Realistic simulation: cable TV networks for J.83/B and DOCSIS 3.0

Despite faults and interference in cable networks, set-top boxes and cable modems always have to provide perfect reception. Therefore, they are thoroughly tested during development and production to make sure they fulfill this requirement. Rohde&Schwarz offers a system that, for the first time, can realistically simulate cable TV networks. The system consists of the R&S®SFU broadcast test system and several R&S®SFE100 test transmitters.

Interference affecting the path to the set-top box

Both the less-than-ideal modulation at the cable headend, e.g. due to phase noise, and the transmission path affect the signal quality. Amplifier stages ensure a sufficient signal level, but they also increase the noise component, superimpose AC hum, and the nonlinearities cause intermodulation products such as composite second order (CSO) and composite triple beat (CTB). The transmission path starts at the modulator output of the cable headend and ends at the real load, i.e. at the cable tuner of the set-top box or the TV set. Ideally, the characteristic impedance of cable TV distribution network should remain constant at every point along the transmission path. In the real world, however, differing impedances at terminals and connections lead to mismatches in the overall system. A part of the signal energy fed into the cable returns to the source. This type of micro-reflection causes amplitude and phase ripple in the transmitted signals.

Rack with several R&S®SFE100 for use in production.

"Breathtaking: It is small in size and fail-safe, consumes minimum power, provides high signal quality for all relevant broadcasting standards and is favorably priced …" This is how the R&S®SFE100 test transmitter was presented in NEWS 198, (pp. 62–64).

This article shows how the R&S®SFE100, together with the R&S®SFU broadcast test system, realistically simulates cable networks.

The most crucial components in the transmission chain are the TV receivers or set-top boxes. They should not produce additional interference and have to work perfectly outside the lab environment in various cable TV networks, even if the interferences described above are present. The large number of signals present in the cable network, primarily analog and digital adjacent channels, is also very critical. Electromagnetic interference from 3G/4G wireless communications signals in the upper frequency bands formerly used for terrestrial TV also increasingly causes problems for cable TV reception.

Simulation of cable TV networks in the lab

Up until now, in order to simulate a cable TV network in the lab, each channel needed its own generator. Although this enables a good simulation of analog TV signals with a CW signal, a large number of units are needed. Simulation is more efficient with a combination of arbitrary waveform generators and broadcast signal generators from Rohde&Schwarz (FIG 1). When simulating cable TV networks, there are three types of channels: the useful signal that is received by the set-top box under test, its two direct adjacent channels, and all other channels (also referred to as load). In addition to the simulation of a fully occupied cable network, the above-mentioned interference such as AC hum, micro-reflection and phase noise as well as white noise and pulse-like noise should be applied to the useful signal.

The R&S®SFU broadcast test system generates such useful signals in a reproducible way and in high quality. With its interferer management option, the R&S®SFU also generates the useful signal's two direct adjacent channels and allows interference from 3G/4G wireless communications signals to be simulated. The R&S®SFE100 test transmitter makes it much easier to simulate the other TV channels in the cable network, as compared to conventional systems which need a large number of units. Each R&S®SFE100 generates several adjacent analog or digital TV signals using a multichannel arbitrary waveform from the R&S®SFU-K356 waveform

