ROHDE&SCHWARZ    SMJ 100A – VECTOR SIGNAL GENERATOR

# R&S®SMJ100A Vector Signal Generator

Data sheet



**ROHDE&SCHWARZ**

# CONTENTS

# Key features

**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

**Outstanding signal quality**

- I/Q modulator with 200 MHz RF bandwidth
- Very low SSB phase noise of typ. –133 dBc (f = 1 GHz, 20 kHz carrier offset, 1 Hz measurement bandwidth)
- Wideband noise of typ. –153 dBc (CW, f = 1 GHz, >10 MHz carrier offset, 1 Hz measurement bandwidth)
- Excellent ACLR performance of typ. +69 dB with 3GPP FDD (test model 1, 64 DPCH)
- Very high level repeatability of 0.05 dB
- High-stability reference oscillator as standard

**Unrivaled flexibility**

- Support of EUTRA/LTE signal generation
- Support of WiMAX IEEE 802.16-2004/Corr1-2005, 802.16e-2005, and WiBro
- Four code channels in realtime for 3GPP FDD, support of HSDPA and HSUPA
- Support of WLAN IEEE 802.11a, b, g and n
- Change of modulation from slot to slot for GSM/EDGE
- Baseband generator with universal coder for realtime signal generation
- Arbitrary waveform generator with 16 Msample, 64 Msample or 128 Msample and multisegment support
- Arbitrary waveform generator supported by R&S®WinIQSIM2™ and R&S®WinIQSIM™ simulation software

**Ideal for production**

- Very short frequency and level setting times (<2 ms); only 450 µs in List mode
- Electronic attenuator with overvoltage protection up to 6 GHz over full level range
- Flexible high speed measurements with RF List mode and multisegment waveforms

**Connectivity**

- Remote control via LAN (Gigabit Ethernet, VXI11) and GPIB
- Remote operation via Windows Remote Desktop or VNC
- User-selectable trigger and marker signals
- USB connectors for keyboard, mouse, and memory stick
- LXI class C compliance

# Baseband generator options

The R&S®SMJ100A can be equipped with one of the following I/Q baseband generators:

| R&S®SMJ-B9 | Baseband Generator with ARB (128 Msample) and Digital Modulation (realtime) |
|---|---|
| R&S®SMJ-B10 | Baseband Generator with ARB (64 Msample) and Digital Modulation (realtime) |
| R&S®SMJ-B11 | Baseband Generator with ARB (16 Msample) and Digital Modulation (realtime) |
| R&S®SMJ-B50 | Baseband Generator with ARB (64 Msample) |
| R&S®SMJ-B51 | Baseband Generator with ARB (16 Msample) |

The R&S®SMJ-B9/-B10/-B11 baseband generators include an arbitrary waveform generator and a realtime coder. If these baseband generators are installed, the following software options can be added:

- Digital standards and modulation systems running on the instrument (R&S®SMJ-K40 to R&S®SMJ-K61 options)
- Digital standards with R&S®WinIQSIM2™ (R&S®SMJ-K240 to R&S®SMJ-K262 options); R&S®WinIQSIM2™ runs on an external PC
- Digital standards with R&S®WinIQSIM™ (R&S®SMJ-K11 to R&S®SMJ-K20 options); R&S®WinIQSIM™ runs on an external PC
- R&S®SMJ-K5/-K6/-K8 options

The R&S®SMJ-B50/-B51 baseband generators include an arbitrary waveform generator. If these baseband generators are installed, the following software options can be added:

- Digital standards with R&S®WinIQSIM2™ (R&S®SMJ-K240 to R&S®SMJ-K262 options); R&S®WinIQSIM2™ runs on an external PC
- Digital standards with R&S®WinIQSIM™ (R&S®SMJ-K11 to R&S®SMJ-K20 options); R&S®WinIQSIM™ runs on an external PC
- R&S®SMJ-K6 option

# Modulation

## Possible modulation types

Amplitude modulation, frequency/phase modulation (optional), vector modulation, digital modulation via internal baseband section (optional), pulse modulation, wideband amplitude modulation

## Simultaneous modulation

|  | AM | FM | φM | Pulse | BB-AM | I/Q | DM | ARB |
|---|---|---|---|---|---|---|---|---|
| **Amplitude modulation (AM)** | / | + | + | + | – | – | – | – |
| **Frequency modulation (FM)** | + | / | – | + | + | + | + | + |
| **Phase modulation (φM)** | + | – | / | + | + | + | + | + |
| **Pulse modulation** | + | + | + | / | + | + | + | + |
| **Broadband AM (BB-AM)** | – | + | + | + | / | – | – | – |
| **Vector modulation (I/Q)** | – | + | + | + | – | / | – | – |
| **Digital modulation (DM)** | – | + | + | + | – | – | / | – |
| **ARB** | – | + | + | + | – | – | – | / |

+ = compatible, – = not compatible, switch off each other

# RF characteristics

## Frequency

| Range | underrange | 100 kHz to <300 kHz |
|---|---|---|
| | R&S®SMJ-B103 | up to 3 GHz |
| | R&S®SMJ-B106 | up to 6 GHz |
| Resolution of setting | | 0.01 Hz |
| Resolution of synthesis | standard, fundamental frequency range 750 MHz to 1500 MHz | 5 µHz |
| Setting time[1] | to within $<1 \times 10^{-7}$ for f > 200 MHz or $<124$ Hz for f < 200 MHz, with GUI update stopped | |
| | after IEC/IEEE bus delimiter | <2 ms, typ. 1.5 ms |
| | in ALC OFF MODE S&H | <4 ms, typ. 2.5 ms |
| | after trigger pulse in List mode | <450 µs, typ. 300 µs |
| Phase offset | | adjustable in 0.1° steps |

## Frequency sweep

| Operating modes | digital sweep in discrete steps | automatic, step, single, external single, external step, manual or external trigger, linear or logarithmic spacing |
|---|---|---|
| Sweep range | | full frequency range |
| Step width | linear | full frequency range |
| | logarithmic | 0.01 % to 100 % per step |

## Reference frequency

| Aging | after 30 days of uninterrupted operation | $<1 \times 10^{-9}$/day, $<1 \times 10^{-7}$/year |
|---|---|---|
| Temperature effect | in operating temperature range | $\pm6 \times 10^{-8}$ |
| Warm-up time | to nominal thermostat temperature | ≤10 min |
| 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 | $3 \times 10^{-6}$ |
| | input level, limits | ≥–6 dBm, ≤19 dBm |
| | recommended | 0 dBm to 19 dBm |
| | input impedance | 50 Ω |
| Electronic tuning from input AUX I/O | sensitivity | typ. $1 \times 10^{-8}$/V to $3 \times 10^{-8}$/V |
| | input voltage | –10 V to +10 V |
| | input impedance | 10 kΩ |

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[1] Installation of software that is not authorized by Rohde & Schwarz for use on the R&S®SMJ100A or installation of antivirus software can deteriorate the setting time performance.

# Level

| Setting range | | −145 dBm to +20 dBm |
|---|---|---|
| Maximum level | f ≤ 3 GHz | +13 dBm (PEP)[2] |
| | f > 3 GHz | +11 dBm (PEP) |
| Resolution | | 0.01 dB |
| Level uncertainty | for levels >−120 dBm, attenuator mode Auto, temperature range +18 °C to +28 °C | |
| | 1 MHz ≤ f ≤ 3 GHz | <0.5 dB |
| | f > 3 GHz | <0.9 dB |
| Additional uncertainty with ALC OFF, S&H | This function is needed only in some special applications. | <0.2 dB |
| Output impedance VSWR in 50 Ω system | ALC state ON    f ≤ 3 GHz    f > 3 GHz | <br><1.6, typ. <1.4<br><1.85, typ. <1.6 |
| Setting time[3] | after IEC/IEEE bus delimiter, to <0.1 dB deviation from final value, with GUI update stopped, temperature range +18 °C to +28 °C | |
| | ALC state ON | <2 ms, typ. 1.5 ms |
| | ALC state OFF | <4 ms, typ. 2.5 ms |
| | in List mode after trigger impulse to <0.3 dB deviation from final value | <450 µs, typ. 300 µs |
| Uninterrupted level setting | with attenuator mode fixed, ALC state ON | |
| | setting range | >20 dB |
| Back-feed (from ≥50 Ω source) | maximum permissible RF power in output frequency range for f > 1 MHz | |
| | 1 MHz ≤ f ≤ 3 GHz | 50 W |
| | f > 3 GHz | 10 W |
| | maximum permissible DC voltage | 50 V |

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[2] PEP = peak envelope power.

[3] Installation of software that is not authorized by Rohde & Schwarz for use on the R&S®SMJ100A or installation of antivirus software can deteriorate the setting time performance.

