

R&S CMU200 (K20,K21,K22,K23,K24,K42, K43), CMUgo

## (E)GPRS Measurements with R&S CMU200 and CMUgo

### Application Note

This application note describes how to test and perform (E)GPRS-related measurements on mobile phones in compliance with the GSM standard using the R&S CMU200 by means of the remote-control program CMUgo or manual operation.



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## **1 Overview**

The Radio Communication Tester R&S CMU200 can be used to perform fast and accurate measurements of different standards such as GSM, IS-136, AMPS, CDMA, cdma2000, 1xEVDO, WCDMA and Bluetooth.

One aspect of GSM are the packet-oriented services GPRS and EGPRS.

This application note describes how to use CMUgo, a Windows application for remote control of the R&S CMU200 and for measuring and testing (E)GPRS aspects of mobile phones in compliance with the GSM standard.

## **2 Introduction**

This application note is not intended to explain the associated theory in full but rather simply provides a brief summary of the most important aspects.

The 'General Packet Data Service' (GPRS) and the 'Enhanced GPRS' (EGPRS) provide packet-oriented services for data communication in existing networks (e.g. Internet) in compliance with the GSM standard. GPRS offers increased data rates by bundling several timeslots (as with 'High Speed Circuit Switched Data' (HSCSD)), and EGPRS provides a further increase in data rate by means of 'Enhanced Data Rates for GSM Evolution' (EDGE; new modulation: 8PSK).

(E)GPRS is simply an extension of GSM and uses physical resources of GSM (phase 2+ or 2.5).

Packet-oriented data communication means that resources are only used if data is actually to be transmitted. In (E)GPRS, this is referred to as 'Temporary Block Flow' (TBF).

To allow better adaptation to the given channel characteristics, four channel codes (CS1 to CS4; CS1 provides optimum protection and the lowest data rate) have been defined in GPRS and nine modulation and channel-coding schemes (MCS1 to MCS9) defined in EGPRS (Figure 1). Here it is important to note that MCS1 to MCS4 are also GMSK-modulated in EGPRS.

## (E)GPRS with CMU and CMUgo

Scheme	Code rate	Modulation	RLC blocks per Radio Block (20ms)	Raw Data within one Radio Block	Family	BCS	Punctured bits	Data rate kb/s
CS-1	0.5	GMSK	1	456	-	40	0	9.05
CS-2	$\approx 2/3$		1	588	-	16	132	13.4
CS-3	$\approx 3/4$		1	676	-	16	220	15.6
CS-4	1		1	456	-	16	-	21.4

Scheme	Code rate	Modulation	RLC blocks per Radio Block (20ms)	Raw Data within one Radio Block	Family	BCS	Punctured bits	Data rate kb/s
MCS-9	1.0	8PSK	2	2x592	A	2x12	1224	59.2
MCS-8	0.92		2	2x544	A		1080	54.4
MCS-7	0.76		2	2x448	B		792	44.8
MCS-6	0.49		1	592 544+48	A	12	588	29.6 27.2
MCS-5	0.37	1	448	B	196		22.4	
MCS-4	1.0	GMSK	1	352	C		576	17.6
MCS-3	0.80		1	296 272+24	A		576	14.8 13.6
MCS-2	0.66		1	224	B	360	11.2	
MCS-1	0.53		1	176	C	216	8.8	

Figure 1 - Channel coding schemes in (E)GPRS

## 3 Manual Operation of the the R&S CMU200

### Call Setup and Release

Since the various mobile phones require different parameters in (E)GPRS, the settings necessary prior to the actual call setup are described here.

#### CMU200 signalling unit (B21)

The CMU200 can be equipped with two different link handlers. Information on this can be displayed under SETUP|OPTIONS (Figure 2).

## (E)GPRS with CMU and CMUgo

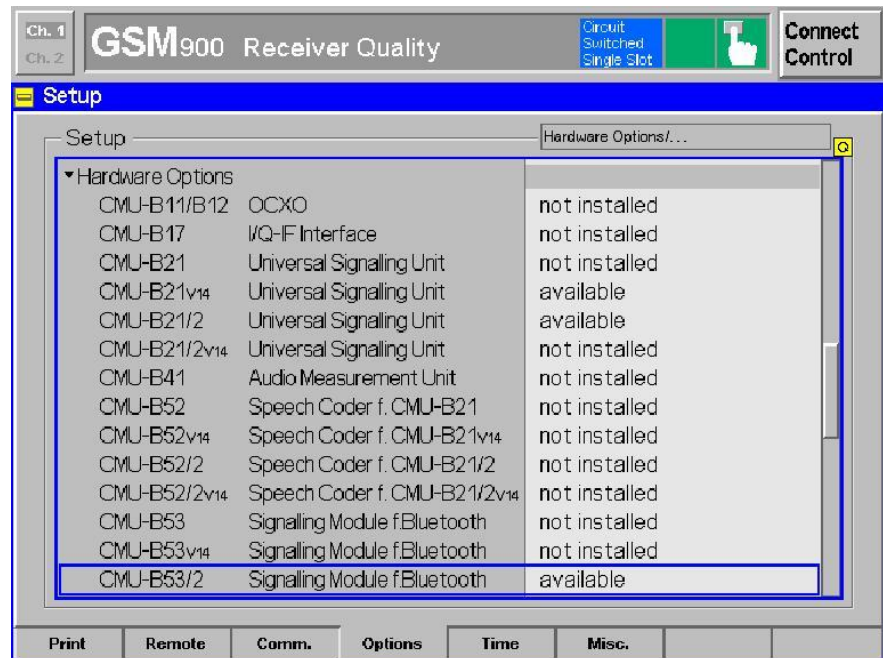


Figure 2 - Hardware options

There are two different versions: B21 and B21V14. If the older B21 version is installed, a DSP must first be switched over to measure the BLER on several downlinks. To do so, the parameter 'B52 Mode' in the **Network** tab must be set to 'Multislot Support' in the 'Signal Off' state (Figure 3).

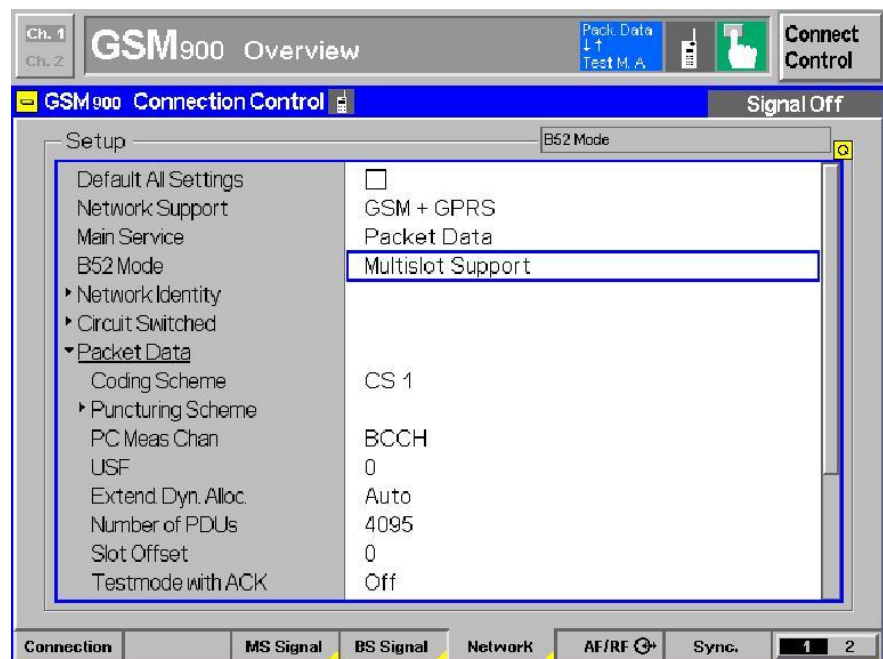


Figure 3 - DSP setting for MultiSlot Support

With the more recent version 14 (B21V14), no additional settings need to be made; the associated parameter is not available. Furthermore, B21V14 allows BLER measurements in EGPRS to be performed on 4 downlinks at the same time.

## (E)GPRS with CMU and CMUgo

### Auxiliary RF generator (AuxTX - B95)

In the standard GSM environment, a single generator in the CMU is still sufficient to test the mobile phones. Here, the CMU generates the BCCH in timeslot 0. Timeslots 1 and 7 are disabled due to settling times; timeslots 2 to 6 are therefore available for the TCH (Figure 4).

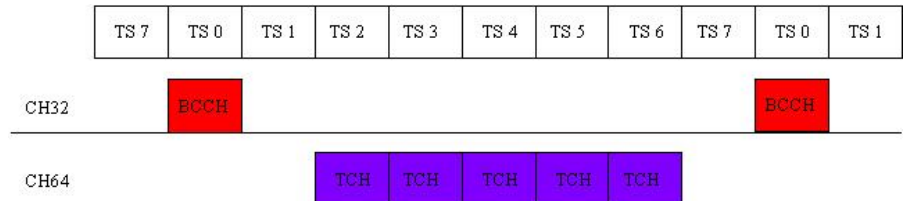


Figure 4 - Downlink on 2 channels without B95

Figure 5 shows the required CMU settings in the **BS Signal** tab. The parameters 'BCCH Channel' and 'TCH Channel' are particularly important here. The level of the BCCH ('BCCH Level') and the **Main Timeslot** can also be set here. The **Mode** parameter is only relevant for the conventional GSM mode; here the BCCH can be disabled following call setup ('BCCH or TCH') to allow measurement on all timeslots.

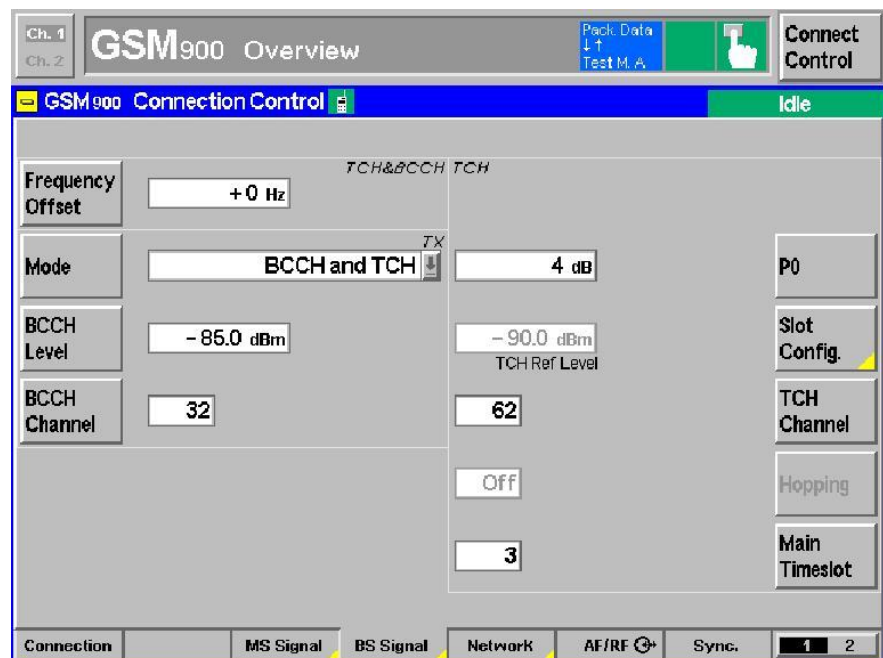


Figure 5 - CMU setup for BS Signal without B95

Since there is no continuous-time transmission in GPRS mode but data is instead only transmitted when required, the majority of mobile phones perform a power measurement on the BCCH at undefined points in time. If this measurement fails, the call is automatically released by the mobile phone. The CMU now provides two ways of preventing this:

BCCH and TCH are on the same channel. This means that an auxiliary generator is not required. However, a channel change or dual-band handover (Figure 6) cannot be performed.

## (E)GPRS with CMU and CMUgo

If the auxiliary generator is available, a permanent BCCH is generated and channel change and dual-band handover are possible (Figure 7).

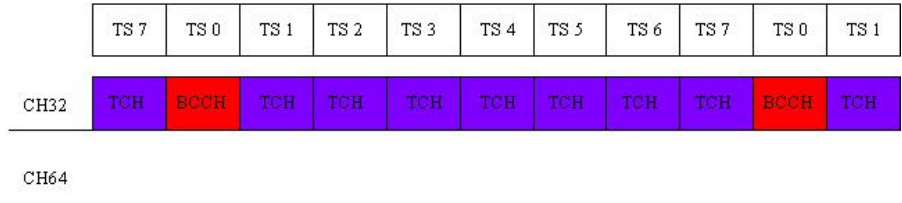


Figure 6 - Downlink on same channel without B95

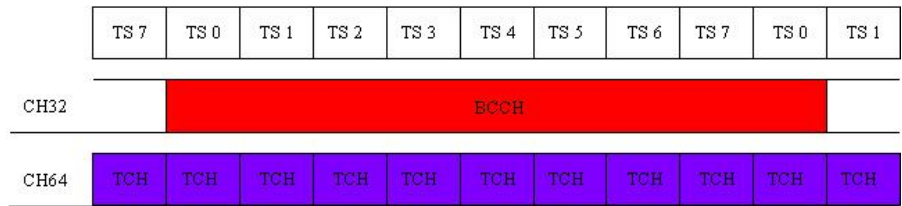


Figure 7 - Downlink with B95

Figure 8 shows the **BS Signal** tab when the B95 is used.

