



Baseband Fading Simulator ABFS

Saving costs through real-world fading tests

- 2 fading channels
(4 with option ABFS-B2)
- 12 propagation paths
(24 with option ABFS-B2)
- Universal use in research, development and production
- Simulation of present and future communication systems thanks to flexible concept
- Receiver tests at I/Q level together with a baseband source
- Ease of operation
- High reliability



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The characteristics of a radio channel may strongly impair signal transmission between a transmitter and in particular a moving receiver.

Baseband Fading Simulator ABFS generates signals which simulate real receive conditions in mobile applications. Thus, the response of receivers under real-world conditions can be checked already during development and QM acceptance testing. The simulation of fading signals at baseband level reduces costs.

Advantages of fading simulation in baseband

Conventional fading simulators normally convert the signal of the radio channel to the IF, perform fading and then reconvert the signal to its RF frequency. It is however less costly to loop in the simulator prior to the first conversion to the carrier frequency, ie to simulate at baseband level (I and Q) and then convert to the correct frequency in the test system (see Fig. 2). Signals will therefore not be impaired by the effects of multiple conversion. Due to this baseband fading simulation an upgrade to new networks or standards is easy.

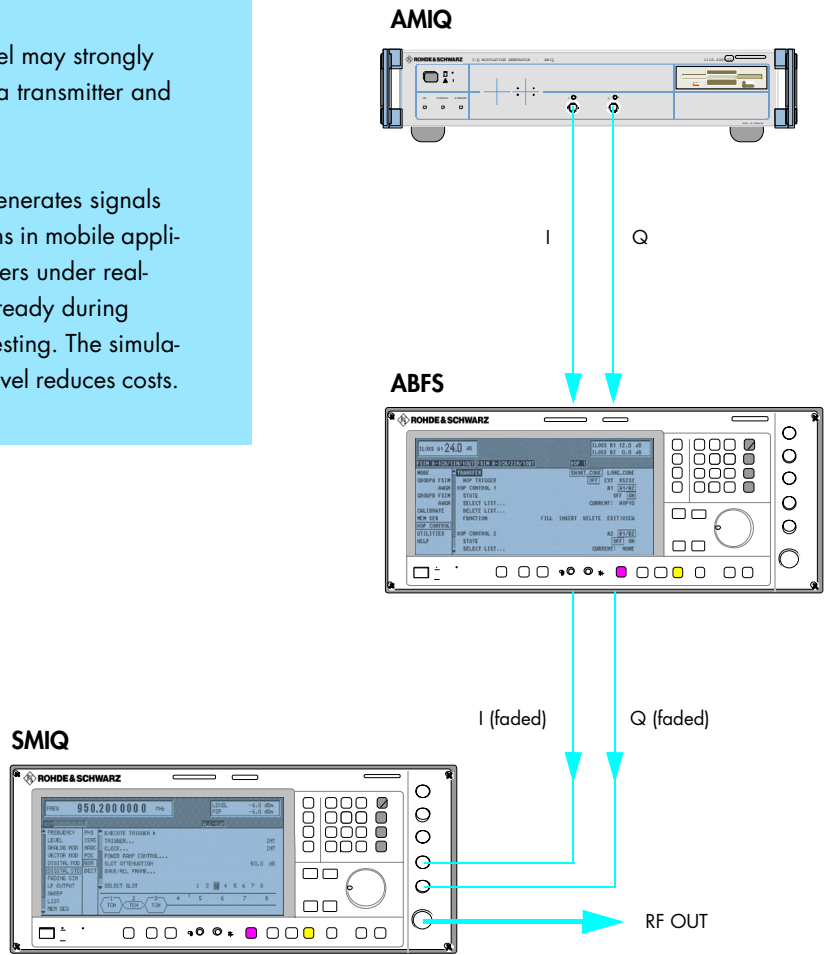
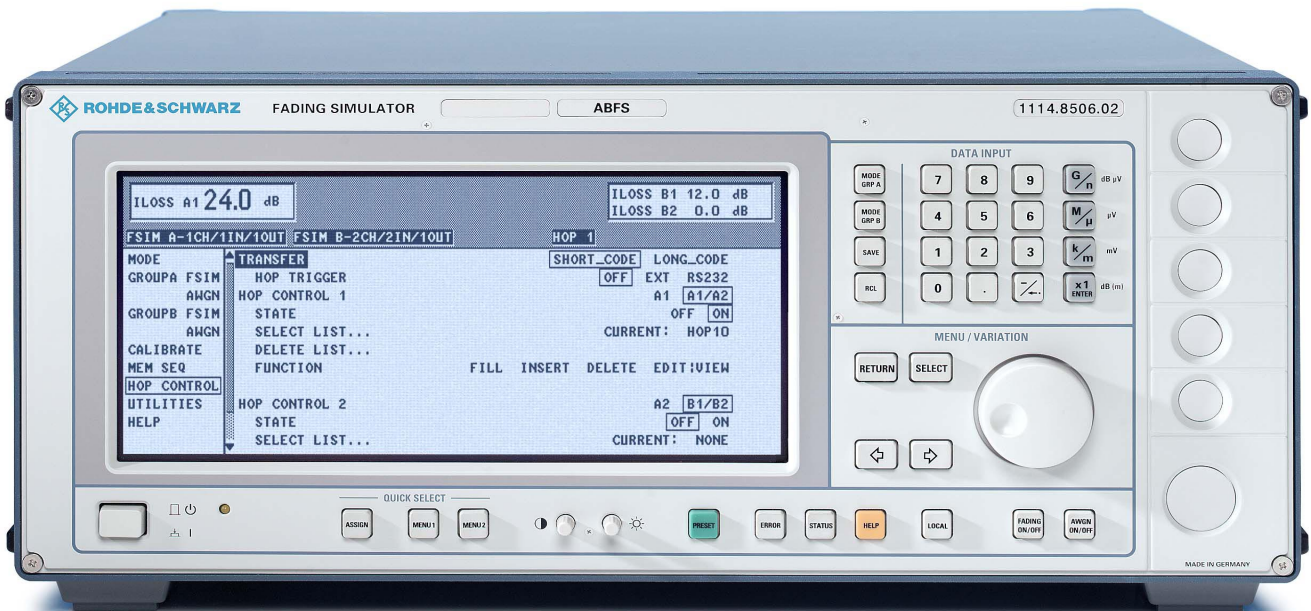


