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Complimentary Reference Material

This PDF has been made available as a complimentary service for you to assist in evaluating this model for your testing requirements.

TMG offers a wide range of test equipment solutions, from renting short to long term, buying refurbished and purchasing new. Financing options, such as Financial Rental, and Leasing are also available on application.

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Version
01.00

May
2006

I/Q Modulation Generator R&S® AFQ 100A

Meeting new challenges in baseband signal generation



Leading the way in I/Q signal generation

Digital communications systems are rapidly evolving today, calling for test equipment that can meet the new challenges they present.

An important component of such test equipment is a flexible baseband source that allows development and production tests to be performed on state-of-the-art receivers for a variety of standards. A self-contained baseband source must fulfill a wide range of signal requirements. Plus, it needs variable digital and analog outputs in order to directly operate the DUT. Used as a modulation source for vector signal generators, the R&S®AFQ 100A provides I/Q signals that offer all the sophistication of modern communications standards for generating the required RF signal.

Featuring a maximum clock rate of 300 MHz and a waveform memory of up to 1 Gsample, the new R&S®AFQ 100A generator provides unprecedented functionality and offers precisely the flexibility that is required. It allows long sequences to be generated for bit error ratio measurements; moreover, its high clock rate provides the necessary bandwidth for supporting future broadband communications systems.

Especially in the case of very broadband applications, modules such as I/Q modulators produce a nonlinear frequency response. To compensate for this effect, the R&S®AFQ 100A is equipped with an equalizer that linearizes the entire frequency response in realtime.

The R&S®AFQ 100A combines flexibility with outstanding signal quality. Its spurious suppression, for example, is first-rate, and its frequency response extremely linear.

All these basic features combined with a host of other functions make the R&S®AFQ 100A a versatile baseband generator that can easily be adapted to changes.

Broad scope of applications

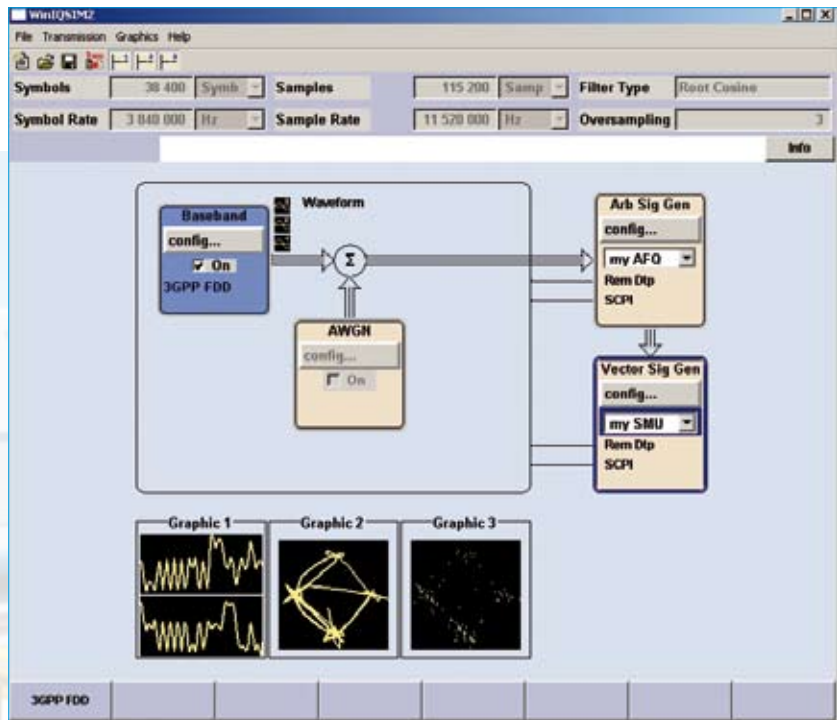
- ◆ Variable memory clock rate (1 kHz to 300 MHz) can be optimally adjusted to the useful signal
- ◆ Maximum I/Q bandwidth of up to 100 MHz for an RF bandwidth of 200 MHz
- ◆ Long signal duration – 256 Msample or 1 Gsample
- ◆ Analog I/Q outputs (balanced and unbalanced) and optional digital outputs
- ◆ Variable output level at the analog outputs
- ◆ Multisegment waveform reduces switching time between different signals; no reloading required
- ◆ Optimum memory use due to integrated clock rate converter and memory granularity of 1
- ◆ Shiftable markers without disrupting and recalculating the output signal

