ATSC Test Receiver EFA

All measurement functions for North-American digital TV standard

Following North America’s decision in favour of ATSC/VSB (Advanced Television Systems Committee) for digital TV broadcasting, Rohde & Schwarz started to develop the necessary instrumentation and transmitters (see overview on page 13). After the successful launch of test receivers for analog TV signals and European digital TV standards, a new member for ATSC has now joined the EFA family. Compact in design and with extensive automatic test functionality, this receiver (FIG 1) is ideal for applications in the development and production of transmitter modulators as well as acceptance testing of large transmitter systems and monitoring the quality of digital TV signals.

Full ATSC coverage by 2002

Key features of the North-American digital TV standard are the use of MPEG2 (Moving Pictures Experts Group) to compress video and audio signals, and 8VSB modulation (see box, pp 12–13).

A decisive factor for fast, nationwide introduction of digital TV in the United States was the allocation of additional 6 MHz channels for the parallel transmission of digital TV programs by all the approximately 1600 broadcast stations. This made it possible to operate simultaneously on digital and analog channels during the transition period.

Another milestone was the definition of a tight time frame by the legislation, compelling stations to start broadcasting digital TV signals in good time. The first digital programs were transmitted on schedule in November 1998. To date (May 2000) some 120 stations are on air with digital programs, providing coverage for about 60% of the US-American population. By late 2002 all commercial TV stations are to follow. It is planned to shut down all analog channels by the end of 2006.

EFA – characteristics

ATSC Test Receiver EFA, fully compatible with the ATSC Doc. A/53 standard, receives, demodulates, decodes and analyzes VSB (vestigial sideband) signals. All major parameters for demodulating the receive signal can be selected automatically or manually:
- 8VSB modulation,
- trellis decoder (code rate 2/3),
- variable symbol rate for special modulator tests and lab analysis,
- Reed-Solomon error correction 207/187/10,
- filter bandwidth 6 MHz, optionally 2 MHz and 8 MHz.

The operating principle of the new receiver is largely identical with that of the other receivers of the EFA family [*] except for standard-specific functions.

Singular versatility

The new test receiver features a multitude of innovative measurement functions right from the basic version, allowing comprehensive, in-depth signal analysis. In addition to measurement of general parameters such as bit error ratio (BER) (FIG 2), more thorough analysis includes:
- I/Q constellation diagrams with selectable number of symbols to be represented,
- eye aperture and modulation error (MER/EVM) versus time,
of its rapid data acquisition, the test receiver is an ideal choice not only in R&D but also in production monitoring, where high measurement speed is called for.

**EFA-ATSC as monitoring receiver**

Monitoring receivers permanently monitor the major parameters of broadcast signals directly at the transmitting station (FIG 6). EFA-ATSC is tailor-made for this application. Six parameters with separately selectable alarm thresholds can be configured for monitoring. Particularly worth emphasizing is BER monitoring ahead of and after the various error-protection blocks, allowing early detection of any problems. Detected transmission errors are saved in the test receiver together with the date and time in error reports comprising up to 1000 entries. In addition, it triggers an acoustic alarm.

**Use as relay receiver**

For this special application, EFA is simply optimized for reception at a keystroke. This allows reception even under adverse operating conditions. The user is also able to configure the bandwidths of the main amplitude- and phase-control loops.

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**Realtime signal analysis**

The powerful digital signal processing of EFA provides fast and in-depth analysis of 8VSB signals (FIG 5). Analysis is simultaneous with and independent of demodulation and decoding, so the MPEG transport stream is permanently available for vision and sound reproduction. Thanks to this realtime analysis capability, the large number of measured values necessary for the complex calculation and display processes are produced fast for subsequent mathematical-statistical processing. Because

- calculation of transmission parameters like pilot carrier,
- amplitude spectrum of user channel,
- linearity analysis from histogram of amplitude distribution,
- complex channel transmission function,
- received echo signals (ghost pattern).

Any failures and degradations are visible straight away from the constellation diagram (FIG 3). Effects of interest can be located more precisely by varying the number of symbols represented. A particularly effective method here is presentation of eye aperture as a function of time. Eye apertures plus decision thresholds are displayed on a largely user-selectable scale revealing, for example, periodic transmission errors or individual interferers at a glance and allowing immediate identification. Trend analyses, too, are possible with this method.

The integrated spectral analysis function enables simple examination of the signal type and its spectrum. You can see immediately, for example, whether there is a marked frequency offset, or if the pilot-carrier level matches the specification (FIG 4). An optional filter with 8 MHz channel bandwidth covers spectral components outside the 6 MHz user channel while effectively suppressing more distant components.

