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, *BER / BLER* 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.

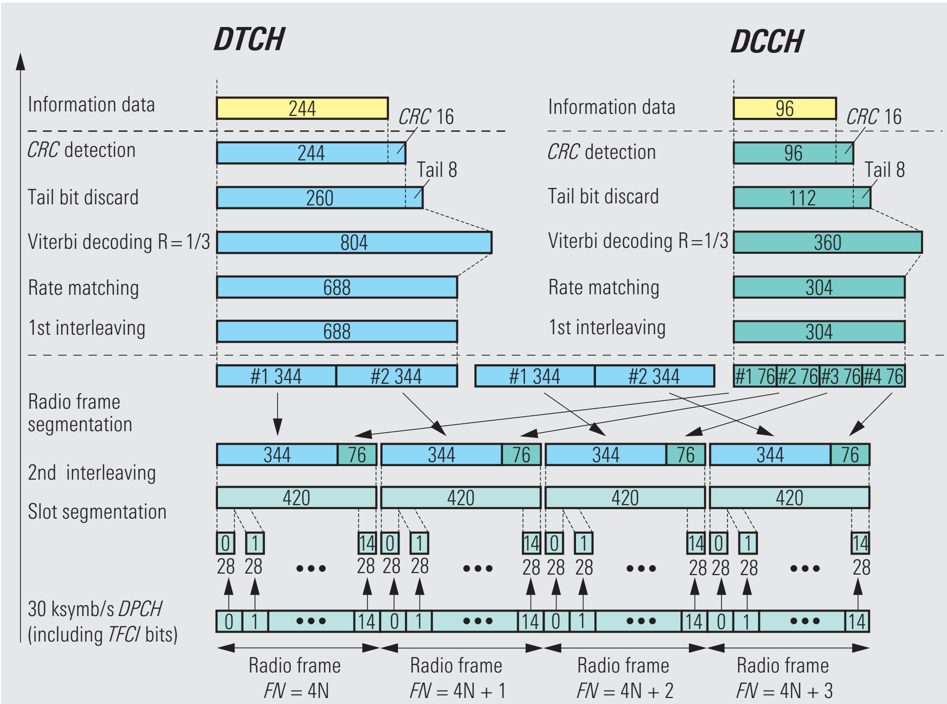

FIG 2 Coding of transport channels up to *DPCH* in *RMC* with data rate of 12.2 kbit/s (example)

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 *RMC*s, 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 *RMC*s 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.

