



## TV Test Transmitter R&S SFQ

### Digital signals for antenna, satellite and cable

- ◆ Wide output frequency range from 0.3 MHz to 3300 MHz
- ◆ Large output level range for transmission, receiver and module measurements
- ◆ Standard DVB, DTV signals and FM satellite signals
- ◆ Several standards in one unit
- ◆ Satellite FM
  - PAL, SECAM, NTSC
  - FM and ADR sound subcarrier
- ◆ Flexible input interfaces
  - ASI
  - SPI
  - SMPTE310
- ◆ Antenna DVB-T
  - 2K and 8K COFDM
  - 6/7/8 MHz bandwidth
  - Hierarchical coding
- ◆ Antenna ATSC
  - 8VSB
- ◆ Cable DVB-C
  - Selectable QAM: 16, 32, 64, 128, 256QAM
- ◆ Satellite DVB-S, DVB-DSNG, turbocoder
  - QPSK, QPSK turbo
  - 8PSK, 8PSK turbo
  - 16QAM
- ◆ Cable J.83B
  - Selectable QAM (64, 256QAM)
- ◆ Internal fading simulator
  - 6 or 12 paths
  - Profiles: Constant Phase, Rayleigh, Rice, Pure Doppler, Log Normal
  - Predefined and user-defined profiles
  - Fading output power selectable for sum signal or main path
- ◆ Internal noise generator for high-precision C/N settings
- ◆ Internal BER measurement facility for all digital modulation modes (DVB-C, DVB-S/-DSNG, turbo coder, DVB-T, 8VSB, J.83B)
- ◆ Output and input for I/Q signals

# Basic models – Options for DVB/8VSB/J83.B, transmission simulation

## Basic models

- ◆ DVB-C: R&S SFQ02 + R&S SFQ-B21
- ◆ DVB-S/-DSNG: R&S SFQ02 + R&S SFQ-B23
- ◆ TurboCoder: R&S SFQ02 + R&S SFQ-B23 + R&S SFQ-B25
- ◆ DVB-T: R&S SFQ02 + R&S SFQ-B10
- ◆ ATSC: R&S SFQ02 + R&S SFQ-B12
- ◆ J.83B: R&S SFQ02 + R&S SFQ-B13
- ◆ FM: R&S SFQ02 + R&S SFQ-B2

## DVB/VSF options

- ◆ Input interface (ASI, SPI, SMPTE310; settable symbol rate, accurate data clock)
- ◆ DVB-T coder
- ◆ Hierarchical coding for DVB-T coder
- ◆ ATSC/8VSB coder
- ◆ DVB-C coder
- ◆ DVB-S/-DSNG coder
- ◆ TurboCoder
- ◆ J.83B coder
- ◆ I/Q output/input

## Transmission simulation

- ◆ Fading simulator (6 or 12 paths)
- ◆ Noise generator
- ◆ BER measurement

## Broadband FM options

- ◆ Broadband FM modulator
- ◆ FM sound subcarrier with internal audio generators
- ◆ ADR sound subcarrier with internal MUSICAM generators



## Basic features

- ◆ Frequency range 0.3 MHz to 3.3 GHz
- ◆ Large level range  $-99.9$  dBm to  $+13$  dBm
- ◆ Simple, user-friendly hardkey and softkey control
- ◆ Large display with all important parameters in headline
- ◆ Status menu for supplementary information
- ◆ User-definable transmitter tables
- ◆ Storage of instrument settings internally and on memory card
- ◆ Online help
- ◆ IEC625/IEEE bus, RS-232-C interface
- ◆ Modular design
- ◆ Software update via RS-232-C interface (or memory card)



## General

TV Test Transmitter R&S SFQ is a complete solution for testing digital TV links and receivers. The open-end software and modular hardware make the R&S SFQ future-proof. The standards for DVB-T, DVB-S/DVB-DSNG, turbocoding, DVB-C, J.83B and ATSC/8VSB are fully complied with. Thanks to its adaptability to future system changes, R&S SFQ is a useful and rewarding investment for your launch onto the digital TV market.

Moreover, R&S SFQ also processes analog frequency-modulated satellite signals in line with PAL, SECAM, NTSC standards. The sound signals are transmitted using analog FM and digital ADR sound subcarriers.

The test signals produced are of high precision and comply with the standards, but they can also be varied and provided with predefined errors to determine the performance of your products at their limits. The reproducible simulation of real transmission conditions by means of the noise generator and the fading simulator enables the specification of modules under test.

## Applications

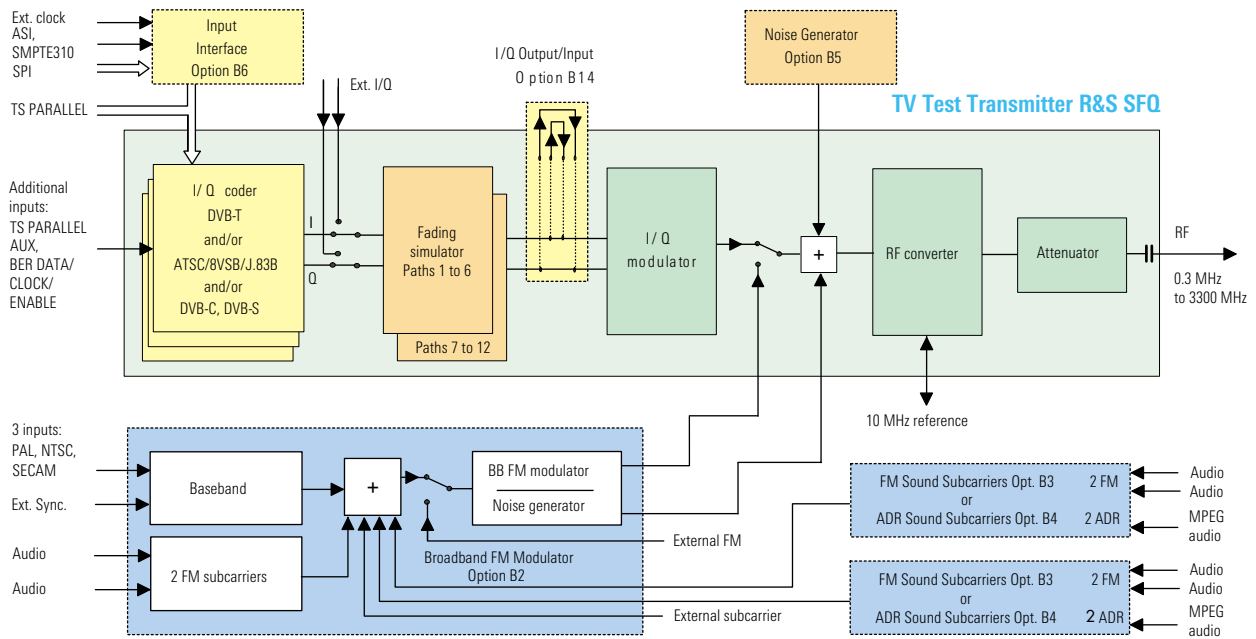
Because of its high signal quality and versatile parameters variations, R&S SFQ is ideal as a source for digital terrestrial signals (DVB-T and ATSC), for testing satellite (DVB-S/-DSNG, turbocoding and FM) and digital cable links (DVB-C, J.83B), as a standard-signal generator in development, as a reference in quality monitoring, EMC labs, inspection and test centers and for use in production.

The output frequency range allows R&S SFQ to be used as a back-channel generator and covers future extensions of the satellite IF range.

Operational parameters (e.g. roll-off, puncturing rate or QAM mode) can easily be varied. For laboratory applications, values outside those defined in the standard can be selected. For special measurements, e.g. DVB-T, it is possible to switch off modulation, individual carriers or groups of carriers. Sweep can be performed over the complete RF range.

A shift function for frequency, level and C/N makes it possible to determine the functional limits of the DUT, compensate for external matching pads, adjust two units to give exactly the same output signal, etc. The advantage is that the output signal can be changed as required while the standard/nominal value continues to be displayed on R&S SFQ.

The analog R&S SFQ supplies frequency-modulated satellite signals conforming to standards. Various TV standards can be selected and up to six sound subcarriers (FM and ADR) can be integrated. In addition, external sound subcarriers can be applied. Operational parameters are in line with standards; parameters such as amplitude, frequency and deviation are variable. Signals such as noise or energy dispersal can be added. It is thus possible to test satellite links and receivers with the aid of standard signals and to check the response to nonstandard signals.



