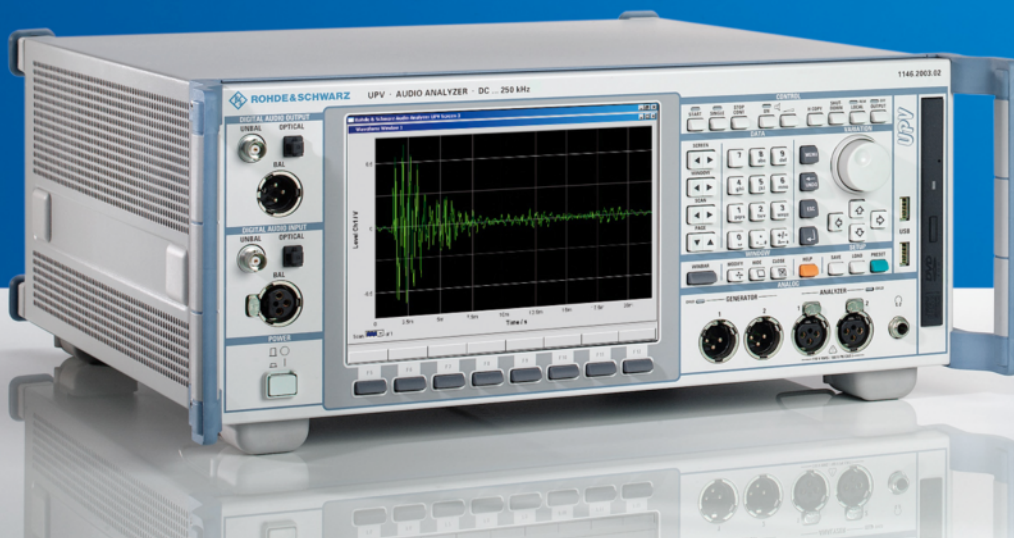


Operating Manual



Mobile Phone Tests for GSM and WCDMA

R&S[®] UPV-K9

1402.0008.02

R&S[®] UPV-K91

1402.0108.02

Version 1.00

Printed in Germany



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1 Overview

The acoustic transmission and reproduction quality of a mobile phone is its most important characteristic in everyday use. Even the most visually appealing design and wonderfully sophisticated operating concept are not much use, when the user cannot or can hardly understand what is being said at the other end.

Instruments and methods for measuring acoustic characteristics are therefore essential tools for assessing the quality and suitability of a mobile phone.

Since a digital audio interface is no longer required even for type-approval tests on 3rd generation mobile phones, it was necessary to develop new test methods that allowed measurements to be performed via the air interface and the normal speech coder and decoder. The test signals have to simulate human voice in the frequency and time domain to be able to test the mobile phone in the normal operating mode with DSP assessment such as voice activity detector (VAD), noise suppression, echo cancellation, etc switched on.

These tests are based on new standards for 3GPP mobile phones. The test methods are stipulated in 3GPP TS 26.132 and the values to be attained in 3GPP TS 26.131.

As of release 4 of the GSM 51.010 standard (successor to GSM 11.10), even GSM mobile phones may be tested to 3GPP TS 26.132.

The R&S UPV-K9 and R&S UPV-K91 options (UMTS/GSM Mobile Phone Tests) of the Audio Analyzer R&S UPV, called herein below "UPV", is now available for measuring the acoustic characteristics of 3GPP and GSM mobile phones. The measurements are in line with 3GPP TS 26.131, TS 26.132 and TS 51.010 and have been validated by an independent test house for type-approval testing on UMTS and GSM mobile phones.

2 Preparation and Start of the Application Software

Required Measuring Instruments and Accessories

The Audio Analyzer R&S UPV with the following options is required for the measurements:

- Base Software for Mobile Phone Tests R&S UPV-K9
- UMTS/GSM Mobile Phone Tests R&S UPV-K91 (version 1.0)

The GSM mobile phone under test is connected via the RF interface using the Universal Digital Radio Communication Tester R&S CMU200, called herein below CMU 200. This tester simulates a base station for the mobile phone so that a call can be set up. For GSM, the CMU200 must be equipped with the options CMU-B21 (signalling unit), CMU-B52 (speech coder/decoder) and the appropriate software options for the GSM band used. For WCDMA, the option CMU-B69 is required. The firmware level in the CMU200 must be 3.50 or higher.

