R&S®SFU
Broadcast Test System
The multistandard reference signal generator for broadcasting and mobile TV

ROHDE&SCHWARZ

R&S®SFU Broadcast Test System

At a glance

The R&S®SFU broadcast test system is a multistandard signal generator that is used worldwide. It provides a platform that supports all conventional TV and audio broadcasting standards and is used as a reference signal source. This all-in-one compact solution combines many applications in a single instrument of only four height units.

The R&S®SFU offers unique features in the RF band and and the baseband, in channel simulation and interferer generation, plus a powerful fading simulator and a variety of noise sources.

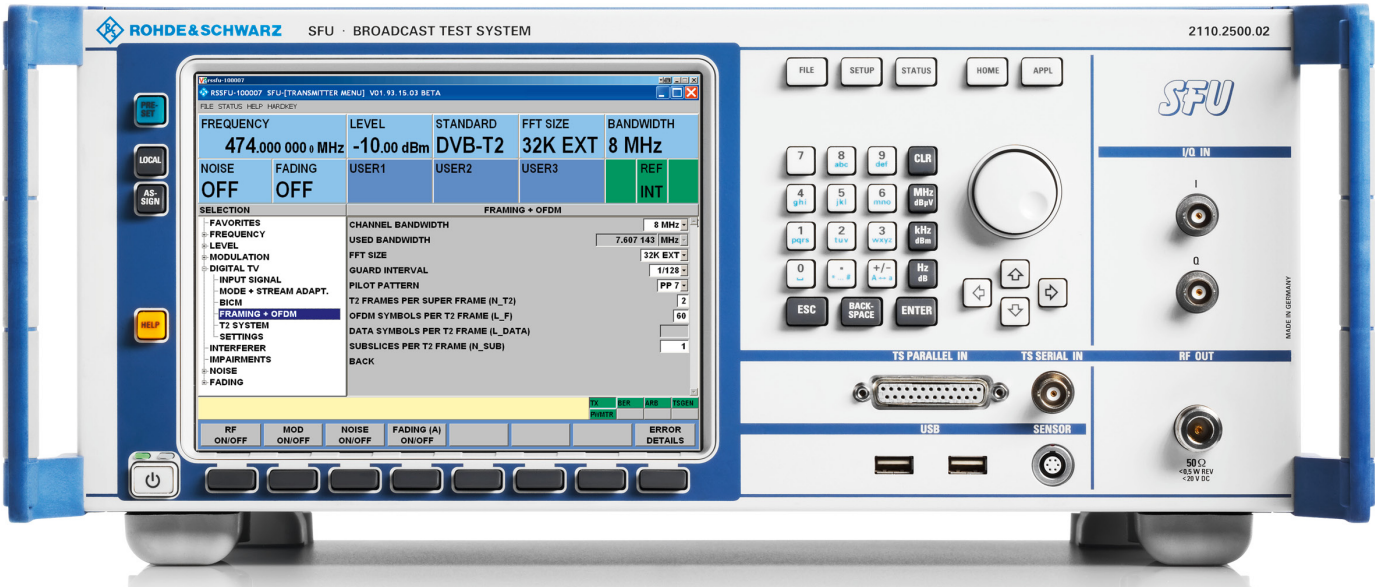
Due to its modular design and flexible option concept, the R&S®SFU can be optimally adapted to the requirements of different applications. It is an ideal research and development tool for improving established standards and generating new standard signals.

The R&S®SFUs top RF performance both in terms of quality and precision, as well as its outstanding simulation capabilities provide an excellent basis for performance and conformance tests as well as for integration into test systems.

Even after purchase, the R&S®SFU can be quickly and easily expanded to include new modulation modes through the installation of software options.

Key facts

- All-in-one compact solution
- Multistandard reference signal generator
- Realtime TV and audio broadcasting signal generation
- Analog and digital transmission standards
- Wide frequency range from 100 kHz to 3000 MHz
- Outstanding signal quality
- Transmission and interferer simulations
- Bit error ratio (BER) tester
- Internal analog and digital video and audio signal sources



R&S®SFU Broadcast Test System

Benefits and key features

Multistandard reference signal generator with realtime coding

- Digital and analog TV standards for cable, satellite and terrestrial transmission
- Digital and analog audio broadcasting standards
- Realtime signal generation with selectable modulation and coding parameters
- Standards available as software options

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High-precision reference signal generation over wide frequency and level range

- Frequency range from 100 kHz to 3000 MHz
- Level range from –120 dBm to +19 dBm
- Extremely short switchover times
- Low phase noise and high MER

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Integrated transport stream generator, recorder, player and audio/video generator

- Transport stream generator and transport stream player for endless and seamless replay
- Transport stream and ETI recorder
- Extensive transport stream libraries from Rohde&Schwarz
- Audio/video generator with test pattern library for analog TV
- Test signal generation in line with customer specifications

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Simulation of multipath propagation, single-frequency networks and cable networks

- Powerful fading simulator
- Numerous fading configurations
- Standard-compliant fading profiles
- Complex parameter sets

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Flexible signal generation with arbitrary waveform generator (AWG)

- Large AWG memory, intelligent memory management and high sample rates
- Waveform libraries from Rohde&Schwarz
- Support of R&S®WinIQSIM™ and R&S®WinIQSIM2™
- Digital I/Q interface

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Simulation of interferers and adjacent channel scenarios

- Interferer management
- Interferers from broadcasting and wireless communications
- Digital dividend

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Receiver tests with noise sources, BER tester and power measurement

- Noise generator with AWGN, impulsive noise, phase noise
- BER measurement at transport stream or bit level
- Integrated power measurement using R&S®NRP-Zxx power sensors

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Development of broadcast receivers

- Multistandard chip and tuner development for set-top boxes, TV sets and radios
- Simulation of real-life transmission conditions
- Fast and efficient generation of adjacent channel and co-channel scenarios
- Impact of wireless communications signals
- Diversity tests

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Certification and logo tests of broadcast receivers in test labs

- Reference signal generation for globally used broadcast standards for research, development and type approval
- Use in test systems

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Convenient graphical user interface

- 19" × 4 HU cabinet with large XVGA color display
- Intuitive user interface under Windows XP Embedded
- Context-sensitive help system
- User-definable favorites for quick access
- Remote control and remote operation via LAN and GPIB

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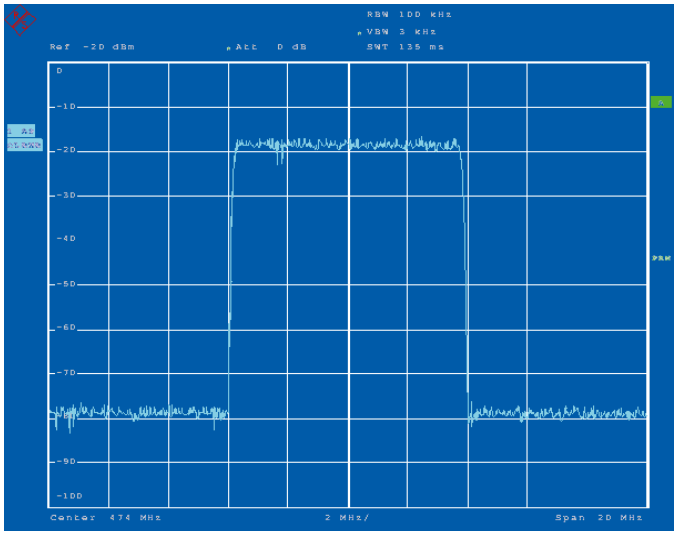
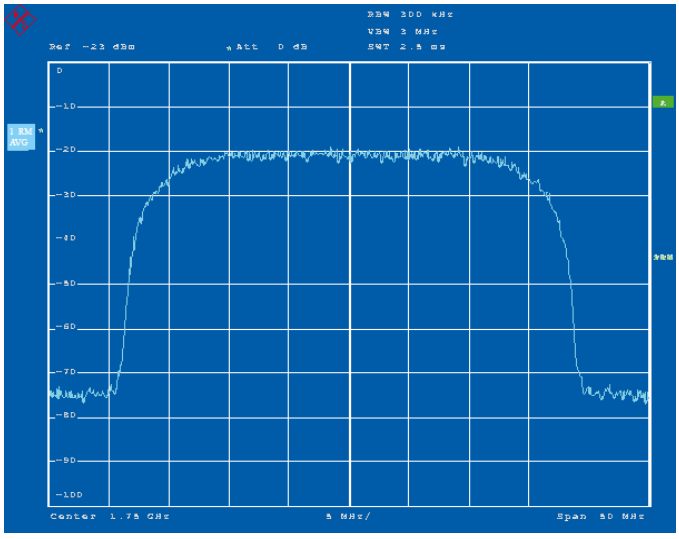
Multistandard reference signal generator with realtime coding

DVB-T2 spectrum.



DVB-S2 spectrum.



The R&S®SFU broadcast test system includes a powerful multistandard signal generator that supports all conventional broadcast systems. Signals for a wide range of standards – including audio and TV, analog and digital, terrestrial, satellite and cable – can be generated using just one instrument. Pressing a button is all it takes to switch quickly and easily from one standard to another. Additional and future standards can be installed at any time with a software update.

Digital and analog TV standards for cable, satellite and terrestrial transmission

The R&S®SFU supports the following TV standards:

- Digital terrestrial TV:
  DVB-T2, DVB-T, ATSC/8VSB, ISDB-T, ISDB-T_B, DTMB
- Digital satellite TV:
  DVB-S2, DVB-S, DIRECTV, ISDB-S [1)]
- Digital cable TV:
  DVB-C2, DVB-C, J.83/B, ISDB-C
- Digital mobile TV:
  DVB-H, DVB-SH, T-DMB, ISDB-T 1 seg, CMMB, ATSC Mobile DTV, MediaFLO™
- Analog TV:
  B/G, D/K, M/N, I/I1, L/L

Digital and analog audio broadcasting standards

The R&S®SFU supports the following audio broadcasting standards:

- Digital audio broadcasting:
  DAB, DAB+, DMB (French DMB, Visual Radio), DRM [2)], DRM+ [1)], ISDB-T_{SB}, HD Radio™ [2)]
- Analog audio broadcasting:
  FM stereo with RDS, FM mono, AM

Realtime signal generation with selectable modulation and coding parameters

The R&S®SFU broadcast test system's main function is realtime generation of modulated signals for a wide range of transmission standards. The R&S®SFU uses a powerful universal hardware platform for baseband signal processing which provides the I and Q bit streams for the broadband vector modulator. The result is a highly accurate spectrum for all modulation modes. Users can switch from one transmission standard to another by loading the appropriate FPGA configuration.

1) Waveform library will soon be available.
2) Waveform library.

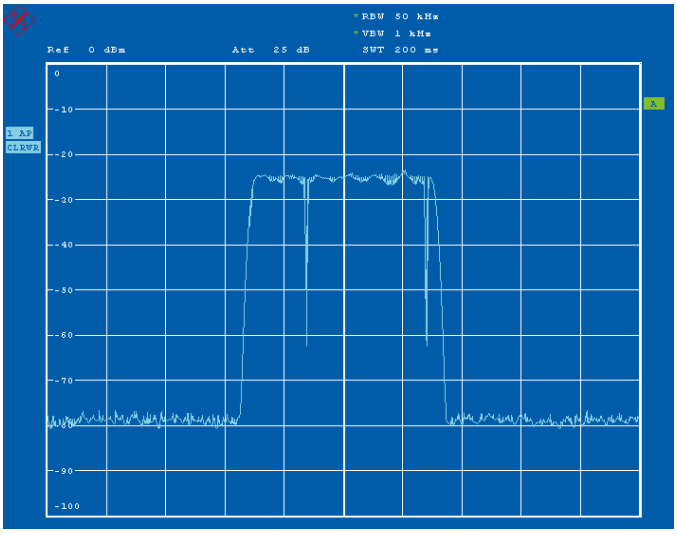
For each transmission standard, various modulation parameters such as constellation, code rate and FFT mode have to be defined. These parameters can be varied regardless of the transport stream to be transmitted [1]. It is thus possible to test all conceivable configurations of a standard. The R&S®SFU broadcast test system allows additional parameter settings even beyond the limits of the individual standards.

