TV Test Transmitter SFL

Five specialists in production: test signals for all digital standards

In broadband communication networks and in satellite and terrestrial transmission, the changeover from analog to digital TV transmission is well under way. Receivers and set-top boxes for digital reception are being produced in large quantities for the consumer market. The TV Test Transmitter Family SFL has been developed by Rohde & Schwarz to test these receivers. The SFL test transmitters offer all the features required of modern test transmitters in production: wide frequency range, comprehensive modulation modes, high reliability – and all this at an attractive price.

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FIG 1 Fully-fledged DVB-T test transmitter in a compact case (here: DVB-T model SFL-T)

All digital modulation modes

The different SFL models (FIGs 1 and 2) cover all digital modulation modes relevant in broadcasting in the frequency range 5 MHz to 1.1 GHz (model SFL-S up to 3.3 GHz). Where frequency accuracy and spectral purity are concerned, the SFL family is a perfect match for the universal TV Test Transmitter Family SFQ [1, 2, 3] from Rohde & Schwarz. Frequency setting is crystal-controlled with resolution of 0.1 Hz. Excellent SSB phase noise and spurious values are ensured by direct digital frequency synthesis (DDS), which not only makes for outstanding noise characteristics but also short frequency setting times – vital features in production environments.

New approaches were also taken in I/Q modulation. The SFL modulates the carrier directly at its output frequency. This is possible thanks to an integrated circuit developed by Rohde & Schwarz.

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

High demands are placed on the I/Q modulator, particularly with regard to high-order quadrature amplitude and COFDM modulation. The internal calibration of the SFL ensures that the I and Q paths have identical gain, the phase is exactly 90° and maximum carrier suppression is attained.

Versatile input interfaces

The SFL input is capable of handling MPEG transport streams of 188 byte or 204 byte packet length (see block diagram, FIG 3). The SFL ensures a standard-conformant output symbol rate for virtually any input data rate. This is achieved by means of the stuffing functionality of the SPI (synchronous parallel interface) and the ASI (asynchronous serial interface), which allows setting of the output symbol rate independently of the input data rate. A synthesizer generates the exact symbol rate even if no transport stream is present at the input. This enables any desired symbol rates to be generated independently of the input data rate. The following input interfaces are available:

- Synchronous parallel interface (TS parallel or SPI)
- Asynchronous serial interface (ASI) with up to 270 Mbit/s
- Externally clocked asynchronous serial interface (ASI ext. clock)
- Externally clocked parallel interface (SPI ext. clock)
- SMPTE-310 interface for ATSC (optionally with ext. clock)

Instead of an external transport stream, internal data sources can be used, e.g. PRBS sequences for bit-error-rate measurements on receivers.

Processing useful data in line with standards

The I/Q coder of the TV Test Transmitter SFL encodes the incoming transport stream in line with standards for transmission via antenna, satellite or cable, and processes it so that I and Q signals are obtained. For optimal protection of the data streams during transmission, they are subjected in the coder to forward error correction (FER), which widely varies between standards.

First, sync detection is usually performed, then a randomizer adds a random bit sequence to the signal. The next FEC steps are Reed-Solomon coding and interleaving. With DVB-C, these steps are followed by mapping to generate the I and Q signals, whereas in the case of the other standards, convolutional encoding and puncturing or trellis encoding come first.

With DVB-S and 8VSB / J.83/B, mapping is performed after convolutional encoding and puncturing/trellis encoding. With the American cable standard [1], trailer symbols are inserted in addition ahead of the trellis encoder or, with the American terrestrial standard [2], a field sync after the trellis encoder. These measures improve synchronization at the receiving end.

Model	Test signals for	Standard	Modulation modes
SFL-T	Terrestrial transmission	DVB-T	COFDM (coded orthogonal frequency division multiplexing)
SFL-V	Terrestrial transmission	ATSC / 8VSB	8VSB (eight-level trellis-coded vestigial sideband)
SFL-J	Cable transmission	ITU-T J.83/B	64 / 256QAM
SFL-C	Cable transmission	DVB-C, J.83/A / C	16 / 32 / 64 / 128 / 256 QAM
SFL-S	Satellite transmission	DVB-S (DSNG)	QPSK, 8PSK, 16QAM

FIG 2 Five models are available to optimally suit your application. The I/Q modulator of the SFL of course also supplies signals to any other digital standards with the aid of an external I/Q signal.

