TV Test Transmitter SFQ

Digital test signals for the television future

TV Test Transmitter SFQ is a complete solution for testing digital TV receivers. It specializes in the generation of standard DVB signals for satellite and cable transmissions. SFQ also processes analog, frequency-modulated satellite TV and sound signals to PAL, SECAM and NTSC standards. Audio signals are transmitted with analog FM and digital ADR sound subcarriers.

FIG 1 TV Test Transmitter SFQ generates standard DVB signals. Photo 42 592

Timed just right for the beginning of the era of digital TV, Rohde & Schwarz is launching a new TV test transmitter on the market: the SFQ (FIG 1). It is capable of processing source-coded signals to MPEG2 standard for digital transmission via satellite or cable. The main **features** of SFQ are:

- wide output frequency range from 0.3 to 3300 MHz,
- generation of standard DVB-S and DVB-C signals (S = satellite, C = cable) in line with ETS 300 421 and 300 429 specifications [1],
- input data rate selectable between 2 and 60 Mbit/s,
- switch-selected energy dispersal, Reed-Solomon coder and interleaver,
- variable rolloff factor for pulse shaping,
- data, random sequence, null transport stream packet selectable as modulation signal,
- application of external I/Q signals,
- adjustable puncturing rate for QPSK (quadrature phase shift keying),
- selectable QAM (quadrature amplitude modulation) modes (16, 32, 64, 128, 256QAM),
- generation of standardized FM satellite signals,
- selectable standard for FM transmission (PAL, SECAM and NTSC),
- up to six FM sound subcarriers with internal audio generators,
- up to twelve ADR sound subcarriers (Astra digital radio) with internal MUSICAM generators,
- internal noise generator.

These features open up a wide **field of application** for SFQ in development and production as well as in the service of digital TV receivers and their modules. System margins have to be checked at the latest during final testing of receivers to avoid their early failure at the customer. SFQ with built-in noise generator and MPEG2 Generator DVG [2] are the right team for this job. In the laboratory SFQ convinces by its great variety of modulation modes and parameter settings. When it comes to EMC testing, SFQ and DVG form an ideal signal source for checking out TV receivers.

Design and options

The **flexible modular concept** allows SFQ to be equipped to suit the customer's measurement requirements. The TV test transmitter comes in three models (FIG 2). Model 10 is particularly suitable for the requirements of DVB applications. Model 90 comprises all the modules required for analog satellite FM transmission. Model 50 is the complete solution made up of models 10 and 90 for generating digital DVB signals and analog FM satellite signals.

Realistic receiving conditions can be simulated with the aid of a noise generator. For this purpose the digital SFQ model 10 can be equipped with a **broadband FM module** comprising a noise generator in addition to the FM modulator. The noise signal is added to the information signal by way of a coupler to produce a defined C/N (carrier-to-noise) signal. With the broadband FM module included in models 90 and 50, the noise generator is automatically available. The **FM subcarrier module** in models 90 and 50 generates two completely conditioned FM subcarriers. Two additional subcarrier modules may optionally be fitted: FM or

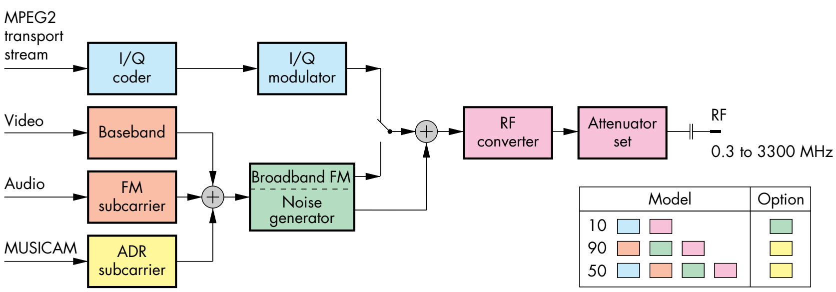

FIG 2 Block diagram of three models of TV Test Transmitter SFQ

ADR subcarrier. A total of six carriers can then be transmitted.