Standards available as software options

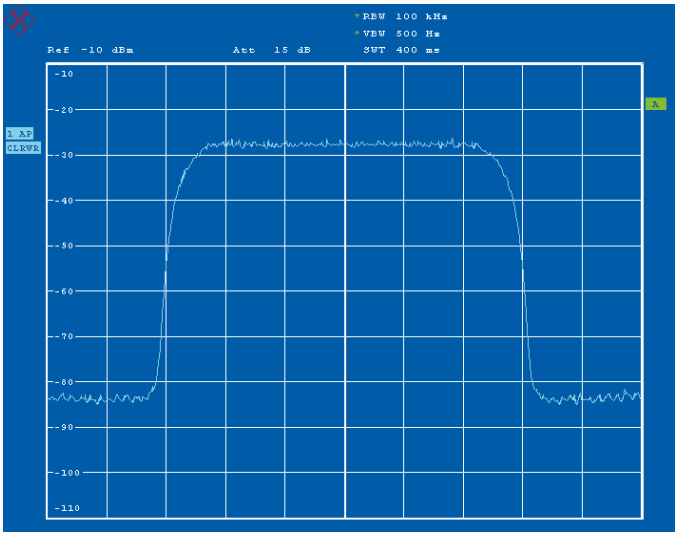
The R&S®SFU's powerful hardware platform makes it possible to have completely firmware-based realtime coders for the various modulation modes. Consequently, further transmission standards can be added quickly and easily at any time. The standards come pre-installed with the firmware and can be enabled by entering a key code. New standards are integrated into the new firmware version, which is provided at regular intervals to update the R&S®SFU with the corresponding functionalities.

[1] The variation of the parameters depends on the standard. With some standards, e.g. MediaFLO™, the coding parameters are controlled by the transport stream used.

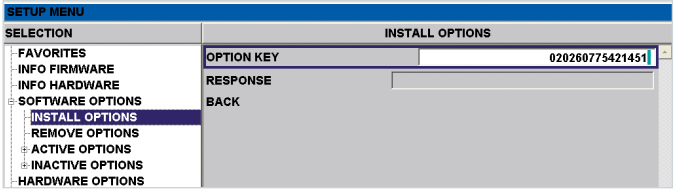
T-DMB spectrum.



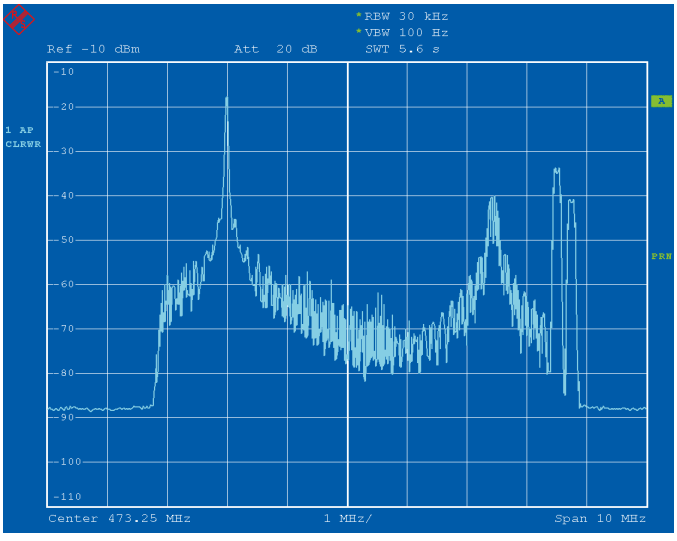
J.83/B spectrum.



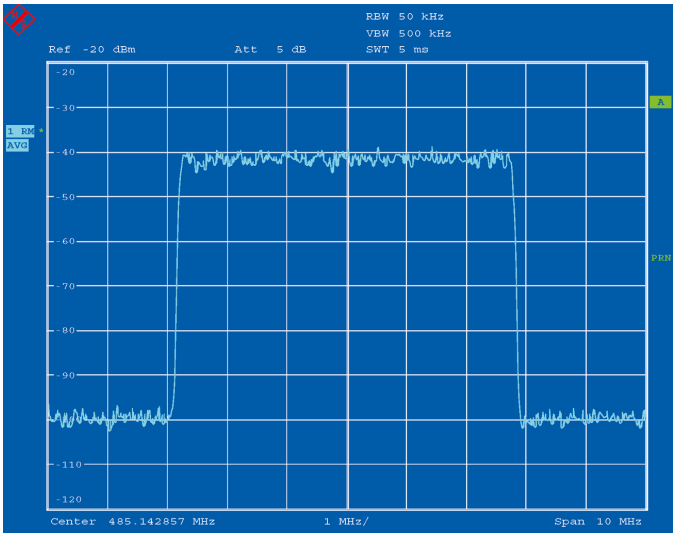
Graphical user interface (GUI) for key code input.



PAL B/G spectrum.



ISDB-T/T_B spectrum.



High-precision reference signal generation over wide frequency and level range

The R&S®SFU broadcast test system covers the entire frequency range relevant to broadcast applications, from IF, VHF, UHF and the L band all the way up to the S band, and offers exceptional signal quality throughout this range.

Frequency range from 100 kHz to 3 GHz

The frequency can be set in steps of 0.1 Hz. Either the channel center frequency or the vision carrier frequency or a channel number from the selected channel table can be entered.

Level range from –120 dBm to +19 dBm

The output level of the R&S®SFU can be set in 0.1 dB steps over a wide range from –120 dBm to +19 dBm. This makes it possible to test tuners throughout their full dynamic range, from the sensitivity threshold up to saturation. The instrument's wear-free electronic attenuator enables a virtually unlimited number of switching cycles with excellent reproducibility.

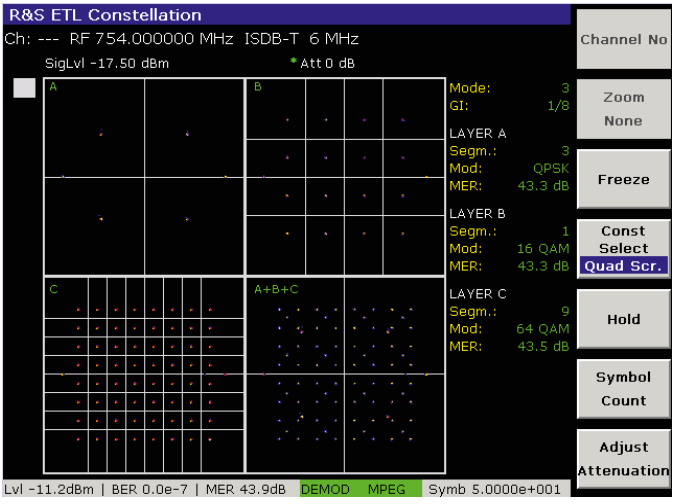
Extremely short switchover times

Short switchover times boost efficiency and reduce costs in the development of consumer electronics equipment. The R&S®SFU's extremely short switchover times significantly contribute toward minimizing development times. Level, frequency and parameter switching is accomplished in less than 20 milliseconds, and even switching between modulation standards takes no more than approx. six seconds.

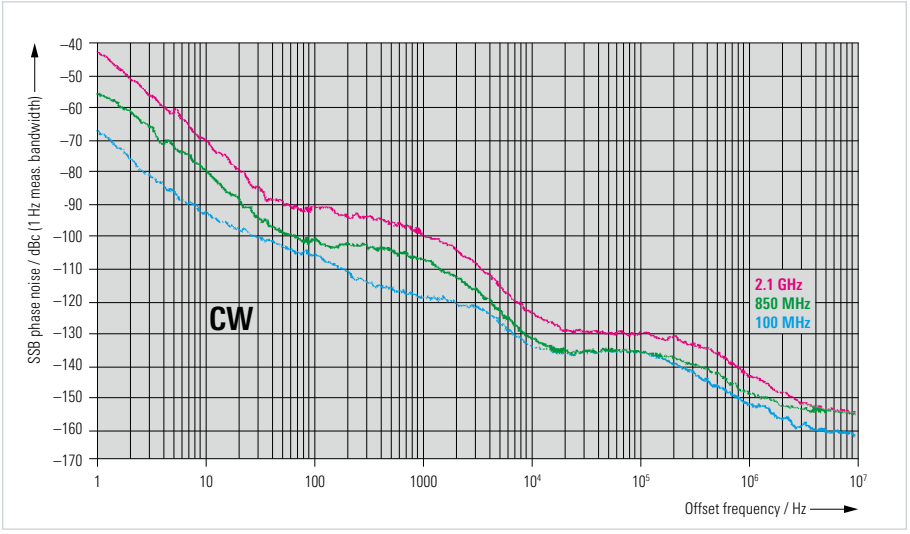
Low phase noise and high MER

Advanced COFDM modulation methods place stringent demands on the stability and spectral purity of the oscillator signal. Featuring an SSB phase noise of < –131 dBc (typ. at 1 GHz and 20 kHz carrier offset), the R&S®SFU broadcast test system achieves very high MER values of up to 43 dB (typ.). Plus, the R&S®SFU stands out for its low broadband noise and high harmonics suppression.

ISDB-T three-layer constellation diagram.



Typical phase noise characteristics.



Overview of supported transmission modes

Terrestrial TV						
Standard	Europe	North America	South America	Asia	Australia	Africa
DVB-T2	●					
DVB-T	●			●	●	●
ATSC/8VSB		●		●		
ISDB-T				●		
ISDB-T_B			●			
DTMB				●		
Analog	●	●	●	●	●	●

Cable TV						
Standard	Europe	North America	South America	Asia	Australia	Africa
DVB-C2	●					
DVB-C	●					
J.83/B		●		●		
ISDB-C				●		

Satellite TV						
Standard	Europe	North America	South America	Asia	Australia	Africa
DVB-S	●			●		
DVB-S2	●	●		●		
DIRECTV		●	●			
ISDB-S				●		

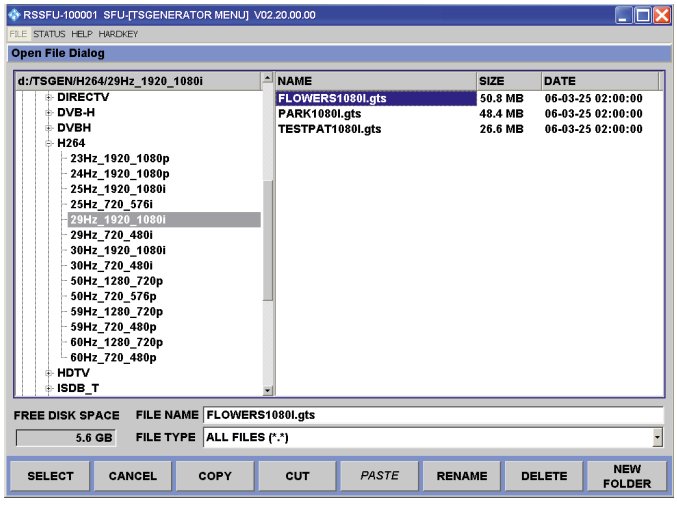
Mobile TV						
Standard	Europe	North America	South America	Asia	Australia	Africa
DVB-H	●				●	●
DVB-SH	●					
T-DMB	●			●		
ISDB-T 1 seg			●	●		
CMMB				●		
MediaFLO™		●				
ATSC Mobile DTV		●				

Audio broadcasting						
Standard	Europe	North America	South America	Asia	Australia	Africa
AM/FM	●	●	●	●	●	●
DAB/DAB+	●				●	
DMB (France)	●					
DRM/DRM+	●					
ISDB-T_{SB}			●	●		
HD Radio™		●	●			
XM		●				
SIRIUS		●				

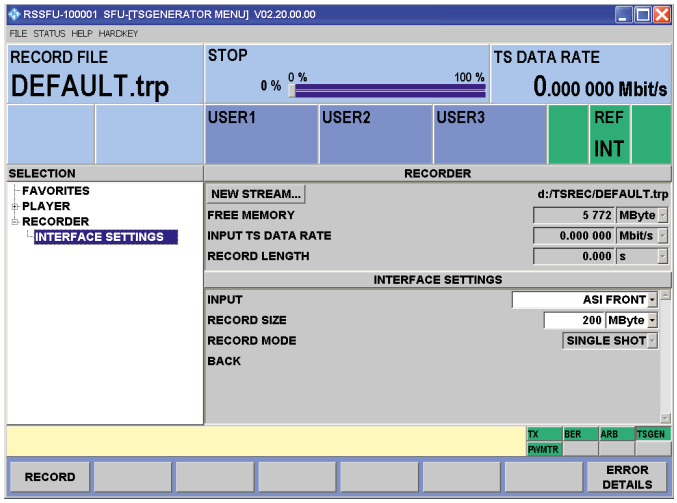
Integrated transport stream generator, recorder, player and audio/video generator

Digital transmission methods require digitized video, audio and data signals, coded in formats such as MPEG-2 transport stream, ETI, MFS or T2-MI. Modulators for analog TV and audio broadcasting, in contrast, require CCVS and audio signals.

