bit), data lists |
| Current user | | 1 to 16 |

# TD-SCDMA (3GPP TDD LCR) enhanced BS/MS test including HSDPA (R&S®AMU-K51 option)

At least one R&S®AMU-K50 option must be installed.

| | | |
|---|---|---|
| General parameters | This option extends the R&S®AMU-K50 (TD-SCDMA digital standard) to full channel coding and HSDPA support. Therefore, all general parameters of the R&S®AMU-K50 such as frequency range or modulation are also valid for the R&S®AMU-K51. | |
| Signal generation modes/sequence length | Simulation of up to 4 TD-SCDMA cells with generation of the coded P-CCPCH (BCH with running SFN) and the reference measurement channels RMC 12.2 kbps up to RMC 2048 kbps. Simulation of the HSDPA channels HS-SCCH, HS-PDSCH (QPSK and 16QAM modulation), HS-SICH, and the channel-coded H-RMC 526 kbps and H-RMC 730 kbps.<br>Furthermore, bit and block errors can be inserted. | |
| Modulation | | QPSK, 8PSK, 16QAM |
| HSDPA physical channels | high speed shared control channel 1 (HS-SCCH 1) | |
| | high speed shared control channel 2 (HS-SCCH 2) | |
| | high speed physical downlink shared channel QPSK (HS-PDSCH QPSK) | |
| | high speed physical downlink shared channel 16QAM (HS-PDSCH 16QAM) | |
| | high speed shared information channel (HS-SICH) | |
| Channel coding | coding of enhanced channels in line with the definition of reference measurement channels in TS 25.102, TS 25.105, and TS 25.142 | |
| | predefined channel coding schemes for | |
| | downlink | coded BCH including<br>SFN<br>RMC 12.2 kbps<br>RMC 64 kbps<br>RMC 144 kbps<br>RMC 384 kbps<br>RMC 2048 kbps<br>H-RMC 526 kbps<br>H-RMC 730 kbps |
| | uplink | RMC 12.2 kbps<br>RMC 64 kbps<br>RMC 144 kbps<br>RMC 384 kbps<br>RMC 2048 kbps |
| Applications | BER measurements in line with TS 25.102/105/142 (radio transmission and reception)<br>e.g. adjacent channel selectivity<br>blocking characteristics<br>intermodulation characteristics | |
| | BLER measurements in line with TS 25.102/105 (radio transmission and reception), e.g. demodulation of dedicated channel under static propagation conditions (AWGN generation together with R&S®AMU-K62)<br>test of decoder in receiver | |
| Bit error insertion | deliberate generation of bit errors by impairing the data stream prior to channel coding or at the physical layer | |
| | bit error ratio | 0.5 to $10^{-7}$ |
| Application | verification of internal BER calculation in line with TS 25.142 (BS conformance testing) | |
| Block error insertion | deliberate generation of block errors by impairing the CRC during coding of enhanced channels | |
| | block error ratio | 0.5 to $10^{-4}$ |
| Application | verification of internal BLER calculation in line with TS 25.142 (BS conformance testing) | |

## DVB-H digital standard (R&S®AMU-K52 option)

| | | |
|---|---|---|
| DVB-H digital standard | | in line with ETSI EN 300 744 V1.5.1 standard |
| **General settings** | | |
| Hierarchy mode | | non-hierarchical |
| Sequence length | number of superframes | min.: 1<br>max.: depending on memory option |
| Baseband filter | standard | cosine, $\alpha$ = 0.1 |
| | other | see I/Q baseband generator |
| Clipping | Setting of clipping value relative to highest peak in percent. Clipping takes place prior to baseband filtering. Clipping reduces the crest factor | |
| | modes | vector \|i + j q\|<br>scalar \|i\|, \|q\| |
| | clipping level | 1 % to 100 % |
| Generate waveform file | filtering of data generated in ARB mode and saving it as waveform file | |
| Marker | | restart<br>superframe start<br>frame start<br>pulse<br>pattern<br>ON/OFF ratio |
| Triggering | | see I/Q baseband generator |
| **Signal path parameters** | | |
| Input data | zero packets are generated and filled up with desired data | PN 15, 23<br>all 0<br>all 1 |
| | transport stream | transport stream file (*.gts) |
| Scrambler | state | ON/OFF |
| Outer coder | | Reed Solomon (204, 188, t = 8) |
| | state | ON/OFF |
| Outer interleaver | | convolutional byte-wise (depth: 12) |
| | state | ON/OFF |
| Inner coder | | convolutional, punctured |
| | state | ON/OFF |
| | code rates | 1/2, 2/3, 3/4, 5/6, 7/8 |
| Inner interleaver | | bit-wise interleaving<br>symbol interleaving |
| | state | ON/OFF |
| | symbol interleaving block size | 1512 bits in 2K mode<br>3024 bits in 4K mode<br>6048 bits in 8K mode |
| | symbol interleaving modes | native, in-depth |
| Modulation | | QPSK, 16QAM, 64QAM |
| Transmission modes | | 2K with 1705 carriers<br>4K with 3409 carriers<br>8K with 6817 carriers |
| Guard interval | cyclic continuation of useful signal part | length: 1/4, 1/8, 1/16, 1/32 of useful signal part |
| **Framing and signaling** | | |
| Super frame size | | 4 frames |
| Frame size | | 68 OFDM symbols |
| TPS settings | cell ID | 0000 to FFFF (user-defined) |
| | time-slicing | ON/OFF |
| | MPE-FEC | ON/OFF |