Outstanding signal quality

- ◆ Excellent spurious free dynamic range (SFDR) of typ. 83 dBc (1 MHz signal at 100 MHz bandwidth)
- ◆ Frequency response typ. 0.05 dB across 100 MHz I/Q bandwidth
- ◆ Versatile impairments
 - Settable skew with 10 ps resolution to allow exact adjustment of different cable lengths
 - Gain and offset for I and Q can be set independently
 - Phase error
- ◆ Loadable equalization to compensate for external components such as I/Q modulators (minimum frequency response in realtime across all components involved)
- ◆ Adjustment of DC offsets by biasing the differential I/Q outputs

Connectors and operation

- ◆ Remote control via GPIB, USB and LAN
- ◆ User interface via external monitor or Windows XP Remote Desktop
- ◆ R&S® WinIQSIM2™ for controlling the R&S® AFQ 100A and generating test signals in line with different standards
- ◆ Direct control via MATLAB®
- ◆ USB connectors for USB equipment (keyboard, mouse, memory stick)



R&S® WinIQSIM2™ screenshot

What makes the R&S®AFQ 100A so unique?

Analog signal output with unsurpassed specifications

A universal I/Q source must provide high signal quality. With its optimized design and state-of-the-art components, the R&S®AFQ 100A achieves a spurious free dynamic range (SFDR) of typ. 83 dBc.

Today, new digital systems are developed with ever larger bandwidths, which makes the frequency response of such broadband signals especially interesting. This is where the R&S®AFQ 100A really

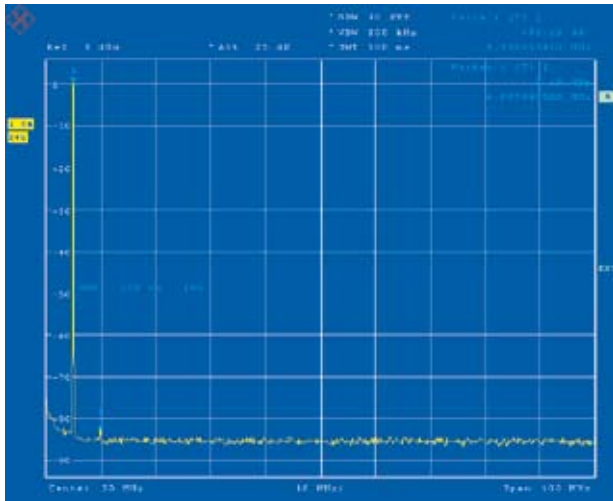
excels, since it features a very high linear frequency response of typ. 0.05 dB.

System optimization

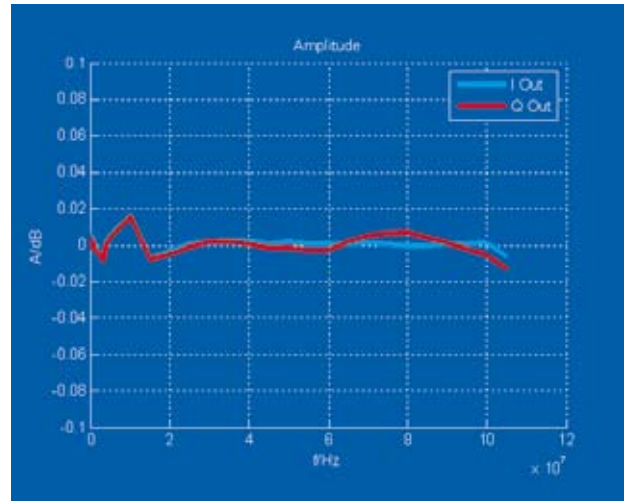
However, even unrivaled baseband performance does not guarantee a flawless RF signal, since impairments can affect the signal quality by the time the signal is output. The R&S®AFQ 100A features a variety of functions to minimize the effect of these impairments, including its capability to compensate for the magnitude and phase of a non-ideal frequen-

cy response (e.g. of an external I/Q modulator) by means of settable filters. In this case, data can be measured by an external program and transferred to the R&S®AFQ 100A. During output, a matching inverse filter is taken into account in the signal, achieving a linear frequency response and optimum sideband suppression throughout the entire system.