GUI of TS generator with selectable libraries and files.



GUI of TS recorder.



All these signals can be fed to the R&S®SFU broadcast test system via dedicated inputs on the instrument. Alternatively, the R&S®SFU broadcast test system can be equipped with baseband sources matching the installed transmission standards. Externally fed signals from test pattern and audio generators are then no longer needed. This considerably reduces investment in other equipment.

Transport stream generator and transport stream player for endless and seamless replay

The optional internal transport stream generator supplies test streams in the baseband for the realtime coder. It can be used to generate endless and seamless MPEG-2 transport streams with high bit rate. The transport stream generator comes with an extensive SDTV transport stream library. [1)]

The optional transport stream player ideally complements the transport stream generator and allows customers to replay their own and recorded transport streams in TRP or BIN format. The transport stream player is also used to replay DAB, DAB+ and T-DMB ETI streams, as well as MediaFLO™ and CMMB streams, or even T2-MI streams for DVB-T2. Moreover, it replays MPEG-2 transport streams endlessly and seamlessly. During replay, it continuously updates the PCR [2)], DTS [3)] and PTS [4)] time stamps and continuity counter information, and overwrites the TDT [5)] and TOT [6)] time information with the R&S®SFU system time.

Transport stream and ETI recorder

An MPEG-2 transport stream and ETI recorder is available for the R&S®SFU for expanding the data source. It records any externally supplied streams with data rates of 100 kbit/s to 90 Mbit/s. Generally, any data streams of standards that physically use the frame structure of ASI, SPI or ETI with ITU-T G.703/G.704 can be recorded. The integrated recorder can therefore be used to record baseband signals of virtually all digital TV broadcast standards.

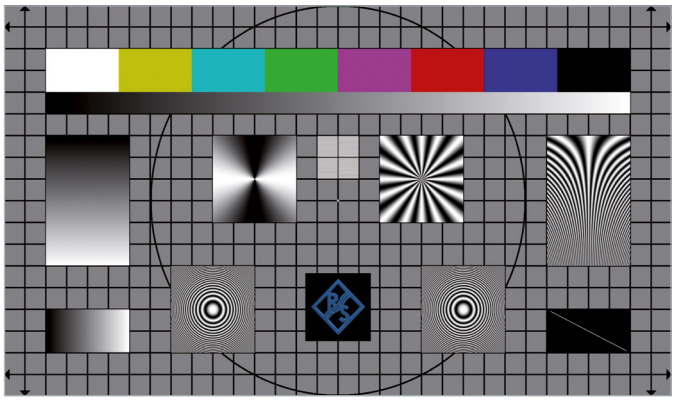
TRP with eight bits (8 bit data) and T10 (10 bit data, 1 bit data valid, 1 bit packet sync) are available as recording formats. For the 8 bit and T10 formats, the parallel SPI (LVDS) interface is used. This interface also supports an 8 bit raw mode as BIN format. Streams in ETI format are recorded and output via the optional R&S®SFU-B11 ETI interface.

1) SDTV: standard definition television.
2) PCR: program clock reference.
3) DTS: decoding time stamp.
4) PTS: presentation time stamp.
5) TDT: time and date table.
6) TOT: time offset table.

The maximum data volume for recordings is limited only by the size of the hard disk. Recorded transport streams can be transferred to other storage media via the USB or LAN interface. They can be replayed endlessly and seamlessly on the TS recorder in such a way that the end-of-file/start-of-file transition takes place exactly at the end of a packet.

Test patterns from different Rohde&Schwarz test signal libraries.

Test signal "HDTV test pattern".



Live sequence "Flowers".

Extensive transport stream libraries from Rohde&Schwarz

Rohde&Schwarz offers a wide range of transport stream libraries for its broadcast signal generators [1]. For the transport stream generator, libraries for SDTV, HDTV, H.264, DVB-H, ISDB-T and TCM are available. The transport stream player supports libraries for DAB, DAB+, CMMB, ATSC Mobile DTV, ISDB-T_B and MediaFLO™.

Audio/video generator with test pattern library for analog TV

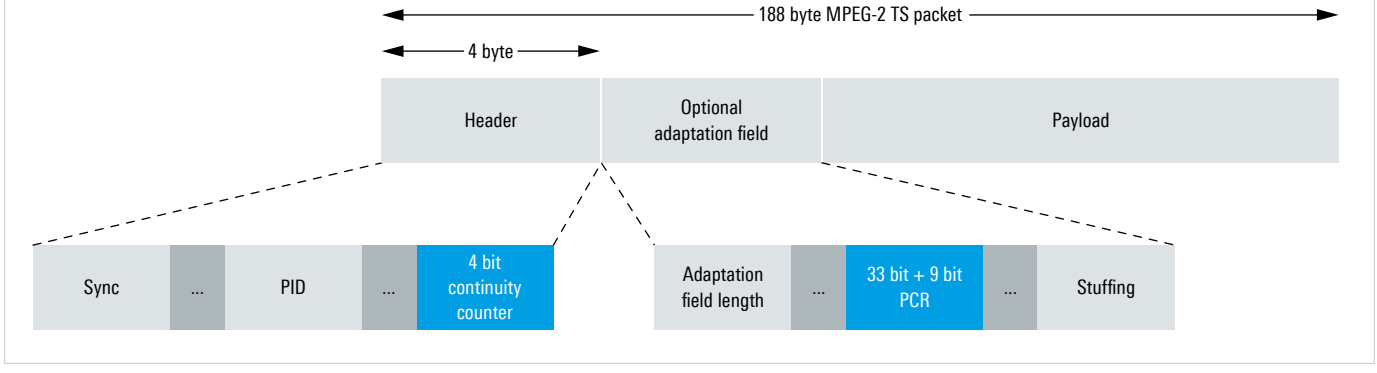
The audio/video generator delivers test patterns and audio signals for analog TV. It comes with a set of FuBK [2] and color bar test patterns for PAL, SECAM and NTSC. In addition, an ATV video library is available from Rohde&Schwarz that provides a broad range of test patterns for analog TV far beyond the basic set of test patterns supplied with the audio/video generator.

Test signal generation in line with customer specifications

Rohde&Schwarz creates customized MPEG-2 transport streams and analog CCVS signals as a service. The customer can define the signal content. Still images or video sequences can be used as video content. Customized transport streams can include system information for DVB, ATSC, ISDB and DTMB, as well as audio signals or audio sequences. Since CCVS signals carry no audio content, the audio signal is delivered directly by the R&S®SFU audio generator.

[1] See "Stream Libraries for broadcasting T&M equipment from Rohde&Schwarz" data sheet, (PD 5213.7202.32).
[2] German federal authority for television transmission.

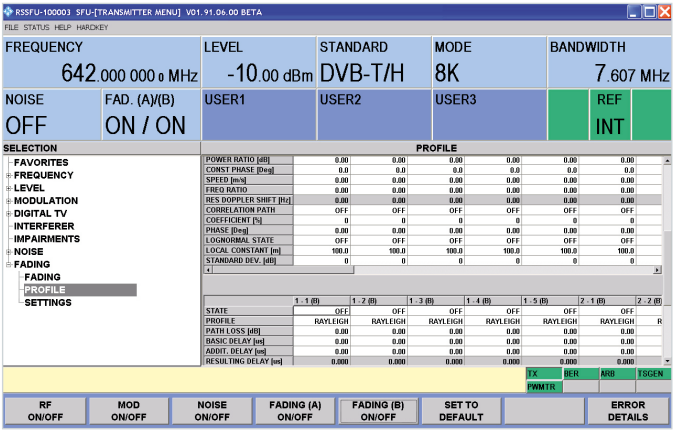
Seamless transport stream generation



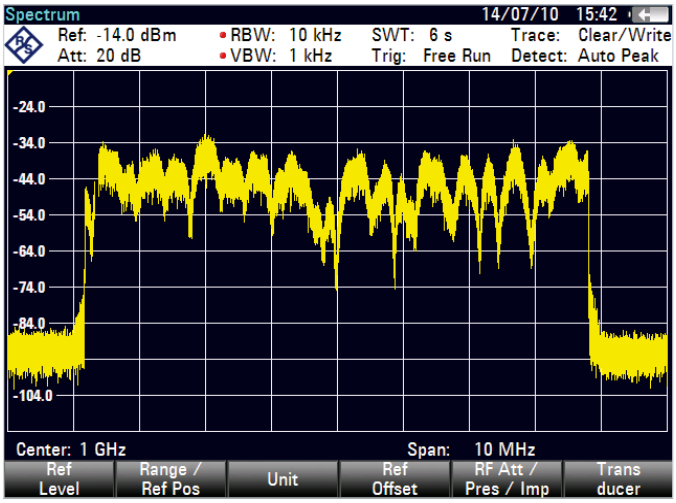
Simulation of multi-path propagation, single-frequency networks and cable networks

The fading simulator of the R&S®SFU broadcast test system is used in the development and certification of audio and TV broadcasting receivers. It reproducibly simulates the conditions in multipath and mobile reception.It also simulates specific reception conditions encountered in single-frequency networks (SFNs), such as pre-echoes and echoes outside the guard interval.

Fading table.



Fading with RL20 parameter set.



Powerful fading simulator

The fading simulator is a powerful FPGA-based hardware option for the R&S®SFU. It supports a maximum of 40 paths with two independent fading simulators that can also be used separately to provide dual-channel fading, using for instance an identical input signal for diversity tests.

The fading simulators are divided into eight delay groups. The path loss, delay, fading profile and Doppler shift can be defined individually for each path. The paths within a group can be delayed by up to 40 µs relative to one another. A maximum additional delay of 5.242 ms can be introduced between the first group and all other groups.

The time resolution of the path delay is 10 ns as standard. It can be optionally enhanced to yield a unique fineness of 0.01 ns. The fading process always starts from a defined point. A restart is performed either manually or automatically. These defined start conditions ensure reproducibility of the fading tests.

The R&S®SFU's fading simulator supports a variety of standards such as DVB, ATTC, World DMB and MediaFLO™ with fading profiles, fading configurations and complex fading parameter sets in order to simulate diverse channel conditions.

Numerous fading configurations

The propagation scenario to be simulated is determined by selecting the appropriate fading configuration. For classic fading with simulation of the level fluctuations that occur in the receive signal due to the typical multipath propagation and the location- and time-dependent propagation conditions, three delay configurations can be selected: Standard Delay, Fine Delay 30 MHz and Fine Delay 50 MHz. The delay configurations differ with regard to the number of paths, the resolution of the path-specific delay and the available RF bandwidth. For fading with dynamically changing delays, the following configurations are provided: birth-death propagation, moving propagation and 2-path dynamic delay. The available settings in the fading menus and path tables depend on the selected configuration.

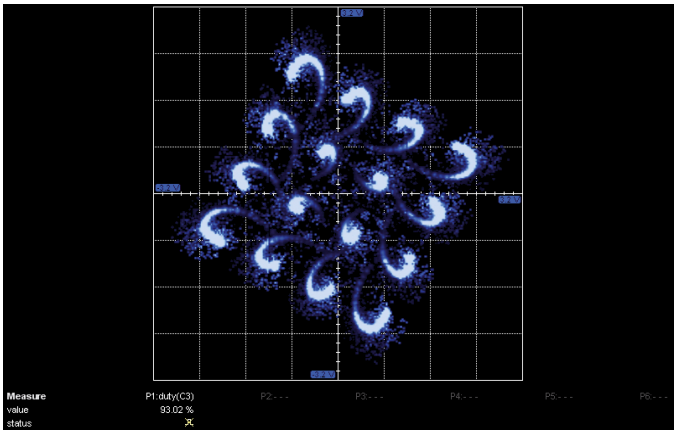
Standard-compliant fading profiles

The different fading profiles can be selected for each path and combined with one another as desired.