Coding and mapping for satellite and cable

TV Test Transmitter SFQ encodes the applied transport stream for satellite and cable transmissions to standard and conditions it so that I and Q (inphase and quadrature) signals are obtained. SFQ accepts transport streams with a packet length of 188 or 204 bytes. The input interface is synchronously parallel in LVDS (low-voltage differential signalling) format [3]. The input data rate can be set between 2 and 60 Mbit/s. The incoming data rate is measured and adopted in the setting by a simple keystroke.

In addition to the external transport data stream, a random sequence or null transport stream packet as defined in the DVB measurement guidelines [4] can be selected. SFQ warns the user if the input signal fails or the set data rate does not match the incoming one. In this case the data stream is linked to a random sequence, ensuring that signal energy is evenly distributed (energy dispersal). Energy dispersal can of course be disabled.

Following energy dispersal a Reed-Solomon coder (204, 188) is provided as an outer coder for error control. 16 bytes are added to the unchanged 188 data bytes. These 16 bytes represent the redundancy that allows eight errored bytes of a frame to be corrected. A convolutional interleaver with depth of 12 and base delay of 17 transmits the data evenly distributed over a relatively long period of time. If data transmission is impaired for a limited time, the large interference is split into many small interferences that can be corrected by the Reed-Solomon decoder. The interleaver can also be disabled.

Until after the convolutional interleaver, coding is the same for satellite and cable transmission. After the interleaver additional inner error-control coding is performed for the **satellite signal:** convolutional encoding with subsequent puncturing. The convolutional encoder has a rate of 1/2, constraint length of 7 and generator polynomials 171 (octal) and 133 (octal). This procedure doubles the data rate. Puncturing is carried out next, ie bits are left out in the transmission as specified in the standard so that the data rate is reduced again. Mapping into the I and Q path is performed at the same time. All DVB puncturing rates (1/2, 2/3, 3/4, 5/6 and 7/8) are selectable on SFQ. The concatenated error control for satellite transmission ensures that with input error rates of 1×10^{-3} a data signal with a BER of approx. 1×10^{-12} is available at the receiver end. The spectrum is limited by pulse filtering. A square root cosine rolloff factor of 0.35 is prescribed for satellite transmissions. The factor can be adjusted in SFQ between 0.25 and 0.45.

No inner coding is performed for **cable transmissions,** as in this case interference due to noise, nonlinearities and interruptions is less likely than on satellite links. Mapping is carried out first, depending on the QAM order. 64QAM is normally used in cable transmissions. With 64QAM, six bits are combined to a symbol and differentially coded. 16QAM, 32QAM, 128QAM and 256QAM can also be selected in SFQ. For cable transmission too, pulse filtering is used to limit the signal spectrum. The nominal factor is 0.15 and can be varied between 0.1 and 0.2.

I/Q modulation

In the I/Q modulator the two orthogonal I and Q components of the RF signal are controlled in amplitude and phase by the serial I and Q data streams from the coder. The two RF components are added to give an output signal that can be amplitude- and phase-modulated as required.

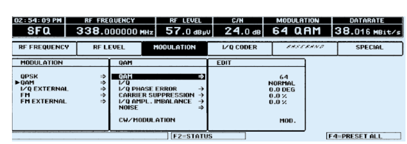

FIG 3 Menu display for QAM modulation

Assignment of I and Q components in SFQ can be interchanged 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 SFQ guarantees that I and Q paths show identical gain, the phase is exactly 90° and carrier suppression at least 50 dB. Non-ideal behaviour of the I/Q modulator can be simulated by deliberately detuning amplitude, phase and residual carrier (FIG 3). As a result bit errors are produced allowing quality assessment of receivers or demodulators