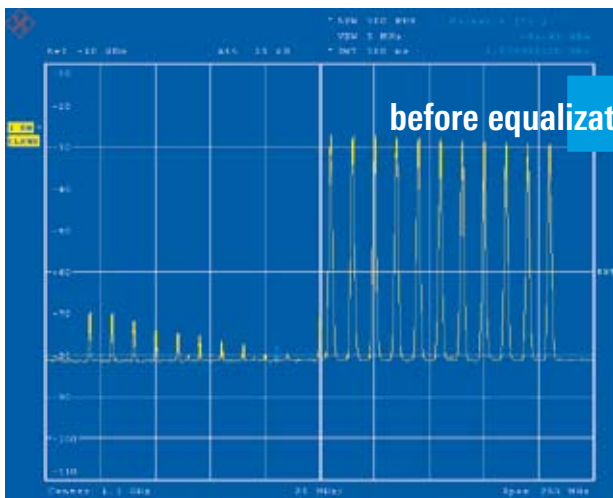
The R&S®AFQ 100A also provides I and Q compensation capabilities for each channel for level offset, delay and gain. Thus, in addition to being able to compensate for delays and effects due to external



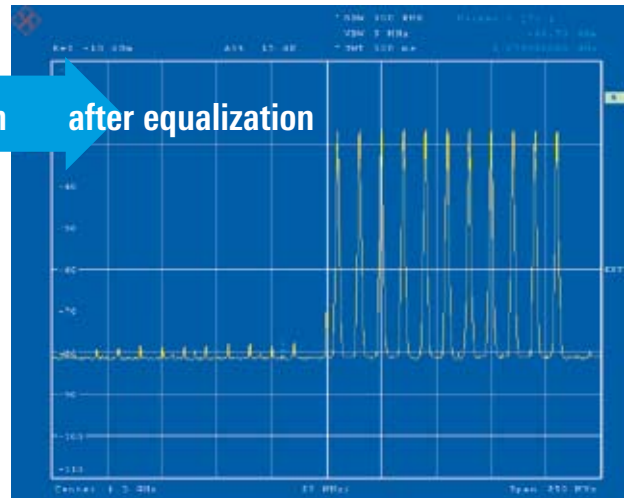
SFDR measurement at 100 MHz bandwidth



Highly linear frequency response of typ. 0.05 dB up to 100 MHz I/Q bandwidth



before equalization



after equalization

Signal with 200 MHz bandwidth

Signal with 200 MHz bandwidth

cables or other inserted elements, you can vary them on purpose in order to test receiver performance.

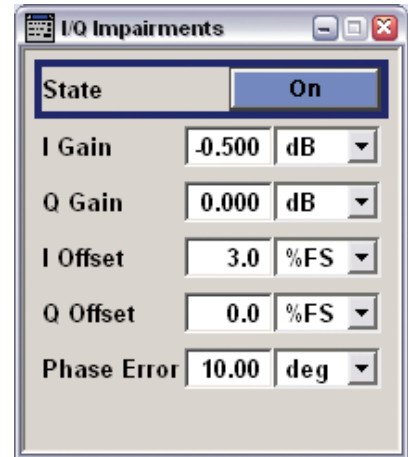
Optimal memory utilization

In addition to an excellent analog front-end, the R&S® AFQ 100A offers special memory features.

The readout speed of data from the internal memory is user-selectable and can be optimally adapted to the useful signal internally. The R&S® AFQ 100A digitally converts the I/Q samples to the higher clock rate of the converter in real-time. This loss-free resampling makes it possible to implement a fixed clock rate for the D/A converter and an optimally adapted anti-aliasing filter, providing ideal signal characteristics. Furthermore, resampling allows you to read out data at a theoretical minimum clock rate, an advantage that means maximum signal duration using a specific memory depth.

Memory management in the R&S® AFQ 100A provides yet another advantage: a granularity of 1 sample (min. addressable block size). To cyclically repeat a signal that is to be output, the signal at the memory end must be seamlessly continued with the signal at the beginning of the memory. In the past, a signal whose length did not match the memory granularity had to be converted to a length suitable for the memory, or saved multiple times in memory.

