Bluetooth® RF Production Testers R&S®CBT / R&S®CBT 32

Fast Bluetooth® RF testers compatible with the R&S®CMU 200

When manufacturers purchase test tools, the manufacturing costs of *Bluetooth*®* modules are an important consideration. Increasing integration means falling sales prices, which, in turn, means ever tighter budgets for testing. To meet this trend, Rohde & Schwarz offers two economical *Bluetooth* RF testers for production – the R&S®CBT and the R&S®CBT 32. Both instruments contain the same high-quality and fast T&M technology but are designed for different applications.

FIG 1 The *Bluetooth* RF Production Tester R&S®CBT for laboratory use.

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

For laboratories and production

The R&S®CBT is designed primarily for development and secondarily for production. It occupies four height units and $^{7}/_{8}$ the width of a 19" rack, and it features control elements and a large colour display (FIG 1).

In contrast, the R&S®CBT 32 (FIG 2) occupies only two height units and is a full 19" in width. It is lower in price and is designed solely for production. Of course, you can also connect it to an external monitor for tasks such as debugging remote control operations.

Both testers (here collectively referred to as the R&S®CBT) support the entire *Bluetooth* frequency range of 2402 MHz to 2495 MHz at a channel spacing of 1 MHz and levels between –90 dBm and 0 dBm. They provide tests for power, modulation and bit error ratio for the various frequency hopping schemes specified in the *Bluetooth* standard. To allow quick adjustments of *Bluetooth* modules in preproduction, the testers

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contain not only a generator but also a universal power meter and a frequency counter.

For remote control, the testers provide both a GPIB (IEEE 488/IEC 60625) and an RS-232-C interface. At no extra charge, Rohde&Schwarz also offers the R&S®CBTGo Windows™ software, which enables you to easily create complex measurement sequences. Thus, you can quickly and conveniently carry out and evaluate a number of test scenarios specified in the standard. These two *Bluetooth* testers support almost all receiver and transmitter tests stipulated by *Bluetooth* specifications 1.1 and 1.2.

The R&S®CBT is always the master

To set up a connection, the R&S®CBT and the DUT must be made "aware" of each other. You can do this either by using the inquiry protocol or – to save even more time – by manually setting the device address (BD address) of the DUT. If you are operating several R&S®CBT testers, you can also set different BD addresses for each one. This enables you to test several DUTs side-by-side without them affecting each other if limited shielding is used, for example.

The R&S®CBT always serves as the master of a connection. It allows you to set up a connection with the DUT either in ACL mode (asynchronous connectionless link) or by immediately activating the test mode. You can then activate the various submodes, i.e. Audio, Park, Hold or Sniff.

You do not need any special test adapters since every *Bluetooth* device supports ACL-mode connections, and the R&S®CBT can also determine power and frequency accuracy in this type of connection.

If your DUTs support the standard host controller interface (HCI) protocol via a serial interface, Rohde&Schwarz offers the R&S®DUTControl software as a download. This software enables you to change the DUTs to the various submodes without having manufacturer-specific test adapters. Many DUTs also support a variety of different audio codecs but do not allow activation via the RF interface. R&S®DUTControl enables you to activate the required audio mode even in these cases.

Typical tests

The production of *Bluetooth* modules usually includes checking various RF parameters and making any necessary corrections (such as adjusting the transmitter power). In most cases, the DUT's transmitter power is tested and the modulation is analyzed. You can also determine the RF spectrum that is used.

The R&S®CBT's modern concept enables you to measure the power and perform modulation analysis at the same time by using a combined measurement application. You can typically perform a complete RF test in less than three seconds. Such a test involves measuring the transmitter power and essential modulation characteristics by evaluating ten DH5 packets on each of three channels. If you also need information about the receive quality of the DUT (RX test), the test will take a total of four to five seconds. These measurement times also include connection setup time.

To determine receiver quality, the R&S®CBT offers measurements for bit error ratio (BER) and packet error ratio (PER), plus an automatic BER search routine for determining the typical sharp increase in bit errors starting at a specific low level.

The R&S®CBT spectrum measurement consists of two applications. The OBW measurement, also known as the –20 dB measurement, determines the DUT's occupied bandwidth. The ACP measurement determines adjacent channel power. These measurements are particularly important given the steadily growing market for instruments of the +20 dBm power class. At these power levels, instruments with impure RF can significantly impair signals for other

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Fig. 2 Size comparison of the R&S®CBT and R&S®CBT32.

users who are operating at the same frequencies nearby (FIG 3).

