Receiver measurements on GPRS and EGPRS mobile phones

What UMTS holds for the future is already materializing in GSM networks: high-speed data transmission. This is made possible with the 2.5G standards GPRS and EGPRS. While EGPRS mobile phones are still in the development stage, GPRS mobiles are already on the market. The new 2.5G standards mean new measurement challenges for manufacturers of mobile phones. For example, new approaches have to be taken in receiver measurements. The Universal Radio Communication Tester R&S CMU200 from Rohde&Schwarz provides full receiver test capability not only for GPRS, but now for EGPRS mobile phones as well.

See page 25 of this issue for another contribution on the R&S CMU200.

GPRS/EGPRS packet-based data links

In packet-based data transmission, an entire physical path will not generally be established between the communicating terminals throughout the time of communication. Rather, a link is set up only when data is actually transmitted. First, the base station agrees with the mobile phone on the timeslot(s) of the RF channel to be used for data exchange. A total of eight timeslots is available. The number of timeslots used depends on the multislot class of the mobile and on the base station loading. In addition, the mobile is assigned an uplink state flag (USF). The USF flag, which is transmitted by the base station in the downlink (DL), determines whether or not the mobile may send data in one of the corresponding uplink (UL) timeslots. Up to seven mobiles can in this way share a timeslot. Each time a mobile decodes its USF in a data block in a downlink timeslot, it may – and should – send a data block in the corresponding uplink timeslot in the subsequent radio link control (RLC) block frame if the mobile was assigned this uplink timeslot beforehand (FIG 1). If, at a given instance, the mobile has no user data to send in the uplink timeslot, it sends a dummy block instead. This addressing mode is known as dynamic allocation. However, if the mobile is assigned several uplink timeslots, this mode has the disadvantage that, for each uplink data block to be sent, the mobile first has to decode a downlink data block. The capabilities of today's mobiles, featuring only one synthesizer for the uplink and the downlink, are thus stretched to their limits, i.e. mobiles can handle no more than two uplink timeslots. For this reason, the extended dynamic allocation mode was introduced. With this addressing mode, the first valid USF flag received by the mobile is also valid for all uplink timeslots in the current RLC block frame (FIG 2). The addressing mode to be used in a packet-based data link is determined by the base station.

Receiver measurements with packet-based data links

Standardization bodies have defined the block error rate (BLER) as the relevant quantity for receiver measurements with packet-based data links. In GPRS or EGPRS systems, the mobile requests all errored data blocks received to be retransmitted. The BLER is the ratio of errored data blocks received (i.e. data blocks to be retransmitted) to the total number of data blocks transmitted. But the BLER is not the only receiver quantity of interest.

There is, for example, the USF BLER. What does this quantity stand for? A mobile may send a data block in the uplink only if it has received a valid USF in the downlink. However, if the mobile does not correctly decode the USF, it will not send a data block in the corresponding uplink timeslot. The USF BLER designates the ratio of the number of incorrectly decoded USF flags to the total number of USF flags transmitted (FIG 3).

BLER and USF BLER measurements are mandatory for conformance testing of GPRS and EGPRS mobiles. BLER measurements are problematic in production, however, since they are time-consuming and, by their very nature, may stop, so that measurement time is not reliably predictable [1]. Bit error rate (BER) measurements are, therefore, the much more viable alternative for production. BER measurements require a pseudo random data stream. They can be implemented by means of the GPRS test mode B defined by the standardization bodies. In this test mode, the mobile returns the data block received, so that the transmitted data stream can be compared with the received data stream and the BER determined. Unfortunately, standardization bodies originally only had transmitter measurements in mind when working out test mode B, and had not specified exactly what kind of data a mobile should return in response to an errored data block. Most of the mobiles presently available return dummy RLC blocks instead of the data received. This does not allow BER measurements, however. Test mode B was therefore modified by standardization bodies so that it can be used for BER measurements.

