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R&S® SFU Broadcast Test System

Data sheet

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Introduction

The R&S®SFU Broadcast Test System has been designed as a platform for different applications and for future options. It provides multiple instrument functionality in a cabinet of only four height units and offers unrivaled RF and baseband characteristics.

Due to its modular design, the R&S®SFU can be optimally adapted to the requirements of different applications. It is an ideal research and development tool for making improvements to introduced standards and for generating new standard signals. Applications that previously required many different instruments are now fully covered by the R&S®SFU. The modern, intuitive concept of the R&S®SFU ensures fast and easy operation.

Applications overview

- Broadcast test transmitter with all important digital and analog standards in one box
- Wide level range for receiver and chip test applications
- Wide range of inputs and outputs for research and development applications
- Wide frequency range for limit tests
- RF generator and IF generator functionality
- Frequency steps of 0.1 Hz and uninterrupted level change for margin tests (PLL, AGC)
- Digital noise source with highly precise carrier/noise ratio for channel simulation
- Variable noise signal by combining several internal noise sources
- Dynamic fading (channel) simulation for testing mobile and multipath reception, diversity simulations
- Intelligent interferer management for a variety of sources (ARB, ATV predefined, analog I/Q, digital I/Q)
- User-definable signal impairments and signal modifications for research and development
- Modifiable standard parameters for research and development
- BER measurement on PRBS as well as on MPEG-2 transport streams
- Internal transport stream and video generator and special test signals
- Internal transport stream and ETI recorder and player for recording and replaying data streams
- Internal TRP player for replaying data streams
- Internal arbitrary waveform generator together with R&S®WinIQSIM™ software
- Use of waveform and data stream libraries
- Wide choice of libraries with test data streams and waveforms
- Wide choice of T-DMB/DAB test waveforms
- Remote control capability for use in production
- Wear-free electronic attenuator for use in production



Key features

General

- Analog TV, digital TV and audio broadcast multistandard test platform
- Output frequency from 100 kHz to 3 GHz
- Generation of internal noise and interferer signals
- Fully digital baseband signal processing
- Upgradeability to multifunctional broadcast test system
- Easy installation of most options at customer site

Intuitive, fast and easy operation

- Color display with 1024 × 768 pixels (XVGA format)
- Intuitive user interface with Windows XP Embedded
- Context-sensitive help system
- User-definable favorites for fast access

Outstanding signal quality

- I/Q modulator with 180 MHz RF bandwidth
- Very low SSB phase noise of typ. -135 dBc at 1 GHz (20 kHz carrier offset, 1 Hz measurement bandwidth)
- High optional output power of up to +19 dBm (PEP), overrange +26 dBm
- High-stability reference oscillator as standard

Unrivalled flexibility for research and development

- Multistandard platform that supports expansions
- Transmission simulations
- TS baseband generator and recorder with universal coder for realtime signal generation
- TRP baseband player for realtime signal generation
- Video generator for realtime signal generation
- Arbitrary waveform generator with 64 Msample (128 Msample), supported by R&S@WinIQSIMTM software
- Internal hard disk as standard for storing waveforms and modulation data

Ideal for use in production

- Wear-free electronic attenuator of up to 3 GHz over the full level range
- Minimum space requirements: generator and test transmitter accommodated in one instrument of only four height units

Easy remote access

- Remote control via GPIB and LAN
- User-friendly remote access by VNC or Remote Desktop
- USB connectors for keyboard, mouse, and USB memory module



Specifications

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.

RF characteristics

Frequency

Range	underrange	300 kHz to 3 GHz 100 kHz to <300 kHz
Accuracy		depends on reference frequency
Resolution of setting		0.1 Hz
Resolution of synthesis	standard, fundamental frequency range 750 MHz to 1500 MHz	5 µHz

Frequency sweep

Digital sweep in discrete steps		
	operating modes	automatic, single shot, manual or external trigger, linear or logarithmic
	sweep range	full range
	step width (lin)	full range
	step width (log)	0.01 % to 100 %

Reference frequency

Accuracy		$<1 \times 10^{-7}$
Aging	after 30 days of uninterrupted operation	$<1 \times 10^{-9}/\text{day}$
Temperature effect	in operating temperature range from 0 °C to +50 °C, standard	$<6 \times 10^{-8}$
Warm-up time	to nominal thermostat temperature	≤10 min
Input for external reference signal	frequency (approx. sinewave) maximum deviation input level limits recommended input impedance connector	5 MHz, 10 MHz, or 13 MHz 3×10^{-6} ≥-6 dBm to ≤19 dBm 0 dBm to 19 dBm 50 Ω BNC female, rear
Output for internal reference signal	frequency (approx. sinewave) level source impedance connector	10 MHz or external input frequency typ. 5 dBm 50 Ω BNC female, rear

Level

RF output	connector output impedance	N female, front 50 Ω
Maximum level	without option with R&S®SFU-B90 option (high power and overvoltage protection)	≥+13 dBm (PEP) ¹ ≥+19 dBm (PEP)
Setting range	without option with R&S®SFU-B90 option (high power and overvoltage protection) resolution	-120 dBm to +20 dBm -120 dBm to +30 dBm 0.01 dB
Level accuracy	"auto" attenuator mode, temperature range +18 °C to +33 °C f ≤ 3 GHz / level ≥ -100 dBm	<0.5 dB
Additional uncertainty with ALC OFF, S&H (sample & hold)	(This function is needed only for some special applications.)	<0.2 dB
Output impedance VSWR in 50 Ω system	ALC state ON, standard f ≤ 3 GHz ALC state ON, with R&S®SFU-B90 option "normal" attenuator mode "high power" attenuator mode	<1.6, typ. <1.4 <1.8, typ. <1.6 <1.9, typ. <1.7
Uninterrupted level setting	"fixed" attenuator mode, ALC state ON setting range	>20 dB

¹ PEP = peak envelope power (CW), for other modulation modes depending on crest factor.

Back-feed (from $\geq 50 \Omega$ source)	maximum permissible RF power in output frequency range of RF path	0.5 W
	maximum permissible DC voltage with R&S®SFU-B90 option (high power and overvoltage protection)	20 V
	maximum permissible RF power in output frequency range of RF path	
	1 MHz < f ≤ 1 GHz	50 W
	1 GHz < f ≤ 2 GHz	25 W
	2 GHz < f ≤ 3 GHz	10 W
	maximum permissible DC voltage	35 V

Spectral purity

Harmonics	level ≤ 8 dBm, CW level ≤ 12 dBm with R&S®SFU-B90 option, "high power" attenuator mode, CW	<-30 dBc <-30 dBc
Nonharmonics	level ≥ -50 dBm CW, vector modulation (full-scale input), >10 kHz offset from carrier and outside the modulation spectrum	
	0.3 MHz ≤ f ≤ 200 MHz	<-77 dBc
	200 MHz < f ≤ 1.5 GHz	<-80 dBc
	1.5 GHz < f ≤ 3.0 GHz	<-74 dBc
	>850 kHz offset from carrier and outside the modulation spectrum	
	0.3 MHz ≤ f ≤ 200 MHz	<-77 dBc
	200 MHz < f ≤ 1.5 GHz	<-86 dBc
	1.5 GHz < f ≤ 3.0 GHz	<-80 dBc
	caused by power supply unit or mechanical components, at RF = 1 GHz, 50 Hz to 10 kHz offset from carrier	<-70 dBc
Subharmonics	f > 1.5 GHz to 3.0 GHz	<-74 dBc
Wideband noise	carrier offset >10 MHz, measurement bandwidth 1 Hz CW	
	20 MHz ≤ f ≤ 200 MHz	<-146 dBc
	200 MHz < f ≤ 1.5 GHz	<-150 dBc
	1.5 GHz < f ≤ 3 GHz	<-148 dBc
	vector modulation with full-scale input I/Q input gain +3 dB	
	20 MHz ≤ f ≤ 200 MHz	<-143 dBc
	200 MHz < f ≤ 1.5 GHz	<-146 dBc
	1.5 GHz < f ≤ 3 GHz	<-145 dBc
SSB phase noise	carrier offset 20 kHz, measurement bandwidth 1 Hz	
	20 MHz ≤ f ≤ 200 MHz	<-128 dBc
	f = 1 GHz	<-131 dBc
	f = 2 GHz	<-125 dBc
	f = 3 GHz	<-121 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 at f = 1 GHz	<0.02 %

High power and overvoltage protection (R&S®SFU-B90 option)

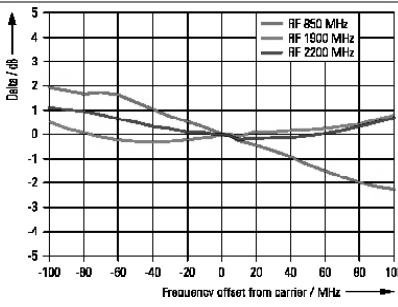
Extends the output level and protects the instrument against externally applied RF power from a 50 Ω source.		
Maximum level		19 dBm
Maximum permissible RF power		50 W
Maximum permissible DC voltage		35 V