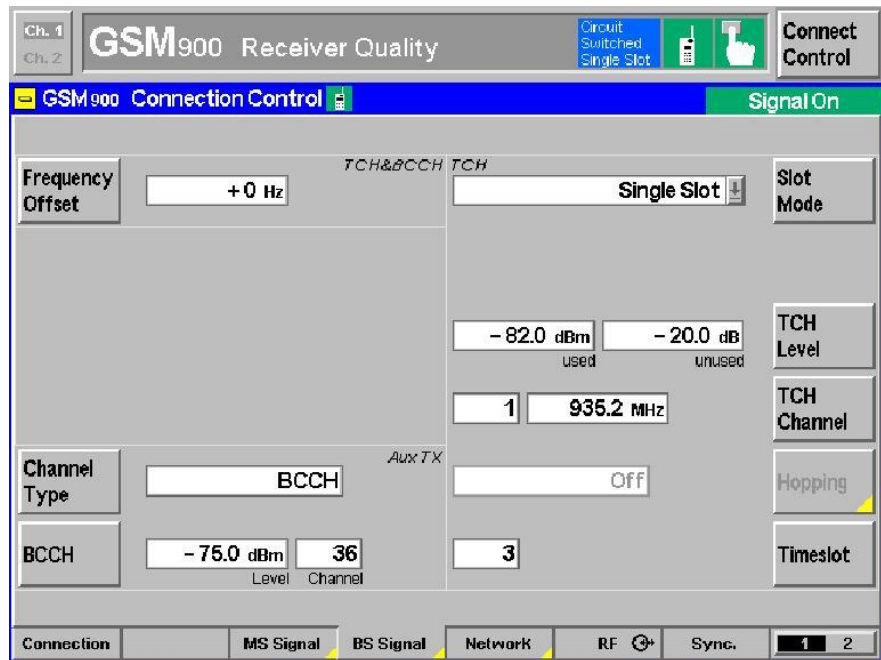


Figure 8 - CMU setup for BS Signal with B95

A number of restrictions apply if the B95 is used:

- Max. 2 W RMS can be applied at the connection RF1.
- RF3 out cannot be used while the B95 is being used.
- A maximum of -60 dBm can be set as the BCCH level at RF2.

The actual call setup takes place under 'Connection Control' in the **Connection** tab (Figure 9).

## (E)GPRS with CMU and CMUgo

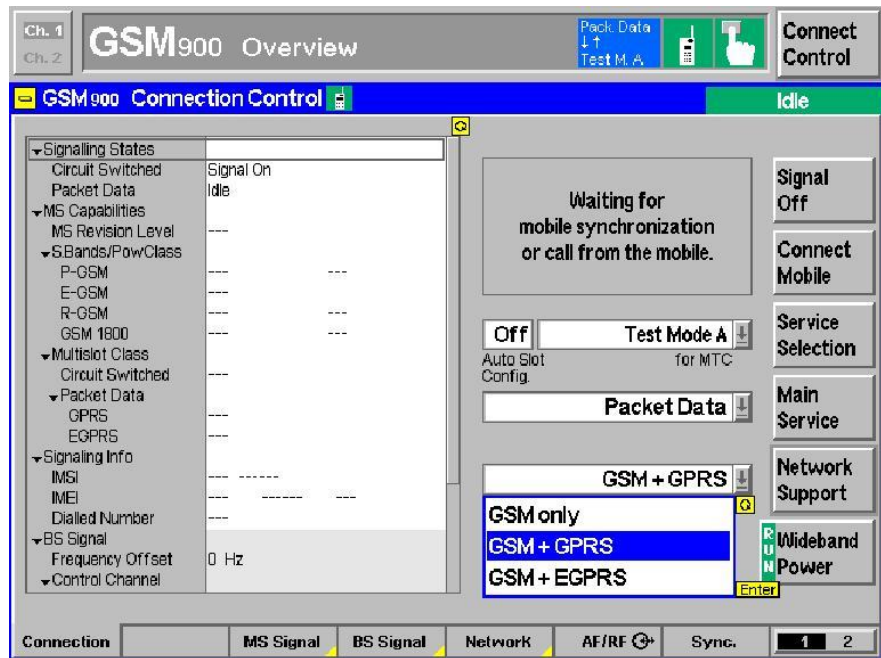


Figure 9 - Overview of Call Setup

First of all, 'GPRS' or 'EGPRS' must be selected under **Network Support**. Additionally, **Main Service** must be set to 'Packet Data'.

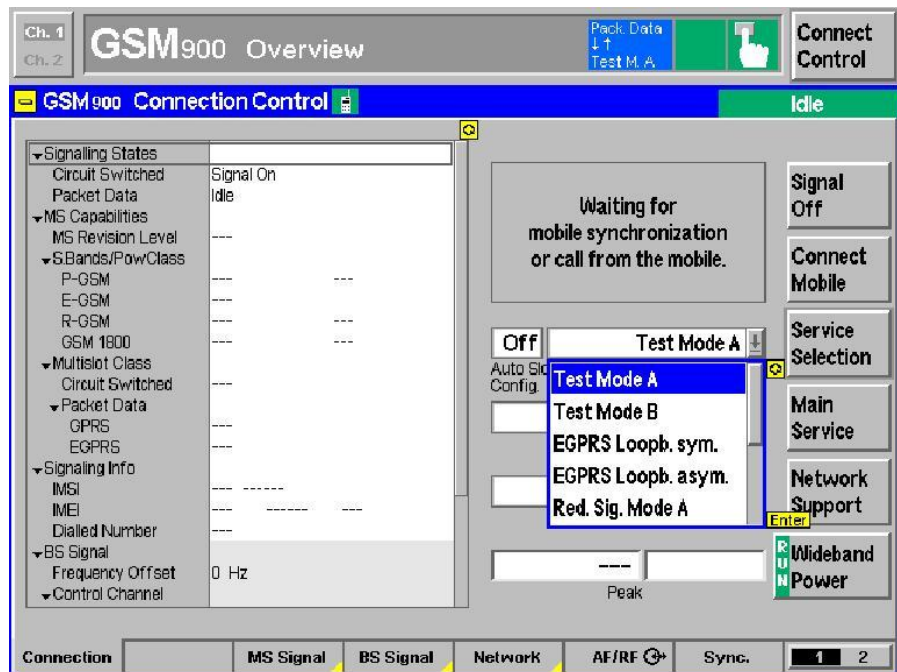


Figure 10 - Overview of Call Setup – Test Modes

Under **Service Selection**, it is now possible to select a test mode (important: A, B, BLER) and to enable 'Automatic Slot Configuration' (see the section Automatic slot configuration).



## (E)GPRS with CMU and CMUgo

In the **Network** tab, the various 'Coding Schemes' (GPRS: CS1 to CS4; EGPRS: MCS1 to MCS9) can be set and a number of settings specific to mobile phones can also be configured (Figure 11).

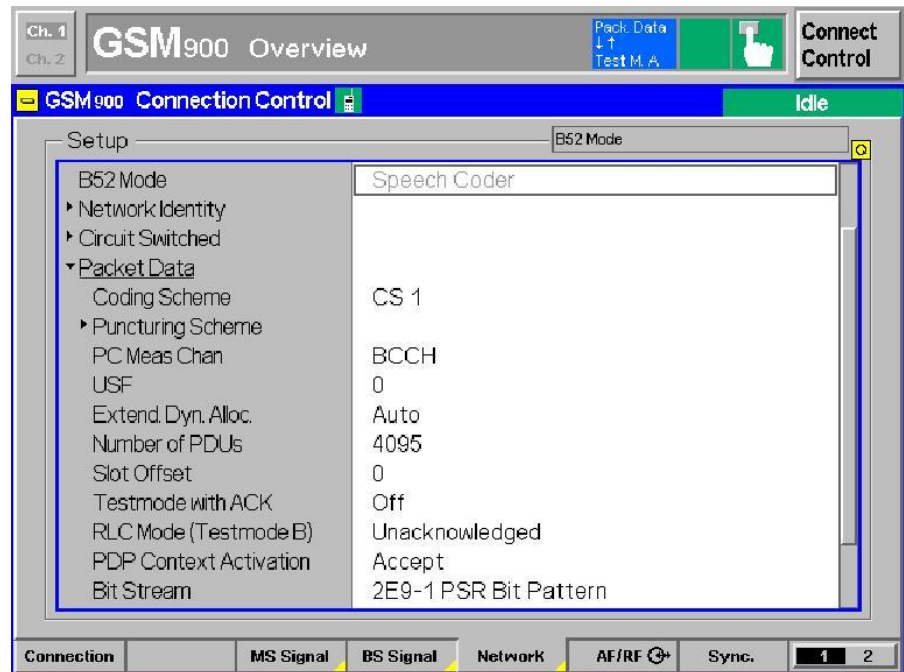


Figure 11 - CMU settings under Network – Packet Data

The MultiSlot settings can, of course, also be made under **MS Signal** (Figure 12). When doing so, the functional capabilities of the mobile phone must be taken into consideration (see also the section Automatic slot configuration). In the downlink, the CMU allows each timeslot to be enabled and disabled separately and different levels to be set. The levels are set relative to a reference level. The uplink timeslots and levels of the mobile phone can also be set individually.

## (E)GPRS with CMU and CMUgo

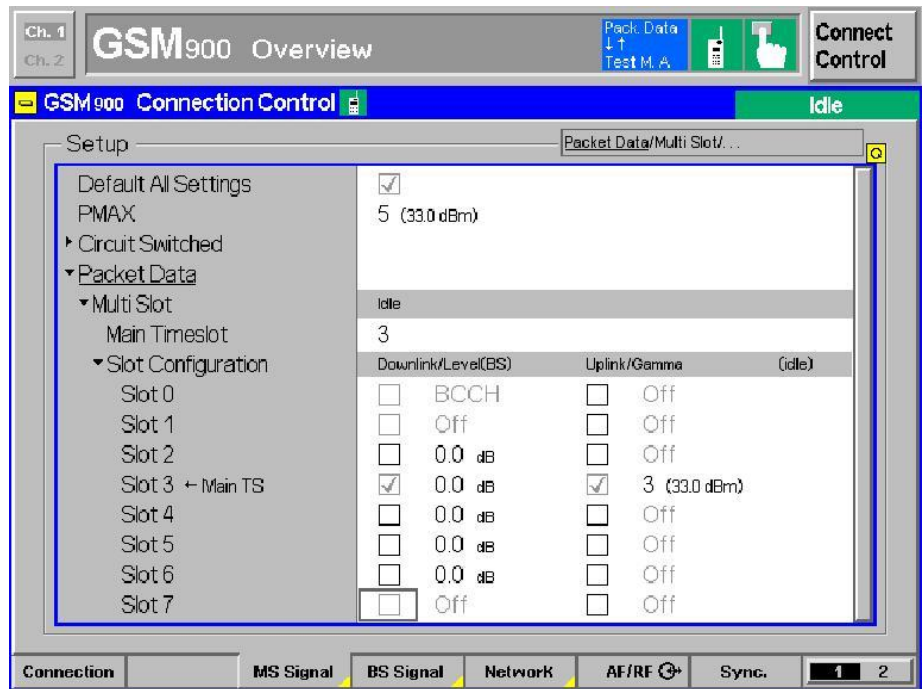


Figure 12 - CMU MultiSlot settings

### Automatic slot configuration

The CMU also allows automatic setup of the slot configuration. The associated parameter must first be set to 'ON' under **Service Selection**. Following the 'location update', the mobile phone also transmits its GPRS capability (MultiSlotClass) during the 'attach' procedure. The CMU uses the MultislotClass information, the selected test mode and the 'Coding Scheme' to set up an optimum configuration (Figure 13). This is done separately for GPRS and EGPRS as the MultiSlot classes may be different.