Due to the memory granularity of 1 sample, neither conversion nor multiple saving is required for the R&S® AFQ 100A in order to achieve interference-free cyclical repetition.

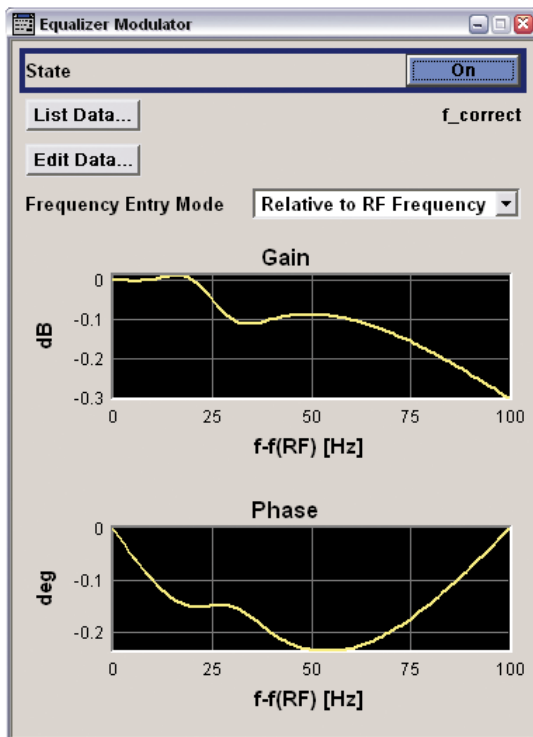


I/Q impairments

Versatile yet easy to operate

Although the generator's hardware is concealed in a black box, you can easily access its software. The R&S® AFQ 100A features a modern graphical user interface that can either be controlled directly via an external display, mouse and keyboard or easily transferred to any computer in the network via Windows XP Remote Desktop (via LAN) and operated from there.

Remote control via SCPI commands is also available.



Display of compensation in the R&S® AFQ 100A

Outstanding features for all applications

Long sequences

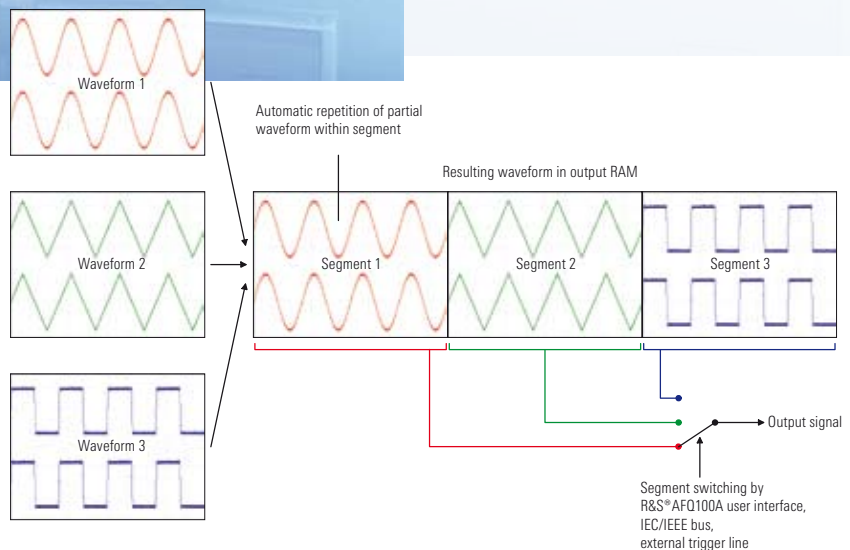
The R&S® AFQ 100A provides a memory depth of up to 1 Gsample. To permit optimum use of the memory, the I/Q modulation generator allows you to select an output memory clock between 1 kHz and 300 MHz. Thus, the oversampling taken into account in the waveform can be reduced to a minimum, since the generator's hardware uses oversampling prior to D/A conversion. The memory is thus ideally utilized and the effective signal duration extended for testing.

In addition to the clock rate, you can also select the signal length without having to take into account the memory granularity. The optimized addressability of the memory in the R&S® AFQ 100A allows the playback of long signal sequences without unnecessary overhead.