I/Q modulation

I/Q modulator

Operating modes		external wideband I/Q internal baseband I/Q
Modulation frequency range	I/Q wideband	100 MHz
I/Q modulation inputs	connector input impedance VSWR up to 30 MHz input voltage for full-scale input minimum input voltage for ALC state ON	BNC female, front 50 Ω <1.2 $\sqrt{V_i^2 + V_q^2} = 0.5 \text{ V}$ 0.1 V
Static error vector	rms value f ≤ 200 MHz f > 200 MHz peak value f ≤ 200 MHz f > 200 MHz	<0.3 % <(0.2 % + 0.1 % × f/GHz) <0.6 % <(0.4 % + 0.2 % × f/GHz)
Modulation frequency response	I/Q wideband up to 50 MHz up to 5 MHz	<3 dB <0.6 dB
Carrier leakage	without input signal, referenced to full-scale input ²	<-55 dBc
I/Q impairments	I offset, Q offset setting range resolution gain imbalance setting range resolution quadrature offset setting range resolution	-10 % to +10 % 0.01 % -1 dB to +1 dB 0.001 dB -10° to +10° 0.1°
I/Q swap	I and Q signals swapped	ON, OFF

External wideband I/Q

I/Q inputs (I/Q EXT) (connector equal to I/Q analog IN)	connector input impedance VSWR up to 50 MHz input voltage for full-scale input minimum input voltage for ALC state ON	BNC female, front 50 Ω <1.2 $\sqrt{V_i^2 + V_q^2} = 0.5 \text{ V}$ 0.1 V
Modulation frequency range ³		100 MHz
Carrier leakage	without input signal, referenced to full-scale input ²	<-55 dBc
Static error vector	16QAM, pulse filtering: root raised cosine roll-off, α = 0.15, symbol rate 10 kHz rms value f ≤ 200 MHz f > 200 MHz peak value f ≤ 200 MHz f > 200 MHz	<0.3 % <(0.2 % + 0.1 % × f/GHz) <0.6 % <(0.4 % + 0.2 % × f/GHz)

² Value applies after 1 hour warm-up and recalibration for 4 hours of operation and temperature variations of less than 5 °C.

³ I/Q wideband ON. This frequency response superimposes all frequency responses specified in the data sheet.

Internal baseband I/Q

Signal characteristics		see digital modulation systems
D/A converter	data rate resolution sampling rate	100 MHz 16 bit 400 MHz (internal interpolation × 4)
Aliasing filter	with amplitude, group delay and Si correction bandwidth 0.1 dB	40 MHz
I/Q impairment	I offset, Q offset setting range resolution gain imbalance setting range resolution quadrature offset setting range resolution	–10 % to +10 % 0.01 % –1 dB to +1 dB 0.01 dB –10° to +10° 0.1°

Internal optimization of RF parameters is always ON.

I/Q output

I/Q output	connector output impedance With $R_L = 50 \Omega$, the output voltage depends on the set modulation signal. output voltage	BNC female, rear 50 Ω 0.5 V (V_P)
Offset		<1 mV

Extended I/Q (R&S®SFU-K80 option)

The R&S®SFU-K80 option allows external analog and digital signals to be fed into the baseband signal processing of the R&S®SFU. Input signals can be faded in and noise signals superimposed if the fading simulator and noise options have been installed. In addition, the digital baseband signals are available externally.

Analog I/Q IN		
I/Q analog inputs (I/Q EXT) (connector equal to I/Q wideband IN)	connector input impedance VSWR (up to 25 MHz) input voltage for full-scale input frequency response up to 30 MHz A/D converter offset	BNC female, front 50 Ω <1.2 $\sqrt{V_i^2 + V_q^2} = 0.5 \text{ V}$ 0.5 dB 100 MHz/14 bit <–55 dBFS
Digital I/Q IN		
I/Q digital input	connector output level	Mini D Ribbon, 26 pins, rear channel link
I/Q digital modulation inputs	level word width analog bandwidth symbol rate	LVDS 16 bit 0 Hz to 31 MHz 3 ksp/s to 100 Msps
Digital I/Q OUT		
I/Q digital output	connector output level	Mini D Ribbon, 26 pins, rear channel link
I/Q digital modulation outputs	level word width symbol rate	LVDS 16 bit 100 Msps

Digital baseband

Internal test signals

MPEG-2 TS packet	header + 184 byte payload PID	00 (hex), FF (hex), PRBS (selectable) NULL (1FFF hex)/variable
MPEG-specific TS packet	sync byte + 187 byte payload	00 (hex), FF (hex), PRBS (selectable)
DIRECTV TS packet	header + 127 byte payload	PRBS (DIRECTV only)
DIRECTV-specific TS packet	130 byte payload	PRBS (DIRECTV only)
PRBS	PRBS in accordance with ITU-T O.151	$2^{23}-1$ / $2^{15}-1$ (selectable)

MPEG-2 inputs

Parallel SPI input	connector input level input impedance	D-Sub female, 25 pins, front and rear LVDS 100 Ω , differential
ASI/SMPTE 310 serial input	connector ASI input level SMPTE 310 input level input impedance ASI data rate SMPTE 310 data rate	BNC female, front and rear 200 mV to 880 mV 400 mV to 880 mV 75 Ω 270 Mbit/s 19.392658 Mbit/s
Stuffing	ASI, SMPTE 310, SPI stuffing packets	ON/OFF see MPEG-2 TS packet at "Internal test signals"
TS EXT CLK	connector input level input impedance	BNC female, rear TTL, sinewave (0 dBm) 50 Ω
Indication	measured values	packet length, data rate, useful data rate

ETI input/output (R&S[®]SFU-B11 option)

The R&S[®]SFU-B11 option allows external ETI data streams to be fed into the baseband signal processing of the R&S[®]SFU. T-DMB/DAB signals can be faded in and noise signals superimposed if the fading simulator and noise options have been installed.

ETI input/output		in line with ETI NI, ETI NA5592, ETI NA5376
Serial ETI input	connector ETI input level input impedance ETI data rate coding	BNC female, rear 0 V to ± 2.37 V (ITU-T G.703/G.704) 75 Ω 2048 kbit/s HDB3
Serial ETI output ⁴	connector ETI output level output impedance ETI data rate coding	BNC female, rear 0 V to ± 2.37 V (ITU-T G.703/G.704) 75 Ω 2048 kbit/s HDB3

⁴ Requires Coder 2110.3306 with C.I. >4.xx and R&S[®]SFU-B11 model .03 (2110.3887)

TS generator (R&S® SFU-K20 option)

Serial TS output	mode connector output impedance ASI output level data rate mode SMPTE 310M output level data rate	ASI, SMPTE 310M (selectable) BNC female, rear 75 Ω 200 mV to 880 mV 270 Mbit/s packet or continuous 400 mV to 880 mV 19.392658 Mbit/s
Transport stream	files file format length of transport stream packets sequence length data rate net data rate data volume	Rohde & Schwarz data streams generated transport streams (GTS) format ATSC: 188/208 bytes (selectable) DVB: 188/204 bytes (selectable) generation of endless and seamless transport streams with repetition of video, audio, and data contents 100 kbit/s to 214 Mbit/s (including null packets) max. 90 Mbit/s max. 80 Mbyte payload
PCR jitter	shape frequency amplitude	sinewave, rectangle, triangle 1 MHz to 100 kHz 0 ms to 1 ms, in increments of 0.1 μs
Signal set		moving picture sequences and test patterns with test tones, for 625 and 525 lines; DVB/ATSC systems, additional signals via options

TS recorder (R&S® SFU-K21 option) (see ordering information)

The TS recorder can be used for recording ETI data streams if the ETI input/output (R&S® SFU-B11 option) is installed.

Parallel input	mode connector input impedance SPI input level clock	SPI D-Sub female, 25 pins, front and rear 100 Ω, differential LVDS 84.375 kHz to 7.5 MHz (60 Mbit/s NTFS) 84.375 kHz to 11.25 MHz (90 Mbit/s CFS)
Serial TS input	mode connector input impedance ASI input level data rate mode SMPTE 310M input level data rate	ASI, SMPTE 310M, ETI (selectable) BNC female, front and rear 75 Ω 200 mV to 880 mV 270 Mbit/s packet or continuous 400 mV to 880 mV 19.392658 Mbit/s

Recording	mode TRP T10 BIN data rate data volume recording time	recording via ASI, SPI, SMPTE 310M, or ETI; check of transport stream structure and packet size (188/204/208); SPI 8-bit interface: recording of data as a function of DVALID signal recording via SPI or ETI; check of transport stream structure and packet size (188/204/208); recording of 8-bit data + DVALID + PSYNC or recording of 10-bit raw data recording via SPI; no checking of transport stream structure; recording of 8-bit data 100 kbit/s to 90 Mbit/s (including null packets) max. data volume for recording limited only by hard disk size depends on net data rate of incoming transport stream and on hard disk size
Replay		see R&S®SFU-K22 option
Serial TS output		see R&S®SFU-K22 option
Serial ETI input/output		see R&S®SFU-B11 option

TRP player (R&S®SFU-K22 option) (see ordering information)

To output ETI data streams to external T-DMB/DAB devices, the R&S®SFU-B11 ETI input/output option is required.

