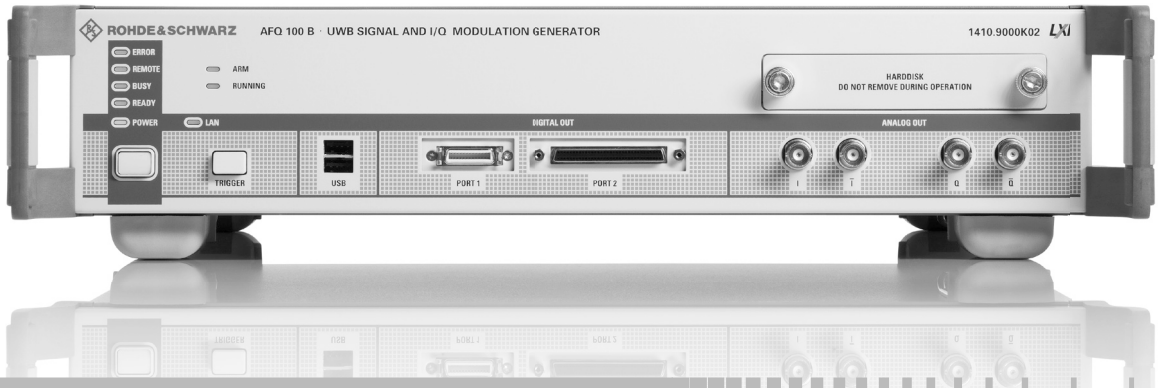
R&S®AFQ100A
I/Q Modulation Generator
R&S®AFQ100B
UWB Signal and
I/Q Modulation Generator
Specifications



ROHDE&SCHWARZ

Data Sheet | Version 04.00

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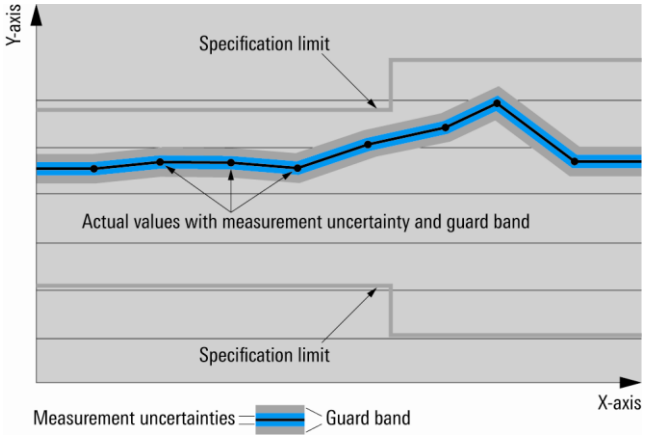
Definitions

General
Product data applies under the following conditions:

- Three hours storage at ambient temperature followed by 30 minutes warm-up operation
- Specified environmental conditions met
- Recommended calibration interval adhered to
- All internal automatic adjustments performed, if applicable

Specifications with limits
Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as <, ≤, >, ≥, ±, or descriptions such as maximum, limit of, minimum. Compliance is ensured by testing or is derived from the design. Test limits are narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



Specifications without limits
Represent warranted product performance for the specified parameter. These specifications are not specially marked and represent values with no or negligible deviations from the given value (e.g. dimensions or resolution of a setting parameter). Compliance is ensured by design.

Typical data (typ.)
Characterizes product performance by means of representative information for the given parameter. When marked with <, > or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

Nominal values (nom.)
Characterize product performance by means of a representative value for the given parameter (e.g. nominal impedance). In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

Measured values (meas.)
Characterize expected product performance by means of measurement results gained from individual samples.

Uncertainties
Represent limits of measurement uncertainty for a given measurand. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.

Device settings and GUI parameters are indicated as follows: “parameter: value”.

Typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

Key features

R&S®AFQ100A and R&S®AFQ100B specific features

R&S®AFQ100A – fit for digital communications systems

- Variable memory clock rate (1 kHz to 300 MHz) can optimally be adjusted to the useful signal
- RF bandwidth of 200 MHz, e.g. for compensating higher-order non-linearities of multicarrier power amplifiers (MCPA)
- Long signal duration of up to 1 Gsample (R&S®AFQ-B11 option); long signals required e.g. for BER measurements
- R&S®WinIQSIM2™ options for communications standards such as WiMAX™, LTE, HSPA, etc.

