Monitoring DAB and DVB-T transmitter systems

Measurements made easy: firm grip on complex problems

To identify transmitters, handle interference and verify compliance with stipulated conditions for authorization, the monitoring services of licensing authorities must be capable of measuring the technical parameters of transmitter systems off air. Rohde & Schwarz offers an extensive range of monitoring and measuring equipment for this purpose (FIG 1).

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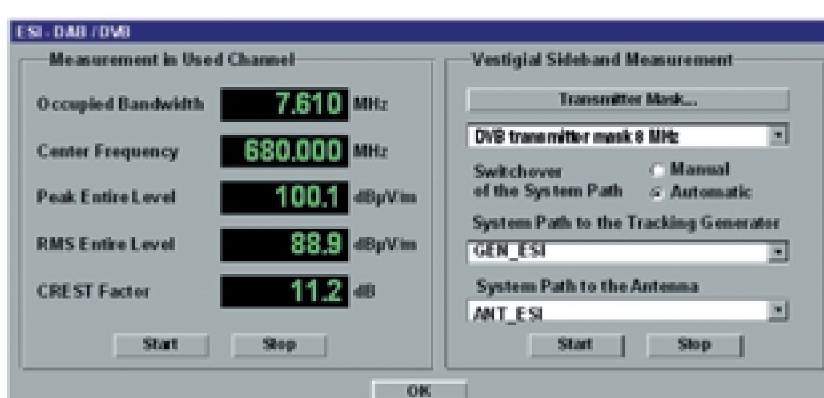
FIG 1 Rohde & Schwarz offers an extensive range of stationary and mobile monitoring and measuring equipment for the latest methods of digital transmission

Evaluation of interference on digital transmission links additionally requires measurements of coverage and bit error rate. Here too, Rohde & Schwarz is able to offer a wide selection of coverage measurement systems [2].

Complete product line for complex measurement tasks

Modern DAB and DVB-T systems use complex modes of digital transmission, the measurement and identification of which require special instruments and methods. All major technical parameters of such systems can be measured with **Spectrum Monitoring System ARGUS-IT** (formerly SMSI) [1] together with Spectrum Analyzer FSE, Signal Analyzer FSIQ or EMI Test Receiver ESI plus Measurement Software ArgusMon (FIG 2). Some typical measurements are described below.

FIG 2
Dialog window of EMI Test Receiver ESI in DAB/DVB-T measurements with Measurement Software ArgusMon



Typical tasks of monitoring services

Receive level

The strength of the receive level must be known to assess quality and propagation conditions. And it is also the basis for coverage measurements. Unlike with analog signals, the type of detector used plays an important role in transmissions with digital contents. Depending on the modulation of the individual carriers, the level of a DAB/DVB-T signal has different peak, average and rms values. Whereas the peak value of the main carrier (or the sum of the carriers with COFDM) represents the maximum of the rms values collected during the measurement time, the time-averaged rms value corresponds to the power of an unmodulated CW carrier of the same level. Both values can be varied by suitably influencing (coding) the transmitted information. For example, if you ensure that practically no 64QAM values simultaneously have 0° or 180° phase and maximum amplitude, the result is a signal with a very large margin between peak and rms, whereas in simple frequency shift keying without any amplitude modification the two values will be the same.

For adequate reception quality, the total energy applied to the receiver, ie the rms value, is decisive. If the digital transmission system is the source of interference however, the peak value is the key factor, since this determines the extent of interference especially on analog receivers. So monitoring services must be capable of measuring both peak and rms values. The difference between the two is called the crest factor and specified in dB. It is a characteristic feature of every kind of digital transmission, and for DAB/DVB-T it is typically between 10 dB and 13 dB. To avoid impairment of other radio services by high peak loads and to make effective use of available transmitter power, it is necessary to keep this value as low as possible, for example by appropriate coding of the data stream.

Digital transmission systems take up a lot of bandwidth, so broader IF filters than for analog radio services are usually needed to measure level accurately. Assuming that the transmitted energy is uniformly distributed across the used channel (as with DAB and DVB-T), the entire level can also be measured with narrower filters and converted to the actual bandwidth. The ArgusMon software sets the analyzer to a filter bandwidth of 1 MHz for this measurement. Conversion to entire level is done automatically using the occupied bandwidth measured narrowband.