Replay	file format length of transport stream packets replay time/sequence length data rate data volume	TRP, T10, BIN, ETI, DAB/DAB_C (any recorded data streams) corresponding to externally applied/recorded transport stream endless (but not seamless) replay with cut at transition from end of file to beginning of file corresponding to recording data rate and setting (100 kbit/s to max. 90 Mbit/s) from hard disk corresponding to recorded data volume; limited only by hard disk size
Serial TS output	mode connector output impedance ASI output level data rate mode SMPTE 310M output level data rate	ASI, SMPTE 310M (selectable) BNC female, rear 75 Ω 200 mV to 880 mV 270 Mbit/s packet or continuous 400 mV to 880 mV 19.392658 Mbit/s
Serial ETI output		see R&S®SFU-B11 option

Analog baseband

Analog video/audio input

If the external video/audio inputs are used, the analog I and Q inputs can no longer be assigned.

		included in R&S®SFU-K190 to -K194
Video input	connector input level CCVS input impedance DC restoration	BNC female, front panel, I input with R&S®SFU-Z19 adapter $V_{pp} = 1 \text{ V}$ 75 Ω clamping of back porch
Audio input	connector input level input impedance	BNC female, front, Q input 0 dBm 50 Ω

Internal audio signal generator

Audio signals	number of signals frequency level	2, can be set separately 30 Hz to 15 kHz, in 1 Hz steps -60 dB to +12 dB, in 0.01 dB steps, 6 dBu corresponds to standard deviation
NICAM signals	fixed sequences stereo1 dual1 mono1	L: 1 kHz R: 2 kHz L: 2 kHz R: 5 kHz F: 1 kHz

Internal video signal generator (R&S®SFU-K23 option) (see ordering information)

Internal video signal generator		included in R&S®SFU-K190 to -K194
Video signals	ATV video basic	COLORBARS_75 (PAL) COLORBARS_75 (PAL M) COLORBARS_75 (PAL N) COLORBARS_75 (NTSC) COLORBARS_75 (SECAM) FUBK (PAL)
Insertion test signal structure	in line with country-specific standards	
PAL – color bar 75 %	first field lines 8, 10 line 16 lines 17, 18 line 19 lines 20, 21 second field line 323 line 329 lines 330, 331 line 332 line 333 lines 334, 335	2T pulse data line 1 CCIR17 CCIR18/2 teletext test line teletext test line data line 2 CCIR330/5 CCIR331/1 sinx/x teletext test line
PAL M – color bar 75 %	first field line 17 line 18 second field line 17 line 18	NTC7 composite FCC composite NTC7 combined sinx/x

PAL N – color bar 75 %	first field lines 8, 10 line 16 line 17 line 18 line 19 lines 20, 21 second field line 323 lines 330, 331 line 332 line 333 lines 334, 335	2T pulse data line 1 CCIR17 CCIR18/1 CCIR18/2 teletext test line teletext test line CCIR330/5 CCIR331/1 sinx/x teletext test line
NTSC – color bar 75 %	first field line 17 line 18 second field line 17 line 18	NTC7 composite FCC composite NTC7 combined sinx/x
SECAM – color bar 75 %	first field lines 7 to 14 line 15 line 17 line 18 second field lines 320 to 328 line 330 lines 331,332 line 333	discriminating signal teletext test line CCIR17 CCIR18, 6 multiburst packets discriminating signal CCIR330 CCIR331 CCIR331/1
PAL – FuBK	first field lines 8, 10 line 16 lines 17, 18 line 19 lines 20, 21 second field line 323 line 329 lines 330, 331 line 332 line 333 lines 334, 335	2T pulse data line 1 CCIR17 CCIR18/2 teletext test line teletext test line data line 2 CCIR330/5 CCIR331/1 sinx/x teletext test line
Additional video signals	ATV video	see R&S®ATV Video option

Digital modulation systems

Terrestrial standards

DVB-T/H (R&S® SFU-K1 option)

DVB-T/H	in line with EN 300744/EN 302304	
Modulation	mode bandwidth MER modulation frequency response shoulder attenuation	COFDM 5 MHz, 6 MHz, 7 MHz, 8 MHz (settable for variable bandwidth: 1 MHz to 10 MHz) >40 dB ⁵ <±0.2 dB >48 dB
Coding	constellation code rate guard interval FFT mode interleaver TPS carrier modification	QPSK, 16QAM, 64QAM, hierarchical coding 1/2, 2/3, 3/4, 5/6, 7/8 1/4, 1/8, 1/16, 1/32 2k, 4k, and 8k COFDM native and in-depth in line with DVB-T/H carriers and carrier groups can be switched off
Special functions	scrambler, sync byte inversion, Reed-Solomon encoder, convolutional interleaver, bit interleaver, symbol interleaver, guard interval	can be switched off
Test signals		TS test packet (see "Internal test signals") PRBS before convolutional encoder PRBS after convolutional encoder PRBS before mapper

T-DMB/DAB (R&S® SFU-K11 option)

T-DMB/DAB	in line with T-DMB/EN 300401	Korea/Europe
Transmission	modulation mode bandwidth modulation frequency response shoulder attenuation	COFDM I, II, III, IV 1.536 MHz <0.2 dB >45 dB
Single-frequency network	network mode control	MFN MID, manual
Special functions	external ETI data stream PRBS Gaussian fading profiles	requires R&S® SFU-B11 option can be inserted into a subchannel ⁶ included in T-DMB/DAB R&S® SFU-K11, requires R&S® SFU-B30 option

DMB-T (TDS-OFDM, R&S® SFU-K7 option) (see ordering information)

DMB-T (TDS-OFDM)	in line with TDS-OFDM	field trials in China
Modulation	mode bandwidth modulation frequency response shoulder attenuation	COFDM 6 MHz, 7 MHz, 8 MHz (settable for variable bandwidth: 5.6 MHz to 7.962 MHz) <0.2 dB >50 dB
Coding	constellation code rate guard interval time interleaver FFT mode	QPSK, 16QAM, 64QAM 4/9, 2/3, 8/9 420, 945 48, 240, 720 4k COFDM
Special functions	byte interleaver, randomizer, sync word randomizer, pilot data, guard interval, power boost randomizer restart	can be switched off packet/frame
Single-frequency network	network mode control	MFN MIP, manual
Test signals		TS test packet (see "Internal test signals")

⁵ With internal test signals.

⁶ Can be inserted into an existing, user-selectable subchannel of an incoming, valid ETI data stream.

DTMB/DMB-TH (R&S® SFU-K12 option) (see ordering information)

DTMB (TDS-OFDM) DMB-TH	in line with GB20600-2006 in line with LS specification	field trials in China
Modulation	mode bandwidth modulation frequency response shoulder attenuation	COFDM/single carrier 6 MHz, 7 MHz, 8 MHz <0.2 dB >50 dB
Coding	constellation code rate guard interval time interleaver FFT mode	QPSK, QPSK-NR, 16QAM, 32QAM, 64QAM 0.4, 0.6, 0.8 420, 595, 945 off, 48, 240, 720 symbols 4k COFDM/single carrier
Special functions	GI power boost LDPC output QAM and QPSK constellation DMB-TH mode	can be switched off I first, Q first, can be switched over, Plus, Minus can be switched over can be switched on
Single-frequency network	network mode control	MFN MIP, manual
Test signals		TS test packet (see "Internal test signals")

ISDB-T/ISDTV/ISDB-T_{SB} (R&S® SFU-K6 option)

ISDB-T, ISDTV ISDB-T _{SB}	in line with ARIB STD-B31 version 1.5 in line with ARIB STD-B29	
Modulation	mode bandwidth number of segments ARIB STD-B31 ARIB STD-B29 MER modulation frequency response shoulder attenuation	OFDM 6 MHz (variable: ±1000 ppm) 13 1, 3 >40 dB <0.2 dB >48 dB
Coding	FFT mode number of layers constellation code rate guard interval time interleaver ISDB-T ISDB-T _{SB}	2k, 4k, and 8k 1 to 3 QPSK, DQPSK, 16QAM, 64QAM 1/2, 2/3, 3/4, 5/6, 7/8 1/4, 1/8, 1/16, 1/32 0, 1, 2, 4, 8, 16 0, 1, 2, 4, 8, 16, 32
Special functions	scrambler, Reed-Solomon, byte interleaver, bit interleaver, frequency interleaver, guard interval, pilots, OFDM segments AC information	can be switched off PRBS, all "1"
Test signals		TS test packet (see "Internal test signals")