## (E)GPRS with CMU and CMUgo

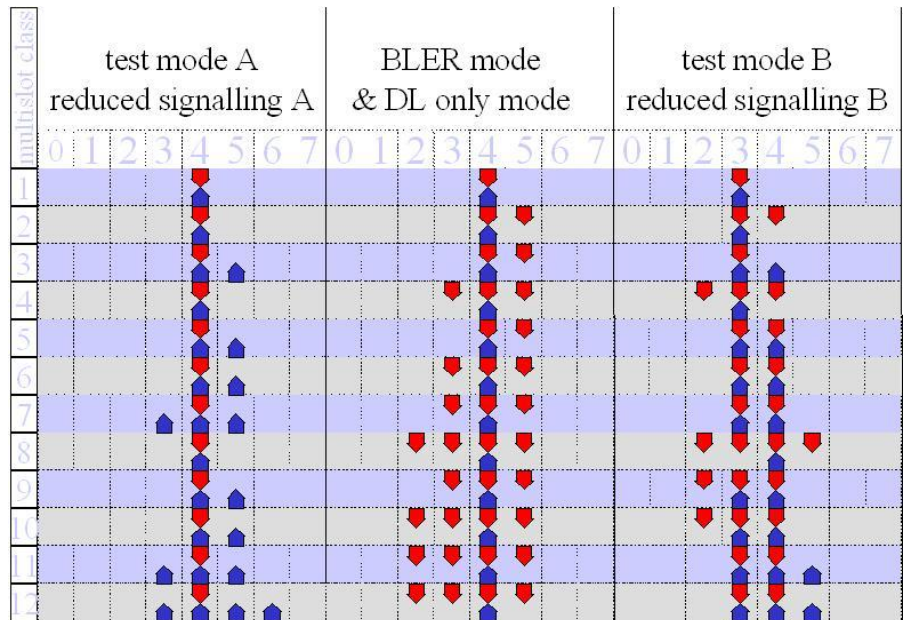


Figure 13 - Mechanism for automatic slot configuration

The mobile phone can be switched on once all relevant settings have been made. It performs a 'location update' (GSM) and must then perform an 'attach' ((E)GPRS).<sup>1</sup>

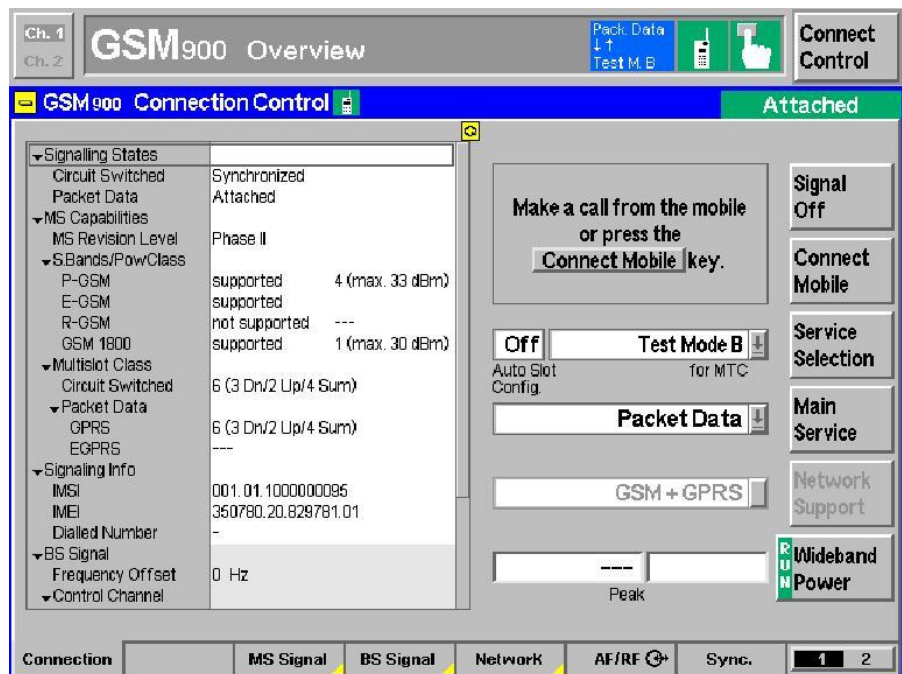


Figure 14 - 'Attached' state

A call to the mobile phone can now be set up by pressing **Connect Mobile**. The individual measurements can then be started.

<sup>1</sup> In some cases, the 'attach' is performed automatically, but in other cases it needs to be performed manually (via the mobile phone).

## ***(E)GPRS with CMU and CMUgo***

Figure 15 again shows the internal states in the CMU. GSM and (E)GPRS are identical up to the 'Attached' and 'Synchronized' state, i.e. a circuit-switched call is also possible in the 'Attached' state.

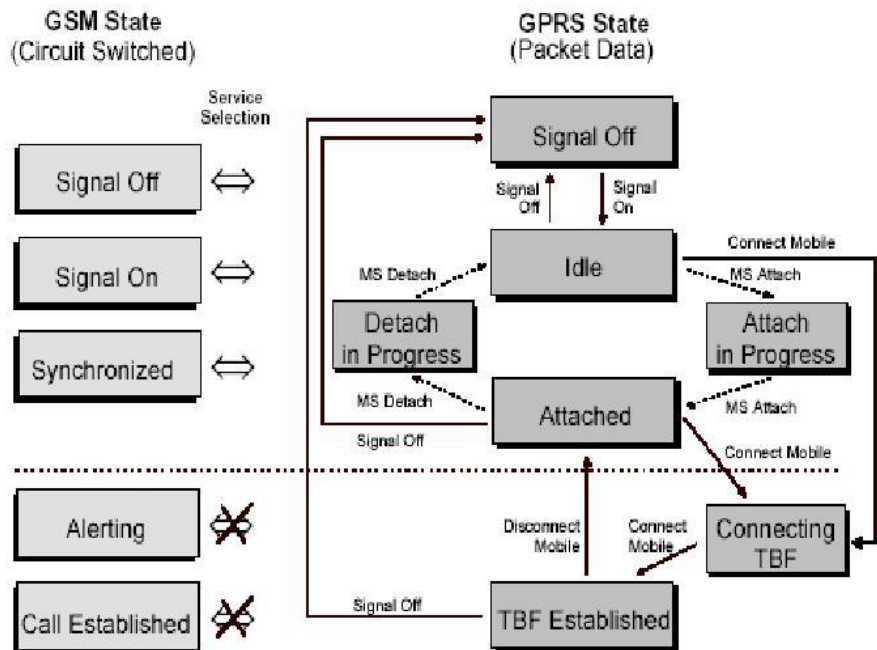


Figure 15 - (E)GPRS states in CMU

## **Measurements**

In (E)GPRS the same measurements can be performed as in GSM. For this reason, only special features and additional options are explained here.

### **Test Mode A**

In Test Mode A, the mobile phone sends a defined PRBS; any number of TX measurements can be performed.

The measurements are the same as the standard measurements available in GSM (Power, Modulation, Spectrum). In the case of MultiSlot mode, the timeslot to be measured can be set for each individual measurement, i.e. measurements continue to be performed on just one timeslot.

It is, of course, the measurements in MultiSlot uplink mode which are most relevant for TX measurements. Here, the CMU allows up to 4 uplink slots to be taken into consideration in the power measurement (Figure 16).

**(E)GPRS with CMU and CMUgo**

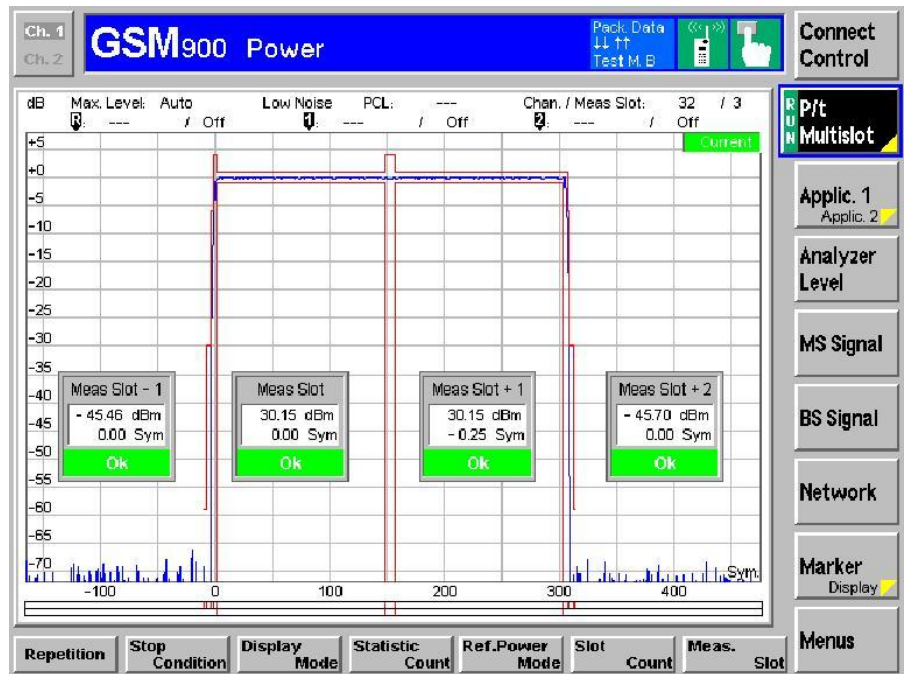


Figure 16 - Power measurement with multislot

The CMU automatically detects whether GMSK or 8PSK is used for modulation, and displays the measurement accordingly (Figure 17). Furthermore, the CMU also automatically detects 'Access' and 'Normal Burst'.

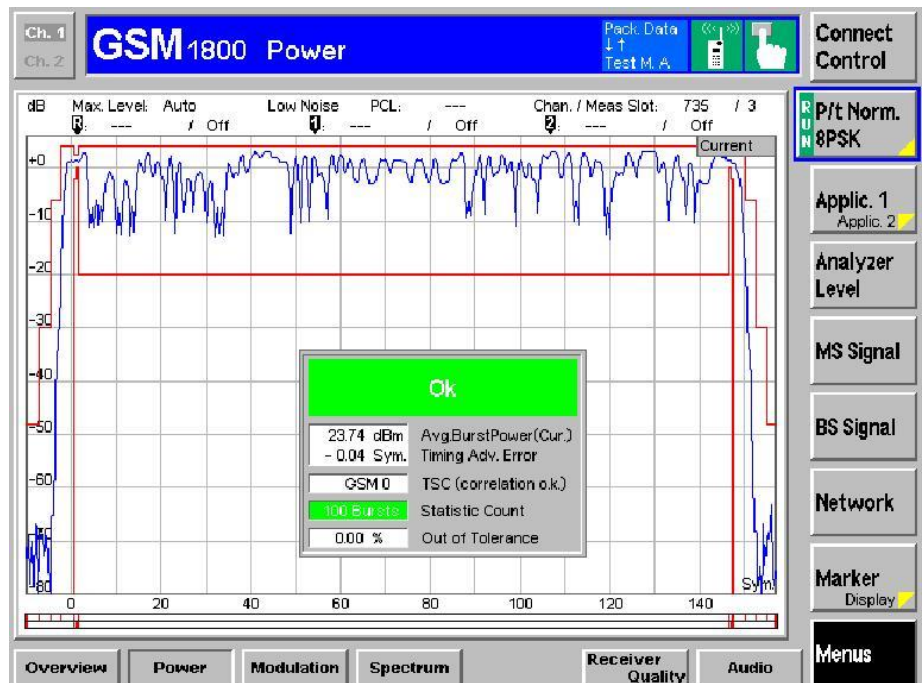


Figure 17 - Power measurement with EDGE (8PSK)

A new spectrum measurement allows the measurements 'due to Modulation' and 'due to Switching' to be performed simultaneously (Figure 18).

## (E)GPRS with CMU and CMUgo

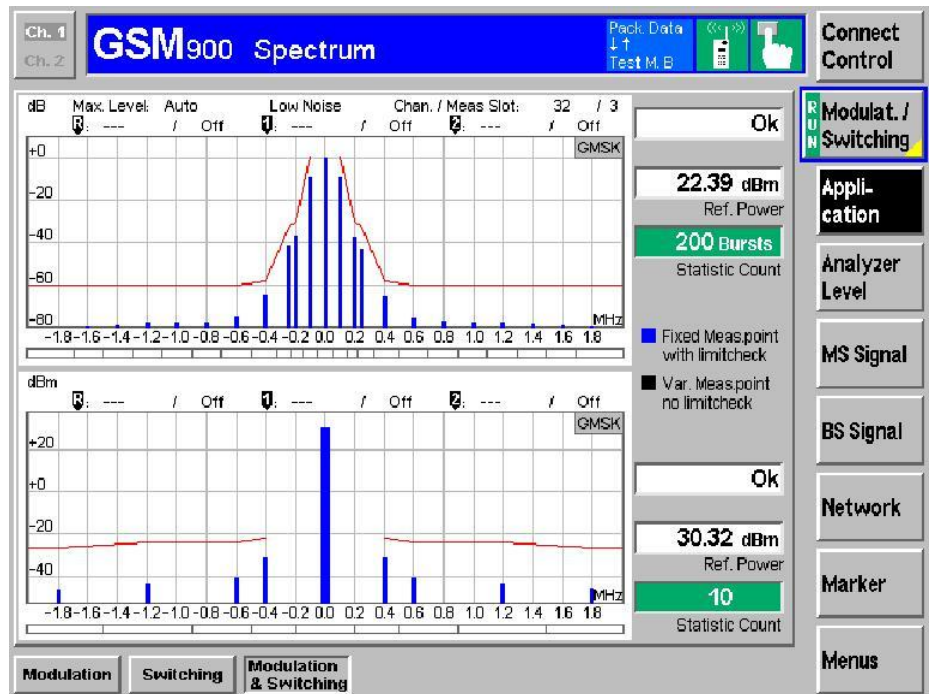


Figure 18 - Spectrum measurement

### Test Mode B

In Test Mode B, the mobile phone internally closes a loop and sends the data generated by the CMU (RLC blocks) back to the CMU. It is then possible to perform RX measurements in addition to the TX measurements described under Test Mode A (see the section Test Mode A) (Figure 19).