# EUTRA/LTE digital standard (R&S®AMU-K55 option)

| | | |
|---|---|---|
| EUTRA/LTE digital standard | | in line with 3GPP standard release 8 |
| **General settings** | | |
| Sequence length | number of frames | sequence length can be entered in frames (10 ms each); max. length depends on sample rate and ARB size |
| Baseband filter | standard | cosine, $\alpha$ = 0.1 |
| | other | see I/Q baseband generator |
| Clipping | Setting of clipping value relative to highest peak in percent. Clipping takes place prior to baseband filtering. Clipping reduces the crest factor. | |
| | Modes | vector \|i + j q\|<br>scalar \|i\|, \|q\| |
| | clipping level | 1 % to 100 % |
| Marker | | subframe<br>radio frame start<br>restart<br>pulse<br>pattern<br>ON/OFF ratio |
| Triggering | | see I/Q baseband generator |
| Duplexing | determines duplexing mode<br>Note: TDD is not supported in this version. | FDD,TDD |
| Link direction | determines whether uplink or downlink is simulated<br>Note: Uplink is not supported in this version. | downlink, uplink |
| Physical layer mode | fixed value: depends on chosen link direction:<br>OFDMA in downlink, SC-FDMA in uplink | |
| Frame duration | | fixed value: 10 ms |
| Subframe duration | | fixed value: 0.5 ms |
| **Physical settings** | | |
| Channel bandwidth | determines the channel bandwidth used | 1.25 MHz, 2.5 MHz, 5 MHz, 10 MHz,<br>15 MHz, 20 MHz |
| Physical resource block bandwidth | determines the size of a physical resource block (this parameter will be finally determined in the R&S®AMU-K55 as soon as it is defined in the official 3GPP specification)<br>Note: 180 kHz is not supported in this version. | 180 kHz, 375 kHz |
| Sampling rate | | automatically set in line with the selected channel bandwidth |
| FFT size | | automatically set in line with the selected channel bandwidth |
| Number of occupied subcarriers | | automatically set in line with the selected channel bandwidth |
| Number of left guard subcarriers | | automatically set in line with the selected FFT size |
| Number of right guard subcarriers | | automatically set in line with the selected FFT size |
| Number of resource blocks | | automatically set in line with the selected channel bandwidth and physical resource block bandwidth |

| | | |
|---|---|---|
| **Downlink reference signal structure** | | |
| Reference symbol configuration | simulated antenna configuration<br>Note: Antennas 2 to 4 are not supported in this version. | antennas 1 to 4 |
| First reference symbol position | position in subframe of the first reference symbols | 1st symbol, 2nd symbol |
| Frequency spacing | determines spacing in subcarriers between two pilots | 2/4/6/8 subcarriers |
| Subcarrier offset | offset in subcarriers within one resource block | 0 to (subcarrier_interleaving_factor – 1) |
| Reference symbol repetition period | determines the period in subframes after which the sequence for reference symbols is repeated<br>Note: The uploaded sequence for the reference symbols should be long enough to fill the selected period. | 1/2/4/5/10/20 subframes |
| First reference symbol power | power of 1st reference symbols | –80 dB to 10 dB |
| Use second reference symbols | determines whether 2nd reference symbols are used | yes, no |
| Second reference symbol power | power of 2nd reference symbols | –80 dB to 10 dB |
| Reference symbol sequence | Note: QPSK is assumed to be used for reference symbols. | data set for reference symbols to be uploaded (in R&S®AMU200A data list format) |
| **SCH/BCH settings** | | |
| SCH repetition period | determines the period in subframes between two SCH subframes | 2/4/5/10/20 subframes |
| First SCH subframe | determines the subframe in the frame in which the SCH is initially transmitted<br>Note: The SCH is automatically mapped to the endmost symbol of the subframe. | 0 to (SCH_rep_period – 1) |
| SCH power | determines the power of the SCH allocations | –80 dB to 10 dB |
| SCH sequence | Note: QPSK is assumed to be used for SCH. The first 150 bits are taken from the selected sequence and are mapped to the subcarriers used; therefore, the SCH always consists of the same sequence, regardless of the subframe. | data set for SCH to be uploaded (in R&S®AMU200A data list format) |
| BCH subframe | determines the subframe in the frame in which the BCH is transmitted<br>Note: Must not overlap with SCH subframes. Otherwise, last valid configuration is restored. | 0 to 19 |
| BCH length | determines the length of the BCH in OFDMA symbols<br>Note: The BCH is automatically mapped to the endmost symbols of the subframe | 1 OFDMA symbol to 4 OFDMA symbols |
| BCH bandwidth | determines the bandwidth of the BCH<br>Note: BCH bandwidth of 5MHz is only selectable if channel bandwidth ≥5MHz | 1.25 MHz, 5 MHz |
| BCH power | determines the power of the BCH allocation | –80 dB to 10 dB |
| BCH data source | determines the data source of the BCH allocation<br>Note: QPSK is assumed to be used for BCH. | PN9, PN11, PN15, …, PN 23, DList, pattern, all 0, all 1 |