Acoustic devices such as an artificial mouth, artificial ear and other accessories are required for the measurements. The following equipment from Brüel & Kjær or G.R.A.S. is normally used:

Device	Description	Type (examples)
Telephone test head	Device for fixing the DUT in the prescribed position	B&K 4602B
Wideband ear simulator	IEC 711 type occluded ear simulator with adapters for connection to the ear piece of the DUT	B&K 4195 (type 3.2)
Artificial mouth	Special loudspeaker for simulation of the mouth	B&K 4227 or G.R.A.S. 44AB or 44AA (with power amplifier)
Head and torso simulator	Head and torso simulator with artificial ear (type 3.3) and artificial mouth, may be used alternatively to the abovementioned devices	B&K 4128 D
Measurement microphone	½" or ¼" measurement microphone for measurement of artificial mouth output during calibration. This microphone can use the preamplifier of the artificial ear.	B&K4191 (free field, may be used for hands free tests), B&K 4192 (pressure field, may be used with type 1 art. ear)
Acoustic calibrator	Sound level calibrator for calibrating the measuring microphone	B&K 4231
Microphone power supply	Power supply and preamplifier for the measuring microphone	B&K 2829, 5935L or 2690A0S2 or G.R.A.S. 12AD or 12AA

Note: *With the amplifier set to 0 dB, the microphone power supply B&K 2690A0S2 produces too much noise for measuring idle noise and distortion. It is therefore advisable to set a gain of 20 dB.*

A cable with a BNC connector and special small or angled banana plugs is required for connecting the artificial mouth, as the space between the mouth connectors and the test rack (B&K 4602B) is too small for common banana plugs.

The transformer supplied with option R&S UPV-K9 must be connected between generator output 1 of Audio Analyzer R&S UPV and the connector of the artificial mouth. The transformer matches the impedance of the loudspeaker in the artificial mouth to that of the generator output of the R&S UPV. Without this transformer, the available power is too low for driving the artificial mouth.

Alternatively, a power amplifier, preferably with a voltage gain of approx. 0 dB, can be connected between generator output and mouth instead of the transformer. In this case, the gain set must be kept absolutely stable after calibration.

A cable with male (analyzer) and female (generator) XLR connector is supplied for connection to the "Speech" connector of the Digital Radio Communication Tester CMU.

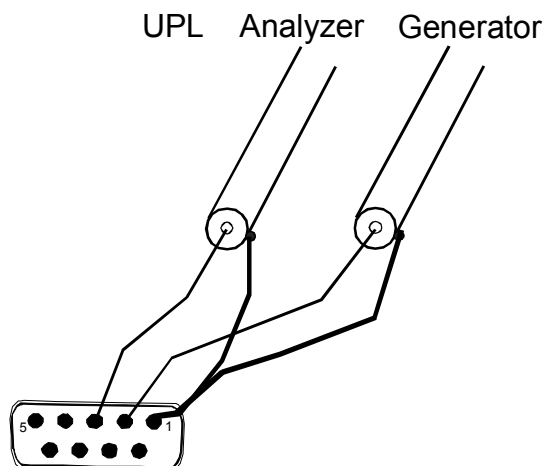


Fig. 1 Assignment of 9-contact speech connector on CMU front panel

This cable is configured for connection to link handler #1 in the CMU. Depending on the CMU hardware, link handler #2 in the CMU can also be used for GSM; in this case, the supplied adapter must be inserted between the cable and the speech connector on the CMU.

Caution: *If the CODEC calibration fails, the adapter has most likely to be inserted.*

The CMU connects pin 1 of the R&S UPV generator output to the equipment grounding conductor of the mains. If an external power amplifier is used, care must be taken that the external power amplifier does not connect R&S UPV generator output pin 2 to the equipment grounding conductor of the mains. If available, a balanced connection to the power amplifier should be preferred.