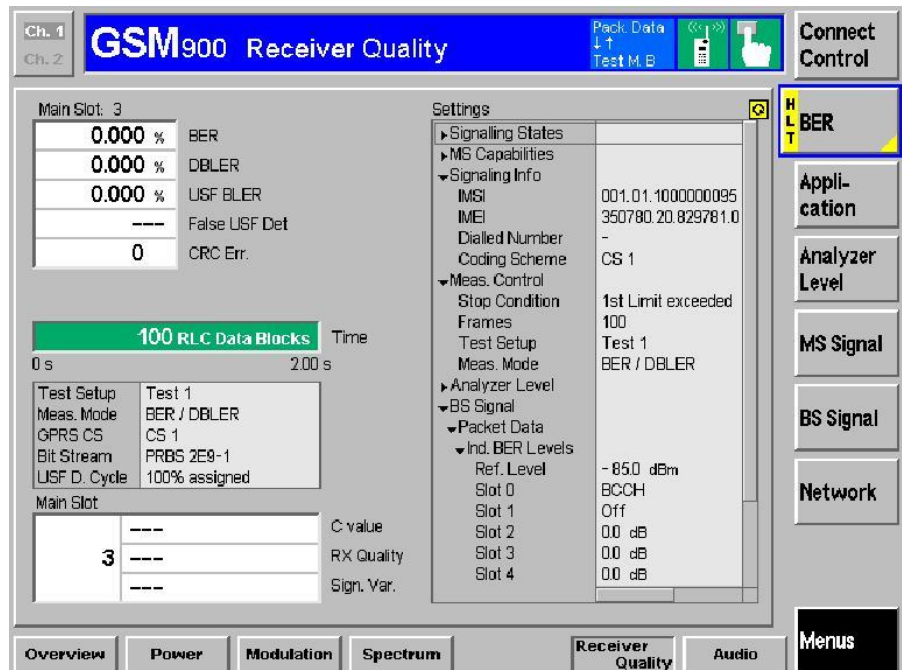


Figure 19 - BER measurement

## ***(E)GPRS with CMU and CMUgo***

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In Test Mode B, the CMU sends blocks containing PRBS data and compares them with the data sent back from the mobile phone (bit error rate – BER)<sup>2</sup>. If the CMU detects bit errors in the data field of the current block, this block is declared as invalid (data block error rate – DBLER). If a mobile phone decodes a USF incorrectly, it will not send the associated uplink block; this allows the USF-BLER to be measured. Conversely, if a mobile phone wrongly receives a USF, it wrongly sends an uplink block. This block is indicated as 'False USF Detection'. To allow this, 'USF Duty Cycle' must of course be set accordingly. The 'CRC Errors' are also displayed.

Here too, the CMU allows levels to be set individually for each downlink timeslot.

### **EGPRS Loopback Symmetric or Asymmetric ( SRB )**

In **EGPRS Loopback Symmetric** or **Asymmetric**, the mobile phone internally closes a loop and sends the data generated by the CMU (RLC blocks) back to the CMU, whereby no channel coding takes place (corresponds to Burst-By-Burst mode (BBB) in GSM). This mode is basically the same as Test Mode B, except that there is no channel coding. As a result, both TX and RX measurements can be performed. The CMU sends blocks containing PRBS data and compares them with the data sent back from the mobile phone (bit error rate – BER). If the CMU detects bit errors in the data field of the current block, this block is declared as invalid (data block error rate – DBLER). If a mobile phone decodes a USF incorrectly, it will not send the associated uplink block; this allows the USF-BLER to be measured. Conversely, if a mobile phone wrongly receives a USF, it wrongly sends an uplink block. This block is indicated as 'False USF Detection'. To allow this, 'USF Duty Cycle' must of course be set accordingly. The 'CRC Errors' are also displayed.

Here too, the CMU allows levels to be set individually for each downlink timeslot.

In *Symmetric* mode, both the uplink and downlink are modulated using the same modulation type (either GMSK or 8PSK); all data can thus be sent back 1:1.

In *Asymmetric* mode, only the downlink is 8PSK-modulated, while the uplink is GMSK-modulated; as a result, the downlink carries three times as much data as can be sent back in the uplink. To ensure that the data rate of the downlink corresponds to that of the uplink, the CMU only sends data to the mobile phone in every third RLC block.

### **BLER**

In BLER mode, the CMU again sends data blocks; however, the mobile phone does not return complete data blocks but instead only informs the CMU whether it has received the blocks correctly or incorrectly. Incorrectly received blocks are sent again (block error rate – BLER).

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<sup>2</sup> According to the original specification (which has since been updated), some mobile phones return a dummy burst if errors are detected in a block. In this case, no BER measurement can be performed.

**(E)GPRS with CMU and CMUgo**

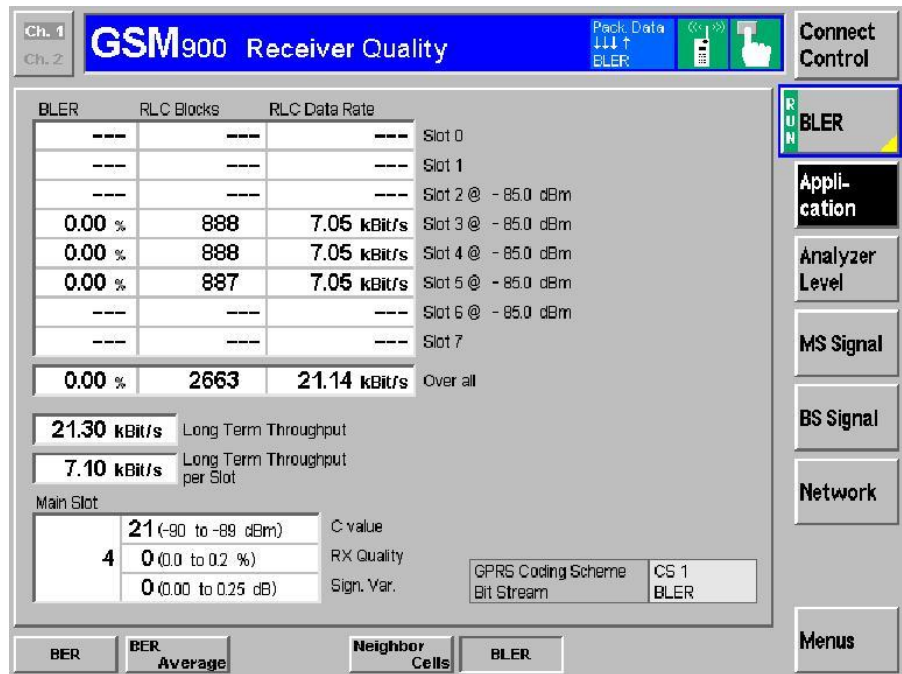


Figure 20 - BLER measurement

The CMU is able to perform measurements on up to four downlink slots simultaneously; this reduces the measurement time.

Here too, the levels of the downlink slots can be set individually.



## **4 Remote Control of the R&S CMU200 with CMUgo**

### **Software Features**

CMUgo offers a simple user interface for remote control of the R&S CMU200 for all standards available on the R&S CMU200 both via a GPIB bus (IEE488.2) and via the RS-232-C interface.

CMUgo includes a feature for outputting test reports. Moreover, a report of remote-control commands with the times of the individual items can be output and the remote-control commands can be copied directly to the Windows clipboard for further processing.

### **Hardware and Software Requirements**

#### **Hardware requirements**

- CPU: min. 300 MHz
- RAM: min. 64 MByte
- Monitor: SVGA with min. 800 x 600 pixels
- Hard disk: 50 MByte of free memory
- Peripherals: National Instruments GPIB bus or RS-232-C interface, mouse

#### **Software requirements**

- Windows 98 / ME / 2000 / XP
- CMUgo V1.45 with GSM/GPRS modules V1.45 or newer

### **Using CMUgo**

Please refer to the CMUgo manual [2] for information on how to connect the computer and the R&S CMU200, as well as how to install, start and operate CMUgo.

With CMUgo, the remote sequence can be output by using the **Demo** function. Individual sequences can then be created based on this sequence. CMUgo tries to perform the test sequences as quickly as possible. Since the program is structured as a sequencer (information about the previous module is not available), it is sometimes possible to save time by making additional optimizations.

**Note:** All modules with the prefix 'GSM' can also be used in (E)GPRS. Single parameters or measurements are, however, of little use and are therefore not taken into consideration. Reference to these restrictions is made again in the descriptions of the individual (GSM) modules in this document.

## **GPRS Call Setup Module**

The GPRS Call Setup module must always be at the beginning of a sequence for (E)GPRS (after Basic Initializing). All parameters relevant for setting up a GPRS connection to a mobile phone are set here.

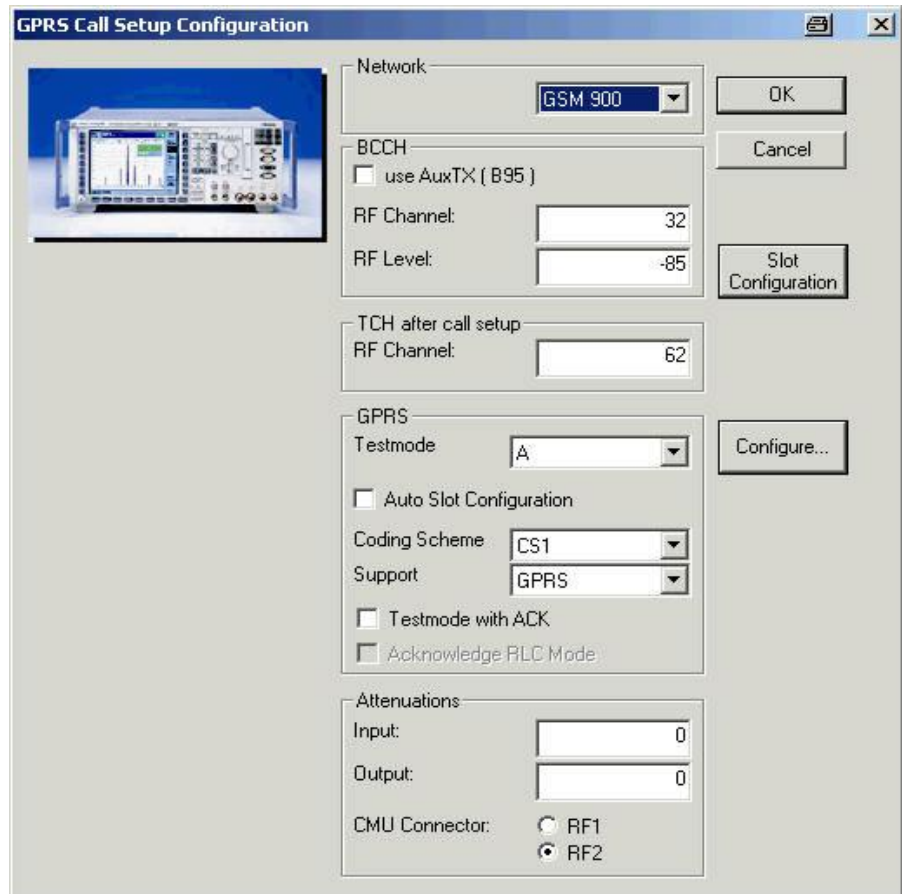


Figure 21 - GPRS Call Setup module

First of all, the desired band (450, 850, 900, 1800, 1900 MHz) must be selected in the **Network** section.

The auxiliary RF generator ('use AuxTx (B95)') can be enabled and the channel and level of the BCCH can be set in the **BCCH** section. The traffic channel (TCH) can, of course, also be specified.

In the **GPRS** section, the desired 'Testmode' (A, B, EGPRS Loopb sym, EGPRS Loopb asym or BLER) can be selected and 'Auto Slot Configuration' enabled. The 'Coding Scheme' (CS1 to CS4, MCS1 to MCS9) can also be selected. Only GPRS and EGPRS can be selected under 'Support' (there is no sense in setting 'GSM only' here).