# Measured level data

Frequency response at Level =  5.00 dBm :

/dB                                    ALC ON



*Measured level versus frequency*
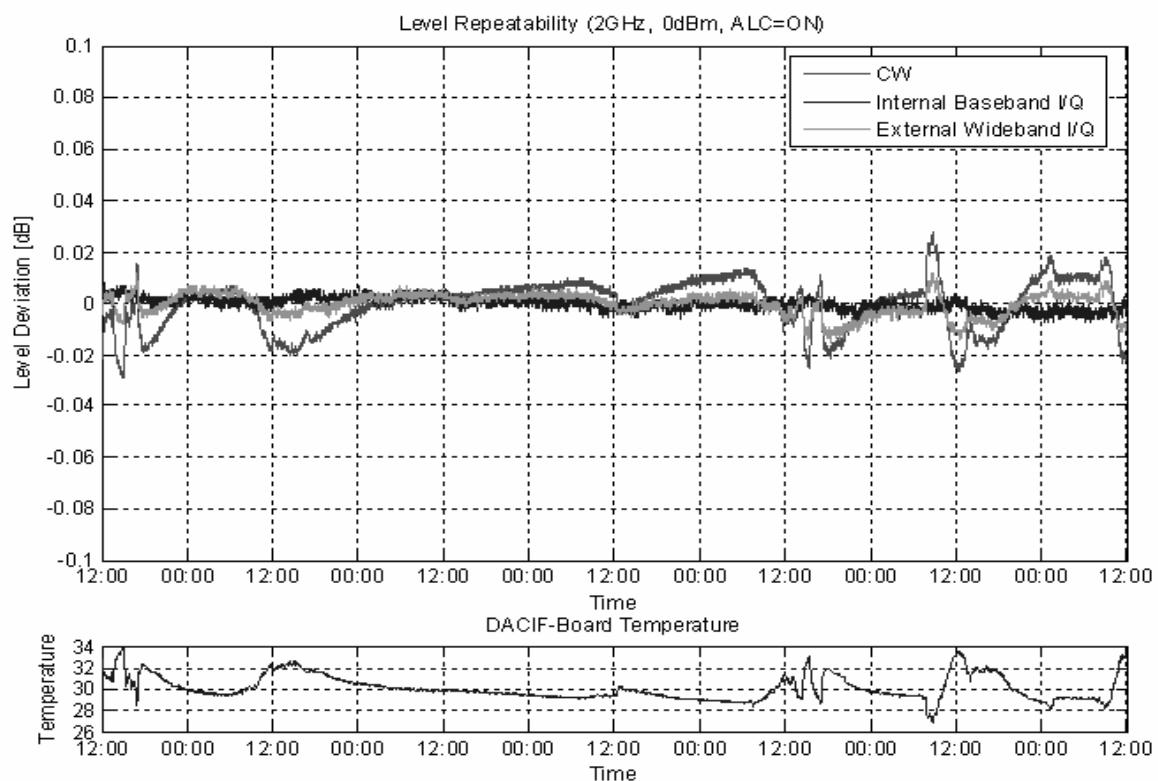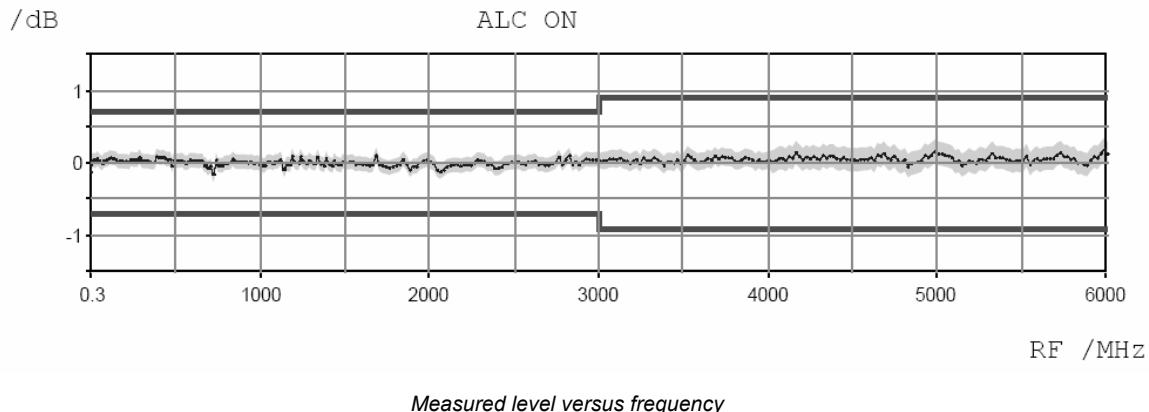


*Level repeatability with random settings between measurements (upper diagram)*
*The lower diagram shows the temperature inside the instrument during the measurement*

## Level sweep

| Operating modes | digital sweep in discrete steps | automatic, single, step, external single, external step, manual, or external trigger |
|---|---|---|
| Sweep range | | full level range |
| Step width | logarithmic | 0.1 dB to 20 dB per step |
| Dwell time | range | 10 ms to 10 s |
| | resolution | 0.1 ms |

## Spectral purity

| Harmonics | unmodulated | |
|---|---|---|
| | level <8 dBm | <–30 dBc |
| | level <13 dBm | typ. <–30 dBc |
| Nonharmonics | level >–50 dBm, CW, vector modulation (full-scale DC input), >10 kHz offset from carrier and outside the modulation spectrum | |
| | 0.3 MHz ≤ f ≤ 200 MHz | <–77 dBc |
| | 200 MHz < f ≤ 1500 MHz | <–80 dBc |
| | 1500 MHz < f ≤ 3000 MHz | <–74 dBc |
| | f > 3000 MHz | <–68 dBc |
| | 850 kHz offset from carrier and outside the modulation spectrum | |
| | 0.3 MHz ≤ f ≤ 200 MHz | <–77 dBc |
| | 200 MHz < f ≤ 1500 MHz | <–86 dBc |
| | 1500 MHz < f ≤ 3000 MHz | <–80 dBc |
| | f > 3000 MHz | <–74 dBc |
| Power supply and mechanically related nonharmonics | at RF = 1 GHz, 50 Hz to 10 kHz from carrier | <–70 dBc |
| Subharmonics | 1500 MHz < f ≤ 3000 MHz | <–74 dBc |
| | 3000 MHz < f ≤ 6000 MHz | <–50 dBc |
| Wideband noise | carrier offset >10 MHz, measurement bandwidth 1 Hz, CW | |
| | 20 MHz ≤ f ≤ 200 MHz | <–146 dBc (typ. –149 dBc) |
| | 200 MHz < f ≤ 1500 MHz | <–150 dBc (typ. –153 dBc) |
| | 1.5 GHz < f ≤ 3 GHz | <–148 dBc (typ. –151 dBc) |
| | f > 3 GHz | <–146 dBc (typ. –149 dBc) |
| | vector modulation with full-scale DC input | |
| | 20 MHz ≤ f ≤ 200 MHz | <–140 dBc (typ. –143 dBc) |
| | 200 MHz < f ≤ 1500 MHz | <–143 dBc (typ. –146 dBc) |
| | 1.5 GHz < f ≤ 3 GHz | <–142 dBc (typ. –145 dBc) |
| | f > 3 GHz | <–140 dBc (typ. –143 dBc) |
| SSB phase noise | carrier offset 20 kHz, measurement bandwidth 1 Hz, unmodulated | |
| | 20 MHz ≤ f ≤ 200 MHz | <–126 dBc (typ. –130 dBc) |
| | f = 1 GHz | <–129 dBc (typ. –133 dBc) |
| | f = 2 GHz | <–123 dBc (typ. –127 dBc) |
| | f = 3 GHz | <–119 dBc (typ. –123 dBc) |
| | f = 4 GHz | <–117 dBc (typ. –121 dBc) |
| | f = 6 GHz | <–113 dBc (typ. –117 dBc) |
| Residual FM | rms value at f = 1 GHz | |
| | 300 Hz to 3 kHz | <1 Hz |
| | 20 Hz to 23 kHz | <4 Hz |
| Residual AM | rms value 20 Hz to 23 kHz | <0.02 % |