An external power amplifier should be switched on after the R&S UPV-K9 main program has been started, and switched off before the program is ended. This prevents the artificial mouth

from undue power loading by setups which are loaded external to the application.

An external USB keyboard and a mouse must be connected to the R&S UPV.

Caution: R&S UPV-K9 does not support the use of headphones. Do not connect headphones to the R&S UPV during mobile phone tests. High level signals may be present at the headphone connector.

The program required and the associated files are on an installation CD supplied with the R&S UPV-K91 option. The audio analyzer must meet the following firmware requirements:

- R&S UPV firmware version 1.4.1.210 or higher
- Option R&S UPV-K9 installed
- Option R&S UPV-K91 installed.

Installing the Software

The application program requires option keys K9 and K91 to be installed. The keys are installed in the factory in case a new R&S UPV is ordered together with these options. If the options are ordered separately, the keys are part of the delivery. Please refer to the R&S UPV Operating Manual for details on the installation of option keys.

Copy the files R&S UPV-K91.msi, Setup.Exe and Setup.Ini to a subdirectory on the R&S UPV hard disk (e.g. "D:\R&S Software\K91\Version 1.0") and start "Setup.Exe". Follow the instructions of the installer on the screen.

Test Setup

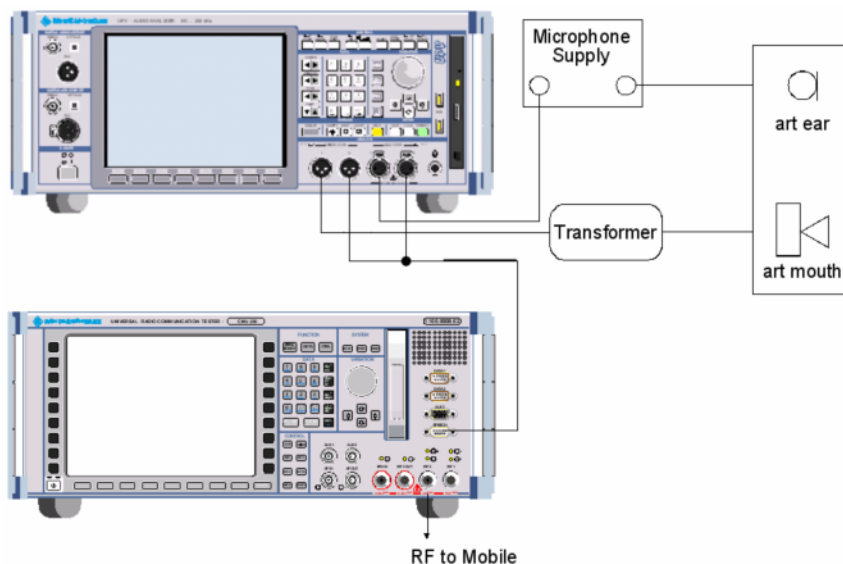


Fig. 2 Test setup and connection of external components

Starting the Application Software

After installation, the program can be started by double-clicking the icon “UPV-K9 Mobile Phone Tests” or by clicking “R&S UPV Applications → UPV-K9 Mobile Phone Tests” in the “Programs” menu.

At the first start of the program, selection windows appear for the standard according to which the measurements should be made, and for the artificial ear and artificial mouth used.