**Note:** If GSM and (E)GPRS functions are to be tested successively, the **GSM Call Setup** module (not described here) allows GPRS and/or EGPRS to be selected.

The parameters 'Testmode with ACK' and (in Test Mode B only) 'Acknowledge RLC Mode' can also be activated in this section.

The **Slot Configuration** button opens a window in which slots can be set up individually (Figure 22).

## (E)GPRS with CMU and CMUgo

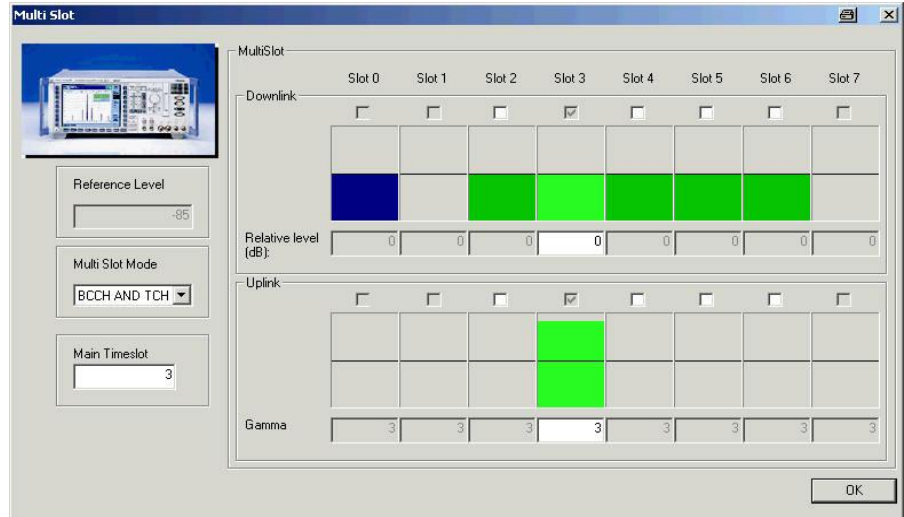


Figure 22 - Call Setup – MultiSlot configuration

The 'Main Timeslot' can be set here first of all. The 'Main Timeslot' is activated automatically in the graphical **MultiSlot** section. The slot with the blue marking indicates the BCCH, the grey markings indicate deactivated slots without level, the dark green markings indicate non-activated slots with a defined level, and the light green markings indicate activated slots. In the **Downlink** section, slots can be activated and a level relative to the 'Reference Level' can be set. In the **Uplink** section, slots are activated and the gamma value to be used by the mobile phone can be specified.

**Note:** These settings are overwritten if 'Auto Slot Config' is activated.

Clicking the **Configure** button opens another window (Figure 23). Additional parameters can be set in this window.

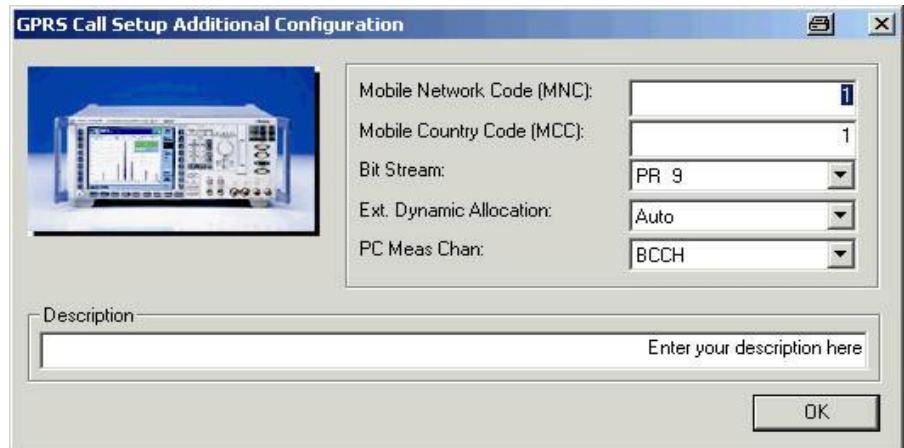


Figure 23 - Call Setup – Configure

Figure 24 shows a typical entry in the test report. If 'Auto Slot Config' is activated, the respective settings are only overwritten after the call has been set up.

## (E)GPRS with CMU and CMUgo

Network: GSM 900, BCCH Channel Level: 32/-85.0 dBm, TCH Channel: 62, Ref. Level: -85.0, Support GPRS  
Main Timeslot: 3, Attenuation (In/Out): 0.0/0.0 dB, Bitstream: PR9, Aux TX: Off  
Multi Slot Mode: BCCH AND TCH, Testmode: A, Coding Scheme: CS1, Acknowledge: Off, RLC Mode: Not ack  
Automatic Slot Configuration: Off  
Downlink (Slot 0..7: Enable, dB): OFF, OFF, OFF, ON, OFF, OFF, OFF, OFF, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0  
Uplink (Slot 0..7: Enable, Gamma): OFF, OFF, OFF, ON, OFF, OFF, OFF, OFF, 3, 3, 3, 3, 3, 3, 3, 3  
Extended Dynamic Allocation: Auto, PC Meas Channel: BCCH  
IMSI: 0.0.1000000095, IMEI: 0.0. 0.0, Revision: PH2P, Power Class: 4, Multi Slot Class: 8  
GPRS Call to Mobile:   passed ✓

Figure 24 - Call Setup report

Once the sequence has been started, the user is prompted to switch the mobile phone off and then on again.



Figure 25 - Location update

### Note:

The GPRS Call Setup module uses the RF analyzer setting 'PCL/Gamma' and automatically configures the DSP on the 'Signalling Unit B21' so that four timeslots can be observed at the same time in the BLER measurement (see the section CMU200 signalling unit (B21)).

## GPRS Call Release Module

In the Call Release module, the active call to the mobile phone is released; the R&S CMU200 enters the 'Attached' and 'Synchronized' state (Figure 26). If 'Free all CMU resources' is activated, the instrument changes to the 'SOFF' state.

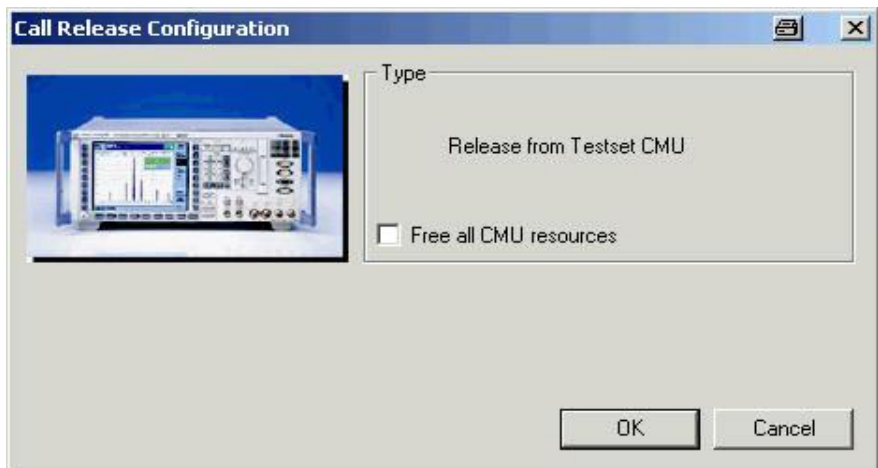


Figure 26 - Call Release module

## ***(E)GPRS with CMU and CMUgo***

If the call is not set up or released, the following window will be displayed (Figure 27). This query is also performed by all other modules (except for Call Setup).

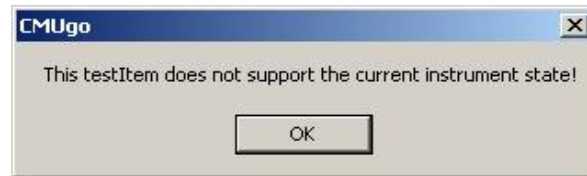


Figure 27 - Information: No connection

Figure 28 shows the Call Release entry in the test report.



Figure 28 - Call Release report

## **GPRS Call Change Module**

A number of parameters can also be changed during an active call; the GPRS Call Change module is used for this purpose (Figure 29).

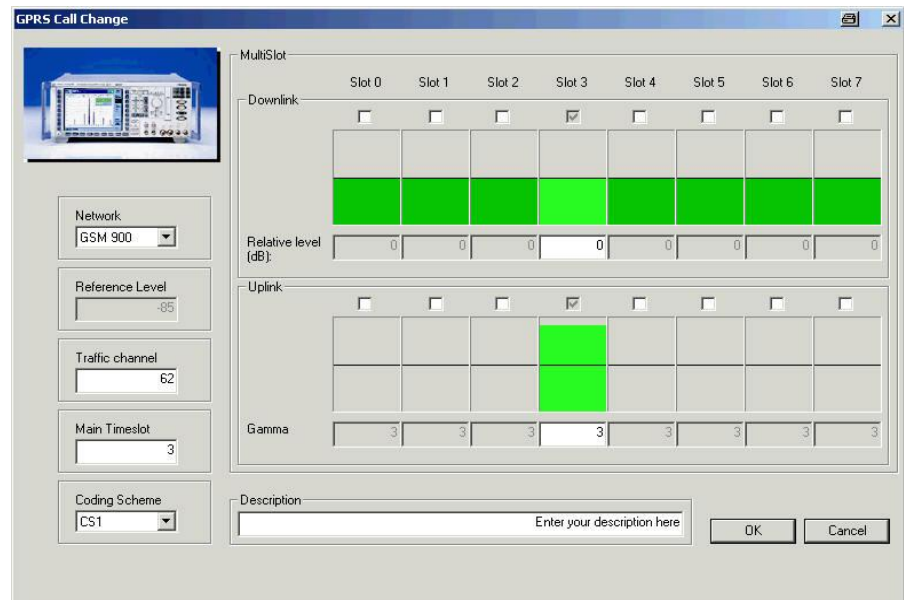


Figure 29 - GPRS Call Change module

The various GSM bands can again be selected in the **Network** section. If this setting differs from the current setting, a *dual-band handover* is performed.

The channel ('Traffic Channel'), timeslot ('Main Timeslot') and channel code ('Coding Scheme') can also be changed in this module.

The multislot structure can be changed in the **MultiSlot** section; once again, the grey markings indicate deactivated timeslots without level, dark green markings indicate non-activated slots with a defined level, and the light green markings indicate activated timeslots. In the **Downlink** section, slots can be activated and a level relative to the 'Reference Level' can be set. In the **Uplink** section, slots are activated and the gamma value to be used by the mobile phone can be specified.

## (E)GPRS with CMU and CMUgo

Figure 30 shows the corresponding entry in the test report.

*Downlink (Slot 0..7: Enable, dB): OFF,OFF,OFF,ON,OFF,OFF,OFF,OFF, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0*  
*Uplink (Slot 0..7: Enable, Gamma): OFF,OFF,OFF,ON,OFF,OFF,OFF,OFF, 3, 3, 3, 3, 3, 3, 3, 3*  
*Main Timeslot: 3, GSM 900, Traffic channel: 62, Coding Scheme: CS1*

Figure 30 - Call Change report

## GPRS BER/BLER Test Module

The receiver measurements (RX Quality) in (E)GPRS are performed in this module (Figure 31).

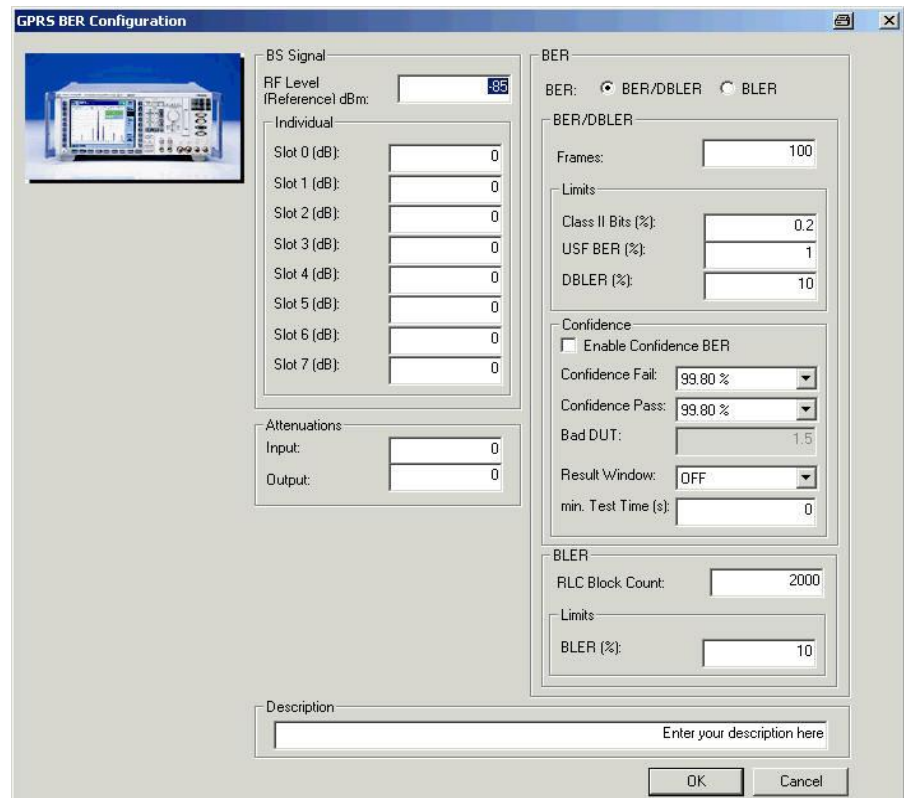


Figure 31 - GPRS BER/BLER test

In the **BS Signal** section, a level ('Slot 0' to 'Slot 7') relative to the reference level ('RF Level (Reference)') must be set for each timeslot. The level settings are only valid during the associated measurement; the previously set levels are used again after the measurement has been completed. It is again possible to specify the attenuation ('Attenuations').