R&S®AFQ100B – tailored to UWB applications

- Memory clock rate:
  - Mode 1: variable clock rate (1 kHz to 300 MHz) can optimally be adjusted to the useful signal
  - Mode 2: very high clock rate of 600 MHz
- RF bandwidth:
  - Mode 1: 200 MHz
  - Mode 2: 528 MHz (especially suited for UWB applications)
- Long signal duration of up to 1 Gsample (R&S®AFQ-B11 option). Long signals are required, for example, when using multisegment waveforms to reduce switching times between different test signals
- R&S®WinIQSIM2™ option (R&S®AFQ-K264) for flexible UWB (EMCA-368) signal generation
- Nearly all R&S®AFQ100A features also included

R&S®AFQ100A and R&S®AFQ100B shared features

Aerospace and defense applications

- High bandwidth for generating very short pulses with short rise and fall times
- Pulse sequencer software for generating complex pulse patterns (R&S®AFQ-K6 option)
- Accuracy <20 ps when starting several instruments simultaneously → phased-array antenna development and testing
- Removable hard disk to meet high security requirements

Outstanding signal quality

- Excellent spurious-free dynamic range (SFDR) of up to typ. 83 dBc
- Frequency response of typ. 0.05 dB across 100 MHz I/Q bandwidth
- Frequency response compensation
- Very pure sinewave source

Broad scope of applications

- Analog I/Q outputs (balanced and unbalanced) and optional digital outputs, e.g. for D/A and A/D converter tests
- Multisegment waveform for reducing switching time between different test signals and thus improving test throughput
- Numerous trigger and marker capabilities, e.g. for synchronization with a DUT
- Optional BER measurements for characterizing receivers

Easy creation of test signals

- Digital standards using R&S®WinIQSIM2™
- Pulsed signals with pulse sequencer software (R&S®AFQ-K6 option)
- MATLAB® transfer toolbox for easy interoperability with MATLAB®
- ARB toolbox for converting numeric I/Q data into R&S®AFQ100A/R&S®AFQ100B waveform files

Easy operation

- Remote control via GPIB, USB and LAN
- User interface via external monitor or Windows XP Remote Desktop
- USB connectors for USB equipment (keyboard, mouse, memory stick)

Specifications

Output memory

Memory clock of the R&S®AFQ100A		1 kHz to 300 MHz
Memory clock of the R&S®AFQ100B		1 kHz to 300 MHz (mode 1), 600 MHz (mode 2)
Waveform length (data and markers) of the R&S®AFQ100A		from 3 sample in steps of 1 sample
	waveform memory (R&S®AFQ-B10)	up to 256 Msample
	waveform memory (R&S®AFQ-B11)	up to 1 Gsample
Waveform length (data and markers) of the R&S®AFQ100B		from 3 sample in steps of 1 sample (mode 1), from 6 sample in steps of 2 sample (mode 2)
	waveform memory (R&S®AFQ-B11)	up to 1 Gsample
	waveform memory (R&S®AFQ-B12)	up to 512 Msample
Waveform bandwidth		max. 0.33 × memory clock [1], max. 0.44 × memory clock [2]
Amplitude resolution of data words		16 bit analog and digital (R&S®AFQ-B18)
Marker channels		4
	control	
	by separate internal signal generators	pulse, pattern, ON/OFF ratio
	from main memory	4 bit per sample, deducted from waveform memory
	offset relative to signal waveform	0 sample to 2000 sample

