Universal Radio Communication Tester R&S®CMU200

Measurements and signaling tests in the dual transfer mode

The dual transfer mode (DTM) – an expansion of the GSM mobile radio standard – permits voice telephony and data transfer at the same time. The R&S®CMU200 is well prepared to meet these requirements: With the R&S®CMU-K44 software option, the mobile radio tester can simulate a DTM-compatible GSM base station and thus perform a variety of measurements and signaling tests on mobile radio devices.

Both voice and data connections

The use of mobile phones has undergone amazing changes in recent years. While voice communication was the clear focus at the beginning, data transfer in the form of e-mails, documents or SMS/MMS as well as the use of the Internet is becoming increasingly important. This is a result of the technical progress.

Simultaneous transmission of voice and data is made possible by the dual transfer mode, an expansion of the GSM mobile radio standard. While talking to somebody on the mobile phone, you can receive e-mails. Or you can make a phone call while a large document is being transmitted. When expanded with the R&S®CMU-K44 software option, the Universal Radio Communication Tester R&S®CMU200 can perform measurements in the dual transfer mode. Since the R&S®CMU200 has a modular and flexible hardware concept, hardware expansions or modifications are normally not required for the dual transfer mode.

Three classes

The GSM standard differentiates between three classes of mobile radio devices:

- **Class A** Voice and data connection possible at the same time
- **Class B** Voice and data connection possible, but not at the same time.
- **Class C** Only voice or only data connection possible; manual switchover may be possible between voice and data operation

FIG 1 DTM multislot classes and their characteristics.

Multislot class	Max. number of downlink slots	Max. number of uplink slots	Max. sum of uplink and downlink
5	2	2	4
6	3	2	4
9	3	2	5
10	4	2	5
11	4	3	5
31, 36	5	2	6
32, 37	5	3	6
34, 39	5	5	6
41	6	2	7
42	6	3	7
45	6	6	7

Packet-data connection mode	Description
GPRS test mode A	The mobile radio device generates pseudo random data packets and sends these to the R&S®CMU200 in the uplink.
GPRS test mode B	The R&S®CMU200 generates pseudo random data packets in the downlink which are returned by the mobile radio device in the uplink.
BLER	The R&S®CMU200 sends data packets in the downlink to the mobile radio device. The BLER measurement can be started in this connection mode.
EGPRS loopback	The R&S®CMU200 generates pseudo random data packets in the downlink which are returned by the mobile radio device in the uplink. In contrast to test mode B, the data in the mobile radio device is returned after the demodulator and not sent to the channel coder. This connection mode is only defined for EGPRS coding schemes.

Only class A mobile radio devices can support the dual transfer mode. These devices communicate their DTM multislot classes for GPRS and EGPRS when logging on to the network and the R&S®CMU 200 displays the classes in the Overview menu. FIG 1 illustrates the multislot classes defined for the dual transfer mode and their characteristics.

Perfect operation

The dual transfer mode was perfectly integrated into the R&S®CMU 200 operating concept – not a single menu or control element had to be changed. Users can quickly master instrument operation and existing remote-control test programs can continue to be used.

A DTM connection exists when the circuit-switched part of the R&S®CMU 200 is in the *Call Established* state and the packet-data part is in the *TBF Established* state at the same time. Previously, you had to select between a circuit-switched or a packet-data connection prior to setting up a call via the main service. With the DTM option, you can even switch between the circuit-switched and packet-data menus while a connection exists.

Parameterization

The dual transfer mode also ensures highly flexible parameterization of the R&S®CMU 200 for the circuit-switched part and the packet-data part of a DTM connection: Almost all parameters maintain their functions. Frequency hopping or timing advance is possible, for example. FIGs 2 and 3 show the connection modes that can be set in the packet-data part and in the circuit-switched part of a DTM connection. You can combine the connection modes in any manner you wish.

You can also configure timeslots however you wish: just select the timeslots to be used in the configuration editor and set the desired level on the right (FIG 4).

DTM CS Timeslot in the configuration editor defines the timeslot for the circuit-switched part of the DTM connection; *Main Timeslot* defines the main timeslot for the packet-data part. While only one uplink and downlink timeslot is used for the circuit-switched part, you can configure more than just the main timeslot for the packet-data part depending on the DTM multislot class of the mobile radio device.