**Block diagram of TV Test Transmitter R&S SFQ with available options**

R&S SFQ models			
Models	Description	Free slots for options	
R&S SFQ02 + option R&S SFQ-B21	TV Test Transmitter for DVB-C	5	
R&S SFQ02 + option R&S SFQ-B23	TV Test Transmitter for DVB-S/-DSNG	5	
R&S SFQ02 + option R&S SFQ-B10	TV Test Transmitter for DVB-T	5	
R&S SFQ02 + option R&S SFQ-B12	TV Test Transmitter for ATSC/8VSB	5	
R&S SFQ02 + option R&S SFQ-B13	TV Test Transmitter for J.83B	5	
R&S SFQ02 + option R&S SFQ-B2	TV Test Transmitter for Broadband FM	3	
DVB/8VSB/J.83B options			
Options	Description/Application (always state R&S SFQ serial number when ordering an R&S SFQ option)		Required slots
R&S SFQ-B6	Input Interface	ASI, SPI input with stuffing, SMPTE input, enhanced clock accuracy of internal signals	0
R&S SFQ-B10	DVB-T Coder	Included in model 20* (see options R&S SFQ-B3 and R&S SFQ-B4)	1
R&S SFQ-B16	DVB-T/ Hierarchical Coding	Only in conjunction with R&S SFQ model 20* or option R&S SFQ-B10	0
R&S SFQ-B12	ATSC/8VSB Coder (HW + FW)	Included in model 30*, not in conjunction with R&S SFQ-B13	1
R&S SFQ-B8	ATSC/8VSB (FW)	Only in conjunction with option R&S SFQ-B13, included in the R&S SFQ-B12	0
R&S SFQ-B13	ITU-T/J.83B Coder (HW + FW)	Only in conjunction with option R&S SFQ-B6, not in conjunction with R&S SFQ-B12	1
R&S SFQ-B9	ITU-T/J.83B (FW)	Only in conjunction with option R&S SFQ-B12, included in the R&S SFQ-B13	0

### DVB/SVSB/J.83B options (contd.)

Options	Description/Application (always state R&S SFQ serial number when ordering an R&S SFQ option)		Required slots
R&S SFQ-B15	DVB-C/DVB-S Coder	No longer available	
R&S SFQ-B21	DVB-C Coder (HW + FW)	Not in conjunction with R&S SFQ-B15, R&S SFQ-B23	1
R&S SFQ-B22	DVB-C (only FW)	Only in conjunction with R&S SFQ-B23, included in the R&S SFQ-B21	0
R&S SFQ-B23	DVB-S/-DSNG Coder (HW + FW)	Not in conjunction with R&S SFQ-B15, R&S SFQ-B21 and R&S SFQ-B6 Var. 02	1
R&S SFQ-B24	DVB-S/-DSNG (only FW)	Only in conjunction with R&S SFQ-B21, not in conjunction with R&S SFQ-B6 Var. 02, included in the R&S SFQ-B23	0
R&S SFQ-B25	Satellite Turbo	Only in conjunction with R&S SFQ-B23 or R&S SFQ-B24	0
R&S SFQ-B14	I/Q Output/Input	Output/input for external applications (e.g. external modulator) and for signal modification/manipulation (see option R&S SFQ-B2)	0

### Options for transmission simulation

Options	Description/Application (always state R&S SFQ serial number when ordering an R&S SFQ option)		Required slots
R&S SFQ-B11 model 02	Fading Simulator, paths 1 to 6	Fading simulation for up to 6 paths 2 slots for R&S SFQ model 10* delivered before September 1999; serial number of R&S SFQ must be stated	1
R&S SFQ-B11 model 04	Fading Simulator, paths 7 to 12	Fading simulation for up to 12 paths; only in conjunction with option R&S SFQ-B11, model 02	1
R&S SFQ-B5	Noise Generator	BER vs C/N, measurement of system margins; not in conjunction with option R&S SFQ-B2	1
R&S SFQ-B17	BER Measurement	Only in conjunction with R&S SFQ model 20* or option R&S SFQ-B10	0

### BB-FM options

Options	Description/Application (always state R&S SFQ serial number when ordering an R&S SFQ option)		Required slots
R&S SFQ-B2	Broadband FM Modulator	Satellite FM with 2 FM sound subcarriers, noise generator included, not in conjunction with option R&S SFQ-B5 <u>Restriction in conjunction with option R&amp;S SFQ-B14:</u> only one video input on front panel available	3
R&S SFQ-B3	2 FM Sound Subcarriers	2 additional FM sound subcarriers, only in conjunction with option R&S SFQ-B2 <u>Restriction in conjunction with option R&amp;S SFQ-B10:</u> sound inputs only for one R&S SFQ-B3 option <u>or</u> one R&S SFQ-B4 option	1
R&S SFQ-B4	2 ADR Sound Subcarriers	2 additional ADR sound subcarriers, only in conjunction with option R&S SFQ-B2 <u>Restriction in conjunction with option R&amp;S SFQ-B10:</u> sound inputs only for one R&S SFQ-B3 option <u>or</u> one R&S SFQ-B4 option	1

\* previous model designations

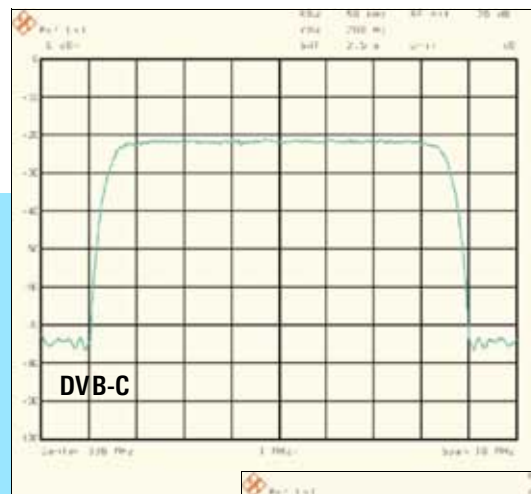
## DVB: coding and mapping for antenna, satellite and cable

The I/Q coders of TV Test Transmitter R&S SFQ encode the applied transport stream for terrestrial transmission via antenna or for satellite or cable transmission in line with standards and condition it so that I and Q (inphase and quadrature) signals are obtained. R&S SFQ accepts MPEG transport streams with a packet length of 188 or 204 bytes. The input interfaces are synchronous parallel (TS parallel, SPI) and asynchronous serial (ASI). The input data rate and the symbol rate for DVB-C, DVB-S and DVB-DSNG modulation are selectable. With DVB-T modulation, With DVB-T modulation, the channel bandwidths of 6 MHz, 7 MHz and 8 MHz can be selected; their default settings can be varied.

Instead of the external transport data stream (DATA) being used, an internal data source can generate null transport stream packets (NULL TS PACKET, as defined in the DVB Measurement Guidelines), or an unpacked random sequence (PRBS). The PRBS sequence is also available in packeted form in the null transport stream packets (NULL PRBS PACKET). R&S SFQ warns the user if the input signal fails, the set data rate does not match the incoming one or the USEFUL DATA RATE is too high.

The input data stream is linked to a random sequence, ensuring that the signal energy is evenly distributed (energy dispersal). Energy dispersal can be switched off. The same applies to SYNC BYTE inversion.

Following energy dispersal, a Reed-Solomon coder (204,188) is provided as an outer encoder for forward error correction (FEC). 16 parity bytes are added to the unchanged 188 data bytes of each transport stream packet. These 16 parity bytes form the redundancy that allows eight errored bytes of a frame to be corrected by the receiver. A convolutional interleaver distributes the data so that consecutive bits are separated. Burst errors occurring on the transmission path are split up by the de-interleaver into single errors that can be corrected by the Reed-Solomon decoder. The interleaver, too, can be disabled.



Up to and including the convolutional interleaver, coding is identical for antenna (COFDM), satellite (QPSK, 8PSK, 16QAM) and cable (QAM) transmission. No further FEC coding is provided for cable transmissions, as in this case interference due to noise, nonlinearities and interruptions is less likely than on satellite links or with antenna transmissions. With cable transmissions, mapping into the I and Q paths is performed next.

For terrestrial transmissions via antenna and for satellite transmissions, additional inner FEC coding is performed after the convolutional interleaver. The procedure, which is known as convolutional encoding, doubles the data rate. Puncturing is carried out next, ie certain bits are left out in the

transmission according to a defined algorithm, so that the data rate is reduced again.

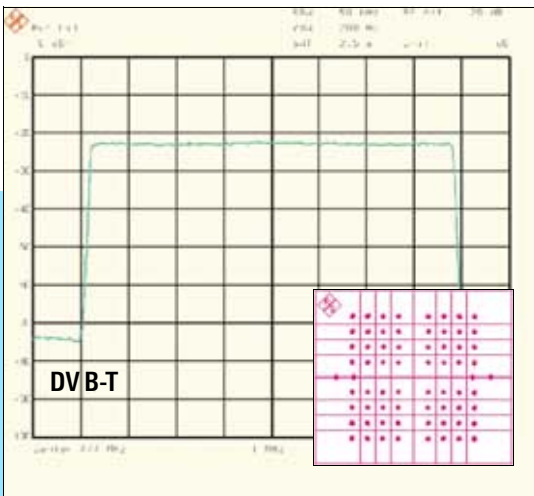
With DVB-S satellite transmissions, mapping into the I and Q paths is performed at this point. Instead of the convolutional encoder (DVB-S), a pragmatic trellis coding type is used for DVB-DSNG satellite transmission.

A turbocoder provides inner error correction for turbocoding and allows operation at considerably lower C/N ratios at the same BER.

For terrestrial transmissions, the signal is made to pass through further FEC stages because of the inherently unfavourable propagation conditions: an inner bit inter-

leaver (at the antenna end) and a symbol interleaver. Next, mapping is performed according to the selected QPSK, 16QAM or 64QAM constellation. After insertion of the pilot and TPS (transmission parameter signalling) carriers in the frame adapter, conversion of the frequency domain to the time domain is effected by an inverse fast Fourier transform, to a 1705 (2K) or 6817 (8K) carrier depending on the selected mode. As a last step, the guard interval is inserted.

Prior to modulation, the spectrum has to be limited by filtering. The roll-off factor (root cosine) can be varied in for DVB-S, DVB-DSNG and DVB-C.