Multisegment waveform

The memory depth of the R&S® AFQ 100A permits further applications such as the multisegment waveform function, which allows fast switchover between different signals. The special feature is that several different waveforms are already loaded into the memory, making it unnecessary to reload waveforms from the internal hard disk or an external controller.

Various output modes support very fast switching times and seamless transition between the different segments of the multisegment waveform. This makes phase-continuous transition possible, which helps to avoid resynchronization when testing receivers.



Multisegment waveform concept (MSW concept)

Differential and digital I/Q outputs

Since modern baseband components are often equipped with differential inputs and outputs, the R&S® AFQ 100A also comes with differential outputs as standard. Of course, it is also possible to switch to the classic unbalanced I/Q output. In addition, the generator allows a DC voltage (bias) of up to ± 2.5 V to be added to the differential output signal.

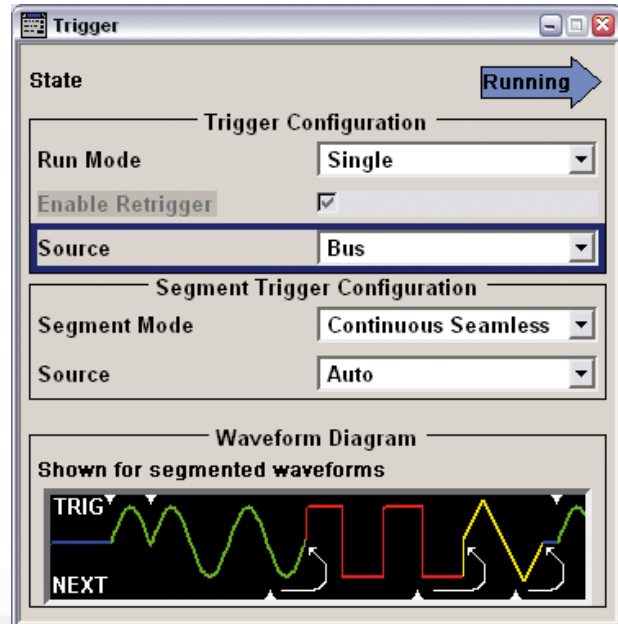
Both operating modes permit flexible level setting. However, to achieve a good signal-to-noise ratio at lower levels as well, the R&S® AFQ 100A is equipped with switchable attenuator pads. This enables continued use of the entire dynamic range and then an analogous attenuation of the level by max. 21 dB. As a result, the R&S® AFQ 100A provides high signal quality not only at an ideal level value but also across a wide level range.

In addition to the flexible analog outputs, the R&S® AFQ 100A can optionally be equipped with two digital outputs. The first is a 68-pin HD-SCSI connector that outputs the digital I and Q signals in a common LVDS format at a maximum resolution of 16 bit each. This output supplies the data, including the clock

signal, directly from memory. D/A converters can thus be ideally operated as DUTs. The second output provides the digital signals in a multiplexed LVDS data format, which allows the R&S® AFQ 100A to ideally interface with other equipment from Rohde & Schwarz.

Digital IF, fast hopping

In addition to the normal I and Q output in the baseband, the R&S® AFQ 100A offers an IF signal output. The digitally implemented I/Q modulator features fully linear frequency response. The high clock rate of the R&S® AFQ 100A expands its range of applications up to 100 MHz. This digital implementation allows frequency changes virtually without delay, supporting fast hopping.



Trigger settings for multisegment waveform (MSW)

Numerous trigger capabilities

An important function of an I/Q modulation generator is to control the signal output for synchronization with an external setup. To make this possible, the R&S® AFQ 100A offers numerous trigger capabilities:

- ◆ Triggering via remote control
- ◆ Two external trigger inputs (BNC)
- ◆ Manual trigger button on the front panel

This is particularly important when multisegment waveforms are used, as the two external trigger inputs – TRIG for starting and NEXT for switching to the next segment – provide the exact flexibility needed in order to make optimum use of the mode.



