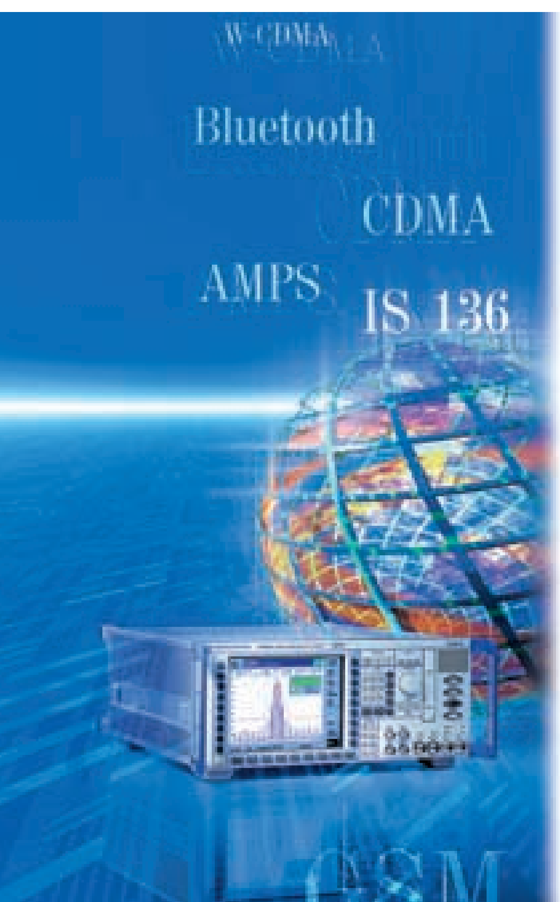
Universal Radio Communication Tester CMU 200

Measuring bit error rate on GSM mobiles

The test modes defined by GSM standardization committees prescribe how to measure the receiver characteristics of GSM mobile phones. This is the kind of application that CMU 200 [1] with its advanced concept excels in.



BER – a measure of receiver sensitivity

The transmitter characteristics of GSM mobiles are relatively simple to measure, since the physical effects can be checked directly on the tester. But when it comes to receiver characteristics, the physical effects appear in the tested device itself, so no direct measurement is possible. GSM standardization committees therefore defined test modes for measuring the receiver characteristics of GSM mobiles.

The major feature of a receiver is its sensitivity. In digital systems, this is determined through the bit error rate (BER). The receiver is fed a test signal with pseudo-random bit sequence and defined level, and the number of bit errors is measured at its output.

In development and conformance testing of GSM mobiles the receiver characteristics have to be tested under various aspects like fading, multipath reception or intermodulation. But in production it is sufficient to stimulate the receiver with a low-level GSM signal. Usually, either reference sensitivity or absolute receiver sensitivity is measured on GSM mobiles.

Reference or absolute sensitivity?

To check the reference sensitivity, a signal with defined level (e.g. –102 dBm or –104 dBm for GSM 900) is applied to the receiver. If the measured BER is below the specified limit, the receiver is ok. To determine the absolute receiver sensitivity on the other hand, the level of the test signal is varied until a defined BER is obtained.

Obviously, absolute receiver sensitivity takes more time to measure than reference sensitivity. So in production, where you are interested in maximum throughput, measurement of the reference sensitivity is naturally often preferred.

BER test modes

The basic principle of the BER test modes is simple: the radiocommunication tester sends a data stream to the mobile, which then sends it back to the tester (loop). The tester compares sent and received data streams to determine the number of bit errors (FIG 1).

