

## Universal Radio Communication Tester R&amp;S®CMU 200

## Expanding WCDMA receiver tests

Mobile user equipment for applications with high data rates such as video transmission or Internet browsing is equipped with complex receivers. The R&S®-K65 to -K69 (3GPP FDD) WCDMA software packages for the R&S®CMU 200 [\*] provide new measurement components for receiver tests that help to examine these sophisticated receivers in UMTS mobile phones and to assess their quality. This article covers the BER measurement with asymmetric data rates in the DUT transmitter and receiver, explains UMTS-specific blind transport format detection (BTFD) tests and presents measurements that the DUT itself carries out (UE measurement reports).

## BER measurements with asymmetric data rates

A typical receiver test setup is shown in FIG 1: The Universal Radio Communication Tester R&S®CMU 200 transmits the required pilot and synchronization signals over the air interface. It generates random data in the baseband, codes it, inserts it into a dedicated channel (DCH) in the downlink<sup>1)</sup> and transmits the modulated data to the DUT over the air interface. During the receiver tests, the DUT is typically in loopback mode, i.e. the DUT demodulates the received data, decodes it in the baseband and then transmits it back in the uplink<sup>2)</sup> with a time delay. If the test setup can ensure that the uplink is free of transmission errors, the R&S®CMU 200 can compare the data in the downlink and uplink and determine the typical receiver key parameters BER<sup>3)</sup> and BLER<sup>4)</sup>.

The 3GPP 34.121 test specification for RF measurements defines propagation conditions in the RF channel which, in conjunction with the quality of the individual stages in the receiver, affect the measured error rate. If the symbol rate on the radio frequency remains constant (3.84 Mchip/s for 3GPP FDD), error detection and correction in the receiver decreases (depending on the system) as the actual information data rate increases and vice versa.

Receiver tests check the receiver sensitivity for different useful information data rates. For radio-frequency tests, the 3GPP standard has specified examples of several reference measurement channels (RMC) for different useful information data rates (12.2 kbit/s, 64 kbit/s, 144 kbit/s, 384 kbit/s). The above model works as long as the same data rates are processed in the uplink and downlink.

But things are different if mobile user equipment that is primarily used for Internet browsing, for example, mainly requires high data rates only in the downlink. The equipment therefore comes with a powerful receiver, while the transmitter can be a more basic model. Thus, the method described above, i.e. the same data rates in the downlink and uplink, is no longer applicable.

A method is implemented in the R&S®CMU 200 that is able to perform useful receiver tests despite this asymmetry with the support of the test loops defined in 3GPP TS 34.109. For this purpose, transport blocks for useful information are generated in the baseband of the radio tester in a defined time grid (FIG 2). Each transport block with a length of  $N+n$  (bits) is filled with the data  $b_0$  to  $b_{N+n-1}$ ; after the cyclic redundancy check (CRC) checksum has been added, the block is then processed and modulated in the individual function blocks of the baseband and transmitted over the air interface (FIG 3). The receiver in the DUT performs these steps in reverse order so that  $b_0'$  to  $b_{N+n-1}'$  are present in decoded form in the DUT. Part of this data is then transmitted back to the tester.

1) Downlink (DL): transmit signal of the radio tester to the DUT.

2) Uplink (UL): transmit signal of the DUT to the tester.

3) BER: bit error ratio.

4) BLER: block error ratio.



On page 14, you will find another article on the Universal Radio Communication Tester R&S®CMU 200 titled "Solutions not only for (E)GPRS mobile radio development".

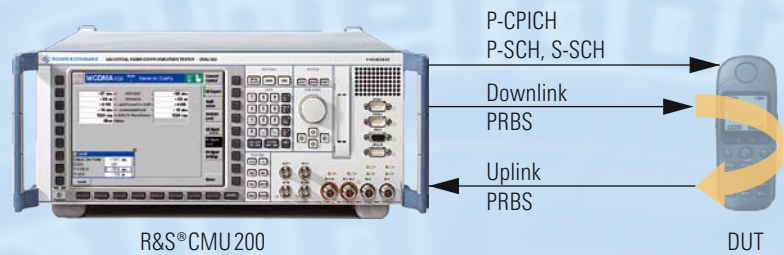


FIG 1 Test setup for BER measurements with the DUT in loopback mode.