Measured SSB phase noise, unmodulated (typical values)
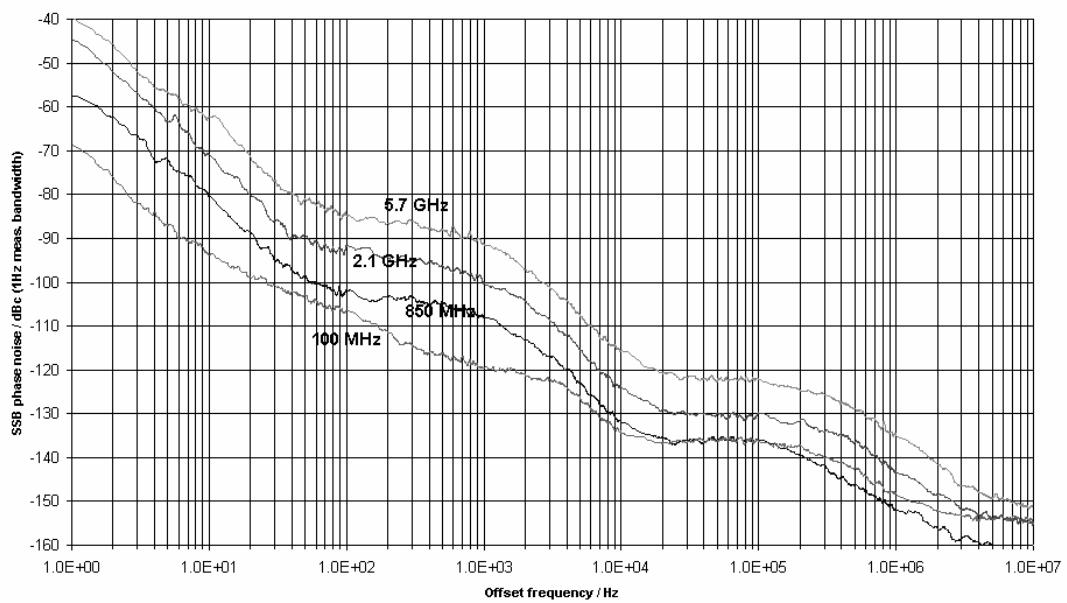
Measured SSB phase noise, I/Q modulated (typical values)
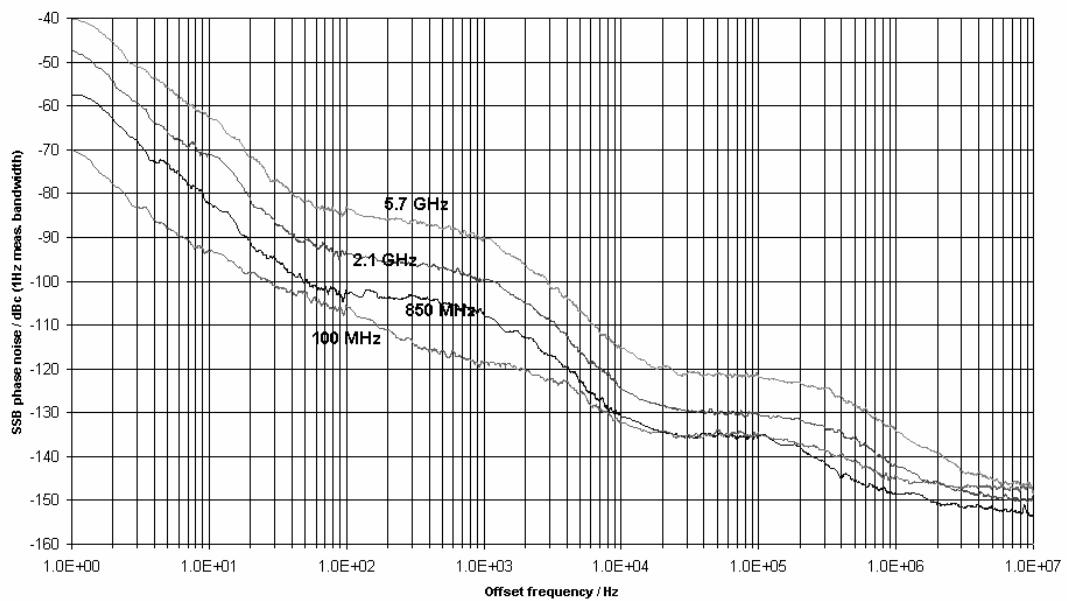
# List mode

| Frequency and level values can be stored in a list and set in an extremely short amount of time. | | |
|---|---|---|
| Operating modes | | automatic, single sweep, manual or external trigger |
| Maximum number of channels | | 10000 |
| Dwell time | | 1 ms to 1 s |
|    Resolution | | 0.1 ms |
| Setting time | after external trigger | see frequency and level data |

# Analog modulation

## Internal modulation generator

| Frequency range | | 0.1 Hz to 1 MHz |
|---|---|---|
| Resolution of setting | | 0.1 Hz |
| Frequency uncertainty | | <0.012 Hz + relative deviation of reference frequency |
| Frequency response | up to 100 kHz | <0.1 dB |
| | up to 1 MHz | <1 dB |
| Distortion | up to 100 kHz at $R_L$ >200 $\Omega$, level ($V_p$) 1 V | <0.1 % |
| Output voltage | $V_p$ at LF connector, $R_L$ >200 $\Omega$ | 1 mV to 3 V |
| | resolution | 1 mV |
| | setting uncertainty at 1 kHz | <(1 % of reading + 1 mV) |
| Output impedance | | 16 $\Omega$ |
| Frequency setting time | to within <1 × $10^{-7}$, with GUI update stopped, after IEC/IEEE bus delimiter | <3 ms |
| Sweep | digital sweep in discrete steps | |
| | operating modes | automatic, step, single, external single, external step, manual or external trigger, linear or logarithmic spacing |
| | sweep range | full frequency range |
| | linear step width | full frequency range |
| | logarithmic step width | 0.01 % to 100 % per step |

## Input for external modulation signals

| Modulation input EXT MOD | input impedance | high (>100 k$\Omega$), switchable to 50 $\Omega$ with R&S®SMJ-B20 option |
|---|---|---|
| | input sensitivity (peak value for set modulation depth or deviation) | 1 V |
| | absolute maximum rating | 10 V |

## Amplitude modulation

| Operating modes | | internal, external AC/DC |
|---|---|---|
| Modulation depth | At high levels, modulation is clipped if the maximum PEP is reached. | 0 % to 100 % |
| Resolution | | 0.1 % |
| Setting uncertainty | attenuator mode Auto, $f_{mod}$ = 1 kHz and m <80 % | <(1 % of reading + 1 %) |
| AM distortion | PEP in specified range, attenuator mode Auto | |
| | f ≤ 3 GHz, at $f_{mod}$ = 1 kHz | |
| | m = 30 % | <0.5 % |
| | m = 80 % | <0.8 % |
| | f > 3 GHz, at $f_{mod}$ = 1 kHz | |
| | m = 30 % | <1 % |
| | m = 80 % | <1.6 % |
| Modulation frequency range | | DC, 20 Hz to 500 kHz |
| Modulation frequency response | AC mode, 20 Hz to 500 kHz | <1 dB |
| Incidental φM at AM | m = 30 %, $f_{mod}$ = 1 kHz, peak value | <0.1 rad |

## Wideband amplitude modulation

| Operating modes | modulation input I | external DC |
|---|---|---|
| Modulation frequency response | as with I/Q modulation – external wideband I/Q | |
| Input impedance | | 50 Ω |
| Input sensitivity | peak voltage for 100 % AM | 0.25 V |

## Pulse modulation

| Operating modes | | external, internal (duty cycle approx. 1:1) |
|---|---|---|
| ON/OFF ratio | | >70 dB |
| Rise/fall time | 10 %/90 % of RF amplitude | typ. 1 µs |
| Pulse repetition frequency | | 0 Hz to 100 kHz |
| Video crosstalk | spectral line of fundamental of 100 kHz squarewave modulation | <−30 dBc |
| Modulation input EXT MOD A/B | input level | rising 1.7 V, falling typ. 1.1 V |
| | input impedance | >10 kΩ |
| | polarity | selectable |

## Frequency modulation (R&S®SMJ-B20 option)

| Operating modes | | internal, external, internal + external, AC/DC |
|---|---|---|
| FM/φM range multiplier | 0.3 MHz ≤ f ≤ 200 MHz | rm = 1 |
| | 200 MHz < f ≤ 375 MHz | rm = 0.25 |
| | 375 MHz < f ≤ 750 MHz | rm = 0.5 |
| | 750 MHz < f ≤ 1500 MHz | rm = 1 |
| | 1500 MHz < f ≤ 3000 MHz | rm = 2 |
| | f > 3000 MHz | rm = 4 |
| Maximum deviation | | rm × 10 MHz |
| Resolution | | <200 ppm, min. rm × 0.1 Hz |
| Setting uncertainty | $f_{mod}$ = 10 kHz, deviation ≤ half of maximum deviation | |
| | internal | <(1.5 % of reading + 20 Hz) |
| | external | <(2.0 % of reading + 20 Hz) |
| FM distortion | $f_{mod}$ = 10 kHz and 1 MHz deviation | <0.1 % |
| Modulation frequency response | 10 Hz to 100 kHz | <0.5 dB |
| | 10 Hz to 10 MHz | <3 dB |
| Synchronous AM | 40 kHz deviation, $f_{mod}$ = 1 kHz, f > 5 MHz | <0.1 % |
| | f > 3 GHz | <0.2 % |
| Carrier frequency offset at FM | | <0.2 % of set deviation |