**Captions to FIGs 2 through 6**

**FIG 2** Measurement menu: all important data visible at a glance

**FIG 3** Constellation diagram, here representing 10000 symbols

**FIG 4** Spectral analysis of 8VSB signal by means of FFT

**FIG 5** Display of calculated 8VSB transmission parameters in corresponding measurement menu

**FIG 6** Simultaneous analysis/measurement of key parameters – ideal for monitoring tasks

Further articles on Test Receivers EFA on pages 32 and 37 of this issue.

**ATSC/VSB MEASURE**

<table>
<thead>
<tr>
<th>CENTER FREQ</th>
<th>CHANNEL</th>
<th>ATTEN</th>
<th>S/N</th>
<th>Measurement menu: all important data visible at a glance</th>
</tr>
</thead>
<tbody>
<tr>
<td>300.000 MHz</td>
<td>1.2 dBm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Modulation:** 8VSB

**Frequency:**
- SET CENTER FREQ 300.000 MHz
- SET PILOT FREQ 257.300 MHz
- PILOT FREQ OFFSET 0 dB
- SET SYMBOL RATE 10 793 symbol/s
- SYMBOL RATE OFFSET +2.8 ppm

**BER:**
- BER BEFORE UT 0.0 E-10 (1000/1000)
- BER BEFORE RS 0.0 E-10 (1000/1000)
- BER AFTER RS 0.0 E-3 (1048/1048)
- RESET BER

Further articles on Test Receivers EFA on pages 32 and 37 of this issue.
specific amplitude level (eight levels). Synchronization data (segment sync, field sync) are added to the coded signal for data recovery in the receiver (error correction, channel equalizer). For carrier recovery in the receiver, the unmodulated carrier is added to the 8VSB signal as a pilot. To make the most efficient use of the available bandwidth, only one sideband of the AM-modulated signal is transmitted (vestigial-sideband suppression). Prior to emission, the modulated signal is shaped by a root-cosine rolloff filter \( (r = 0.115) \).

### ATSC/VSB Measure: Spectrum

- **Center Freq**: 200 MHz
- **Channel**: 1.2 dBm
- **Pilot Carrier**:
  - **Pilot Value**: 1.25
  - **Data Signal / Pilot**: 14.3 dB
  - **Pilot Amplitude Error**: 0.0 dB
- **Transmission**:
  - **Phase Jitter (PMS)**: 0.23
  - **Signal Noise Ratio**: 41.8 dB
- **Summary**:
  - **BER (PES)**: 1.0 x 10^-6
  - **BER (PES)**: 0.05
  - **BER (PES)**: 1.25
- **HDC Noise OFF**

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### ATSC/VSB Alarm: Config

- **Center Freq**: 200 MHz
- **Channel**: 1.2 dBm
- **Disabled**: 30 dB
- **Level**:
  - **Disabled**: 30 dB
  - **Sync**:
  - **Disabled**: 30 dB
  - **Error / Error**:
  - **Disabled**: 30 dB
- **BER Before viT**:
  - **Disabled**: 30 dB
  - **BER Before RS**:
  - **Disabled**: 30 dB
  - **MPEG Error**:
  - **Disabled**: 30 dB

### Condensed data of EFA-ATSC

- **Frequency range**:
  - Model 50: 48 MHz to 862 MHz
  - Model 53: 43 MHz to 1000 MHz
  - Model 53 with option EBA: 5 MHz to 1000 MHz
- **Input level range**:
  - Model 50: -77 dBm to +10 dBm
  - Model 53: -47 dBm to +14 dBm
  - Model 53 with option EBA: -77 dBm to +14 dBm
- **Bandwidths**: 8 VSB
- **Modulation**: 8 VSB
- **Symbol rate**: 2 to 11 Msymbol/s
- **Equalizer**: auto/freeze/off
- **BER analysis**: ahead of and after Reed-Solomon decoder, ahead of Viterbi decoder
- **Measurement functions**: level, BER, MER, EVM, SNR, pilot-carrier level, pilot-carrier frequency, symbol rate
- **Graphical functions**: I/Q constellation, amplitude spectrum, echo signals (ghost pattern), complex channel transmission function, amplitude distribution, eye pattern, history
- **Output signals**: SMPT 310, MPEG-TS: SPI, ASI
- **Options**: RF preselection (EBA-83), SAW filter 8 MHz/2 MHz (EBA-83/-B14)

### Reader service card 167/03

**UHF Transmitter Family NH/NV7000**

**MPEG2 Realtime Monitor DVRM**

**REFERENCES**