Testing Bluetooth® stereo headphones in development and production

In labs and in manufacturing, the R&S®CBT and R&S®CBT32 Bluetooth® testers can carry out comprehensive RF measurements. Fitted with new audio options, they can now also be used for simple, fast audio tests of Bluetooth® stereo headphones.

Everything you need for testing analog audio components

Modern mobile phones with built-in Bluetooth® radio interface usually support the corresponding A2DP stereo profile for wireless connection to stereo headphones. These headphones generally have an integrated microphone for phone conversations, which means that the user can listen to stereo music from the mobile phone's MP3 player and also make phone calls without having to take the headphones off.

As the A2DP stereo profile can only transmit audio signals in one direction, it is not suitable for phone conversations. The headphones are therefore also fitted with headset or hands-free profiles. Both of these profiles were developed for speech-quality connections to Bluetooth® headsets and hands-free car units, and are not suitable for high-quality music transmission.

Usually, no analog audio components are necessary for playing MP3 music files with a mobile phone and transmitting them via the Bluetooth® interface. The entire signal processing within the mobile phone through to the Bluetooth® SBC stereo codec is purely digital, and the associated audio parameters can thus be precisely calculated by means of computer simulation. The situation for Bluetooth® stereo headphones is quite different, where D/A converters, filters, amplifiers and acoustic transducers are at the end of the signal transmission chain. All of these analog components significantly affect the audio quality of the headphones, and must therefore be optimized during development. When it comes to high-quality products, equivalent audio tests for verification purposes are also recommended in production.

The audio options for the R&S®CBT (FIG 1) and R&S®CBT32 Bluetooth® testers provide all the measurement functions required for the audio tests on Bluetooth® stereo headphones:

- Two multifrequency audio generators and analyzers (R&S®CBT-B41 option) for generating audio test signals and for measuring audio parameters
- A2DP profile with SBC codec (R&S®CBT-K52 option) for activating and testing the stereo functionality of headphones
- Headset and hands-free profiles (R&S®CBT-K54 option) for activating and testing built-in microphones

FIG 1 A powerful tool, both in the lab and in production: The R&S®CBT Bluetooth® tester carries out comprehensive measurements of RF characteristics, but can also examine audio parameters.

FIG 2 In order to test the microphone and the analog components, the audio generator 1 generates a test signal for the loudspeaker of an artificial head or for a reference loudspeaker. The DUT returns the recorded signal to the tester for analysis.

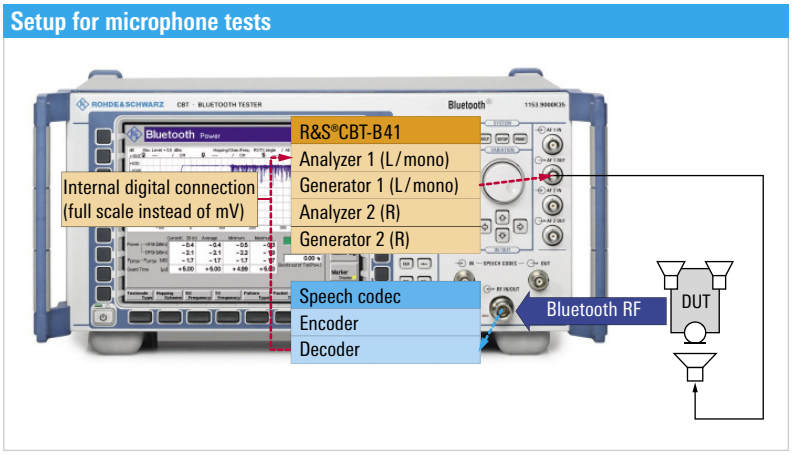
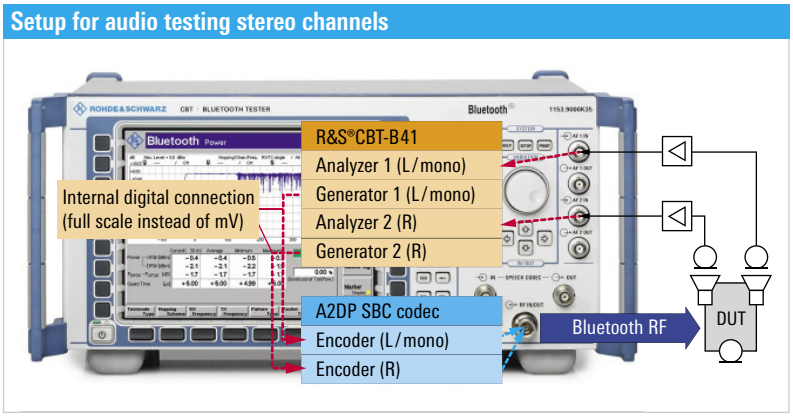