*Status menu*

RF FREQUENCY	RF LEVEL	MODULATION	USED BANDWIDTH	C/N	FADING
474.000 MHz	67.0 dBµV	DVB-T 64QAM	7.607 MHz	OFF	OFF
DVB-S QPSK	DVB-C QAM	DVB-T COFDM	ATSC USB	IQ EXTERNAL	REGULAR TUSO
DVB-T COFDM MODULATION		CODER		CODER	
I/Q PHASE ERROR... 0 DEG	CARRIER SUPPRESS. 0 %	I/Q AMPL. BALANCE 0 %	I/Q MODE... NORMAL	CONSTELLATION... 64QAM	NOISE C/N... 49.9 dB
NOISE BANDWIDTH... 7.6 MHz	FADING... REGULAR TUSO	DISABLED CARRIERS	INPUT... SPI	DATA RATE... 24.882353 Mbit/s	MODE... DATA
			CODE RATE... 3/4	PACKET LENGTH... 188 BYTE	SCRAMBLER... ON
			SYNC. BYTE INV... ON	REED SOLOMON... ON	CONV. INTERL... ON
			FFT MODE... 8K	GUARD INTERVAL... 1/8	BIT INTERL... ON
			SYMBOL INTERL... ON		
F2=EXIT					

## ATSC/8VSB: coding and mapping for antenna

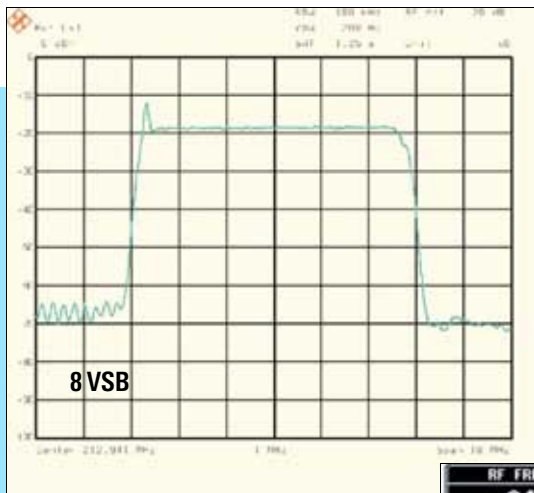
The I/Q coder for 8VSB of TV Test Transmitter R&S SFQ encodes the applied transport stream for terrestrial transmission via antenna in line with standards and processes it so that I and Q (inphase and quadrature) signals are obtained.

With 8VSB, R&S SFQ accepts MPEG transport streams with a packet length of 188 bytes. The input interfaces are synchronous parallel (TS parallel, SPI) and asynchronous serial (ASI). When using the TS parallel input, an input data rate of 19.3926 Mbit/s  $\pm$ 10% can be attained. Use of the optional input interface yields a USEFUL DATA RATE in a wide range of up to 19.3926 Mbit/s.

R&S SFQ warns the user if the input signal fails or if the USEFUL DATA RATE is too high. Instead of the external transport stream (DATA) being applied, an internal data source can generate null transport stream packets (NULL TS PACKET, NULL PRBS PACKET). A SYNC PRBS is implemented for bit error evaluation in receivers. An unpacked random sequence may also be selected. With 8VSB the PRBS sequence can be selected before (PRBS BEFORE TELLIS) or after the trellis coder (PRBS AFTER TELLIS). The PRBS sequence is also available in packeted form in the null transport stream packets (NULL PRBS PACKET).

Generation of the standard frame is followed by a randomizer which ensures that energy is evenly distributed in the channel (energy dispersal). The randomizer can be disabled. Following energy dispersal, a Reed-Solomon coder (208,188) is provided

for forward error correction (FEC). 20 parity bytes are added to the unchanged 188 data bytes. Up to ten errors per segment can thus be corrected. A convolutional interleaver changes the position of the individual bytes so that consecutive bytes are separated. Burst errors occurring on the transmission path are split up by the receiver into individual errors that can be corrected by the Reed-Solomon decoder. The interleaver can be disabled. A trellis coder follows for further FEC. After the interleaver or trellis coder the segment sync and the field sync pulses are inserted. The mapper assigns the relevant amplitude steps to the symbols. The pilot used by the receiver for synchronization is also added in the mapper. The pilot amplitude can be modified and switched off. Prior to modulation, the spectrum must be limited by appropriate filtering. The roll-off is permanently set to 0.115 (root cosine).



Status menu

RF FREQUENCY	RF LEVEL	MODULATION	SYMBOLRATE	C/N	FADING			
210.250 MHz	67.0 dBµV	ATSC 8VSB	10.762 MSym/s	OFF	OFF			
DUB-S QPSK	DUB-C QAM	DUB-T COFDM	111-1 122/8	ATSC USB	IQ EXTERNAL	PREPAND USBF0	PREPAND SUB.FN	PREPAND SUB.ANK
ATSC USB MODULATION				CODER				
I/Q PHASE ERROR ..... 0 DEG				INPUT ..... ASI				
CARRIER SUPPRESS ..... 0 %				DATA RATE ..... 19.393 Mbit/s				
I/Q AMPL. BALANCE ..... 0 %				MODE ..... DATA				
I/Q MODE ..... NORMAL				ROLL OFF ..... 0.115				
USB LEVEL ..... 8VSB				RANDOMIZER ..... ON				
NOISE C/N ..... 25.0 dB				REED SOLOMON ..... ON				
NOISE BANDWIDTH ..... 5.4 MHz				INTERLEAVER ..... ON				
FADING: USER REGULAR TUSO				PILOT ..... ON				
				PILOT VALUE ..... 1.25				
[F2=EXIT]								



## ITU T/J.83B: coding and mapping for North-American cable

The symbol rate of the coder and so the bandwidth of the output signal can be varied over a wide range of  $\pm 10\%$  of the standard symbol rate.

Larger variations of the symbol rate can be made in the TS parallel mode, where the symbol rate of the coder immediately follows the coder input data rate. However, conformance with specifications cannot be warranted outside the range  $\pm 10\%$ .

The data signal applied to R&S SFQ can be replaced with an internal test sequence (NULL TS PACKETS, NULL PRBS PACKETS, SYNC PRBS), which is helpful for BER measurements.

**Coding:** The coder expects an MPEG-coded input data stream packetized to standard with a packet length of 188 bytes. The data are divided into packets by means of a sync byte (47 hex) in the transport stream, the sync byte also being used for receiver synchronization.

In the J83.B cable transmission system, additional error control is introduced at the transport stream level by means of a sliding checksum, calculated for the transport stream packets, and substituted for the sync byte. This check sum byte allows the receiver to synchronize to the packets and to check for errored packets.

The J83.B FEC layer, which is next, accepts and transports data without any restrictions imposed by the protocol, i.e. the checksum generation and FEC coding are completely independent processes.

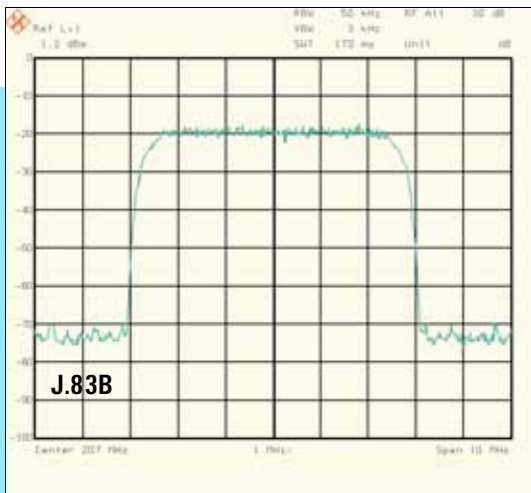
FEC in the J83.B system is implemented in four stages to ensure reliable data transmission via cable. These are:

- ◆ Reed-Solomon coding (128, 122) for outer error correction, allowing up to 3 symbols in a Reed-Solomon block to be corrected
- ◆ a convolutional interleaver distributing consecutive symbols uniformly across the data stream, so protecting the signal from burst-type impairments
- ◆ a randomizer to give a uniform power density in the channel, and
- ◆ trellis coding for inner error correction, involving convolutional coding of data and adding defined redundant information to the symbols, thus enabling the receiver to detect and correct any sporadic impairments on the transmission path by means of soft-decision methods

The randomizer, interleaver and Reed-Solomon coder can be switched off, which is very useful when receivers are being developed.

All interleaver modes defined in J83.B are implemented (level 1 and level 2), allowing the system to adapt easily to different transmission conditions.

**FEC frame:** With 64QAM, a frame sync trailer is inserted after 60 Reed-Solomon packets (with 256QAM after 88 Reed-Solomon packets), so forming an FEC frame. The frame sync trailer is a sync word that carries information about the current interleaver configuration. The trailer is inserted immediately ahead of trellis coding and used by the receiver for FEC synchronization and interleaver mode evaluation.



The trellis coder for 64QAM performs differential coding of the input data as well as 4/5 punctured convolutional coding. The overall code rate is 14/15, i.e. the trellis coder generates 15 output bits from 14 input bits. The output word length of the trellis coder is 6 bits, corresponding to the modulation level of 6 for 64QAM. The output signal of the trellis coder is applied to the mapper, which converts the symbols formed by the trellis coder into constellation points. The trailer is also coded by the trellis coder like normal FEC data and, because of its length, occupies all the bit positions in a trellis group.