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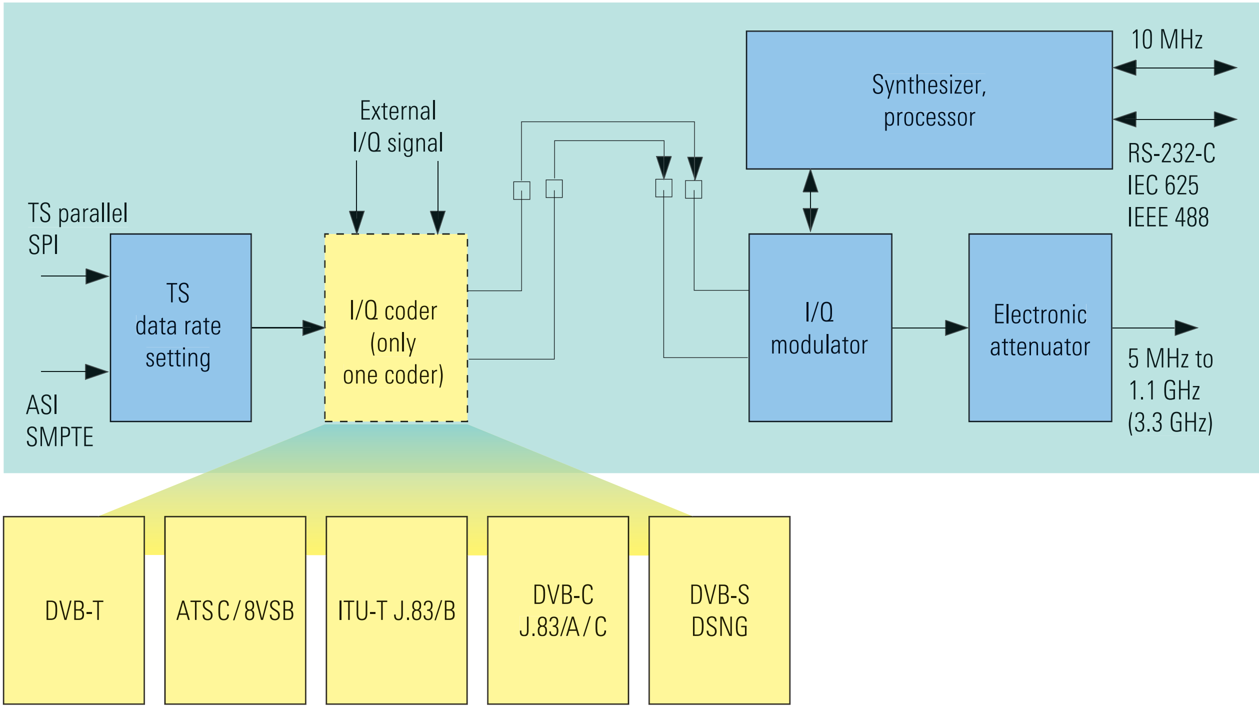


FIG 3 Block diagram of TV Test Transmitter SFL

With the terrestrial system DVB-T [3], convolutional encoding is followed by an additional interleaver, then come mapping, framing, and OFDM modulation with 1705 or 6817 carriers generated by an inverse Fourier transform.

As a final step, all coders carry out FIR (finite impulse response) filtering of the I and Q signals before these are further processed in the modulator.

Electronic level setting

Tough production environments place heavy demands on the attenuator in the output of a test transmitter. Precision and speed are called for, and above all maximum reliability.

That is why the TV test transmitters are fitted with an electronic attenuator. Any number of levels may be set without causing wear, and setting times are very short. The high-precision frequency response correction ensures the same high levels of accuracy as provided by conventional test transmitters with mechanical attenuators.

Mechanical attenuators do not perform continuous level setting, nor do electronic attenuators. The SFL, therefore, like test transmitters with a mechanical attenuator, offers a "non-interrupting level setting" mode. In this mode, the level can be decreased over a range of 20 dB, starting from a user-selectable value between 0 dBm and –140 dBm. This makes the SFL ideal for sensitivity measurements.