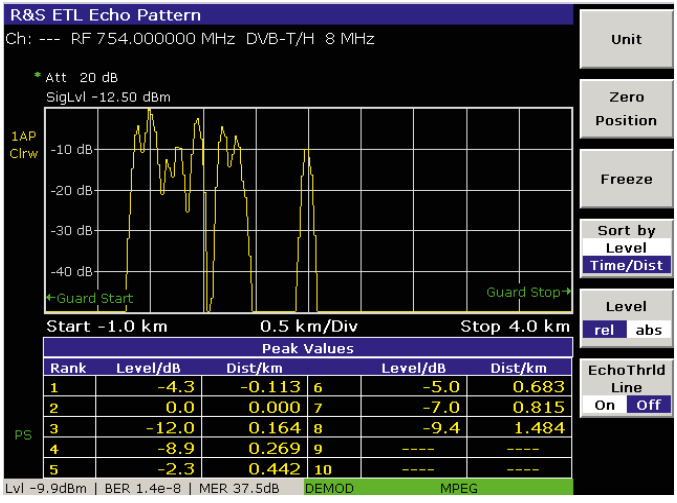
Combinable fading profiles of individual fading paths:

- Static Path is the simplest channel model. It simulates a static transmission path with definable path loss and delay
- Constant Phase also simulates a static transmission path. Here, the signal experiences a definable constant phase shift as occurs, for example, when it is reflected by metallic objects

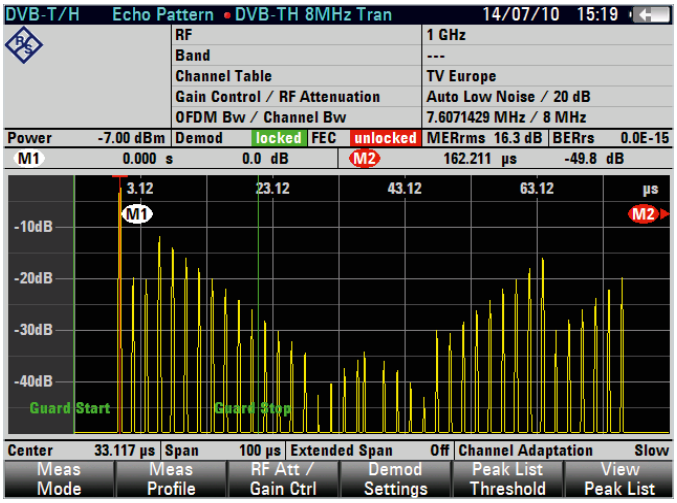
16 QAM with Rice profile.



Fading spectrum with DVB 20 paths fading profile RL20ANxB.



Fading spectrum with echo profile.



- Pure Doppler simulates a single transmission path from a transmitter to a moving receiver. The frequency of the received signal varies proportionally to the speed of movement
- Rayleigh (also known as Classical) simulates signal propagation in densely built-up urban areas. The Rayleigh fading profile simulates a radio traffic area in which many different partial signals arrive at a moving receiver. The partial signals are produced by reflection, refraction, scattering and diffraction of the original signal. The resulting field strength at the receiver varies as a function of time. Its probability density function exhibits a Rayleigh distribution
- Rice is a combination of a Rayleigh profile and a Pure Doppler profile. Many strongly scattered partial signals arrive at a moving receiver. There is a direct line of sight (LOS) between the receiver and the transmitter. The probability density function of the receive field strength exhibits a Rician distribution
- Gaussian simulates a transmission path that is characterized by a Gaussian distributed and scattered component. Based on this distribution, additional components with different standard deviations can be configured. A combined Gaussian and Doppler profile also includes a Pure Doppler component, whereas other profiles such as Gaussian 1 and Gaussian 2 use a sum of two Gaussian profiles to simulate a transmission path. Moreover, a GAUSSDAB profile is available for DAB transmission path simulation

Complex parameter sets

Up to 65 different, preconfigured parameter sets for many internationally recognized and established test scenarios are currently available at the press of a button. There is no need to tediously search for standards matching the different parameter sets, and the time-consuming, error-prone manual input of data is eliminated.

The preconfigured parameter sets include, for example, known scenarios from ETSI TR 101290, EN300744, Typical Urban (TU3, TU6 and TU50), COST 207, Validate, Motivate, MBRAI, Rural Area (RA4 to RA6), Vehicle Urban, Pedestrian Indoor and Outdoor, ATTC Static Multipath and Random, Brazil A to E, DAB, MediaFLO™ Channel Profiles 1 to 7, and many more.

Of course, these preconfigured settings can also be manually modified as desired and saved.

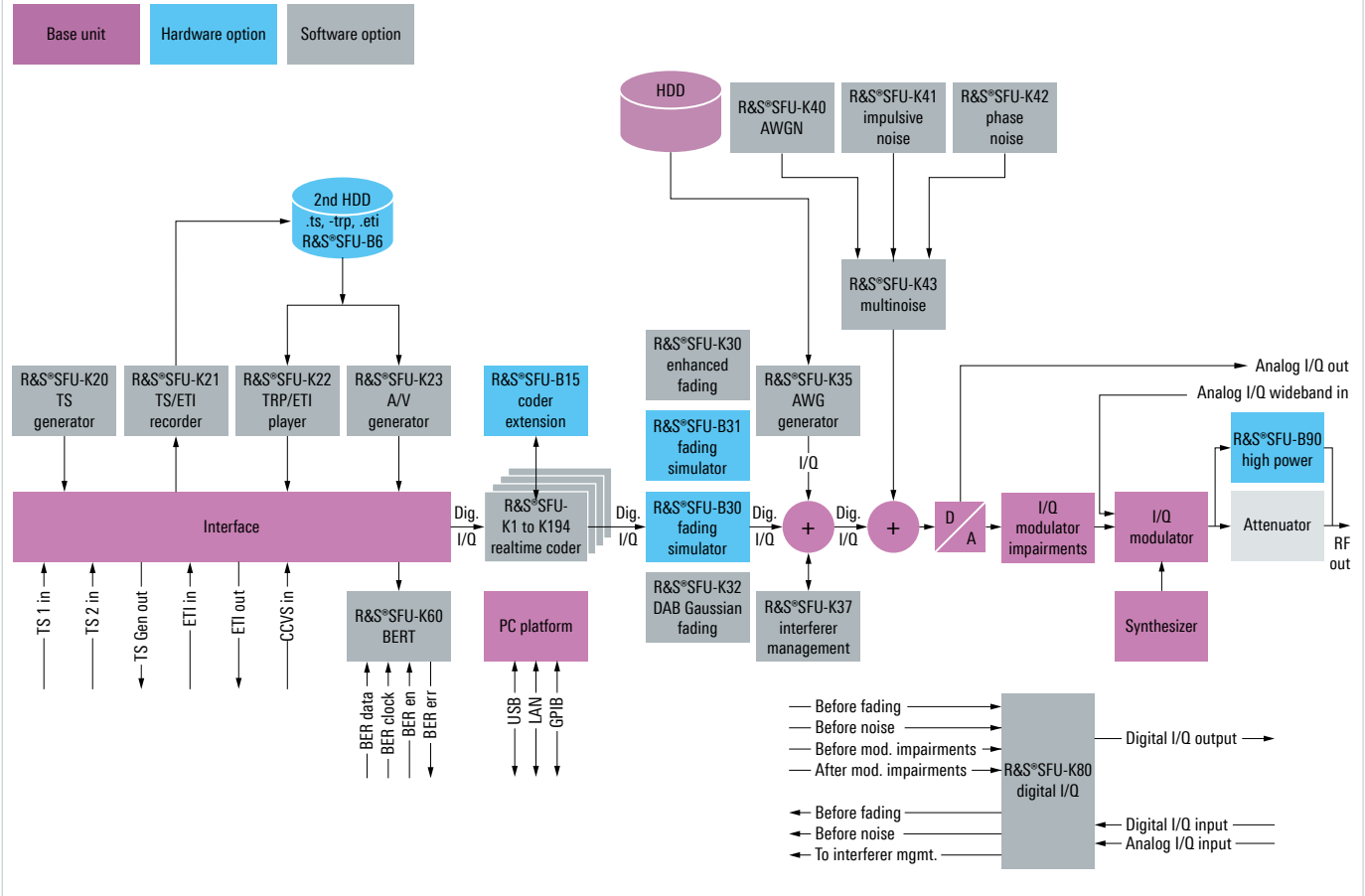
Flexible signal generation with arbitrary waveform generator

The optional integrated arbitrary waveform generator (AWG) of the R&S®SFU broadcast test system can replay customer-owned I/Q waveforms as well as waveforms from Rohde&Schwarz libraries. It is possible to generate any externally computed RF signal. In particular, modulation signals can be generated regardless of the realtime coders installed.

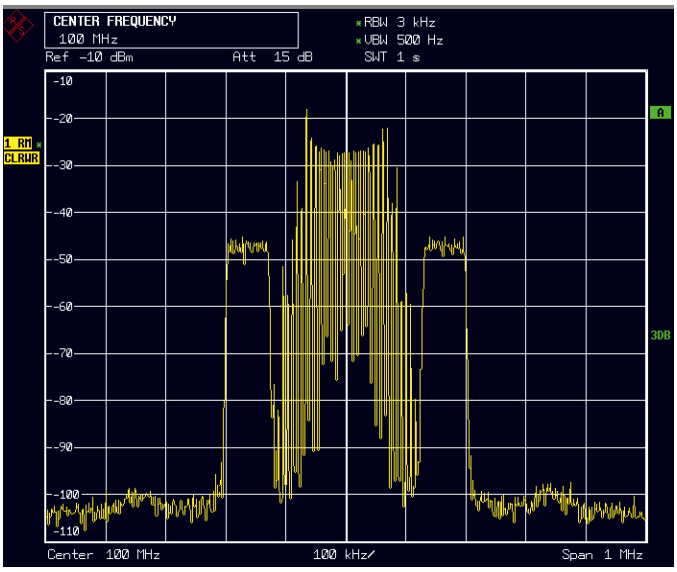
Large AWG memory, intelligent memory management and high sample rates

Cutting-edge memory technology, 512 Msample (2 Gbyte) memory capacity and sample rates of up to 100 Msample/s make the R&S®SFU's arbitrary waveform generator one of the most powerful in its class. The AWG features not only a large memory but also intelligent memory management. Several short files can be stored in the AWG memory and are therefore ready to be replayed without delay. Besides merely playing waveforms, the AWG can also be used as an additional internal signal source for simulating interferers. For example, it can generate signals with multiple adjacent analog or digital TV channels such as needed to simulate cable TV networks.

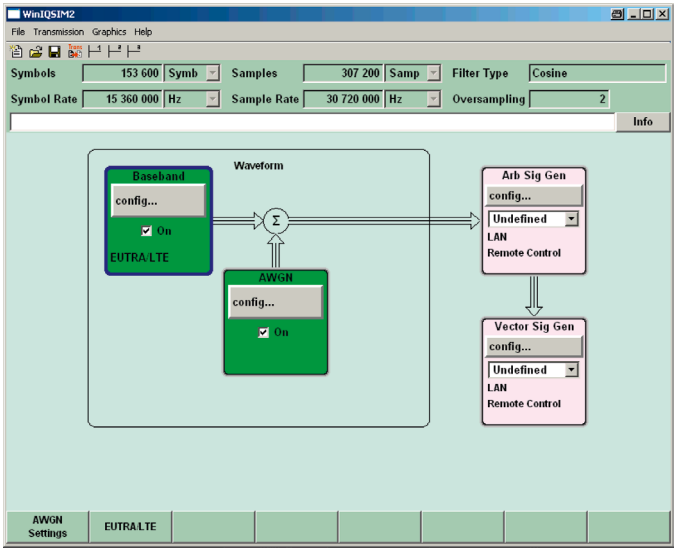
R&S®SFU block diagram



HD Radio™ spectrum.



R&S®WinIQSIM2™.



Waveform libraries from Rohde&Schwarz

Rohde&Schwarz offers arbitrary waveform libraries for the following broadcast standards: HD Radio™, DRM, DRM+ [1], DVB-T2, MediaFLO™ and T-DMB/DAB. Further waveform libraries are available for generating interferer signals for terrestrial and cable broadcast signals.

Support of R&S®WinIQSIM™ and R&S®WinIQSIM2™

The R&S®SFU broadcast test system supports the use of R&S®WinIQSIM™ PC software. Waveforms generated with this software can be loaded into the R&S®SFU's arbitrary waveform generator and replayed. Using R&S®WinIQSIM2™, the R&S®SFU can simulate cellular mobile radio standards as well as the digital dividend. Mobile radio standards such as Long Term Evolution (LTE) or GSM can be user-configured, generated and added as an interferer to a useful broadcast signal.

Digital I/Q interface

The optional digital I/Q interface transmits I/Q signals from the R&S®SFU to other Rohde&Schwarz instruments and vice versa. This makes it possible, for example, to expand an R&S®SFU broadcast test system into a dual-channel or multichannel TV signal generator capable of testing receivers operating in antenna diversity mode.

[1] Soon to be available.

