

WCDMA generator for fast testing of 3G mobile radios

The first public WCDMA (FDD) network to the NTT DoCoMo standard went into operation in Japan in October 2001, so an increase in the production of mobile phones can be expected for the year 2002. In mid-2001 already, Rohde & Schwarz presented the first Universal Radio Communication Tester R&S CMU 200 with WCDMA measurement functions. The following article illustrates how to make excellent use of this tester in the development and production of 3G mobile radios.

All the essentials for production tests

The *BER** – and for packet switching services the *BLER* – is of particular importance when checking the receiver characteristics of mobile phones. Receiver sensitivity can be measured at very low generator levels; at high levels you determine overdriving strength. These measurements are described in 3GPP TS 34.121 section 6 [1].

The WCDMA options for the R&S CMU 200 provide all key functions for production tests and can be adapted to the required test functions in two steps (FIG 1).

Unidirectional BER measurement

During a unidirectional *BER* measurement, the tester transmits on different channels, to which the DUT – a mobile or simply a module – synchronizes in time or frequency. The *DPDCH* channel contains a selectable data sequence, for instance a random *PRBS9*. A 3GPP mobile selects this sequence from the

demodulated data channel, synchronizes itself and independently calculates the deviations from the expected *PRBS*. This yields the *BER*, which can be queried via a mobile phone interface.

This method does not require a link setup, which is an important advantage. It is a time-saving factor in the production test; in addition, the *BER* measurement can also be performed on RF/layer 1 modules without higher layers.

The current configuration of the R&S CMU 200 enables the simultaneous operation of up to five channels: *P-CPICH*, *P-SCH*, *S-SCH*, *P-CCPCH* and *DPCH*. The power of all channels can be set separately. The *P-CPICH* serves as an absolute reference, whereas the power of the other channels is given as a relative value. Since there is no real signalling during communication with the DUT, the *P-CCPCH* cannot transmit complete *BCH* information; only the system frame number is included. A mobile phone can synchronize to this and identify the R&S CMU 200 as the *UTRAN*.

3GPP-conformant configuration of primary and secondary scrambling codes is possible. The primary scrambling code affects only *P-CPICH* and *P-CCPCH*, whereas both scrambling codes are of importance for coding the *DPCH*. The *P-SCH* and *S-SCH* channels, on the other hand, are not scrambled and thus do not necessarily behave orthogonally to the other code channels.

Model/option	Designation	Functions
R&S CMU 200	Basic model	
R&S CMU-U65/K65	Hardware upgrade and software	Transmitter measurements on WCDMA uplink signals
R&S CMU-B66/K66	Hardware upgrade and software for WCDMA downlink generator	Receiver measurements, <i>BER/BLER</i> measurement with evaluation in mobile phone, synchronization

FIG 1 Options for upgrading the R&S CMU 200 for WCDMA tests

* Abbreviations in the text are explained in the box on page 11.

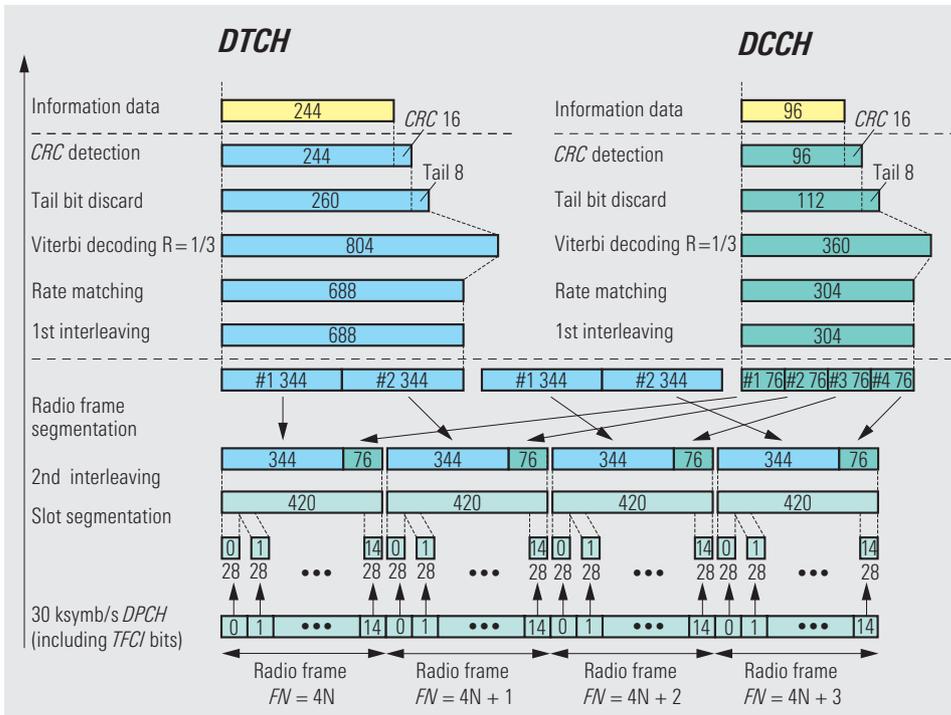


FIG 2 Coding of transport channels up to DPCH in RMC with data rate of 12.2 kbit/s (example)