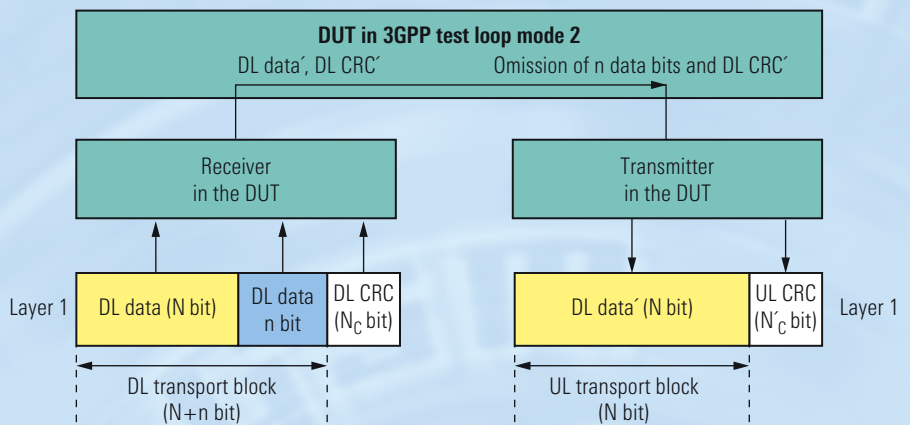
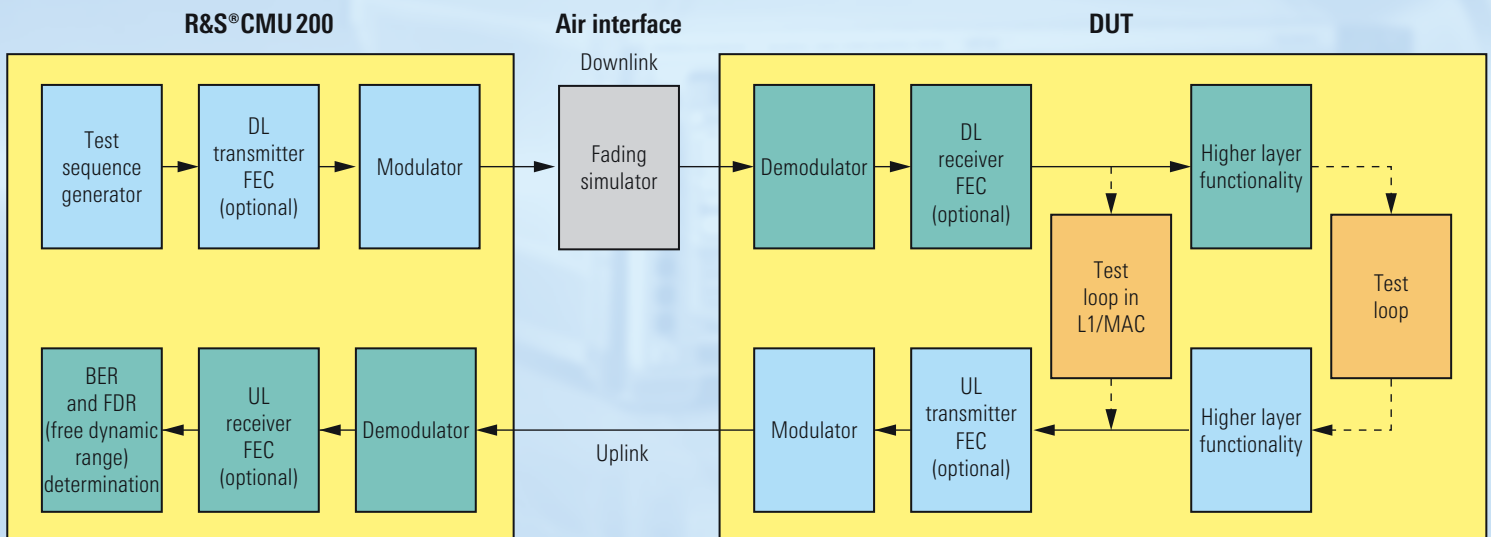


FIG 2 DUT in test loop mode 2 in accordance with 3GPP TS34.109.

FIG 3 The processing stages in the R&S®CMU 200 and DUT.