Clock generation

The data is read from memory with the memory clock and internally resampled to the converter clock of the DAC.		
Clock rates, analog output	memory clock	1 kHz to 300 MHz [1]
		600 MHz [2]
	converter clock (with digital lowpass filter and clock rate converter)	1200 MHz
Clock rates, digital output, port 1 (LVDS, multiplexed × 7)	interface clock (with digital lowpass filter and clock rate converter)	100 MHz
	data clock	700 MHz (in line with TIA644)
	memory clock	1 kHz to interface clock rate
	operating modes	
	with clock rate converter	with digital lowpass filter and clock rate conversion (memory clock to interface clock), configurable filter for frequency response correction
	with data enable	valid samples are marked with a "data valid" bit; system clock rate = memory clock
Clock rates, digital output, port 2 (LVDS, parallel)	interface clock	1 kHz to 300 MHz
	data clock	same as interface clock (direct output, no filters)
	memory clock	same as interface clock
Resolution		1×10^{-7}
Clock output		memory clock
	level	LVTTL, 2 V into 50 Ω
External clock input	input level	0 V to 3 V, threshold can be set between 10 mV and 1.9 V
	input impedance	50 Ω/1 kΩ, switchable
	frequency	1 kHz to 300 MHz

[1] R&S®AFQ100A and R&S®AFQ100B, mode 1.

[2] R&S®AFQ100B, mode 2.

Reference frequency

Output for internal reference	frequency	10 MHz
	aging (after 30 days of operation)	1×10^{-6}/year
	temperature effect (+5 °C to +45 °C)	1×10^{-6}
	level	0.35 V (rms, sinewave, into 50 Ω)
	output impedance	50 Ω
Input for external reference	frequency	10 MHz
	permissible frequency deviation	0.05 %
	level	0.2 V to 2 V (rms, sinewave)
	input impedance	50 Ω

Signal output

Number of outputs		2 (I and Q)
Output (unbalanced) of the R&S®AFQ100A		1 V (V_{pp}) (into 50 Ω (nominal))
	level range	0 V to 1.5 V (V_{pp}) (into 50 Ω)
	hardware attenuator	0 dB to 21 dB in steps of 3 dB
	fine variation	±5 %, separately for I and Q channel
	resolution	14 bit
	impedance	50 Ω each
	pulse rise/fall time (10 %/90 %)	6 ns
	level error (DC, at 1 V (V_{pp}))	< ±1 % (at 1 kHz, after auto alignment)
	level difference between the two channels	< ±0.1 % (at 1 kHz, after auto alignment)
	frequency response (relative to DC)	±0.05 dB up to 50 MHz
		±0.1 dB up to 100 MHz
Output (unbalanced) of the R&S®AFQ100B	same as balanced outputs	if operated unbalanced, the other end should be terminated with 50 Ω
Output (balanced) of the R&S®AFQ100A		2 V (V_{pp}) (between I and $\bar{I}$ into 100 Ω, nominal)
	level range	0 V to 3 V (V_{pp}) (into 100 Ω)
	hardware attenuator	0 dB to 21 dB in steps of 3 dB
	fine variation	±5 %, separately for I and Q channel
	resolution	14 bit
	impedance	50 Ω each
	bias voltage	–2.5 V to +2.5 V in steps of 10 mV
	pulse rise/fall time (10 %/90 %)	6 ns
	level error (DC, at 2 V (V_{pp}))	< ±1 % (at 1 kHz, after auto alignment)
	level difference between the two channels	< ±0.1 % (at 1 kHz, after auto alignment, bias voltage OFF)
		< ±0.5 % (at 1 kHz, after auto alignment, bias voltage ON)
	frequency response (relative to DC)	±0.05 dB up to 50 MHz
		±0.1 dB up to 100 MHz
Output (balanced) of the R&S®AFQ100B		1 V (V_{pp}) (between I and $\bar{I}$ into 100 Ω, nominal)
	level range	0 V to 1.4 V (V_{pp}) (into 100 Ω)
	hardware attenuator	0 dB, 6 dB
	fine variation	±5 %, separately for I and Q channel
	resolution	14 bit
	impedance	50 Ω each
	bias voltage	–2.5 V to +2.5 V in steps of 10 mV
	pulse rise/fall time (10 %/90 %)	2.5 ns
	level error (DC, at 1 V (V_{pp}))	< ±1 % (at 1 kHz, after auto alignment)
	level difference between the two channels	< ±0.1 % (at 1 kHz, after auto alignment, bias voltage OFF)
		< ±0.5 % (at 1 kHz, after auto alignment, bias voltage ON)
	frequency response (relative to DC)	mode 1: ±0.5 dB up to 100 MHz, typ. 0.3 dB
		mode 2: ±0.8 dB up to 100 MHz, typ. 0.5 dB
		±1 dB up to 150 MHz
		±2 dB up to 240 MHz
		±2.5 dB up to 264 MHz