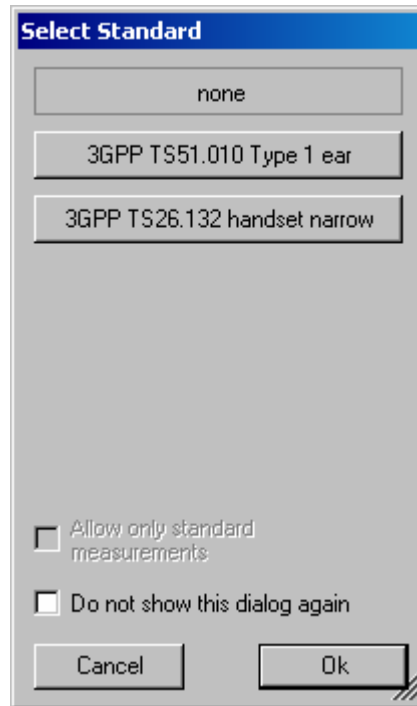


Fig. 3 Query window for selection of applied standard

If “none” is selected in the standard selection window, all measurements appear in the “Measurement” menu. If a standard is selected, all measurements appear in the “Measurement” menu, but compliant measurements are checked in the menu. If “Allow only standard measurements” is checked, non-compliant measurements are suppressed in the Measurement menu.

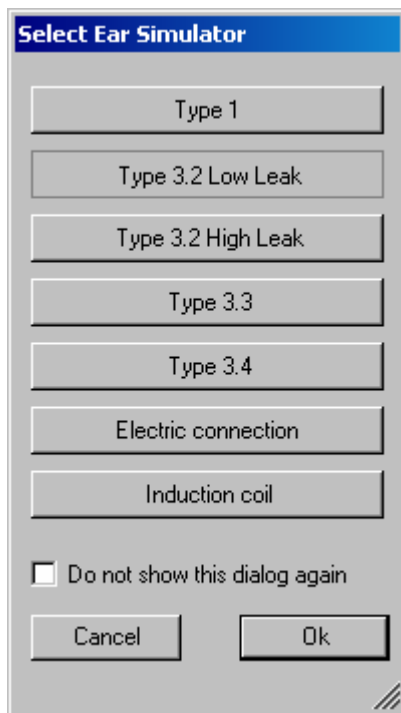


Fig. 4 Query window for selection of artificial ear

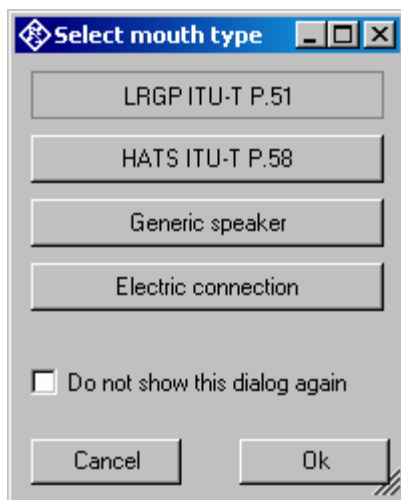


Fig. 5 Query window for selection of artificial mouth

When the checkbox “Do not show this dialog again” is checked, the corresponding selection window will not appear at the program start in future. However, the selection is still available in the “Options” menu (see below). After the last of the three selection windows has been closed, the main window of the R&S UPV-K9 opens.

The screenshot shows the 'Telephone Tests' application window. The title bar includes 'Telephone Tests' and standard window controls. The menu bar contains 'File', 'Data', 'Calibration', 'Measurement', 'Sequence', 'Report', 'Options', and 'Help'. Below the menu bar is a 'Test results overview' section with a table of test results. The table has five columns: 'Date and time', 'Measurement title', 'Test object', 'Verdi', and 'Comment'. The table contains 28 rows of data, with alternating green and white background colors for each row. At the bottom of the window, there are several tabs and buttons. The tabs are '3 GPP HandS Narrow', 'Type 3.2 Low Leak Art.Ear', 'CMU / CRTU', and 'Sample test object'. Below the tabs are buttons for 'Report last measurement', 'Report last sequence', and 'Exit'.

