



R&S CMU200 (B53, K53, possibly B41), CMUgo

Measurements on Bluetooth Devices using R&S CMU200 and CMUgo

Application Note

This application note describes how Bluetooth devices are tested and measured using the R&S CMU200 by means of the CMUgo remote control program or manual operation.



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1 Overview

The Universal 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, WCDMA and Bluetooth.

This application note describes the use of CMUgo, a Windows application for remote control of the R&S CMU200 and for measuring and testing Bluetooth devices. CMUgo also offers different modules for performing tests according to Test Specification RF 1.1 Revision 0.91 [1].

The most important settings and interpretations of the measurement results are also briefly presented within the information regarding manual operation. They are based on CMUgo.

2 Remote Control of 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 via a GPIB bus (IEE488.2) and via the RS-232 interface.

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

Hardware and Software Requirements

Hardware requirements

- CPU: at least 300 MHz
- RAM: at least 64 MByte
- Monitor: SVGA with 800 x 600 pixels or higher
- Hard disk: 50 MByte available space
- Peripherals: National Instruments GPIB bus or RS-232 interface, mouse

Software requirements

- Windows 98/ME/2000/XP
- CMUgo V1.10 with Bluetooth modules V1.20 or newer

CMUgo Operation

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. Because the program is structured as a sequencer (information about the previous module is not available), time can be saved through further optimization.

Bluetooth Call Setup Module

The Call Setup module must always be positioned to the beginning of a sequence for Bluetooth (after Basic Initializing). All important parameters for establishing a connection with a Bluetooth device are set here (Fig. 1).

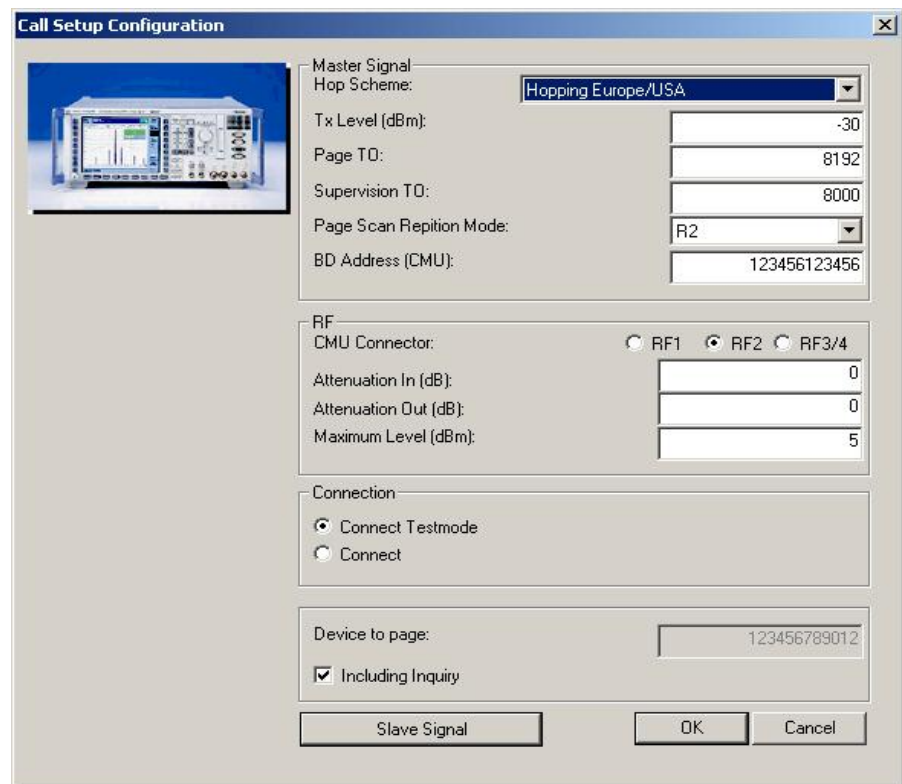


Fig. 1 - Call Setup Configuration

The parameters of the downlink from the R&S CMU200 to the Bluetooth device are set in the **Master signal** section. The TX level of the R&S CMU200, the timeout for call release (supervision TO) and the page scan repetition mode are of primary importance. These parameters *cannot* be modified *after* a connection has been established (exception: TX level).

The CMU connector of the R&S CMU200 (normally RF2, although RF3/4 is better for connections via air) is set under the **RF** section. The settings for attenuation are valid for the complete Bluetooth sequence. They cannot be changed during the test.

Caution: The setting of the 'Maximum level' parameter is important. It should be 5 dB above the expected power of the Bluetooth device. The presetting refers to a class 2 unit with a nominal power of 0 dBm.

The **Connection** section is used to set up a 'normal' Bluetooth connection with the Bluetooth device (**Connect**). The submode can be changed later. **Connect test mode** sets up a connection with the Bluetooth device and then automatically switches to the test mode. Please note that the Bluetooth module may have to be enabled beforehand for the test mode.

In addition, the address to be called can directly be set here or, alternatively, an inquiry can be performed. The inquiry is interrupted when the first Bluetooth device is found. This first address found will then be used for setting up the connection.

If 'Connect test mode' is selected, further parameters can be set via **Slave signal**. If 'Connect' is set, this button cannot be selected.

The **Slave signal** button opens up the **Call Setup Slave Signal** dialog (refer to Fig. 2).

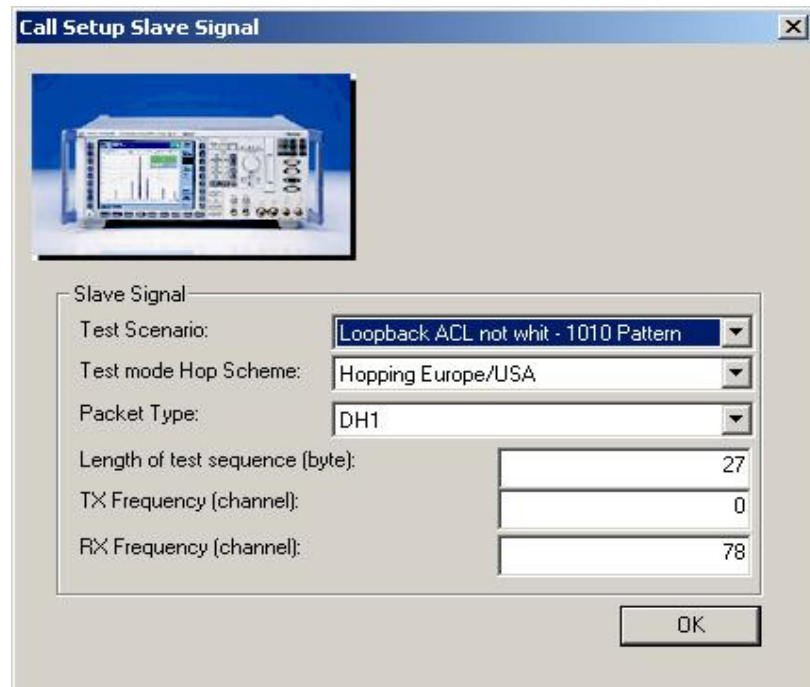


Fig. 2 - Call Setup Slave Signal dialog

The test mode settings are predefined in this dialog. After a connection has been established via 'Connect test mode', these settings remain valid until they are changed by other modules.

The following parameters are combined in **Test scenario**:

- Test mode type: TX test or Loopback
- Whitening: On or Off
- Pattern type

In addition, the **Test mode hop scheme**, the **Packet type** (DH1, DH3 or DH5), the **Length of test sequence** (DH1 up to 27 bytes, DH3 up to 183 bytes and DH5 up to 339 bytes) and the transmit and receive channels (**TX** and **RX Frequency** [refer to the Bluetooth device]) can be set.

Fig. 3 shows a typical entry in the Call Setup report.

Bluetooth with R&S CMU and CMUgo

Test Name and Condition	Lower Limit	Upper Limit	Measured Value	P/F
Country: Hopping Europe/USA, Tx Level: -30.0 dBm, Attenuation (In/Out): 0.0/0.0 dB, Max. Level: 5.0, Page Scan Repetition Mode: R2				
Hop Scheme: Hopping Europe/USA, Packet Type: DH1, Length of Testsequence: 27				
Default Device Address: 123456789012, Inquiry: Done				
BD Address (CMU): 123456123456, Test Scenario: Loopback ACL not whit - 1010 Pattern				
Name: Demo, LMP Version: 1.1, Company ID: Ericsson, Version: 123, BD Address: 1234567890				
Connection to Device:			passed	✓

Fig. 3 - Call Setup report

Bluetooth Call Release Module

In the Bluetooth Call Release module, the existing call to the Bluetooth device is released; the R&S CMU200 enters the standby state (Fig. 4).

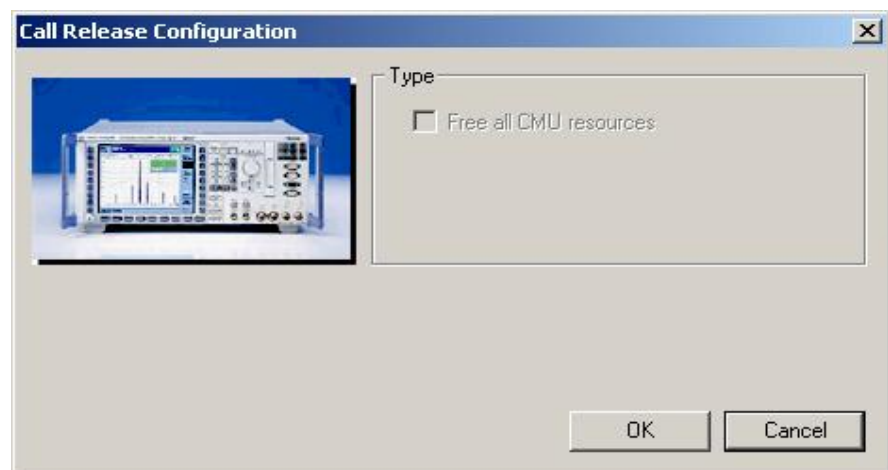


Fig. 4 - Call Release Configuration

If the call is not set up or released, the following window will be displayed (Fig. 5). All other modules (except for Call Setup) will also perform this query.

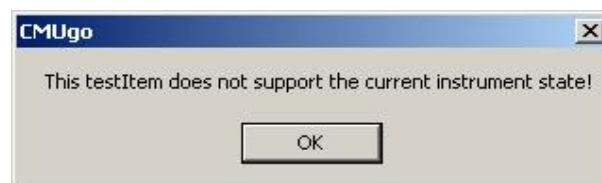


Fig. 5 – No connection

Fig. 6 shows the entry of Bluetooth Call Release in the test report.

Detach device:			passed	✓
----------------	--	--	--------	---

Fig. 6 - Call Release report

Bluetooth Submode Module

The Bluetooth Submode module does not perform any measurements. It is used to switch between the individual submodes (Fig. 7).

The following modes are provided in the **Submode** section:

- Test
- Audio
- Sniff
- Park
- Hold

Some Bluetooth devices may not allow each and every transition between submodes.