Waveform libraries available for the R&S®SFU

PD 5214.3898.22

PD 5214.3900.22

PD 5214.1020.22

PD 5214.3546.22

PD 5214.3923.22

PD 5214.3930.22

PD 5214.2691.22

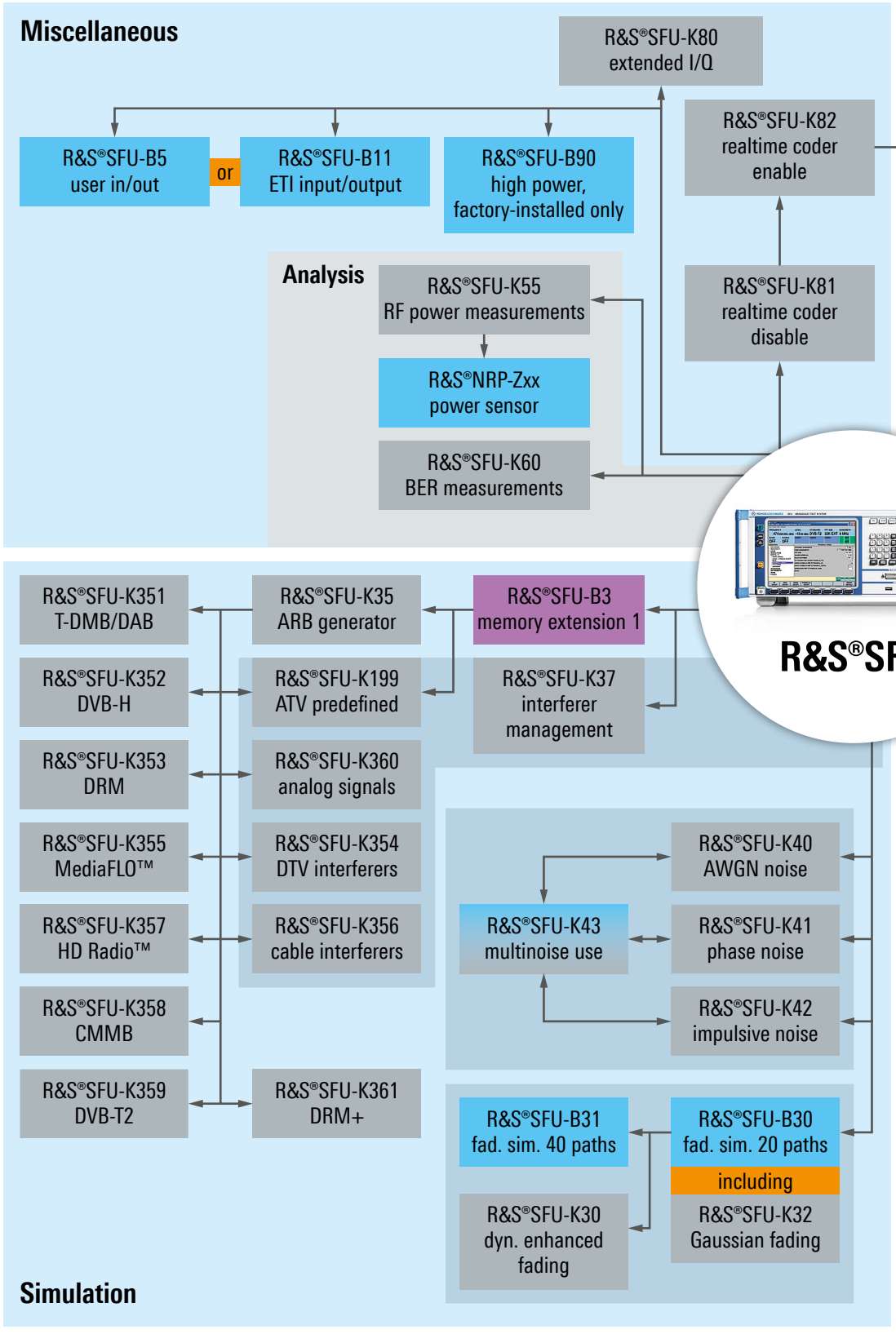
PD 5214.2656.22

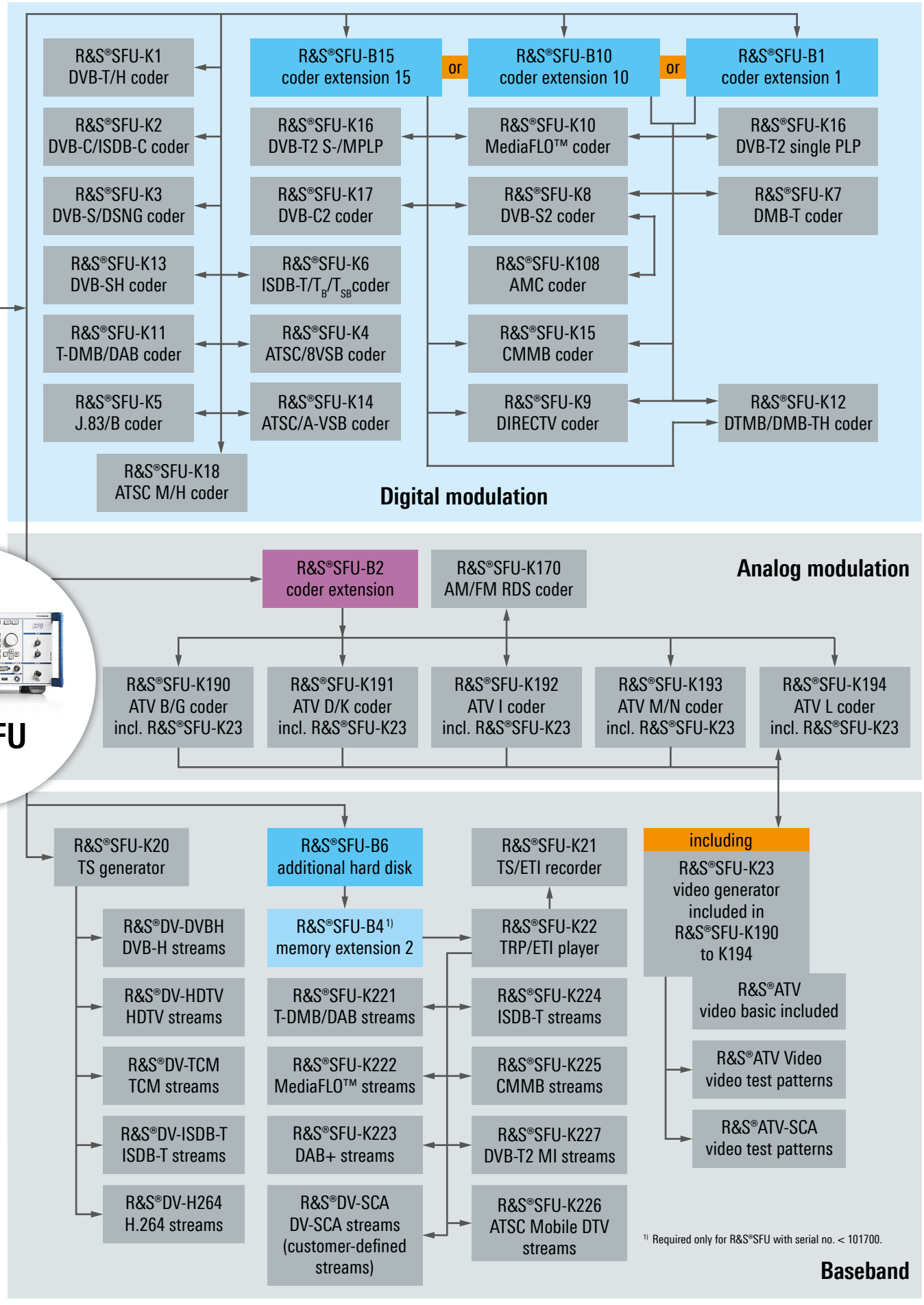
PD 5214.2662.22

PD 5214.3146.22

R&S®SFU options

Pre-installed hardware | Hardware option | Software option

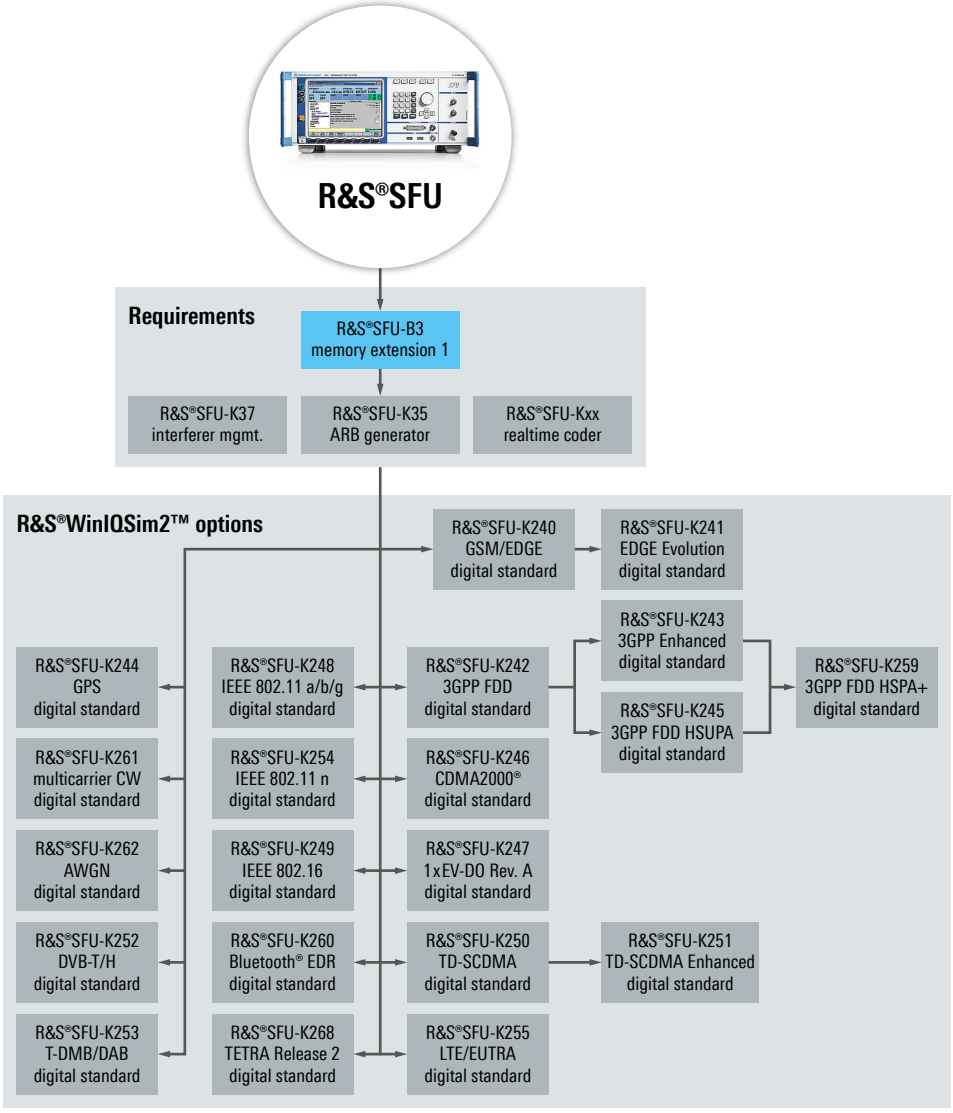



R&S®SFU-K1
DVB-T/H coder
R&S®SFU-B15
coder extension 15
or
R&S®SFU-B10
coder extension 10
or
R&S®SFU-B1
coder extension 1
R&S®SFU-K2
DVB-C/ISDB-C coder
R&S®SFU-K16
DVB-T2 S-/MPLP
R&S®SFU-K10
MediaFLO™ coder
R&S®SFU-K16
DVB-T2 single PLP
R&S®SFU-K3
DVB-S/DSNG coder
R&S®SFU-K17
DVB-C2 coder
R&S®SFU-K8
DVB-S2 coder
R&S®SFU-K7
DMB-T coder
R&S®SFU-K13
DVB-SH coder
R&S®SFU-K6
ISDB-T/T_B/T_SB coder
R&S®SFU-K108
AMC coder
R&S®SFU-K11
T-DMB/DAB coder
R&S®SFU-K4
ATSC/8VSB coder
R&S®SFU-K15
CMMB coder
R&S®SFU-K5
J.83/B coder
R&S®SFU-K14
ATSC/A-VSB coder
R&S®SFU-K9
DIRECTV coder
R&S®SFU-K12
DTMB/DMB-TH coder
R&S®SFU-K18
ATSC M/H coder
Digital modulation
R&S®SFU-B2
coder extension
R&S®SFU-K170
AM/FM RDS coder
Analog modulation
R&S®SFU-K190
ATV B/G coder
incl. R&S®SFU-K23
R&S®SFU-K191
ATV D/K coder
incl. R&S®SFU-K23
R&S®SFU-K192
ATV I coder
incl. R&S®SFU-K23
R&S®SFU-K193
ATV M/N coder
incl. R&S®SFU-K23
R&S®SFU-K194
ATV L coder
incl. R&S®SFU-K23
R&S®SFU-K20
TS generator
R&S®SFU-B6
additional hard disk
R&S®SFU-K21
TS/ETI recorder
including
R&S®SFU-K23
video generator
included in
R&S®SFU-K190
to K194
R&S®DV-DVBH
DVB-H streams
R&S®SFU-B4 1)
memory extension 2
R&S®SFU-K22
TRP/ETI player
R&S®DV-HDTV
HDTV streams
R&S®SFU-K221
T-DMB/DAB streams
R&S®SFU-K224
ISDB-T streams
R&S®ATV
video basic included
R&S®DV-TCM
TCM streams
R&S®SFU-K222
MediaFLO™ streams
R&S®SFU-K225
CMMB streams
R&S®ATV Video
video test patterns
R&S®DV-ISDB-T
ISDB-T streams
R&S®SFU-K223
DAB+ streams
R&S®SFU-K227
DVB-T2 MI streams
R&S®ATV-SCA
video test patterns
R&S®DV-H264
H.264 streams
R&S®DV-SCA
DV-SCA streams
(customer-defined
streams)
R&S®SFU-K226
ATSC Mobile DTV
streams
1) Required only for R&S®SFU with serial no. < 101700.
Baseband