One more test mode was defined for EGPRS mobiles: EGPRS switched radio block loopback mode (frequently also referred to as test mode C). In this mode, channel coding is omitted, leaving more data bits for BER measurement (comparable to burst-by-burst BER measurement in circuit-switched links). Mobiles capable of 8PSK EDGE modulation both in the uplink and the downlink return exactly as many data bits as they have received (FIG 4). By contrast, mobiles capable of handling 8PSK EDGE modulation only in the downlink and using GMSK modulation in the uplink are able to return only one third of the data bits received. To solve this problem, test equipment is allowed to transmit data blocks to such a mobile in every third RLC block frame only. The mobile will then return the data in three consecutive RLC block frames (FIG 5).

Reduced signalling cuts down on test time

In mobile phone production every millisecond of test time counts. Manufacturers therefore make every effort to reduce test time. A substantial reduction of measurement time can be achieved by omitting signalling sequences. These are irrelevant in production, as they are software based and therefore need not be tested on every mobile. Many mobile phone manufacturers have for this reason replaced GSM signalling sequences by proprietary mobile phone interfaces and commands, and expect their mobile radio test system to be capable of handling such reduced sequences [2].

GPRS and EGPRS receiver measurements with R&S CMU200

The Universal Radio Communication Tester R&S CMU200 performs all relevant receiver measurements on GPRS and EGPRS mobile phones, offering outstanding user convenience. For example, BLER is output separately for each timeslot and as a total value over all timeslots used. The total data transmission rate achieved is also output (FIG 6). In test mode A, which is actually intended for transmitter tests only, the R&S CMU200 in addition determines the USF BLER. This is of interest especially for GPRS mobiles that only support test mode A. In test mode B, the R&S CMU200 calculates the BER as well as the USF BLER and the D(data)BLER (FIG 7). The DBLER is a calculated block error rate, which comes very close to the actual BLER [1]. The DBLER can be determined even if the mobile, in test mode B, only returns a dummy RLC block in response to an errored data block. The tester supports test modes A and B for GPRS also with reduced signalling sequences, thus cutting down on measurement time.

For the figures shown opposite, the following should be noted: The frames comprising timeslots 0 to 7 are RLC block frames and should not be confused with GSM frames. Several GSM frames, i.e. several transmit bursts in a given timeslot, are needed to transmit one RLC data block.

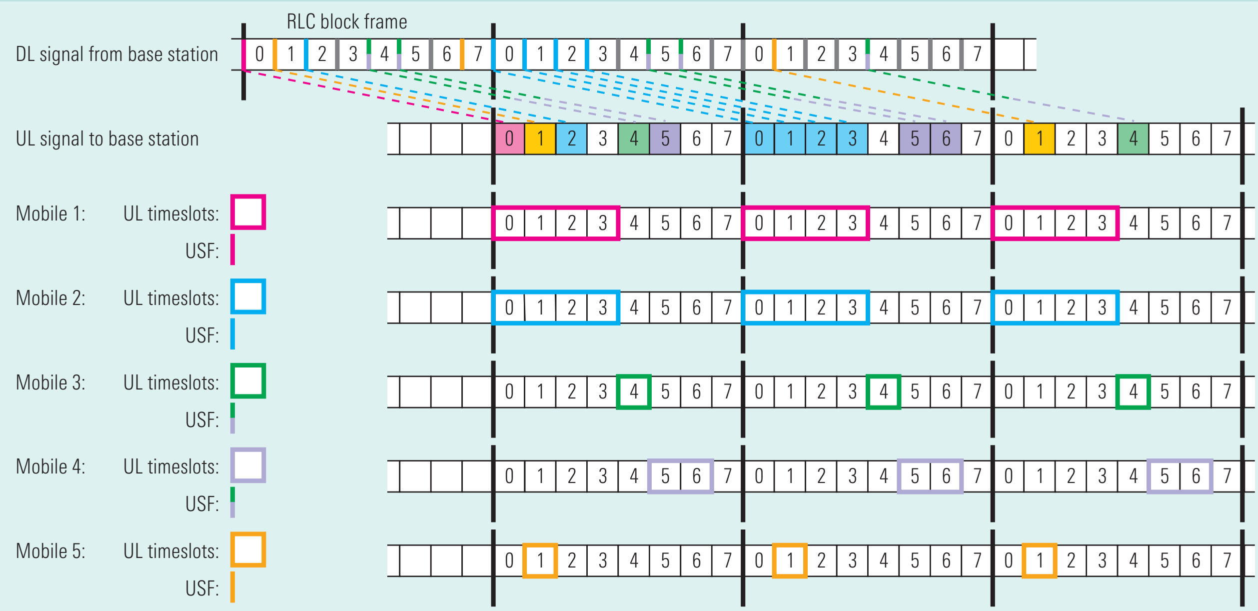
FIG 1
Packet-based data transmission with dynamic allocation. On link setup, the base station agrees with the mobile on the timeslot(s) in which the mobile may send data and assigns a USF flag to the mobile. Several mobiles can be assigned identical timeslots and different USF flags (mobiles 1, 2 and 5 in this example) or identical USF flags and different timeslots (mobiles 3 and 4 in this example). The USF flags transmitted by the base station in the downlink are marked by different colours. The mobile receives the different USF flags. It will send a data packet each time it recognizes its own USF flag if the corresponding uplink timeslot is assigned to the mobile.