Spectral purity of the R&S®AFQ100A	SFDR (without harmonics)	>80 dBc, typ. 83 dBc
	harmonics	
	10 MHz signal (bandwidth 0 Hz to 100 MHz, V_{out} = 1 V (V_{pp}), bias voltage OFF)	< –70 dBc, typ. –75 dBc
	50 MHz signal (bandwidth 0 Hz to 500 MHz, V_{out} = 1 V (V_{pp}), bias voltage OFF)	< –65 dBc, typ. –68 dBc
	100 MHz signal (bandwidth 0 Hz to 500 MHz, V_{out} = 1 V (V_{pp}), bias voltage OFF)	typ. –50 dBc
	3GPP signal, test model 1/64 (V_{out} = 1.5 V (V_{pp}), bias voltage OFF) [3]	
	adjacent channel	typ. –80 dBc
	alternate channel	typ. –80 dBc
	3GPP signal, test model 1/64 (V_{out} = 1.5 V (V_{pp}), bias voltage OFF, f(IF) = 25 MHz)	
	adjacent channel	typ. –75 dBc
	alternate channel	typ. –77 dBc
Spectral purity of the R&S®AFQ100B	SFDR (without harmonics)	>75 dBc, typ. 78 dBc
	harmonics	
	1 MHz signal, bandwidth 0 MHz to 100 MHz V_{out} = 0.5 V (V_{pp})	< –70 dBc, typ. –75 dBc
	10 MHz signal, bandwidth 0 MHz to 100 MHz V_{out} = 0.5 V (V_{pp})	< –70 dBc, typ. –75 dBc
	50 MHz signal, bandwidth 0 MHz to 500 MHz V_{out} = 0.5 V (V_{pp})	< –55 dBc, typ. –60 dBc
	100 MHz signal, bandwidth 0 MHz to 500 MHz V_{out} = 0.5 V (V_{pp})	typ. –55 dBc
	150 MHz signal, bandwidth 0 MHz to 500 MHz V_{out} = 0.5 V (V_{pp})	typ. –50 dBc
Noise floor	at V_{pp} = 0.7 V	< –154 dBc (1 Hz)
Digital filters		4 filters (15 taps each) in butterfly structure [4]
Skew between I and Q channel		–2 ns to +2 ns (can be digitally set in steps of 10 ps) [4]
DC offset	alignment	automatic, separately for each channel
	residual offset	< ±1 mV (after auto alignment)

[3] Measured with additional external channel filter.

[4] R&S®AFQ100A and R&S®AFQ100B, mode 1.

Operating modes

Continuous output		repetitive output of waveform from output memory
Single output		single output of waveform from output memory
Segment mode		output of up to 2048 different segments; for each segment, the stepping condition for advancing to the next segment (NEXT) can be selected
Trigger inputs		2, TRIG and NEXT (BNC)
	input level	0 V to 3 V, threshold can be set between 10 mV and 1.9 V
	input impedance	50 Ω/1 kΩ, switchable
	pulse width	min. 10 ns
	min. trigger repetition period	100 µs + 25 memory clock cycles
	dead time between trigger input and output of first data word	1.8 µs + 13 memory clock cycles + 3.3 ns jitter; with an external trigger, the output is synchronized with the trigger input
Direct IF		digital modulator for direct generation of user-selectable IF (within signal bandwidth)

Auxiliary outputs

Markers		user-configurable signals aligned to data words
	number	4, BNC
	level	LVTTL, 2 V into 50 Ω

BERT (R&S®AFQ-K80 option)

Data supplied by the DUT can be compared with a pseudo-random binary sequence (data content of the I/Q signal) output by the instrument. Results are transferred to the host computer (via the currently used remote control system).		
Pseudo-random binary sequences		PRBS9, PRBS11, PRBS15, PRBS16, PRBS20, PRBS21, PRBS23
Clock source		clock signal supplied by DUT; one clock pulse is required for each valid bit
Clock rate		min. 1 kHz, max. 100 MHz
Interface		BNC
	data	TTL
	clock	TTL
	setup time	4 ns
	hold time	0 ns
Polarity		normal and inverted (data, clock)
	input level	0 V to 3 V, selectable threshold
	input impedance	50 Ω/1 kΩ, switchable
Results		BER in ppm