Signaling

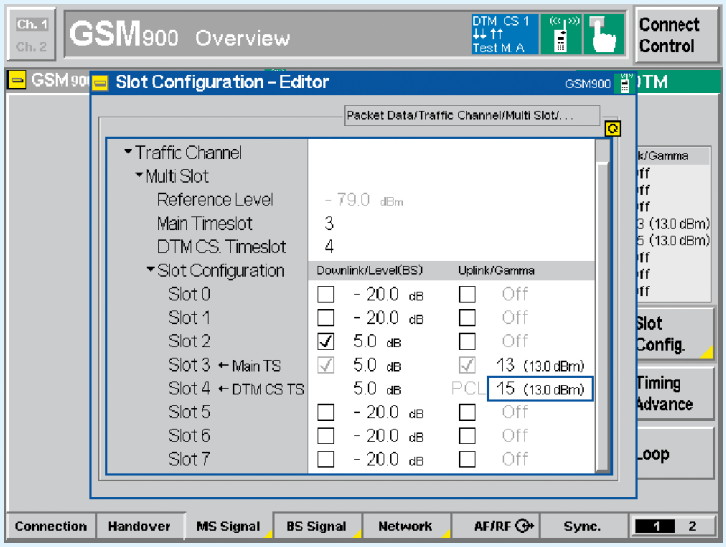
A voice connection must be present to set the mobile radio device to the dual transfer mode. You can then activate the packet-data part and establish a data connection as well. You can run signaling routines to dynamically modify parameters such as channel or timeslot change, and make modifications to the timeslot configuration, to the packet-

FIG 2 Connection modes in the packet-data part of the DTM connection.

FIG 3 Connection modes in the circuit-switched part of the DTM connection.

Circuit-switched connection mode	Description
Full rate version 1	Standard voice channel coding at full data rate
Half rate version 1	Standard voice channel coding at half data rate
Full rate version 2	Channel coding with improved voice quality and full data rate
AMR full rate (option R&S®CMU-K45 required)	Adaptive multi rate voice connection at full data rate
AMR half rate (option R&S®CMU-K45 required)	Adaptive multi rate voice connection at half data rate

FIG 4 Editor for uplink and downlink timeslots.



data coding scheme or to the circuit-switched traffic mode in the usual manner during a DTM connection.

You can use the Message Viewer R&S®CMU-Z49 to visualize the signaling process and display or analyze the contents of each message (FIG 5).

Transmitter measurements

Transmitter measurements are used to check the RF characteristics of the transmit section in the mobile radio device. Since EGPRS- and DTM-supporting mobile radio devices using modulation modes GMSK and 8PSK can transmit data on different timeslots while a DTM connection is established, you can check both modulators with only a single measurement. The circuit-switched timeslot of a DTM connection is always GMSK-modulated while the packet-data timeslot can also be 8PSK-modulated.

The power-versus-time measurement graphically displays the power ramp characteristic of the mobile radio device (FIG 6). Compliance with the tolerance limits defined in the GSM standard can thus be checked at a glance.

Receiver measurements

Receiver measurements check the reception quality of the mobile station receiver. The measuring principle is based on the fact that low RF-level random data is sent to the mobile radio device in the downlink. The mobile radio device then returns high RF-level data in the uplink. The R&S®CMU 200 compares sent data and received data and calculates the error ratio. This calculation is based on an ideal uplink so that transmission errors do not occur.

The bit error ratio (BER) is measured via the circuit-switched part of the DTM connection. In this case, random data is sent to the mobile radio device which returns the data to the R&S®CMU200 unchanged (FIG 7).

The block error ratio (BLER) is measured on the packet-data part of the DTM connection. In this case, data blocks with random data are sent to the mobile radio device (FIG 8). In the uplink mode, the mobile radio device acknowledges the receipt of error-free data blocks by sending ACK/NACK messages. The R&S®CMU 200 then calculates the block error ratio (total and per slot) and the data transmission rate achieved.

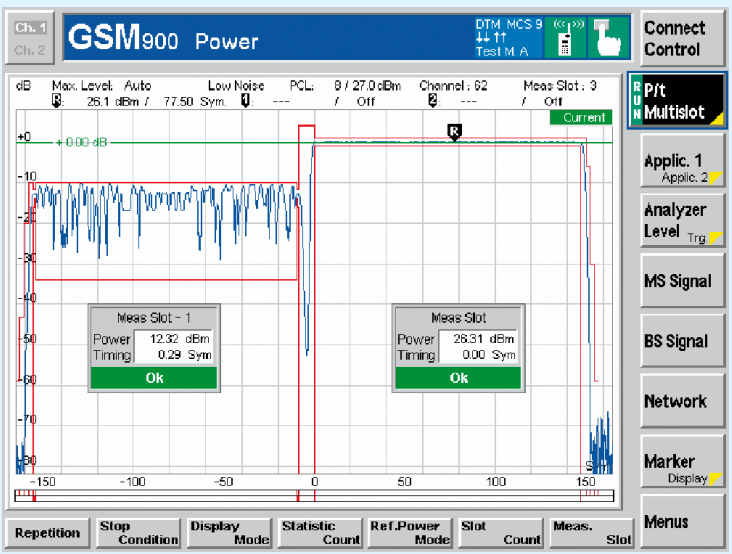
Ultrafast in production

During a DTM connection, you can simultaneously run the BER and BLER measurements in the remote-control mode. This reduces the test time for a mobile radio device to a minimum.