Date and time	Measurement title	Test object	Verdi	Comment
9/8/2006 3:17:26 PM	3GPP Receiving Handset, nom. Vol	Test mobile A	PASS	
9/8/2006 3:18:13 PM	3GPP Idle channel noise receiving, nom. vol.	Test mobile A	PASS	
9/8/2006 3:18:32 PM	3GPP Sidetone Masking Rating	Test mobile A	FAIL	
9/8/2006 3:19:10 PM	3GPP Distortion receiving	Test mobile A	PASS	
9/8/2006 3:20:10 PM	3GPP Sending Handset	Test mobile A	PASS	
9/8/2006 3:20:49 PM	3GPP Distortion sending Rel. 6	Test mobile A	PASS	
9/8/2006 3:21:51 PM	3GPP Idle channel noise sending	Test mobile A	PASS	
9/8/2006 3:22:49 PM	3GPP Receiving Handset, min. Vol.	Test mobile A	PASS	
9/8/2006 3:25:11 PM	3GPP Receiving Handset, max. Vol.	Test mobile A	PASS	
9/8/2006 3:25:42 PM	3GPP Idle channel noise receiving, max. vol.	Test mobile A	PASS	
9/8/2006 3:27:07 PM	3GPP Echo loss with training	Test mobile A	PASS	
9/8/2006 3:28:14 PM	3GPP Stability margin	Test mobile A	PASS	
9/8/2006 4:05:14 PM	3GPP GSM Rel. 4 Receiving Handset, nom. V	Test mobile B	PASS	
9/8/2006 4:16:23 PM	3GPP Sidetone Masking Rating	Test mobile B	PASS	
9/8/2006 4:19:38 PM	3GPP Idle channel noise receiving, nom. vol.	Test mobile B	FAIL	
9/8/2006 4:20:01 PM	3GPP Distortion receiving	Test mobile B	PASS	
9/11/2006 5:42:48 PM	3GPP Receiving Handset, nom. Vol	Sample test object	FAIL	
9/11/2006 5:45:06 PM	3GPP Idle channel noise receiving, nom. vol.	Sample test object	PASS	
9/11/2006 5:47:31 PM	3GPP Receiving Handset, max. Vol.	Sample test object	PASS	
9/11/2006 5:48:03 PM	3GPP Idle channel noise receiving, nom. vol.	Sample test object	PASS	
9/11/2006 5:48:54 PM	3GPP Distortion receiving	Sample test object	PASS	
9/11/2006 5:50:50 PM	3GPP Echo loss with training	Sample test object	PASS	
9/11/2006 5:54:40 PM	3GPP Echo loss with training	Sample test object	PASS	
9/11/2006 5:57:12 PM	3GPP Sidetone Masking Rating	Sample test object	FAIL	
9/11/2006 5:58:39 PM	3GPP Sending Handset	Sample test object	PASS	
9/11/2006 6:00:22 PM	3GPP Distortion sending Rel. 6	Sample test object	PASS	
9/11/2006 6:02:26 PM	3GPP Idle channel noise receiving	Sample test object	PASS	

Fig. 6 Main window

Initially the data grid in the center of the screen which shows the result overview is empty. The screenshot below shows an example after a number of measurements have been made.

3 Operating Concept

R&S mobile phone tests consist of at least two components. R&S UPV-K9 provides the main user interface window, general settings, calibration routines, data handling, automatic sequencing and reporting tools.

Separate options for different standards (R&S UPV-K91 for 3GPP GSM and WCDMA tests) provide test macros for basic measurement types defined in the standards. Each measurement type provides a set of parameters (R&S UPV setup files, limits etc.) which are defined in separated measurement definition files, one for each test case.

Options (General settings)

The “Options” menu in the main window allows to change a set of general settings like ear type and mouth type used which are valid for all or at least a plurality of the tests.

“**Measurement frequency range**” allows to enter the frequency range in which the artificial head is calibrated. In general this will be 100 Hz to 10 kHz which is the default. “Number of points” specifies the number of (logarithmically spaced) frequencies measured for the mouth equalization.

“**Standard**” allows to select one of the available standards. Measurements belonging to this standard will be checked in the measurement menu. If “Allow only standard measurements” is checked, it is not possible to start single measurements which do not belong to the standard.

If “**Select standard at startup**” is checked, the selection window for the standard is opened at each start of the program.

“**Ear simulator**” allows to select the type of ear simulator used. For details on the handling of calibration data see section 4 “Calibration” below.