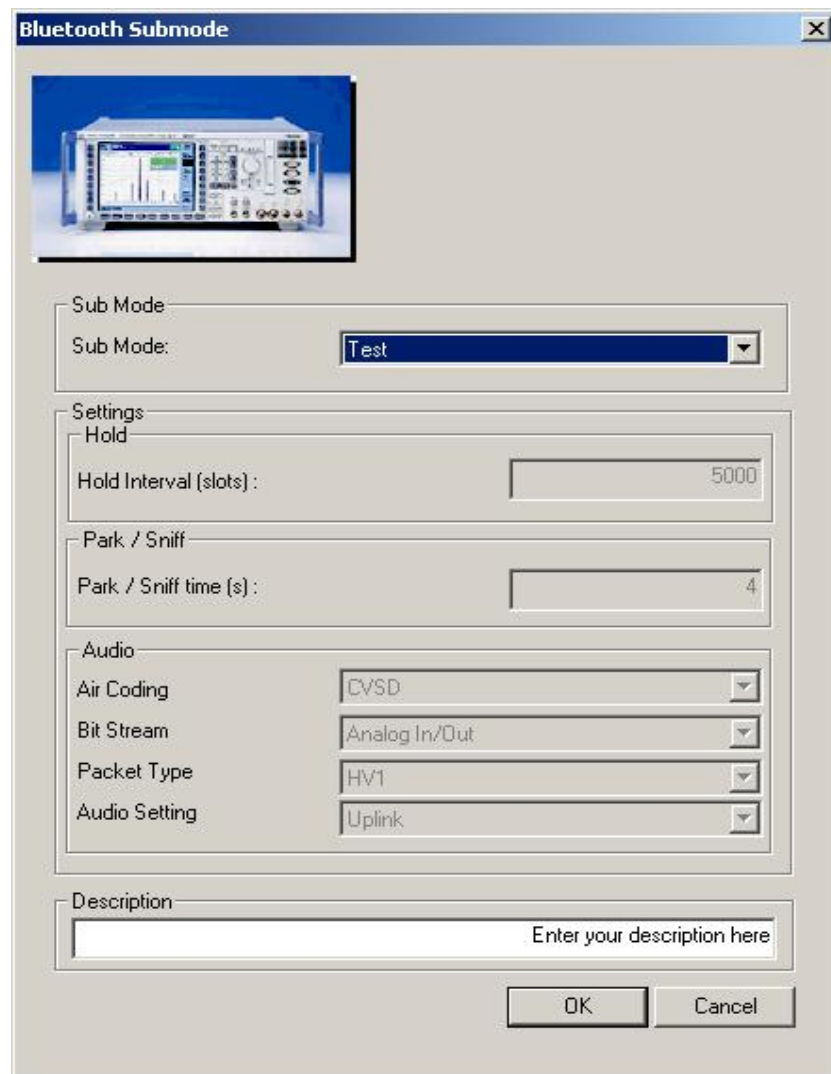


Fig. 7 – Submode

The states and transitions between the individual submodes are shown in Fig. 8.

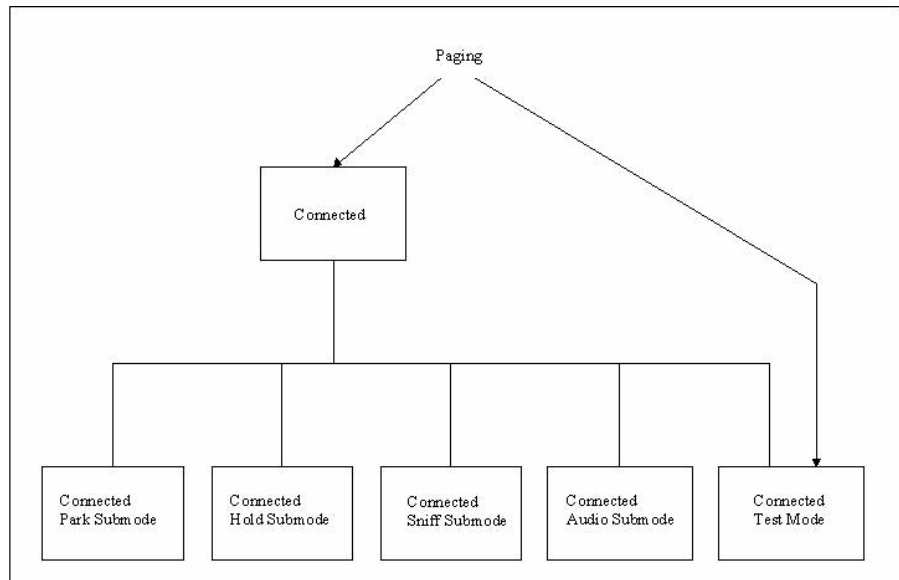


Fig. 8 - States and transitions between the submodes

Test mode

The test mode is a special mode for measuring different parameters. It may be necessary to externally enable the Bluetooth device for the test mode ('Enable Device Under Test'). The CMU200 can be used to change to this state directly via **Connect test mode** (see Call Setup) or via **Connect** followed by 'Enter submode test mode'.

Audio

In the Audio section, the following parameters can be set:

Air coding: CVSD, u-law or A-law

Bit stream: analog in/out or echo

Packet type: HV1, HV2 or HV3

Audio setting: uplink, downlink or crosstalk

The following test scenarios are possible in Audio (to):

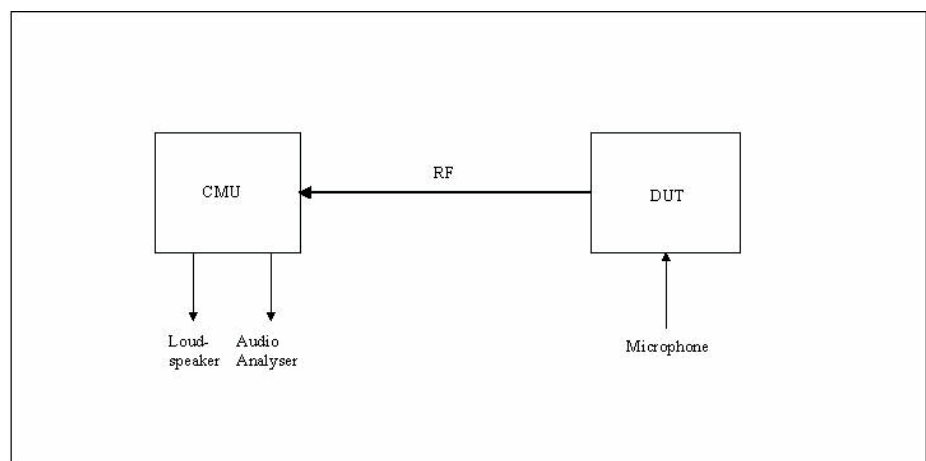


Fig. 9 - Audio uplink

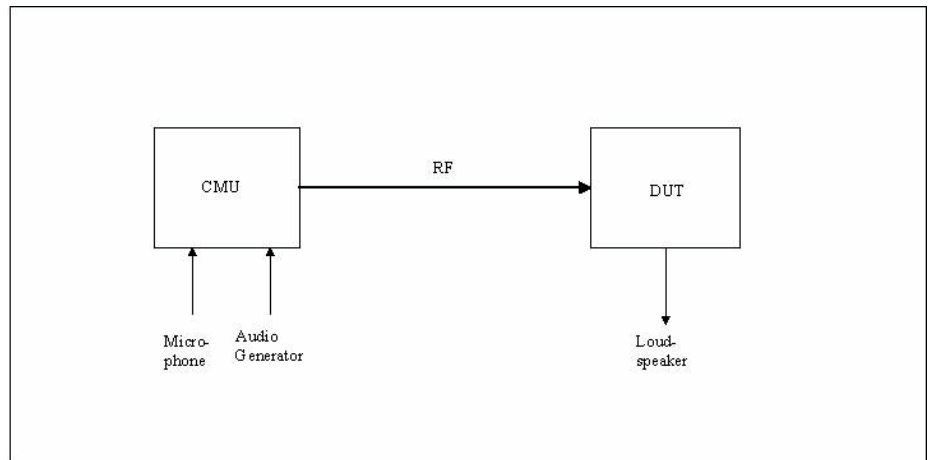


Fig. 10 - Audio downlink

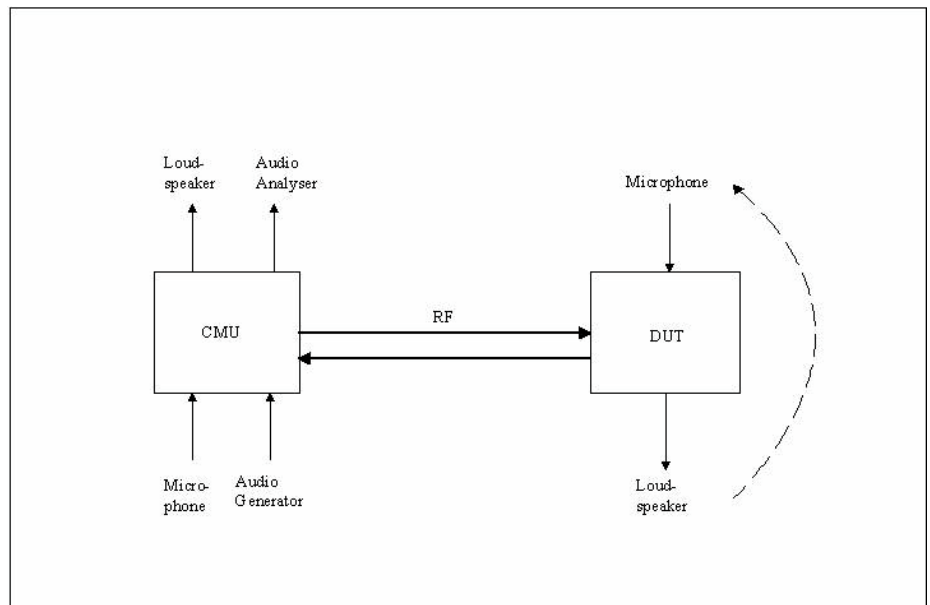


Fig. 11 - Audio crosstalk

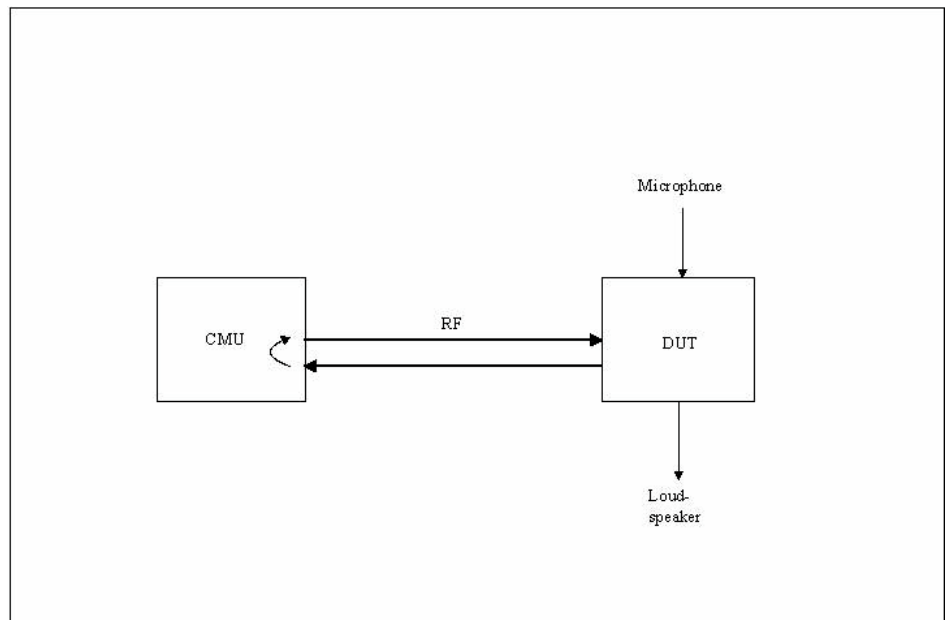


Fig. 12 - Audio echo

Measurements in the 'Analog In/Out' setting can be performed with an external audio analyzer or with option B41 of the R&S CMU200 via the (general) **Audio Test Configuration** (Fig. 13) module in CMUgo.