Realistic test conditions

Standard-conformant signals are useful in go/nogo tests but in most cases do not adequately reflect realistic transmission conditions. The SFL can simulate the errors occurring in practice, thus enabling the error limits and performance limits of devices under test to be determined. The following functions make the SFL an ideal choice for such tests:

- It can generate output signals with I/Q modulation, thus allowing sideband switchover (IF/RF inversion)
- The residual carrier, I/Q phase and I/Q imbalance can be set deviating from the optimal value
- The high-precision digital Noise Generator SFL-N (option) allows bit error ratio (BER) characteristics of receivers to be recorded for quality classification
- All important steps of FEC can be disabled. This is necessary in the development of receivers and decoder chips and facilitates troubleshooting in servicing
- The data signal applied to the SFL can be replaced by internally generated test signals at various points of

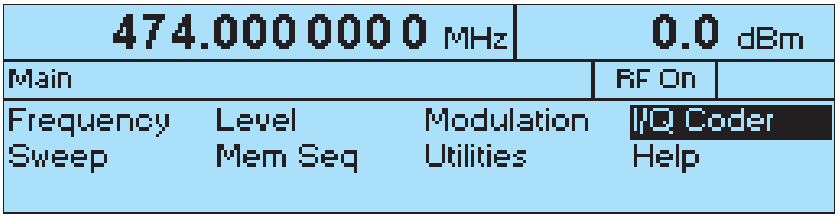


FIG 4 Menu concept for operation of TV test transmitter: straightforward as in all instruments from Rohde & Schwarz

the encoder. The following test signals are available:

- null TS packets,
- null PRBS packets ($2^{15}-1$ or $2^{23}-1$),
- PRBS before / after convolutional/ trellis encoder,
- PRBS before mapper for simple BER measurements on receivers.

The wide output frequency range of the SFL models enables tests far beyond the frequency ranges defined by the standards. The wide output level range allows measurements on high-sensitivity receiver modules as well as transmission measurements at high levels.

To obtain reliable information as to the quality of components or modules, high output level accuracy is required. The SFL perfectly meets this requirement thanks to its close-tolerance level deviation and high level reproducibility. The extremely short setting times for frequency and level are unmatched among competitors. They allow short test times and make the SFL an optimal test transmitter in production.

In the unlikely event of a fault, built-in diagnostics help cut time to repair to a minimum. Not only an extremely attractive price but also low follow-on costs make the SFL a sound investment.

The logically structured menu system (FIG 4) makes operation very convenient. Complex test sequences are executed automatically at a keystroke in the integrated list mode.

In production environments, space is often at a premium. Here, the SFL's compact size is a particular plus. The solid mechanical construction ensures high RF shielding of the enclosure, which is especially important in measurements on highly sensitive receivers.

Summary

Like the successful SFQ models, the SFL offers many proven features: user-friendly operation, messages indicating non-standard settings or operating states, status menu, online help, IEC/ IEEE bus and RS-232-C interfaces as well as firmware updates via PC.

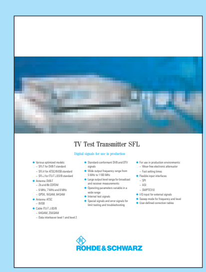
As an alternative to the universal Test Transmitter Family SFQ, the SFL offers single-standard functionality optimized for production. The SFL is thus a budget-priced and future-proof investment.

Albert Dietl

Condensed data of SFL

Frequency range	5 MHz to 1.1 GHz (SFL-S: 3.3 GHz)
Level range	–140 dBm to 0 dBm
Data inputs	TS parallel (LVDS), SPI, ASI, SMPTE 310
Option	Digital Noise Generator SFL-N
Remote control	IEC-625 (IEEE 488) and RS-232-C

More information and data sheet at www.rohde-schwarz.com (search word: SFL)



Data sheet SFL

REFERENCES
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[2] SFQ goes North American – with digital TV standard ATSC. News from Rohde & Schwarz (2000) No. 166, pp 13–15
[3] SFQ Model 20 – TV via antenna: digitally fit. News from Rohde & Schwarz (1999) No. 161, pp 4–6