If “**Select ear simulator at startup**” is checked, the selection window for the ear simulator is opened at each start of the program.

“**Artificial mouth**” allows to select the type of artificial mouth used. For details on the handling of calibration data see section 4 “Calibration” below.

If “**Select artificial mouth at startup**” is checked, the selection window for the artificial mouth is opened at each start of the program.

“**System simulator**” allows to select the type of system simulator used. For details on the handling of calibration data see section 4 “Calibration” below.

If “**Select system simulator at startup**” is checked, the selection window for the system simulator is opened at each start of the program.

If “**Show operator instructions**” is checked, instructions to the operator are displayed in a window before the measurement starts. The operator may be prompted to position the mobile in a defined way or to set the volume to a certain setting.

“**Report settings**” allows to define the type of information which should appear in the reports. For details on reporting, see section 8 below.

If “**Generate temporary export files**” is checked, each measurement macro created “result.exp” with result value and verdict, and, if applicable, “abscurve.exp” and “relcurve.exp” files with curve data in ASCII format.

4 Calibration

Calibration Devices

R&S UPV-K9 allows to simultaneously store calibration values for multiple individuals of the same type. This allows to switch devices without the requirement for re-calibration. However, regular re-calibration is recommended in order to assure the correct function of the used devices.

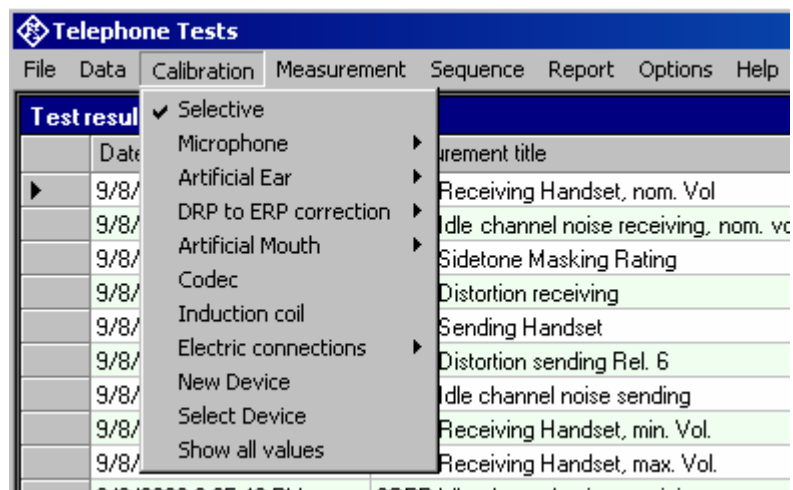


Fig. 7 Calibration menu

For every device to be calibrated, an entry must be created using “Calibration → New device” in the main menu. This menu item opens an entry window to specify the calibrated device. A category of device must be chosen from the combo box on top. Type, manufacturer and serial number are entered into the text boxes below. The entries are confirmed by clicking on the “Save and close” button.



Fig. 8 Input window for information about calibrated device

Before a device can be calibrated or used, it must be selected with “Calibration → Select device” in the main menu. Clicking on this item opens a window with a table of all entered devices.