MediaFLO™ (R&S® SFU-K10 option) (see ordering information)

MediaFLO™	in line with QUALCOMM 80-T0455-1 Rev. E	
Modulation	mode bandwidth modulation frequency response shoulder attenuation	COFDM 5 MHz, 6 MHz <0.2 dB 40 dB
Coding	FFT mode	4k COFDM
Special function	TDM1	can be switched off
Test signals		PRBS

ATSC/8VSB (R&S®SFU-K4 option)

ATSC/8VSB	in line with ATSC Doc. A/53 (8VSB)	
Modulation	mode bandwidth symbol rate range pilot range pulse filtering MER modulation frequency response shoulder attenuation	8VSB 6 MHz 10.762 Msps ±5 % settable 1.25 (can be switched off) settable (from 0 to 5 in steps of 0.001) root raised cosine roll-off, $\alpha = 0.115$ >40 dB ⁷ <±0.25 dB >45 dB
Coding	input data rate	19.392658 Mbit/s
Special functions	randomizer, interleaver	can be switched off
Test signals		TS test packet (see "Internal test signals") PRBS before convolutional encoder PRBS after convolutional encoder PRBS before mapper

ATSC/A-VSB (R&S®SFU-K14 option)

ATSC/A-VSB	in line with ATSC	in preparation
Modulation	mode bandwidth symbol rate range pilot range pulse filtering MER modulation frequency response shoulder attenuation	8VSB 6 MHz 10.762 Msps ±5 % settable 1.25 (can be switched off) settable (from 0 to 5 in steps of 0.001) root raised cosine roll-off, $\alpha = 0.115$ >40 dB <±0.25 dB >45 dB
Coding	input data rate SRS modes turbo stream modes	19.392658 Mbit/s 0 to 4 0 to 8
Special functions	randomizer, interleaver	can be switched off
Test signals		TS test packet (see "Internal test signals") PRBS before convolutional encoder PRBS after convolutional encoder PRBS before mapper

Cable standards

DVB-C/ISDB-C (R&S®SFU-K2 option)

DVB-C ISDB-C	in line with EN 300429 (ITU-T J.83/A) in line with ITU-T J.83/C	
Modulation	mode symbol rate pulse filtering MER modulation frequency response shoulder attenuation	16QAM, 32QAM, 64QAM, 128QAM, 256QAM 0.1 Msps to 8 Msps, settable root raised cosine roll-off, $\alpha = 0.15$, variable roll-off (0.1; 0.13; 0.15; 0.18; 0.20) >40 dB ±0.25 dB >48 dB
Special functions	energy dispersal, Reed-Solomon encoder (204, 188, t = 8), convolutional interleaver	can be switched off
Test signals		TS test packet (see "Internal test signals") PRBS before mapper

⁷ With internal test signals.

J.83/B (R&S® SFU-K5 option)

J.83/B	in line with ITU-T J.83/B	
Modulation	mode bandwidth symbol rate 64QAM 256QAM 1024QAM pulse filtering MER modulation frequency response shoulder attenuation 64QAM 256QAM 1024QAM	64QAM, 256QAM, 1024QAM 6 MHz 5.0569 Msps 5.3600 Msps 5.3600 Msps root raised cosine roll-off, $\alpha = 0.18$ (64QAM), 0.12 (256/1024QAM) >40 dB ± 0.25 dB >50 dB >45 dB >45 dB
Coding	input data rate 64QAM 256QAM 1024QAM data interleaver	26.97035 Mbit/s 38.81070 Mbit/s 49.02525 Mbit/s can be switched off, level 1 and level 2
Special functions	randomizer, Reed-Solomon encoder, interleaver, checksum	can be switched off
Test signals		TS test packet (see "Internal test signals") PRBS before Trellis encoder PRBS before mapper

Satellite standards

DVB-S/DVB-DSNG (R&S® SFU-K3 option)

DVB-S/DVB-DSNG	in line with EN 300421/EN 301210	
Modulation	mode symbol rate overrange pulse filtering MER modulation frequency response shoulder attenuation	QPSK, 8PSK, 16QAM 0.1 Msps to 45 Msps, settable >45 Msps to 66 Msps root raised cosine roll-off, $\alpha = 0.35$, variable roll-off (0.25; 0.30; 0.35; 0.40; 0.45) 38 dB (27.5 Msps) ± 0.25 dB >45 dB
Coding	code rate	QPSK: 1/2, 2/3, 3/4, 5/6, 7/8 8PSK: 2/3, 5/6, 8/9 16QAM: 3/4, 7/8
Special functions	energy dispersal, Reed-Solomon encoder (204, 188, t = 8), convolutional interleaver	can be switched off
Test signals		TS test packet (see "Internal test signals") PRBS before convolutional encoder

DVB-S2 (R&S®SFU-K8 option) (see ordering information)

DVB-S2	in line with EN 302307, broadcast services	
Modulation	mode symbol rate QPSK, 8PSK 16APSK 32APSK pulse filtering MER modulation frequency response shoulder attenuation	QPSK, 8PSK, 16APSK, 32APSK 1 Msps to 35 Msps (overrange 40 Msps) 2 Msps to 30 Msps 2 Msps to 25 Msps root raised cosine roll-off, $\alpha = 0.20$, variable roll-off (0.15, 0.20, 0.25, 0.35) 38 dB (20 Msps) ± 0.25 dB >45 dB
Coding	code rate QPSK 8PSK 16APSK 32APSK FEC frame pilot insertion	1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 3/5, 2/3, 3/4, 5/6, 8/9, 9/10 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 3/4, 4/5, 5/6, 8/9, 9/10 normal, 64800 bit; short, 16200 bit can be switched off
Special function	error insertion	after CRC-8, BCH or LDPC
Test signals		TS test packet (see "Internal test signals")

DIRECTV legacy modulation (R&S®SFU-K9 option) (see ordering information)

DIRECTV legacy modulation	in line with DIRECTV transmission specifications	
Modulation	mode symbol rate overrange pulse filtering MER modulation frequency response shoulder attenuation	QPSK 20 Msps 1 Msps to 30 Msps root raised cosine roll-off, $\alpha = 0.20$, variable roll-off (0.15, 0.20, 0.25, 0.35) 38 dB (20 Msps) < ± 0.25 dB >45 dB
Coding	code rate	1/2, 2/3, 6/7
Special function	customer-specific DIRECTV streams error insertion	can be replayed in 188-byte format, requires R&S®SFU-K21, R&S®SFU-K22 option after convolutional encoder
Test signals		TS test packet (see "Internal test signals")

AMC (R&S®SFU-K108 option) (see ordering information)

AMC (advanced modulation coding)	in line with AMC	supports DIRECTV as well as parts of DVB-S and phase noise
Modulation	mode symbol rate overrange for DIRECTV pulse filtering MER modulation frequency response shoulder attenuation	QPSK, H8PSK DVB-S: 1 Msps to 36 Msps (and up to 42 Msps depending on code rate) DIRECTV: 20 Msps 1 Msps to 30 Msps root raised cosine roll-off, $\alpha = 0.20$, variable roll-off (0.15, 0.20, 0.25, 0.35) 38 dB (20 Msps) < ± 0.25 dB >45 dB
Coding	constellation code rate	QPSK DIRECTV: 1/2, 2/3, 6/7 DVB-S: 1/2, 2/3, 3/4, 5/6, 7/8
Special function	phase noise	can be switched on

Analog modulation systems

Standard B/G (R&S®SFU-K190 option) (see ordering information)

Standard B/G	in line with country-specific standard	
Vision modulation	modulation group delay precorrection frequency response vestigial sideband filtering amplitude frequency response S/N ratio video	B/G CCIR – B/G Germany general half (can be switched off) <20 ns (with/without vestigial sideband filtering) B/G, can be switched off <0.5 dB (–0.6 MHz to +4.8 MHz) (with/without vestigial sideband filtering) >60 dB weighted
Sound modulation	mode modulation of sound carrier 1, 2 modulation mode frequency deviation preemphasis vision/sound carrier frequency spacing vision/sound carrier level spacing pilot tone S/N ratio sound	mono, stereo, dual sound, mono/NICAM, NICAM FM 30 kHz (settable) 50 µs/75 µs (can be switched off) 5.5 MHz/5.74 MHz (settable) 13 dB/20 dB (settable) in sound carrier 2 (can be switched off) >60 dB weighted (CCIR)
Video signals	internal video generator external video input	see R&S®SFU-K23 option see video input
Audio signals	internal audio generator external audio input	see R&S®SFU-K23 option see audio input