By implementing a "dirty Transmitter" (dirty TX) in the R&S®CBT, Rohde & Schwarz now offers for the first time a mixture of signal impurities in accordance with the *Bluetooth* specification. Dirty TX defines several RF parameters that intentionally create impurities in the transmit signal of the production tester both statically and dynamically:

- Frequency offset from the start of a packet (±250 kHz)
- Modulation index (0.20 to 0.44)
- Symbol time error (±20 ppm)
- Sinusoidal frequency drift across the entire TX packet

The modulation index is calculated from the ratio of the frequency deviation of the R&S®CBT to a deviation of 500 kHz. For example, a modulation index of 0.22 indicates a frequency deviation of 110 kHz for the tester's transmit signal.

The R&S®CBT provides two dirty TX tables: a fixed one in accordance with the *Bluetooth* specification and one derived from the fixed table which you can modify. The ten rows of these tables are superimposed on the transmit signal one row at a time in 20 ms intervals. As an alternative to these tables, the R&S®CBT also allows you to statically define the three key parameters (FIG 4).

Further details

If the test mode is active for a DUT, you can set the packet type and the corresponding payload size using the R&S®CBT. The supported packet types are DH1, DH3, and DH5, with a payload of 0 bytes to 339 bytes. You can also set the transmitted data pattern. The R&S®CBT provides predefined data patterns ("1010", "0000", etc, user-defined) plus two pseudo-random sequences (static and dynamic). The data pattern selected controls the volume of valid results that the instrument determines. For example, choosing the data pattern "1111" would not yield any valid conclusion about the DUT's frequency deviation since the deviation remains constant for the entire payload of the data burst. FIG 5 shows the evaluations that are possible for each data pattern. To determine the initial frequency accuracy, the R&S®CBT requires only the four-bit preamble of a *Bluetooth* packet (content "1010"), which has a duration of only 4 µs (FIG 6).

To test audio applications, the R&S®CBT can set up a synchronous connection-oriented (SCO) link with the DUT in addition to the ACL connection. The quality of audio processing in the DUT can be checked using external generators and audio analyzers. Internally, the R&S®CBT supports three *Bluetooth* audio codecs: CVSD, A-law and µ-law. For audio tests, the AF signal is coupled in and out via two BNC connectors on the front panel of the instrument.

The R&S®CBT can switch a DUT to one of the three power-saving modes Park, Hold or Sniff at the press of a button or via a remote control command. This enables you to determine the reduction in power consumption – one of the critical components in battery-operated devices – by using an external measur-

FIG 3 OBW spectrum of a typical *Bluetooth* DUT with PRBS data.

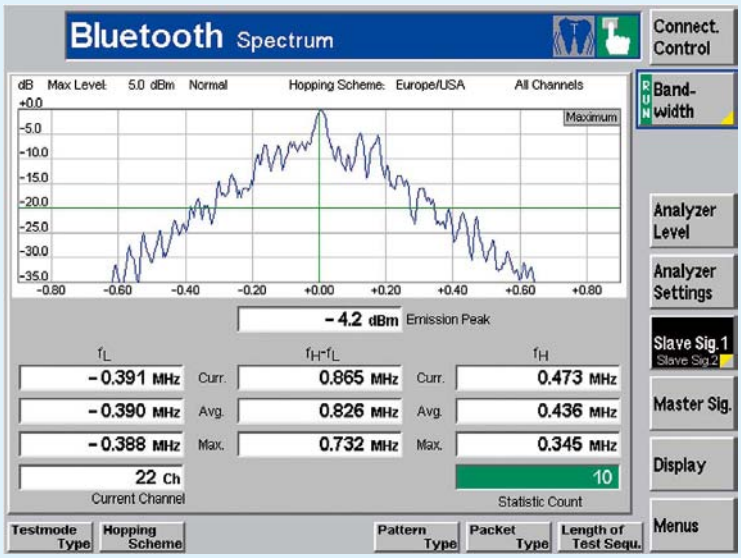
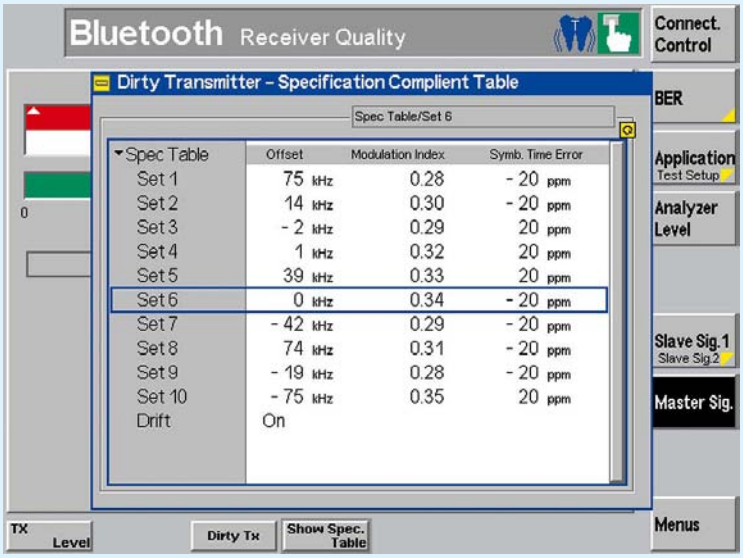


FIG 4 Dirty TX table in accordance with the *Bluetooth* specification.