FIG 3 The two audio generators 1 and 2 independently generate test signals for the left-hand and the right-hand channels of the stereo signal. In this way, the two acoustic transducers in the stereo headphones are tested, as well as the analog components that are connected ahead.



Testing microphone characteristics

In order to test the audio characteristics of the built-in microphone and the associated analog components, the audio generator 1 generates a test signal that is output by the R&S®CBT through a BNC socket on the front panel (FIG 2). The signal is fed to the loudspeaker of an artificial head or a reference loudspeaker, for example, and the sound is picked up by the microphone of the DUT. By using the headset or hands-free profile, the R&S®CBT establishes an audio connection to the DUT and in response the DUT sends the coded audio signal via the Bluetooth® connection to the tester. The tester decodes the signal in the R&S®CBT speech decoder and transmits the decoded audio signal to the integrated audio analyzer 1, which then performs a range of different audio measurements.

The R&S®CBT can measure the frequency response very quickly with the aid of a multitone signal (FIG 4). The individual frequencies and limit values are user-definable. In addition to the peak and RMS levels, the Bluetooth® tester also measures a variety of distortion figures in single-tone mode. It displays all absolute levels referenced to the maximum digital signal level using the full scale (FS) unit.

Testing music replay characteristics

In order to test the two acoustic transducers in the stereo headphones, including the analog components that are connected ahead, the two audio generators 1 and 2 independently generate test signals for the left-hand and right-hand channels of the stereo signal (FIG 3). The absolute audio

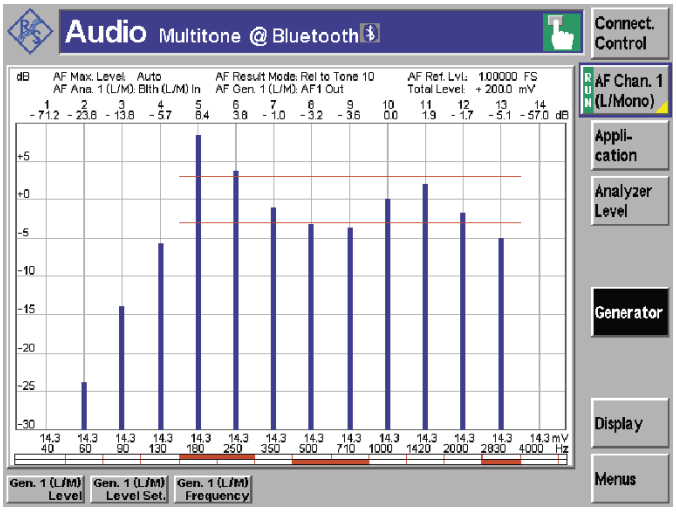


FIG 4 Frequency response measurement of a built-in microphone.

level is again defined in FS units to ensure that the full range of the digital signal level is used for the measurements. The R&S®CBT now uses the A2DP profile to establish an audio connection to the DUT and feeds the two audio test signals to the internal Bluetooth® SBC stereo codec. The test signal is routed to the decoder of the stereo headphones via the Bluetooth® connection. The decoded, audible sound signals are then picked up by an artificial head or by two reference microphones, and transmitted via two amplifiers to the two audio analyzers in the R&S®CBT via two BNC sockets.

The audio analyzer in the R&S®CBT measures the two channels simultaneously in stereo mode, displaying the measurement results one above the other in two windows (FIG 5 illustrates this, using the total harmonic distortion measurement as an example).

