Universal Radio Communication Tester R&S CMU 200

# Signalling and RF measurements for WCDMA

**Owing to the R&S CMU 200, Rohde & Schwarz was intrinsically involved in the development of the WCDMA standard right from the beginning. The fast and accurate radio tester now also masters signalling with combined RF measurements for WCDMA.**


## The trend toward higher data rates continues

The delays with UMTS are a controversial topic currently debated among the public. Time and again, the high financial burden, resulting for example from the steep license costs and the necessarily complex technology, is quoted as an impediment. While some operators are reporting delays in the network start, various established standards such GSM or its follow-on development GPRS are already offering data-intensive services such as multimedia message service (MMS). The WCDMA technology used in UMTS will promote these fast applications and open up new possibilities.

With its Universal Radio Communication Tester R&S CMU 200, Rohde & Schwarz contributed step by step to the technical development of the WCDMA standard – ranging from the first module developments to testing in trial networks. At the beginning, T&M technology ensured the transmitter characteristics [1], followed by the WCDMA generator functionality [2], which simulates the physical channels of a WCDMA cell and provides a means of checking the DUT receiver for different synchronization and decoding capabilities up to BER and BLER evaluation.

The R&S CMU-K67, -K68 and -K69 WCDMA signalling options are new on the market. As with real field operation, the R&S CMU 200 controls the DUT exclusively via the radio interface. Specific basic functions, such as incoming or outgoing calls, can be easily tested. Moreover, it is possible to put the mobile phone in a mode that permits conclusive and detailed RF measurements. In this case, it is not the network, but the software in the radio tester that controls the integrated UMTS protocol and the associated RRC, RLC, MAC and PHY layers. Owing to multipurpose parameters, the general analysis conditions can be flexibly configured via the display or the remote-control interface of the R&S CMU 200. FIG 1 shows an excerpt of the checkable default functions of a phone.

**More articles on the R&S CMU 200: see page 12 and page 15.**

## Transmitter measurements

T&M technology and the high accuracy of the WCDMA transmitter measurements have already been detailed in [1]; a concise overview is given below:

- **Power evaluation**
  Max / min / off power, inner loop power control
- **Modulation quality**
  Error vector magnitude, magnitude error, phase error, IQ offset, IQ imbalance, waveform quality
- **Code domain power**
- **Spectral evaluation** (FIG 2)
  Adjacent channel leakage power ratio, spectrum emission mask, occupied frequency bandwidth

## Receiver measurements

With receiver measurements, the DUT has to demodulate and descramble the downlink (DL) signal generated by the tester and decode the information bits. This process must then be mirrored for the uplink (UL) signal so that the information the DUT contains is returned to the tester. For this purpose, the R&S CMU 200 switches the phone to loopback mode by using a command defined in layer 3, and compares the data received with the data previously transmitted. The specifications according to 3GPP 34.109 define a specific test mode and test loop for these purposes, which are mandatory for 3GPP phones.

Moreover, 3GPP TS34.121 defines reference measurement channels (RMC) for RF measurements. They are configured by the tester after the successful call setup via signalling on the dedicated radio link; a useful scenario for BER tests is thus generated. The R&S CMU 200 supports the receiver measurements for different data rates.

In compliance with the 3GPP specification, the BER measurement should not be performed at the lowest physical layer, but at the transport block layer, i.e. at the interface between layer 1 and layer 2. The evaluation of the receiver quality thus not only includes the characteristics of the RF modules on the air interface, but also the quality of the baseband error correction implemented in the DUT. This test philosophy comes very close to the real operating conditions.

| Test function | Test method | Functions checked |
|---|---|---|
| Call to telephone | MTC (mobile terminated call) | ◆ Telephone synchronization to the base station signal in the time and frequency domain<br>◆ Decoding of signalled system information at the telephone end<br>◆ Call setup via information exchange with standard signalling protocol on the RRC, RLC, MAC, PHY layers<br>◆ Basic telephone test such as ringing tone, display information, etc |
| Call from phone to R&S CMU 200 | MOC (mobile originated call) | ◆ Same as for MTC<br>◆ Telephone keyboard via displayed call number in the R&S CMU 200 |
| Replacing at the phone end | MIR (mobile initiated release) | ◆ Standard disconnect |
| Replacing at the base station end | NIR (network initiated release) | ◆ Standard disconnect |
| Immunity of connection | Temporary switchoff of the tester signal, comparable to shadow effects in the field, etc | ◆ Immunity or sensitivity of the phone regarding synchronization interference |
| Speech intelligibility | Echo test on speech channel | – |

**FIG 1 Excerpt of the checkable basic functions of a telephone.**

### Bit error rate (BER)

The BER is calculated from the bit errors in the data fields of the transport data blocks that are usually used for information bits of a dedicated link:
BER = bit error / (total number of information bits received by the tester in the loopback) × 100 %.