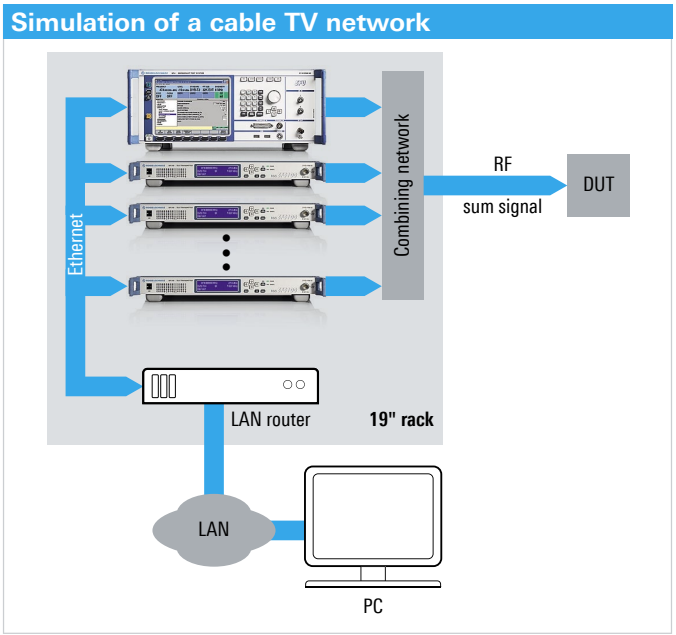

FIG 1 Signal-generation principle for simulation of a cable TV network.

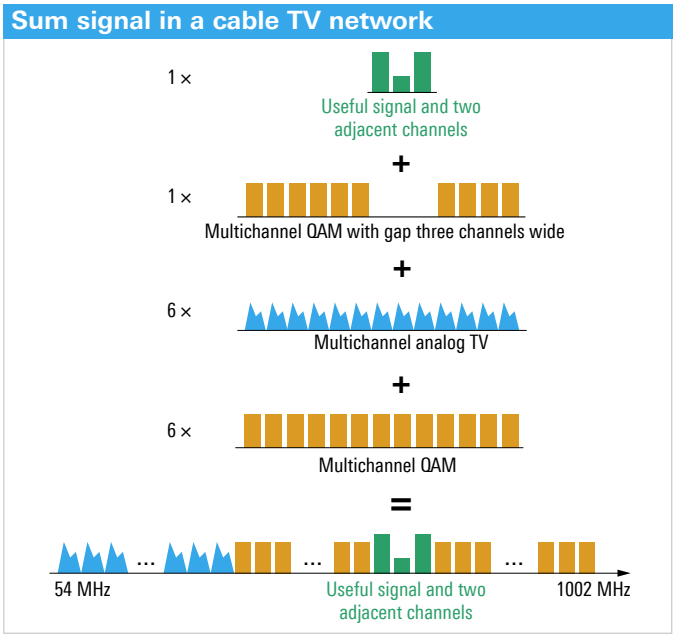

FIG 2 The total spectrum results from superimposing the useful signal, its adjacent channels and the load channels.

library. For example, an R&S®SFE100 test transmitter can generate 13 channels with 6 MHz channel bandwidth for the USA television. Only 13 R&S®SFE100 test transmitters are required for the entire 54 MHz to 1002 MHz (158 channels) frequency range used in the USA.

Seamless spectrum over 158 TV channels

The partial signals from each R&S®SFE100 test transmitter and from the R&S®SFU broadcast test system have to be superimposed. The R&S®SFU-K356 waveform library contains fully occupied multichannel signals and also a variety of multichannel waveforms with a gap three channels wide in which the R&S®SFU inserts the useful signal and the two adjacent channels. There is a suitable waveform for each possible position of the gap. Using a broadband combining network, all the signals can be superimposed and added together to form a seamless single-output sum signal (FIG 2). The signal generators and the combining network are mounted in a 19" rack, together with a power distributor and a fan unit. A LAN router, also integrated in the rack, connects the Ethernet interface of the units so that the entire system can be remotely controlled by a PC. This is a very compact solution and, compared to conventional solutions, the low number of units also reduces power consumption considerably. This conserves our environment and considerably reduces the operating costs.

Measurements in line with the USA ANSI/SCTE 40 standard

ANSI/SCTE 40* defines the minimum requirements based on the above scenario for cable TV networks and their components and receivers. In the USA, cable network operators always require proof from their suppliers that they meet this specification. Similar test specifications, adapted to local conditions, are used in Europe and Asia. The Rohde&Schwarz system makes it possible to simulate all common measurement scenarios in a universal and reproducible manner. Manufacturers can test their cable receivers in accordance with the highest quality requirements.

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* ANSI/SCTE 40 conformance testing using the R&S®SFU, R&S®SFE and R&S®SFE100. Application Note 7BM68 from Rohde&Schwarz.