Trigger button on the front panel and trigger inputs on the rear panel

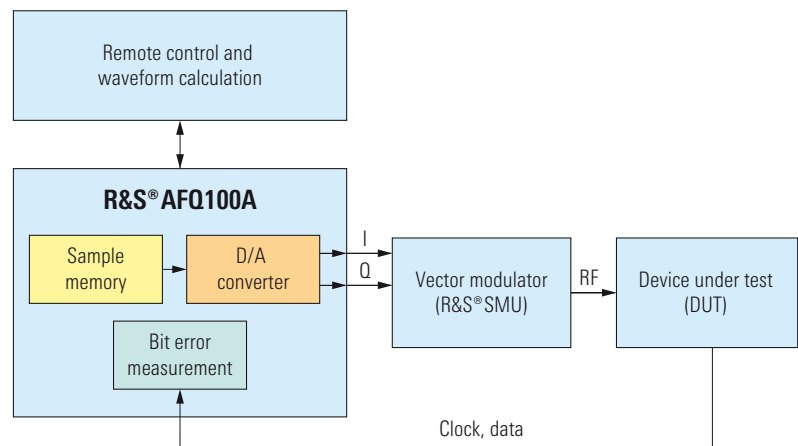
Markers shiftable without signal interruption

In addition to synchronizing the signal output, the output of marker signals is of interest. The R&S® AFQ 100A supplies four independent marker signals, which can be used, for example, to start a receiver or to mark a burst in a pulsed signal.

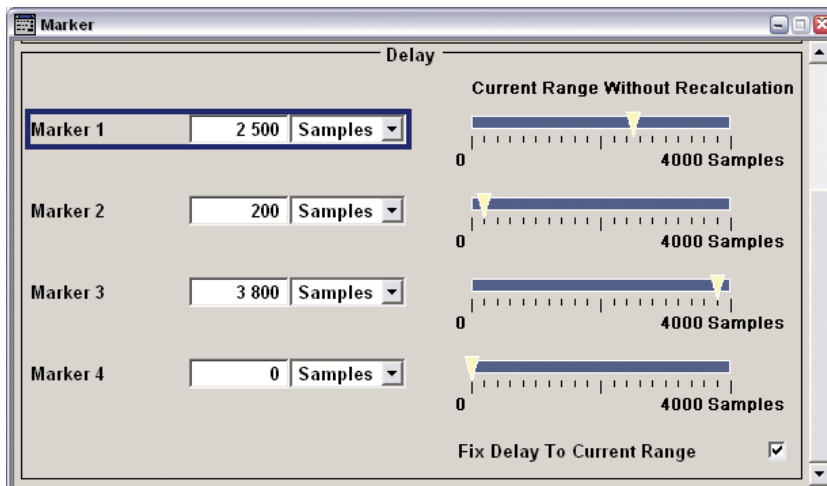
For precise adjustments during signal output, the marker outputs can be delayed without interrupting the I/Q output signal. Thus, time-consuming receiver resynchronization can be avoided while the marker delay is adjusted to the test setup.

BER measurements

When testing modules for digital communications standards, measuring bit error ratios is a common quality characteristic for determining receiver sensitivity or selectivity. However, when components are tested that cannot measure bit errors, the R&S® AFQ 100A handles this task. To make this possible, the DUT must provide the demodulated useful data and – if possible – the associated clock. If the DUT does not provide a clock, the R&S® AFQ 100A supplies the required clock signal via a marker output. This is another application where a shiftable marker comes in handy for compensating the delays in the DUT.



Setup for BER measurements



R&S® AFQ 100A marker menu

Easy handling

Although the R&S® AFQ 100A is a compact black box, it is easy to operate and control. The R&S® WinIQSIM2™ simulation software is a state-of-the-art graphical software tool for manual operation; in addition to controlling the instrument, it also allows waveforms to be generated in accordance with a variety of standards such as WiMAX or HSDPA.

The R&S® AFQ 100A is also equipped with a video output for an external display. The graphical user interface (GUI) is a standalone solution for keyboard and mouse operation; you do not need to connect a remote controller.

By using Remote Desktop, a Windows XP software solution, you can transfer the GUI to any controller in the network, conveniently allowing control from any workstation.

Connectors

The R&S® AFQ 100A can be remote-controlled via GPIB (IEC/IEEE bus), USB and LAN (Gigabit Ethernet). The two high-speed USB and LAN connectors are suitable for transferring larger waveforms. The generator comes with an internal 160 Gbyte hard disk, enough space to hold a large number of signals and eliminate the need for additionally retransmitting waveforms into the R&S® AFQ 100A.