Fig. 1: Fading of a baseband signal from AMIQ with Fading Simulator ABFS



Fit for the future

Baseband Fading Simulator ABFS is suitable for universal mobile radio applications in research, development and production. It comprises all scenarios and statistical models for simulating sporadic fading as specified in the test regulations of mobile radio standards (eg GSM, IS-54/US-136 or IS-95 CDMA).

The flexible concept of ABFS allows the simulation of radio channels of existing and future communication systems (eg mobile radio, broadcasting, flight telephone, WLL, or WLAN systems).

ABFS can also simulate frequency hopping systems. ABFS is fast enough to follow the frequency hopping of a test system for example within a frame of 4,616 ms (GSM frame time).

Furthermore, an offset voltage for each I and Q input or output can be entered to compensate external DC offset voltages.

Together with a baseband source (eg I/Q Modulation Generator AMIQ from Rohde & Schwarz, see Fig. 1 on the left) receiver tests can be performed at I/Q level even if the corresponding RF link is not available. During the development of receivers or correction circuits in the receiver (eg equalizer), the effects of fading can thus be checked at a very early stage.

The basic model of ABFS comes with two independent channels for 6-path fading. The two channels can be interconnected as follows (see Fig. 3):

- Distribution of an input to two outputs (eg with different fading profiles). This feature makes it possible to simulate the signal of two antennas with different characteristics or frequency diversity methods
- Simulation of two channels with individual profiles and addition at output. Cell change or superposition of interferers can be tested with this configuration
- Coupling of two channels so that a channel with 12 propagation paths is obtained (Fig. 4 gives a more detailed insight how the fading simulator works).