In the **BER** section, it is possible to choose between a **BER/DBLER** measurement for 'Test Mode B' and a **BLER** measurement for the 'BLER' mode. The number of 'Frames' and the individual limits can be set in the subsection BER/BLER; the number of blocks ('RLC Block Count') and a limit can be specified under BLER. The BER/DBLER measurement can be performed as a confidence BER. To allow this, 'Enable Confidence BER' must be activated in the **Confidence** section and the appropriate parameters must be set.

## (E)GPRS with CMU and CMUgo

BS Reference Level (dBm): -85.0, Slots (0...7, dB) 0.0/0.0/0.0/0.0/0.0/0.0/0.0/0.0, Attenuation In/Out (dB): 0.0/0.0				
BER: 100 Frames		0.20 %	0.00 %	✓
USFBLER: 100 Frames		1.00 %	0.00 %	✓
DBLER: 100 Frames		10.00 %	0.00 %	✓
CRC: 100 Frames			0	✓

Figure 32 - BER/DBLER test report

BS Reference Level (dBm): -85.0, Slots (0...7, dB) 0.0/0.0/0.0/0.0/0.0/0.0/0.0/0.0, Attenuation In/Out (dB): 0.0/0.0				
BER: 100 Frames		0.20 %	0.00 %	✓
USFBLER: 100 Frames		1.00 %	0.00 %	✓
DBLER: 100 Frames		10.00 %	0.00 %	✓
CRC: 100 Frames			0	✓
Confidence: for limit 0.20 : Early			passed	✓

Figure 33 - BER/DBLER test report with confidence interval

BS Reference Level (dBm): -85.0, Slots (0...7, dB) 0.0/0.0/0.0/0.0/0.0/0.0/0.0/0.0, Attenuation In/Out (dB): 0.0/0.0				
BLER: 200 Blocks		10.00 %	0.00 %	✓

Figure 34 - BLER report

## GSM Testset Module

All TX measurements in GPRS with GMSK modulation are performed using the **GSM Testset** module (Figure 35); the 'Power versus Time' measurement for multislot is performed in the **GSM Multislot** module (see GSM Multislot Test Module). It is important to note that parameters in GPRS should be changed under GPRS Call Change. The settings which can be made in the top left-hand section (**Network, TCH, BS Signal**) are ignored in GPRS mode; only the **Attenuations** and the measurement-specific settings are valid (**Meas Slot**). The measurements selected in the right-hand section are all valid, except for **RXQual**, **RXLev** and **Receiver Quality**. RXLev and RXQual are of no use in the case of a GPRS connection; a dedicated module (GPRS BER/BLER Test) is provided for measuring receiver quality.

## (E)GPRS with CMU and CMUgo

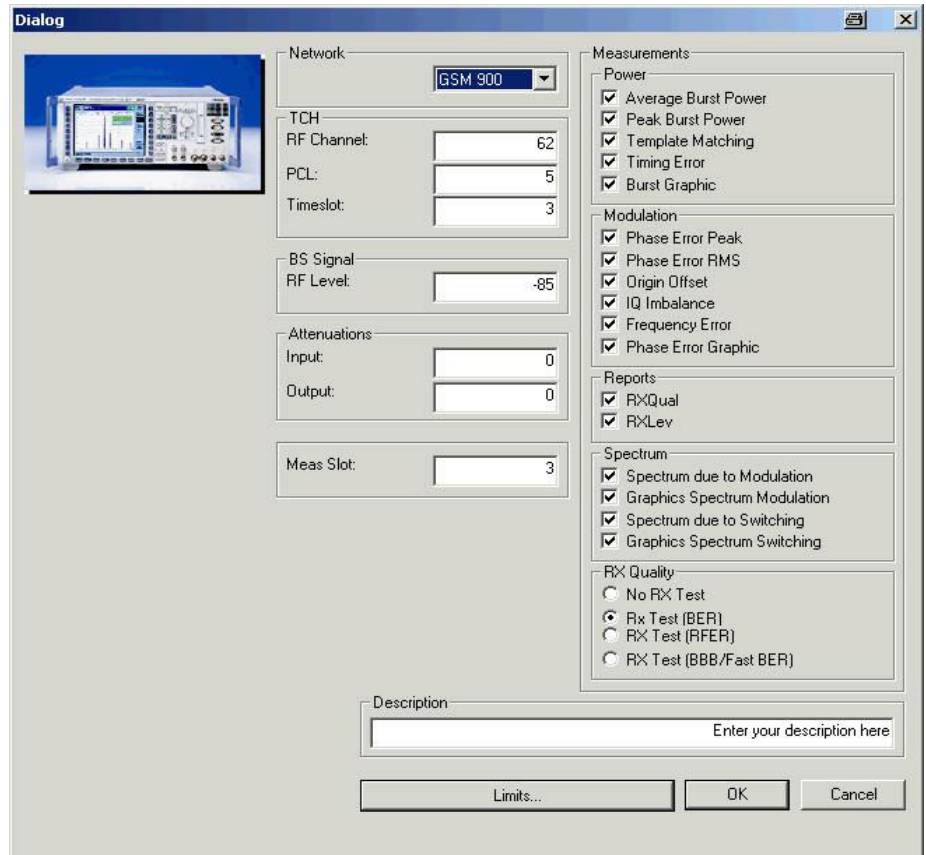


Figure 35 - GSM Testset

The timeslot to be measured is set using 'Meas Slot'.

The individual measurements can be selected in the respective sections. Where possible, CMUgo combines the **Power** and **Modulation** measurements to form a common measurement (designation in remote mode: POWER:MPR). To allow this, measurements must be selected under Power and Modulation; 'Origin Offset' and/or 'IQ Imbalance' under Modulation should, however, not be selected. Additionally, graphs can be output for each measurement. If both spectrum measurements are activated ('Spectrum due to Modulation' and 'Spectrum due to Switching'), the combined spectrum measurement is used (designation in remote mode: SPECTrum:MSW). Once again, a graphical display can be activated in each case.

Clicking the **Limits** button opens the dialog shown in Figure 36.



## (E)GPRS with CMU and CMUgo

The screenshot shows the 'Limits' configuration window with the following settings:

- TX Averaging (Bursts):** 10
- Power Upper Limit (dBm):** 35
- Power Lower Limit (dBm):** 31
- Max. Timing Error (Bits):** 2
- max. Frequency Error (Hz):** 90
- max. Phase Error RMS (°):** 5
- max. Phase Error Peak (°):** 20
- max. Origin Offset (dB):** -20
- max. IQ Imbalance (dB):** -20
- Decoding with guard and tail bits
- Average
- Maximum
- RX Averaging (Frames):** 88
- Bit stream synchronisation time (s):** 0.2
- Class II Error (max. %):** 0.2
- Class Ib Errors (max. %):** 0
- Erased Frames (max. %):** 0
- Enable Confidence BER
- Confidence Fail:** 99.80 %
- Confidence Pass:** 99.80 %
- Bad DUT:** 1.5
- Result Window:** OFF
- min. Test Time (s):** 0
- RXLev (max.):** 27
- RXLev (Min.):** 23
- RXQual (Max.):** 1
- Spectrum Slot Count:** 1
- Var. Meas Point 1 (MHz): 0.8
- Var. Meas Point 2 (MHz): 1
- Var. Meas Point 3 (MHz): 1.4
- Var. Meas Point 4 (MHz): 1.6
- Spectrum due to Modulation No of Bursts:** 10
- Offsets:** 100 | 200 | 250 | 400 | 600 | 800 | 1000 | 1200 | 1400 | 1600 | 1800
- Spectrum due to Switching No of Bursts:** 10
- Offsets:** 400 | 600 | 1200 | 1800

Figure 36 - GSM Testset – Limits

The parameters for the TX measurements are set in the top left-hand section. First of all, the desired number of TX bursts must be set under 'TX Averaging (Bursts)'. The limits for power ('Power Upper Limit' and 'Power Lower Limit'), the 'Max Timing Error' and the various parameters for the modulation measurement can also be set here. Furthermore, it is possible to activate 'Decoding with Guard and Tail Bits' and to choose between 'Average' and 'Maximum'.

The top right-hand section is reserved for the RX measurements and is not required in GPRS mode.

The bottom section **Spectrum** is reserved for the two spectrum measurements. The 'Offsets', depending on the specification, and the number of bursts ('No. of Bursts') can be set underneath the two measurements. It is also possible to activate and enter four variable offsets ('Var. Meas Point 1' to 'Var. Meas Point 4'). The parameter 'Slot Count' refers to the measurement 'due to Switching' for multislot measurements.

## (E)GPRS with CMU and CMUgo

Figure 37, Figure 38 and Figure 39 show the entries in the test report.

GSM 900, Channel 62, PCL 5, Timeslot: 3, BS RF Level -85.0 dBm, Attenuation (In/Out) 0.0 dB / 0.0 dB, Meas. Slot: 3

Decoding for modulation: Standard, BER Synch time: 0.20 s

Average Power: 10 Bursts	31.00 dBm	35.00 dBm	31.01 dBm	✓
Peak Burst Power: 10 Bursts	31.00 dBm	35.00 dBm	34.09 dBm	✓
Power Time Template: 10 Bursts			passed	✓
Timing Error: 10 Bursts	-2.00 Bit	2.00 Bit	0.66 Bit	✓
Phase Error Peak: 10 Bursts	-20.00 °	20.00 °	-8.08 °	✓
Phase Error RMS: 10 Bursts		5.00 °	4.26 °	✓
Origin Offset: 10 Bursts		-20.00 dB	-9.72 dB	✓
IQ Imbalance: 10 Bursts		-20.00 dB	-19.74 dB	✓
Frequency Error: 10 Bursts	-90.00 Hz	90.00 Hz	15.32 Hz	✓
Spectrum due to Switching:			passed	✓
Spectrum Switching: @ - 0.6 MHz			-47.74 dBm	✓
Spectrum Switching: @ - 0.4 MHz			-86.34 dBm	✓
Spectrum Switching: @ 0.4 MHz			-73.31 dBm	✓
Spectrum Switching: @ 0.6 MHz			-19.33 dBm	✓
Spectrum due to Modulation:			passed	✓
Spectrum Modulation: @ - 0.6 MHz			-36.65 dBc	✓
Spectrum Modulation: @ - 0.4 MHz			-74.44 dBc	✓
Spectrum Reference Power: @ 0 MHz			20.00 dBm	✓
Spectrum Modulation: @ 0.4 MHz			-22.99 dBc	✓
Spectrum Modulation: @ 0.6 MHz			-61.55 dBc	✓

Figure 37 - Testset report

### Annex: Spectrum due to Modulation

PCL: 5, Channel: 62, Reference Power: 21.8 dBm

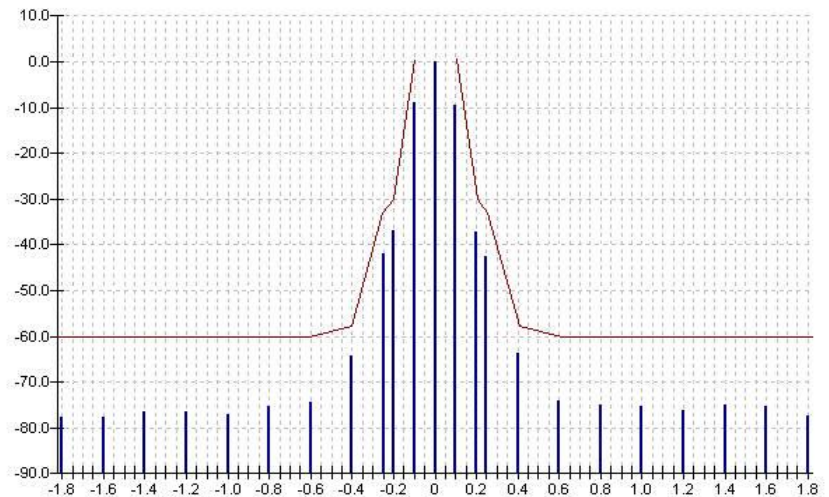


Figure 38 - Spectrum due to modulation (graph)