Standard D/K (R&S®SFU-K191 option) (see ordering information)

Standard D/K	in line with country-specific standard	
Vision modulation	modulation group delay precorrection frequency response vestigial sideband filtering amplitude frequency response S/N ratio video	D/K OIRT – D/K half (can be switched off) <20 ns (with/without vestigial sideband filtering) DK, DK FM2, DK NICAM, can be switched off <0.5 dB (–1 MHz to +5.8 MHz) (with/without vestigial sideband filtering) >60 dB weighted
Sound modulation	mode modulation of sound carrier 1, 2 modulation mode frequency deviation preemphasis vision/sound carrier frequency spacing vision/sound carrier level spacing pilot tone S/N ratio sound	mono, stereo, dual sound, NICAM, mono/NICAM FM 30 kHz (settable) 50 µs/75 µs (can be switched off) 6.5 MHz/6.74 MHz (settable) 13 dB / 20 dB (settable) in sound carrier 2 (can be switched off) >60 dB weighted (CCIR)
Video signals	internal video generator external video input	see R&S®SFU-K23 option see video input
Audio signals	internal audio generator external audio input	see R&S®SFU-K23 option see audio input

Standard I (R&S® SFU-K192 option) (see ordering information)

Standard I	in line with country-specific standard	
Vision modulation	modulation group delay precorrection frequency response vestigial sideband filtering amplitude frequency response S/N ratio video	I UK – I (can be switched off) <20 ns (with/without vestigial sideband filtering) I, I1, can be switched off <0.5 dB (–1 MHz to +4.8 MHz) (with/without vestigial sideband filtering) >60 dB weighted
Sound modulation	mode modulation of sound carrier 1 modulation mode frequency deviation preemphasis vision/sound carrier frequency spacing vision/sound carrier level spacing modulation of sound carrier 2 modulation mode vision/sound carrier frequency spacing vision/sound carrier level spacing S/N ratio sound	mono, mono/NICAM, NICAM FM 30 kHz (settable) 50 µs/75 µs (can be switched off) 6 MHz (settable) 13 dB (settable) NICAM 6.552 MHz (settable) 20 dB (settable) >60 dB weighted (CCIR)
Video signals	internal video generator external video input	see R&S® SFU-K23 option see video input
Audio signals	internal audio generator external audio input	see R&S® SFU-K23 option see audio input

Standard M/N (R&S® SFU-K193 option) (see ordering information)

Standard M/N	in line with country-specific standard	
Vision modulation	modulation group delay precorrection frequency response vestigial sideband filtering amplitude frequency response S/N ratio video	M/N FCC – M/N (can be switched off) <20 ns (with/without vestigial sideband filtering) M, N, can be switched off <0.5 dB (–0.6 MHz to +4 MHz) (with/without vestigial sideband filtering) >60 dB weighted
Sound modulation	mode modulation of sound carrier 1, 2 modulation mode frequency deviation preemphasis vision/sound carrier frequency spacing vision/sound carrier level spacing S/N ratio sound	BTSC mono, FM stereo Korea, FM dual sound Korea BTSC 25 kHz (settable) 50 µs/75 µs (can be switched off) 4.5 MHz (settable) 7 dB (settable) >60 dB weighted (CCIR)
Video signals	internal video generator external video input	see R&S® SFU-K23 option see video input
Audio signals	internal audio generator external audio input	see R&S® SFU-K23 option see audio input

Standard L (R&S® SFU-K194 option) (see ordering information)

Standard L	in line with country-specific standard	
Vision modulation	modulation group delay precorrection frequency response vestigial sideband filtering amplitude frequency response	L TDF - L (can be switched off) <20 ns (with/without vestigial sideband filtering) L, L NICAM, can be switched off <0.5 dB (-1 MHz to +5.8 MHz) (with/without vestigial sideband filtering)
Sound modulation	mode modulation of sound carrier 1 modulation mode vision/sound carrier frequency spacing vision/sound carrier level spacing modulation of sound carrier 2 modulation mode frequency deviation vision/sound carrier frequency spacing vision/sound carrier level spacing	AM mono, mono/NICAM, NICAM NICAM 5.85 MHz (settable) 27 dB (settable) AM modulation depth 54 % (settable) 6.5 MHz (settable) 10 dB (settable)
Video signals	internal video generator external video input	see R&S® SFU-K23 option see video input
Audio signals	internal audio generator external audio input	see R&S® SFU-K23 option see audio input

Multi ATV predefined (R&S® SFU-K199 option) (see ordering information)

Multi ATV predefined	in line with country-specific standards and MBRAI	
Modulation	standards signals	B/G, B/G N, I, D/K, M/N, L one defined ATV signal per standard
Standard PAL B/G	implementation video test signal insertion test signal structure sound subcarrier sound 1 sound 2 audio coding left right group delay precorrection residual carrier	in line with MBRAI PAL B/G with A2 PAL B/G – color bar 75 % see below FM 50 kHz deviation/5.5 MHz/13 dB FM 50 kHz deviation/5.742 MHz/20 dB stereo 1 kHz 1 kHz CCIR B/G Germany 10 %
Standard PAL B/G + NICAM	implementation video test signal insertion test signal structure sound subcarrier sound 1 sound 2 audio coding sound 1 group delay precorrection residual carrier	in line with MBRAI PAL B/G with NICAM PAL B/G – color bar 75 % see below FM 50 kHz deviation/5.5 MHz/13 dB NICAM ⁸ roll-off = 40 %/5.85 MHz/20 dB mono 1 kHz CCIR B/G Germany 10 %

⁸ Simulation of NICAM spectrum by means of PN sequence and appropriate pulse shaping.

Standard PAL I	implementation video test signal insertion test signal structure sound subcarrier sound 1 sound 2 audio coding sound 1 group delay pre-correction residual carrier	in line with MBRAI PAL I1 PAL I – color bar 75 % see below FM 50 kHz deviation/6.0 MHz/13 dB NICAM ⁸ roll-off = 100 %/6.552 MHz/20 dB mono 1 kHz flat 20 %
Standard PAL D/K	video test signal insertion test signal structure sound subcarrier sound 1 sound 2 audio coding left right group delay pre-correction residual carrier	PAL D/K – FuBK ⁹ see below FM 50 kHz deviation/6.5 MHz/13 dB FM 50 kHz deviation/6.74 MHz/20 dB stereo 1 kHz 1 kHz flat 12.5 %
Standard NTSC M	video test signal insertion test signal structure sound subcarrier audio coding left right group delay pre-correction residual carrier	NTSC M – color bar 75 % with PLUGE see below BTSC/ FM 73 kHz deviation/4.5 MHz/20 dB stereo + SAP 0.4 kHz 0.4 kHz 5 MHz/FCC 12 %
Standard SECAM L	implementation video test signal insertion test signal structure sound subcarrier sound 1 sound 2 audio coding sound 1 sound 2 group delay pre-correction residual carrier	in line with MBRAI SECAM L SECAM L – color bar 75 % see below NICAM ⁸ roll-off = 40 %/5.85 MHz/27 dB AM modulation depth = 54 %/6.5 MHz/10 dB mono 1 kHz flat 3 %

Insertion test signal structure

Insertion test signal structure	in line with country-specific standards	
Standards B/G,B/G N, I, D/K Standard IEC 62002 with 2 CH. PAL B (MBRAI) 2 CH. PAL G (MBRAI) 2 CH. PAL B N (MBRAI) 2 CH. PAL G N (MBRAI) 2 CH. PAL I1 (MBRAI) DVB-T + PAL B (MBRAI) DVB-T + PAL G (MBRAI) DVB-T + PAL B N (MBRAI), DVB-T + PAL G N (MBRAI) DVB-T + PAL I1 (MBRAI)	first field lines 8, 10 line 16 lines 17, 18 line 19 lines 20, 21 second field line 323 line 329 lines 330, 331 line 332 line 333 lines 334, 335	2T pulse data line 1 CCIR17 CCIR18/2 teletext test line teletext test line data line 2 CCIR330/5 CCIR331/1 sinx/x teletext test line
Standards M/N	first field line 17 line 18 second field line 17 line 18	NTC7 composite FCC composite NTC7 combined sinx/x

⁹ FuBK: Federal German authority for television transmission.