### Block error rate (BLER)

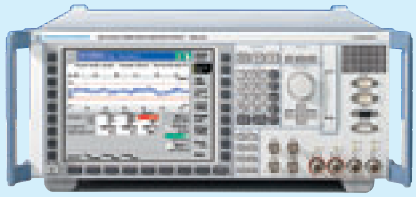
If cyclic redundancy check (CRC) errors are detected in the decoded transport blocks or checksums, the entire block is marked as faulty. The DUT must therefore forward its CRC – decoded in the downlink – via the uplink to the tester. FIG 3 illustrates the flow of the transport block data and the CRC checksum from the tester to the DUT (DL) and back (UL).

## Interaction of signalling and T & M technology

In addition to the conventional transmitter and receiver measurements, CDMA systems also offer combined signalling and measurement functions which require synchronized interaction of these two units in the radio tester. The TPC stimulation and inner loop power (ILP) measurement detailed below illustrate this interaction.

Fast power control is crucial in CDMA radio networks to ensure optimum connections (e.g. for speech or data transmission) while keeping the use of resources to a minimum – under varying propagation conditions.

Operation, display means and remote-control command set for measurement and WCDMA signalling menus correspond to the other R&S CMU 200 standards. Users already familiar with this tester master these quickly and can easily adjust existing remote-control scripts of other function groups to match WCDMA applications.



The 3GPP specifications classify the physical layer into frames (10 ms each) and slots (15 timeslots per frame). For each timeslot (667 µs), two transmit power control (TPC) bits are reserved in the physical layer on the dedicated physical control channel (DPCCH) of the downlink signal. The significance of these bits is to cause spontaneous power variation (approx. 300 µs later) at the beginning of the next uplink timeslot. The magnitude of the reference power variation (1 dB, 2 dB or 3 dB), in turn, is a parameter signalled by the higher layers when a dedicated connection (radio bearer setup) is established; it must be decoded correctly by the DUT.

FIG 4 shows how a mobile phone responds to the stimulation for power increase by means of a DL TPC sequence of ten "1" bits and subsequently ten "0" bits (attenuation of power). The output power of the mobile phone follows these commands. In addition to the power variation per step – the reference value is 1 dB in the above example – the integration of ten subsequent steps is rated against a minimum and a maximum value, as stipulated by the 3GPP specifications.

The R&S CMU 200 users will embrace the different means for evaluating the quality of mobile phones by using technical data as well as the subjective capability of this tester to evaluate the DUTs. For example, the user can now establish a speech connection between the R&S CMU 200 and the mobile phone. If the user speaks into the microphone of the mobile phone, this signal is transmitted via the speech channel to the tester, where it is decoded and returned as an echo at a delay, and then output at the loudspeaker of the telephone.