R&S®SFU

R&S®WinIQSIM2™ options for the R&S®SFU

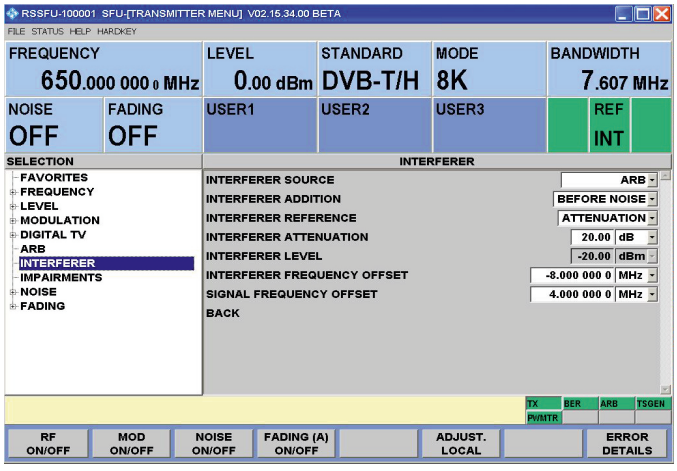
R&S®WinIQSIM2™ options for the R&S®SFU



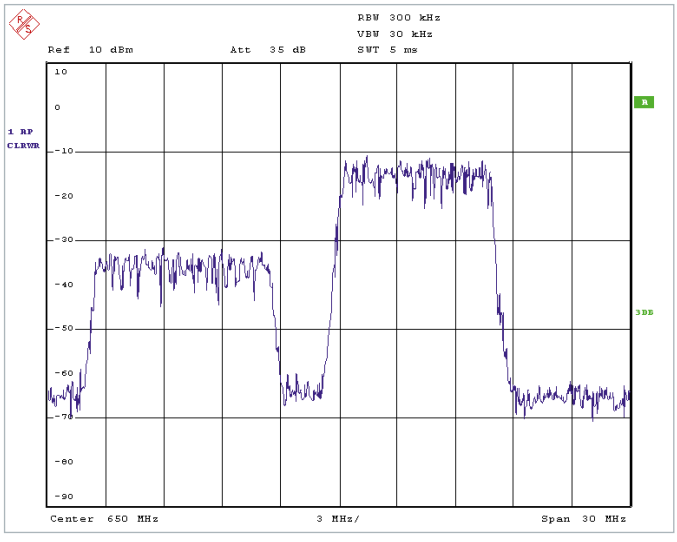
Simulation of interferers and adjacent channel scenarios

An important feature is the simulation of adjacent channel and co-channel signals. Such signals may cause interference when a useful signal is received. The R&S®SFU broadcast test system internally provides the functionality for generating and processing interferers of this type.

GUI of R&S®SFU interferer management.



Spectrum of an LTE interferer added to a DVB-T useful signal.



Interferer management

Interferer management is used to process interferers and add them to the realtime useful signal. The interferer management function makes it possible to shift the frequencies of the useful signal and the interferer independently of each other over a bandwidth of 80 MHz and to vary the level difference of the signals in a dynamic range of 60 dB. The useful signals either come from the arbitrary waveform generator or are externally fed in via the analog or digital I/Q interface. Interferer management is easy to operate and allows complex interferer scenarios to be generated and examined quickly and conveniently. This eliminates the need for a time-consuming, cost-intensive and complex setup involving many different generators.

Interferers from broadcasting and wireless communications

The convergence of mobile radio and broadcasting also calls for the technical coexistence of these services. This requirement first came up with the concept of mobile TV, where receive tuners, for example for GSM and DVB-T/H, are densely packed together in mobile phones, and the joint testing of mobile radio and broadcast signals is required. This coexistence is now growing due to the digital dividend.

Digital dividend

Due to the shutdown of analog TV transmitters and the reallocation of the frequencies to other radio services, the digital dividend is becoming available in an increasing number of countries. This utilization of a subrange of the TV band results in new types of modulation. In terrestrial applications, broadcast and mobile radio signals coexist in adjacent channels, whereas in cable networks the entirefrequency range is occupied by broadcast signals throughout. The testing of such scenarios requires the generation of broadcast and mobile radio signals.

The R&S®SFU is the only broadcast signal generator that allows simulation of the digital dividend using only one instrument. The support of R&S®WinIQSIM2™ makes it possible to generate a large number of wireless communications standards with user-configurable waveforms, such as Long Term Evolution (LTE). The wireless communications standards can be added as interferers to the broadcast standards, which are available in realtime on the R&S®SFU, in order to simulate the desired scenarios.

Receiver tests with noise sources, BER tester and power measurement

Noise sources with AWGN, impulsive noise and phase noise

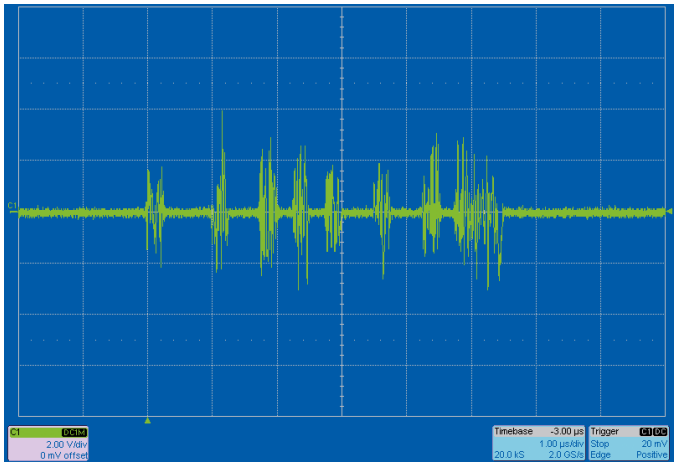
The optional AWGN noise generator produces additive white Gaussian noise (AWGN) in the R&S®SFU's digital baseband signal processing section. The AWGN is superimposed on the modulated useful signal, making it possible to simulate realistic interferences in the transmission path. If the useful signal is switched off, a pure noise signal is obtained. The signal-to-noise ratio (SNR) can be set over a wide range. The R&S®SFU AWGN generator delivers broadband noise with a 3 dB bandwidth of 96 MHz.

The impulsive noise source allows the pulsed addition of an AWGN signal to the useful signal with a settable number of pulses. The implementation is in line with DTG, D-Book and A/74 with a maximum bandwidth of 96 MHz. The pulse spacing range, the number of pulses and the burst duration can be very easily adjusted to obtain the desired settings.

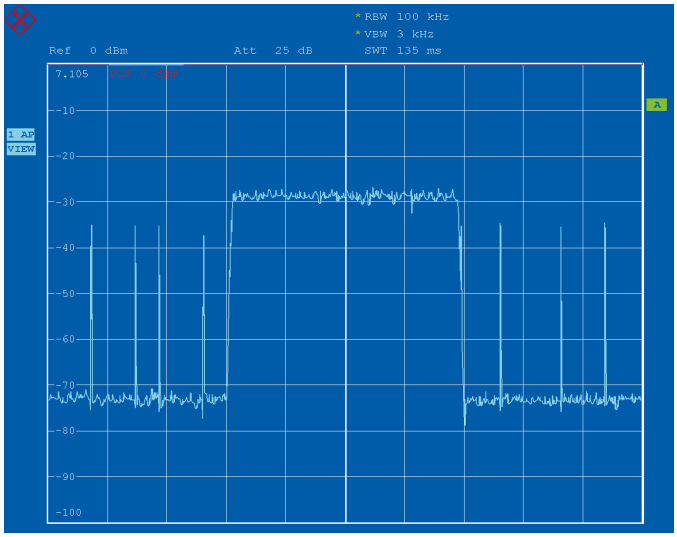
The R&S®SFU phase noise option makes it possible to simulate phase noise in a setting range of –10 dBc/Hz to –110 dBc/Hz. User profiles that have been generated by means of simulation programs such as MATLAB® can be loaded via USB, for example. The creation of user profiles is supported by the R&S®Phase Noise Creator tool.

As an option, all three noise sources can be combined with one another as desired and added to the useful signal in the form of an additive noise signal.

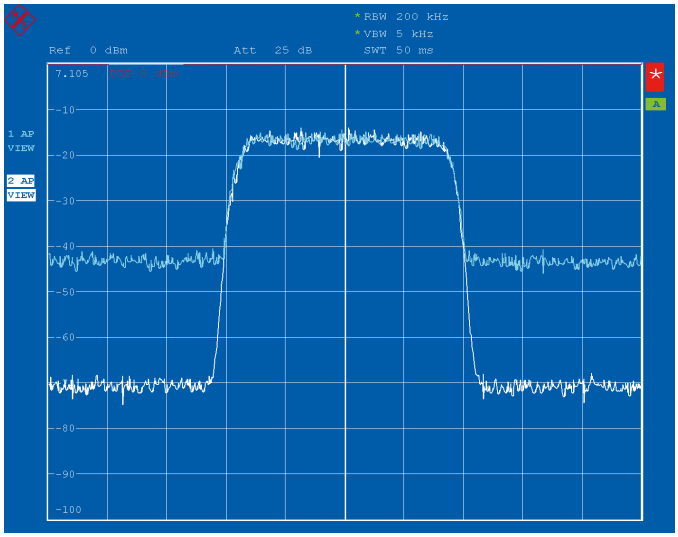
Spectrum with multiple additive noise signal and DVB-T.



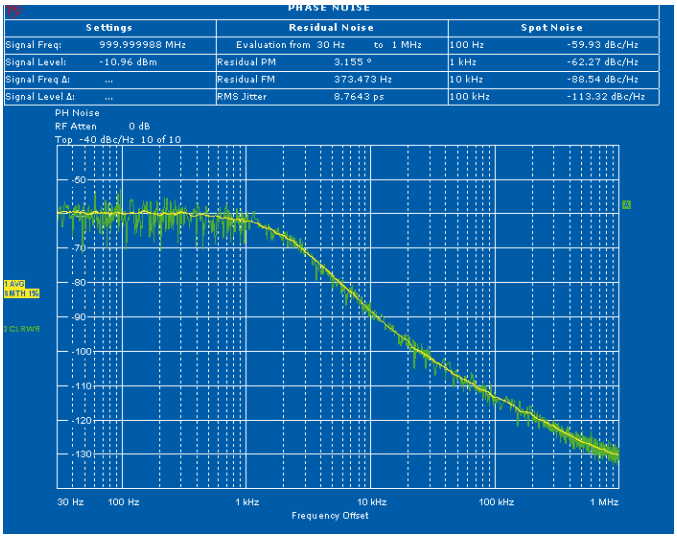
Spectrum with impulsive noise.



Useful signal with additive white Gaussian noise (AWGN).



Spectrum with phase noise.



Power measurement with the R&S®SFU and R&S®NRP-Z11.