When things get tricky use an external audio analyzer

The R&S®CBT-B41 audio option provides the key audio measuring functions for quick verification of the DUT. To solve particularly tricky measurement problems, however, the use of an external audio analyzer might be a good approach. If, for example, the distortion values are unexpectedly high, an audio analyzer will allow the cause to be pinpointed by means of an FFT signal analysis. The R&S®UPV audio analyzer, for example, is ideal for this task (FIG 6). The R&S®UPV generator signals pass through the digital audio interface (R&S®CBT-B42 option) to the R&S®CBT. In this example, the two audio signals from the DUT are analyzed directly by the R&S®UPV audio analyzer, without taking the acoustic transducers into consideration. The R&S®UPV displays the spectrum of the audio signals via FFT, allowing conclusions to be drawn about possible internal sources of interference in the DUT.

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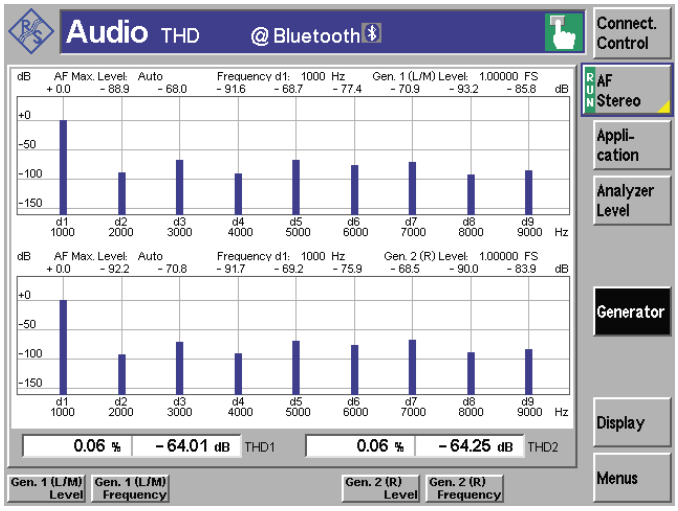

FIG 5 THD measurement of the two stereo channels.

For special measurement problems: R&S®UPV audio analyzer

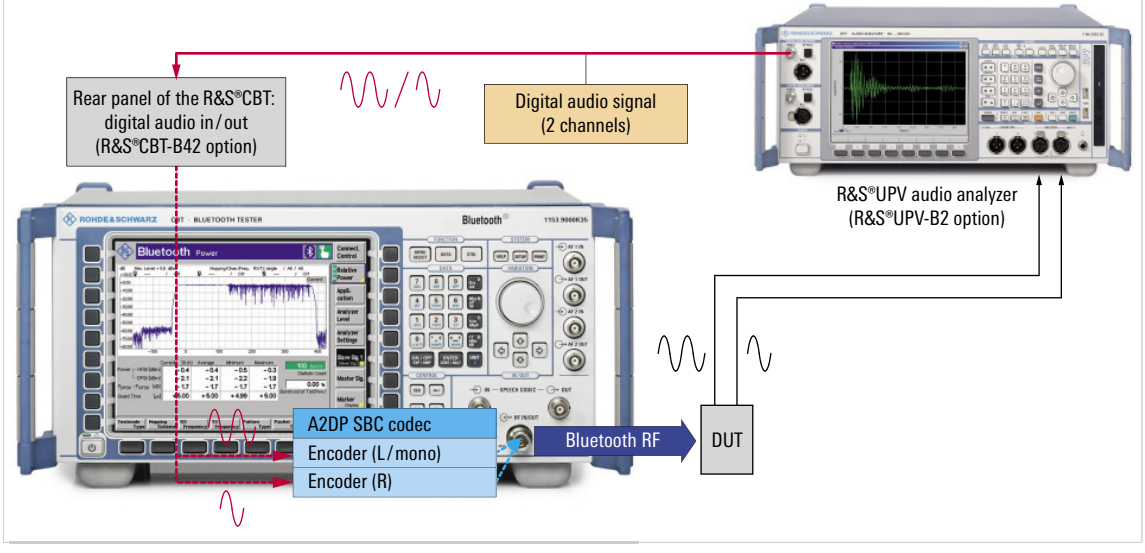

FIG 6 It can be helpful to use an external audio analyzer in order to solve particularly tricky measurement problems. An example of coupling an audio analyzer to the R&S®CBT via the digital audio interface is shown here.