

R&S® SFD DOCSIS® SIGNAL GENERATOR



Signal generator for DOCSIS 3.1
downstream and upstream



Product Brochure
Version 02.00

ROHDE & SCHWARZ

Make ideas real



AT A GLANCE

The DOCSIS® 3.1 standard is driving the all-IP trend in cable TV networks. The R&S®SFD generates a DOCSIS 3.1 OFDM broadband signal as well as legacy cable signals such as DOCSIS 3.0 and downstream digital and analog TV channels. Upstream, the instrument can generate DOCSIS 3.1 or DOCSIS 3.0 signals.

The R&S®SFD produces signals for DOCSIS 3.1, DOCSIS 3.0, digital cable TV in line with J.83/A/B/C and analog cable TV. Its downstream frequency range is 47 MHz to 1794 MHz for DOCSIS 3.1 and 47 MHz to 1218 MHz for DOCSIS 3.0 and TV. Within this range, the R&S®SFD generates a DOCSIS 3.1 channel with up to 192 MHz bandwidth or a minimum of 80 simultaneous SC-QAM channels between 1002 MHz to 1794 MHz for DOCSIS 4.0. It is possible to set the channel level, frequency, forward error correction (FEC) and constellation. The R&S®SFD can also produce a digital, QAM-modulated or analog TV signal. The DOCSIS 3.1 channel or digital TV channel is modulated in realtime. The transmission data can be fed in via IP or internally generated by the R&S®SFD.

The upstream frequency range is 5 MHz to 204 MHz. Within this range, a DOCSIS 3.1 orthogonal frequency division multiple access (OFDMA) signal can be generated in realtime. A DOCSIS 3.0 TDMA or CDMA signal can be produced in realtime in the 5 MHz to 85 MHz range.

The digital signal generation capabilities of the R&S®SFD make it ideal for testing tuners, cable modems and upstream CMTS receivers in R&D and production and also for simulating DOCSIS 3.1 signals in real cable segments. The R&S®SFD can add interference such as noise, phase noise, hum, tilt and even a defined bit error rate for realistic signal generation.

The generator has a ½ 19" housing that only takes up two height units. The complex signal generation process can be conveniently configured from a PC or a web interface. Remote control SCPI commands enable the generator to be used in automatic test systems. The software option concept enables the R&S®SFD to be adapted to different applications.

Key facts

- ▶ Frequency range in downstream: 47 MHz to 1218 MHz (extendable to 1794 MHz)
- ▶ Frequency range in upstream: 5 MHz to 204 MHz
- ▶ DOCSIS 3.1, DOCSIS 3.0, J.83/A/B/C and analog TV
- ▶ Simultaneous generation of at least 80 SC-QAM channels between 1002 MHz and 1794 MHz with the R&S®SFD-K202 option for DOCSIS 4.0
- ▶ ARB generator bandwidth up to 200 MHz
- ▶ Signal interference and distortion simulation

BENEFITS AND KEY FEATURES

Downstream signal generation

- ▶ Realtime modulation of DOCSIS 3.1 and J.83/A/B/C

Upstream cable modem data traffic simulation

- ▶ Realtime modulation of DOCSIS 3.1 and DOCSIS 3.0
- ▶ All OFDMA, TDMA and CDMA signals
- ▶ Trigger function for burst timing control