| | | |
|---|---|---|
| **Resource allocation downlink** | | |
| Number of configurable subframes | determines the number of configurable subframes; the 20 subframes of one frame are filled periodically with the configured subframes<br>Note: SCH and BCH are configured globally and therefore not copied here. Using this function ensures a valid frame configuration. | 1 to 20 |
| Behavior in unscheduled resource blocks | determines whether unscheduled resource blocks and subframes are filled with dummy data or left DTX | dummy data, DTX |
| Cyclic prefix | determines whether short or long cyclic prefix is used for a specific subframe<br>Note: Automatically determines number of OFDM symbols per subframe. | short, long |
| Number of allocations used | determines the number of scheduled allocations in the selected subframe | 0 to (“total number of RBs” + SCH/BCH + L1/L2CCH) |
| **Allocation table** | | |
| Modulation | determines the modulation scheme used | QPSK, 16QAM, 64QAM |
| CC (channel coding) | determines the channel coding scheme used<br>Note: Turbo coder is not supported in this version. | TC (turbo coding)/OFF |
| Transmission | determines whether the allocation is localized or distributed<br>Note: *Distributed* is not supported in this version. | localized, distributed |
| Number of resource blocks (RB) | defines size of selected allocation in terms of resource blocks | 1 to “total number of RBs” |
| Number of symbols | defines size of selected allocation in terms of OFDM symbols | 1 to ”number of OFDM symbols per sub-frame” |
| Offset RB | defines start resource block of selected allocation<br>Note: This value is read-only if Auto mode is activated for this allocation. | 0 to “total number of RBs” – 1 |
| Offset symbol | defines start OFDM symbol of allocation | 0 to “number of OFDM symbols per subframe" – 1” |
| Number of bits | shows size of selected allocation in bits | |
| Data source | determines data source of selected allocation<br>Note: Data sources for users 0 to 3 can be configured in the Configure User panel | user 0, user 1, user 2, user 3, PN9, PN11, PN15, …, PN 23, DList, pattern, all 0, all 1 |
| Power | determines power of selected allocation | –80 dB to +10 dB |
| Content type | determines type of selected allocation<br>Note: SCH and BCH will be set automatically in line with the General E-UTRA DL Settings menu. | data, L1/L2 CCH |
| Conflict | Note: If a resource conflict between a data allocation and a control channel occurs, the control channel wins, and no conflict is displayed here. | display in case an allocation collides with another allocation |

| | | |
|---|---|---|
| **Configure user** | | |
| | The Configure User dialog offers the possibility to define and configure up to 4 scheduled UEs that can be distributed as required over the whole frame by setting the data source of a specific allocation in the allocation table to User. Thus, subframe allocations that are not adjacent or allocations of a different subframe can be configured to allow the use of a common data source. | |
| TTI | determines the transport time interval in subframes of the user currently being configured | 1 subframe |
| Channel coding | determines the channel coding scheme of the user currently being configured<br>Note: Turbo coder is not supported in this version. | TC (turbo coding)/OFF |
| Data source | determines the data source of the user currently being configured | PN9, PN11, PN15, …, PN 23, DList, pattern, all 0, all 1 |
| **Configure dummy data** | | |
| Dummy data – modulation | determines modulation of dummy data | QPSK, 16QAM, 64QAM |
| Dummy data – data source | determines data source of dummy data | PN9, PN11, PN15, …, PN 23, DList, pattern, all 0, all 1 |
| Dummy data – power | determines power of dummy data allocations | –80 dB to +10 dB |