Standards L and standard IEC 62002 with DVB-T + SECAM L (MBRAI), 2 CH. SECAM L (MBRAI)	first field lines 7 to 14 line 15 line 17 line 18 second field lines 320 to 328 line 330 lines 331, 332 line 333	discriminating signal teletext test line CCIR17 CCIR18, 6 multiburst packets discriminating signal CCIR330 CCIR331 CCIR331/1
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MBRAI signal combinations

Signal combinations	in line with IEC 62002 (MBRAI)	
Digital/analog multi-interferer	pattern L1 digital N+2/analog N+4 signal	DVB-T + PAL B (MBRAI) DVB-T + PAL G (MBRAI) DVB-T + PAL B N (MBRAI) DVB-T + PAL G N (MBRAI) DVB-T + PAL I1 (MBRAI) DVB-T + SECAM L (MBRAI)
Analog multi-interferer	pattern L2 2 analog N+2 / N+4 signals	2 CH. PAL B (MBRAI) 2 CH. PAL G (MBRAI) 2 CH. PAL B N (MBRAI) 2 CH. PAL G N (MBRAI) 2 CH. PAL I1 (MBRAI) 2 CH. SECAM L (MBRAI)

Simulation

Arbitrary waveform generator (R&S®SFU-K35 option) (see ordering information)

Waveform memory	length resolution loading time for 10 Msample nonvolatile memory	512 sample to 128 Msample in one-sample steps 16 bit 3 s hard disk
Clock generation	clock rate accuracy operating mode frequency accuracy (internal)	400 Hz to 100 MHz 0.001 Hz internal accuracy of reference frequency
Interpolation	bandwidth with clock rate = 100 MHz (no interpolation), bandwidth 0.1 dB with clock rate <100 MHz, bandwidth -0.1 dB sampling rate	40 MHz 0.31 × clock rate automatically interpolated to the internal 100 MHz data rate
Trigger	operating mode source delay inhibit	auto, retrigger, armed auto, armed retrigger internal, external settable from 0 to 2 ³² -1 samples settable from 0 to 2 ³² -1 samples
Marker	position delay	restart waveform settable from 0 to waveform length in samples
Special function		can be used with R&S®WinIQSIM™ 10

¹⁰ With R&S®WinIQSIM™: Software version 4.24 or later supports the download of I/Q data and the control of the R&S®SFU-K35.

T-DMB/DAB waveforms (R&S®SFU-K351 option)

T-DMB/DAB waveforms	I/Q sequences with audio and video contents	for details see description of option
Transmission	modulation	I, II
Signal set	video resolution sequences audio audio program service signal level sampling rate mode data rate	CIF (352 × 288), QCIF (176 × 144), QVGA (320 × 240) diver, fishes background music 1 kHz sinewave 0 dBFS 48 kHz stereo 192 kbit/s
Special function	Gaussian fading profiles	R&S®SFU-K32 option included, can be used with R&S®SFU-B30 option

DVB-H waveforms (R&S®SFU-K352 option)

DVB-H waveforms	I/Q sequences with audio and video contents	for details see description of option
Transmission	mode	different DVB-H modes
Signal set	video/audio	different resolutions and sequences

DRM waveforms (R&S®SFU-K353 option)

DRM waveforms	I/Q sequences with audio contents	for details see description of option
Transmission	mode constellation bandwidth sampling rate	A, B, C, and D 4QAM, 16QAM, and 64QAM (OFDM) 4.5 kHz, 5 kHz, 9 kHz, 10 kHz, 18 kHz, 20 kHz 12 kHz, 48 kHz
Signal set	audio signal level mode coding data rate	different sequences –10 dBFS, –12 dBFS mono MPEG-4 AAC, MPEG-4 CELP 4.8 kbit/s to 30.6 kbit/s

DTV interferers (R&S®SFU-K354 option)

DTV interferers	I/Q sequences in line with country-specific standards, IEC 62002 MBRAI, NORDIG, Dbook, A.74	for details see description of option
Waveforms	length resolution loading time for 64 Msample nonvolatile memory	512 sample to 128 Msample 16 bit 20 s hard disk
Signal set	standards	DVB-T, ATSC/8VSB, T-DMB/DAB, MediaFLO™, ISDB-T, ISDB-T _{SB} , FM
DVB-T standard	length single-interferer sequence bandwidths FFT mode constellation code rate guard interval multi-interferer sequence pattern bandwidth FFT mode constellation code rate guard interval	superframe 5 MHz, 6 MHz, 7 MHz, and 8 MHz 8k 16QAM 2/3 1/8 pattern L3 (2 DVB-T signals N+2/N+4) 8 MHz 8k 16QAM 2/3 1/8
ATSC/8VSB standard	length sequences	1 data frame center frequency, pilot frequency

T-DMB/DAB standard	length mode channel bandwidth single-interferer sequence multi-interferer sequence two channels three channels four channels	frame mode I 8 MHz center frequency A, D, with frequency gap B, C, A, C, with frequency gap B, D with frequency offset 1.712 MHz, A, B, with frequency gap C, D, with frequency offset 3.424 MHz A, B, C, with frequency offset 1.712 MHz, A, C, D, with frequency gap B, A, B, D, with frequency gap C, A, B, C, D
MediaFLO™ standard	length bandwidth	1 s 6 MHz
Standard ISDB-T	length single-interferer sequence OFDM segments	approx. 231 ms 13
Standard ISDB-T _{SB}	length single-interferer sequence OFDM segments	approx. 202 ms, 231 ms 1, 3
Standard FM	length single-interferer sequence FM jammer frequency frequency deviation	frame infinite seamless 1 kHz ±50 kHz (in line with GSM900 TX)

MediaFLO™ waveforms (R&S® SFU-K355 option)

MediaFLO™ waveforms	I/Q sequences in line with MediaFLO™	for details see description of option
Transmission	content length bandwidth	data 6 superframes, 6 seconds 6MHz
Signal set	wide area ID local area ID data	15 10 and 15 several MediaFLO™ IDs with different TX modes depending on sequence

Cable interferers (R&S® SFU-K356 option)

Cable interferers	I/Q sequences in line with country-specific standards: SCTE 40 etc	for details see description of option
Signal set	standards	digital: J.83/B analog: M/N
Standard J.83/B	sequences	64QAM, 256QAM: digital/digital
Standard M/N	sequences	analog/analog

Interferer management (R&S® SFU-K37 option)

Interferer	mode bandwidth level setting range frequency offset points for adding interferer signals	ARB, ATV predefined, analog I/Q, digital I/Q <±40 MHz (referenced to useful signal) -60 dB to +60 dB (relative to useful signal) ¹¹ -40 MHz to +40 MHz (relative to useful signal frequency) before noise addition/after noise addition
Signal set		activated options, waveforms and interferers, customer-specific waveforms

¹¹ High interferer power is at the expense of diminished useful signal values.

AWGN noise (R&S® SFU-K40 option)

RF bandwidth	3 dB spectrum (AWGN)	>96 MHz
Noise	density distribution function crest factor	Gaussian, statistical, separate for I and Q 18 dB
C/N	setting range resolution uncertainty for system bandwidth = symbol rate and C/N <20 dB	-30 dB to +60 dB 0.1 dB <0.2 dB
System bandwidth	(bandwidth for calculating the noise power) range	100 kHz to 80 MHz

Phase noise (R&S® SFU-K41 option)

Phase noise	frequency response amplitude at $f_{carrier} \pm 100$ Hz setting range resolution max. phase angle density distribution function	selection from profile files -10.0 dBc/Hz to -110.0 dBc/Hz, depending on selected profile 0.1 dB $\pm 180^\circ$ Gaussian
System bandwidth	sampling rate	10 MHz
Profile files	phase noise masks format	min. 8 predefined files text files, editable
Special function		customer-specific files can be used

Impulsive noise (R&S® SFU-K42 option)

Pulsed addition of an AWGN signal to the useful signal with settable number of pulses per frame and within settable limits of randomly distributed pulse intervals.

AWGN signal (not pulsed)	data	see R&S® SFU-K40 option
Pulse generator		
Frame	duration	10 ms, 100 ms, 1000 ms
Pulse	duration	0.25 μ s, fixed
Pulses per frame	setting range	1 to 40000
Minimum pulse interval	for number of pulses >1 setting range resolution	0.25 μ s to 16 ms 0.25 μ s
Maximum pulse interval	for number of pulses >1 setting range resolution	0.25 μ s to 16 ms 0.25 μ s
Distribution of pulse intervals	function	PRBS

Multinoise use (R&S® SFU-K43 option) (see ordering information)

Selectable noise sources can be combined to form a cumulative noise signal, which is then added to the useful signal. The C/N and level can be set for the overall signal. **R&S® SFU broadcast test systems delivered before May 2006 require a hardware extension¹².**

Signal sources	AWGN noise phase noise impulsive noise	see R&S® SFU-K40 option see R&S® SFU-K41 option see R&S® SFU-K42 option
Cumulative signal	signal sources that can be combined AWGN noise phase noise impulsive noise	depending on options installed addition can be activated addition can be activated addition can be activated
C/N setting for cumulative signal	setting range resolution uncertainty for system bandwidth = symbol rate and C/N <20 dB	-30 dB to +60 dB 0.1 dB <0.2 dB

¹² Check in SETUP -> HARDWARE INFO. Status of installed hardware extension: D/A Converter Board 2110.3406 model .03 required.