Various test modes (loop types) are defined. With types A, B, D, E and F the tester generates a pseudo-random bit stream, which is channel-coded and applied via the RF interface to the receiver of the mobile. There the data stream passes through the channel decoder and – via channel coder, RF interface and channel decoder – is sent back to the tester. What precisely the mobile sends back depends on the type of loop. With loop B it returns exactly what it has received. With loop A, however, received voice frames with non-correctable class 1a errors are not returned but marked as erased frames. This is possible because GSM voice transmission is protected by bits so that bit errors can be corrected. Depending on their significance, the protection bits are divided into the following classes:

- Class 1a bits: very good protection
- Class 1b bits: little protection
- Class 2 bits: no protection

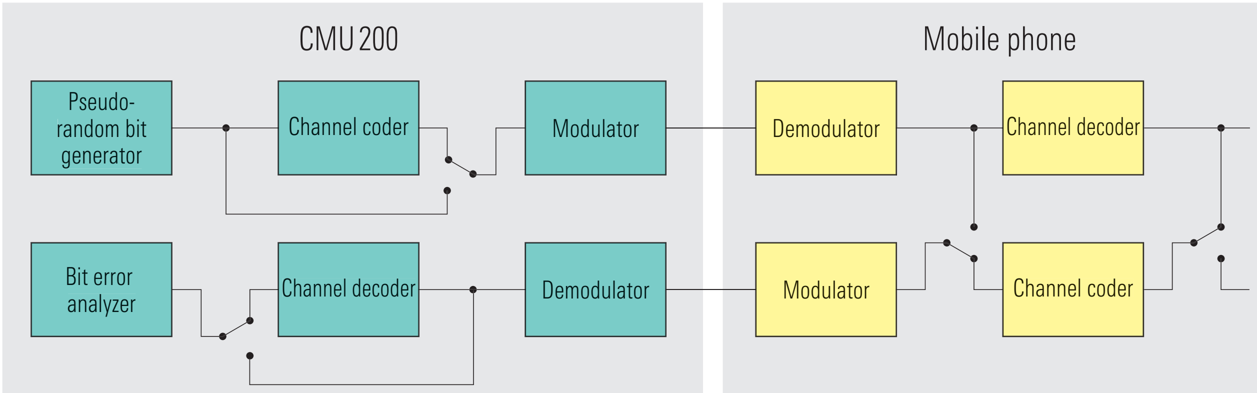


FIG 1 **The GSM mobile can send the received data stream back to the tester via different loops: before (loop C) or after the channel decoder (loops A, B, D, E and F). The diagram shows switch positions for loops A, B, D, E and F. All switches are set opposite for loop type C**

In the case of erased frames the mobile sends back a voice frame consisting entirely of zeroes. On receiving such a voice frame, the tester increments the FER (frame error rate) counter. With this type of loop therefore only voice frames with a certain minimum quality are considered in the BER. This explains the singular effect occurring with this loop type, namely that with decreasing receive level the BER suddenly improves. The lower the level, the more erased frames occur. So only voice frames with the smallest number of bit errors will be considered in the BER measurement.

Loop types D, E and F are used for half-rate connections and are of minor significance in production. Like with loop type A, certain frames are not considered in the BER measurement (unreliable frames, erased SID frames and erased valid SID frames). Such frames are marked by zeroes.

The larger the numbers of mobile phones produced, the more important it becomes to cut testing times. This was the reason for introducing loop type C. The mobile sends back the received data stream without taking it through the channel decoder. The advantage here is that, for the same transmission period, about five times as many bits are available for determining bit errors. This type of loop is not supported by all mobile phones however.

Further loop types and test modes have meanwhile been defined for the new and upcoming mobiles that support HSCSD (high-speed circuit-switched data) and GPRS (general packet radio services).

Measuring GSM BER with CMU 200

Outstanding convenience

The advanced concept of Universal Radio Communication Tester CMU 200 excels not only in transmitter measurements (see [2] and [3]) but also in receiver measurements. BER measurement is coupled to a special transmitter level setting for instance. Using a high transmitter level it ensures reliable call setup with the mobile. As soon as the BER measurement is active, the tester automatically selects a low transmitter level and, after completing the measurement, returns to the high level.

Data stream transfer from CMU 200 to the mobile is also very convenient for the user: during the BER measurement, CMU 200 automatically selects a pseudo-random bit sequence. And of course it opens and closes the test loops in the mobile automatically. All these features enable straightforward operation of the tester.

CMU 200 also classifies the bits and provides limit values for each class (FIG 2).