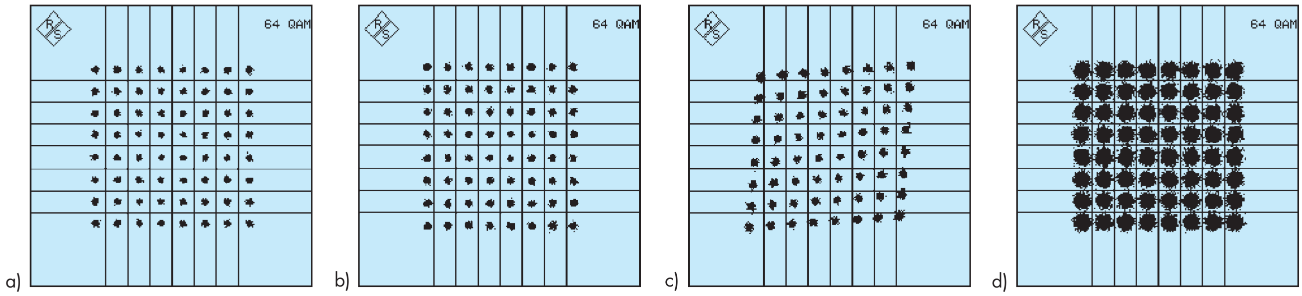

FIG 4 Constellation diagram showing at left ideal 64QAM signal of accurately aligned I/Q modulator a) and deliberately misaligned 64QAM signals with b) 10% amplitude imbalance, c) 10° phase error and d) superimposed noise (C/N = 24 dB)

(FIG 4). DVB Test Receiver EFA [5] is an ideal instrument for detecting and calculating QAM quality parameters.

Analog baseband conditioning and frequency modulation

Analog FM TV transmission via satellite will certainly be used for years alongside digital QPSK modulation. For this reason SFQ is also able to condition analog TV channels with all appropriate characteristics: eg dispersal signal synchronous to video frame, automatic deviation doubling in the case of video signal failure, deviation inversion for video and energy-dispersal signal, deviation adjustment for video signal, dispersal signal and separately for each sound subcarrier. TV standards PAL, SECAM or NTSC are selectable.

In the Astra satellite system it is planned to transmit further audio and data channels in addition to the accompanying stereo (7.02/7.20 MHz) or mono (6.5 MHz) sound channel. The built-in MUSICAM generator can produce up to twelve ADR subcarriers. If more than six subcarriers are required, a second SFQ will have to be used. The modules of this unit are controlled by the master SFQ via the internal SERBUS. SFQ thus meets all requirements for conditioning analog TV channels transmitted via satellite.

Noise generator

The noise generator produces white noise with a Gaussian distribution at the set output frequency over the channel bandwidth. The power density of the noise signal can be set indirectly as a C/N (carrier-to-noise) ratio. This is extremely convenient for the user as the C/N ratio in dB can be entered immediately after the selection of the demodulator receive bandwidth. SFQ can thus simulate different types of interference as they really occur along the satellite or cable transmission path to the receiver.

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REFERENCES

[1] ETS Specifications (1994): Digital broadcasting systems for television, sound and data services. Framing structure, channel coding and modulation for 11/12 GHz satellite services (ETS 300 421); ~ for cable systems (ETS 300 429)

[2] Fischbacher, M.; Weigold, H.: MPEG2 Generator DVG and MPEG2 Measurement Decoder DMVD – Test equipment for digital TV in line with MPEG2. News from Rohde & Schwarz (1996) No. 152, pp 20–23

[3] DVB-PI 154: Interfaces for CATV/SMATV Headends and Similar Professional Equipment (1995)

[4] DVB-TM 1601: Measurement Guidelines for DVB Systems

[5] Balz, C.; Polz, E.; Fischer, W.: TV Test Receiver Family EFA – Top fit for digital television. News from Rohde & Schwarz (1996) No. 152, pp 17–19

Condensed data of TV Test Transmitter SFQ

Coding and modulation (DVB-S and -C)	to ETS 300 421 and ETS 300 429
For DVB-S	
Puncturing rates	1/2, 2/3, 3/4, 5/6, 7/8
Modulation	QPSK
For DVB-C	
Modulation	16, 32, 64, 128, 256QAM
I/Q modulation	
Detuning of phase error	±10°
Detuning of amplitude imbalance	±10%
Detuning of residual carrier	0 to 50%
Analog baseband and FM	
Video and dispersal signal conditioning	for PAL, SECAM and NTSC
FM sound subcarriers	up to 6, internal
ADR sound subcarriers	up to 12, internal
Output frequency range	0.3 to 3300 MHz
Output level	+4 to –99 dBm (CW: +13 dBm)
Noise generator	C/N = 0 to 60 dB, resolution 0.1 dB

Reader service card 153/05