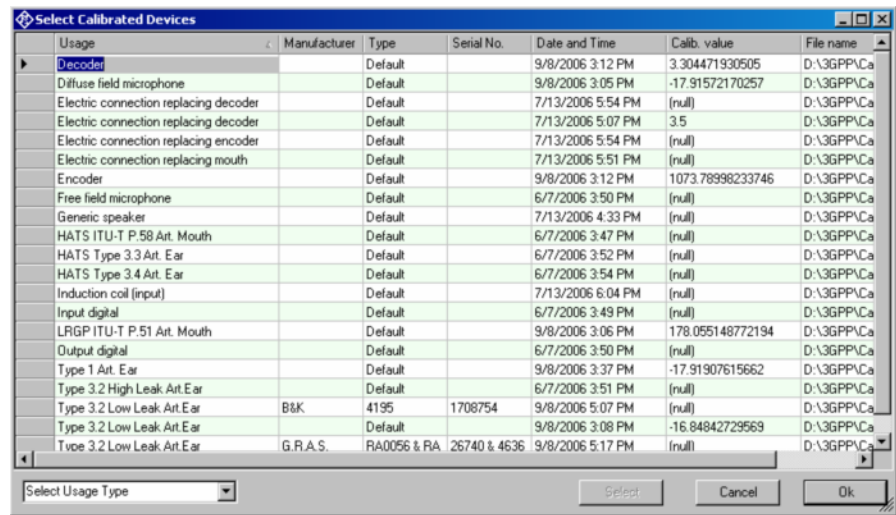


Fig. 9 Window for selection of calibrated devices

In the combo box lower left, a category of devices must be selected. Subsequently the table is reduced to available devices in this category. At first startup, there is only a “Default” device for each category, but when more devices have been created with the “New device” function, a choice will be available in this view. In this state a row in the table can be marked with a mouse click on its left end. A mouse click on the button “Select” selects this device for the associated usage.

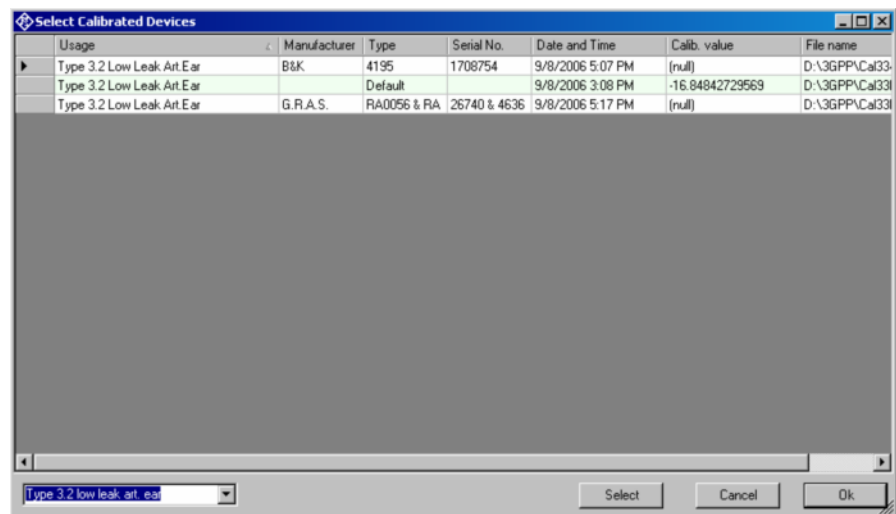


Fig. 10 Selection window for particular device type

Subsequently this procedure may be repeated for other categories. Finally all selections are confirmed by clicking the “Ok” button.

All calibration data are stored on the R&S UPV hard disk and are therefore automatically available again after every restart. The calibration values for the R&S UPV-K9 option are stored independently of other options.

All calibration routines below require as pre-requisite that a device for the respective usage has been generated and selected.

To simplify the procedure for the case that it is not intended to use multiple devices of the same category nor to include information about the used devices into a report, there is a “Default” device selected for each device type or category after the first start of the program.

Microphone Calibration

- **Insert the measuring microphone fully into the adapter of the sound level calibrator and switch on the calibrator.**

Note: After inserting the microphone, wait about 10 s to allow for static pressure equalization.

- **Call the test routine with “Calibration → Microphone → Free field” or “Calibration → Microphone → Diffuse field” from the main menu, depending on the microphone.**