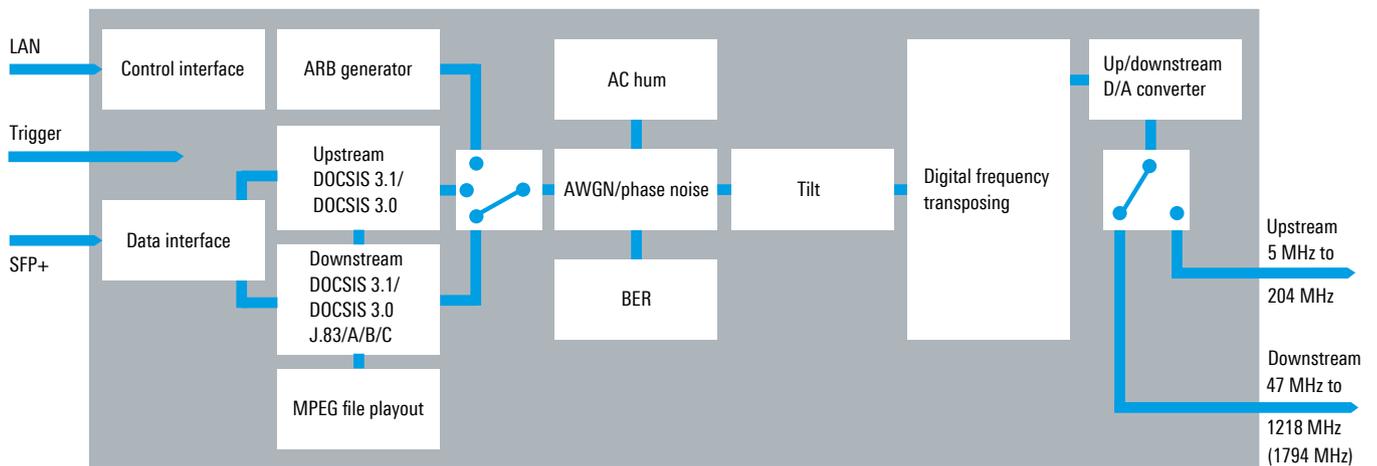
Signal interference and distortion simulation

- ▶ Configurable bit error rate
- ▶ White noise and phase noise
- ▶ AC hum
- ▶ Tilt

Powerful ARB generator

- ▶ Up to 200 MHz bandwidth
- ▶ 256 Mbyte memory

Overview of the R&S®SFD interfaces and function blocks



DOWNSTREAM SIGNAL GENERATION

Realtime DOCSIS 3.1 and J.83/A/B/C modulation

The R&S®SFD features an FPGA-based modulator for broadband DOCSIS 3.1 data transmissions and digital cable TV in line with ITU-T J.83/A/B/C. The modulator works in realtime and generates signals with decodable content – just like CMTS and headend modulators. Frequency, level and modulation parameters can be set as required. The following parameters are relevant for DOCSIS3.1:

- ▶ FFT size or number of OFDM carriers: 4k or 8k
- ▶ Interleaver depth
- ▶ Profile constellation: 16QAM to 4096QAM, 8kQAM and 16kQAM
- ▶ NCP constellation: QPSK to 64QAM
- ▶ PLC location
- ▶ Cyclic prefix and windowing
- ▶ Exclusion band: list of unused OFDM carriers
- ▶ Continuous pilot parameter

The R&S®SFD DOCSIS3.1 channel transmits internally generated PRBS or data streams fed in from outside via IP. The R&S®SFD generates digital cable TV signals in line with J.83/A (DVB-C), J.83/B and J.83/C (ISDB-C). Users can set frequency, level, symbol rate, interleaver depth and constellation as required. The digital TV channel in the R&S®SFD contains PRBS or MPEG-2 transport streams that are either fed in from outside via IP or played back from a file.

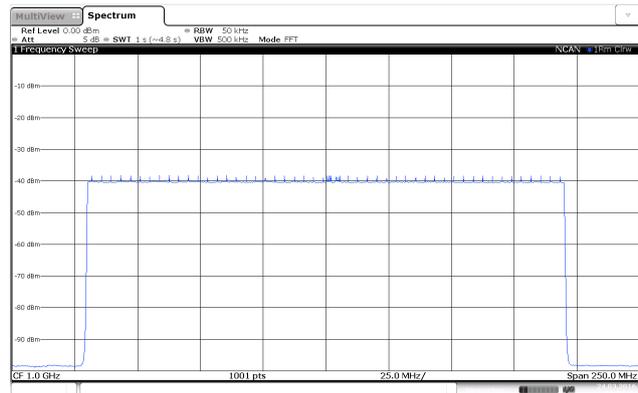
The integrated ARB generator can generate up to 200 MHz signals and is usable in the entire downstream frequency range.

DOCSIS 4.0 requires QAM channel testing up to 1794 MHz. The R&S®SFD-K202 option makes the R&S®SFD a powerful cable load generator for extended spectrum SC-QAM frequencies in the 1002 MHz to 1794 MHz range.