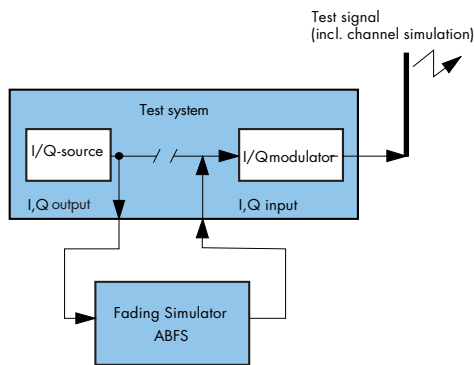


Fig. 2: Fading simulation in baseband

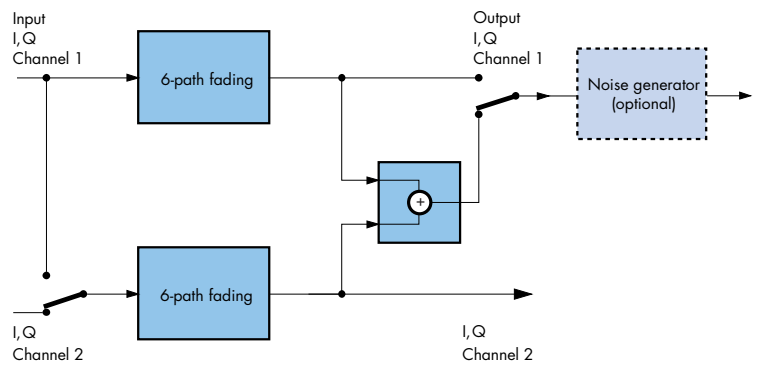
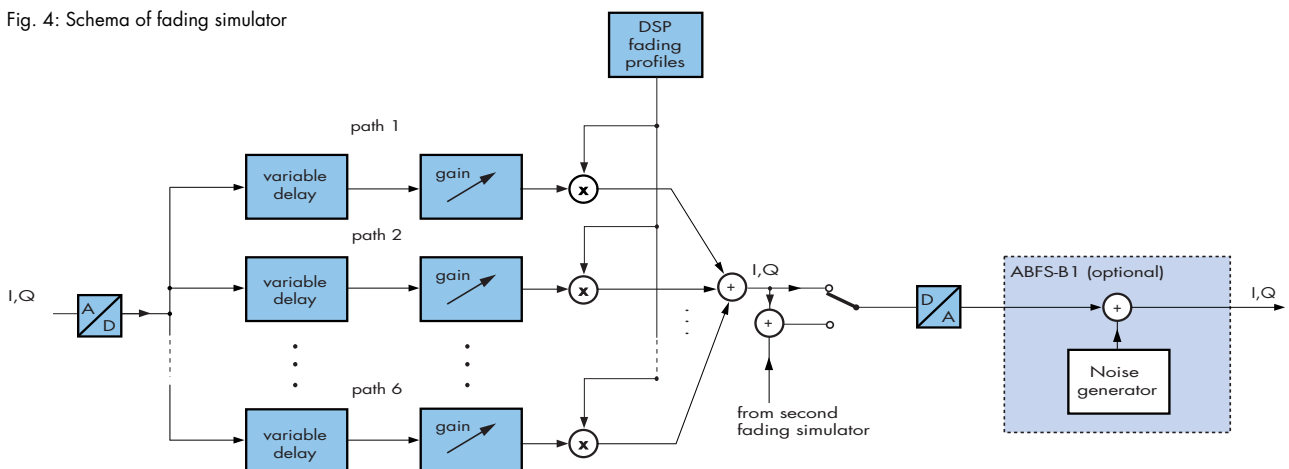


Fig. 3: Interconnections of ABFS

Fig. 4: Schema of fading simulator



High versatility by options

Noise Generator ABFS-B1 adds a noise source to the output of the first channel (see Fig. 3) so that noise can be simulated in the frequency band used. The noise generator can be switched on or off irrespective of the operating modes of the basic version.

Second Fading Simulator ABFS-B2 offers two extra channels with the same characteristics in addition to the two channels of the basic model.

Second Noise Generator ABFS-B3 represents an additional noise source for a further output. This second noise generator is either assigned to the second channel of the basic ABFS (with first noise generator ABFS-B1 for the first channel) or to the first channel of the second fading simulator ABFS-B2.

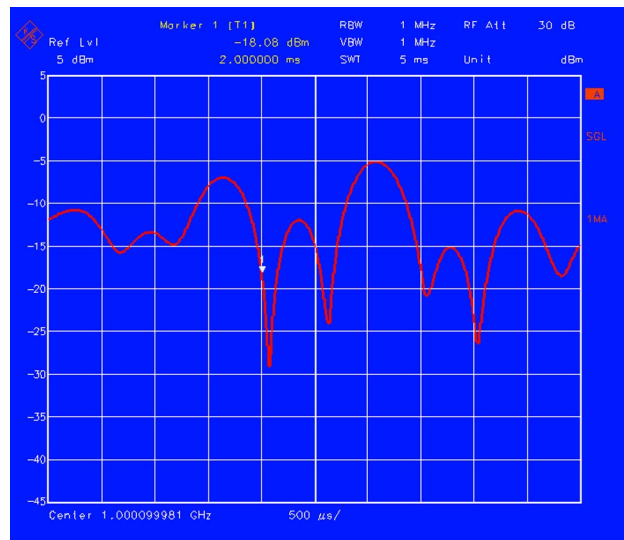
Fading profiles of the Rayleigh, Rician, Pure Doppler, Lognormal or Suzuki method can be assigned to each of the propagation paths irrespective of the selected circuit (see Fig. 3).