The differential/convolutional encoder in the trellis block for 256QAM is identical to the 64QAM trellis coder but has an overall code rate of 19/20. In contrast to 64QAM, the trailer is inserted only at the differentially coded bit positions of a trellis group and transmitted in five sync trellis groups because of its length. The output word length is 8 bits, corresponding to 256 constellation points.

After the mapper and prior to modulation proper, the output spectrum is band-limited by a  $\sqrt{\cos}$  roll-off filter to match the 6 MHz channel spacing. Roll-off is 0.18 with 64QAM and 0.12 with 256QAM in line with the standard.

## Input interface

The optional input interface adds two further inputs to the TS PARALLEL input in LVDS (low voltage differential signalling) format built into the basic unit: SPI (synchronous parallel interface) and ASI (asynchronous serial interface).

Both inputs allow setting of the symbol rate independently of the input data rate, so that the input data rate is independent of the symbol rate or channel bandwidth. To this effect, all null packets are

removed. The data rate required for a given symbol rate or bandwidth is obtained by stuffing, i.e. by inserting new null packets. The PCR (program clock reference) values are adapted. A built-in synthesizer ensures an accurate data clock at all inputs. For synchronization to a receiver, an external clock can be applied to ASI and SPI instead of the internal clock.

## Fading simulation

To test receivers, it is necessary to simulate all real-life transmission conditions as completely as possible and in a reproducible way. R&S SFQ caters for this necessity by offering a fading simulator in addition to the noise generator. The fading simulator is indispensable for the simulation of terrestrial – and in particular

mobile – receive conditions, but can also be used for QAM and QPSK (max. 14 MHz RF bandwidth), for example to simulate reflection. For fading simulation, a signal is passed through 6 or 12 parallel paths which are combined again ahead of the modulator. Each active simulation path shapes the signal independently of the other paths and without any synchronization between the paths.

For each path, loss and delay can be set individually and a profile selected. Various profiles are available. The constant phase profile allows extremely short delays to be simulated. The pure Doppler profile is suitable for the simulation of mobile reception. One speaks of mobile reception when the receiver is moving or the signal is reflected by a moving object. The assumed speed of movement can be varied over a wide range. Moreover, the

### Typical operating menu

RF FREQUENCY	RF LEVEL	MODULATION	SYMBOL RATE	C/N	FADING
1750.000 MHz	-30.0 dBm	DVB-S 8PSK	45.000 MSym/s	OFF	OFF

RF FREQUENCY	RF LEVEL	MODULATION	I/Q CODER	BASEBAND	SPECIAL
I/Q CODER		EDIT (INFO)		MEASURE	
INPUT SELECT	⇒	ASI		19.393 MBit/s	
INPUT DATA RATE	⇒	(MAX. 103.676 MBit/s)		4.556 MBit/s	
USEFUL DATA RATE	⇒	45.000 MSym/s			
SYMBOL RATE	⇒	DATA			
MODE	⇒	5/6			
CODE RATE	⇒	0.35			
ROLL OFF	⇒				
SPECIAL	⇒				

F2=STATUS      F4=PRESET CODER

SETUP							
HARDWARE	INFO FIRMWARE	TIME/DATE CLOCK	COMMUNICATION	PRESET	CHANNEL TABLE	FADING PARAMETER	SERVICE
REGULAR TU50							
PATH STATE	ON	ON	ON	ON	ON	ON	ON
PROFILE	RAYLEIGH	RAYLEIGH	RAYLEIGH	RAYLEIGH	RAYLEIGH	RAYLEIGH	RAYLEIGH
PATH LOSS	3.0 dB	0.0 dB	2.0 dB	6.0 dB	8.0 dB	10.0 dB	10.0 dB
DELAY	0.00 µs	0.20 µs	0.50 µs	1.60 µs	2.30 µs	5.00 µs	10.0 µs
SPEED	13.9 m/s	13.9 m/s	13.9 m/s	13.9 m/s	13.9 m/s	13.9 m/s	13.9 m/s
DOPPLER FREQUENCY	22.0 Hz	22.0 Hz	22.0 Hz	22.0 Hz	22.0 Hz	22.0 Hz	22.0 Hz
PHASE	00.000	00.000	00.000	00.000	00.000	00.000	00.000
DISCREET COMPONENT	OFF	OFF	OFF	OFF	OFF	OFF	OFF
POWER RATIO	00.00	00.00	00.00	00.00	00.00	00.00	00.00
FREQUENCY RATIO	1.0	1.0	1.0	1.0	1.0	1.0	1.0

ACTIVE SET: REGULAR TU50 / OFF      F2=ALL EQUAL      F4=PG DOWN

Setup menu for fading: regular TU50 (i.e. typical urban, 50 km/h, 6 paths)

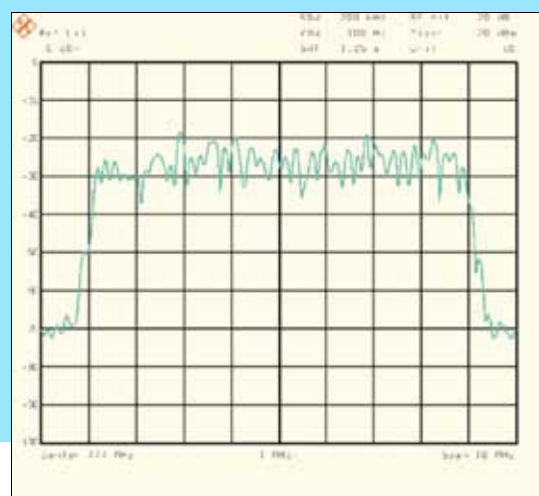
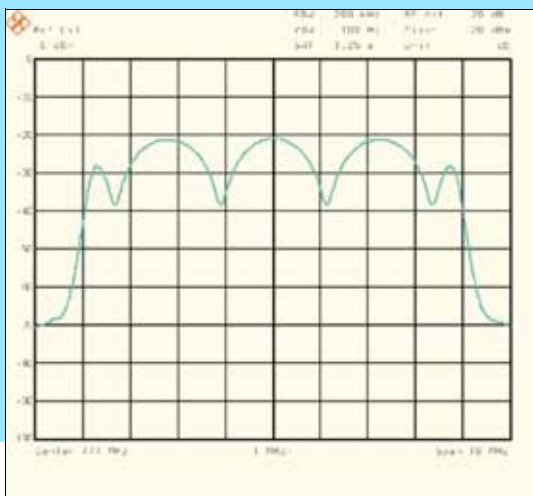
direction of movement can be defined with reference to the transmitter site. Special profiles have been developed for the reproducible simulation of complex scenarios. The profiles are based on the WSSUS (wide sense stationary uncorrelated scattering) model and are recommended by the relevant DVB and DAB bodies (MOTIVATE, COST 207, EUREKA 147). Rayleigh fading, for example, simulates a radio field with many strongly scattered partial waves uniformly distributed and arriving at the mobile receiver from all directions. Rice fading simulates the same situation as Rayleigh fading, but with a variable, discrete component received via a direct path. Lognormal fading simulates slow variation of the receive amplitude; together with Rayleigh fading, Suzuki fading is obtained.

To configure a complete channel simulation model, a large number of parameters has to be set for each of the 6 or 12 paths: on/off, profile, loss, delay, speed/Doppler frequency, direction, discrete component, local constant for lognormal. To provide for comparable, reproducible measurements, international bodies recommend the use of defined channel models, for example typical urban, rural area, hilly terrain, difficult RA250 (difficult rural area, 250 km/h). The fading simulator offers the recommended as well as frequently used channel models as predefined setups for convenient testing. All parameters can be modified to match the requirements of a given task.

Following the fading simulator, all paths are combined for modulation. Simulation

may cause a considerable change of RF power. Depending on the settings of the FADING POWER parameter (MULTIPATH or MAIN), the R&S SFQ displays the total power of all paths involved or the power of the main path. The C/N ratio is set according to the two power models.

With different phases in the individual paths, RF power may be reduced through cancellation and, more frequently, increased through addition of the paths. Therefore, with the fading simulator switched on, the maximum RF level is reduced to avoid overloading.

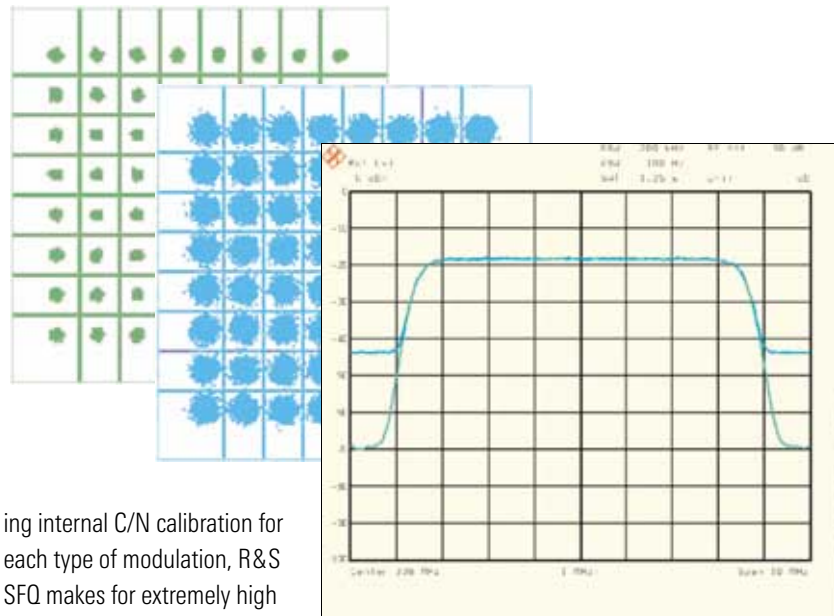


*DVB-T spectrum with constant phase (phase 0 degree, delay 0 μs/0.45 μs, 2 paths) and fading regular TU50 (typical urban, 50 km/h, 6 paths)*

## Noise generator

The noise generator produces broadband white noise with a Gaussian distribution. The power density of the noise signal can be set indirectly as C/N (carrier-to-noise) ratio.