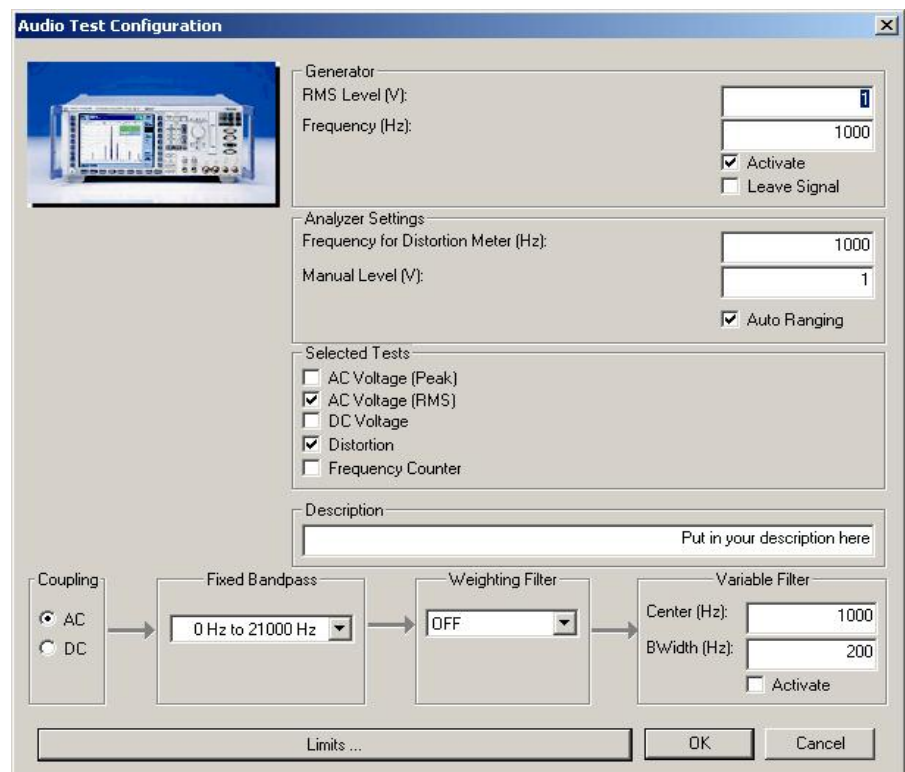


Fig. 13 - Audio Test Configuration

In the Audio Test Configuration module, the audio generator and the audio analyzer of option B41 can be controlled. Moreover, the different limits are set via **Limits** (Fig. 14).

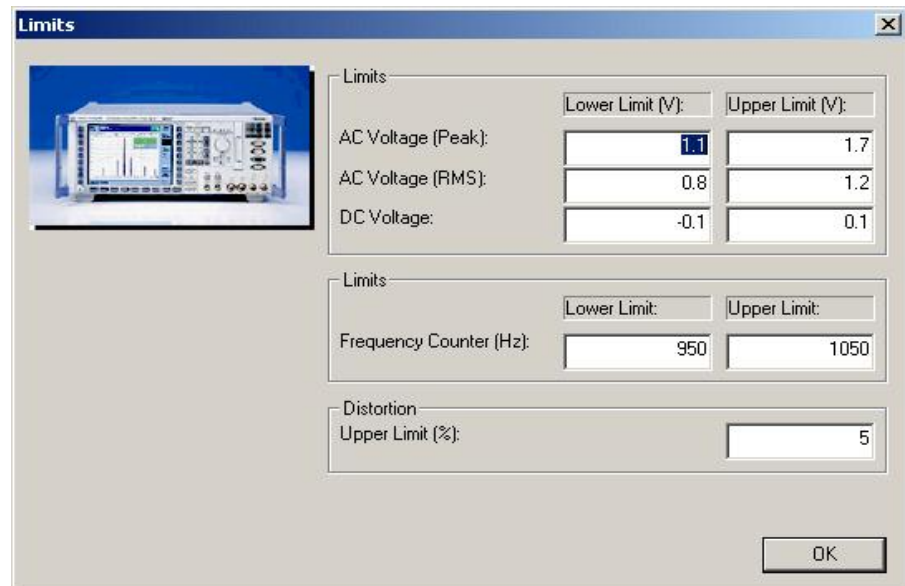


Fig. 14 - Audio limits

Sniff

CMUgo maintains the connection for the specified time (park/sniff time in seconds) in the sniff mode. The normal mode will then be re-activated automatically. If the set time exceeds that of the 'Supervision timeout' (see Call Setup), the time of the 'Supervision timeout' is used.

Park

CMUgo maintains the connection for the specified time (Park/Sniff time in seconds) in the Park mode. The normal mode will then be re-activated automatically. If the set time exceeds that of 'Supervision timeout' (see Call Setup), the time of the 'Supervision timeout' is used.

Hold

The Bluetooth specification stipulates automatic return from hold to normal mode. This does not require that an extra command be sent. The length of the hold interval can be set by the number of slots.

Fig. 15 shows all possible submode messages in the test report.

```
Mode: Test
Mode: Audio, Bit Stream: Analog In/Out, Air Coding: CVSD, Packet Type: HV1, Setting: Uplink
Mode: Sniff for 4.0 seconds
Mode: Park for 4.0 seconds
Mode: Hold for 5000 slots
Mode: Normal
```

Fig. 15 - Submode report

Bluetooth Power Step Module

Power Step offers four different actions for setting the power of the Bluetooth device ('Power Control') (Fig. 16).

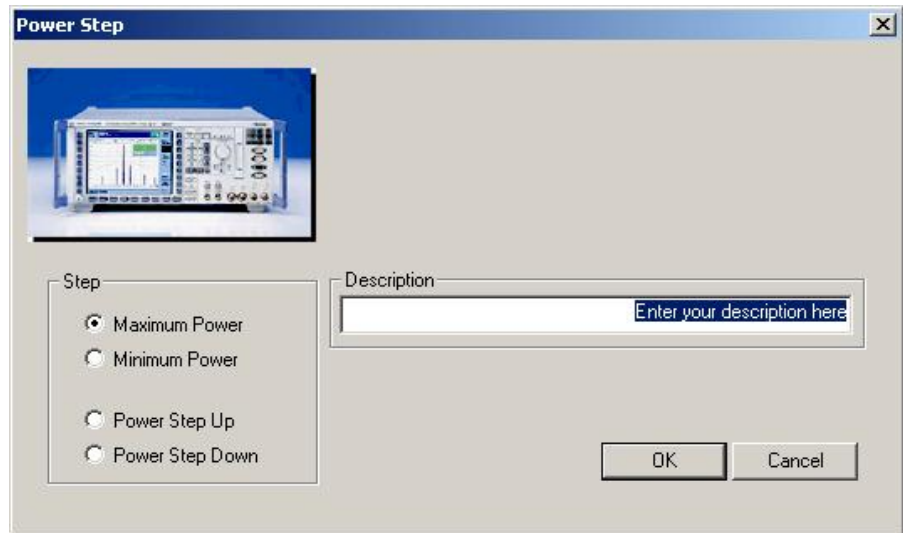


Fig. 16 - Power Step

As a preliminary check, the signaling info queries whether the Bluetooth device actually supports power control. If not, a warning is issued (Fig. 17).



Fig. 17 - Bluetooth device does not support power control

If the Bluetooth device supports power control, various operations can be performed. **Maximum** or **Minimum power** performs one or more power step up(s) or down(s) as long as the Bluetooth device to be tested acknowledges that it is transmitting at a maximum or minimum TX level.

Power step up or **Power step down** performs only one step. If the Bluetooth device acknowledges this step, this acknowledgement is also output in the report.

Fig. 18 shows a typical Power Step entry in the test report.

Power Step: Maximum
Limit reached!

Fig. 18 - Power Step report

Bluetooth Test Set Module

The Test Set Configuration module allows power and modulation to be measured in one operation (Fig. 19).

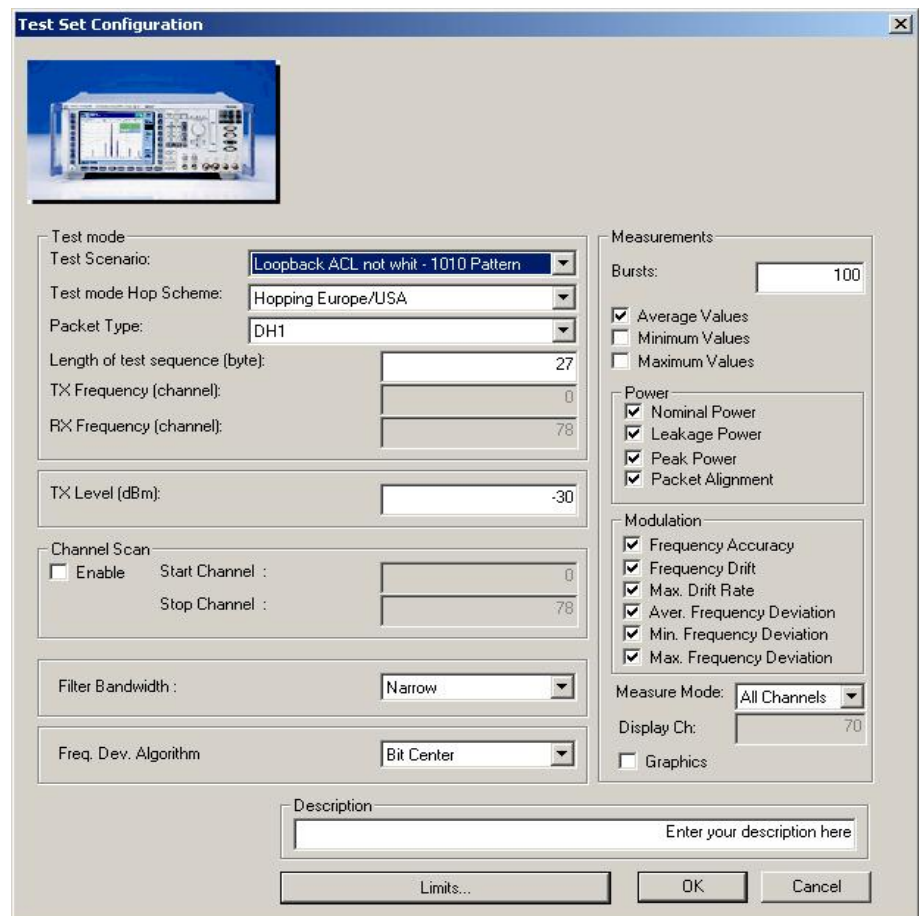


Fig. 19 – Test Set Configuration

The **Test mode** section is used to change the connection parameters. The default settings correspond to the values from the Call Setup module. However, the Call Setup values are not transferred dynamically. The TX level of the R&S CMU200 can also be changed.

The **Measurements** section is used to select the specific measurements to be displayed, set the number of bursts and define how results are displayed (average, minimum and/or maximum values). The measurement returns all results irrespective of the selection (and thus always requires the same amount of time), i.e. the selection of results only affects the content of the report itself. If the connection is in the hopping mode, the 'Measure mode' parameter can be used to set whether all channels or only a single channel/display channel is measured. If 'Graphics' is selected, two graphs will be output for the power and modulation characteristic.

Two additional parameters can be set for the measurements. 'Filter bandwidth' can be set between narrow (1.3 MHz) and wide (approx. 2.2 MHz). The measurement algorithm can be selected between integration average and bit-centered average via 'Freq. dev. algorithm'.

Channel scan is used to perform the selected measurements in different (all) channels. The results are automatically displayed in a graph.

The following window (Fig. 20) opens after the **Limits** button is pressed.