## Phase modulation (R&S®SMJ-B20 option)

| Operating mode | | internal, external, internal + external, AC/DC, High Bandwidth, High Deviation |
|---|---|---|
| Maximum deviation | High Deviation φM mode | rm × 20.0 rad |
| | High Bandwidth φM mode | rm × 1.0 rad |
| Resolution | High Deviation φM mode | <200 ppm, min. rm × 20 µrad |
| | High Bandwidth φM mode | <0.1 %, min. rm × 20 µrad |
| Setting uncertainty | $f_{mod}$ = 10 kHz, deviation ≤ half of maximum deviation | |
| | internal | <(1.5 % of reading + 0.01 rad) |
| | external | <(2.0 % of reading + 0.01 rad) |
| φM distortion | $f_{mod}$ = 10 kHz, half of maximum deviation | <0.2 %, typ. 0.1 % |
| Modulation frequency response | High Deviation, 10 Hz to 500 kHz | <1 dB |
| | High Bandwidth, 10 Hz to 10 MHz | <3 dB |

# I/Q modulation

## I/Q modulator

| Operating modes | | external wideband I/Q, internal baseband I/Q |
|---|---|---|
| I/Q impairments | I offset, Q offset | |
| | setting range | −10 % to +10 % |
| | resolution | 0.01 % |
| | gain imbalance | |
| | setting range | −1.0 dB to +1.0 dB |
| | resolution | 0.001 dB |
| | quadrature offset | |
| | setting range | −10° to +10° |
| | resolution | 0.01° |
| I/Q swap | I and Q signals swapped | ON/OFF |

## External wideband I/Q

| I/Q inputs | input impedance | 50 Ω |
|---|---|---|
| | VSWR up to 50 MHz | <1.2 |
| | input voltage for full-scale input | $\sqrt{V_i^2 + V_q^2} = 0.5\ V$ |
| | minimum input voltage for ALC state ON | 0.1 V |
| Modulation frequency range | I/Q wideband ON | 100 MHz |
| Carrier leakage | without input signal, referenced to full-scale input[4] | <−55 dBc, typ. <−65 dBc |
| Error vector | measured with 16QAM, root cosine filter, $\alpha = 0.5$, symbol rate 10 kHz | |
| | rms value | |
| | f ≤ 200 MHz | <0.3 % |
| | f > 200 MHz | <(0.2 % + 0.1 % × f/GHz) |
| | peak value | |
| | f ≤ 200 MHz | <0.6 % |
| | f > 200 MHz | <(0.4 % + 0.2 % × f/GHz) |
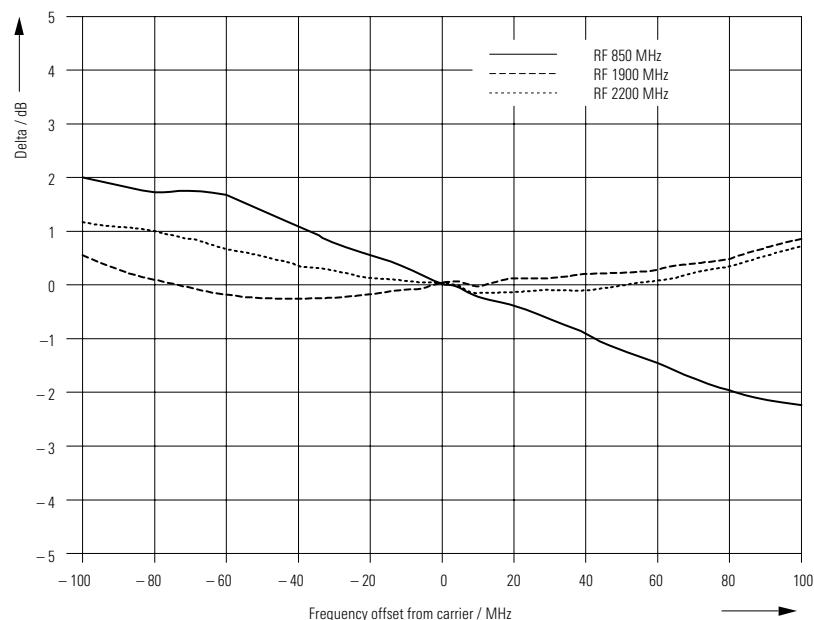


*Measured frequency response of external wideband I/Q modulation*

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[4]  Value applies after 1 hour warm-up and recalibration for 4 hours of operation and temperature variations of less than +5 °C.

# Internal baseband I/Q (with R&S®SMJ-B13 option)

The R&S®SMJ-B13 converts the internal digital baseband signals of the R&S®SMJ-B9/-B10/-B11/-B50/-B51 into analog signals for driving the I/Q modulator. It also generates the analog I/Q output signals.

| | | |
|---|---|---|
| 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 | |
| | 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° |
| RF frequency response for entire instrument in modulation bandwidth | I/Q wideband ON, optimize internal I/Q impairments for RF output ON | |
| | up to 10 MHz | <1.5 dB, typ 0.7 dB |
| | up to 40 MHz | <4.5 dB, typ. 2.0 dB |
| Suppression of image sideband for entire instrument in modulation bandwidth[5] | up to 10 MHz | >44 dB, typ. 50 dB |
| | up to 40 MHz | >34 dB, typ. 44 dB |
| Carrier leakage[5] | referenced to full-scale input | <−55 dBc, typ. <−65 dBc |
| Additional level uncertainty referenced to CW | measured at 0 dBm with 16QAM, root cosine filter, $\alpha$ = 0.5, symbol rate 10 kHz | <0.2 dB |
| **I/Q outputs** | | |
| Output impedance | | 50 Ω |
| Output voltage | EMF (output voltage depends on set modulation signal) | 1 V (V$_p$) |
| Offset | EMF | <1 mV |
| Frequency response[6] | at R$_L$ = 50 Ω | |
| | 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° |
| I/Q balance[6] | 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 |

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[5] Value applies after 1 hour warm-up time and recalibration for 4 hours of operation and temperature variations of less than +5 °C.

[6] Optimize internal I/Q impairments for RF output switched OFF.
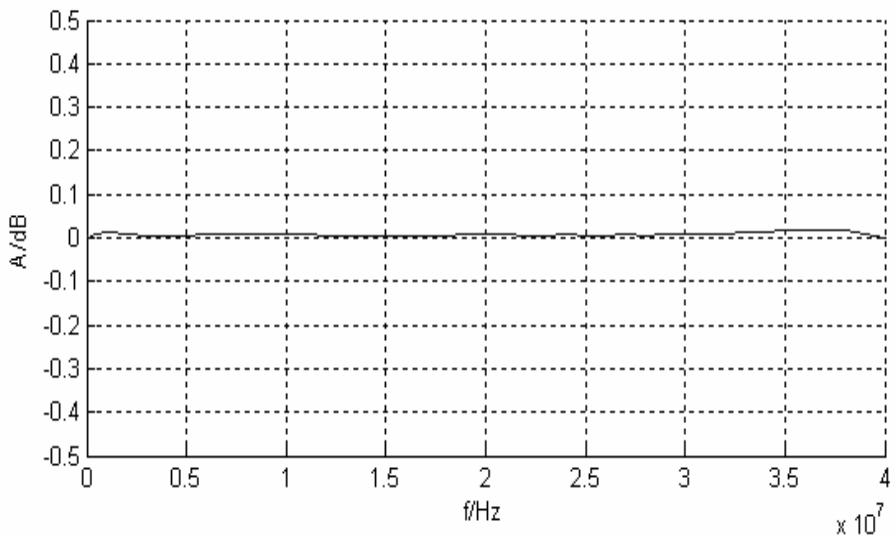
*Frequency response of I/Q outputs*
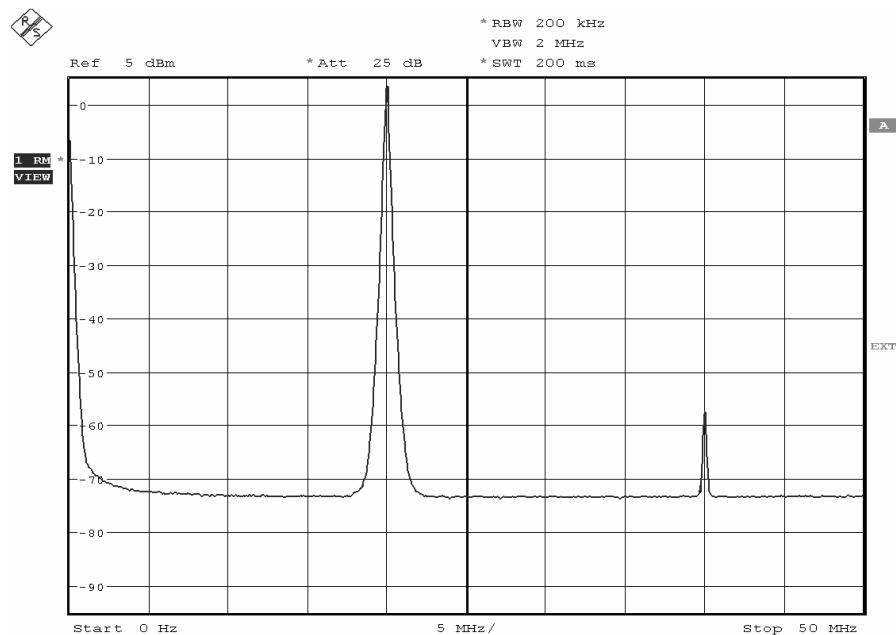