## Multicarrier CW signal generation (R&S®AMU-K61 option)

| | | |
|---|---|---|
| Signal generation | | simulation of unmodulated multicarrier signals in arbitrary waveform mode |
| Number of carriers | | 1 to 8192 |
| Carrier spacing | user-settable, maximum spacing depending on number of carriers | 1 Hz to 80 MHz |
| Parameters of each carrier | state | ON/OFF |
| | power | –80 dB to 0 dB |
| | start phase | 0° to +360° |
| Crest factor | optimization of crest factor by varying the start phases of the carrier; available modes: | |
| | OFF | no optimization, manual entry of phase possible |
| | chirp | the phases of each carrier are set such that a chirp signal is obtained for the I and Q components |
| | target crest | iterative variation of carrier start phases until a presettable crest factor is attained |
| Trigger | In internal clock mode, a trigger event restarts the clock generation. The clock phase is then synchronous with the trigger (with a certain timing uncertainty).<br>In external clock mode, the trigger event is synchronized to the symbol clock. | |
| | operating mode | internal, external |
| | modes | Auto, Retrig, Armed Auto, Armed Retrig |
| | setting uncertainty for clock phase related to trigger in internal clock mode | <18 ns |
| | external trigger delay | |
| | setting range | 0 sample to $2^{16}$ sample |
| | resolution | |
| | internal clock mode | 0.01 sample |
| | external clock mode | 1 sample |
| | setting uncertainty | <5 ns |
| | external trigger inhibit | |
| | setting range | 0 sample to $2^{26}$ sample |
| | resolution | 1 sample |
| | external trigger pulse width | >15 ns |
| | external trigger frequency | <0.02 × sampling rate |
| Marker | number | 4 |
| | level | LVTTL |
| | operating modes | unchanged, restart, pulse, pattern, ratio |
| | marker delay (in sample) | |
| | setting range | 0 to (waveform length – 1) |
| | setting range without recalculation | 0 to 2000 |
| | resolution of setting | 0.001 |
| | setting uncertainty | <10 ns |

# Digital standards with R&S®WinIQSIM2™ (for R&S®AMU-B9/-B10/-B11 ARB)

| | |
|---|---|
| GSM/EDGE digital standard | R&S®AMU-K240 option |
| 3GPP FDD digital standard | R&S®AMU-K242 option |
| 3GPP FDD enhanced BS/MS tests including HSDPA | R&S®AMU-K243 option |
| GPS digital standard | R&S®AMU-K244 option |
| 3GPP FDD enhanced BS/MS tests including HSUPA | R&S®AMU-K245 option |
| CDMA2000® digital standard | R&S®AMU-K246 option |
| IEEE 802.11 a/b/g digital standard | R&S®AMU-K248 option |
| IEEE 802.16 WiMAX digital standard including 802.16e | R&S®AMU-K249 option |
| TD-SCDMA digital standard (3GPP TDD LCR) | R&S®AMU-K250 option |
| TD-SCDMA (3GPP TDD LCR) enhanced BS/MS tests including HSDPA | R&S®AMU-K251 option |
| DVB-H digital standard | R&S®AMU-K252 option |
| EUTRA/LTE digital standard | R&S®AMU-K255 option |
| Multicarrier CW signal generation | R&S®AMU-K261 option |
| Additive white Gaussian noise | AWGN, R&S®AMU-K262 option |

The options are described in the R&S®WinIQSIM2™ data sheet (PD 5213.7460.22).

# Fading and noise

## Fading simulator (R&S®AMU-B14 option) and fading simulator extension (R&S®AMU-B15 option)

The R&S®AMU-B9/-B10/-B11 or R&S®AMU-B17 is required to generate input signals for the fading simulator.
All frequency and time settings are coupled to the internal reference frequency.

| | | |
|---|---|---|
| Number of signal paths | with R&S®AMU-B14 | 1 |
| | with R&S®AMU-B14 and R&S®AMU-B15 | 1 or 2 |
| Signal routing | only possible with R&S®AMU-B14 and R&S®AMU-B15 | |
| | input | both signal paths split or combined |
| | output | split, one signal path only, or sum of both signal paths |
| Number of fading paths | depending on options and signal routing, see table on page 48 | |
| Fading path loss | setting range | 0 dB to 50 dB |
| | resolution | 0.01 dB |
| | accuracy | <0.01 dB |
| Fading path delay | setting range | 0 s to 2.56 ms |
| | resolution | 10 ns |
| | with R&S®AMU-K71 option | 0.01 ns |
| Delay groups | | max. 4 per signal path |
| | permitted delay differences within one group | <40 µs |
| Speed range | at f = 1 GHz | 0 km/h to 1725 km/h |
| | accuracy | <0.128 % |
| Doppler frequency | setting range | 0 Hz to 1600 Hz |
| | accuracy | <0.1 % |
| Restart | standard | auto |
| | with R&S®AMU-B9/-B10/-B11 option installed | auto, internal from baseband A or B, external |
| Total insertion loss | automatic or user-definable, with clipping indicator | 0 dB to 18 dB |
| Correlation | fading paths in signal path A pairwise with fading paths in signal path B | |
| | correlation coefficient | |
| | setting range | 0 % to 100 % |
| | resolution | 5 % |
| | correlation phase | |
| | setting range | 0° to 360° |
| | resolution | 1° |
| **Fading profiles** | | |
| Rayleigh | pseudo-noise interval | >93 h |
| Pure Doppler | frequency ratio | (–1 to +1) × current Doppler frequency |
| | resolution | 0.01 × current Doppler frequency |
| Rician | combination of Rayleigh and pure Doppler | |
| | power ratio | –30 dB to +30 dB |
| Lognormal | standard deviation | 0 dB to 12 dB |
| | resolution | 1 dB |
| | local constant at f = 1 GHz | 12 m to 200 m |
| Static, constant phase | path loss | 0 dB to 50 dB |
| | phase | 0° to 360° |
| | resolution | 1° |