Occupied bandwidth

This is an important criterion for identifying radio services since their channel spacings are known. And measuring the occupied bandwidth of digital systems is especially important because they often tend to produce considerable spurious emissions due to the types of modulation used, and these unduly expand the actual occupied bandwidth. Basically bandwidth is measured by the same principles as for analog signals. The decisive parameter in most cases is the 99% bandwidth, ie the bandwidth into which 99% of the total emitted energy falls. The DAB/DVB-T signal is scanned for this purpose using a 1 kHz test filter. Calculation of the 99% bandwidth is then made by graphical integration of the recorded RF spectrum. Two markers are set on the cutoff frequencies for a plausibility check by the user.

Frequency

The frequency of DAB/DVB-T signals cannot be measured like with analog signals because of the special nature of the modulation. Measurement Software ArgusMon calculates the frequency using the two marker frequencies of the bandwidth measurement and displays it.

Vestigial sideband characteristic

Measuring the characteristic of vestigial sideband emissions is of particular importance with DAB/DVB-T transmitters.

Due to the almost rectangular form of the RF spectrum of DAB/DVB-T transmitters, practically the full transmitting energy is present directly at the boundary to channels of adjacent radio services – unlike with all other systems. The specified transmitter mask, defining spectral characteristic versus frequency, has very steep edges at the channel boundaries to prevent undue impairment of other radio services by vestigial sideband emissions. Compliance with these masks is especially difficult in the case of DAB/DVB-T transmitters since the type of signal involved, with its large number of adjacent carriers, is susceptible to the formation of intermodulation products. Reducing vestigial sideband emissions to an acceptable level can in most cases be achieved only by considerable technical effort at the transmitter end. Monitoring services as well as the operators of such transmitters must therefore be able to measure the characteristic of sideband emissions. The currently valid transmitter masks for DAB and DVB-T (FIG 3/4) stipulate

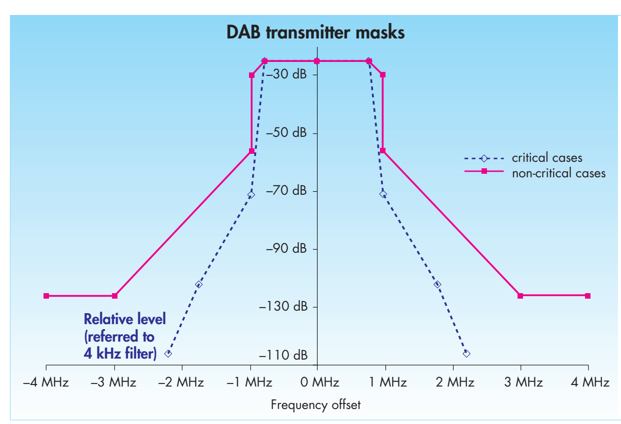


FIG 3
DAB transmitter masks according to Wiesbaden agreement

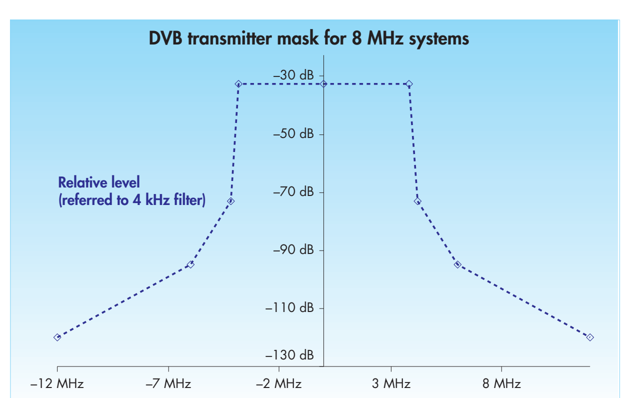


FIG 4
DVB transmitter mask according to Chester agreement 1997

level reductions down to –126 dB (referred to entire level and 4 kHz measurement bandwidth).
From FIG 3 it can be seen that the spectral characteristic of a DAB transmitter would have to be recorded with a dynamic range of at least 110 dB to verify compliance with the critical mask. This is not possible with currently available test receivers or analyzers alone. The limits of measurement techniques also show for DVB-T. In the presence of a multicarrier signal, test receivers too are susceptible to intermodulation, so the maximum used level must not exceed about 50 dBμV for this measurement (provided that a measurement filter with 4 kHz bandwidth is available). With this useful level, emissions of –27 dBμV would have to be measured accurately at a frequency offset of 12 MHz from the DVB-T center.