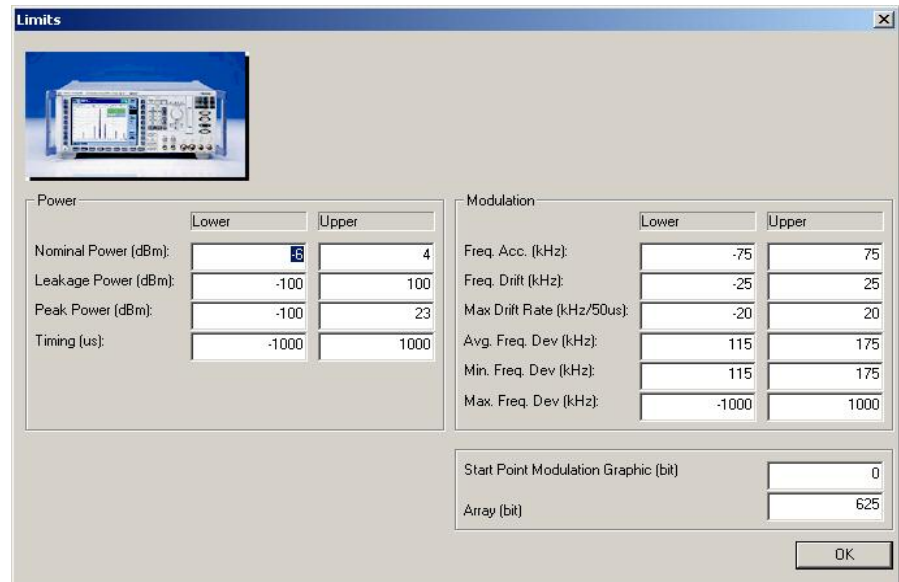


Fig. 20 - Limits

The various limits can be set in the **Power** and **Modulation** sections. The starting point for the modulation graph and the length of the graph can be set. Fig. 21 shows the report for the normal Test Set.

Hop Scheme: Hopping Europe/USA, Packet Type: DH1, Length of Testsequence: 27

Tx Level: -30.0 dBm, 100 Bursts, Mode: All

Test Scenario: Loopback ACL not whit - 1010 Pattern, Filter Bandwidth: Narrow, Freq. Dev. Algorithm: Bit Center

Nominal Power: Average	-6.00 dBm	4.00 dBm	-5.99 dBm	✓
Leakage Power: Average	-100.00 dBm	100.00 dBm	61.75 dBm	✓
Peak Power Average	-100.00 dBm	23.00 dBm	-56.91 dBm	✓
Packet Alignment Average	-1000.00 us	1000.00 us	493.21 us	✓
Frequency Accuracy Average	-75.00 kHz	75.00 kHz	31.58 kHz	✓
Frequency Drift Average	-25.00 kHz	25.00 kHz	-24.25 kHz	✓
Maximum Drift Rate Average (/ 50 us)	-20.00 kHz	20.00 kHz	-14.11 kHz	✓
Average Frequency Deviation Average	115.00 kHz	175.00 kHz	141.74 kHz	✓
Minimum Frequency Deviation Average	115.00 kHz	175.00 kHz	115.53 kHz	✓
Maximum Frequency Deviation Average	-1000.00 kHz	1000.00 kHz	142.37 kHz	✓

Fig. 21 - Test Set report

Fig. 22 shows an example of a report for Test Set with channel scan activated. The maximum and minimum and the channel are output for each selected measurement. Fig. 23 again shows the channel scan as a graph in the annex of the report.

Bluetooth with R&S CMU and CMUgo

Hop Scheme: RXTX single frequency, Packet Type: DH1, Length of Testsequence: 27, RX.Frequency: 78

Tx Level: -30.0 dBm, 100 Packets, Mode: —

Test Scenario: Loopback ACL not whit - 1010 Pattern, Filter Bandwidth: Narrow, Freq. Dev. Algorithm: Bit Center

Nominal Power Maximum: @ Channel: 70, Average			-0.54 dBm	✓
Nominal Power Minimum: @ Channel: 0, Average			-1.69 dBm	✓
Nominal Power Maximum: @ Channel: 70, Minimum			-0.55 dBm	✓
Nominal Power Minimum: @ Channel: 0, Minimum			-1.70 dBm	✓
Nominal Power Maximum: @ Channel: 70, Maximum			-0.52 dBm	✓
Nominal Power Minimum: @ Channel: 0, Maximum			-1.68 dBm	✓
Peak Power Maximum: @ Channel: 70, Average			-0.28 dBm	✓
Peak Power Minimum: @ Channel: 0, Average			-1.41 dBm	✓
Peak Power Maximum: @ Channel: 74, Minimum			-0.30 dBm	✓
Peak Power Minimum: @ Channel: 0, Minimum			-1.44 dBm	✓
Peak Power Maximum: @ Channel: 64, Maximum			-0.23 dBm	✓
Peak Power Minimum: @ Channel: 0, Maximum			-1.38 dBm	✓

Fig. 22 - Test Set report with channel scan

Annex: Nominal Power:

Start Channel: 0, Stop Channel: 78, Average: blue, Min. green, Max: red

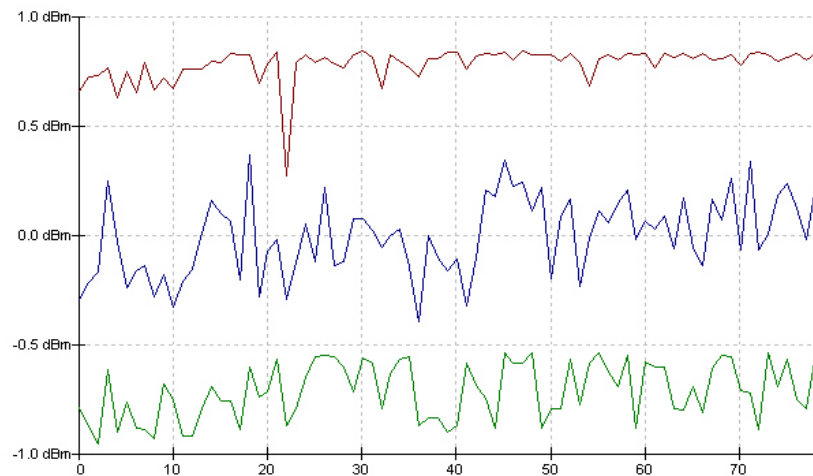


Fig. 23 - Channel scan graph for Test Set report

Bluetooth BER Test Module

Different receiver tests can be performed with the BERTest (Fig. 24) module. The bit error rate is measured for a specific level.

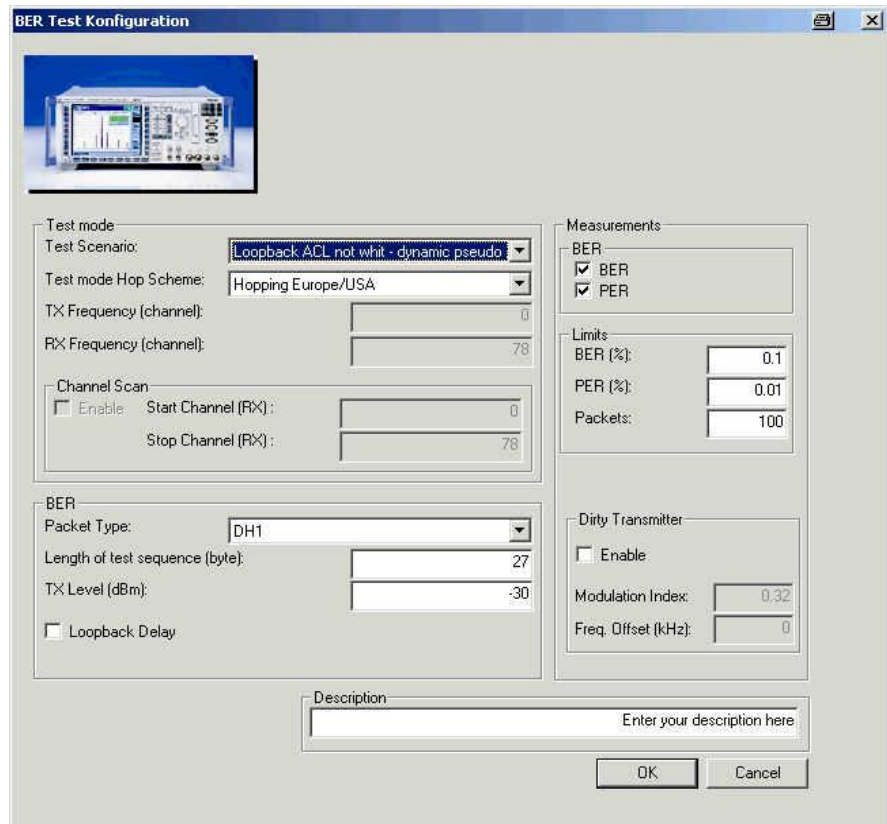


Fig. 24 - BERTest

The various parameters can be changed in the **Test mode** section (note that only the parameters with loopback can be selected). A channel scan can be carried out by several (all) RX channels, automatically displayed in a graph.

The **BER** section is used to set the packet type, the length of the test sequence and the TX level of the BER measurement. In addition, the 'Loopback delay' parameter has to be adjusted to the corresponding Bluetooth device.

The measurements, the limits and the number of packets can be selected under **Measurements**. Moreover, a static dirty transmitter with adjustable parameters can be activated.

This module is used to perform the *Sensitivity – Single Slot Packages* (5.1.13 RCV/CA/01/C) and *Sensitivity – Multislot Packages* (5.1.14 RCV/CA/02/C) tests with a static dirty transmitter. The following settings are required:

- Loopback ACL not whitened – PRBS9 (static pseudo random).
- Hopping off (RX/TX on single).
- TX level –70.0 dBm.

- DH1 for single slot, or DH3 and/or DH5 for multislots.
- Bluetooth device must transmit at maximum level (power step may be called beforehand).
- 1600000 bits correspond to 7408 packets for DH1, 1093 packets for DH3 and 590 packets for DH5.
- All tests have to be carried out on three frequencies, normally receive channels 0, 39 and 78.

The *Maximum Input Level* (5.1.18 RCV/CA/06/C) test can also be simulated. The same settings as described above apply but only DH1 packets are used for a level of -20 dBm.

Fig. 25 shows an example of a BERTest report.

Hop Scheme: Hopping Europe/USA, Packet Type: DH1, Length of Testsequence: 27

Tx Level: -30.0 dBm, 100 Packets, Test Scenario: Loopback ACL not whit - dynamic pseudo random

Loopback Delay: Off, Dirty Transmitter: Off

BER:	<input type="text"/>	0.10 %	0.00 %	✓
PER:	<input type="text"/>	0.01 %	0.00 %	✓

Fig. 25 - BERTest report

Bluetooth BER Search Module

The level required to exceed a certain bit error rate is determined here (Fig. 26).

Fig. 26 - BER Search Configuration

BER Search basically offers the same parameters as the BERTest with the exception that a **Search TX level upper** or **lower** and a **Search value** are defined. The R&S CMU200 performs the measurement several times (number in **Search cycles**) until it exceeds the stipulated search value or the minimum level has been reached. If the search value is not reached within the interval, 'not performed' is output for 'Search result'.

Fig. 27 shows a report for BER Search.

Hop Scheme: Hopping Europe/USA, Packet Type: DH1, Length of Testsequence: 27

Search Tx Level Lower: -80.0 dBm, Search Tx Level Upper: -60.0 dBm, Search Cycles: 20, Search Value: 0.1 %

Test Scenario: Loopback ACL not whit - dynamic pseudo random, 100 Packets

Loopback Delay: Off, Dirty Transmitter: Off

BER:			0.25 %	✔
PER			0.00 %	✔
Search Result (Tx Level):			-78.95 dBm	✔

Fig. 27 - BER Search report

Bluetooth Power Module

The *Output Power* (5.1.3 TRM/CA/01/C) and *Power Control* (5.1.5 TRM/CA/03/C) measurements can be performed with Power (Fig. 28).