**Number of fading paths, RF bandwidth, and timing resolution**

| | |
|---|---|
| (hatched) | With R&S® AMU-K71 only |

| With R&S®AMU-B14 | | | |
|---|---|---|---|
| Signal paths | Fading paths | RF bandwidth | Timing resolution |
| 1 | 20 | 80 MHz | 10 ns |
| 1 | 12 | 30 MHz | 0.01 ns |
| 1 | 8 | 50 MHz | 0.01 ns |

| With R&S®AMU-B14 and R&S®AMU-B15 | | | |
|---|---|---|---|
| Signal paths | Fading paths | RF bandwidth | Timing resolution |
| 1 | 40 | 80 MHz | 10 ns |
| 1 | 24 | 30 MHz | 0.01 ns |
| 1 | 16 | 50 MHz | 0.01 ns |
| 2 | 20 | 80 MHz | 10 ns |
| 2 | 12 | 30 MHz | 0.01 ns |
| 2 | 8 | 50 MHz | 0.01 ns |

# Dynamic fading and enhanced resolution (R&S®AMU-K71 option)

At least one R&S®AMU-B14 fading simulator must be installed. If both the R&S®AMU-B14 and the R&S®AMU-B15 are installed (signal path A and B), dynamic fading and enhanced resolution can be used either on signal path A or B with one R&S®AMU-K71 option. For dynamic fading and enhanced resolution to be used on signal paths A and B simultaneously, two R&S®AMU-K71 must be installed.

| **Moving delay mode** | | |
|---|---|---|
| System bandwidth | | 50 MHz |
| Number of fading paths | | 2 per signal path |
| Fading profiles | | none |
| Basic delay | in steps of 10 ns | 0 ms to 2.56 ms |
| Delay variation | peak to peak | 300 s to 40 μs |
| Variation period | | 10 s to 500 s |
| Variation speed | | 0 μs/s to 500 μs/s |
| Delay step size | | <10 ps |
| **Birth-death mode** | | |
| System bandwidth | | 50 MHz |
| Number of fading paths | | 2 per signal path |
| Fading profiles | | pure Doppler |
| Delay range[6] | | 0 s to 40 μs |
| Delay grid | | 0 s to 20 μs |
| Positions | | 3 to 50 |
| Hopping dwell | | 100 ms to 5 s |
| Start offset | separately settable for each signal path | 1 ms to 200 ms |
| Delay resolution | | 10 ns |

[6] The maximum delay range of 40 μs cannot be exceeded.

## Extended statistic functions (R&S®AMU-K72 option)

At least one R&S®AMU-B14 fading simulator must be installed. If both the R&S®AMU-B14 and the R&S®AMU-B15 are installed (signal path A and B), extended statistic functions can be used either on signal path A or B with one R&S®AMU-K72 option. For dynamic fading and enhanced resolution to be used on signal paths A and B simultaneously, two R&S®AMU-K72 must be installed.

| **Fading profiles** | | |
|---|---|---|
| Gauss I, Gauss II | sum of two Gaussian distributions | in line with DAB standard |
| Gauss DAB 1, Gauss DAB 2 | Gaussian distribution, shifted in frequency | in line with DAB standard |
| WiMAX Doppler | rounded Doppler PSD model | in line with IEEE 802.16a-03-01 |
| WiMAX Rice | like WiMAX Doppler plus pure Doppler | in line with IEEE 802.16a-03-01 |
| Predefined settings | SUI1 to SUI6 | in line with IEEE 802.16a-03-01 |
| | ITU OIP-A ITU OIP-B ITU V-A | in line with 3GPP TS34.121-1 annex D.2.2 table D.2.2.1A |
| | DAB-RA, DAB-TU, DAB-SFN | in line with EN 50248-2001 |

## Additive white Gaussian noise (AWGN, R&S®AMU-K62 option)

At least one R&S®AMU-B13 baseband main module must be installed. If two R&S®AMU-B13 are installed (paths A and B), AWGN can be generated either on path A or B with one R&S®AMU-K62 option. For AWGN to be generated on paths A and B simultaneously, two R&S®AMU-K62 must be installed.

Addition of an AWGN signal of settable bandwidth and settable C/N ratio or Eb/N0 to a wanted signal. If the noise generator is used, a frequency offset cannot be added to the wanted signal.

| | | |
|---|---|---|
| Noise | distribution density | Gaussian, statistical, separate for I and Q |
| | crest factor | >18 dB |
| | periodicity | >48 h |
| C/N, $E_b/N_0$ | setting range | –30 dB to +30 dB |
| | resolution | 0.1 dB |
| | uncertainty for system bandwidth = symbol rate, symbol rate <4 MHz, –24 dB < C/N < 30 dB and crest factor <12 dB | <0.1 dB |
| System bandwidth | bandwidth for determining noise power | |
| | range | 1 kHz to 80 MHz |
| | resolution | 100 Hz |