- ▶ An uplink channel with reduced data capacity can only process transport blocks with reduced length  $N$  with  $b_0$  to  $b_{N-1}$  in the baseband (per time unit) and transmit them over the air interface. The R&S®CMU 200 thus only compares  $b_0$  to  $b_{N-1}$  with  $b_0$  to  $b_{N-1}$  and then calculates the BER and the number of defective blocks from the result.

Due to the coding and interleaving steps in the baseband chain, bits  $b_0$  to  $b_{N-1}$  in the transmission channel are not transmitted one after the other as a packet but at different points in time over the air interface. Even if the data volume is reduced, the BER provides a valuable assessment of the receiver quality, with the receiver itself being operated at the full data rate. The tester provides the data rate combinations 384/144, 384/64 and 144/64 (each DL/UL in kbit/s).

### Selectable resources – occupancy in the transmission channel

In practice, transmission channels are often used only to transmit “in batches”, i.e. there are significant differences between the peak and average data rates during a connection and these differences may affect the entire mobile phone, including its power management. The R&S®CMU 200 is able to emulate these conditions by setting up a high-capacity transmission channel in the downlink but not at full occupancy, i.e. it fills only every second, fourth, etc. block with data. If a receiver measurement is performed simultaneously during

this phase, the tester, of course, takes into consideration only the data blocks that were actually filled with useful information.

### BTFD measurements

To save transmission bandwidth and signal energy, the transport format combination identifier (TFCI) signalling bits – which inform the DUT about the data rate and the transport format used – can be omitted on the dedicated downlink channel. For this purpose, special timeslot formats are defined in 3GPP TS25.211 without TFCI bits (NTFCI = 0), or these bits are not transmitted via discontinuous transmission (DTX), i.e. they are modulated with zero energy (FIG 5).

The DUT must be able to detect the transport format from the data stream even without this signalling information in order to correctly decode the useful information. This is referred to as blind transport format detection (BTFD).

During call setup, the radio tester uses the signalling channel to inform the DUT about the nine transport formats that are defined in 3GPP TS34.121 for the BTFD measurement. The mobile phone must now select the correct data rate from among these different formats. As in the test setup for BER/BLER measurements, the DUT is also operated in test loop 2 for BTFD.

The radio tester transmits a user-selected data rate on the downlink (FIG 4). In accordance with

3GPP TS34.121, the measurement needs to be carried out only with the DTCH rates 12.2 kbit/s, 7.95 kbit/s and 1.95 kbit/s. The R&S®CMU 200, however, lets the developer choose from among the nine data rates provided. The DUT detects the transport format used and transmits the data and the downlink CRC checksum back to the tester in the uplink. The uplink is configured in such a way that the nine different transport formats and the downlink checksum can be transmitted.

By using the received data stream, the R&S®CMU 200 determines the BER and BLER and – as a new feature – the false transport format detection ratio (FDR). An FDR event is counted if a valid data block with valid checksum arrives in the tester uplink but does not correspond to the transport format previously sent in the downlink.

### Measurement reports of the DUT

Mobile user equipment itself must perform measurements in order to assess the channel quality in the offered cells or in a call that is already set up. For example, the power measured in the CPICH pilot channel in a WCDMA cell during connection setup is incorporated as a key parameter in the power setting of the DUT transmitter. The more power the user equipment has for receiving the pilot signal, the less power it will use when starting to send the uplink signal.

Once the R&S®CMU 200 has established a connection to the DUT, it can send sig-

FIG 4 Data rates that the R&S®CMU 200 provides for the nine different transport formats (orange: the data rates specified by 3GPP TS34.121).

	1	2	3	4	5	6	7	8	9
DTCH	12.2 kbit/s	10.2 kbit/s	7.95 kbit/s	7.4 kbit/s	6.7 kbit/s	5.9 kbit/s	5.15 kbit/s	4.75 kbit/s	1.95 kbit/s

nalling messages to the DUT over the air interface requesting the DUT to send back the internal measurement results as a "measurement report", which the R&S®CMU 200 can then display. The developer can thus assess the accuracy of both the receiver and the internal correction tables at a glance (FIG 6).

The user equipment must be able to measure the power, timing and transmission quality not only of its "own" cell but also that of any adjacent cells such as WCDMA cells or those of other networks, e.g. GSM. This topic will be discussed in more detail in a future issue.

## Summary

The flexible Universal Radio Communication Tester R&S®CMU 200 offers a versatile scope of tools for signalling and test and measurement. As a result, the R&S®CMU 200 is becoming a standard piece of equipment in UMTS development and quality labs as well as in setups for production and system test solutions.