Dir	Name	log. Channel
RX	DL-RA-Ind	RACH
TX	Immediate Assignment	AGCH
RX	CM Service Req	FACCH
TX	System Info Type 6	SACCH
TX	CM Service Accept	FACCH
TX	System Info Type 5	SACCH
RX	CC Setup	FACCH
TX	CC Call Proceeding	FACCH
TX	Channel Mode Modify	FACCH
RX	Channel Mode Modify Ack	FACCH
TX	Alerting	FACCH
TX	CC Connect	FACCH
RX	CC Connect Ack	FACCH
TX	DTM Assignment Command	FACCH
RX	Assignment Complete	FACCH
TX	GPRS Test Mode Cmd	GPRS
RX	Packet Downlink Ack	GPRS
RX	Packet Downlink Ack	GPRS
TX	Packet Uplink Assignment	GPRS
RX	Packet Downlink Ack	GPRS
RX	Packet Downlink Ack	GPRS
RX	Packet Control Ack	GPRS
TX	DTM Assignment Command	FACCH
RX	Assignment Complete	FACCH
RX	CC Disconnect	FACCH
TX	CC Release	FACCH
TX	Packet Uplink Ack	GPRS
RX	CC Release Complete	FACCH
TX	Channel Release	FACCH

FIG 5 Display of message sequence with Message Viewer R&S®CMU-Z49: call setup and release of a DTM connection in the GPRS test mode.

FIG 6 Power-versus-time measurement with 8PSK modulation in the packet-data part and GMSK modulation in the circuit-switched part.



In addition to the signaling tests, the R&S®CMU 200 also offers the reduced signaling mode which is used during production testing. Mainly RF characteristics of mobile radio devices are checked. This mode allows you to skip parts of the signaling and thus reduces the test time per mobile radio device. The complete reduced signaling mode has also been implemented for DTM connections.

All operating steps of the dual transfer mode can be fully remote-controlled via the IEC/IEEE bus interface.

Summary and future developments

The R&S®CMU-K44 DTM software option expands the Universal Radio Communication Tester R&S®CMU 200 to include a feature that will be supported by almost any modern future mobile phone. The largest manufacturers are currently expanding their mobile radio devices to include the dual transfer mode. The R&S®CMU 200 is an innovative tester that is extremely useful both in development and production.

Peter Seelbach

More information and data sheet at www.rohde-schwarz.com (search term: CMU200)

REFERENCES

– Technical Specification 3GPP TS 43.055, Dual Transfer Mode, 3rd Generation Partnership Project, Technical Specification Group GSM/EDGE
– Universal Protocol Tester R&S®CRTU-G Test cases for dual transfer mode in GSM/(E)GPRS networks. News from Rohde&Schwarz (2005) No. 185, p 7

FIG 7 Measurement of bit error ratio on the circuit-switched timeslot of a DTM connection.

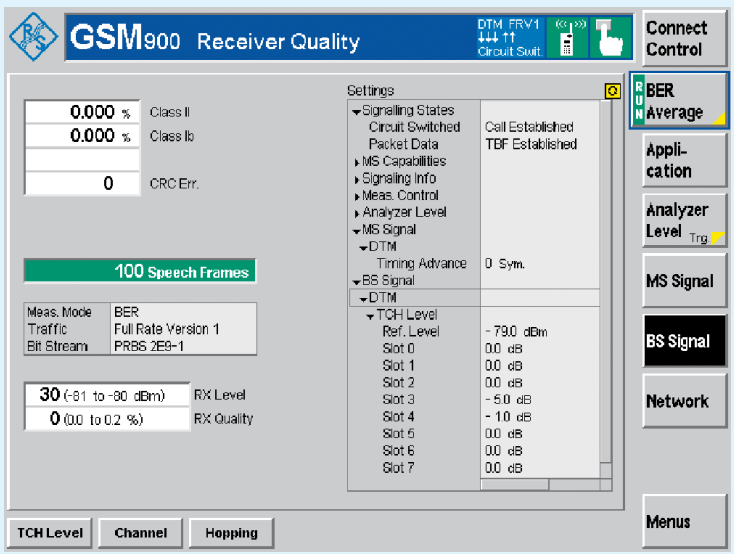


FIG 8 Measurement of block error ratio on the packet-data timeslots of a DTM connection.