# Other options

## Bluetooth® [7] digital standard (external PC software) (R&S®AMU-K5 option)

| | | |
|---|---|---|
| Supported packet types | | DH1, DH3, DH5, AUX1<br>in all data mode or with packet editor |
| Data sources (in all data mode) | | all 0, all 1, PRBS 7 to PRBS 23, user data |
| Data whitening | | supported |
| Packet editor features | access code | calculated from entered device address |
| | header bits | can be set individually, SEQN bit toggles with each generated packet |
| | HEC | calculated automatically |
| | payload data sources | all 0, all 1, PRBS 7 to 23, pattern, user data |
| | payload CRC | calculated automatically |
| Sequence length | | up to 53687 packets |
| Power ramping | ramp function | $\cos^2$, linear |
| | ramp time | 1 symbol to 32 symbol |
| | rise offset, fall offset | 0 symbol to 32 symbol |
| Modulation | defaults | preset in line with Bluetooth® standard<br>2FSK, 160 kHz deviation,<br>1 MHz symbol rate |
| | 2FSK frequency deviation | 100 kHz to 200 kHz |
| | 2FSK symbol rate | 400 Hz to 15 MHz |
| Filter | filter function | Gaussian, rectangle |
| | B × T (for Gaussian filter) | 0.1 to 2.5 |

[7] The Bluetooth® word mark and logos are owned by the Bluetooth SIG, Inc. and any use of such marks by Rohde & Schwarz is under license.

## Pulse sequencer (external PC software) (R&S®AMU-K6 option)

The pulse sequencer software generates complex pulses and bursts for use with any of the R&S®AMU-B9, R&S®AMU-B10, or R&S®AMU-B11 baseband generators. This software is a standalone, PC-based application that creates waveform files.

| | | |
|---|---|---|
| Typical applications | DFS pulse generation | FCC CFR 47 part 15.407 (06-96A), ETSI EN 301 893 V1.3.1 |
| | RFID signal generation | ISO/IEC 14443, 18000 |
| | radar waveform generation | receiver tests |
| | component test with pulsed signals | amplifiers, mixers, converters |
| Data structure of project files | pulse library | up to 256 pulse definitions |
| | sequence library | up to 64 sequences |
| | multisegment waveforms | up to 64 |
| | RF lists | up to 12 |
| Pulse timing parameters | settings | delay, rise, pulse ON, fall, pulse OFF, PRI, PRF |
| | resolution | 1 ns or 1/ARB clock rate, whichever is greater |
| | minimum pulse width, internal BB | 175 ns ( 7th harmonic, 40 MHz bandwidth ) |
| Pulse level parameters | settings | attenuation, droop |
| | ON/OFF ratio | >55 dB |
| Other pulse parameters | ramp type | linear, raised cosine, $cos^2$, custom |
| | frequency | frequency offset, start phase |
| Intrapulse modulation | types | ASK, FSK, BPSK, QPSK, FM chirp, FM, AM, user plugin (custom) |
| | data sources | user data, PRBS: 7,9,11,15,16, 20, 21, 23 |
| Marker settings | markers 1 to 4 | delay, rise, pulse ON, fall, OFF, restart |
| Jitter | distribution | uniform, Gaussian, list, shape |
| | number of jitters | up to 3, independent |
| | affected parameters | any timing setting, frequency offset, phase, all level settings, FM deviation |
| Baseband filter | filter function | rectangular, Gaussian, cosine, root raised cosine |
| | window functions | Rife Vincent 2, von Hann, Hamming, Blackman, Blackman-Harris, Flat Top |
| Sequences | pulse entries in sequence | up to 128 |
| | pulse data mode | append, overlay add, overlay multiply |
| | jitter mode vs repetitions | all individual, all same, continue, OFF |
| | marker mask vs repetitions | all, first only, last only, none |
| Multisegment waveforms | sequence entries in MSW | up to 64 |
| Graphical display | I/Q vs time | I/Q traces, polar, envelope in dB |
| | I/Q plane | vector, density plot |
| | FFT | entire data, view port only |
| | cursors | t1, t2, Δt, Δf |

## BER measurement (R&S®AMU-K80 option)

The data supplied by the DUT is compared with a reference pseudo-random bit sequence.

| | | |
|---|---|---|
| Clock | | supplied by DUT; a clock pulse is required for each valid bit |
| Clock rate | | 100 Hz to 60 MHz |
| Data | PRBS | |
| | sequence length | 9, 11, 15, 16, 20, 21, 23 |
| | pattern ignore | OFF, all 0, all 1 |
| | data enable | external |
| | modes | OFF, high, low |
| | restart | external |
| | modes | ON/OFF |
| Synchronization time | | 28 clock cycles |
| Interface | | 9-pin D-Sub connector, D-Sub/BNC cable supplied with option |
| Clock, data, enable, and restart inputs | input impedance | 1 kΩ, 50 Ω |
| | trigger threshold | |
| | setting range | 0 V to 2.50 V |
| | resolution | 0.01 V |
| Polarity | data, clock, data enable | normal, inverted |
| Measurement time | | selectable through maximum number of data bits or bit errors (max. $2^{31}$ bits each), continuous measurement |
| Measurement result | if selected number of data bits or bit errors is attained | BER in ppm, %, or decade values |
| Status displays | | not synchronized, no clock, no data |