This is extremely convenient for the user as the C/N ratio can be entered in dB immediately after selection of the demodulator receive bandwidth. The receive bandwidth is set to match the symbol rate but can be modified. R&S SFQ can thus simulate different types of interference as they really occur along the satellite, cable or antenna transmission path to the receiver. The C/N ratio is set according to the two fading power models (FADING POWER). Featur-

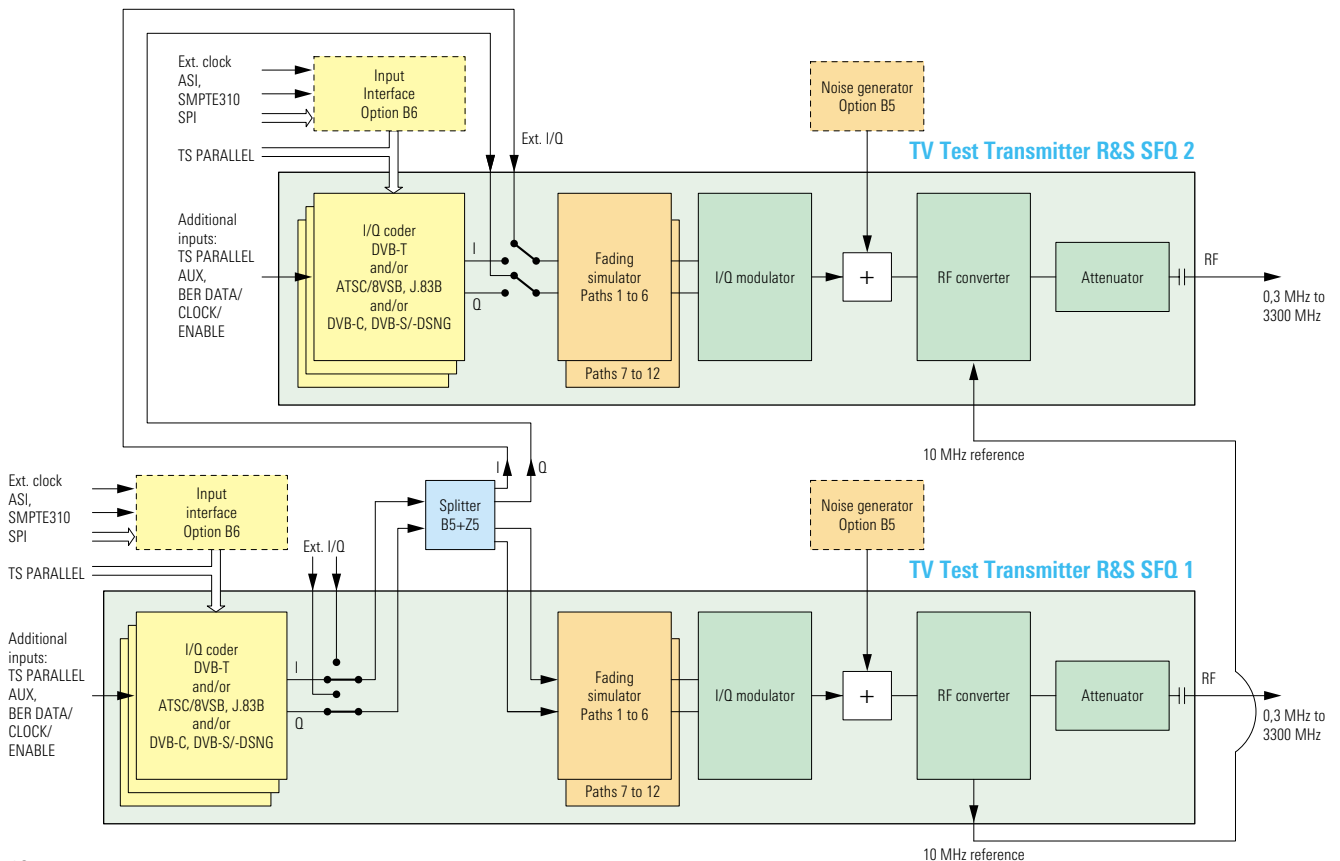


ing internal C/N calibration for each type of modulation, R&S SFQ makes for extremely high accuracy.

*DVB-C spectrum without and with noise (24 dB C/N), corresponding I/Q constellations*

**Circuit diagram with two R&S SFQs and R&S Z5 cable set for generating diversity signals**  
 – RF frequency above 10 MHz doubled  
 – Same fading profile, but uncorrelated  
 – Uncorrelated noise generators for every receive path  
 – Cascadable for several diversity signals

### Generating diversity signals



## Diversity simulation

For testing diversity receivers, each antenna of the receiver requires a separate RF signal. The RF signals must carry the same video signal and be coupled to

each other via the reference frequency. The interference simulation (noise, fading) produced by the individual transmitters must not be intercorrelated; this can be realized only by providing one R&S SFQ per antenna. Only one MPEG2 transport stream is used; the RF is coupled to the

reference frequency (see block diagram opposite). To enable cascading, which is required for this application, the noise generator incorporates a splitter which can be activated by means of the accessory cable set R&S SFQ-Z5.

## BER measurement

The internal BER measurement facility permits the BER of receivers to be measured without external equipment being required. The demodulated data streams are fed back to R&S SFQ.

A selection can be made between the serial inputs DATA, CLOCK (BNC connectors, TTL level, 75  $\Omega$ ) and the parallel input for MPEG signals (sub-D, LVDS level).

The BER measurement is independent in its function from other settings in the R&S SFQ and can be used with all digital modulation modes. The current BER is permanently displayed for this purpose. For measurements on MPEG transmission systems, R&S SFQ is set to NULL PRBS PACKET. This ensures receiver synchroniza-

tion, and allows measurements over a very wide BER range. A PRBS  $2^{23}-1$  or PRBS  $2^{15}-1$  to ITU-T Rec. O.151 can be selected and evaluated.

A particularly important application is the BER measurement before the Reed-Solomon decoder. The BER of set-top boxes

can be determined with the aid of an adapter card (R&S SFQ-Z17) for the common interface. The BER measurement can also be performed for instance after the demapper. The BER measurement facility is accommodated on the DVB-T coder module.

RF FREQUENCY	RF LEVEL	MODULATION	USED BANDWIDTH	C/M	FADING
474.000 MHz	-30.0 dBm	DVB-T 64QAM	7.607 MHz	OFF	OFF
BER: 8.52E-07 (2610 / 10K)					
RF FREQUENCY	RF LEVEL	MODULATION	I/Q CODER	SPECIAL	SPECIAL
SPECIAL		BER INPUT		PARALLEL	
SWEEP START/STOP →		ON			
SWEEP CENTER/SPAN →		8.52E-07 (2610 / 10K)			
BER MEASUREMENT		PARALLEL		▶ MODE	
BER					
▶ BER INPUT					
				PRBS INVERTED	
				▶ NULL PRBS PACKET	
				PID F. FOR PRBS PACKET	
F2=STATUS					

BER setting menu

## I/Q modulation

In the I/Q modulator, the orthogonal I and Q components of the RF signal are controlled in amplitude and phase by the analog I and Q signals from the coder. The two RF components are added to give an output signal that can be amplitude- and phase-modu-

lated as required. Assignment of I and Q components can be interchanged in R&S SFQ so that an inverted RF signal is obtained. High demands are placed on the I/Q modulator particularly with a view to high-order quadrature amplitude modulation. The internal calibration of R&S SFQ ensures that I and Q paths have identical

gain, the phase is exactly 90° and carrier suppression at least 50 dB.

Non-ideal behaviour of an I/Q modulator can be simulated by detuning amplitude, phase and carrier leakage in R&S SFQ. As a result, bit errors are produced that allow quality assessment of receivers and demodulators.