Fading simulator (R&S®SFU-B30 option)

Number of paths	with R&S®SFU-B31 option	20 40
System bandwidth		80 MHz
Path loss	range resolution accuracy	0 dB to 50 dB 0.01 dB <0.01 dB
Path delay	range resolution with R&S®SFU-K30 option	0 ms to 5.242 ms 10 ns 0.01 ns
Delay groups	maximum number with R&S®SFU-B30 option with R&S®SFU-B31 option allowed delay differences	4 8 <40 µs per group
Speed range	range accuracy	0 km/h to 1725 km/h for 1 GHz <0.128 %
Doppler frequency range	setting range accuracy	0 Hz to 1600 Hz <0.1 %
Restart		automatic, manual
Insertion loss		-3 dB to 18 dB, automatic or user-defined, with clipping indication
Correlation	correlation correlation coefficient setting range resolution correlation phase setting range resolution	with R&S®SFU-B31 option; two faded channels can be correlated in pairs 0 % to 100 % 5 % 0° to 360° 1°
Fading profiles		
Pure Doppler	frequency ratio resolution	(-1 to +1) × current Doppler frequency 0.01 × current Doppler frequency
Static and constant phase	path loss phase resolution	0 dB to 50 dB 0° to 360° 1°
Rayleigh fading	pseudo noise interval	>93 h
Rice fading	combination of Rayleigh fading and pure Doppler power ratio ¹³	-30 dB to +30 dB
GAUSSDOPPLER (PI profile)	amplitude distribution power density function	pseudo noise interval >93 h $S(\tau, f) = G(0.1A; 0; 0.08fd) + \delta(f - 0.5fd)$
GAUSS0_1 (PO profile)	amplitude distribution power density function	pseudo noise interval >93 h $S(\tau, f) = G(A; f; 0.08fd)$
GAUSS0_08 (VU30, MR100 profile)	amplitude distribution power density function	pseudo noise interval >93 h $S(\tau, f) = G(A; f; 0.1fd)$
Lognormal fading	standard deviation resolution local constant	0 dB to 12 dB 1 dB 12 m to 200 m for $f_{RF} = 1$ GHz

¹³ Ratio of discrete component to distributed component.

Enhanced fading (R&S®SFU-K30 option) (see ordering information)

30 MHz fine delay mode	number of paths system bandwidth path delay resolution	12, 24 (with R&S®SFU-B31 option) 30 MHz see R&S®SFU-B30 option 0.01 ns
50 MHz fine delay mode	number of paths system bandwidth path delay resolution	8, 16 (with R&S®SFU-B31 option) 50 MHz see R&S®SFU-B30 option 0.01 ns
Moving delay mode	system bandwidth fading number of fading paths profile reference path delay resolution moving delay path mean delay delay variation resolution variation period	50 MHz 2 per signal path none 0 µs to 40 µs 10 ns 150 ns to 39.85 µs 0.3 µs to 40 µs 10 ns 10 s to 500 s in steps of 100 ms
Birth-death mode	system bandwidth fading number of fading paths profile speed range Doppler frequency range delay minimum delay delay grid resolution grid positions hopping parameters start offset hopping dwell time total (start offset + hopping dwell time) resolution	50 MHz 2 per signal path pure Doppler see R&S SFU-B30 option see R&S SFU-B30 option 0 µs to 40 µs ¹⁴ 100 ns to 40/3 µs ¹⁴ 1 ns 3 to 50 ¹⁴ 0 s to 429 s 1 ms to 429 s max. 429 s 100 ns
Two-path dynamic delay	system bandwidth fading number of fading paths moving mode hopping positions sliding function profile speed range Doppler frequency range delay reference path (statistically in delay) moving path minimum delay maximum delay resolution hopping dwell time sliding period resolution	50 MHz 2 per signal path hopping/sliding 2/alternating sinusoidal static, pure Doppler, Rayleigh see R&S SFU-B30 option see R&S SFU-B30 option 0 s to 1638.00 µs 0 s to 1000.00 µs 0 s to 1000.00 µs 10 ns 100 ms to 10 s 50 s to 1000 s 10 ms

¹⁴ The maximum delay range of 40 µs may not be exceeded.

Gaussian fading (R&S® SFU-K32 option) (see ordering information)

Additional fading profiles	in line with EN 50248	
Gaus1	amplitude distribution power density function	pseudo noise interval >93 h $S(\tau, f) = G(A, -0.8fd, 0.05fd) + G(A1, +0.4fd, 0.1fd)$, where A1 is 10 dB less than A
Gaus2	amplitude distribution power density function	pseudo noise interval >93 h $S(\tau, f) = G(B, +0.7fd, 0.1fd) + G(B1, -0.4fd, 0.15fd)$, where B1 is 15 dB less than B
GausDAB	amplitude distribution power density function	pseudo noise interval >93 h $S(\tau, f) = G(A, \pm 0.7fd, 0.1fd)$ where +0.7fd is used for paths of even path number, and -0.7fd is used for paths of uneven path number; path 1 is an exception and is parameterized with +0.7fd

BER measurements (R&S® SFU-K60 option)

For DVB-S2, DIRECTV, DMB-TH, and MediaFLO™, BER measurements cannot be performed at all or only to a limited extent.

BER measurements	for all digital modulation modes	
Display	measured value	BER error count measurement time
Start/restart		manual
PRBS measurements		
Inputs for BER clock, BER data, BER enable	connectors input impedance input level	BNC female, rear 50 Ω HCT
BER data	input data rate PRBS	up to 90 Mbit/s $2^{23}-1 / 2^{15}-1$ (in line with ITU-T O.151)
BER clock, BER data	polarity	normal, inverted
BER enable		always, active high, active low
Output for BER error	connector output impedance output level	BNC female, rear 50 Ω HCT
MPEG-2 TS measurements		
Input	input interfaces input signal payload (PRBS in line with ITU-T O.151) PID	ASI, SPI (stuffing off), SMPTE 310 (see MPEG-2 inputs) TS packet (see "Internal test signals") $2^{23}-1 / 2^{15}-1$ NULL (1FFF (hex)), variable
DATA VALID	applicable to SPI interface	active always

Trigger inputs/outputs

Triggers and connections reserved for future use

Triggers 1 to 10 IN/OUT	connector input impedance load resistor input/output level	D-Sub female, 25 pins, rear high impedance >200 Ω HCT
Main trigger IN Main trigger OUT	connector input impedance input level	BNC female, rear 50 Ω HCT
Main trigger OUT	connector load resistor output level	BNC female, rear >200 Ω HCT

General data

System data

System	operating system memories for settings	PC platform Windows XP Embedded internal hard disk 50
Local control	display controls	XVGA 1024 × 768 rotary knob, hardkeys, and softkeys
External control	controls	external mouse and keyboard via USB
Remote control	command set IEC/IEEE address range IEC/IEEE interface functions Ethernet USB	SCPI 1999.5 IEC 60625 (IEEE 488) 1 to 30 SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C0 10/100BaseT 1.1 (full speed)
Connectors	IEC/IEEE Ethernet USB AC supply input	Amphenol, 24 pins, rear RJ-45, rear USB, front and rear IEC 60320 C14, rear

Operating data

Power supply	input voltage range, AC, nominal AC supply frequency power factor correction	100 V to 240 V 3.6 A to 1.3 A 47 Hz to 63 Hz in line with EN 61000-3-2
EMC		in line with EN 55011 class B, EN 61326
Immunity to interfering field strength		up to 10 V/m
Environmental conditions	operating temperature range storage temperature range climatic resistance, 95 % rel. humidity, cyclic test at +25 °C/+40 °C	+5 °C to +45 °C ¹⁵ in line with EN 60068-2-1, EN 60068-2-2 –20 °C to +60 °C in line with EN 60068-2-3, EN 60068-2-30
Mechanical resistance	vibration, sinusoidal vibration, random shock	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 10 Hz to 300 Hz, acceleration 1.2 g (rms), in line with EN 60068-2-64 40 g shock spectrum, in line with EN 60068-2-27, MIL-STD-810E
Electrical safety		in line with IEC 61010-1, 61010-1, and UL 61010B-1, CSA C22.2 No. 1010.1
Dimensions	W × H × D W × H × D	435 mm × 192 mm × 460 mm (4 HU) 17.14 in × 7.56 in × 18.12 in (4 HU)
Weight	fully equipped fully equipped	15 kg 33.1 lb
Recommended calibration interval		3 years
Standard warranty period		1 year

¹⁵ Reduced brightness of LCD at higher operating temperatures.

Ordering information

Option identification: R&S®SFU-Bxy = hardware option, R&S®SFU-Kxy = software option.
 Delivery of R&S®SFU base unit only with at least one coder or with the R&S®SFU-K81 option installed.
 If the R&S®SFU-K81 option is installed, no digital or analog modulation system can be used.