**FIG 2**
**Graphical menu with modulation evaluation.**

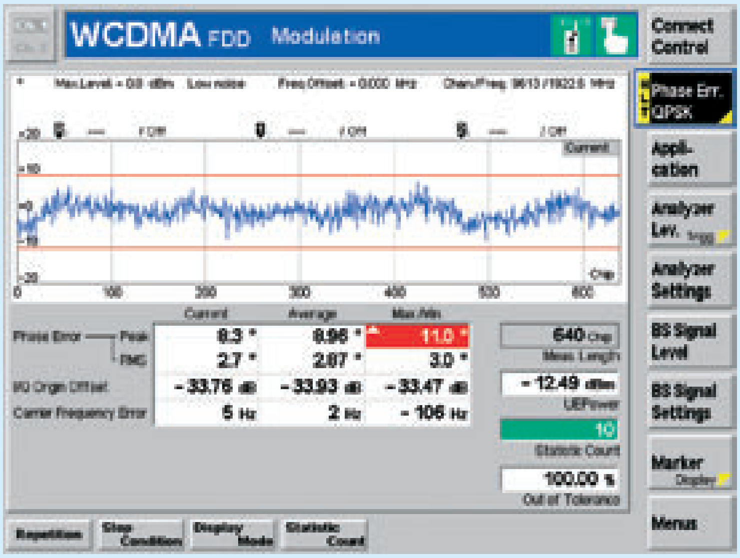



**FIG 3**
**Layer1 (L1) receive and transmit path with loop in DUT for e.g. RMC at 12.2 kbit/s.**

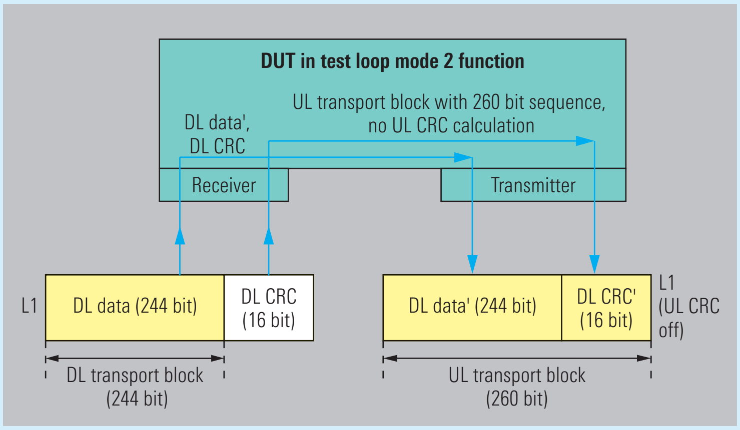
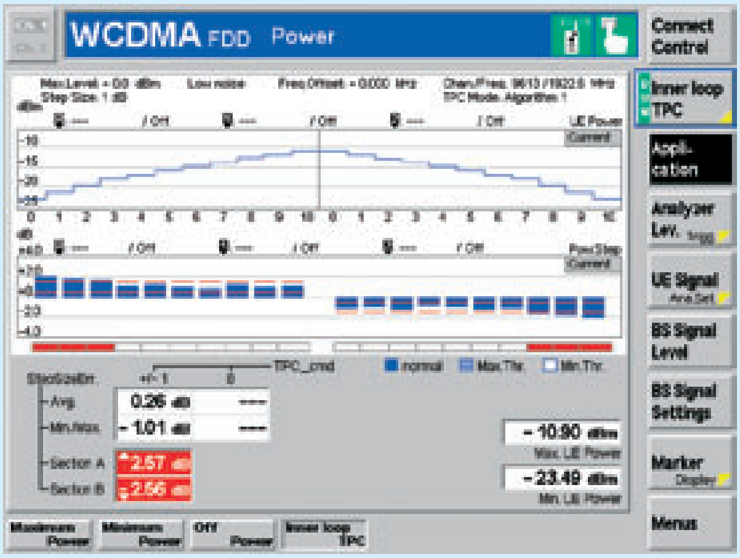



**FIG 4**
**DUT reaction to the stimulation by a DL TPC sequence of ten "1" bits (power increase) and, subsequently, ten "0" bits (power attenuation).**



## High measurement speed and flexibility

Since the R&S CMU 200 was also designed for production-related applications, Rohde & Schwarz paid particular attention to high measurement speed and accuracy right from the start of the tester development. Users involved in the hardware or software development of a WCDMA telephone can generate a large number of test setups by means of the flexible parameterization of the measurement and signalling functions. Right now, with UMTS still on its marks, users benefit from the joint platform components of the Protocol Tester R&S CRTU-W and the R&S CMU 200. The protocol tester is thus able to integrate possible changes in the 3GPP standard into the signalling unit of the radio tester, keeping time delay to a minimum.

If the R&S CMU 200 is fitted with the optional IQ/IF Interface R&S CMU-B17 [3], it is possible to couple or decouple directly at the baseband or in the IF of the DUTs, enabling the testing of pure baseband or RF module characteristics.

## Summary

The R&S CMU 200 as a multimode tester is able to test in a single test sequence DUTs that can contain modules for WCDMA, GSM and *Bluetooth*. Since practical UMTS applications are still in their infancy, other versatile test functions, also between the different cellular standards, will be developed on this basis.

Pirmin Seebacher

REFERENCES R&S CMU 200

[1] First WCDMA measurement functions. News from Rohde & Schwarz (2001) No. 171, pp 13–15

[2] WCDMA generator for fast testing of 3G mobile radios. News from Rohde & Schwarz (2002) No. 173, pp 9–11

[3] Optional IQ and IF interfaces for new applications. News from Rohde & Schwarz (2002) No. 175, pp 12–14

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# User-specific correction of frequency response and level response

**The seemingly inconspicuous functions of a mobile radio tester are often the ones that contribute to a productivity increase in production. This also applies to the user-specific correction of frequency response and level response in the R&S CMU 200, which offers quite a few advantages in mobile phone production.**

## Why such a correction?

You may ask yourself why a user-specific correction of frequency response and level response is required if a professional mobile tester can reliably be expected to perform precise measurements across the entire frequency range. At first glance, this is, of course, true. However, once the instrument is integrated into a test system in a production line, the situation is different. The total measurement error includes not only inaccuracies of the radio tester, but also errors in the test setup such as the frequency response of cabling and any power divider that may be used. To compensate for these wiring losses, "external attenuation" may be entered in the mobile radio testers, often also separately for several frequency bands. Even so, this type of correction is frequently insufficient, e.g. when using an antenna coupler for coupling the DUT, since notable level changes in these instruments can often be detected even across individual radio channels.

Such frequency responses are usually measured and stored as correction