*SFDR of I/Q outputs*

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

| Additional specifications for I/Q outputs with R&S®SMJ-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[7] | 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° |

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[7]   Optimize internal I/Q impairments for RF output switched OFF.

# Digital baseband output (R&S®SMJ-B18 option)

The R&S®SMJ-B18 option makes digital I/Q signals available on the rear panel of the instrument. The digital I/Q output can be used for the lossless connection of the R&S®SMJ100A to the digital I/Q input of other Rohde & Schwarz instruments (e.g. R&S®AMU200A baseband signal generator and fading simulator).

| 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 | 30 MHz to 100 MHz with 1 MHz resolution, 81.6 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 being necessary. With source 'digital I/Q out' or 'digital I/Q in', the sample rate will be estimated on the basis of the applied I/Q data clock. | |
| | source | user-defined, digital I/Q out, digital I/Q in |
| | sample rate | 400 Hz to 100 MHz |
| | | max. sample rate limited by actual interface data rate |
| | resolution (user-defined) | 0.001 Hz |
| | frequency uncertainty (user-defined) | $< 5 \times 10^{-14}$ |
| I/Q data | resolution | 18 bit |
| | logic format | two's complement |
| | physical signal level | |
| | setting range | 0 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 marked in data stream |

# I/Q baseband generator (R&S®SMJ-B9/-B10/-B11/-B50/-B51 option) – arbitrary waveform mode

The R&S®SMJ-B13 baseband main module must be installed.

| | | |
|---|---|---|
| Waveform memory | output memory | |
| | waveform length with the R&S®SMJ-B9 | 128 sample to 128 Msample in one-sample steps |
| | waveform length with the R&S®SMJ-B10/-B50 | 128 sample to 64 Msample in one-sample steps |
| | waveform length with the R&S®SMJ-B11/-B51 | 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) | typ. 5 µs at 50 MHz clock rate |
| | seamless changeover | output up to end of current segment, followed by changeover to next segment |
| Multicarrier waveform | number of carriers | max. 32 |
| | total RF bandwidth | max. 80 MHz |
| | crest factor modes | maximize, minimize, off |
| | signal period modes | longest file, shortest file, user (max. 1 s) |
| | single carrier gain | –80 dB to 0 dB |
| | single carrier start phase | 0° to 360° |
| | single carrier delay | 0 s to 1 s |
| Clock generation | clock rate | 400 Hz to 100 MHz |
| | resolution | 0.001 Hz |
| | operating mode | internal, external |
| | frequency uncertainty (internal) | $<5 \times 10^{-14} \times$ 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 |

| | | |
|---|---|---|
| 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 uncertainty for clock phase related to trigger in internal clock mode | <18 ns |
| | external trigger delay | |
| | setting range | 0 sample to $(2^{16} - 1)$ 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 $(2^{26} - 1)$ 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 uncertainty | <10 ns |
| Operation with R&S®WinIQSIM2™: As of version 2.04, the software supports I/Q data download and control of the R&S®SMJ-B9/-B10/-B11/-B50/-B51. | | |
| Operation with R&S®WinIQSIM™: As of version 4.50, the software supports I/Q data download and control of the R&S®SMJ-B9/-B10/-B11/-B50/-B51. | | |

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

The R&S®SMJ-B13 baseband main module must be installed.

| 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, $\pi$/4-QPSK, $\pi$/2-DBPSK, $\pi$/4-DQPSK, $\pi$/8-D8PSK, 8PSK, 8PSK EDGE |
| | QAM | 16QAM, 32QAM, 64QAM, 256QAM, 1024QAM |
| Coding | Not all coding methods can be used with every type of modulation. | OOFF, Differential, Diff. Phase, Diff. + Gray, Gray, GSM, NADC, PDC, PHS, TETRA, APCO25 (PSK), PWT, TFTS, INMARSAT, VDL, EDGE, APCO25(FSK), ICO, CDMA2000® [8], 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 if the bandwidth is exceeded. | |
| | cosine, root cosine | |
| | filter parameter $\alpha$ | 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 |

---

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

| | | |
|---|---|---|
| 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, QAM | 400 Hz to 25 MHz |
| |    FSK | 400 Hz to 15 MHz |
| | resolution | 0.001 Hz |
| | frequency uncertainty (internal) | $<5 \times 10^{-14} \times$ symbol rate + reference frequency uncertainty |
| | external clock | symbol, K × symbol, 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 | $<5 \times 10^{-10} \times$ frequency offset + reference frequency error |
| 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 of the R&S®SMJ-B9 | 8 bit to 4 Gbit |
| |    output memory of the R&S®SMJ-B10 | 8 bit to 2 Gbit |
| |    output memory of the R&S®SMJ-B11 | 8 bit to 512 Mbit |
| |    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).<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 $(2^{16} - 1)$ sample |
| | resolution | |
| | internal clock mode | 0.01 sample |
| | external clock mode | 1 sample |
| | setting uncertainty | <5 ns |
| | external trigger inhibit | 0 sample to $(2^{26} - 1)$ sample |
| | setting range | |
| | 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). If 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. If 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 | The 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 | 0.00 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® [9], 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 % |



*Measured EVM versus symbol rate*

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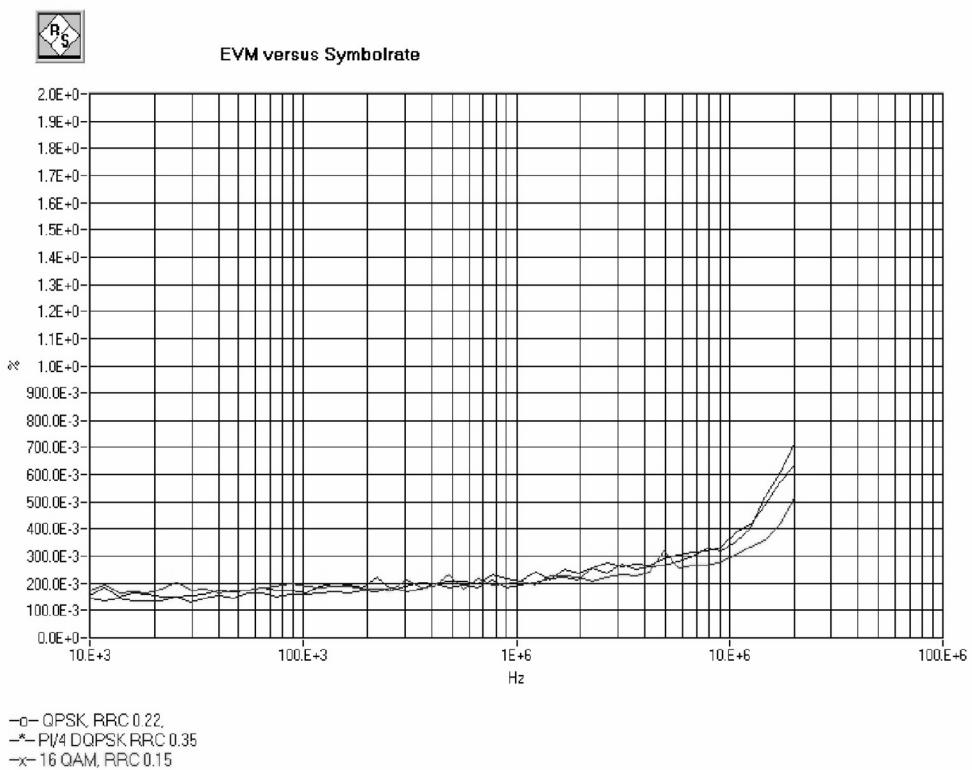
[9]   The Bluetooth® word mark and logos are owned by the Bluetooth SIG, Inc. and any use of such marks by Rohde & Schwarz is under license.