### Annex: Spectrum due to Switching

PCL: 5, Channel: 62, Reference Power: 0.0 dBm

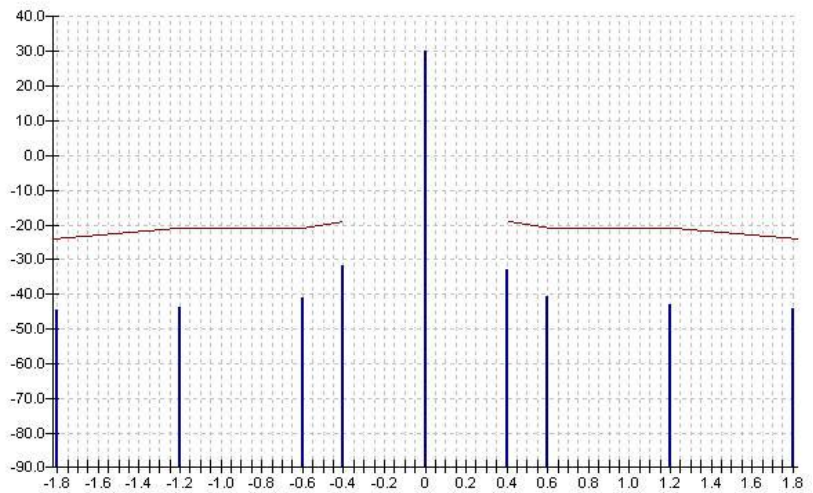


Figure 39 - Spectrum due to switching (graph)

### GSM Call Edge Module

The GSM Call Edge module is basically the same as the GSM Testset module, except that here the measurements are performed with 8PSK modulation (Figure 40). All TX measurements in GPRS with 8PSK modulation are performed using the **GSM Call Edge** module; the 'Power versus Time' measurement for multislot is performed in the **GSM Multislot** module (see GSM Multislot Test Module). It is important to note that parameters in GPRS should be changed under 'GPRS Call Change'. The settings which can be made in the left-hand section (**TCH, BS Signal**) are ignored in GPRS mode; only **Attenuations** and the measurement-specific settings are valid (**Meas Slot**). The measurements are selected in the right-hand section (**Measurements**).

## (E)GPRS with CMU and CMUgo

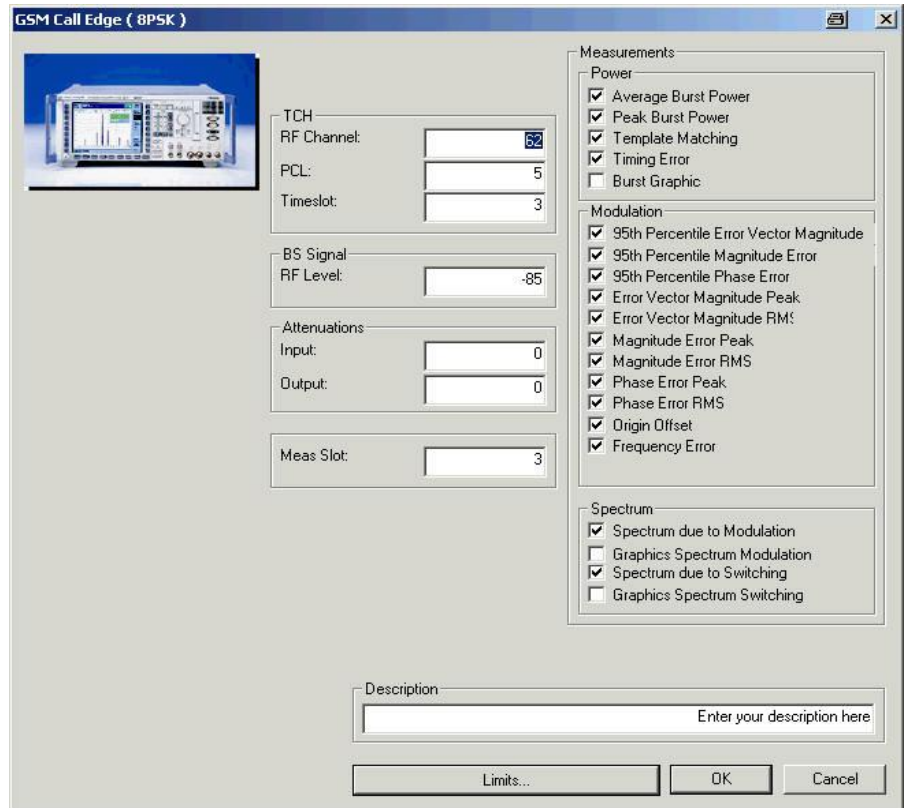


Figure 40 - GSM Call Edge

The timeslot to be measured is set using 'Meas Slot'.

The individual measurements can be selected in the respective sections. Additionally, graphs can be output for each measurement. If both spectrum measurements are activated ('Spectrum due to Modulation' and 'Spectrum due to Switching'), the combined spectrum measurement is used (designation in remote mode: SPECTrum:MSW). Once again, a graphical display can be activated in each case.

Clicking the **Limits** button opens the dialog shown in Figure 41 - GSM Call Edge Limits.

## (E)GPRS with CMU and CMUgo

**Edge Limits**

**Power / Modulation**

Number of Bursts:   Average  Maximum

**Power**

Power Upper Limit (dBm):

Power Lower Limit (dBm):

Max. Timing Error (Bits):

**Modulation**

max. Frequency Error (Hz):

max. Origin Offset (dB):

max. Phase Error RMS (°):

max. Phase Error Peak (°):

max. Magn. Error RMS (%):

max. Magn. Error Peak (%):

max. EVM RMS (°):

max. EVM Peak (°):

max. 95th perc. Phase Err (°):

max. 95th perc. Magn Err (%):

max. 95th perc. EVM (%):

**Spectrum**

Slot Count:

Var. Meas Point 1 (MHz):   Var. Meas Point 2 (MHz):

Var. Meas Point 3 (MHz):   Var. Meas Point 4 (MHz):

**Spectrum due to Modulation**

No of Bursts:

Offsets:

**Spectrum due to Switching**

No of Bursts:

Offsets:

OK

Figure 41 - GSM Call Edge Limits

First of all, the desired number of TX bursts must be set under 'No of Bursts' in the top section **Power/Modulation**. The limits for power ('Power Upper Limit' and 'Power Lower Limit'), the 'Max Timing Error' and the various parameters for the modulation measurement can also be set here. It is also possible to choose between 'Average' and 'Maximum'.

The bottom section **Spectrum** is reserved for the two spectrum measurements. The 'Offsets', depending on the specification, and the number of bursts ('No. of Bursts') can be set underneath the two measurements. It is also possible to activate and enter four variable offsets ('Var. Meas Point 1' to 'Var. Meas Point 4'). The parameter 'Slot Count' refers to the measurement 'due to Switching' for multislot measurements.

## (E)GPRS with CMU and CMUgo

Figure 42 shows the report; the report for the spectrum measurements is identical to that for GSM Testset.

Average Power (8PSK): 100 Bursts	31.00 dBm	33.00 dBm	31.00 dBm	✓
Peak Burst Power (8PSK): 100 Bursts	31.00 dBm	33.00 dBm	32.34 dBm	✓
Power Time Template (8PSK): 100 Bursts			passed	✓
Timing Error (8PSK): 100 Bursts	-2.00 Bit	2.00 Bit	-0.89 Bit	✓
95th percentile EVM (8PSK): 100 Bursts	-15.00 %	15.00 %	-6.35 %	✓
95th percentile Magitude Error (8PSK): 100 Bursts	-5.00 %	5.00 %	1.26 %	✓
95th percentile Phase Error (8PSK): 100 Bursts	-5.00 °	5.00 °	4.91 °	✓
EVM Peak (8PSK): 100 Bursts	-30.00 %	30.00 %	3.80 %	✓
EVM RMS (8PSK): 100 Bursts	-9.00 %	9.00 %	-6.54 %	✓
Magnitude Error Peak (8PSK): 100 Bursts	-17.70 %	17.70 %	8.25 %	✓
Magnitude Error RMS (8PSK): 100 Bursts	-12.50 %	12.50 %	-5.45 %	✓
Phase Error Peak (8PSK): 100 Bursts	-20.00 °	20.00 °	-14.19 °	✓
Phase Error RMS (8PSK): 100 Bursts	-5.00 °	5.00 °	-0.68 °	✓
Origin Offset (8PSK): 100 Bursts		-30.00 dB	-79.90 dB	✓
Frequency Error (8PSK): 100 Bursts	-90.00 Hz	90.00 Hz	53.33 Hz	✓
Spectrum due to Switching (8PSK):			passed	✓
Spectrum due to Modulation (8PSK):			passed	✓

Figure 42 - Call Edge report

## GSM Multislot Test Module

The (multislot) power can be measured in MultiSlot Test (Figure 43).

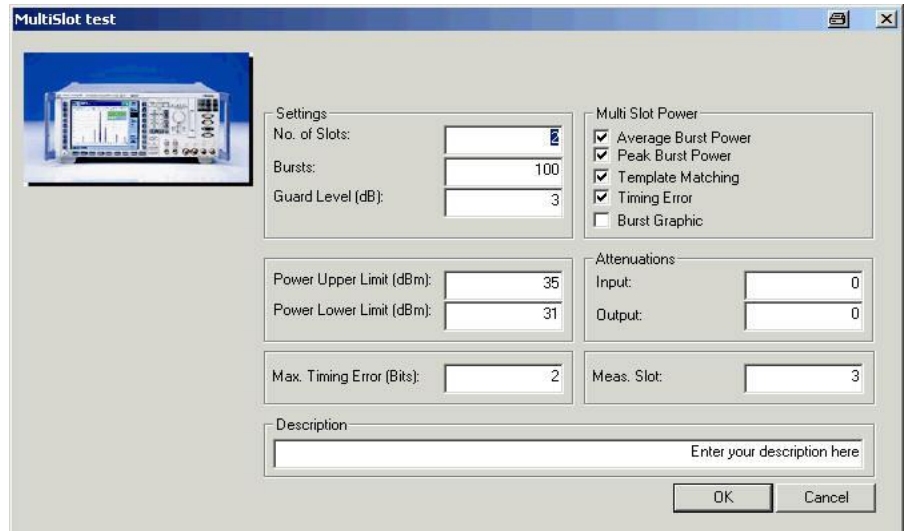


Figure 43 - GSM Multislot Test

The number of timeslots to be measured ('No of Slots'), the number of 'Bursts' and the 'Guard Level' can be set in the **Settings** section. The limits ('Power Upper Limit' and 'Power Lower Limit'), 'Max Timing Error', the attenuations and the timeslot to be measured can also be set. The measurements to be displayed must then be selected in the **Multi Slot Power** section.

## (E)GPRS with CMU and CMUgo

Figure 44 shows a typical entry in the report. If the 'Burst Graphic' tick box is activated, a graph is generated (Figure 45).