## Specifications of basic unit

### Frequency (main carrier)

Range	0.3 MHz to 3.3 GHz
Resolution	1 Hz
Accuracy	see reference frequency

### Reference frequency

Inaccuracy	$<\pm 1 \cdot 10^{-6}$
Aging (after 30 days of operation)	$1 \cdot 10^{-6}$ /year
Temperature effect (0°C to 55°C)	$2 \cdot 10^{-6}$
Output for internal ref. frequency	10 MHz
Level ( $V_{rms}$ EMF, sinewave)	1 V
Input for external reference	
Frequency	5 MHz or 10 MHz
Permissible frequency drift	$3 \cdot 10^{-6}$
Input level ( $V_{rms}$ )	0.1 V to 2 V
Input impedance	200 $\Omega$

### Spectral purity

Spurious signals	
Harmonics (up to 5 GHz)	$<-30$ dBc
Nonharmonics	
CW	$<-70$ dBc
I/Q modulation	$<-56$ dBc (ref. to CW)
SSB phase noise	measured at 750 MHz, CW, 1 Hz bandwidth
Offset from carrier	
1.1 kHz	-85 dB
2.2 kHz	-89 dB
3.4 kHz	-94 dB
4.5 kHz	-98 dB
8.9 kHz	-104 dB
13.4 kHz	-103 dB
20 kHz	$<-108$ dB
Spurious FM rms (f = 1 GHz), 0.3 kHz to 3 kHz (ITU-T)	$<8$ Hz

### Level

Range	CW	-99.9 dBm to +13 dBm
	DVB-C/DVB-S	-99.9 dBm to +4 dBm
	DVB-T	-99.9 dBm to +6 dBm
	ATSC/8VSB	-99.9 dBm to +3 dBm
	J.83B	-99.9 dBm to +2 dBm
	with fading	see R&S SFQ-B11
Resolution		0.1 dB
Total level inaccuracy		$<\pm 1.5$ dB
Frequency response at 0 dBm		$<1$ dB, typ. $<0.5$ dB
Output impedance		50 $\Omega$
VSWR		
	RF level	13 dBm to 0 dBm
		$<2$
		$<0$ dBm to -99 dBm
		$<1.4$
	RF output	with DC block (max. 50 V DC)
Non-interrupting level setting		15 dB in selectable level range
Oversvoltage protection		protection against externally fed RF power

### External I/Q input

(for optional I/Q output/input see page 12)

Modulation inputs for external feed of I and Q	
Input impedance	50 $\Omega$
VSWR (DC to 30 MHz)	$<1.4$
Input voltage for full-scale level	$(I^2 + Q^2)^{1/2} = 0.5$ V (1 V EMF, 50 $\Omega$ )
Level correction for nominal	
RF output level	0 dB...40 dB
Connector	BNC female

### I/Q modulation<sup>1)</sup>

Modulation frequency response	
DC to 3.5 MHz	
RF = 0.3 MHz to 1000 MHz	$<\pm 0.2$ dB
RF = 0.3 MHz to 3300 MHz	$<\pm 0.3$ dB

DC to 17.5 MHz, RF = 0.3 MHz to 3300 MHz	$<\pm 0.8$ dB
DC to 22.5 MHz, RF = 0.3 MHz to 3300 MHz	$<\pm 1$ dB
Carrier leakage at 0 V input voltage referred to full-scale level	$<-50$ dBc (after I/Q calibration in setup menu) with fading, see option R&S SFQ-B11
Carrier leakage	
Setting range	0% to 50%
Resolution	0.1%
I/Q amplitude imbalance	
Setting range	-25% to +25%
Resolution	0.1%
Quadrature offset (phase error)	
Setting range	-10° to +10°
Resolution	0.1°

### Data input for MPEG2 data stream

TS PARALLEL input	synchronous parallel (without stuffing), LVDS
Characteristics	meet EN50083-9
Input impedance	100 $\Omega$
Input level ( $V_{pp}$ )	100 mV to 2 V
Connector	25-contact female, shielded
Symbol rate (DVB-C, DVB-S)	
Accuracy	
with external MPEG signal	synchronized to external MPEG signal
without external MPEG signal	see optional input interface (R&S SFQ-B6)
ASI (asynchronous serial input, with stuffing)	see optional input interface
SPI (synchronous parallel input, with stuffing)	see optional input interface
SMPT (synchronous input)	see optional serial input interface

<sup>1)</sup> Valid for a warm-up period of 1 hour and recalibration for an operating time of 4 hours and temperature variations less than 5 degrees.



## Specifications DVB/8VSB/J.83B

<b>Input Interface</b>		<b>option R&amp;S SFQ-B6</b>
SPI input		synchronous parallel (with stuffing), LVDS
Characteristics		meet EN 50083-9
Input impedance		100 Ω
Input level (V <sub>pp</sub> )		100 mV to 2 V
Connector		25-contact female, shielded
ASI input		asynchronous serial, with stuffing
Characteristics		meet EN 50083-9
Input impedance		75 Ω
Input level (V <sub>pp</sub> )		200 mV to 880 mV
Connector		BNC female
Input signal		270 Mbit
Stuffing bytes		Single-byte and block mode
Input SMPTE 310		synchronous serial (only in conjunction with ATSC Coder 8VSB)
Characteristics		meet SMPTE310M
Input impedance		75 Ω
Input voltage (V <sub>pp</sub> )		400 mV to 880 mV
Connector		BNC female
Data rate		19.392658 Mbit/s
Symbol rate (SPI, ASI)		selectable by inserting null PRBS packets (stuffing)
Inaccuracy of internal data clock		<±1·10 <sup>-5</sup>
External clock		switchable between bit and byte clock
Signal, level		TTL
Input impedance		high-impedance
Connector		BNC female
Internal transport stream		Null transport stream packets with PRBS as payload (PRBS: 2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151)

<b>DVB-T Coder</b>		<b>option R&amp;S SFQ-B10</b>
Characteristics		meet EN 300 744
Input		TS PARALLEL; with R&S SFQ-B6: ASI, SPI
Mode		
DATA		MPEG input signal synchronized to input data rate
NULL TS PACKET		null transport stream packets as defined by Measurement Guidelines for DVB Systems
NULL PRBS PACKET		null transport stream packets with PRBS (PRBS: 2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151)
PRBS before convolutional encoder		2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151
PRBS after convolutional encoder		2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151
PRBS before mapper		2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151
Special functions		scrambler, sync-byte inversion, Reed-Solomon, convolutional interleaver, bit interleaver, symbol interleaver, can be switched off
Bandwidth		6 MHz, 7 MHz, 8 MHz (selectable for variable bandwidth from: 5.164 MHz to 7.962 MHz)
Constellation		QPSK, 16QAM, 64QAM
Code rate		1/2, 2/3, 3/4, 5/6, 7/8
Guard interval		1/4, 1/8, 1/16, 1/32, OFF
FFT mode		2K and 8K COFDM
Carrier modification		switching off carriers, carrier groups, modulation for carrier groups
Hierarchical coding		can be retrofitted (see opt. R&S SFQ-B16)

<b>DVB-T/Hierarchical Coding</b>		<b>option R&amp;S SFQ-B16</b>
only in conjunction with R&S SFQ-B10		
Characteristics		meet EN 300 744
AUX input		TS PARALLEL or SPI (parallel, with stuffing); selectable
Assignment		to high-priority or low-priority path

Mode		for high-priority and low-priority path
DATA		MPEG input signal
NULL TS PACKET		null transport stream packets as defined by Measurement Guidelines for DVB Systems
NULL PRBS PACKET		null transport stream packets (PRBS: 2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151)
PRBS before convolutional encoder		2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151
PRBS after convolutional encoder		2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151
PRBS before mapper		2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151
Special functions		scrambler, sync byte inversion, Reed-Solomon, convolutional interleaver, bit interleaver, symbol interleaver; can be switched off

<b>ATSC/8VSB Coder</b>		<b>option R&amp;S SFQ-B12 (-B8)</b>
Characteristics		meet ATSC Doc. A/53 (8VSB)
Frequency setting		pilot frequency, center frequency, channel tables
Input data rate		19.392658 Mbit/s
Range		±10% (larger range with option R&S SFQ-B6)
Input		LVDS, with R&S SFQ-B6: ASI, SPI, SMPTE310
Mode		
DATA		MPEG input signal with synchronization to input data rate
NULL TS PACKET		null transport stream packets as defined by Measurement Guidelines for DVB Systems
NULL PRBS PACKET		null transport stream packets (PRBS: 2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151)
SYNC PRBS		sync byte with 187 bytes PRBS payload
PRBS before trellis		2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151
PRBS after trellis		2 <sup>23</sup> -1/2 <sup>15</sup> -1 to ITU-T Rec. 0.151
Symbol rate		10.762 Msymb/s
Range		±10%
Bandwidth		6 MHz
Range		±10%
VSB level		8VSB
Pilot		1.25, can be switched off
Range		0 to 5 in steps of 0.125
Pulse filtering (root cosine)		0.115 roll-off
Special functions		randomizer, interleaver; can be switched off
Error simulation		carrier leakage, I/Q imbalance; I/Q phase error, selectable

<b>DVB-C Coder</b>		<b>option R&amp;S SFQ-B21 (-B22)</b>
Characteristics		meet EN 300 429
Type of modulation		16QAM, 32QAM, 64QAM, 128QAM, 256QAM
Symbol rates		0.1 MS/s to 8 MS/s (selectable)
Pulse filtering		root cosine roll-off, alpha=0.15 variable roll-off (0.1 to 0.2)
Energy dispersal		can be switched off
Reed-Solomon coder (204,188, t=8)		can be switched off
Convolutional interleaver		can be switched off
Mode		
DATA		MPEG2 input signal (without input signal automatic switchover to PRBS with TS PARALLEL, stuffing with ASI, SPI)
NULL TS PACKET		null packets (PID=1FFF, payload=0)
NULL PRBS PACKET		null packets (PID=1FFF, payload=PRBS, 2 <sup>15</sup> -1/2 <sup>23</sup> -1 to ITU-T Rec. 0.151)
PRBS before mapper		2 <sup>15</sup> -1/2 <sup>23</sup> -1 to ITU-T Rec. 0.151