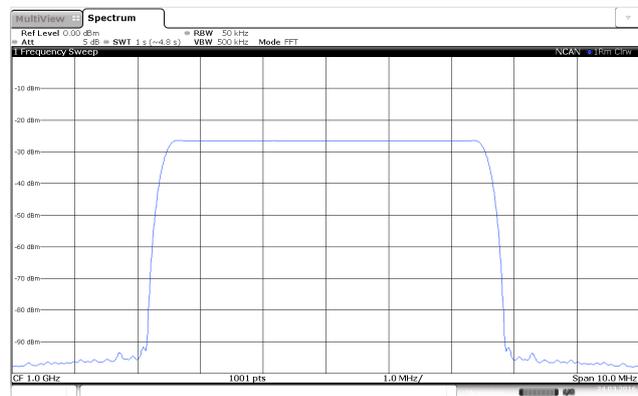
The R&S®SFD is capable of:

- ▶ Generating a block of up to 96 contiguous 6 MHz channels (576 MHz bandwidth) of J.83/B or a block of up to 80 contiguous 8 MHz channels (640 MHz bandwidth) of annex A (DVB-C)
- ▶ Providing a constellation of selectable channel blocks for either 64 QAM or 256 QAM
- ▶ Individually muting channels and having a typical MER of over 47 dB
- ▶ Tying AWGN noise to a channel or to a band of channels with up to 200 MHz of bandwidth

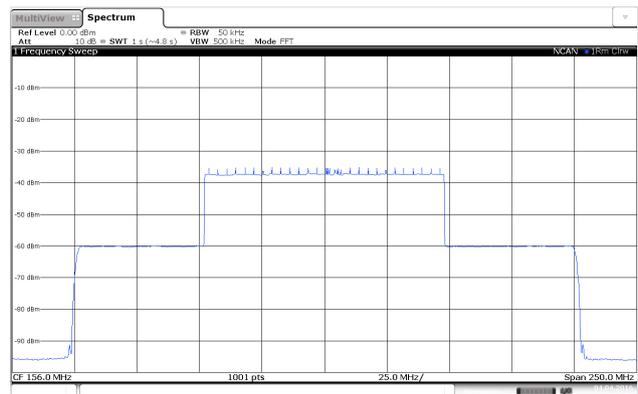
DOCSIS 3.1 OFDM signal with 192 MHz bandwidth



DOCSIS 3.0/J83B signal with 6 MHz bandwidth



DOCSIS 3.1 signal with 96 MHz bandwidth and underlying broadband noise (200 MHz)



CABLE MODEM DATA TRAFFIC SIMULATION IN THE UPSTREAM

All OFDMA, TDMA and CDMA signals

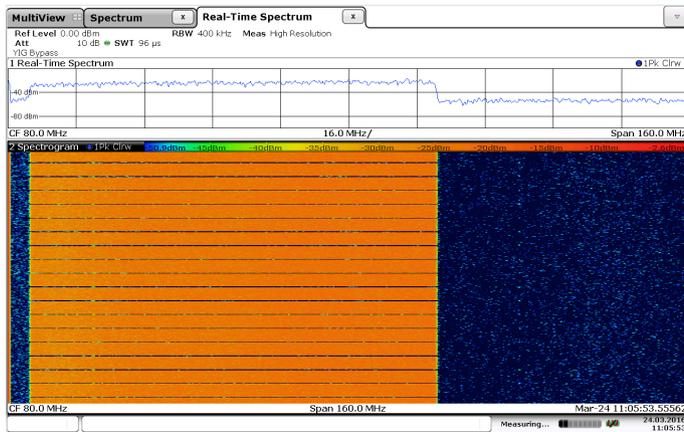
The upstream spectrum arriving at the CMTS receiver consists of transmissions from multiple individual cable modems. The R&S®SFD generates one signal of this type in the frequency range from 5 MHz to 204 MHz. Within this range, realtime modulation of a DOCSIS3.1 OFDMA channel or a DOCSIS3.0 channel with TDMA or CDMA is possible. DOCSIS3.1 signals contain different message types (see table). The R&S®SFD ARB generator can also produce user-defined signals with full upstream bandwidth.

Trigger function for burst timing control

Cable modems transmit short, time-limited data packets (bursts). If there is a sufficiently high number of modems in a network, the individual bursts are superimposed to generate a virtually continuous signal. For DOCSIS3.1, the result is an OFDM signal in which different modems occupy different subcarrier parts. For DOCSIS3.0 TDMA, the result is a pulsed signal with individual bursts from different modems. The R&S®SFD can also generate individual bursts in a single channel. The burst timing is controlled by the trigger function.