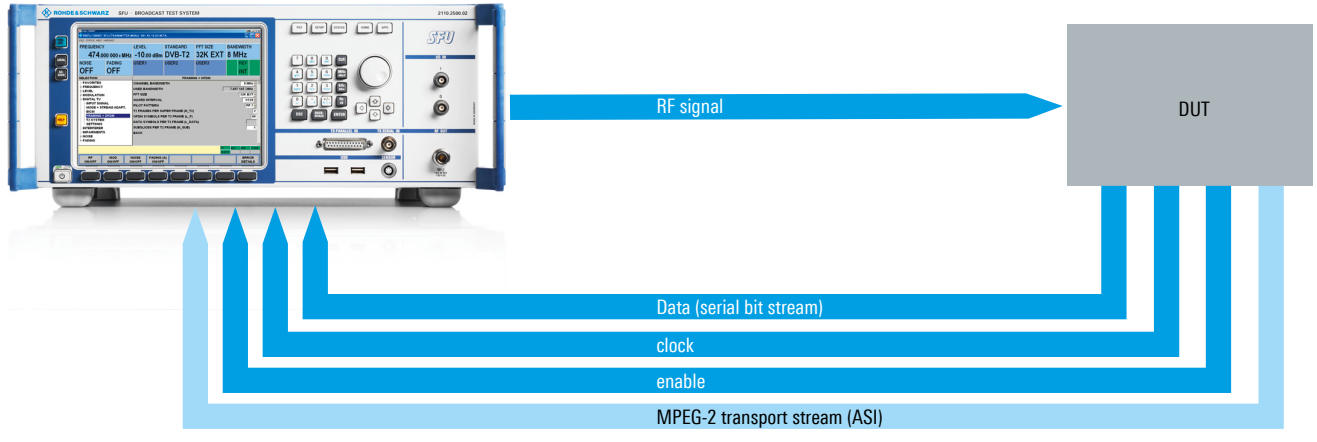
BER measurement at transport stream or bit level

Many test specifications define a specific bit error ratio (BER) as an objective criterion for assessing reception quality. For example, the IEC 62002 (MBRAI) standard specifies a BER not exceeding 2×10^{-4} after the Viterbi decoder for DVB-T transmissions. The R&S®SFU's BER measurements option makes it easy to verify compliance with this limit value. To measure the BER, the R&S®SFU's realtime coder generates a signal carrying a pseudo-random binary sequence (PRBS). The device under test (DUT) decodes the PRBS signal and feeds it back to the R&S®SFU either as a bit sequence with bit clock or as an MPEG-2 transport stream. The BER measurements option compares the sent and the received data and displays the BER. The user can define the measurement duration. For long-term measurements, the BER measurements option generates a log file.

Integrated power measurement using R&S®NRP-Zxx power sensors

Due to components looped into the signal path, it is often necessary to measure RF power directly at the receiver input or at other points in an electronic circuit. As an integrated solution, the R&S®SFU supports power measurements with a wide variety of high-precision R&S®NRP-Zxx power sensors. All settings for measured-value display, operating modes and filter types can be conveniently made on the R&S®SFU. Results are clearly presented on the 8.4" color display.

Principle of BER measurement



Development of broadcast receivers

Multistandard chip and tuner development for set-top boxes, TV sets and radios

Due to the wide variety of standards supported in realtime, the internal digital signal processing and the capabilities to provide generated signals at different application levels, the R&S®SFU is ideal for receiver and chip development. The R&S®SFU broadcast test system covers all application levels, starting at the I/Q level with I/Q signal generation, and continuing through basic physical tuner tests, BER measurements, demodulation testing and video/audio decoding. The R&S®SFU's features and characteristics make the instrument unique. It can therefore be used as a reference signal source.

Simulation of real-life transmission conditions

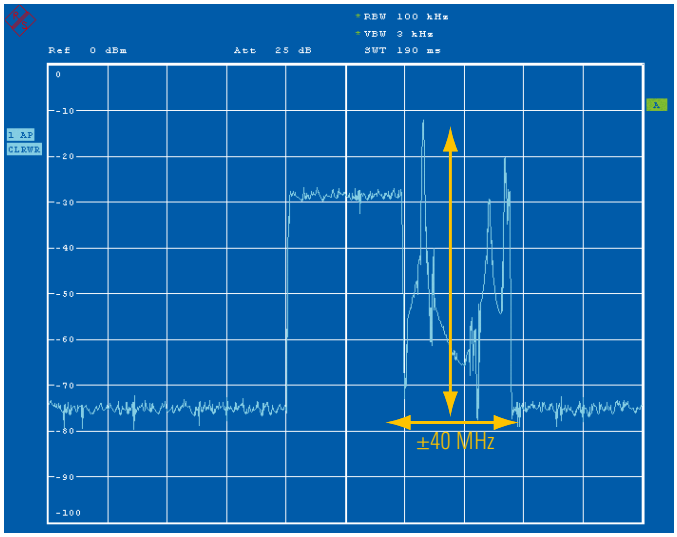
Complex transmission scenarios involving reflections, different delays, signal superpositions and cancellations as well as interferences place stringent demands on any receiver. Developers are therefore faced with the challenge of testing their broadcast receivers under very extreme conditions. Such receiver tests must approximate real-world conditions as closely as possible, and must also be reproducible. The R&S®SFU's channel simulation capabilities make it possible to implement and reproduce realistic environmental conditions in the lab. Extreme reception conditions encountered at a specific site can therefore be ported into the lab, which allows the developers to optimally adapt their products to such environmental conditions.

Fast and efficient generation of adjacent channel and co-channel scenarios

The simulation of adjacent-channel and co-channel scenarios calls for an additional signal generator for each individual interferer to be added. Consequently, the user must make costly investments and needs a lot of time and effort for operation. With an increasing number of interferers, the setup and handling become more complicated, time-consuming and error-prone. The R&S®SFU broadcast test system offers intelligent functionality that provides interferers quickly and easily and facilitates the handling and setting of the useful signal and the interferer. This functionality is achieved through the use of signal libraries that are designed for special test scenarios. Despite the versatile capabilities to vary these scenarios, they are quick and efficient to operate.

R&S®SFU with DVB-S2 evaluation board.

Useful signal with modifiable analog interferer.



Impact of wireless communications signals

The convergence of broadcasting and telecommunications places new demands on simulation capabilities. This includes mobile TV and the digital dividend, which is becoming available after the shutdown of analog TV channels.

The digital dividend has enabled new scenarios of broadcast and mobile radio signals, such as DVB-T and Long Term Evolution (LTE). Since the re-allocation of the previous analog TV frequencies is being promoted worldwide, it becomes necessary to test all terrestrial as well as cable broadcast transmission systems with regard to the coexistence of LTE and broadcast services.

As an integrated solution, the R&S®SFU offers this unique combination of broadcast and wireless communications standards in one instrument. The R&S®WinIQSIM2™ software, which is used to create wireless communications signals, offers a wide range of cellular standards that are in use worldwide. These standards can be configured as desired and added to a broadcast signalas interferers.

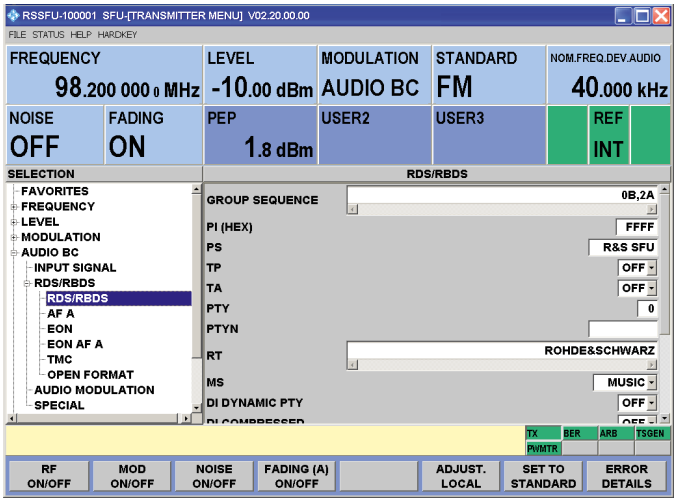
Diversity tests

As a result of the miniaturization of receive chips and tuners, an increasing number of mobile receivers rely on multichannel receiver concepts. At the same time, the design of mobile receivers is becoming more and more compact. Where formerly only one simple, uncorrelated diversity configuration was tested, today highly complex, uncorrelated and correlated diversity tests are gaining in importance. This is also due to the increasingly smaller antenna spacing in the receivers, which results from the compact receiver design.

In these tests, the same MPEG-2 transport stream signal is fed to two independent modulators that are coupled via the reference frequency as well as the loss-free digital I/Q interface. The fading conditions in the transmission paths of the modulators are different.

Due to its integrated and unique fading functionality, the R&S®SFU optimally supports these highly complex diversity test scenarios. Either two R&S®SFUs, or one R&S®SFU and one R&S®SFE or R&S®SFE100, can be coupled with each other via the digital I/Q interface.

R&S®SFU with FM RDS coder (R&S®SFU-K170 option).



Diversity test configuration with the R&S®SFU and R&S®SFE100.

Certification and logo tests of broadcast receivers in test labs

Reference signal generation for globally used broadcast standards for research, development and type approval

Certification, type approval and logo tests place exacting demands on RF signal quality and the reproducibility of scenarios. As a prerequisite for these tests, the test system must support the broadcast standards used in the countries of interest.

This requires highly flexible configuration capabilities in order to cover the test standards, some of which are country-specific. The very widespread use of the R&S®SFU broadcast test system around the world and its globally recognized status as a reference signal generator make it easier for cooperation partners, regulatory authorities and test houses to exchange and accept their mutual test results.

R&S®SFU used for the development of set-top boxes and TV sets.

Use in test systems

Due to its outstanding RF characteristics and the large variety and flexible configuration of software options, the R&S®SFU can be optimally adapted to the requirements of test systems. The R&S®SFU can be integrated into a test system by remote control via various interfaces such as IEC/IEEE (GPIB) and LAN.

The R&S®SFU broadcast test system provides the useful broadcast signals as well as interferer signals for a large number of test specifications, such as MBRAI (IEC62002), NORDIG, DTG D-Book and A.74 ATSC receiver performance test.

At Rohde&Schwarz, the R&S®SFU is integrated into the following test systems:

STB test systems

R&S®TS4510
STB conformance test system for NORDIG, D-Book, European E-Book, Digitenne, BSMI (Taiwan) , D-Book 6.2 with DVB-T2

R&S®TA-DTV
RF test system for digital TV and radio consumer products

R&S®MHP
Test system for multimedia home platform

Automotive test systems

R&S®TA-LPTS
Test system for car radio receiver

Mobile TV test systems

R&S®TU8980
FLO device conformance test system (FDCS)

R&S®GCF DVB-H
IEC 62002-1/2 V1.0 conformance testing

R&S®TS-DVBH
Conformance test system

R&S®TS-BCAST
DVB-H IP packet inserter

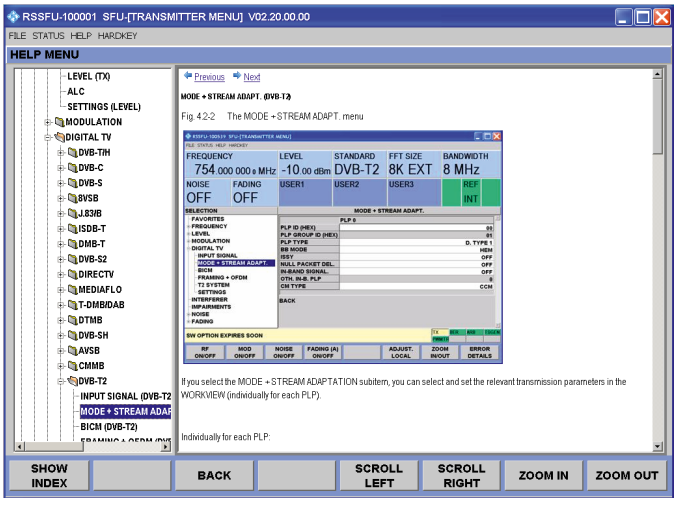
EMC test systems

R&S®TS9980
EMS test system audio and video

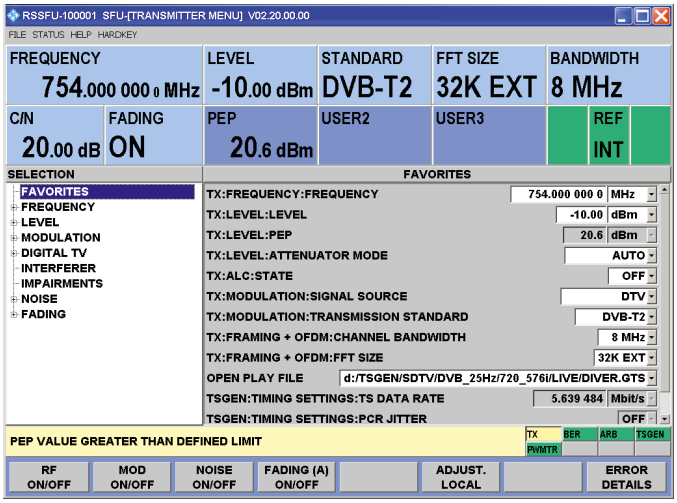
Convenient graphical user interface

The R&S®SFU broadcast test system features a generous graphical user interface with a straightforward design. Despite the wide range of functions offered, the GUI allows reliable and easy navigation via the front panel. The instrument can also be entirely remote-operatedand remote controlled without restrictions.

