

# Calian SFD DOCSIS® Signal Generator

## Signal generator for DOCSIS 3.1 downstream and upstream

The DOCSIS® 3.1 standard is driving the all-IP trend in cable TV networks. The Calian 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.

### At a glance

The Calian 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 Calian 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 Calian 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 Calian 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 Calian 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 Calian 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 1/2 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 Calian 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 SFD-K202 option for DOCSIS 4.0
- ARB generator bandwidth up to 200 MHz
- Signal interference and distortion simulation

Front of the Calian SFD



## 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

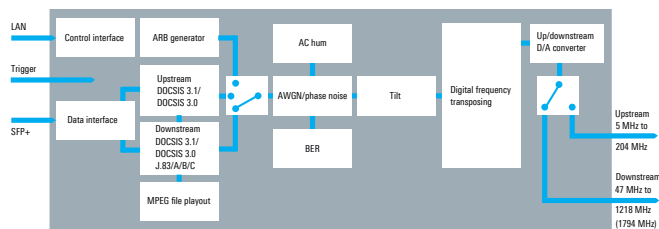
### Signal interference and distortion simulation

- 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 Calian SFD interfaces and function blocks



## Downstream signal generation

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

The Calian 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 DOCSIS 3.1:

- 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 Calian SFD DOCSIS 3.1 channel transmits internally generated PRBS or data streams fed in from outside via IP. The Calian 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 Calian 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 SFD-K202 option makes the Calian SFD a powerful cable load generator for extended spectrum SC-QAM frequencies in the 1002 MHz to 1794 MHz range.

The Calian 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

## 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 Calian SFD generates one signal of this type in the frequency range from 5 MHz to 204 MHz. Within this range, realtime modulation of a DOCSIS 3.1 OFDMA channel or a DOCSIS 3.0 channel with TDMA or CDMA is possible. DOCSIS 3.1 signals contain different message types (see table). The Calian 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 DOCSIS 3.1, the result is an OFDM signal in which different modems occupy different subcarrier parts. For DOCSIS 3.0 TDMA, the result is a pulsed signal with individual bursts from different modems. The Calian 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	Modulation
• DOCSIS 3.1	• OFDMA	• Data (PRBS or via SFP+) • Bandwidth request • Initial ranging • Fine ranging • Wideband probe
• DOCSIS 3.0	• A-TDMA/ S-CDMA	• Data packet (PRBS or via SFP+)

Rear of the Calian SFD



## Specifications in brief

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<b>RF parameters</b>		
Frequency range		47 MHz to 1212 MHz
	With SFD-K3018 option	47 MHz to 1788 MHz
Upstream frequency range		5 MHz to 204 MHz
Level	192 MHz DOCSIS 3.1	59 dBmV
	J.83/A/B/C (DOCSIS 3.0)	62 dBmV
MER	192 MHz DOCSIS 3.1	57 dB (typ.)
	J.83/A/B/C	48 dB (typ.)

## Specifications in brief

### Downstream modulation (SFD-K200 option)

DOCSIS 3.1	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 (SFD-K201 option)

Enhanced functions		Insertion of timestamps in the downstream PLC, display of transmission data rate, Calian FSW compatibility
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### Upstream modulation (SFD-K300 option)

DOCSIS 3.1	Modulation mode	OFDM
	Bandwidth	6.4 MHz to 96 MHz
DOCSIS 3.0	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		DOCSIS 3.1, DOCSIS 3.0, J.83, PAL, NTSC, A-TDMA, S-CDMA
	Included in Calian CLGD-K2	FM spectrum, additional PAL and SECAM signals

### Signal interference (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	DOCSIS 3.1	$\pm 15$ dB (GHz)

### Transmission parameters for 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

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