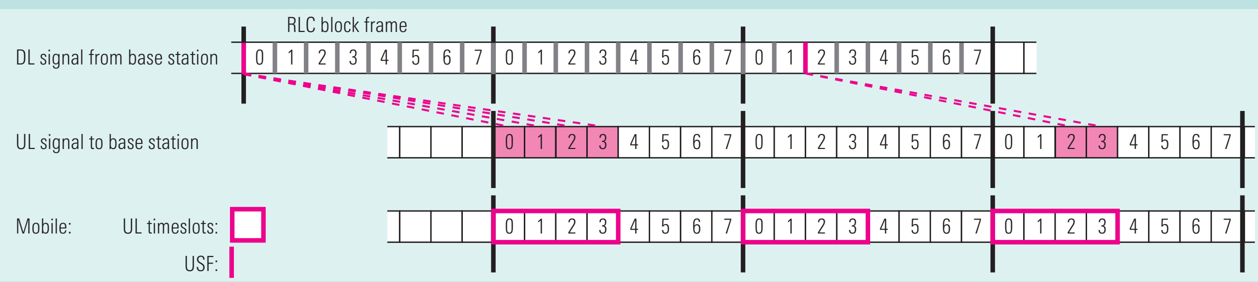
FIG 2
Packet-based data transmission with extended dynamic allocation. This mode functions the same as dynamic allocation. It differs from dynamic allocation only in that the first valid USF flag received is also valid for all following uplink timeslots assigned to the mobile in the current RLC block frame.

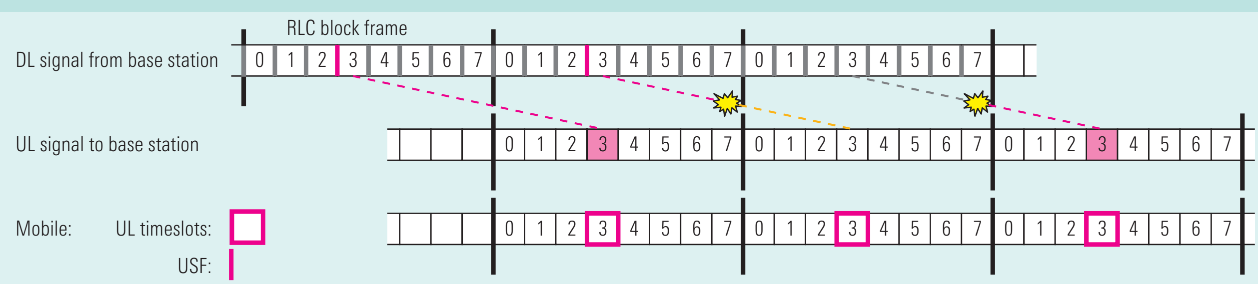
FIG 3
USF BLER: If a mobile decodes a USF flag incorrectly, it will not transmit a data packet in the corresponding uplink RLC timeslot. The USF BLER is the ratio of incorrectly decoded USF flags to the total number of USF flags transmitted. It is also possible that the mobile decodes a USF flag assigned to another mobile as its own flag. In such a case, the mobile would send a data packet in a wrong timeslot. This type of error, which is also measured, is frequently referred to as negative USF BLER.