GUI online help.



GUI favorites.



19" × 4 HU cabinet with large XVGA color display

The 8.4" XVGA color display integrated in the 19" cabinet presents data in clear-cut fashion and allows users to work quickly and conveniently with the GUI. All required operating parameters are clearly visible at all times.

Intuitive user interface under Windows XP Embedded

The R&S®SFU broadcast test system uses the same GUI as the R&S®SFE broadcast tester and R&S®SFE100 broadcast test transmitter. The GUI is clearly organized, with a tree structure on the left and a setting menu on the right. The operating menus have the same consistent structure for all available standards, which makes operation efficient and intuitive. Values are entered using the keypad and the rotary knob. In addition, a keyboard and mouse can be connected to the USB interfaces.

Context-sensitive help system

Even during operation, the R&S®SFU lets users access the comprehensive help system that includes all the information contained in the operating manual. The help system is context-sensitive, i.e. it provides information about the currently selected operating parameter, and can be opened at the press of a button.

User-definable favorites for quick access

Frequently used parameters can be added to the favorites menu to make operation even quicker and easier. This function is especially helpful if parameters from different submenus need to be changed frequently.

Remote control and remote operation via LAN and GPIB

The R&S®SFU can be remote-operated via an Ethernet connection or in a LAN over IP. It is preconfigured for the use of DHCP. Remote operation is very easy with the Windows Remote Desktop software or the additional VNC software supplied with the instrument.

Remote control is by means of SCPI commands via LAN (VXI11) or the IEEE 488 interface. The R&S®SFU can therefore be easily integrated into existing test programs. The remote-control commands are compatible with those used for the R&S®SFE and R&S®SFE100. Rohde&Schwarz also provides drivers for LabWindows/CVI, LabVIEW and VXIplug&play.

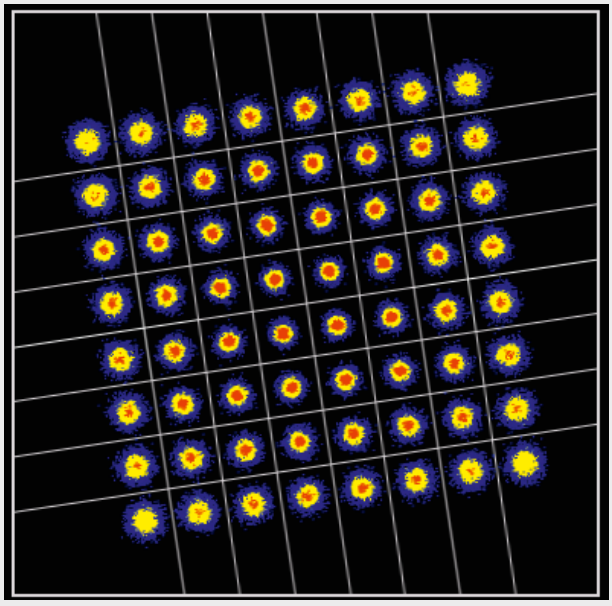
Technologies

DVB-T2: next-generation digital terrestrial TV

DVB-T2 is the new European standard for digital terrestrial TV. It enables data rates unattained so far and for the first time allows the efficient transmission of HDTV programs over terrestrial channels.

Using 16k and 32k FFT modes, 256QAM and rotated constellations, the new standard places exacting demands on signal generation.

The R&S®SFU's powerful FPGA-based realtime coder supports all modulation and coding parameters in line with the DVB-T2 standard for single PLP [1] and multi-PLP.



Rotated DVB-T2 constellation (R&S® SFU-K16 option).

DVB-C2: Next-generation digital cable TV

DVB-C2 is the new European standard for digital cable TV. It enables data rates unattained so far and for the first time allows the efficient transmission of HDTV programs over cable channels.

The new standard, which uses LDPC coding and is able to bundle channels and generate constellations up to 4096QAM, places exacting demands on signal generation. The R&S®SFU's powerful FPGA-based realtime coder supports all modulation and coding parameters in line with the DVB-C2 standard for multi-PLP and multi-DSlice operation.

[1] PLP: physical layer pipe.

Specifications in brief

Specifications in brief		
RF signal		
Frequency range		100 kHz to 3.0 GHz
Frequency resolution		0.1 Hz
Level		–120 dBm to +30 dBm
Level accuracy		< 0.5 dB
Spectral purity		
SSB phase noise	at 1 GHz	< –131 dBc (20 kHz carrier offset/1 Hz)
Broadband noise	from 200 MHz to 1.5 GHz	< –135 dBc (> 10 MHz carrier offset/1 Hz)
Digital realtime modulation systems		
Terrestrial TV		DVB-T2, DVB-T, DTMB, ISDB-T, ISDB-T_B, ATSC/8VSB
Cable TV		DVB-C2 [1], DVB-C, J.83/B, ISDB-C
Satellite TV		DVB-S2, DVB-S, DIRECTV, ISDB-S [1]
Mobile TV		DVB-H, T-DMB, ISDB-T 1 seg, CMMB, MediaFLO™, ATSC-M/H
Digital audio broadcasting		DAB, DAB+, ISDB-T_{SB}
Analog realtime modulation systems		
Analog TV		B/G, D/K, I/I1, M/N, L/L
Analog audio broadcasting		AM, FM mono, FM stereo with RDS
AWG-based modulation systems		
Digital audio broadcasting		HD Radio™, DRM, DRM+ [1]
Digital TV		DVB-T2, CMMB, MediaFLO™
Baseband signal sources		
Transport stream generator/player	file format	GTS, TS, TRP, MPG, T10, ETI, FLO, MFS, PMS, BIN
Transport stream recorder	file format	TRP, T10, BIN, ETI
Audio generator/player	signals	two channels, NICAM
Video generator	signals	PAL, NTSC, SECAM
Arbitrary waveform generator	memory	256 Msample (2 Gbyte)
Simulation and analysis functions		
AWGN generator	signal-to-noise ratio	–30 dB to +60 dB
Fading simulator	number of paths	20 (40 with R&S®SFU-B31 option)
	fading profiles	static path, constant phase, pure doppler, Rayleigh, Rice, Gaussian
	time resolution	10 ns (0.01 ns in fine delay mode)
Interferer management	level range	–60 dB to +60 dB
	frequency offset	–40 MHz to +40 MHz
BER measurement	MPEG-2 TS measurement	ASI, SPI, SMPTE310
General data		
Operating temperature range		+5 °C to +45 °C
Power supply		100 V to 240 V AC, 47 Hz to 63 Hz
Dimensions		435 mm × 192 mm × 460 mm (4 HU) (17.13 in × 7.56 in × 18.11 in)
Weight		15 kg (33.07 lb)

[1] Soon to be available.

Ordering information

Designation	Type	Order No.
Broadcast Test System	R&S®SFU	2110.2500.02
Options		
RF path		
High Power	R&S®SFU-B90	2110.8008.03
Digital modulation systems		
Terrestrial standards		
DVB-T2 Coder	R&S®SFU-K16	2110.7847.02
DVB-T/H Coder	R&S®SFU-K1	2110.7301.02
DVB-SH Coder	R&S®SFU-K13	2110.7801.02
T-DMB/DAB Coder	R&S®SFU-K11	2110.7518.02
DTMB/DMB-TH (TDS-OFDM) Coder	R&S®SFU-K12	2110.7760.02
CMMB Coder	R&S®SFU-K15	2110.7818.02
ISDB-T/ISDB-T_B /ISDB-T_{SB} Coder	R&S®SFU-K6	2110.7376.02
ATSC/8VSB Coder	R&S®SFU-K4	2110.7353.02
ATSC M/H Coder	R&S®SFU-K18	2110.7860.02
MediaFLO™ Coder	R&S®SFU-K10	2110.7524.02
Cable standards		
DVB-C2 Coder	R&S®SFU-K17	on request
DVB-C/ISDB-C Coder	R&S®SFU-K2	2110.7324.02
J.83/B Coder	R&S®SFU-K5	2110.7360.02
Satellite standards		
DVB-S2 Coder	R&S®SFU-K8	2110.7399.02
DVB-S/DVB-DSNG Coder	R&S®SFU-K3	2110.7330.02
DIRECTV Legacy Modulation Coder	R&S®SFU-K9	2110.7401.02
AMC Advanced Modulation Coder	R&S®SFU-K108	on request
Analog modulation systems		
AM/FM RDS Coder	R&S®SFU-K170	2110.7830.02
ATV Standard B/G Coder	R&S®SFU-K190	2110.8050.02
ATV Standard D/K Coder	R&S®SFU-K191	2110.8037.02
ATV Standard I Coder	R&S®SFU-K192	2110.8043.02
ATV Standard M/N Coder	R&S®SFU-K193	2110.8066.02
ATV Standard L Coder	R&S®SFU-K194	2110.8072.02
Multi ATV Predefined	R&S®SFU-K199	2110.8089.02
Simulation		
Fading Simulator	R&S®SFU-B30	2110.7530.02
Fading Simulator Extension to 40 Paths	R&S®SFU-B31	2110.7547.02
Enhanced Fading	R&S®SFU-K30	2110.7560.02
Gaussian Fading	R&S®SFU-K32	2110.7630.02
ARB Generator	R&S®SFU-K35	2110.7601.02
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	R&S®SFU-K43	2110.7682.02
Custom OFDM	R&S®SMU-K15	1160.6402.02

Designation	Type	Order No.
Waveform libraries		
DVB-T2 Waveforms	R&S®SFU-K359	2112.3803.02
CMMB Waveforms	R&S®SFU-K358	2112.3726.02
MediaFLO™ Waveforms	R&S®SFU-K355	2110.2974.02
DVB-H Waveforms	R&S®SFU-K352	2110.4425.02
T-DMB/DAB Waveforms	R&S®SFU-K351	2110.4277.02
DRM Waveforms	R&S®SFU-K353	2110.4554.02
HD Radio™ Waveforms	R&S®SFU-K357	on request
DTV Interferers	R&S®SFU-K354	2110.4690.02
Cable Interferers	R&S®SFU-K356	2110.3212.02
Analog Signals	R&S®SFU-K360	2110.3941.02
Digital baseband		
TS Generator including SDTV stream library	R&S®SFU-K20	2110.7476.02
TRP Player	R&S®SFU-K22	2110.7499.02
TS/ETI Recorder	R&S®SFU-K21	2110.7482.02
TS generator libraries		
DVB-H Stream Library	R&S®DV-DVBH	2085.8704.02
Test Card M Streams	R&S®DV-TCM	2085.7708.02
HDTV Sequences	R&S®DV-HDTV	2085.7650.02
H.264 Stream Library	R&S®DV-H264	2085.9052.02
ISDB-T Stream Library	R&S®DV-ISDBT	2085.9146.02
TRP player libraries		
T-DMB/DAB Streams	R&S®SFU-K221	2110.4348.02
DAB+ Streams	R&S®SFU-K223	2110.4760.02
MediaFLO™ Streams	R&S®SFU-K222	2110.2968.02
ISDB-T Streams	R&S®SFU-K224	2110.4777.02
CMMB Streams	R&S®SFU-K225	2112.3649.02
ATSC Mobile DTV Streams	R&S®SFU-K226	2110.3812.02
Analog baseband		
Video Generator	R&S®SFU-K23	included in R&S®SFU-K190 to -K194
Analog video signal library		
ATV Video	R&S®ATV Video	2110.4831.02
Measurement and analysis functions		
RF Power Measurements	R&S®SFU-K55	2110.7753.02
BER Measurements	R&S®SFU-K60	2110.7782.02

For data sheet, see PD 0758.1658.22 and www.rohde-schwarz.com.

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- ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

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