## Specifications DVB/8VSB/J.83B (cont'd)

<b>DVB-S/-DSNG Coder</b>	<b>option R&amp;S SFQ-B23 (-B24)</b>
Not in conjunction with option R&S SFQ-B6 model 02, R&S SFQ-B6 model 03 recommended	
Characteristics	meet EN 300 421/EN 301 210
Type of modulation	QPSK, 8PSK, 16QAM
Code rate	QPSK: $1/2, 2/3, 3/4, 5/6, 7/8$ 8PSK: $2/3, 5/6, 8/9$ 16QAM: $3/4, 7/8$
Symbol rates	0.1 MS/s to 80 MS/s (selectable)
Pulse filtering	root cosine roll-off, alpha=0.35 variable roll-off (0.25 to 0.45)
Energy dispersal	can be switched off
Reed-Solomon coder (204, 188, t=8)	can be switched off
Convolutional interleaver	can be switched off
Convolutional encoder	can be switched off
Mode	
DATA	MPEG2 input signal (without input signal automatic switchover to PRBS with TS PARALLEL, stuffing with ASI, SPI)
NULL TS PACKET	null packets (PID=1FFF, payload=0)
NULL PRBS PACKET	null packets (PID=1FFF, payload=PRBS, $2^{15}-1/2^{23}-1$ to ITU-T Rec. 0.151)
PRBS before convolutional encoder	$2^{15}-1/2^{23}-1$ to ITU-T Rec. 0.151

<b>Turboencoding</b>	<b>option R&amp;S SFQ-B25</b>
Code rate	QPSK turbo: $2/3, 3/4$ 8PSK turbo: $1/2, 2/3, 3/4, 8/9$

<b>J.83B Coder</b>	<b>option R&amp;S SFQ-B13 (-B9)</b>
Only in conjunction with option R&S SFQ-B6	
Characteristics	meets ITU-T J.83B
Input data rate (nominal, range corresponding to symbol rate)	26.970 Mbit/s for 64QAM, 38.8107 Mbit/s for 256QAM
Input	LVDS, ASI, SPI
Mode	
DATA	input signal synchronized to input data rate
NULL TS PACKET	null transport stream packets
NULL PRBS PACKET	null transport stream packets with PRBS (PRBS: 223-1/215-1 to ITU-T Rec. 0.151)
SYNC PRBS	sync byte with 187 byte PRBS payload
PRBS before trellis coding	PRBS: 223-1/215-1 to ITU-T Rec. 0.151
PRBS after trellis coding	PRBS: 223-1/215-1 to ITU-T Rec. 0.151
Symbol rate	5.0569 Msymbol/s for 64QAM, 5.360 Msymbol/s for 256QAM
Range	$\pm 10\%$
Bandwidth	6 MHz
Pulse filtering (root cosine)	0.18 (64-QAM), 0.12 (256-QAM) roll-off
Data interleaver	level 1 and level 2; can be switched off
Special functions	switchable: randomizer, Reed-Solomon coder
Error simulation	selectable: carrier suppression, I/Q imbalance, I/Q phase error

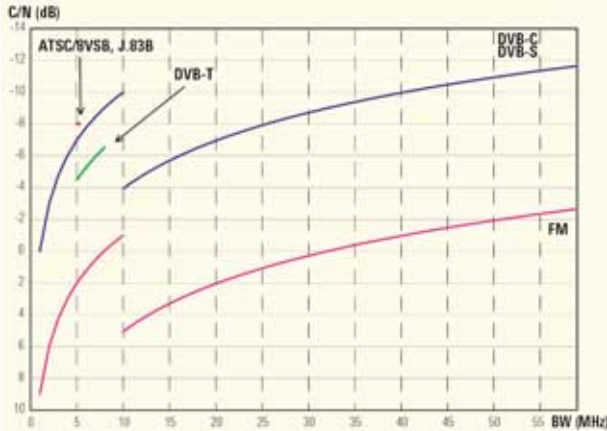
<b>I/Q Output/Input</b>	<b>option R&amp;S SFQ-B14</b>
Output	
Output impedance	50 $\Omega$
Output voltage	depending on selected modulation
Connector	BNC female
Input	
Input impedance	50 $\Omega$
VSWR (DC to 30 MHz)	<1.4
Input voltage for full-scale level	$(I^2 + Q^2)^{1/2} = 0.5 \text{ V (1 V EMF, 50 } \Omega)$
Connector	BNC female

## Specifications of transmission simulation

<b>Fading Simulator</b>	<b>option R&amp;S SFQ-B11</b>
Model 02	paths 1 to 6 (R&S SFQs delivered before 1999: see R&S SFQ-B18)
Model 04	paths 7 to 12 (only in conjunction with R&S SFQ-B11, model 02)
Reduced maximum RF output level	-5.5 dBm for DVB-T (single-path fading without loss)
RF output power	MULTIPATH: the RF level displayed is the sum of the power levels in the individual paths MAIN: the RF level displayed is the power of the main path
C/N ratio	is maintained if the fading parameters are changed; MULTIPATH: C=total power of all paths MAIN: C=power of main path
RF bandwidth (-3 dB)	>14 MHz
Frequency response up to 5 MHz offset from carrier frequency	<0.6 dB, typ. <0.3 dB
Carrier leakage	typ. 45 dBc
Number of paths with R&S SFQ-B11	
Model 02	6
Model 02 plus model 04	12
Path loss	
Range	0 dB to 50 dB
Resolution	0.1 dB
Inaccuracy (from 0 dB to 20 dB)	<0.3 dB
Path delay	
Range	0 ms to 1600 ms
Resolution	50 ns
Inaccuracy	<5 ns
Constant phase	
Range	0° to +359.9°
Resolution	0.1°
Pure Doppler	
Frequency range	0.1 Hz to 1600 Hz
Speed range	$v_{\min} = (0.03 \cdot 10^9 \text{ m/s}^2)/f_{\text{RF}}$ $v_{\max} = (479 \cdot 10^9 \text{ m/s}^2)/f_{\text{RF}}$ for $f_{\text{RF}} = 1 \text{ GHz}$ $v_{\min} = 0.1 \text{ km/h}$ , $v_{\max} = 1724 \text{ km/h}$
Resolution	0.1 km/h, m/s, mph
Inaccuracy	<0.13%
Rayleigh fading	
Pseudo noise interval	>372 h
Deviation from theoretical CPDF <sup>1)</sup> at $P_{\text{avg}} = 0 \text{ dB}$	
from -20 dB to +10 dB	<1 dB, typ. <0.3 dB
from -30 dB to -20 dB	<2 dB, typ. <0.3 dB
Rice fading	
Power ratio <sup>2)</sup>	
Range	-30 dB to +30 dB
Resolution	0.1 dB
Frequency ratio	
Range	-1 to +1
Resolution	0.05
Lognormal fading, Suzuki fading	
Standard deviation	
Range	0 dB to 12 dB
Resolution	1 dB
Local constant	$I_{\min}$ : up to 200 m $(I_{\min} = (12 \cdot 10^9 \text{ m/s}^2)/f_{\text{RF}})$
Fading profile	selectable from a list of predefined profiles; each profile can be modified as required
Reference on frequency change	speed or Doppler frequency can be selected



Noise Generator	option R&S SFQ-B5
Not in conjunction with R&S SFQ-B2 (is already included)	
Bandwidth	
Receiver bandwidth	0,1 MHz to 80 MHz (selectable)
Actual noise bandwidth	10 MHz/60 MHz
C/N setting	
Variation range	50 dB
Minimum selectable C/N	depending on bandwidth and modulation (see diagram)
Resolution	0,1 dB
C/N error	
Absolute error	<0.3 dB (after calibration), typ. <0.2 dB
RF frequency range	
with noise bandwidth ≤10 MHz	≥15 MHz
with noise bandwidth >10 MHz	≥60 MHz



Minimum selectable C/N ratio of Noise Generator R&S SFQ-B5

BER Measurement	option R&S SFQ-B17
only in conjunction with option R&S SFQ-B10	
Characteristics	
integrated BER measurement for all digital modulation modes (DVB-C, DVB-S, DVB-T, 8VSB, J.83B)	
Input data rate	max. 60 Mbit/s (serial input)
PRBS	$2^{23}-1/2^{15}-1$ to ITU-T Rec. 0.151
Input	
Serial	BER DATA, BER CLOCK, BER ENABLE
Input impedance	75 $\Omega$
Input level	TTL
Connector	BNC female
Clock, data	normal, inverted
Enable	always, active high, active low
BER mode	
PRBS	$2^{23}-1/2^{15}-1$ to ITU-T Rec. 0.151
Parallel	TS PARALLEL AUX
Characteristics	meet EN 50083-9
Input impedance	100 $\Omega$
Input level	100 mV to 2 V, LVDS
Connector	25-contact female, shielded
BER mode	
PRBS, PRBS INVERTED	$2^{23}-1/2^{15}-1$ to ITU-T Rec. 0.151
NULL PRBS PACKET	evaluation of standard transport stream; total payload corresponding to PRBS (eg NULL PRBS PACKET of R&S SFQ)
PID FILTER FOR PRBS PACKET	evaluation of null packets (PID=1FFF) of standard TS with payload corresponding to PRBS (e.g. stuffing with R&S SFQ in ASI/SPI mode)

1) CPDF = cumulative probability distribution function, level values referred to average output level value.

2) Ratio of discrete component to distributed component.