In addition to the fading profiles mentioned, the following parameters can be defined for each propagation path:

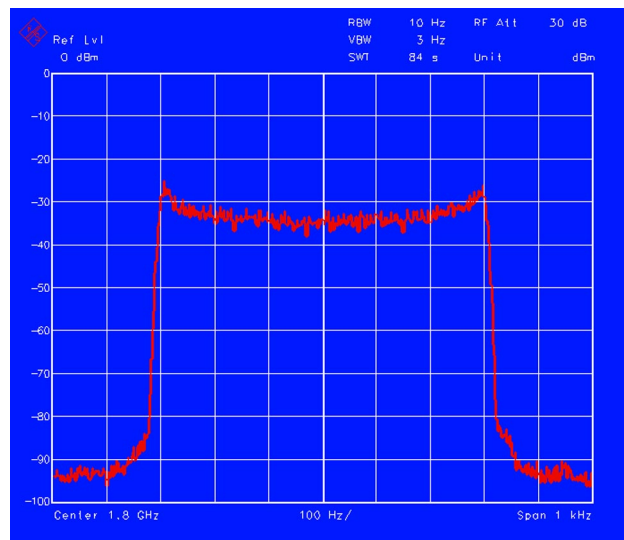
- Path attenuation
- Delay time
- Doppler frequency or speed between transmitter and receiver
- Coupling to another channel

Many fading models (eg GSM Rural Urban, Typical Urban) have already been programmed in ABFS. The user can quickly recall these default settings and also modify the parameters.

Typical Rayleigh fading profile



Rayleigh fading (Doppler spectrum), generated at a speed of 180 km/h (RF = 1.8 GHz)



Why fading tests?

Short-time signal fading, as caused by multipath propagation, strongly affects the error rate of the received signal due to the short symbol periods in digital mobile radio

Modern digital systems overcome these problems with the aid of appropriate error control coding methods as well as algorithms for delay equalizing.

Interleaving is employed to overcome the problem of losing large parts of the messages.

Resistance to fading is an essential quality criterion of digital mobile radio systems and means a considerable competitive advantage for the manufacturer.

Tests with real-world signals using fading simulators are a must to spot the weak points in new concepts at an early stage so that appropriate modifications can be made.

Specifications

IQ inputs and outputs

Impedance	50 Ω
Input voltage for full-scale level	$\sqrt{I^2 + Q^2} = 0.5 \text{ V}$
Residual DC voltage at output	<2 mV, fine tuning by software
Insertion loss of basic unit	0.3 dB