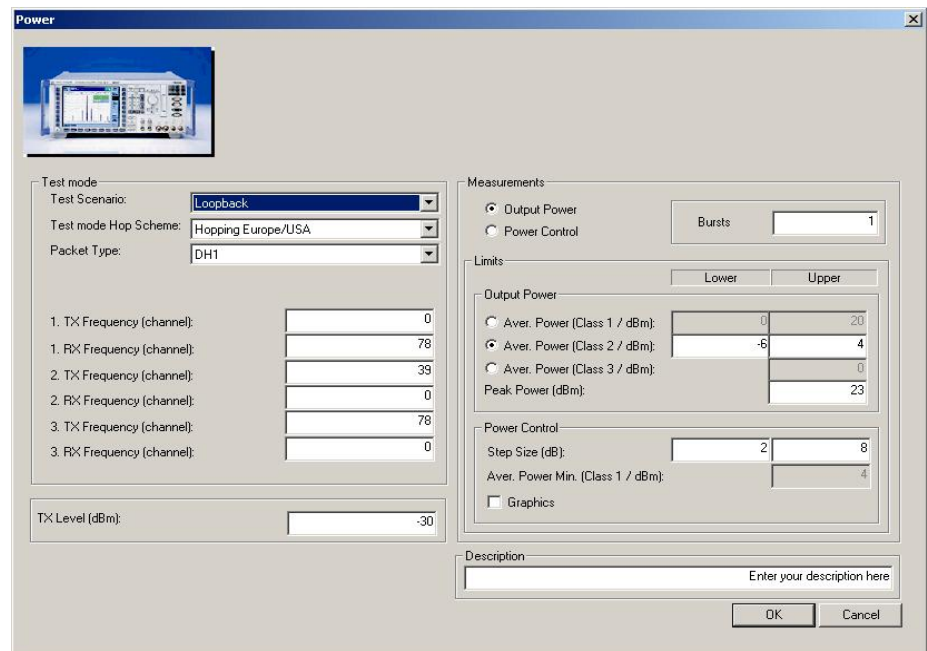


Fig. 28 – Power

The **Test mode** section is used to change the common parameters. The test length is automatically determined by the packet type (DH1: 27 bytes, DH:183 bytes, DH5 339 bytes). The three channels to be measured have been predefined. Moreover, the TX level of the R&S CMU200 can be set.

The **Measurements** section is used to select between output power and power control and to set the number of packets (**Bursts**). The limits for both measurements also have to be set. To obtain the correct limits for output power, the proper power class must be set since it is not transmitted during signalling. An additional graph can be displayed under power control.

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Settings for *Output Power* (5.1.3 TRM/CA/01/C):

- Hopping on.
- Loopback.
- Longest possible packet type.
- Permanent setting: PRBS9 (static pseudo random).
- Bluetooth device has to transmit at maximum level (may be necessary to call Power Step beforehand).
- The peak power and average power are measured.

Fig. 29 shows a report from Power, in this case for output power.

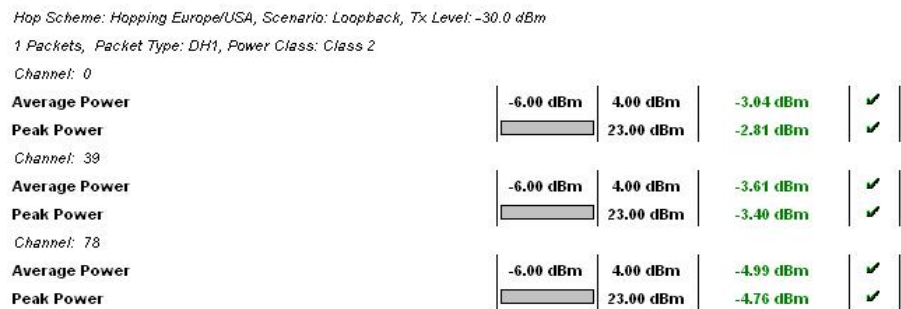


Fig. 29 - Power report for output power

Settings for *Power Control* (5.1.5 TRM/CA/03/C):

- Hopping off (RX/TX on single).
- Loopback.
- DH1.
- Permanent setting: PRBS9 (static pseudo random).
- Bluetooth device must transmit at maximum level (may be necessary to call Power Step beforehand).
- The individual steps are automatically performed on the three channels and displayed.

Fig. 30 shows part of the Power report, in this case for power control. First, the maximum power is output at the beginning of the sequence. The individual steps are then displayed at the bottom. Once the minimum power is reached, it will be displayed and the steps will then be carried out up to maximum power. The same applies to two other channels.

Fig. 31 shows the graphical representation of power control following the power control report. The individual power steps can be clearly seen. The three selected channels are indicated by 11...22...33... on the x axis.

Bluetooth with R&S CMU and CMUgo

Hop Scheme: Hopping Europe/USA, Scenario: Loopback, Tx Level: -30.0 dBm

1 Packets, Packet Type: DH1, Power Class: Class 2

Channel: 0

Power at Maximum			-1.71 dBm	✓
Power Step Down	2.00 dB	8.00 dB	1.67 dB	✗
Power Step Down	2.00 dB	8.00 dB	3.88 dB	✓
Power Step Down	2.00 dB	8.00 dB	3.56 dB	✓
Power Step Down	2.00 dB	8.00 dB	4.16 dB	✓
Power Step Down	2.00 dB	8.00 dB	3.82 dB	✓
Power Step Down	2.00 dB	8.00 dB	3.99 dB	✓
Power Step Down	2.00 dB	8.00 dB	2.98 dB	✓
Power Step Down	2.00 dB	8.00 dB	2.66 dB	✓
Power at Minimum			-28.44 dBm	✓
Power Step Up	2.00 dB	8.00 dB	2.65 dB	✓
Power Step Up	2.00 dB	8.00 dB	2.99 dB	✓
Power Step Up	2.00 dB	8.00 dB	4.01 dB	✓
Power Step Up	2.00 dB	8.00 dB	3.80 dB	✓
Power Step Up	2.00 dB	8.00 dB	4.14 dB	✓
Power Step Up	2.00 dB	8.00 dB	3.58 dB	✓
Power Step Up	2.00 dB	8.00 dB	3.88 dB	✓
Power Step Up	2.00 dB	8.00 dB	1.67 dB	✗
Power at Maximum			-1.72 dBm	✓

Channel: 39

Fig. 30 - Power report for power control

Annex: Power Control Steps

Channel 1: 0, Channel 2: 39, Channel 3: 78

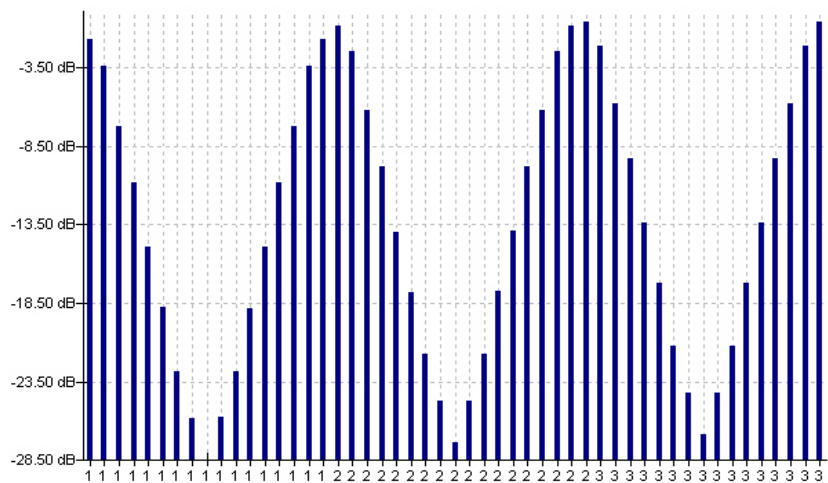


Fig. 31 - Power graph for power control

Bluetooth Modulation Characteristics Module

The *Modulation Characteristics* (5.1.9 TRM/CA/07/C) measurement can be performed with Modulation Characteristics (Fig. 32).

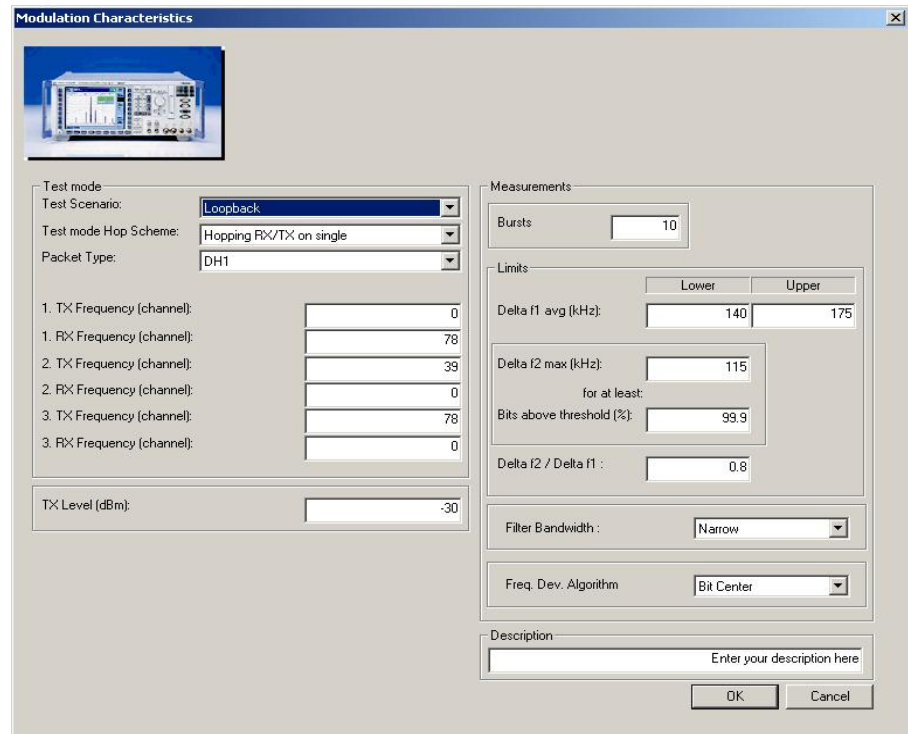


Fig. 32 - Modulation Characteristics

The **Test mode** section is used to change the common parameters. The test length is automatically determined by the packet type (DH1: 27 bytes, DH:183 bytes, DH5 339 bytes). The three channels to be measured have been predefined. Moreover, the TX level of the R&S CMU200 can be set.

The **Measurements** section is used to set the number of packets (bursts) and the various limits. In addition, the filter bandwidth and the calculation algorithm can be set again.

Settings for *Modulation Characteristics* (5.1.9 TRM/CA/07/C):

- Hopping off (RX/TX on single).
- Loopback.
- Longest possible packet type.
- Bluetooth device must transmit at maximum level (may be necessary to call Power Step beforehand).
- At least 10 packets.
- The bit patterns and the three channels are changed automatically.

Fig. 33 shows a Modulation Characteristics report.

*Hop Scheme: RX/TX single frequency, Packet Type: DH1, Length of Testsequence: 27, Scenario: Loopback, Tx Level: -30.0 dBm
10 Packets, Filter Bandwidth: Narrow, Freq. Dev: Algorithm: Bit Center*

<i>Channel: 0</i>				
Delta F1 Avg	140.00 kHz	175.00 kHz	156.12 kHz	✓
Delta F2 Max <i>Threshold: 115.0 kHz</i>	99.90 %	<input type="text"/>	100.00 %	✓
Delta F2 Avg / Delta F1 Avg	0.80	<input type="text"/>	0.95	✓
<i>Channel: 39</i>				
Delta F1 Avg	140.00 kHz	175.00 kHz	161.72 kHz	✓
Delta F2 Max <i>Threshold: 115.0 kHz</i>	99.90 %	<input type="text"/>	100.00 %	✓
Delta F2 Avg / Delta F1 Avg	0.80	<input type="text"/>	0.95	✓
<i>Channel: 78</i>				
Delta F1 Avg	140.00 kHz	175.00 kHz	165.21 kHz	✓
Delta F2 Max <i>Threshold: 115.0 kHz</i>	99.90 %	<input type="text"/>	100.00 %	✓
Delta F2 Avg / Delta F1 Avg	0.80	<input type="text"/>	0.95	✓

Fig. 33 - Modulation Characteristics report

Bluetooth Initial Carrier Frequency Tolerance (ICFT) Module

The *Initial Carrier Frequency Tolerance* (5.1.10 TRM/CA/08/C) measurement can be carried out with ICFT (Fig. 34).