## Specifications BB-FM

Broadband FM Modulator	option R&S SFQ-B2
Analog modulation	broadband FM for video and FM/ADR sound subcarrier
Video transmission characteristics	
Type of modulation	frequency modulation (F3)
Standard	PAL, SECAM, NTSC; selectable
Nominal input level ( $V_{pp}$ )	1 V (75 $\Omega$ )
Video frequency deviation	
Setting range	10 MHz to 40 MHz
Resolution	0.1 MHz
Hum suppression with level clamping on	>40 dB
Linear distortion	
Frequency response, 0 MHz to 5 MHz (ref. to 1.5 MHz and 25 MHz (pp) deviation, with preemphasis and lowpass filter)	<±0.5 dB
Group delay, 0 MHz to 4.8 MHz	<±20 ns with lowpass filter
Transients (streaking) mit 200 ns	
Rise and fall time	<±2%
Energy dispersal signal	
Signal type	25 Hz or 30 Hz triangular signal, coupled to frame frequency (625/525 lines)
Deviation, selectable	0 MHz to 4 MHz, automatically doubled when the video or baseband signal is switched off
Resolution	100 kHz
Nonlinear distortion	
Measurements	with standard video signal and preemphasis and deemphasis switched on
Differential gain at 25 MHz deviation	<1.5%
Differential phase at 25 MHz deviation	<1.5°
Video-frequency S/N ratio, ref. to 22.5 MHz deviation, with preemphasis and deemphasis 100 kHz to 5 MHz	>70 dB rms, weighted to CCIR

Internal noise generator	
Bandwidth	
Receiver bandwidth	0,1 MHz to 80 MHz (selectable)
Actual noise bandwidth	10 MHz/60 MHz
C/N setting	
Variation range	50 dB
Minimum selectable C/N	depending on bandwidth and modulation (see diagram for R&S SFQ-B5, FM)
Resolution	0.1 dB
C/N error	<1 dB
RF frequency range	
with noise bandwidth ≤10 MHz	≥15 MHz
with noise bandwidth >10 MHz	≥60 MHz

FM Sound Subcarriers	option R&S SFQ-B3
only in conjunction with option R&S SFQ-B2 (included once in R&S SFQ-B2)	
Number of subcarriers per module	
Frequency range	5 MHz to 9 MHz
Resolution	10 kHz
Frequency deviation of IF carrier caused by FM sound subcarriers	
Setting range (RF deviation)	1 MHz (pp) to 4 MHz (pp)
Resolution	10 kHz
Audio signal input	
Frequency range	30 Hz to 15 kHz
Bandwidth without lowpass filter	100 kHz
Nominal input level	+9 dBm (600 $\Omega$ )
Input impedance	>5 k $\Omega$ , balanced
Connector	Lemo Triax
Internal modulation generator (DSP)	
Frequency range	30 Hz to 15 kHz
Resolution	100 Hz
Modulation distortion	
Audio S/N ratio (ref. to 50 kHz deviation, AC-coupled)	>65 dB, weighted to CCIR
Preemphasis	50 $\mu$ s, 75 $\mu$ s, J.17, OFF; selectable

## Specifications BB-FM (cont'd)

<b>ADR Sound Subcarriers</b>	<b>option R&amp;S SFQ-B4</b>
only in conjunction with option R&S SFQ-B2 (to ADR specifications)	
Number of subcarriers	2
Frequency range	0.1 MHz to 9 MHz
Resolution	10 kHz
Frequency deviation of IF carrier caused by ADR sound subcarriers	
Setting range (RF deviation)	1 MHz (pp) to 4 MHz (pp)
Resolution	10 kHz
Type of modulation	QPSK
Source data	internal, external, PRBS
Source data rate	192 kbit/s
Transmission rate	256 kbit/s
QPSK test	4 selectable test patterns; I/Q reversal
Bit error generator (symbol errors)	$10^{-2}$ to $10^{-6}$
External data input	only for one of the two subcarriers
Type	clock (invertible) and data
Level	RS-422
Data rate	192 kbit/s
Internal MUSICAM generator	two generators independent of each other (to ISO/IEC 11172-3 Layer II)
Mode	single, dual, stereo
Ancillary data (ANC)	1 of 4 internal data records can be selected, update from memory card
Audio generator	two for each MUSICAM channel
Frequency range	10 Hz to 20 kHz; 10 Hz steps
Amplitude range	100 dB; 0.1 dB steps
Preemphasis	50/15 $\mu$ s, OFF

## General data

Transmitter tables	5 with 100 entries each, editable or loadable by remote control
Storage of instrument settings	internally and on memory card
Interfaces	IEC-625/IEEE-488 bus, RS-232-C
Rated temperature range	+5°C to +45°C
Operating temperature range	0°C to +50°C
Storage temperature range	-40°C to +70°C
Mechanical resistance	
Vibration, sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g, meets IEC 68-2-6, IEC 1010-1, MILT-28800 D class 5
Vibration, random	10 Hz to 300 Hz, 1.2 g (rms)
Shock	40 g shock spectrum, meets MIL-STD 810 C and MILT-28800 D classes 3 and 5
Climatic resistance	95% rel. humidity, cyclic test at +25°C/+40°C, meets IEC 68-2-30
Electromagnetic compatibility	meets EMC directive of EU (89/336/EEC) and complies with German EMC legislation
Power supply	90 V to 132 V/180 V to 265 V (autoranging), 47 Hz to 440 Hz (170 VA)
Electrical safety	meets EN 61010-1
Dimensions (W x H x D)	435 mm x 192 mm x 460 mm
Weight	approx. 20 kg, depending on options fitted



R&S SFQ rear view

## Ordering information

### Order designation

TV Test Transmitter (0.3 MHz to 3300 MHz) for		
DVB-C	R&S SFQ02+	2072.5501.02
	R&S SFQ-B21	2072.8912.02
DVB-S/-DSNG	R&S SFQ02+	2072.5501.02
	R&S SFQ-B23	2072.5830.02
DVB-T, 2K/8K	R&S SFQ02+	2072.5501.02
	R&S SFQ-B10	2072.6166.02
ATSC/8VSB	R&S SFQ02+	2072.5501.02
	R&S SFQ-B12	2072.6220.02
ITU-T, J.83B	R&S SFQ02+	2072.5501.02
	R&S SFQ-B13	2072.6243.02
Broadband FM	R&S SFQ02+	2072.5501.02
	R&S SFQ-B2	2072.6108.02

### Options

Please state serial number of unit when submitting new orders for options.

Input Interface (ASI/SPI input and selectable symbol rate, SMPTE310 input), can be retrofitted	R&S SFQ-B6	2072.7679.03
DVB-T Coder, 2K/8K COFDM Modulator, 6 MHz/7 MHz/8 MHz bandwidth (for R&S SFQ delivered before 1999 see R&S SFQ-B18)	R&S SFQ-B10	2072.6166.02
DVB-T/Hierarchical Coding	R&S SFQ-B16	2072.5782.02
ATSC Coder, 8VSB (HW + FW)	R&S SFQ-B12	2072.6220.02
ITU-T/J.83B (FW)	R&S SFQ-B9	2072.6143.02
ITU-T/J.83B Coder (HW + FW)	R&S SFQ-B13	2072.6243.02
ATSC/8VSB (FW)	R&S SFQ-B8	2072.6120.02
DVB-C Coder (HW + FW)	R&S SFQ-B21	2081.8912.02
DVB-C (only FW)	R&S SFQ-B22	2072.5824.02
DVB-S/-DSNG Coder (HW + FW)	R&S SFQ-B23	2072.5830.02
DVB-S/-DSNG (only FW)	R&S SFQ-B24	2072.5847.02
Turbocoding (only FW)	R&S SFQ-B25	2110.0207.02
I/Q Output/Input	R&S SFQ-B14	2072.6266.02
Power Supply Upgrade for R&S SFQ model 10, delivered before 1999; serial number of R&S SFQ must be stated	R&S SFQ-B18	2072.7191.02
Factory-fitting of R&S SFQ-B18 to R&S SFQs delivered before 1999	R&S SFQ-U11	2072.7040.02
Fading Simulator, paths 1 to 6 (for R&S SFQ delivered before 1999 see R&S SFQ-B18)	R&S SFQ-B11	2072.6189.02
Fading Simulator, paths 7 to 12	R&S SFQ-B11	2072.6189.04
Noise Generator, can be retrofitted and calibrated	R&S SFQ-B5	2072.7579.03
BER Measurement	R&S SFQ-B17	2072.7056.02
Broadband FM Modulator for baseband (PAL, SECAM, NTSC) and FM sound (2 subcarriers)	R&S SFQ-B2	2072.6108.02
2 FM Sound Subcarriers 5 MHz to 9 MHz with 2 audio generators and 2 external audio inputs	R&S SFQ-B3	2072.7379.02
2 ADR Sound Subcarriers 0.1 MHz to 9 MHz with 2 MUSICAM generators and 1 external data input	R&S SFQ-B4	2072.7479.02

### Recommended extras

Documentation of R&S SFQ calibration values	R&S SFQ-DCV	2082.0490.12
Cable Set for diversity	R&S SFQ-Z5	2081.9158.02
Common Interface TS OUT	R&S SFQ-Z17	2081.9364.02
Service Kit	R&S SFQ-Z1	2072.5960.02
Service Manual (English)		2072.6489.22
Memory Card 10 Mbyte (Flash)		0048.5877.00
19" Adapter (4 HU) for rackmounting	R&S ZZA-94	0396.4905.00
Matching Pads 50 $\Omega$ /75 $\Omega$ , 0 GHz to 2.7 GHz, N connectors		
matched at both ends, attenuation 5.7 dB, no DC isolation	R&S RAM	0358.5414.02
matched at one end, attenuation 1.7 dB	R&S RAZ	0358.5714.02



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