To measure the vestigial sideband characteristic of DAB and DVB-T transmitters, the signal is fed through a notch filter, which rejects the used channel as effectively as possible while letting the adjacent channel pass. In this way the test receiver is protected against overloading by the strong used signal while maintaining its full sensitivity in the range of interest of vestigial sideband emissions. The notch filter must be tunable. The attenuation along the frequency band to be represented must be added to the measured signal to obtain the true, unfiltered signal. The tracking generator of the analyzer is needed to accurately determine the filter response curve. FIG 5 illustrates the test setup. The example in the box right demonstrates how easy such measurements can be.

Summary

The combination of Spectrum Monitoring System ARGUS-IT with instruments FSE, FSIQ or ESI makes it very easy to carry out all the above measurements on DAB/DVB-T signals required for interference handling and evaluation of the RF signal characteristic.

Jörg Pfitzner

Measurements made easy with ArgusMon software

Vestigial sideband emissions of DVB transmitter above used channel (FIG 6)

First the notch filter is manually tuned so that the passband begins at the cutoff frequency to be represented (depending on the edge to be measured). A tunable highpass or lowpass filter or a bandpass filter may also be used.

The only values you have to enter in the ArgusMon software are those for the frequency band to be displayed (682 MHz to 692 MHz). The program automatically takes the other values like center frequency (680 MHz) and bandwidth (7.61 MHz) from the results of measurement in the used channel.

Once the measurement is started, everything else is automatic. First the filter response curve, then the level characteristic of the filtered signal are measured across the band of interest, and the values of the two curves are added. The result is a graphical presentation of the true – ie unfiltered – signal characteristic. The relevant limit line normalized to the level is inserted into the diagram so that you see at a glance whether or not the transmitter complies with the stipulated mask.

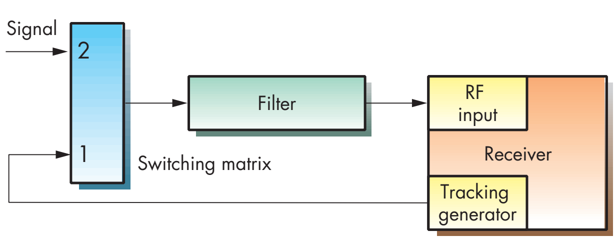


FIG 5
Block diagram of setup for measuring DAB/DVB vestigial sideband emissions

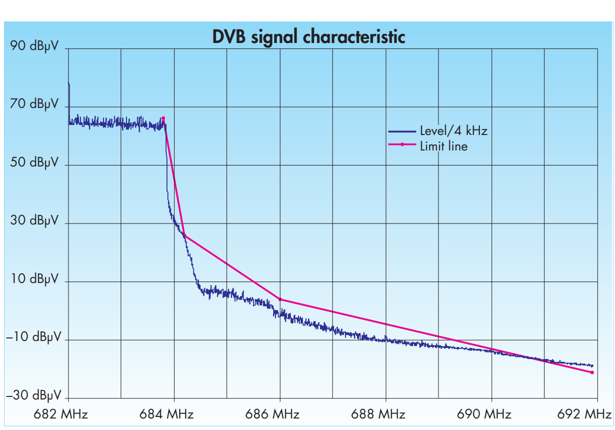


FIG 6
Result of vestigial sideband measurement with wide dynamic range

REFERENCES
[1] Wolf D. Seidl: Spectrum monitoring the ITU way. News from Rohde & Schwarz (1997) No. 153, pp 26–27
[2] Michael Lehmann; Dr Manfred Schukat: Coverage measurement and monitoring systems for DAB-T and DVB-T. News from Rohde & Schwarz (1999) No. 162, pp 22–24

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