Designation	Type	Order No.
Broadcast Test System including power cable, hardcopy of quick start guide, CD-ROM (includes operating manuals and quick start guide)	R&S®SFU	2110.2500.02
Options		
Basic configuration		
Realtime Disabled (option available only at initial delivery)	R&S®SFU-K81	2110.7960.02
Realtime Enabled (only if R&S®SFU-K81 is installed)	R&S®SFU-K82	2110.7976.02
RF path		
High Power and Overvoltage Protection	R&S®SFU-B90	2110.8008.02
Digital modulation systems		
DVB-T/H Coder	R&S®SFU-K1	2110.7301.02
DVB-C/ISDB-C Coder	R&S®SFU-K2	2110.7324.02
DVB-S/DVB-DSNG Coder	R&S®SFU-K3	2110.7330.02
DVB-S2 Coder (requires an installed R&S®SFU-B1 or R&S®SFU-B10)	R&S®SFU-K8	2110.7399.02
ATSC/8VSB Coder	R&S®SFU-K4	2110.7353.02
ATSC/A-VSB Coder	R&S®SFU-K14	2110.7776.02
J.83/B Coder	R&S®SFU-K5	2110.7360.02
ISDB-T/ISDTV/ISDB-T _{SB} Coder	R&S®SFU-K6	2110.7376.02
MediaFLO™ Coder (requires an installed R&S®SFU-B10)	R&S®SFU-K10	2110.7524.02
T-DMB/DAB Coder including Gaussian fading profiles	R&S®SFU-K11	2110.7518.02
DMB-T (TDS-OFDM) Coder (requires an installed R&S®SFU-B1 or R&S®SFU-B10)	R&S®SFU-K7	only on request
DTMB/DMB-TH (TDS-OFDM) Coder (requires an installed R&S®SFU-B1 or R&S®SFU-B10)	R&S®SFU-K12	2110.7760.02
DIRECTV Legacy Modulation Coder (requires an installed R&S®SFU-B1 or R&S®SFU-B10)	R&S®SFU-K9	2110.7401.02
AMC Coder (requires an installed R&S®SFU-K8 (DVB-S2) and an installed R&S®SFU-B1 or R&S®SFU-B10)	R&S®SFU-K108	only on request
Coder Extension 1	R&S®SFU-B1	2110.7424.02
Coder Extension 10	R&S®SFU-B10	2110.7747.02
Analog modulation systems		
ATV Standard B/G Coder (requires an installed R&S®SFU-B2)	R&S®SFU-K190	2110.8050.02
ATV Standard D/K Coder (requires an installed R&S®SFU-B2)	R&S®SFU-K191	2110.8037.02
ATV Standard I Coder (requires an installed R&S®SFU-B2)	R&S®SFU-K192	2110.8043.02
ATV Standard M/N Coder (requires an installed R&S®SFU-B2)	R&S®SFU-K193	2110.8066.02
ATV Standard L Coder (requires an installed R&S®SFU-B2)	R&S®SFU-K194	2110.8072.02
Multi ATV Predefined (requires an installed R&S®SFU-B3)	R&S®SFU-K199	2110.8089.02
Coder Extension 2 preinstalled in R&S®SFU from serial no. 101000	R&S®SFU-B2	2110.7430.02

Simulation		
Fading Simulator	R&S®SFU-B30	2110.7530.02
Fading Simulator Extension to 40 Paths (requires an installed R&S®SFU-B30)	R&S®SFU-B31	2110.7547.02
Enhanced Fading (requires an installed R&S®SFU-B30)	R&S®SFU-K30	2110.7560.02
DAB Gaussian Fading (requires an installed R&S®SFU-B30) (included in R&S®SFU-K11 and R&S®SFU-K351)	R&S®SFU-K32	2110.7630.02
ARB Generator (requires an installed R&S SFU-B3)	R&S®SFU-K35	2110.7601.02
Memory Extension 1 preinstalled in R&S SFU from serial no. 101000	R&S®SFU-B3	2110.7447.02
T-DMB/DAB Waveforms incl. Gaussian fading profiles (requires an installed R&S SFU-K35 and, for using Gaussian fading profiles, an installed R&S SFU-B30)	R&S®SFU-K351	2110.4277.02
DVB-H Waveforms (can be used with R&S SFU-K35)	R&S®SFU-K352	2110.4425.02
DRM Waveforms (can be used with R&S SFU-K35)	R&S®SFU-K353	2110.4554.02
DTV Interferers (can be used with R&S SFU-K35)	R&S®SFU-K354	2110.4690.02
MediaFLO™ Waveforms (can be used with R&S SFU-K35)	R&S®SFU-K355	2110.2974.02
Cable Interferers (can be used with R&S SFU-K35)	R&S®SFU-K356	2110.3212.02
Interferer Management	R&S®SFU-K37	2110.7647.02
AWGN Noise	R&S®SFU-K40	2110.7653.02
Phase Noise	R&S®SFU-K41	2110.7660.02
Impulsive Noise	R&S®SFU-K42	2110.7676.02
Multinoise Use (requires at least one installed R&S SFU-K40, R&S SFU-K41, or R&S SFU-K42)	R&S®SFU-K43	2110.7682.02
Baseband inputs/outputs		
Extended I/Q	R&S®SFU-K80	2110.7953.02
ETI Input/Output	R&S®SFU-B11	2110.7553.03
Digital baseband		
TS Generator including SDTV streams	R&S®SFU-K20	2110.7476.02
DVB-H Stream Library (requires an installed R&S®SFU-K20)	R&S®DV-DVBH	2085.8704.02
Test Card M Streams (requires an installed R&S®SFU-K20)	R&S®DV-TCM	2085.7708.02
HDTV Sequences (requires an installed R&S®SFU-K20)	R&S®DV-HDTV	2085.7650.02
H.264 Stream Library (requires an installed R&S®SFU-K20)	R&S®DV-H264	2085.9052.02
ISDB-T Stream Library (requires an installed R&S®SFU-K20)	R&S®DV-ISDBT	2085.9146.02
TRP Player (requires an installed R&S®SFU-B6 and an installed R&S®SFU-B4)	R&S®SFU-K22	2110.7499.02
TS/ETI Recorder (requires an installed R&S®SFU-K22, R&S®SFU-B6, and R&S®SFU-B4)	R&S®SFU-K21	2110.7482.02
Memory Extension 2	R&S®SFU-B4	2110.7453.02
Additional Hard Disk for instruments with serial numbers <101000	R&S®SFU-B6	2110.7501.02
Additional Hard Disk for instruments with serial numbers >101000	R&S®SFU-B6	2110.7501.03
T-DMB/DAB Streams (requires an installed R&S®SFU-K21 or R&S®SFU-K22)	R&S®SFU-K221	2110.4348.02

Analog baseband		
Video Generator (included in R&S®SFU-K190 to -K194)	R&S®SFU-K23	2110.7799.02
ATV Video Signals (can be used with R&S®SFU-K190 to R&S®SFU-K194)	R&S®ATV Video	2110.4831.02
Impedance Matching Pad 75/50 Ohms (can be used with R&S®SFU-K190 to R&S®SFU-K194)	R&S®SFU-Z19	2110.7276.02
Measurement and analysis functions		
BER Measurements (cannot be used at all or only to a limited extent for DVB-S2, DIRECTV, DTMB, DMB-TH, and MediaFLO™)	R&S®SFU-K60	2110.7782.02
Other expansions		
User I/O (additional input/output)	R&S®SFU-B5	2110.7460.02
Upgrade Kit for R&S®SFU-K43	R&S®SFU-U43	2110.7699.02
Recommended extras		
Hardcopy of operating manuals; includes quick start guide (in English)		2110.2522.12
Documentation of R&S®SFU Calibration Values	R&S®SFU-DCV	2082.0490.30
LVDS Cable for digital I/Q input/output (2 m)	R&S®LVDS BU-BU 26POL 2M	1130.1302.00
Adapter for Telescopic Sliders	R&S®ZZA-T45	1109.3774.00
Keyboard with USB Interface (US assignment)	R&S®PSL-Z2	1157.6870.03
Mouse with USB Interface, optical	R&S®PSL-Z10	1157.7060.02
External USB CD-RW Drive	R&S®PSP-B6	1134.8201.12
Service options		
can only be ordered in connection with the purchase of an instrument		
One-Year Repair Service following the warranty period	R&S®RO2SFU	please contact your local sales
Two-Year Repair Service following the warranty period	R&S®RO3SFU	please contact your local sales
Four-Year Repair Service following the warranty period	R&S®RO5SFU	please contact your local sales
Two-Year Calibration Service	R&S®CO2SFU	please contact your local sales
Three-Year Calibration Service	R&S®CO3SFU	please contact your local sales
Five-Year Calibration Service	R&S®CO5SFU	please contact your local sales



For product brochure, see PD 0758.1658.12
and www.rohde-schwarz.com
(search term: SFU)



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