# Modulation uncertainty for main standards

**Typical values**

| Standard | GSM | EDGE | WCDMA 3GPP (1DPCH) | cdmaOne Reverse | DECT | TETRA | NADC | PDC | IEEE 802.11a |
|---|---|---|---|---|---|---|---|---|---|
| Frequency in MHz | 400 to 2000 | 400 to 2000 | 1800 to 2200 | 800 to 900 | 1880 to 1990 | 380 to 480 | 824 to 894 | 810 to 956 | 2400 to 2485 |
| | | | | 1850 to 2000 | | | 1850 to 2000 | 1429 to 1501 | 5150 to 5825 |
| EVM in % | – | 0.2 | 0.3 | 0.2 | – | 0.2 | 0.2 | 0.2 | 0.4 |
| Phase error in ° | 0.15 | – | – | – | – | – | – | – | – |
| Deviation 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 | −38 | −72 | −80 offset 750 kHz, bandwidth 30 kHz | – | −74 | −34 | −71 | −42 at 11 MHz |
| In alternate channel | −71 | −71 | −76 | −93 offset 1.98 MHz, bandwidth 30 kHz | – | −77 | −78 | −77 | −64 at 20 MHz |
| In 2nd alternate channel | −85 | −85 | – | – | – | – | – | – | −66 at 30 MHz |

# Signal performance for digital standards

| **GSM/EDGE** | with R&S®SMJ-K40 option | |
|---|---|---|
| Burst ON/OFF ratio | | >100 dB |
| 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 | |
| | level ≤10.5 dBm | |
| | frequency 400 MHz to 2 GHz | |
| | 200 kHz offset | <−34 dB, typ. −37 dB |
| | 400 kHz offset | <−68 dB, typ. −71 dB |
| | 600 kHz offset | <−80 dB, typ. −85 dB |

| 3GPP FDD | with R&S®SMJ-K42 option | |
|---|---|---|
| Error vector magnitude | 1 DPCH, rms | <0.8 %, typ. 0.3 % |
| Adjacent channel leakage ratio (ACLR) | test model 1, 64 DPCHs | |
| | level ≤10.5 dBm PEP | |
| | frequency 1800 MHz to 2200 MHz | |
| | offset 5 MHz | >66 dB, typ. 69 dB |
| | offset 10 MHz | >68 dB, typ. 71 dB |
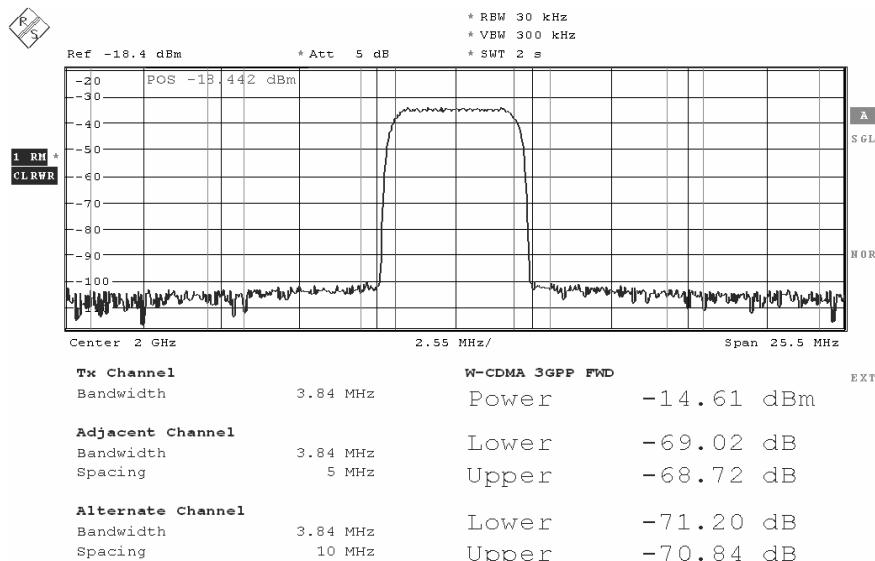


*ACLR (typical values) for 3GPP test model 1, 64 DPCH*
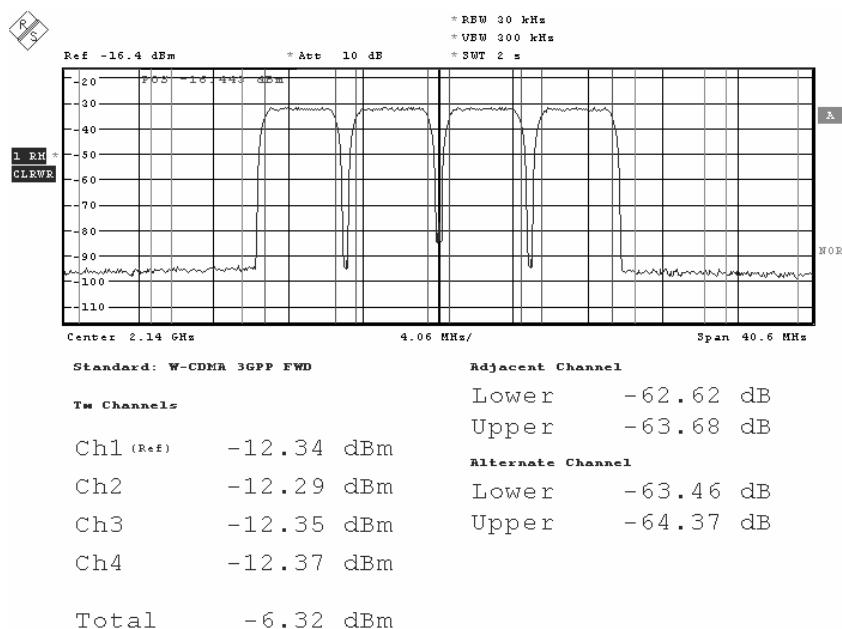


*ACLR (typical values) for a 3GPP four-carrier signal with test model 1, 64 DPCH on each carrier*

| CDMA2000® | with R&S®SMJ-K46 option | |
|---|---|---|
| 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 | |
| | level ≤10.5 dBm PEP | |
| | carrier frequency 800 MHz | |
| | channel spacing 0.75 MHz (bandwidth 30 kHz) | typ. 79 dB |
| | channel spacing 1.98 MHz (bandwidth 30 kHz) | typ. 90 dB |
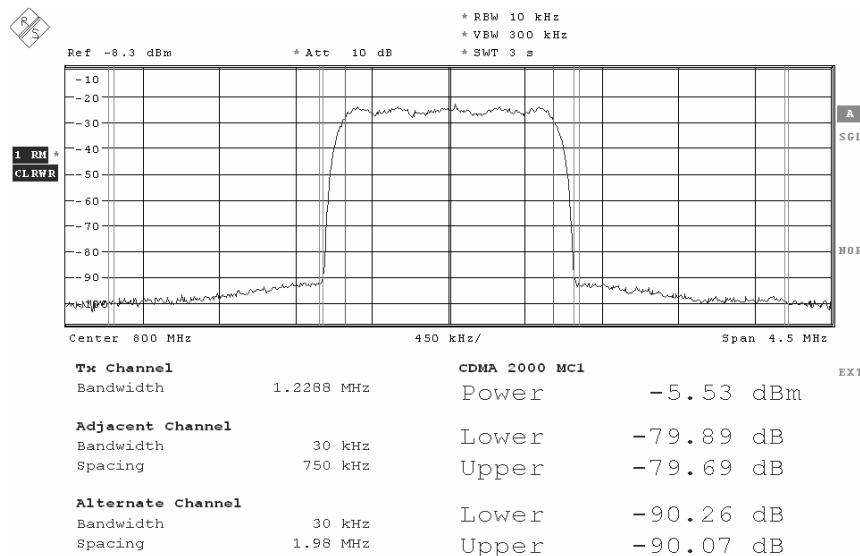