- ▶ The R&S CMU 200 provides multiple settings for the DPCH, which far exceed the RMCs specified by 3GPP (see 3GPP TS 34.121 appendix C). The channel coding mode and the direct data insertion mode are available on the physical layer (FIG 3).

If channel coding is active, an RMC specified by 3GPP is transmitted. The data to be sent via the DPCH is fed in at the transport layer and transmitted to the physical layer after the channel coding is completed.

In the physical mode for instance, the DPCH data fields are filled directly

with a PRBS; the slot format is user-selectable. Compared to the RMCs, even higher data rates of up to 960 kbit/s can be transmitted. For the DPCH, the channelization code determines that part of the code domain to be used for data transmission to the DUT. The R&S CMU 200 prevents entries that would overlap with other channels such as the P-CCPCH.

Reference measurement channels

3GPP defines standardized generator parameters (TS 34.121, [1]) and so creates a uniform measurement

environment for the DUT. These reference measurement channels are available with data rates of 12.2, 64, 144 kbit/s and 384 kbit/s; the WCDMA generator option of course generates RMCs with all these data rates (FIG 4).

An RMC specifies how to code the user data from the transport layer and how to transmit them on the physical layer (FIG 2). At the transport layer, the data consists of the DTCH and the DCCH. All parameters relevant for channel coding – such as the TTI (time transmission interval) or the coding method – are specified in a 3GPP RMC. At the physical layer, for instance, the DPCH slot format is ready defined.

The transmitter characteristics of a WCDMA mobile can be determined by the measurement functions described in [2]. By synchronizing to the generator signal, the transmitter measurements are not only performed more quickly; it is also possible to select a specific slot number to be measured. The frequency error of the mobile phone is determined without external synchronization.

Performance in a WCDMA network depends on good power control. Here the newly added inner loop power measurement (FIG 5) takes effect, where the transmit power of the mobile is continuously increased and decreased in steps by TPC bits from the base station. The R&S CMU 200 simulates this process, measures the power and determines deviations from the nominal value.

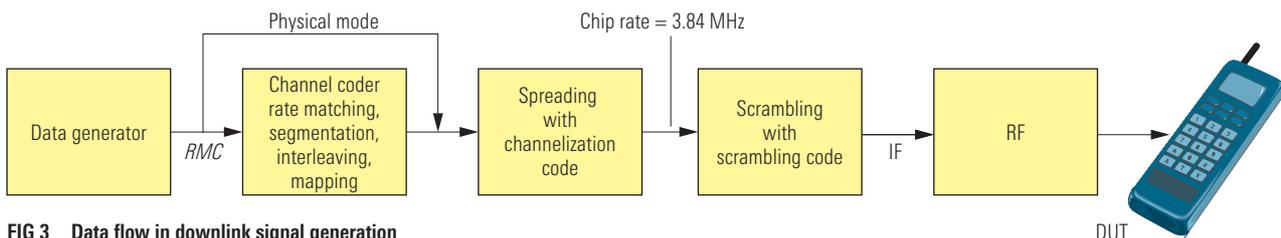


FIG 3 Data flow in downlink signal generation

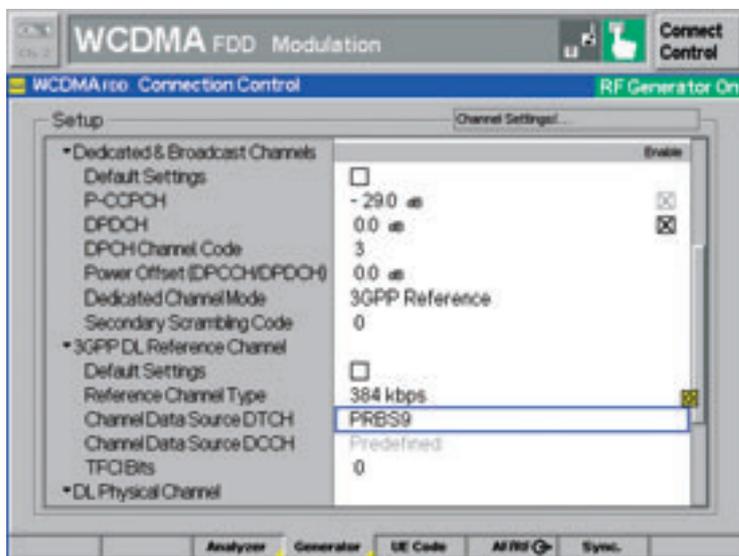


FIG 4
R&S CMU200 menu for transparent setting of generator parameters such as data rate and bit sequences