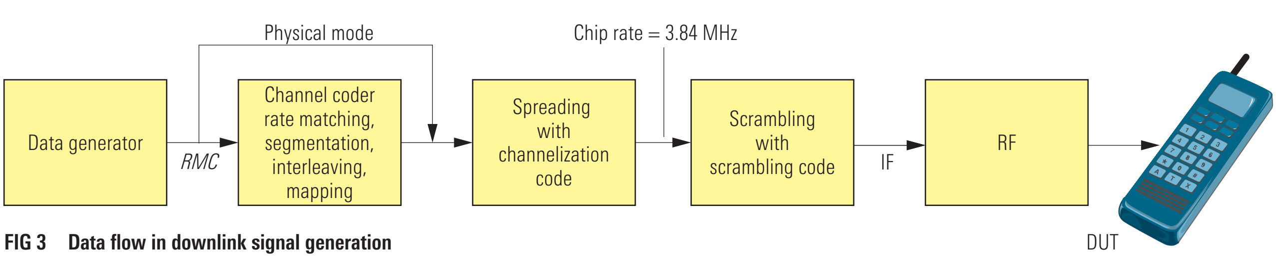

FIG 3 Data flow in downlink signal generation

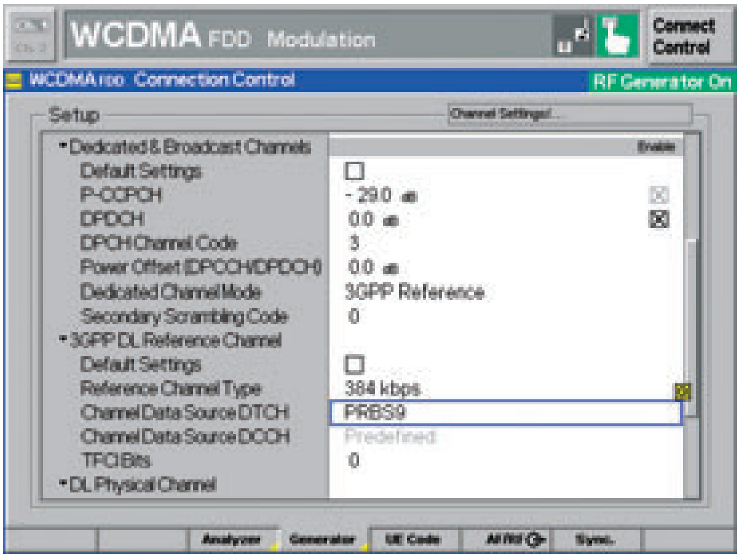

FIG 4
R&S CMU 200 menu for transparent setting of generator parameters such as data rate and bit sequences

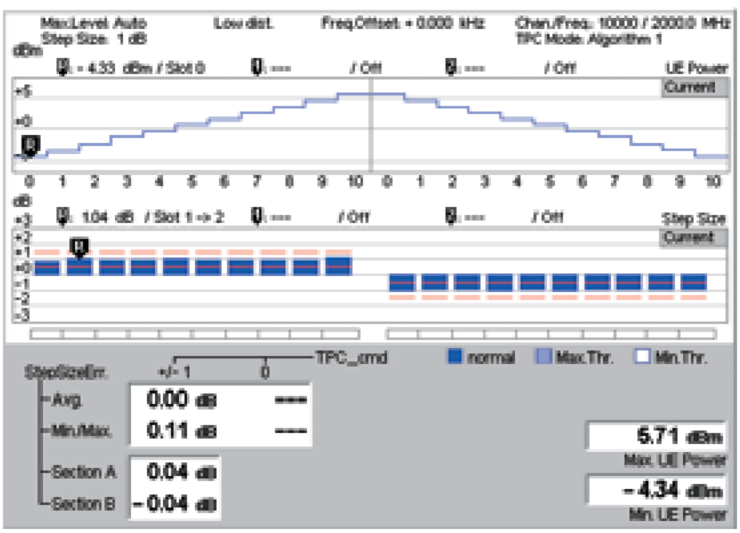

FIG 5
Inner loop power measurement

Abbreviations

ACLR	Adjacent channel leakage power ratio
BER	Bit error rate
BLER	Block error rate
BCH	Broadcast channel
CRC	Cyclic redundancy checksum
DCCH	Dedicated control channel
DL	Downlink (signal from base station to mobile phone)
DPCCH	Dedicated physical control channel
DPCH	Dedicated physical channel
DPDCH	Dedicated physical data channel
DTCH	Dedicated transport channel
EVM	Error vector magnitude
FN	Frame number
ME	Magnitude error
PE	Phase error
PRBS9	Pseudo random bit sequence with bit length 2^9-1
P-CCPCH	Primary common control physical channel
P-CPICH	Primary common pilot channel
PCDE	Peak code domain error
P-SCH	Primary synchronization channel
RMC	Reference measurement channel
SEM	Spectrum emission mask
S-SCH	Secondary synchronization channel
TFCI	Transport block combination indicator
TPC	Transmitter power control
TTI	Time transmission interval
UL	Uplink (signal from mobile phone to base station)
UTRAN	UMTS terrestrial radio access network
3GPP	3rd 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 CMU 200, 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 CMU 200 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.

Gottfried Holzmann; Thomas Zeising

REFERENCES
[1] 3GPP specifications: www.3gpp.org
[2] R&S CMU 200: First WCDMA measurement functions. News from Rohde & Schwarz (2001) No. 171, pp 13–15

Condensed data of WCDMA options for R&S CMU 200

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