Fading simulation

Number of propagation paths and fading channels	
Basic model	1 channel with 12 paths or 2 channels with 6 paths each
with option ABFS-B2	2 channels with 12 paths each or 4 channels with 6 paths each
Insertion loss between input and output at 0 dB path attenuation	min. 9 dB
Frequency response up to 5 MHz offset from carrier frequency (corresponding to 10 MHz system bandwidth)	+0.1 dB to -0.6 dB
Path attenuation	
Range	0 to 50 dB
Resolution	0.1 dB
Error in range 0 to 20 dB	<0.3 dB
Path delay	
Range	0 to 1600 μs
Resolution	50 ns
Error	<5 ns
Doppler shift	
Frequency range	0.1 to 1600 Hz
Speed range	$v_{\min} = \frac{0.03 \cdot 10^9 \text{ m/s}^2}{f_{\text{RF}}}$ $v_{\max} = \frac{479 \cdot 10^9 \text{ m/s}^2}{f_{\text{RF}}}$
	For example at $f_{\text{RF}} = 1 \text{ GHz}$: $v_{\min} = 0.1 \text{ km/h}$, $v_{\max} = 1724 \text{ km/h}$
Resolution	0.1 km/h, m/s, mph
Error	<0.13 %
Rayleigh fading	
Pseudo noise interval	>372 h
Deviation from theoretical CPDF ¹⁾ at $P_{\text{avg}} = 0 \text{ dB}$	
in range -20 dB to +10 dB	<1 dB, typ. <0.3 dB
in range -30 dB to -20 dB	<2 dB, typ. <0.3 dB
Rice fading	
Power ratio ²⁾	
Range	-30 dB to +30 dB
Resolution	0.1 dB
Frequency ratio	
Range	-1 to +1
Resolution	0.05
Lognormal fading, Suzuki fading	
Standard deviation	
Range	0 to 12 dB
Resolution	1 dB
Local constant	l_{\min} to 200 m, $l_{\min} = \frac{12 \cdot 10^9 \text{ m/s}}{f_{\text{RF}}}$
Correlation	paths 1 to 6 with paths 7 to 12 of a channel (A or B)
Range for magnitude	0 to 100 %
Resolution	5 %
Range for phase	0 to 360°
Resolution	1°
RF setting	setting of the RF results in an automatic calculation and display of the Doppler frequency according to the set motion speed ³⁾
Range (for each fading channel)	5 MHz to 8.5 GHz
Frequency hopping mode	RF can be stored in a list and quickly set via a serial interface
Interface	RS 232, 1 byte with start and stop bit
Addressing of frequency list	8 or 16 bit as address for each fading channel
Setting time after frequency change during Rayleigh fading	<3.5 ms

Noise generator with options ABFS-B1 or ABFS-B3

Amplitude distribution	Gaussian, statistically independent for I and Q
Crest factor	14 dB

Noise power level in relation to full-scale level

Range	-17 to -50 dBfs
Resolution	0.05 dB
Error	<0.3 dB
Output level at full-scale level (AC)	$\sqrt{I^2 + Q^2} = 0.5 \text{ V}$ (= 4 dBm)

Insertion loss between input and output

Output spectrum	white noise
Bandwidth	depending on set system bandwidth
Frequency response up to 0.7 x system bandwidth (max. 5 MHz)	<0.5 dB
RF system bandwidth ⁴⁾	bandwidth determining noise power
Setting range	10 kHz to 10 MHz
Resolution	1%
Memory for device settings	50
Storable settings	-0.2 dB to -0.6 dB
Frequency response	

Remote control

System	IEC 625 (IEEE 488)
Command set	SCPI 1993.0
Connector	Amphenol 24-pin
IEC/IEEE-bus address	0 to 30
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C0

General data

Power supply	90 V to 132 V (AC), 47 Hz to 440 Hz, 180 V to 265 V (AC), 47 Hz to 440 Hz, autoranging, max. 300 VA
Electromagnetic compatibility	meets EN 50081-1 and EN 50082-2
Environmental conditions	
Operating temperature range	0 to 45°C, meets IEC68-2-1 and IEC68-2-2
Storage temperature range	-40 to +70°C
Climatic resistance	95% rel. humidity, cyclic test at +25/+40°C, meets IEC68-2-30
Mechanical resistance	
Vibration, sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g const., meets IEC68-2-6, IEC1010-1 and MIL-T-28800D class 5
Vibration, random	10 Hz to 300 Hz, acceleration 1.2 g (rms)
Shock	40 g shock spectrum, meets MIL-STD-810D, MIL-T-28800D, class 3 and 5
Safety	meets EN 61010-1
Dimensions (W x H x D)	435 mm x 192 mm x 460 mm
Weight	20 kg when unit is fully equipped

Ordering information

Baseband Fading Simulator	ABFS	1114.8506.02
Accessories supplied	power cable, operating manual	
Options		
Noise Generator	ABFS-B1	1115.0009.02
Second Fading Simulator	ABFS-B2	1115.0309.02
Second Noise Generator	ABFS-B3	1115.0609.02

Recommended extras

19" Rack Adapter	ZZA-94	0396.4905.00
Service Kit	SM-Z3	1085.2500.02
Trolley	ZZK-1	1014.0510.00
Transit Case	ZZK-944	1013.9366.00
Service Manual	ABFS	1114.8564.94

¹⁾ CPDF: cumulative probability distribution function

²⁾ Ratio between discrete and distributed component

³⁾ The phase differences between paths caused by different settings of path delay are taken into account when the RF is modified. This applies to frequency hopping mode only

⁴⁾ 0.5 x system bandwidth is used for baseband



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