Reference sensitivity

Ten test setups are available for fast and convenient checking of reference sensitivity. Different transmitter levels, test sequence lengths, BER limits and loop types can be preset. The setups can then be called up as test routines, avoiding tiresome reconfiguration between different BER measurements.

CMU 200 also reduces test time for faulty mobiles by prematurely terminating the BER measurement if the required reference sensitivity cannot be achieved.

Absolute receiver sensitivity

For determining the absolute receiver sensitivity the tester provides an optimized routine that allows presetting of the desired averaging depth for BER measurement. During the ongoing measurement the sliding BER average is measured with the aid of this window. The user can at the same time directly vary the transmitter level by means of numerical entry or with the spinwheel. This is a fast and easy way to determine absolute receiver sensitivity. CMU 200 is optimized for use in production, so it also supports loop type C, allowing a very significant reduction in testing time.

AGC test

For testing the AGC (automatic gain control) of a receiver, CMU 200 provides different transmitter levels for the active timeslot and for the unused timeslots. The receiver in the mobile can thus be subjected to unfavourable conditions in the unused timeslots. Plus, it is possible to define a delay for AGC settling in the mobile.

Pseudo-random bit streams

The tester uses a choice of four true pseudo-random bit sequences for BER measurement. You will especially appreciate this feature if you have ever overlooked a faulty channel coder by using a fixed bit pattern, because a pseudo-random sequence is the only reliable means of detecting it.

For transmitter measurements the BER loop can also be kept closed outside BER measurement. This is a simple way of meeting the requirement for a mobile phone transmitter signal modulated with pseudo-random bits, as needed for spectrum and power measurements.

Keeping pace

GSM standardization committees are defining new test modes for the upcoming standards HSCSD, GPRS and EDGE (enhanced data for GSM evolution). Rohde & Schwarz is keeping pace with advances: as soon as new test modes have been defined, they will be implemented in CMU 200.

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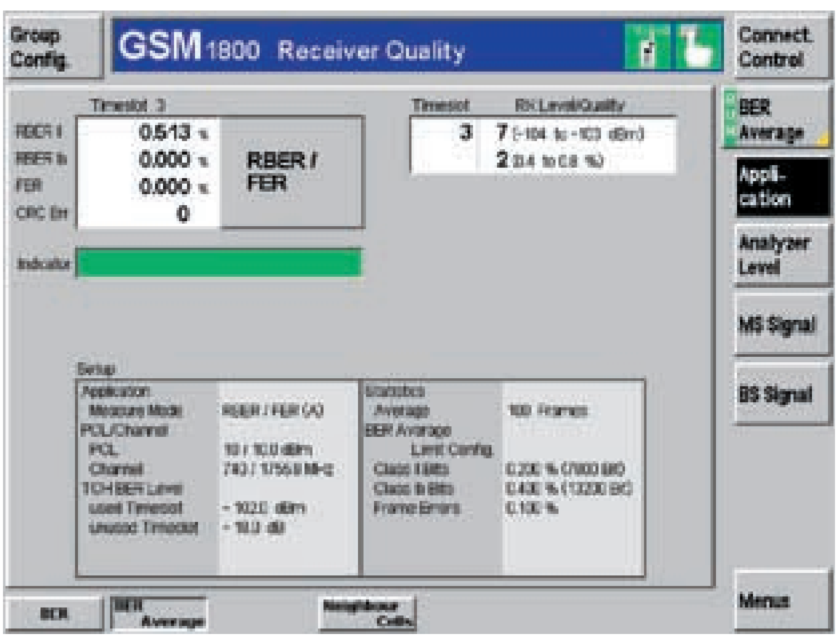

FIG 2 CMU 200 categorizes the measured BER according to bit classes. A separate limit can be defined for each class

REFERENCES

[1] CMU 200: On the fast lane into the mobile radio future. News from Rohde & Schwarz (1999) No. 165, pp 4–7

[2] CMU 200: GSM power measurement – versatile, fast and accurate. News from Rohde & Schwarz (2000) No. 167, pp 24–25

[3] CMU 200: Speeded-up test of GSM mobiles without signalling. News from Rohde & Schwarz (2000) No. 168, pp 16–17