The two USB connectors on the front and rear panel make it possible to use USB equipment such as a mouse/keyboard or memory stick/hard disk.



Specifications

Output memory	
Maximum waveform length	256 Msample or 1 Gsample
Memory granularity	1
Memory clock	1 kHz to 300 MHz
Waveform bandwidth	max. $0.33 \times$ memory clock
Resolution	16 bit
Marker channels	4
Signal output	
Analog output (unbalanced)	
Nominal level	1 V pp into 50Ω
Level range	0 V to 1.5 V pp into 50Ω
Resolution	14 bit
Frequency response	typ. ± 0.05 dB up to 100 MHz I/Q bandwidth
Analog output (balanced)	
Nominal level	2 V pp (between I and \bar{I} into 100Ω)
Level range	0 V to 3 V pp (between I and \bar{I} into 100Ω)
Bias	-2.5 V to $+2.5$ V
Resolution of D/A converter	14 bit across entire clock rate
Direct IF	digital modulator for direct generation of IF signals
Signal quality	
Spurious free dynamic range	typ. 83 dBc (1 MHz signal, 100 MHz measurement bandwidth)
ACLR 3GPP test model 1/64	typ. -80 dBc (adjacent channel) typ. -80 dBc (alternate channel)
Digital outputs	
Port 1	multiplexed I/Q data stream, compatible with other equipment from Rohde & Schwarz
Port 2	parallel I/Q interface, LVDS
Impairments	adjustable gain and offset for I and Q, adjustable phase error
Skew between I and Q channel	-2 ns to $+2$ ns with 10 ps resolution (digital)
Mass storage	160 Gbyte
Interfaces	USB 2.0 (master and slave), Ethernet (Gigabit Ethernet), IEC/IEEE bus

Ordering information

Designation	Type	Order No.
I/Q Modulation Generator ¹⁾	R&S®AFQ100A	1401.3003.02
Including power cable, Quick Start Guide and CD-ROM (with operating and service manual)		
Options		
Baseband hardware		
Waveform Memory 256 Msample	R&S®AFQ-B10	1401.5106.02
Waveform Memory 1 Gsample	R&S®AFQ-B11	1401.5206.02
Digital I/Q Output	R&S®AFQ-B18	1401.5306.02
Baseband software		
Bit Error Ratio Tester	R&S®AFQ-K80	1401.5006.02
R&S®WinIQSIM2™ options		
Digital Standard GSM/EDGE	R&S®AFQ-K240	1401.6302.02
Digital Standard 3GPP FDD	R&S®AFQ-K242	1401.6354.02
Digital Standard 3GPP FDD Enhanced MS/BS Tests, incl. HSDPA	R&S®AFQ-K243	1401.6402.02
Digital Standard GPS	R&S®AFQ-K244	1401.6454.02
Digital Standard HSUPA	R&S®AFQ-K245	1401.6504.02
Digital Standard CDMA2000® incl. 1xEV-DV	R&S®AFQ-K246	1401.6554.02
Digital Standard IEEE802.11 (a/b/g)	R&S®AFQ-K248	1401.6602.02
Digital Standard IEEE802.16	R&S®AFQ-K249	1401.6654.02
Digital Standard TD-SCDMA	R&S®AFQ-K250	1401.6702.02
TD-SCDMA Enhanced	R&S®AFQ-K251	1401.6754.02
Multicarrier CW Signal Generation	R&S®AFQ-K261	1401.6802.02
Additive White Gaussian Noise	R&S®AFQ-K262	1401.6854.02
Recommended extras		
Hardcopy manuals (in English, UK)		1401.3084.32
Hardcopy manuals (in English, US)		1401.3084.39
19" Rack Adapter	R&S®ZZA-211	1096.3260.00
Keyboard with USB Interface (US character set)	R&S®PSL-Z2	1157.6870.04
Mouse with USB Interface, optical	R&S®PSL-Z10	1157.7060.03
External USB DVD Drive	R&S®PSP-B6	1134.8201.22

¹⁾ The base unit must be ordered together with an R&S®AFQ-B10 or R&S®AFQ-B11 option.

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For specifications, see PD 5213.6541.22
and www.rohde-schwarz.com
(search term: AFQ 100A)



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