Digital outputs (R&S®AFQ-B18 option)

Output	port 1	multiplexed I/Q data stream, compatible with other Rohde & Schwarz equipment
	port 2	parallel I/Q interface
Port 1	operating modes	
	interpolated	memory data with digital lowpass filter and clock rate converter (conversion to interface clock)
	with enable	valid samples are marked with a "data valid" bit in the data stream
	clock source	external, internal
	interface	26-pin I/Q interface
	data	LVDS
	clock	LVDS
Port 2	operating mode	direct output of memory data
	clock source	external, internal
	interface	68-pin HD-SCSI, 16 bit for each I and Q, 2 data clock lines
	data	LVDS, >±200 mV into 100 Ω
	clock	LVDS, >±200 mV into 100 Ω
	skew	200 ps
	rise time	400 ps

General data

Computer		industrial PC
Mass memory		3.5" SATA hard disk drive, 160 Gbyte
Interfaces		USB 2.0 (master and slave), Gigabit Ethernet, IEC 625 (IEEE 488)
Operating software updates		via USB

Remote control		via USB, Ethernet, IEC 625-2 (IEEE 488)
Command set		SCPI 1996.0 with extensions
IEC/IEEE interface functions		SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C0

Operating data

Power supply		100 V to 240 V AC, 50 Hz to 60 Hz, 2.0 A to 1.0 A
	power factor correction	in line with EN 61000-3-2
	EMC	in line with EN 55011 class B, EN 61326 Appropriate shielded cables and line termination must be used.
Electromagnetic compatibility		in line with EN 55011 class B and EN 61326
	immunity to RFI	10 V/m
Environmental conditions	operating temperature range	+5 °C to +45 °C; in line with IEC 68-2-1 and IEC 68-2-2
	storage temperature range	–40 °C to +70 °C
	climatic stress	
	damp heat	95 % relative humidity at +40 °C; in line with IEC 68-2-1, without condensation
Mechanical resistance	vibration, sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz, max. 0.5 g at 55 Hz to 150 Hz, in line with EN 60068-2-6
	vibration, random	10 Hz to 300 Hz, acceleration 1.2 g (rms) in line with EN 60068-2-64
	shock	40 g shock spectrum, in line with EN 60068-2-27, MIL-STD-810E
Electrical safety		in line with IEC 1010-1, EN 61010-1, UL 61010-1, CAN/CSA-C22.2 No. 61010-1-04
Approvals		VDE-GS, $_{C}$CSA$_{US}$
Dimensions	W × H × D	426.7 mm × 87.6 mm × 450 mm (16.80 in × 3.45 in × 17.72 in)
Weight	when fully equipped	7.5 kg (16.53 lb)
Recommended calibration interval		3 years

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 automatic adjustments performed.
"Typical values" are designated with the abbreviation "typ." These values are verified during the final test but are not assured by Rohde & Schwarz. "Nominal values" are design parameters that are not assured by Rohde & Schwarz. These values are verified during product development but are not specifically tested during production.

EMC specifications are tested with sufficiently shielded cables and accessories (e.g. mouse and keypad, double-shielded cables for I and Q, rear BNC connectors). To prevent degradation of these specifications, appropriate equipment must be used.

Rohde & Schwarz equipment is designed for reliable operation up to an altitude of 3000 m above sea level, and for transport up to an altitude of 4600 m above sea level.