*ACLR (typical values) for a CDMA2000® 1x signal consisting of F-PICH, F-SYNC, and one F-FCH*

| Multicarrier CW | with R&S®SMJ-K61 option | |
|---|---|---|
| RF frequency response | up to 10 MHz | <1.5 dB, typ 0.7 dB |
| | up to 40 MHz | <4.5 dB, typ. 2.0 dB |
| Suppression of unwanted carriers | up to 10 MHz | >50 dB, typ. 56 dB |
| | up to 40 MHz | >40 dB, typ. 50 dB |
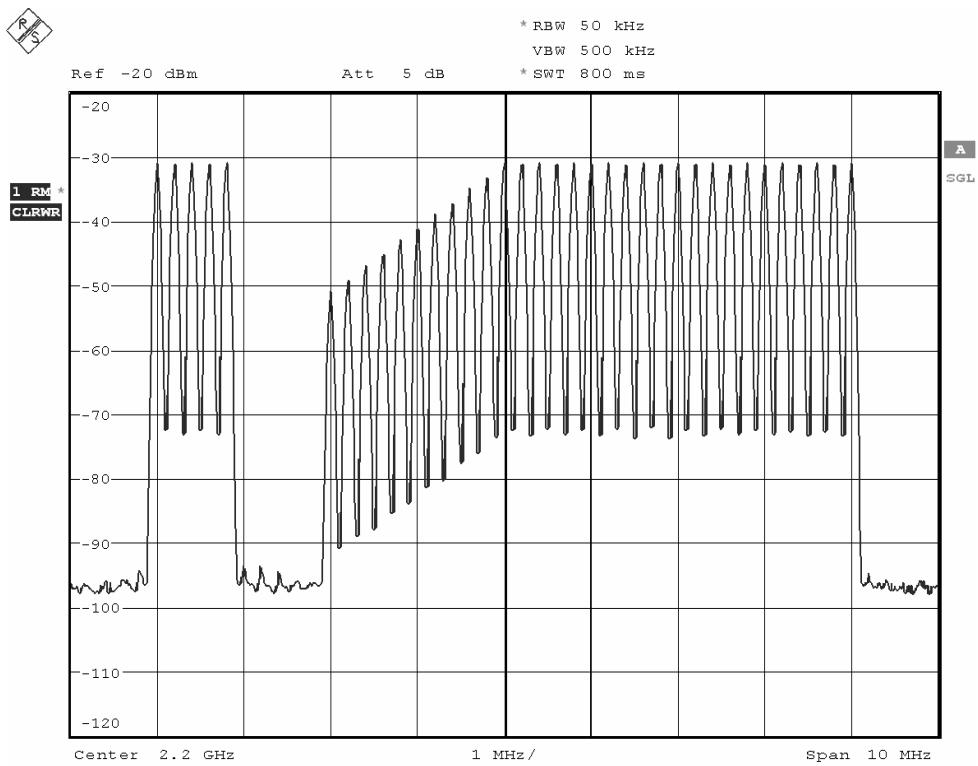
*Example of multicarrier CW, with different carrier powers and some carriers switched off in the left half of the spectrum*

# Digital standards (for the R&S®SMJ-B9/-B10/-B11)

An R&S®SMJ-B9, R&S®SMJ-B10, or R&S®SMJ-B11 I/Q baseband generator is required. The specified data applies together with the parameters of the respective standard. The entire frequency range as well as filter parameters and symbol rates can be set by the user.

| | |
|---|---|
| GSM/EDGE digital standard | R&S®SMJ-K40 option |
| 3GPP FDD digital standard | R&S®SMJ-K42 option |
| 3GPP FDD enhanced BS/MS tests including HSDPA | R&S®SMJ-K43 option |
| GPS digital standard | R&S®SMJ-K44 option |
| 3GPP FDD enhanced BS/MS tests including HSUPA | R&S®SMJ-K45 option |
| CDMA2000® digital standard | R&S®SMJ-K46 option |
| 1xEV-DO digital standard | R&S®SMJ-K47 option |
| IEEE 802.11a/b/g digital standard | R&S®SMJ-K48 option |
| IEEE 802.16 WiMAX digital standard including IEEE 802.16e | R&S®SMJ-K49 option |
| TD-SCDMA (3GPP TDD LCR) digital standard | R&S®SMJ-K50 option |
| TD-SCDMA (3GPP TDD LCR) enhanced BS/MS tests including HSDPA | R&S®SMJ-K51 option |
| DVB-H digital standard | R&S®SMJ-K52 option |
| DAB / T-DMB digital standard | R&S®SMJ-K53 option |
| IEEE 802.11n digital standard | R&S®SMJ-K54 option |
| EUTRA/LTE digital standard | R&S®SMJ-K55 option |
| XM RADIO digital standard | R&S®SMJ-K56 option |
| Multicarrier CW signal generation | R&S®SMJ-K61 option |

The options are described in the Digital Standards data sheet (PD 5213.9434.22).

# Digital standards with external PC software

An I/Q baseband generator must be installed. R&S®SMJ-K5 and -K8 require the R&S®SMJ-B9, -B10, or -B11. R&S®SMJ-K6 can be used with theR&S®SMJ-B9, -B10, -B11, -B50 or -B51.

| | |
|---|---|
| Bluetooth® digital standard (external PC software) | R&S®SMJ-K5 option |
| Pulse sequencer (external PC software) | R&S®SMJ-K6 option |
| TETRA digital standard (external PC software) | R&S®SMJ-K8 option |

The options are described in the Digital Standards data sheet (PD 5213.9434.22).

# Digital standards with R&S®WinIQSIM2™ (for the R&S®SMJ-B9/-B10/-B11/-B50/-B51 ARB)

| | |
|---|---|
| GSM/EDGE digital standard | R&S®SMJ-K240 option |
| 3GPP FDD digital standard | R&S®SMJ-K242 option |
| 3GPP FDD enhanced BS/MS tests including HSDPA | R&S®SMJ-K243 option |
| GPS digital standard | R&S®SMJ-K244 option |
| 3GPP FDD enhanced BS/MS tests including HSUPA | R&S®SMJ-K245 option |
| CDMA2000® digital standard | R&S®SMJ-K246 option |
| 1 x EV-DO digital standard | R&S®SMJ-K247 option |
| IEEE 802.11a/b/g digital standard | R&S®SMJ-K248 option |
| IEEE 802.16 WiMAX digital standard including IEEE 802.16e | R&S®SMJ-K249 option |
| TD-SCDMA (3GPP TDD LCR) digital standard | R&S®SMJ-K250 option |
| TD-SCDMA (3GPP TDD LCR) enhanced BS/MS tests including HSDPA | R&S®SMJ-K251 option |
| DVB-H digital standard | R&S®SMJ-K252 option |
| IEEE 802.11n digital standard | R&S®SMJ-K254 option |
| EUTRA/LTE digital standard | R&S®SMJ-K255 option |
| XM RADIO digital standard | R&S®SMJ-K256 option |
| Multicarrier CW signal generation | R&S®SMJ-K261 option |
| Additive white Gaussian noise (AWGN) | R&S®SMJ-K262 option |

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


# Digital standards with R&S®WinIQSIM™ (for the R&S®SMJ-B9/-B10/-B11/-B50/-B51 ARB)

| | |
|---|---|
| IS-95 digital standard | R&S®SMJ-K11 option |
| CDMA2000® digital standard | R&S®SMJ-K12 option |
| 3GPP TDD HDR digital standard | R&S®SMJ-K13 option |
| 3GPP TDD LDR digital standard (TD-SCDMA) | R&S®SMJ-K14 option |
| OFDM with R&S®WinIQOFDM | R&S®SMJ-K15 option |
| 1xEV-DO (Rev. 0) digital standard | R&S®SMJ-K17 option |
| IEEE 802.11a/b/g digital standard | R&S®SMJ-K19 option |
| 3GPP FDD digital standard including HSDPA | R&S®SMJ-K20 option |

The options are described in the R&S®WinIQSIM™ data sheet (PD 0758.0680.32).

# Noise generation

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

The R&S®SMJ-B13 baseband main module must be installed.

Addition of an AWGN signal of settable bandwidth and settable C/N ratio or $E_b/N_0$ 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

## BER measurement (R&S®SMJ-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 by means of maximum number of data bits or bit errors (max. $2^{31}$ bit 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®SMJ-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 V to 2.50 V |
| | resolution | 0.01 V |
| Polarity | data, clock, data enable | normal, inverted |
| Measurement time | selectable by means of 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) |
| | | Ethernet |
| Command set | | SCPI 1999.5 |
| Connector | | |
| IEC/IEEE | | 24-contact Amphenol |
| Ethernet | | Western |
| 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 | 47 Hz to 63 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 | in line with EMC directive of EU (2004/108/EC), applied standard: EN 61326 (immunity for industrial environment; class A emissions)[10] |
| Immunity to interfering field strength | | up to 10 V/m |
| Environmental conditions | operating temperature range | +5 °C to +45 °C in line with EN 60068-2-1, EN 60068-2-2 |
| | storage temperature range | −20 °C to +60 °C |
| | climatic resistance | +40 °C/90 % rel. humidity in line with EN 60068-2-3 |
| Mechanical resistance | | |
| Vibration | sinusoidal | 5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g const., in line with EN 60068-2-6 |
| | random | 10 Hz to 300 Hz, acceleration 1.2 g (rms), in line with EN 60068-2-64 |
| Shock | | in line with EN 60068-2-27, MIL-STD-810E 40 g shock spectrum |
| Electrical safety | | in line with EN 61010-1 |
| Dimensions | width × height × depth | 435 mm × 192 mm × 460 mm (17.1 in × 7.6 in × 18.1 in) |
| Weight | if fully equipped | 18 kg (39.7 lb) |
| Recommended calibration interval | | 3 years |

## License information

The firmware of this device contains open source software. Details as well as license agreements can be found in release notes and operating manual.