Spec Table	Offset	Modulation Index	Symb. Time Error
Set 1	75 kHz	0.28	- 20 ppm
Set 2	14 kHz	0.30	- 20 ppm
Set 3	- 2 kHz	0.29	20 ppm
Set 4	1 kHz	0.32	20 ppm
Set 5	39 kHz	0.33	20 ppm
Set 6	0 kHz	0.34	- 20 ppm
Set 7	- 42 kHz	0.29	- 20 ppm
Set 8	74 kHz	0.31	- 20 ppm
Set 9	- 19 kHz	0.28	- 20 ppm
Set 10	- 75 kHz	0.35	20 ppm
Drift	On		

	Data "10101010"	Data "11110000"	PRBS, etc
Frequency accuracy	●	●	●
Frequency drift	●	–	–
Maximum drift	●	–	–
Average frequency deviation	●	●	–
Maximum frequency deviation	●	●	–
Minimum frequency deviation	●	●	–

FIG 5
Evaluations supported under the various data patterns.

ing instrument. The R&S®CBT can also send user-defined data to the DUT via the ACL connection. Thus, each manufacturer can send any commands to its instrument in order to activate special DUT functions such as controlling an LED of a headset or adjusting RF parameters via software.

In Power Control mode, the R&S®CBT sends commands to the DUT by means of the link manager protocol (LMP) in order to increase or decrease the output power in accordance with specifications. At each step, the R&S®CBT displays the difference. If saturation occurs, a message appears via a dialog window.

All measurements can be performed using normal frequency hopping as well as with reduced channel utilization:

- **All channels**: hopping covering all channels defined in the specific scheme
- **Simultaneous**: hopping covering five different channels via the reduced hopping method defined in the standard
- **Single**: measurement of a single channel

You can check the DUT quality across the entire *Bluetooth* frequency range by using both the "All channels" method and the function for stopping measurements when limits are exceeded. You can examine the results in closer detail by using the graphical analysis feature in the modulation and power measurement menus. You can zoom in at any resolution between 1/16 of a timeslot and five timeslots. Both RX and TX measurements can be performed by means of the channel utilization explained above (FIG 7).

As a special bonus for users of the "big brother" R&S®CMU 200, Rohde & Schwarz developers have provided the R&S®CBT with complete emulation of the R&S®CMU 200 remote control command set. This allows you to use the same control software in laboratories and production lines that have mixed equipment. Of course, this emulation does not cover the expanded capabilities that the R&S®CBT offers when compared to the *Bluetooth* option in the R&S®CMU (e. g. dirty TX).

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FIG 6 Frequency accuracy in an ACL connection within the 4 µs preamble.

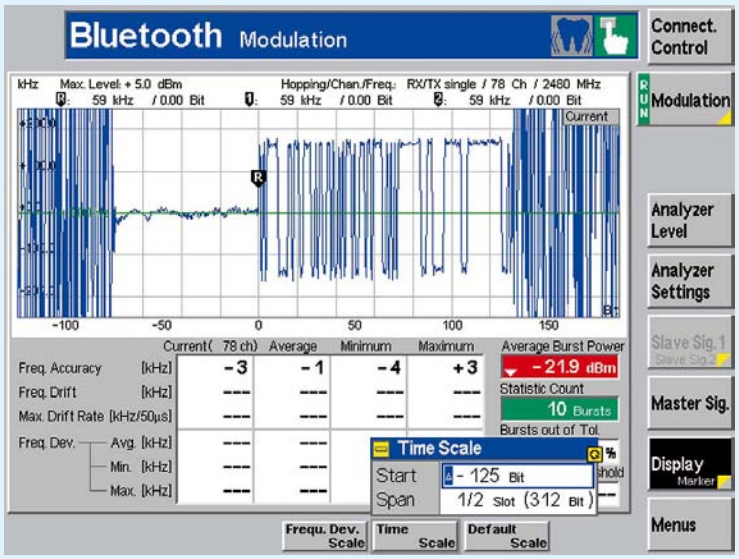

FIG 7 Modulation measurement, stopped when limit exceeded.