## BLER measurement (R&S®AMU-K80 option)

In BLER measurement mode, arbitrary data can be provided by the DUT. A signal marking the block's CRC has to be provided on the data enable connector of the BER/BLER option.

| | | |
|---|---|---|
| Clock | | supplied by DUT; a clock pulse is required for each valid bit |
| Clock rate | | 100 Hz to 60 MHz |
| Data | input data | arbitrary |
| | data enable (marking the block's CRC) | external |
| | modes | high, low |
| CRC | CRC type | CCITT CRC16 ($x^{16} + x^{12} + x^5 + 1$) |
| | CRC bit order | MSB first, LSB first |
| Synchronization time | | 1 block |
| Interface | | 9-pin D-Sub connector, D-Sub/BNC cable supplied with option |
| Clock, data, and enable inputs | input impedance | 1 kΩ, 50 Ω |
| | trigger threshold | |
| | setting range | 0.00 V to 2.50 V |
| | resolution | 0.01 V |
| Polarity | data, clock, data enable | normal, inverted |
| Measurement time | | selectable through maximum number of received blocks or errors (max. $2^{31}$ blocks each), continuous measurement |
| Measurement result | if selected number of received blocks or errors is attained | BLER in ppm, %, or decade values |
| Status displays | | not synchronized, no clock, no data |

# General Data

## Remote Control

| | | |
|---|---|---|
| Systems | | IEC/IEEE bus, IEC 60625 (IEEE 488)<br>Ethernet, TCP/IP |
| Command set | | SCPI 1999.5 |
| Connector | | |
| IEC/IEEE | | 24-contact Amphenol |
| Ethernet | | Western |
| USB | | USB |
| IEC/IEEE-bus address | | 0 to 30 |
| Interface functions | | IEC: SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C0 |

## Operating Data

| | | |
|---|---|---|
| Power supply | input voltage range, AC, nominal | 100 V to 240 V |
| | AC supply frequency | 50 Hz to 60 Hz |
| | input current | 5.0 A to 1.6 A |
| | power factor correction | in line with EN 61000-3-2 |
| EMC | | in line with EN 55011 class B, EN 61326 |
| | with activated digital I/Q output or input | in line with EN 55011 class A, EN 61326 |
| Immunity to interfering field strength | | up to 10 V/m |
| Environmental conditions | operating temperature range | +5 °C to +45 °C<br>in line with DIN EN 60068-2-1,<br>DIN EN 60068-2-2 |
| | storage temperature range | –20 °C to +60 °C |
| | climatic resistance | +40 °C/90 % rel. humidity<br>in line with DIN EN 60068-2-3 |
| Mechanical resistance | | |
| Vibration | sinusoidal | 5 Hz to 150 Hz,<br>max. 2 g at 55 Hz,<br>55 Hz to 150 Hz,<br>0.5 g const.,<br>in line with DIN EN 60068-2-6 |
| | random | 10 Hz to 300 Hz, acceleration 1.2 g (rms),<br>in line with DIN EN 60068-2-64 |
| Shock | | 40 g shock spectrum, in line with<br>DIN EN 60068-2-27, MIL STD 810E |
| Electrical safety | | in line with EN 61010-1 |
| Dimensions | W × H × D | 435 mm × 192 mm × 560 mm<br>(17.1 in × 7.6 in × 22.0 in) |
| Weight | when fully equipped | 13 kg (28.7 lb) |
| Recommended calibration interval | | 3 years |