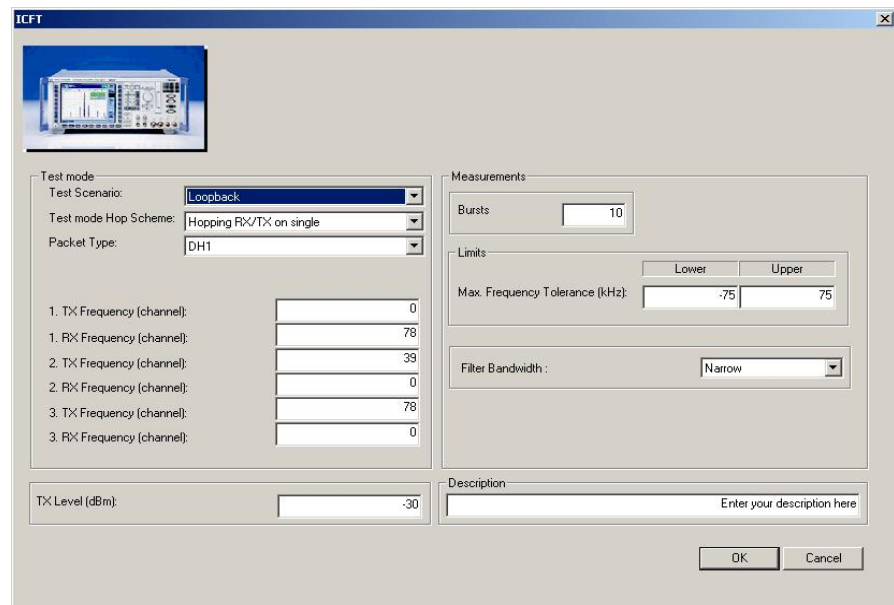


Fig. 34 – ICFT

The **Test mode** section is used to change the common parameters. The test length is automatically determined by the packet type (DH1: 27 bytes, DH:183 bytes, DH5 339 bytes). The three channels to be measured have been predefined. Moreover, the TX level of the R&S CMU200 can be set.

The **Measurements** section is used to set the number of packets (bursts) and the various limits. Moreover, the filter bandwidth can be set again.

Settings for *Initial Carrier Frequency Tolerance* (5.1.10 TRM/CA/08/C):

- Hopping off (RX/TX on single) and hopping on.
- Loopback.
- DH1.
- Permanent setting: Bit pattern PRBS9 (static pseudo random).
- The Bluetooth device must transmit at maximum level (may be necessary to call Power Step beforehand)
- At least 10 packets.
- The three channels are changed automatically.

Fig. 35 shows an example of an ICFT report.

Hop Scheme: RX/TX single frequency, Scenario: Loopback, Tx Level: -30.0 dBm

10 Packets, Filter Bandwidth: Narrow, Packet Type: DH1, Freq. Dev: Algorithm: Bit Center

Channel: 0

Max. Frequency Tolerance	-75.00 kHz	75.00 kHz	13.24 kHz	✔
<i>Channel: 39</i>				
Max. Frequency Tolerance	-75.00 kHz	75.00 kHz	6.16 kHz	✔
<i>Channel: 78</i>				
Max. Frequency Tolerance	-75.00 kHz	75.00 kHz	10.25 kHz	✔

Fig. 35 - Initial Carrier Frequency Tolerance report

Bluetooth Carrier Frequency Drift Module

The *Carrier Frequency Drift* measurement (5.1.10 TRM/CA/09/C) is carried out with Carrier Frequency Drift (Fig. 36).

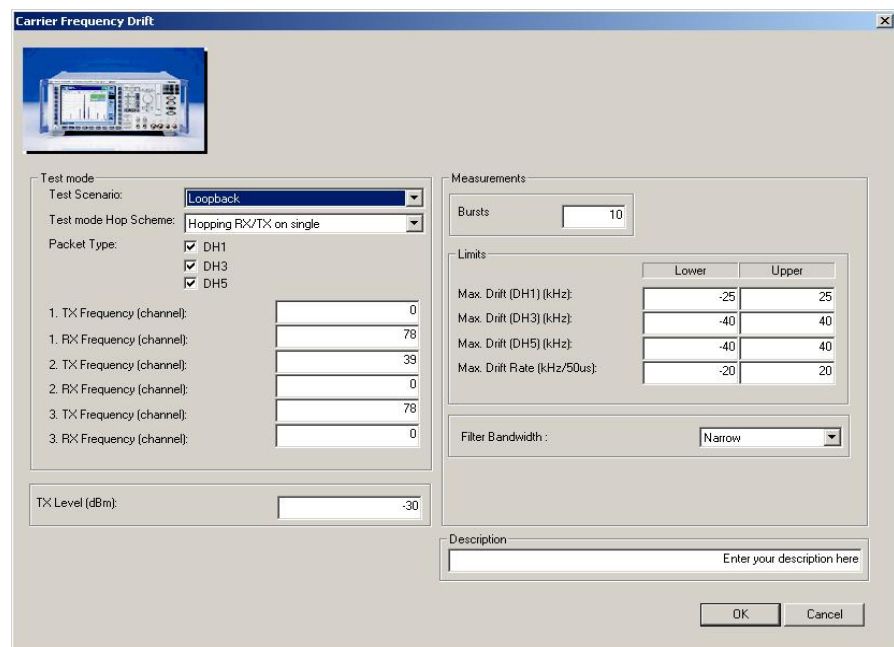


Fig. 36 - Carrier Frequency Drift

The **Test mode** section is used to change the common parameters. The test length is automatically determined by the packet type (DH1: 27 bytes, DH:183 bytes, DH5 339 bytes). The three channels to be measured have been predefined. Moreover, the TX level of the R&S CMU200 can be set.

Bluetooth with R&S CMU and CMUgo

It is not necessary to select just one packet type here, i.e. one or more packet types can be selected.

The **Measurements** section is used to set the number of packets (bursts) and the various limits. Moreover, the filter bandwidth can be set again.

Settings for *Carrier Frequency Drift* (5.1.10 TRM/CA/09/C):

- Hopping off (RX/TX on single) and hopping on.
- Loopback.
- DH1, DH3 and DH5.
- Permanent setting: Correct bit pattern 1010.
- At least 10 packets.
- The three channels are automatically changed.

Fig. 37 shows a Carrier Frequency Drift report.

Hop Scheme: RXTX single frequency, Scenario: Loopback, Tx Level: -30.0 dBm

10 Bursts, Filter Bandwidth: Narrow

Channel: 0

Max. Drift (DH1)	-25.00 kHz	25.00 kHz	14.17 kHz	✓
Max. Drift (DH3)	-40.00 kHz	40.00 kHz	1.59 kHz	✓
Max. Drift (DH5)	-40.00 kHz	40.00 kHz	30.08 kHz	✓
Max. Drift Rate (DH1) (/ 50 us)	-20.00 kHz	20.00 kHz	12.10 kHz	✓
Max. Drift Rate (DH3) (/ 50 us)	-20.00 kHz	20.00 kHz	-7.92 kHz	✓
Max. Drift Rate (DH5) (/ 50 us)	-20.00 kHz	20.00 kHz	9.07 kHz	✓

Channel: 39

Max. Drift (DH1)	-25.00 kHz	25.00 kHz	22.80 kHz	✓
Max. Drift (DH3)	-40.00 kHz	40.00 kHz	3.15 kHz	✓
Max. Drift (DH5)	-40.00 kHz	40.00 kHz	-3.03 kHz	✓
Max. Drift Rate (DH1) (/ 50 us)	-20.00 kHz	20.00 kHz	-14.31 kHz	✓
Max. Drift Rate (DH3) (/ 50 us)	-20.00 kHz	20.00 kHz	0.00 kHz	✓
Max. Drift Rate (DH5) (/ 50 us)	-20.00 kHz	20.00 kHz	-10.59 kHz	✓

Channel: 78

Max. Drift (DH1)	-25.00 kHz	25.00 kHz	18.11 kHz	✓
Max. Drift (DH3)	-40.00 kHz	40.00 kHz	22.37 kHz	✓
Max. Drift (DH5)	-40.00 kHz	40.00 kHz	39.74 kHz	✓
Max. Drift Rate (DH1) (/ 50 us)	-20.00 kHz	20.00 kHz	-11.62 kHz	✓
Max. Drift Rate (DH3) (/ 50 us)	-20.00 kHz	20.00 kHz	13.75 kHz	✓
Max. Drift Rate (DH5) (/ 50 us)	-20.00 kHz	20.00 kHz	19.99 kHz	✓

Fig. 37 - Carrier Frequency Drift report

3 Manual Operation of R&S CMU200

This section **cannot** replace **nor is intended** to replace the Bluetooth manual in the R&S CMU200 [3]. Only a handful of important settings and measurement results are to be interpreted in this section. The structure mainly corresponds to that of CMUgo in section 2.

Call Setup and Release

Before measurements can be performed on a Bluetooth module, a connection has to be set up between the R&S CMU200 (master) and the Bluetooth device.

Fig. 38 shows the Connection Control window. The address of the module to be called must be queried via **Inquire** or entered under 'Master signal'. A connection in the test mode can then be directly established via **Connect test mode** or a connection in the normal Bluetooth mode can be established via **Connect**. For information about the individual submodes see section 2. Once a connection has been established, it can be released using **Detach** (no figure).

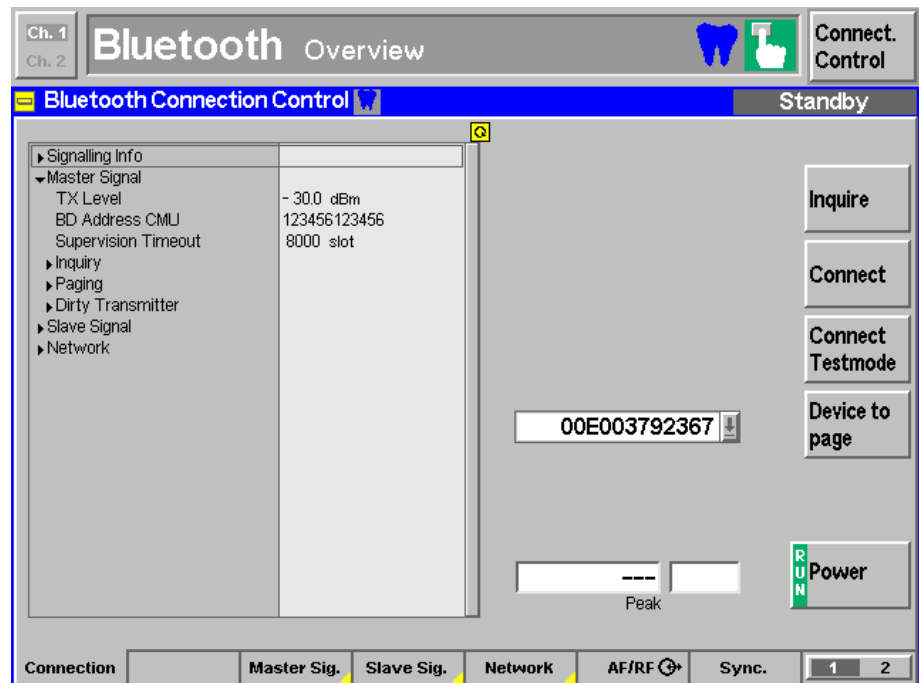


Fig. 38 - Call setup and release

To establish this connection, the R&S CMU200 uses the settings in the **Master signal**, **Slave signal** and **Network** tabs. Parts of these settings can be changed later during an existing connection.

Fig. 39 shows essential settings for master signal.