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[10]  The instrument complies with the emission requirements stipulated by EN 55011 class A. This means that the instrument is suitable for use in industrial environments. In line with EN61000-6-4, operation in residential, commercial and business areas or in small-size companies is not covered. Thus, the instrument may not be operated in residential, commercial and business areas or in small-size companies, unless additional measures are taken to ensure that EN 610000-6-3 is complied with.

# Ordering information

| Designation | Type | Order No. |
|---|---|---|
| **Vector Signal Generator**[11] including power cable, Quick Start Guide, and CD-ROM (with operating and service manual) | R&S®SMJ100A | 1403.4507.02 |
| **Options** | | |
| RF | | |
| 100 kHz to 3 GHz | R&S®SMJ-B103 | 1403.8502.02 |
| 100 kHz to 6 GHz | R&S®SMJ-B106 | 1403.8702.02 |
| FM/φM Modulator | R&S®SMJ-B20 | 1403.9209.02 |
| | | |
| Baseband | | |
| Baseband Generator with ARB (128 Msample) and Digital Modulation (realtime) | R&S®SMJ-B9 | 1404.1501.02 |
| Baseband Generator with ARB (64 Msample) and Digital Modulation (realtime) | R&S®SMJ-B10 | 1403.8902.02 |
| Baseband Generator with ARB (16 Msample) and Digital Modulation (realtime) | R&S®SMJ-B11 | 1403.9009.02 |
| Baseband Main Module | R&S®SMJ-B13 | 1403.9109.02 |
| Differential I/Q Output | R&S®SMJ-B16 | 1403.9409.02 |
| Digital Baseband Output | R&S®SMJ-B18 | 1410.5705.02 |
| Baseband Generator with ARB (64 Msample) | R&S®SMJ-B50 | 1410.5505.02 |
| Baseband Generator with ARB (16 Msample) | R&S®SMJ-B51 | 1410.5605.02 |
| | | |
| Digital standards | | |
| GSM/EDGE | R&S®SMJ-K40 | 1404.0305.02 |
| 3GPP FDD | R&S®SMJ-K42 | 1404.0405.02 |
| 3GPP Enhanced MS/BS Tests incl. HSDPA | R&S®SMJ-K43 | 1404.0505.02 |
| GPS | R&S®SMJ-K44 | 1404.1401.02 |
| 3GPP FDD HSUPA | R&S®SMJ-K45 | 1409.1816.02 |
| CDMA2000® | R&S®SMJ-K46 | 1404.0605.02 |
| 1xEV-DO | R&S®SMJ-K47 | 1409.2306.02 |
| IEEE 802.11 (a/b/g) | R&S®SMJ-K48 | 1404.1001.02 |
| IEEE 802.16 | R&S®SMJ-K49 | 1404.1101.02 |
| TD-SCDMA | R&S®SMJ-K50 | 1404.1660.02 |
| TD-SCDMA Enhanced BS/MS Tests | R&S®SMJ-K51 | 1404.1760.02 |
| DVB-H | R&S®SMJ-K52 | 1409.2106.02 |
| DAB/T-DMB | R&S®SMJ-K53 | 1400.6309.02 |
| IEEE 802.11n | R&S®SMJ-K54 | 1409.2506.02 |
| EUTRA/LTE | R&S®SMJ-K55 | 1409.2206.02 |
| XM RADIO | R&S®SMJ-K56 | 1404.1806.02 |
| Multicarrier CW Signal Generation | R&S®SMJ-K61 | 1404.0705.02 |
| | | |

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[11] The base unit can only be ordered with an R&S®SMJ-B10x frequency option.

| Digital standards using R&S®WinIQSIM2™ [12] | | |
|---|---|---|
| GSM/EDGE | R&S®SMJ-K240 | 1404.0510.02 |
| 3GPP FDD | R&S®SMJ-K242 | 1404.0610.02 |
| 3GPP Enhanced MS/BS Tests incl. HSDPA | R&S®SMJ-K243 | 1404.0710.02 |
| GPS | R&S®SMJ-K244 | 1404.0810.02 |
| 3GPP FDD HSUPA | R&S®SMJ-K245 | 1404.0910.02 |
| CDMA2000® | R&S®SMJ-K246 | 1404.1016.02 |
| 1xEV-DO | R&S®SMJ-K247 | 1409.2358.02 |
| IEEE 802.11 (a/b/g) | R&S®SMJ-K248 | 1404.1116.02 |
| IEEE 802.16 | R&S®SMJ-K249 | 1404.1216.02 |
| TD-SCDMA | R&S®SMJ-K250 | 1404.1316.02 |
| TD-SCDMA Enhanced BS/MS Tests | R&S®SMJ-K251 | 1404.1416.02 |
| DVB-H | R&S®SMJ-K252 | 1409.2406.02 |
| IEEE 802.11n | R&S®SMJ-K254 | 1409.2506.02 |
| EUTRA/LTE | R&S®SMJ-K255 | 1409.2258.02 |
| Multicarrier CW Signal Generation | R&S®SMJ-K261 | 1404.1516.02 |
| Additive White Gaussian Noise (AWGN) | R&S®SMJ-K262 | 1400.6650.02 |
| | | |
| Digital standards using R&S®WinIQSIM™ [12] | | |
| IS-95 | R&S®SMJ-K11 | 1403.9509.02 |
| CDMA2000® | R&S®SMJ-K12 | 1403.9609.02 |
| 3GPP TDD | R&S®SMJ-K13 | 1403.9709.02 |
| TD-SCDMA | R&S®SMJ-K14 | 1403.9809.02 |
| User-Defined OFDM Signals (with R&S®WinIQSIM™ and R&S®WinIQOFDM) | R&S®SMJ-K15 | 1403.9909.02 |
| 1xEV-DO | R&S®SMJ-K17 | 1404.0005.02 |
| IEEE 802.11 (a/b/g) | R&S®SMJ-K19 | 1404.0105.02 |
| 3GPP FDD incl. HSDPA | R&S®SMJ-K20 | 1404.0205.02 |
| Digital standards using external PC software | | |
| Bluetooth® | R&S®SMJ-K5 | 1404.1301.02 |
| Pulse Sequencer | R&S®SMJ-K6 | 1409.2558.02 |
| TETRA | R&S®SMJ-K8 | 1409.1716.02 |
| Noise generation | | |
| Additive White Gaussian Noise (AWGN) | R&S®SMJ-K62 | 1404.0805.02 |
| Other options | | |
| BER/BLER Measurement | R&S®SMJ-K80 | 1404.0905.02 |
| XM RADIO Waveforms | R&S®SMJ-K256 | 1409.2606.02 |
| Rear Connectors | R&S®SMJ-B81 | 1403.9309.02 |
| | | |
| **Recommended extras** | | |
| Hardcopy manuals (in German) | | 1403.7458.31 |
| Hardcopy manuals (in English, UK) | | 1403.7458.32 |
| Hardcopy manuals (in English, USA) | | 1403.7458.39 |
| 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 | 1157.6870.04 |
| Mouse with USB Interface, optical | R&S®PSL-Z10 | 1157.7060.03 |
| External USB CD-RW Drive | R&S®PSP-B6 | 1134.8201.22 |

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[12]  R&S®WinIQSIM2™ and R&S®WinIQSIM™ require an external PC.

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, it is the user's responsibility to use 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.

This document contains the specifications of the R&S®SMJ100A, including RF characteristics, analog modulation, I/Q modulation, and performance of the I/Q baseband generator. The functional specifications of the digital standards (R&S®SMJ-K40 to -K61 options) and the digital standards with external PC software (R&S®SMJ-K5, -K6, -K8 options) are described in the Digital Standards data sheet (PD 5213.9434.22). The digital standards with R&S®WinIQSIM2™ (R&S®SMJ-K240 to -K262 options) are described in the R&S®WinIQSIM2™ data sheet (PD 5213.7460.22), the digital standards with R&S®WinIQSIM™ (R&S®SMJ-K11 to -K20 options) in the R&S®WinIQSIM™ data sheet (PD 0758.0680.32).

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Certified Quality System
**ISO 9001**
DQS REG. NO 1954 QM

Certified Environmental System
**ISO 14001**
DQS REG. NO 1954 UM

For product brochure, see PD 5213.5074.12
and www.rohde-schwarz.com
(search term: SMJ100A)

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