Fading simulation with TV Test Transmitter SFQ

After the start of digital TV transmission via cable (DVB-C) and satellite (DVB-S), terrestrial digital transmission (DVB-T) is about to be introduced. In contrast to analog programs, DVB-T programs are broadcast via single-frequency networks, which allow a much more economical use of frequencies than conventional analog multifrequency networks. Influences of the terrain and the resulting problems of multipath propagation however prevail in this case as well (see blue box on next page).

Photo 43072

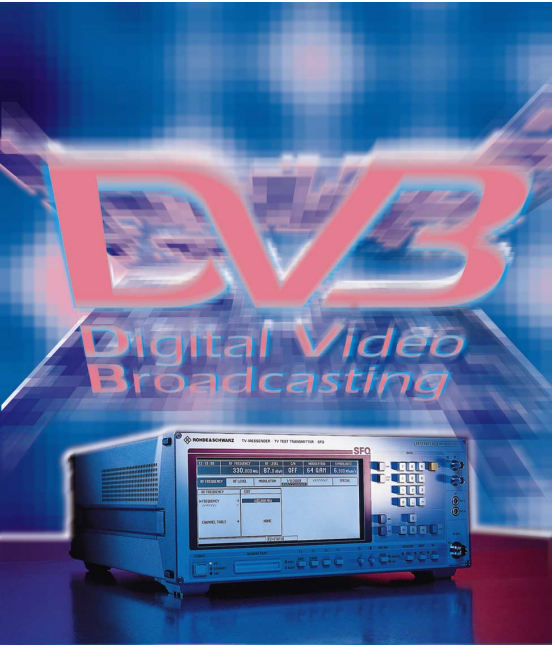

FIG 1 TV Test Transmitter SFQ, complete solution for testing digital TV links and receivers

The simulation of realistic receiving conditions in the terrestrial transmission channel is therefore an absolute necessity in the development of DVB receivers. **Fading simulators** [1] are used to create the corresponding scenarios.

TV Test Transmitter SFQ [2] introduced on the market with great success **for all DVB standards** is now available with **Fading Simulator SFQ-B11** (option). It is therefore ideal for testing and simulating receiving conditions particularly since all necessary features are combined in a single unit.

SFQ comes in two versions: with one option SFQ-B11 for simulating 6-path fading and with two options for 12-path fading. A fading profile using Rayleigh, Rician or pure Doppler distribution can be assigned separately to each path.

Pure Doppler fading simulates transmission on a single direct path between transmitter and mobile receiver. The Doppler shift is at its maximum when the receiver is moving on a direct path towards the transmitter or away from it.

Rayleigh fading simulates a radio traffic area where many strongly scattered waves evenly distributed in amplitude and phase arrive at the mobile receiver from all directions. With unmodulated signals, the Doppler spectrum typical of Rayleigh fading is obtained.

Rician fading simulates a radio traffic area where a strong direct wave is received in addition to many scattered

Multipath propagation

A signal emitted by the transmitter arrives at the receiver not only on the direct path. The transmission channel may be influenced by local conditions, eg topographical obstacles which cause reflections. The transmission behaviour also depends on the transmission frequency and in mobile operation on the vehicle speed. The sum signal at the receiver input may be made up of many single waves arriving with different delays phase and amplitude (FIG 3). In the worst case, the field strength at the receiver can be zero due to the mutual cancellation of the various waves. The Doppler effect has an additional degrading effect.

Impairment of mobile reception

The DVB-T standard was originally defined for stationary and portable reception but not for mobile operation. Detailed laboratory tests and field trials have shown however that the multicarrier method OFDM (orthogonal frequency division multiplexing) used with DVB-T is very reliable and also suitable for mobile reception. Mobile TV receivers are not equipped with roof antennas common for stationary analog receivers but with rod antennas that feature neither directivity nor gain. Due to this design aspect, the impairments caused by multipath propagation are difficult to eliminate.

TV Test Transmitter SFQ with option SFQ-B 11 is able to simulate the complex conditions in the transmission channel and so furnishes information on the response of mobile receivers in such situations.

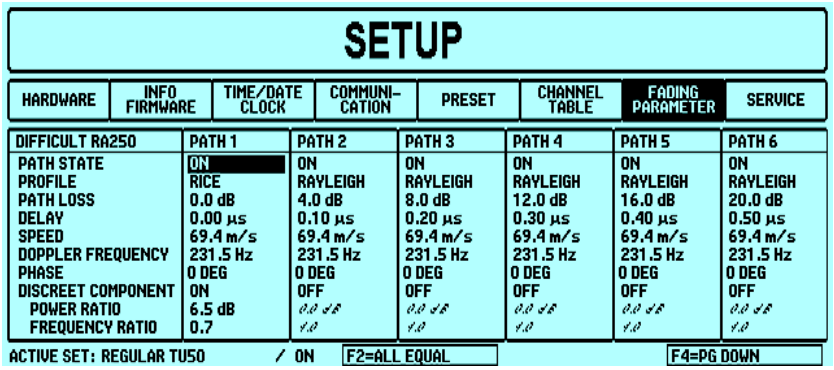

FIG 2 Predefined fading parameter set "DIFFICULT RA 250" in SFQ with six paths

above-mentioned fading types. Predefined channel models are stored in SFQ (FIG 2) and can be readily selected. The parameters can be varied as required.

In autumn 1998, the suitability of several DVB-T receivers for mobile operation was tested at the technology center of Deutsche Telekom within the MOTIVATE (mobile television and innovative receivers) project. On this occasion, SFQ with optional Fading Simulator SFQ-B 11 and Noise Generator SFQ-B 5 demonstrated its merits in this field of application in an impressive way.

Erhard Kretschmer

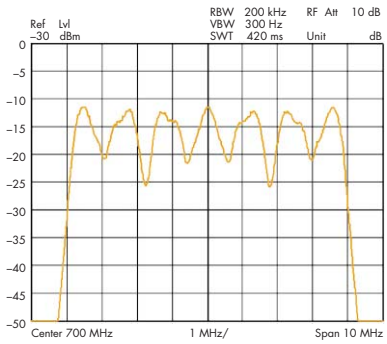

FIG 3 Spectrum of three-transmitter DVB-T single-frequency network. Signals are received with different delays

REFERENCES
[1] Lüttich, F.: Signal Generator SMIQ + SMIQ-B14 – Fading simulator and signal generator in one unit. News from Rohde & Schwarz (1997) No. 155, pp 9–11
[2] Kretschmer, E.; Zimmermann, F.-J.: TV Test Transmitter SFQ – Digital test signals for the television future. News from Rohde & Schwarz (1997) No. 153, pp 14–16

waves. The fading spectrum of an unmodulated signal is the superimposition of the classic Doppler spectrum with a discrete signal line.

Log normal fading simulates an additional, rather slow variation of the receiving amplitude of a mobile receiver. If **Rayleigh fading** is switched on at the same time, **Suzuki fading** is obtained.

For each path, attenuation, delay, Doppler frequency and speed as well as the parameter denoting slow fading can be entered in addition to the

Condensed data of Fading Simulator SFQ-B11

RF bandwidth (3 dB)	14 MHz
Paths	12 (using 2 options SFQ-B 11)
Path attenuation	0 to 50 dB, resolution 0.1 dB
Path delay	0 to 1600 ms, resolution 50 ns
Doppler shift	0 to 1600 Hz
Fading profiles	Rayleigh, Rician, pure Doppler, log normal
Predefined fading parameter sets	5 for 6 paths, 8 for 12 paths

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