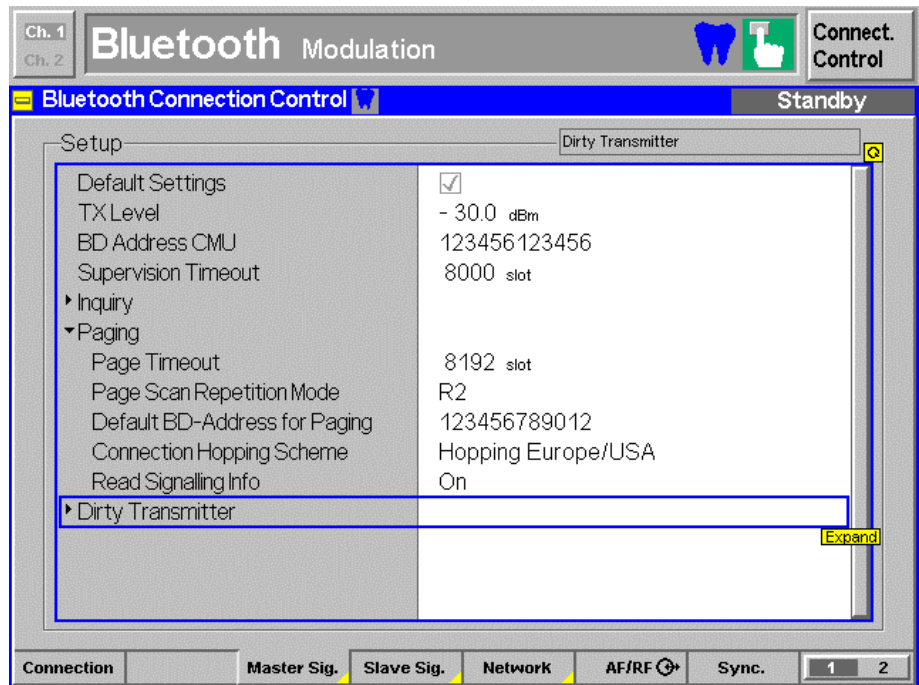


Fig. 39 - Master signal

Fig. 40 shows the most important slave signal parameters that can also be changed in a connection.

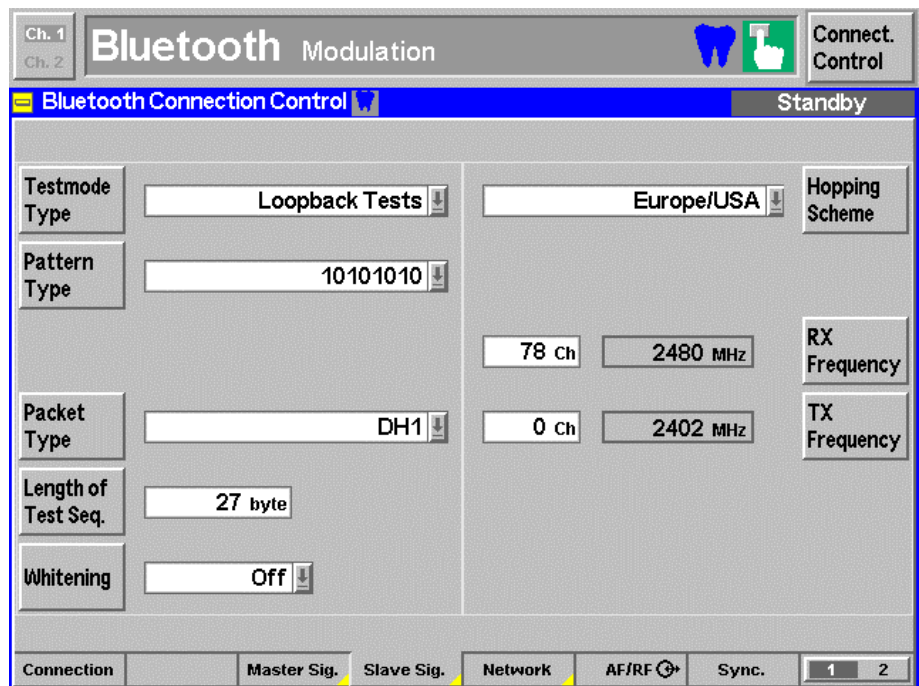


Fig. 40 -Slave signal

The individual submode parameters can be set under 'Network' (Fig. 41):

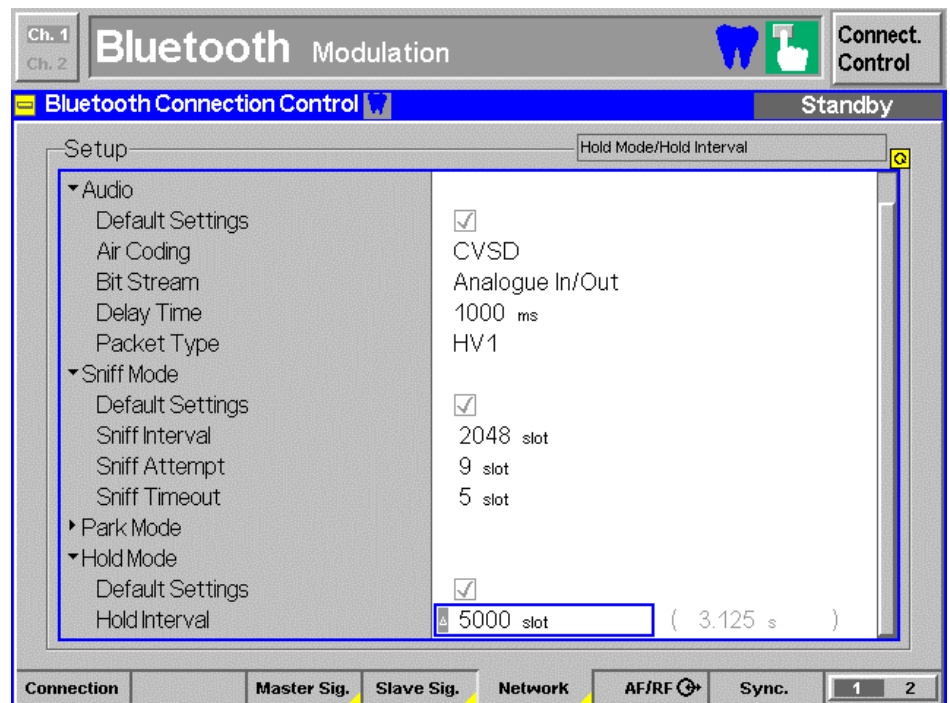


Fig. 41 - Network showing submodes

Once a connection has been established, individual submodes can be activated (Fig. 42). The submode can be activated with 'Enter Submode', and 'Exit...' can be used to return to the normal mode.

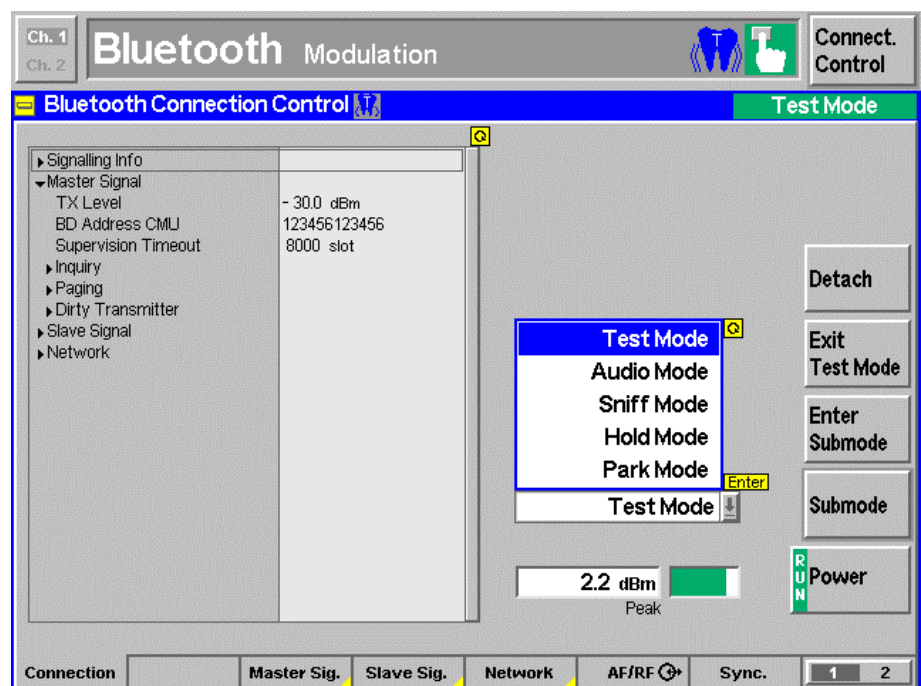


Fig. 42 - Submodes in a connection

Fig. 8 in section 2 shows the various states and transitions between the individual submodes.

Power (Power Control, Output Power)

The **Power** button under Menus is used to access the power measurement display (Fig. 43). The average, minimum and maximum values are shown for the nominal, leakage and peak power.

Power Control (5.1.5 TRM/CA/03/C)

Pressing **Power control** (right bar) will display two additional buttons (**Step up** or **Step down**) in the second bottom row; they are used to test the power control function. If 'Step up' or 'Step down' is pressed, the corresponding action is performed, followed by another power measurement. The before-and-after difference will be displayed as the **Delta level** at the bottom left.

Output Power (5.1.3 TRM/CA/01/C)

The module must initially transmit at full power, i.e. it may be necessary to increase the power with 'Step up' until the message 'Maximum power reached' is displayed. The power measurement will then be performed.

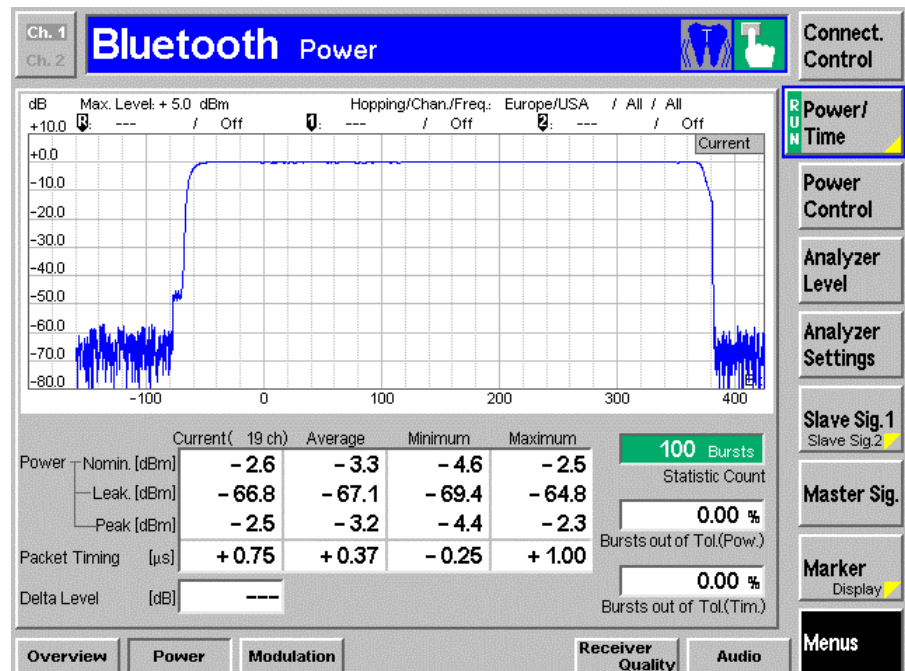


Fig. 43 – Power

Modulation (Mod. Char., ICFT, Carrier Freq. Drift)

The **Modulation** button under Menus is used to access the modulation measurement display (Fig. 44). The average, minimum and maximum values for frequency accuracy, frequency drift, maximum drift rate and frequency deviation are displayed.

The settings for the filter bandwidth and the algorithm for calculating the frequency deviation (Fig. 45) will be displayed after pressing the **Modulation** button in the right bar twice.