Signal types in the upstream		
Standard	Modulation	Message type
DOCSIS3.1	OFDMA	<ul style="list-style-type: none"> ▶ data (PRBS or via SFP+) ▶ bandwidth request ▶ initial ranging ▶ fine ranging ▶ wideband probe
DOCSIS3.0	A-TDMA/S-CDMA	<ul style="list-style-type: none"> ▶ data packet (PRBS or via SFP+)

Waterfall diagram of an upstream burst OFDM signal



SPECIFICATIONS IN BRIEF

Specifications in brief		
RF parameters		
Frequency range		47 MHz to 1212 MHz
	with R&S®SFD-K3018 option	47 MHz to 1788 MHz
Upstream frequency range		5 MHz to 204 MHz
Level	192 MHz DOCSIS3.1	59 dBmV
	J.83/A/B/C (DOCSIS3.0)	62 dBmV
MER	192 MHz DOCSIS3.1	57 dB (typ.)
	J.83/A/B/C	48 dB (typ.)
Downstream modulation (R&S®SFD-K200 option)		
DOCSIS3.1	bandwidth	up to 192 MHz
	constellation	16QAM to 4096QAM, overrange 8kQAM, 16kQAM
	FFT mode	4k, 8k
J.83/A/B/C	bandwidth	6 MHz, 7 MHz, 8 MHz
	constellation	64QAM, 256QAM
Analog TV		PAL, NTSC
Downstream modulation (R&S®SFD-K201 option)		
Enhanced functions		insertion of timestamps in the downstream PLC, display of transmission data rate, R&S®FSW compatibility
Upstream modulation (R&S®SFD-K300 option)		
DOCSIS3.1	modulation mode	OFDM
	bandwidth	6.4 MHz to 96 MHz
DOCSIS3.0	modulation mode	A-TDMA, S-CDMA
	bandwidth	800 kHz, 1.6 MHz, 3.2 MHz, 6.4 MHz
ARB waveform generator		
Bandwidth		200 MHz
Memory		256 Mbyte
Sample rate		240 Msample/s
Waveform		DOCSIS3.1, DOCSIS3.0, J.83, PAL, NTSC, A-TDMA, S-CDMA
	included in R&S®CLGD-K2	FM spectrum, additional PAL and SECAM signals
Signal interference (R&S®SFD-K1050 option)		
Bit error rate		10^{-2} to 10^{-6}
Noise		AWGN, phase noise
AC hum	amplitude modulation	47 Hz to 200 Hz, 0% to 6%
Tilt	DOCSIS3.1	±15 dB (GHz)
Transmission parameters for R&S®SFD-K202		
DVB-C	constellation	64QAM, 256QAM
	rolloff	0.15
	symbol rate	6.952 Msps
J83/B	constellation	64QAM
	rolloff	0.18
	symbol rate	5.056946 Msps
J83/B	constellation	256QAM
	rolloff	0.12
	symbol rate	5.360537 Msps

For data sheet, see PD 3607.3751.22 and www.rohde-schwarz.com.

ORDERING INFORMATION

Designation	Type	Order No.
DOCSIS signal generator, base unit, including power cable, quick start guide and CD-ROM with user manual	R&S®SFD	2118.7400.02
Supplied software		
Basic waveform library	R&S®CLGD-K2	2118.7469.02
Options		
Downstream generator	R&S®SFD-K200	2118.7423.02
Enhanced downstream functions	R&S®SFD-K201	2118.7830.02
Upstream generator	R&S®SFD-K300	2118.7430.02
Downstream frequency range extension to 1794 MHz	R&S®SFD-K3018	2118.7452.02
Signal interference simulation	R&S®SFD-K1050	2118.7446.02
Extended spectrum multi-carrier SC-QAM	R&S®SFD-K202	2118.8242.02

Warranty		
Base unit		3 years
All other items		1 year
Options		
Extended warranty, one year	R&S®WE1	
Extended warranty, two years	R&S®WE2	Please contact your local Rohde & Schwarz sales office.
Extended warranty with calibration coverage, one year	R&S®CW1	
Extended warranty with calibration coverage, two years	R&S®CW2	

Rear of the R&S®SFD



Service that adds value

- ▶ Worldwide
- ▶ Local and personalized
- ▶ Customized and flexible
- ▶ Uncompromising quality
- ▶ Long-term dependability

Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

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