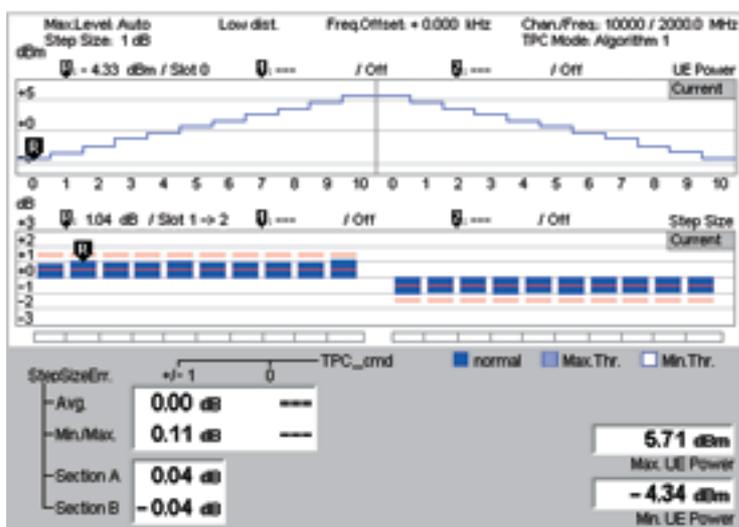


FIG 5
Inner loop power measurement

Abbreviations

<i>ACLR</i>	Adjacent channel leakage power ratio
<i>BER</i>	Bit error rate
<i>BLER</i>	Block error rate
<i>BCH</i>	Broadcast channel
<i>CRC</i>	Cyclic redundancy checksum
<i>DCCH</i>	Dedicated control channel
<i>DL</i>	Downlink (signal from base station to mobile phone)
<i>DPCCCH</i>	Dedicated physical control channel
<i>DPCH</i>	Dedicated physical channel
<i>DPDCH</i>	Dedicated physical data channel
<i>DTCH</i>	Dedicated transport channel
<i>EVM</i>	Error vector magnitude
<i>FN</i>	Frame number
<i>ME</i>	Magnitude error
<i>PE</i>	Phase error
<i>PRBS9</i>	Pseudo random bit sequence with bit length $2^9 - 1$
<i>P-CCPCH</i>	Primary common control physical channel
<i>P-CPICH</i>	Primary common pilot channel
<i>PCDE</i>	Peak code domain error
<i>P-SCH</i>	Primary synchronization channel
<i>RMC</i>	Reference measurement channel
<i>SEM</i>	Spectrum emission mask
<i>S-SCH</i>	Secondary synchronization channel
<i>TFCI</i>	Transport block combination indicator
<i>TPC</i>	Transmitter power control
<i>TTI</i>	Time transmission interval
<i>UL</i>	Uplink (signal from mobile phone to base station)
<i>UTRAN</i>	UMTS terrestrial radio access network
<i>3GPP</i>	3 rd generation partnership project

Future functions

In addition to the ready implemented, unidirectional *BER* measurement described above, there are plans for a layer 1 loopback measurement. Here the mobile reflects back the signal transmitted by the R&S CMU200, which compares it to the signal originally sent and thus calculates the *BER*. Since no link setup is required, this method saves considerable time.

An important future functionality will be the link setup, where the R&S CMU200

acts as a base station to which the mobile registers with subsequent call setup. Here, too, a *BER* measurement can be performed in the loopback mode.

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REFERENCES

- [1] 3GPP specifications: www.3gpp.org
- [2] R&S CMU200: First WCDMA measurement functions. News from Rohde & Schwarz (2001) No. 171, pp 13–15

Condensed data of WCDMA options for R&S CMU200

Standard	3GPP-FDD, testing mobile phones
Transmitter measurements	
Modulation analysis	<i>EVM</i> , <i>PE</i> , <i>ME</i> , frequency error, I/Q offset, I/Q imbalance, <i>PCDE</i>
Power measurement	max., min., off, ILP (inner loop power)
Spectrum measurement	<i>ACLR</i> , <i>SEM</i>
Code domain power	
Generator	downlink signal, <i>P-CPICH</i> , <i>P-SCH</i> , <i>S-SCH</i> , <i>P-CCPCH</i> , <i>DPCH</i>