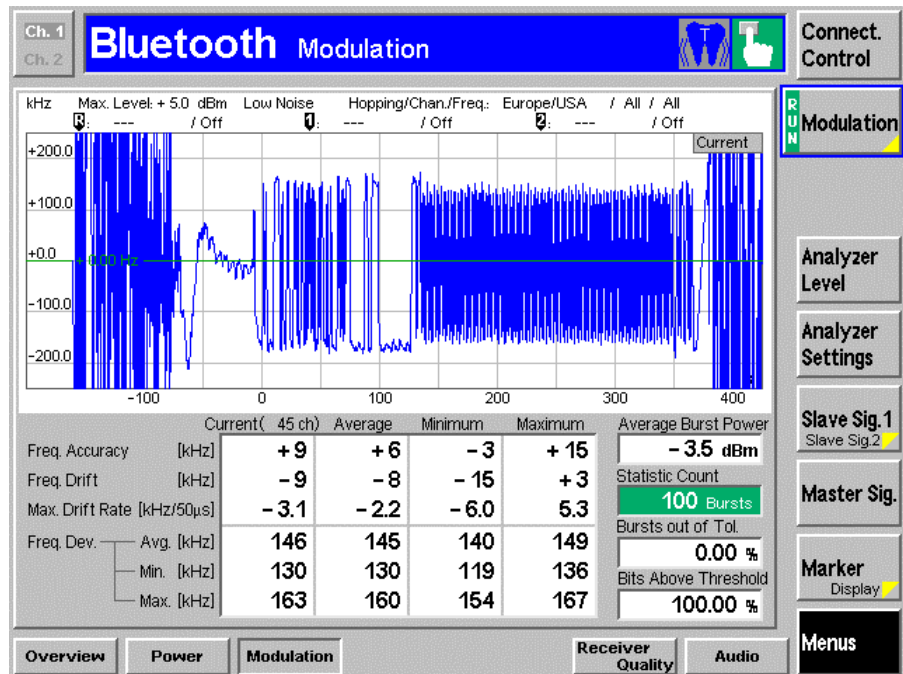


Fig. 44 – Modulation

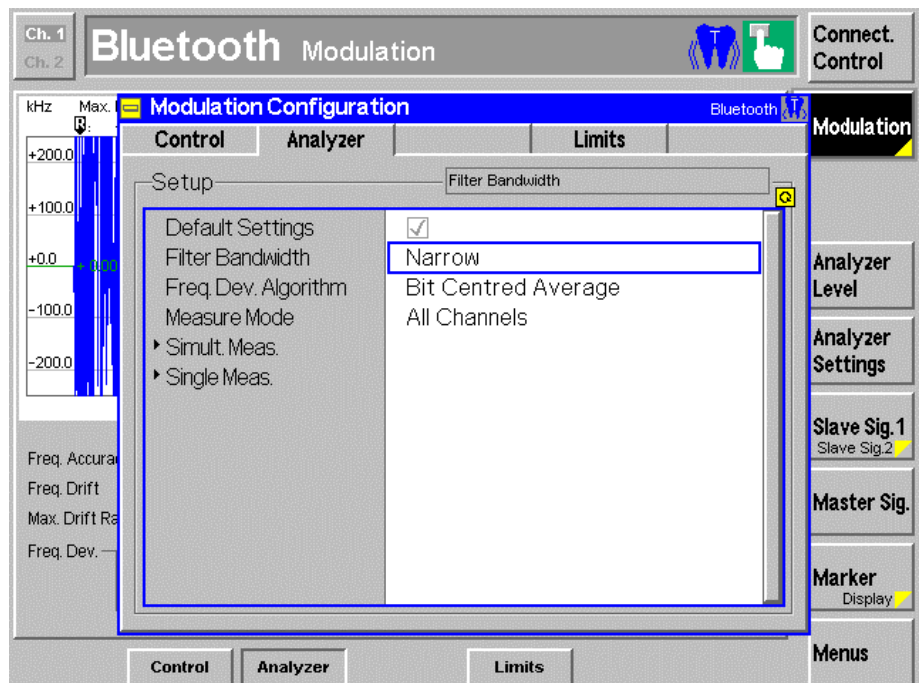


Fig. 45 - Modulation settings

Modulation Characteristics (5.1.9 TRM/CA/07/C)

The results for Δf_{1avg} (with bit pattern 11110000) and Δf_{2avg} (with bit pattern 10101010) are displayed in the **Freq. dev. avg.** row under the **Average** column, and the percentage for Δf_{2max} is displayed in the **Bits above threshold** field. The user must manually switch between the bit patterns.

Initial Carrier Frequency Tolerance (5.1.10 TRM/CA/08/C)

The most important results are shown in the **Freq. accuracy** row under the **Maximum** and **Minimum** columns.

Carrier Frequency Drift (5.1.10 TRM/CA/09/C)

The results in the **Freq. drift** and **Max. drift rate** rows under the **Minimum** and **Maximum** columns have to be taken into consideration.

Receiver Quality

The **Receiver Quality** button under Menus is used to access the Receiver Quality measurement display.

Two different test applications can be selected by pressing the **Application** button in the right bar. 'BER' returns the bit error rate for a fixed level, while 'BER Search' returns the level for a specific bit error rate. A static dirty transmitter can be added via **Master signal** in the right bar. The settings will then be entered via **Modulation index** and **Frequency offset** in the bottom line (Fig. 46).

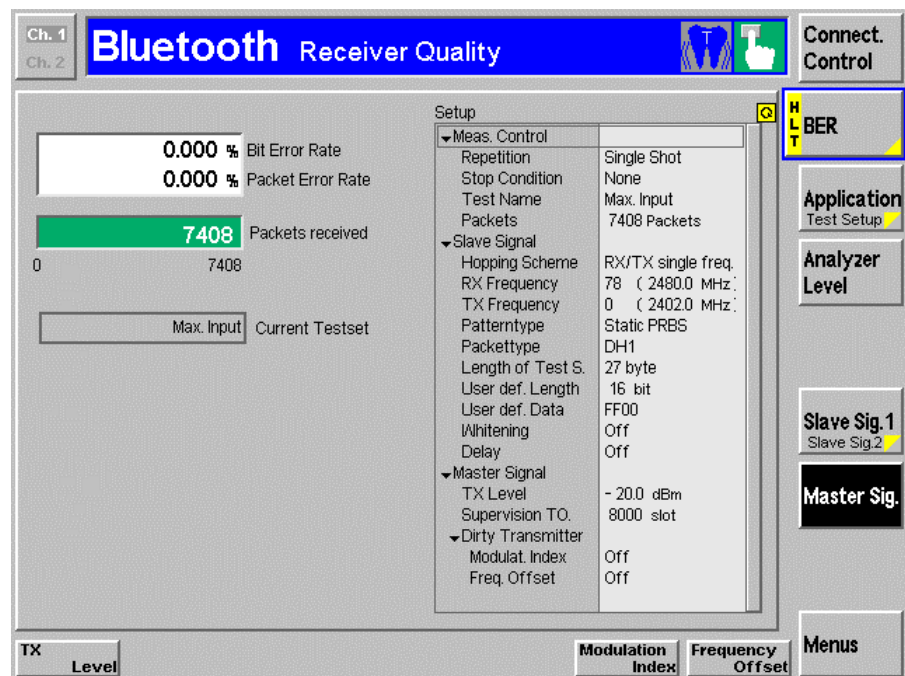


Fig. 46 - Dirty transmitter in Receiver Quality

BER

The bit error rate, packet error rate and the number of packets received are displayed here (Fig. 47).

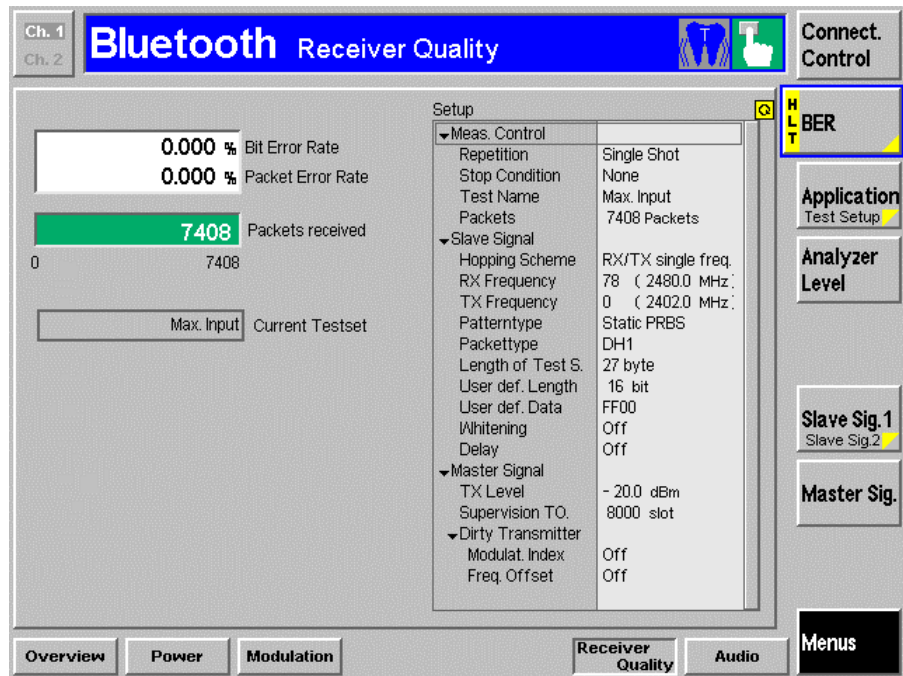


Fig. 47 – BER

BER Search

The bit error rate, packet error rate and the search result are displayed. If no result is displayed, the search interval has to be modified (Fig. 48).

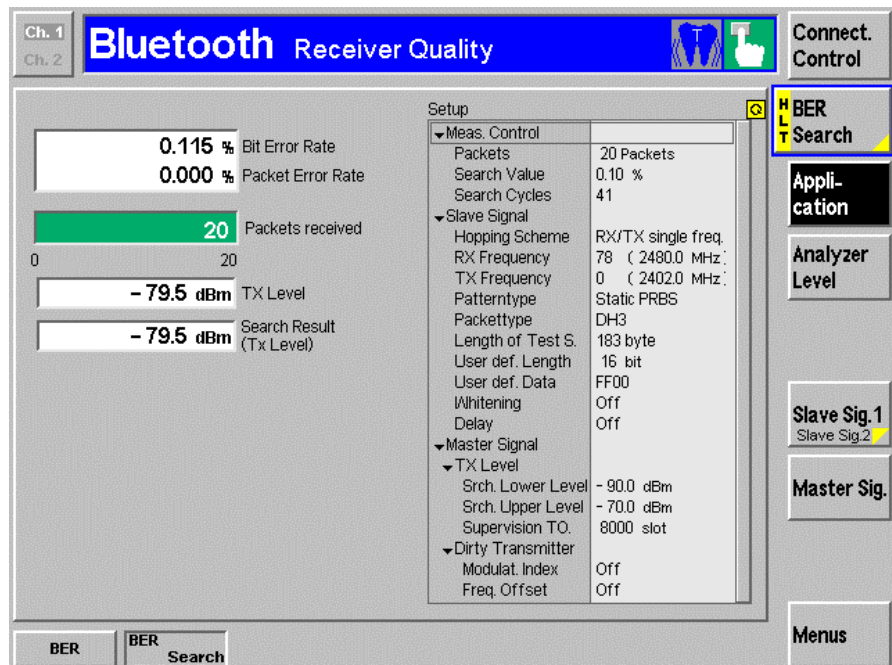


Fig. 48 - BER Search

4 Annex

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References

- [1] Bluetooth Test & Interoperability Working Group: **Test Specification RF 1.1 Revision 0.91**, 07/2001, Bluetooth SIG, Inc.
- [2] Rohde & Schwarz: **Manual for Windows Application CMUgo (V1.00)**, 12/2002, 1136.3971.00
- [3] Rohde & Schwarz: **Operating Manual for Software option K53** (1115.5000.02 Revision 1115.5081.12-06-)

Additional Information

Please send any comments and information regarding this application note to CMUApplication@rsd.rohde-schwarz.com

A file with a Bluetooth example is provided on the Internet.

Ordering Information

Universal Radio Communication Tester

R&S CMU200		1100.0008.02
Option B53	Bluetooth Extension	1100.5700.02
Option K53	Bluetooth test software	1115.5000.02
Option B41 (optional)	Audio generator and analyzer	1100.5300.02



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