# Ordering information

| Designation | Type | Order No. |
|---|---|---|
| **Baseband Signal Generator**[8]<br>including power cable, Quick Start Guide, and CD-ROM<br>(with operating and service manual) | R&S®AMU200A | 1402.4090.02 |
| **Options** | | |
| Baseband | | |
| Baseband Generator with ARB (128 Msample) and Digital Modulation (realtime) | R&S®AMU-B9 | 1402.8809.02 |
| Baseband Generator with ARB (64 Msample) and Digital Modulation (realtime) | R&S®AMU-B10 | 1402.5300.02 |
| Baseband Generator with ARB (16 Msample) and Digital Modulation (realtime) | R&S®AMU-B11 | 1402.5400.02 |
| Baseband Main Module | R&S®AMU-B13 | 1402.5500.02 |
| Differential I/Q Outputs | R&S®AMU-B16 | 1402.5800.02 |
| Analog/Digital Baseband Inputs | R&S®AMU-B17 | 1402.5900.02 |
| Digital I/Q Output | R&S®AMU-B18 | 1402.6006.02 |
| | | |
| Digital modulation systems | | |
| Digital Standard GSM/EDGE | R&S®AMU-K40 | 1402.6106.02 |
| Digital Standard 3GPP FDD | R&S®AMU-K42 | 1402.6206.02 |
| 3GPP Enhanced MS/BS Tests incl. HSDPA | R&S®AMU-K43 | 1402.6306.02 |
| Digital Standard GPS | R&S®AMU-K44 | 1402.6406.02 |
| Digital Standard 3GPP FDD HSUPA | R&S®AMU-K45 | 1402.8909.02 |
| Digital Standard CDMA2000® | R&S®AMU-K46 | 1402.6506.02 |
| Digital Standard IEEE 802.11 (a/b/g) | R&S®AMU-K48 | 1402.6706.02 |
| Digital Standard IEEE 802.16 | R&S®AMU-K49 | 1402.7002.02 |
| Digital Standard TD-SCDMA | R&S®AMU-K50 | 1402.8950.02 |
| Digital Standard TD-SCDMA Enhanced BS/MS Test | R&S®AMU-K51 | 1402.9005.02 |
| Digital Standard DVB-H | R&S®AMU-K52 | 1402.9557.02 |
| Digital Standard EUTRA/LTE | R&S®AMU-K55 | 1402.9405.02 |
| Multicarrier CW Signal Generation | R&S®AMU-K61 | 1402.7102.02 |
| | | |
| Digital modulation systems using R&S WinIQSIM2™[9] | | |
| Digital Standard GSM/EDGE | R&S®AMU-K240 | 1402.7602.02 |
| Digital Standard 3GPP FDD | R&S®AMU-K242 | 1402.7702.02 |
| 3GPP Enhanced MS/BS Tests incl. HSDPA | R&S®AMU-K243 | 1402.7802.02 |
| Digital Standard GPS | R&S®AMU-K244 | 1402.7902.02 |
| Digital Standard 3GPP FDD HSUPA | R&S®AMU-K245 | 1402.8009.02 |
| Digital Standard CDMA2000® | R&S®AMU-K246 | 1402.8109.02 |
| Digital Standard IEEE 802.11 (a/b/g) | R&S®AMU-K248 | 1402.8209.02 |
| Digital Standard IEEE 802.16 | R&S®AMU-K249 | 1402.8309.02 |
| Digital Standard TD-SCDMA | R&S®AMU-K250 | 1402.8409.02 |
| Digital Standard TD-SCDMA Enhanced BS/MS Test | R&S®AMU-K251 | 1402.8509.02 |
| Digital Standard DVB-H | R&S®AMU-K252 | 1402.9505.02 |
| Digital Standard EUTRA/LTE | R&S®AMU-K255 | 1402.9457.02 |
| Multicarrier CW Signal Generation | R&S®AMU-K261 | 1402.8609.02 |
| AWGN | R&S®AMU-K262 | 1402.8709.02 |

[8] The base unit can only be ordered with an R&S®AMU-B13 plus one option out of R&S®AMU-B9/-B10/-B11/-B17.

[9] R&S®WinIQSIM2™ requires an external PC.

| | | |
|---|---|---|
| Digital modulation systems using external PC software | | |
| Digital Standard Bluetooth | R&S®AMU-K5 | 1402.9257.02 |
| Pulse Sequencer | R&S®AMU-K6 | 1402.9805.02 |
| | | |
| Fading and noise | | |
| Fading Simulator | R&S®AMU-B14 | 1402.5600.02 |
| Fading Simulator Extension | R&S®AMU-B15 | 1402.5700.02 |
| Additive White Gaussian Noise (AWGN) | R&S®AMU-K62 | 1402.7202.02 |
| Dynamic Fading and Enhanced Resolution | R&S®AMU-K71 | 1402.7302.02 |
| Enhanced Fading Profiles | R&S®AMU-K72 | 1402.9605.02 |
| | | |
| Other options | | |
| BER/BLER Measurement | R&S®AMU-K80 | 1402.7402.02 |
| I/Q Rear Connectors | R&S®AMU-B81 | 1402.6858.02 |
| | | |
| **Recommended extras** | | |
| Hardcopy manuals (in English, UK) | | 1402.5222.32 |
| Hardcopy manuals (in English, USA) | | 1402.5222.39 |
| 19" Rack Adapter | R&S®ZZA-411 | 1096.3283.00 |
| Adapter for Telescopic Sliders | R&S®ZZA-T45 | 1109.3774.00 |
| BNC Adapter for AUX I/O Connector | R&S®SMU-Z5 | 1160.4545.02 |
| Keyboard with USB Interface (US assignment) | R&S®PSL-Z2 | 1157.6870.03 |
| Mouse with USB Interface, optical | R&S®PSL-Z10 | 1157.7060.02 |
| External USB CD-RW Drive | R&S®PSP-B6 | 1134.8201.12 |

Certified Quality System ISO 9001 DQS REG. NO 1954 QM

Certified Environmental System ISO 14001 DQS REG. NO 1954 UM

For data sheet, see PD 5213.7954.32
and www.rohde-schwarz.com
(search term: AMU200A)

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