Stefan Loth; Pirmin Seebacher

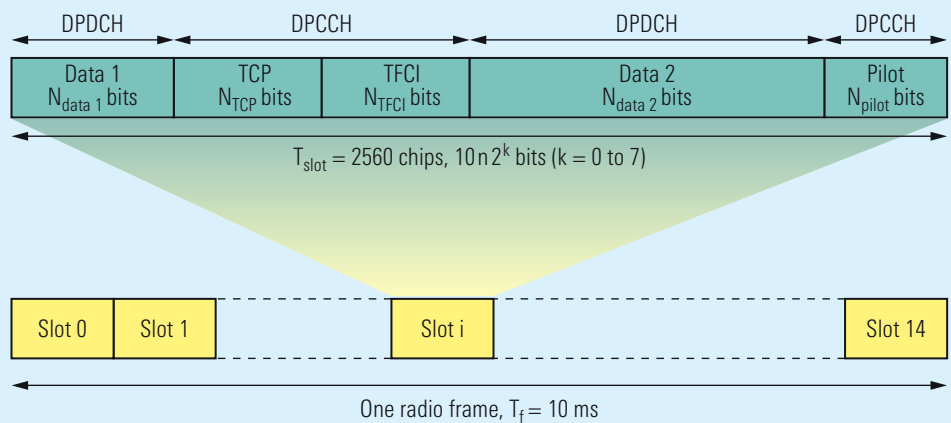
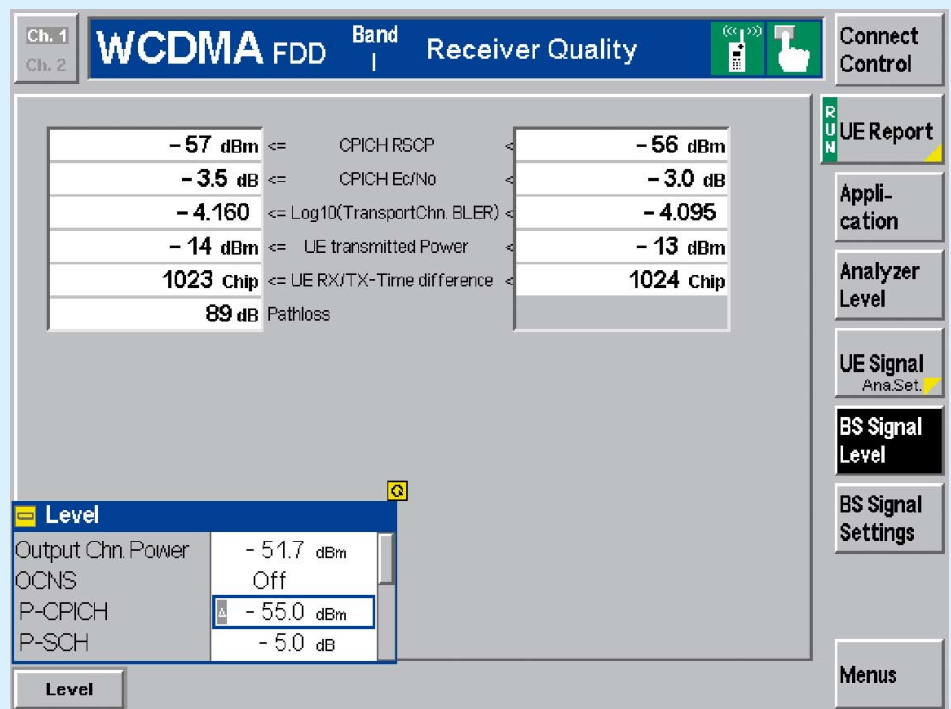


FIG 5 DPCH channel structure in the downlink.

FIG 6 The "UE measurement report" menu on the R&S®CMU 200 displays the accuracy of the receiver and the internal correction tables of a mobile phone.



More information and data sheet at [www.rohde-schwarz.com](http://www.rohde-schwarz.com)  
(search term: CMU 200)



### REFERENCES

- [\*] Universal Radio Communication Tester R&S®CMU 200: Signalling and RF measurements for WCDMA. News from Rohde & Schwarz (2003) No. 177, pp 9–12
- 3GPP standard