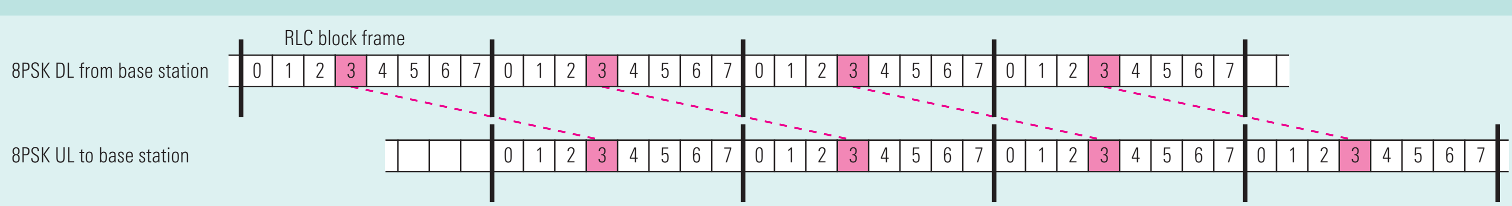
FIG 4
In the symmetrical EGPRS switched radio block loopback mode, the mobile returns to the measuring instrument exactly as many data blocks (without channel coding) as it has received.

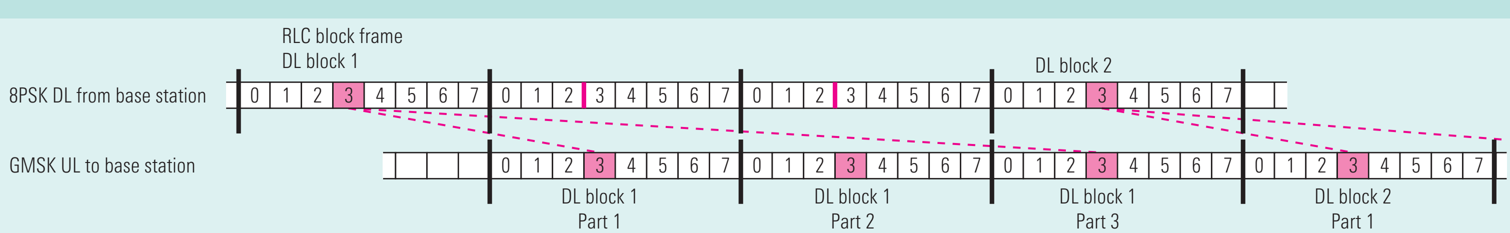
FIG 5
In the nonsymmetrical EGPRS switched radio block loopback mode, the mobile receives three times as many data bits as it can return. For this reason, the measuring instrument is allowed to transmit a valid data block to the mobile only in every third RLC block frame. The mobile returns the data block in three consecutive RLC block frames.


RLC block frame
DL signal from base station
UL signal to base station
Mobile 1: UL timeslots:
USF:
Mobile 2: UL timeslots:
USF:
Mobile 3: UL timeslots:
USF:
Mobile 4: UL timeslots:
USF:
Mobile 5: UL timeslots:
USF:


RLC block frame
DL signal from base station
UL signal to base station
Mobile: UL timeslots:
USF:


RLC block frame
DL signal from base station
UL signal to base station
Mobile: UL timeslots:
USF:


RLC block frame
8PSK DL from base station
8PSK UL to base station


RLC block frame
DL block 1
DL block 2
8PSK DL from base station
GMSK UL to base station
DL block 1
Part 1
DL block 1
Part 2
DL block 1
Part 3
DL block 2
Part 1

▶ The R&S CMU 200 is also the first mobile radio tester to support test modes A and B for EGPRS as well as the EGPRS test mode with reduced signalling. It can handle EGPRS tests both for symmetrical (8PSK in the uplink and the downlink) and nonsymmetrical configurations (8PSK in the downlink and GMSK in the uplink). The EGPRS BLER measurement is already implemented in the Rohde & Schwarz development lab and will soon be available on the market.