Ordering information

Designation	Type	Order No.
I/Q Modulation Generator [5]	R&S®AFQ100A	1401.3003.02
UWB Signal and I/Q Modulation Generator [6]	R&S®AFQ100B	1410.9000.02
Including power cable, Quick Start Guide and CD-ROM (with operating and service manual)		
Options		
Baseband hardware		
Waveform Memory 256 Msample [7]	R&S®AFQ-B10	1401.5106.02
Waveform Memory 1 Gsample	R&S®AFQ-B11	1401.5206.02
Waveform Memory 512 Msample [8]	R&S®AFQ-B12	1411.0007.02
Digital I/Q Output	R&S®AFQ-B18	1401.5306.02
Baseband software		
Bit Error Ratio Tester	R&S®AFQ-K80	1401.5006.02
Digital standards using R&S®WinIQSIM2™ PC software		
GSM/EDGE	R&S®AFQ-K240	1401.6302.02
EDGE Evolution	R&S®AFQ-K241	1401.6102.02
3GPP FDD	R&S®AFQ-K242	1401.6354.02
3GPP FDD Enhanced MS/BS Tests, incl. HSDPA	R&S®AFQ-K243	1401.6402.02
GPS 1 Satellite	R&S®AFQ-K244	1401.6454.02
HSUPA	R&S®AFQ-K245	1401.6504.02
CDMA2000® incl. 1xEV-DV	R&S®AFQ-K246	1401.6554.02
1xEV-DO Rev. A	R&S®AFQ-K247	1401.5958.02
IEEE 802.11 (a/b/g)	R&S®AFQ-K248	1401.6602.02
IEEE 802.16	R&S®AFQ-K249	1401.6654.02
TD-SCDMA	R&S®AFQ-K250	1401.6702.02
TD-SCDMA Enhanced	R&S®AFQ-K251	1401.6754.02
DVB-H	R&S®AFQ-K252	1401.5858.02
DAB/T-DMB	R&S®AFQ-K253	1401.6054.02
IEEE 802.11 a/b/g/n/j/p	R&S®AFQ-K254	1401.5806.02
EUTRA/LTE	R&S®AFQ-K255	1401.5906.02
HSPA+	R&S®AFQ-K259	1401.5658.02
Bluetooth	R&S®AFQ-K260	1401.5758.02
Multicarrier CW Signal Generation	R&S®AFQ-K261	1401.6802.02
Additive White Gaussian Noise	R&S®AFQ-K262	1401.6854.02
ECMA-368 (UWB) 8	R&S®AFQ-K264	1410.8504.02
GALILEO 1 Satellite	R&S®AFQ-K266	1415.0330.02
TETRA Release 2	R&S®AFQ-K268	1401.6202.01
EUTRA/LTE Release 9 and enhanced features	R&S®AFQ-K284	1415.0253.02
EUTRA/LTE Release 10 (LTE-Advanced)	R&S®AFQ-K285	1415.0276.02
IEEE 802.11ac	R&S®AFQ-K286	1415.0299.02
1xEVDO Rev B	R&S®AFQ-K287	1415.0353.02
GLONASS 1 Satellite	R&S®AFQ-K294	1415.0318.02
BeiDou, 1 Sat	R&S®AFQ-K407	1410.8556.02
LTE Release 11 and enhanced features	R&S®AFQ-K412	1410.8604.02
LTE Release 12	R&S®AFQ-K413	1424.1171.02
Digital standards using an external PC software or waveforms		
Pulse Sequencer	R&S®AFQ-K6	1401.5606.02
Playback of XM Radio™ waveforms	R&S®AFQ-K256	1401.6002.02
Playback of HD Radio™ waveforms	R&S®AFQ-K352	1401.6154.02

[5] The base unit must be ordered together with an R&S®AFQ-B10 or R&S®AFQ-B11 option.

[6] The base unit must be ordered together with an R&S®AFQ-B11 or R&S®AFQ-B12 option.

[7] Only for the R&S®AFQ100A.

[8] Only for the R&S®AFQ100B.

Recommended extras		
Hardcopy manuals (in English, UK) for the R&S®AFQ100A		1401.3084.32
Hardcopy manuals (in English, US) for the R&S®AFQ100A		1401.3084.39
Hardcopy manuals (in English, UK) for the R&S®AFQ100B		1410.9069.32
Hardcopy manuals (in English, US) for the R&S®AFQ100B		1410.9069.39
19“ Rack Adapter	R&S®ZZA-211	1096.3260.00

For product brochure, see PD 5214.0799.12 and www.rohde-schwarz.com

Service that adds value

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

Rohde&Schwarz

The Rohde&Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

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Data without tolerance limits is not binding | Subject to change

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