<i>Number of Slots: 4, Guard Level (dB): 3.0</i>				
Average Power: Slot 0, 100 Bursts	31.00 dBm	35.00 dBm	18.49 dBm	-
Average Power: Slot -1, 100 Bursts	31.00 dBm	35.00 dBm	-41.25 dBm	-
Average Power: Slot +1, 100 Bursts	31.00 dBm	35.00 dBm	-41.06 dBm	-
Average Power: Slot +2, 100 Bursts	31.00 dBm	35.00 dBm	-40.86 dBm	-
Peak Burst Power: Slot 0, 100 Bursts	31.00 dBm	35.00 dBm	21.51 dBm	-
Peak Burst Power: Slot -1, 100 Bursts	31.00 dBm	35.00 dBm	-31.68 dBm	-
Peak Burst Power: Slot +1, 100 Bursts	31.00 dBm	35.00 dBm	-32.01 dBm	-
Peak Burst Power: Slot +2, 100 Bursts	31.00 dBm	35.00 dBm	-33.45 dBm	-
Power Time Template: Slot 0, 100 Bursts			passed	✓
Power Time Template: Slot -1, 100 Bursts			passed	✓
Power Time Template: Slot +1, 100 Bursts			passed	✓
Power Time Template: Slot +2, 100 Bursts			passed	✓
Timing Error: Slot 0, 100 Bursts	-2.00 Bit	2.00 Bit	0.00 Bit	✓
Timing Error: Slot -1, 100 Bursts	-2.00 Bit	2.00 Bit	0.50 Bit	✓
Timing Error: Slot +1, 100 Bursts	-2.00 Bit	2.00 Bit	0.50 Bit	✓
Timing Error: Slot +2, 100 Bursts	-2.00 Bit	2.00 Bit	0.50 Bit	✓

Figure 44 - Multislot report (table)

### Annex: Power Graphic

*Guard Level (dB): 3.0, Number of Slots: 4*

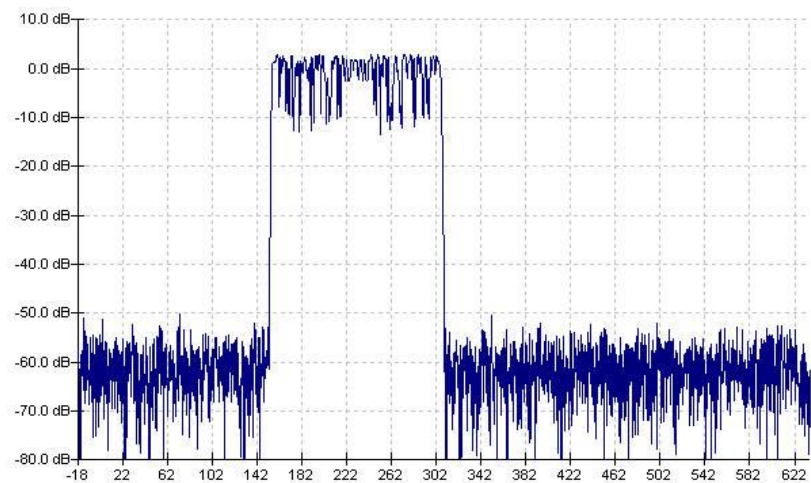


Figure 45 - Multislot report (graph)

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## **Remote Sequences**

### **GPRS Call Setup**

First of all, the RF analyzer is set to PCL/Gamma mode, the RF connector ( RF2 ) is selected and the attenuation ( 0 dB ) is set.

LEV:MODE PCL

SIGN:STAT?

INP:STAT RF2

OUTP:STAT RF2

SENS:CORR:LOSS:INP2 0.0

SENS:CORR:LOSS:OUTP2 0.0

Setting of Network Support (GSM+GPRS), DSP B52 of B21V02 ( Multislot Support ) and parameter P-Zero ( 0 ). Also channel of the BCCH ( 32 ) and level (-85 dBm) as well as the traffic channel ( 62 ) and the main timeslot ( 3 ).

CONF:NETW:NSUP GGPR

CONF:NETW:B52M MSUP

CONF:BSS:PDAT:MSL:PZER 0

CONF:BSS:CCH:CHAN 32

CONF:BSS:CCH:LEV -85.0

CONF:BSS:PDAT:TCH:MSL:CHAN 62

CONF:BSS:PDAT:TCH:MSL:MTIM 3

CONF:SIGN:PDAT:ASC:ENAB OFF

Setting of multislot uplink (slot 3 ON, gamma all 3) and downlink (slot 3, all 0 dB relative), coding scheme ( CS1 )

CONF:MSS:PDAT:TCH:MSL:SCON OFF,OFF,OFF,ON,OFF,OFF,OFF,OFF,3,3,3,3,3,3,3,3

CONF:BSS:PDAT:TCH:MSL:SCON

OFF,OFF,OFF,ON,OFF,OFF,OFF,OFF,0,0,0,0,0,0,0,0,0,0,0,0

CONF:NETW:PDAT:GPRS:CSCH CS1

Acknowledge mode (Off), controchannel mode (BCCH and TCH)

CONF:NETW:PDAT:TWAC OFF

## ***(E)GPRS with CMU and CMUgo***

---

CONF:BSS:CCH:MODE BATC

CONF:NETW:PDAT:RLCM UNAC

Bit stream (pseudo-random 9)

CONF:NETW:PDAT:BITS PR9

CONF:RXQ:PDAT:BITS PR9

MCC (1) and MNC (1)

CONF:NETW:IDEN:MCC 1

CONF:NETW:IDEN:MNC 1

Meas channel (BCCH) and dynamic allocation (Auto)

CONF:NETW:PDAT:PCMC BCCH

CONF:NETW:PDAT:EDAL AUTO

Starting of the generator (GSM and GPRS)

PROC:SIGN:ACT SON

PROC:SIGN:PDAT:ACT SON;\*OPC?

Waiting for location update (SYNC) and attach (ATT) (must be repeated in loops)

SIGN:STAT?

SIGN:PDAT:STAT?

Call to mobile (here Test Mode A), waiting for 'TEST' (must be repeated in loops)

PROC:SIGN:PDAT:ACT CTMA

SIGN:PDAT:STAT?

Querying of information

CONF:MSS:PDAT:MSL:SCON?

CONF:BSS:PDAT:MSL:SCON?

MSS:IMSI:MCC?

MSS:IMSI:MNC?

MSS:IMSI:MSIN?

MSS:IMEI:FAC?

MSS:IMEI:TAC?

MSS:IMEI:SNR?

MSS:IMEI:SVN?

MSS:REV?

MSS:POW:CLAS?

MSS:MSCL:PDAT?

### **GPRSCall Release**

Querying of the status, execution of Call Release (DISC), waiting for 'ATT'.  
If all resources are to be released, the SOFF command is given.

SIGN:PDAT:STAT?

PROC:SIGN:PDAT:ACT DISC

SIGN:PDAT:STAT?

PROC:SIGN:ACT SOFF



## ***(E)GPRS with CMU and CMUgo***

---

CONF:RXQ:BLER:CONT:RLBC 2000  
CONF:RXQ:BLER:CONT:PDAT:TCH:MSL:RLEV -85.0  
CONF:RXQ:BLER:CONT:PDAT:TCH:MSL:LEV:IND 0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0  
INIT:RXQ:BLER  
FETC:RXQ:BLER?

### **GSM Testset**

Status query, attenuation ( 0 dB ) and unimportant BER parameters

SENS:SIGN:STAT?  
SENS:SIGN:PDAT:STAT?  
CONF:SIGN:SMOD?  
INP:STAT?  
SENS:CORR:LOSS:INP2 0.0  
SENS:CORR:LOSS:OUTP2 0.0  
CONF:RXQ:CONT:HTIM 0,0.20  
CONF:RXQ:BER1:CONT:REP NONE,NONE

Changing of call parameters (level -85 dBm, channel 62, timeslot 3, PCL 5), Meas Slot 3

PROC:BSS:TCH:LEV:UTIM?  
PROC:BSS:TCH:LEV:UTIM -85.0  
PROC:SIGN:CHCC?  
PROC:SIGN:CHCC 62,3,5;\*OPC?  
CONF:MCON:MSL:MESL 3

Power measurement (singleshot, 10 bursts)

CONF:POW:CONT:REP SING,NONE,NONE  
CONF:POW:CONT ARR,10  
READ:POW?  
FETC:ARR:POW?

Modulation measurement (singleshot, 10 bursts, standard decoding)

CONF:MOD:XPER:CONT:REP SING,NONE,NONE  
CONF:MOD:XPER:CONT ARR,10  
CONF:MOD:XPER:TIME:DEC STAN  
READ:MOD:XPER?  
FETC:ARR:MOD:XPER?

Spectrum measurement (modulation: points 4 and 5 ON, 10 bursts, singleshot, switching: points 1 and 2 ON, 10 bursts, combined measurement)

CONF:SPEC:MOD:CONT:MPO1:ENAB OFF  
CONF:SPEC:MOD:CONT:MPO2:ENAB OFF  
CONF:SPEC:MOD:CONT:MPO3:ENAB OFF  
CONF:SPEC:MOD:CONT:MPO4:ENAB ON  
CONF:SPEC:MOD:CONT:MPO5:ENAB ON  
CONF:SPEC:MOD:CONT:MPO6:ENAB OFF  
CONF:SPEC:MOD:CONT:MPO7:ENAB OFF

## ***(E)GPRS with CMU and CMUgo***

---

CONF:SPEC:MOD:CONT:MPO8:ENAB OFF  
CONF:SPEC:MOD:CONT:MPO9:ENAB OFF  
CONF:SPEC:MOD:CONT:MPO10:ENAB OFF  
CONF:SPEC:MOD:CONT:MPO11:ENAB OFF  
CONF:SPEC:MOD:CONT ARR,10  
CONF:SPEC:MOD:CONT:REP SING,NONE,NONE  
CONF:SPEC:MSW:CONT ARR  
CONF:SPEC:MSW:CONT:REP SING,NONE,NONE  
CONF:SPEC:SWIT:CONT:MPO1:ENAB ON  
CONF:SPEC:SWIT:CONT:MPO2:ENAB ON  
CONF:SPEC:SWIT:CONT:MPO3:ENAB OFF  
CONF:SPEC:SWIT:CONT:MPO4:ENAB OFF  
CONF:SPEC:SWIT:CONT ARR,10  
CONF:SPEC:SWIT:CONT:REP SING,NONE,NONE  
CONF:SPEC:SWIT:NOSL 1  
INIT:SPEC:MSW  
FETC:SPEC:MSW?  
FETC:ARR:SPEC:MSW?

### **GSM Call Edge**

The spectrum measurements are identical to those for GSM Testset.

Status query, attenuation (0 dB), Meas Slot (3)

SENS:SIGN:STAT?  
SENS:SIGN:PDAT:STAT?  
CONF:SIGN:SMOD?  
INP:STAT?  
PROC:SIGN:PDAT:TCH:MSL:SCON?  
SENS:CORR:LOSS:INP2 0.0  
SENS:CORR:LOSS:OUTP2 0.0  
CONF:MCON:MSL:MESL 3

Edge Power measurement (filter 600 kHz, 10 bursts, singleshot)

CONF:POW:EPSK:FILT B600  
CONF:POW:EPSK:CONT ARR,100  
CONF:POW:EPSK:CONT:REP SING,NONE,NONE  
INIT:POW:EPSK  
FETC:POW:EPSK?

Edge Modulation measurement (100 bursts, singleshot)

CONF:MOD:OVER:EPSK:CONT ARR,100  
CONF:MOD:OVER:EPSK:CONT:REP SING,NONE,NONE  
INIT:MOD:OVER:EPSK  
FETC:MOD:OVER:EPSK?

## ***(E)GPRS with CMU and CMUgo***

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### **GSM Multislot Test**

Status query

`SENS:SIGN:STAT?`

`SENS:SIGN:PDAT:STAT?`

MultiSlot measurement (Meas Slot 3, singleshot, 100 bursts, 4 slots, modulation ANY, filter 500 kHz, guard level 3)

`CONF:MSS:MCON:MESL 3`

`CONF:POW:MSL:CONT:REP SING,NONE,NONE`

`CONF:POW:MSL:CONT ARR,100`

`CONF:POW:MSL:SCO 4`

`CONF:POW:MSL:MVI ANY,ANY,ANY,ANY`

`CONF:POW:MSL:FILT G500`

`CONF:POW:MSL:LIM:LINE:GLEV 3.0`

`INIT:POW:MSL`

`FETC:POW:MSL?`

### **Abbreviations**

CS	Coding Scheme
EDGE	Enhanced Data Rates for GSM Modulation
EGPRS	Enhanced General Packet Radio Service
GPRS	General Packet Radio Service
HSCSD	High Speed Circuit Switched Data
MCS	Modulation and Coding Scheme
RLC	Radio Link Control
TBF	Temporary Block Flow
USF	Uplink State Flag

### **References**

[1] Rohde & Schwarz: **Manual for Windows Application CMUgo (V1.00)**, 12/2002, 1136.3971.00

[2] Rohde & Schwarz: **Operating Manual for Software Options K20, K21, K22, K23, K24, K42, K43** (1115.5900.02, 1115.6007.02, 1115.6107.02, 1115.6207.02, 1115.6307.02, 1115.4691.02, 1115.6907.02) *Revision 1115.6088.12-13-*

### **Additional Information**

Please send any comments or suggestions concerning this application note to [CMUApplication@rsd.rohde-schwarz.com](mailto:CMUApplication@rsd.rohde-schwarz.com).

## Ordering Information

### Communication Tester

R&S CMU200		1100.0008.02
CMU-B21 <sup>(1)</sup>	Versatile signalling unit	1100.5200.02
CMU-B21v14 <sup>(1)</sup>	Universal signalling unit	1100.5200.14
Option B41 (optional)	Audio generator and analyzer	1100.5300.02
CMU-K20	SW options for GSM400	1115.5900.02
CMU-K21	SW options for GSM900	1115.6007.02
CMU-K22	SW options for GSM1800	1115.6107.02
CMU-K23	SW options for GSM1900	1115.6207.02
CMU-K24	SW options for GSM850	1115.6307.02
CMU-K42	SW GPRS extension for GSM	1115.4691.02
CMU-K43	SW EGPRS extension for GSM	1115.6907.02

<sup>(1)</sup> CMU-B21 or CMU-B21v14 with CMU-B54v14 is required.



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