Summary

Due to its innovative hardware and software concept, the R&S CMU 200 over the past few years has not only maintained but even enhanced its position as the top-ranking product on the mobile radio market. Its transmitter and receiver test functionalities are unrivalled especially with regard to the radiocommunication standard of the future – EGPRS. The Universal Radio Communication Tester R&S CMU 200 has thus become indispensable in the development labs of EGPRS mobile phone manufacturers.

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More information and data sheet at www.rohde-schwarz.com (search term: CMU 200)

REFERENCES
[1] Universal Radio Communication Tester R&S CMU 200 – Multislot measurements on HSCSD and GPRS mobile phones. News from Rohde & Schwarz (2001) No. 172, pp 15–17
[2] Universal Radio Communication Tester R&S CMU 200 – Speeded-up test of GSM mobiles without signalling. News from Rohde & Schwarz (2000) No. 168, pp 16–17

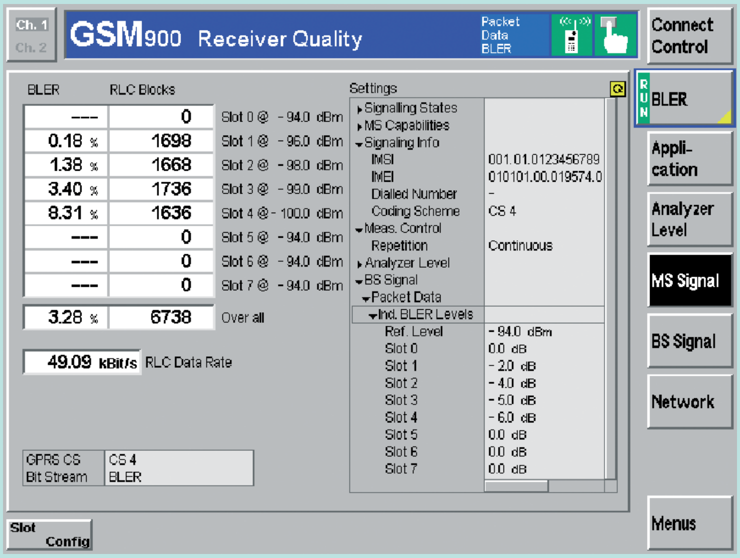

FIG 6 In BLER measurements, the R&S CMU 200 not only determines the total BLER but also the BLER for each timeslot. In conjunction with the tester's capability of transmitting different RF levels in different timeslots, this function enables a quick overview of a mobile's receiver sensitivity. The R&S CMU 200 also determines the achieved data transmission rate.

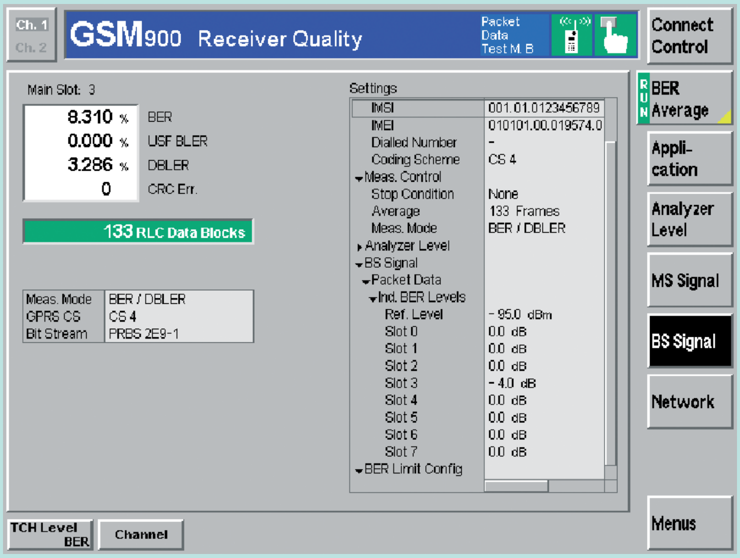

FIG 7 BER measurements are the appropriate choice in mobile phone production. The R&S CMU 200 determines BER as well as USF BLER and DBLER.