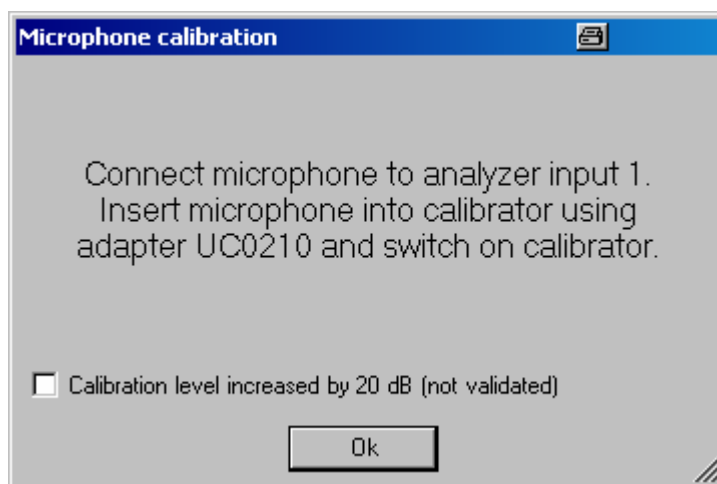


Fig. 11 Initial window of microphone calibration

For calibrators providing a sound pressure level of 114 dB (10 Pa), the checkbox “Calibration level increased by 20 dB” must be checked. In all other cases the checkbox must remain unchecked!

The output voltage of the microphone is measured and the sensitivity displayed with reference to 1 Pa. If a mere power supply without gain is used, the displayed sensitivity must approximately match the value in the calibration certificate of the microphone capsule (typical value for microphone capsule 4134 of artificial ear 4185 is approx. 12 mV/Pa, display = 120 mV/Pa). If a conditioning amplifier with 20 dB gain (recommended value) is used, the displayed sensitivity must be about 10 times higher. If the voltage measured is below 3 mV, an error message is displayed. Possible error sources are, for example, a switched-off microphone power supply or a disabled calibrator. In this case, the program requests that the test be repeated. After switching on the microphone power supply, wait approx. 20 s before restarting the measurement with RUN.

Calibration of Artificial Ear

Prior to the measurements, the absolute sensitivity of the microphone in the artificial ear must be determined using a sound level calibrator such as the Brüel & Kjær 4231 with a sound pressure level of 94 dBSPL or a sound pressure of 1 Pa at 1 kHz.

Calibration of Ear Type 1

- **Switch off the microphone power supply.**

Note: *The 200 V polarization voltage of the microphone may cause a slight electric shock. The current is harmless, but the microphone preamplifier may be damaged.*

- **Remove the microphone from the artificial ear.**
- **Screw back the microphone capsule and switch on the operating voltage.**
- **Insert the microphone fully into the adapter of the sound level calibrator and switch on the calibrator.**

Note: *After inserting the microphone wait about 10 s to allow for static pressure compensation.*

- **Select “Calibration → Artificial ear → Type 1” from the main menu.**

For calibrators providing a sound pressure level of 114 dB (10 Pa), the checkbox “Calibration level increased by 20 dB” must be checked. In all other cases the checkbox must remain unchecked!

The output voltage of the microphone is measured and the sensitivity displayed with reference to 1 Pa. If a mere power supply without gain is used, the displayed sensitivity must approximately match the value in the calibration certificate of the microphone capsule (typical value for microphone capsule 4134 of artificial ear 4185 is approx. 12 mV/Pa, display = 120 mV/Pa). If a conditioning amplifier with 20 dB gain (recommended value) is used, the displayed sensitivity must be about 10 times higher. If the voltage measured is below 3 mV or fluctuating by more than 0.2 dB, an error message is displayed. Possible error sources are, for example, a switched-off microphone power supply or a disabled calibrator. In this case, the program requests that the test be repeated. After switching on the microphone power supply, wait approx. 20 s before restarting the measurement.

The reference value measured is stored in a file on the hard disk and used for all subsequent measurements when the same artificial ear type 1 is used as currently selected.

Calibration of Ear Type 3.2 Low Leakage

- **Connect the sound level calibrator tightly to the artificial ear using the adapter DP0939 and switch on the calibrator.**
- **Select “Calibration → Artificial ear → Type 3.2 Low Leak” from the main menu.**

For calibrators providing a sound pressure level of 114 dB (10 Pa), the checkbox “Calibration level increased by 20 dB” must be checked. In all other cases the checkbox must remain unchecked!

The output voltage of the microphone in the ear is measured and the sensitivity displayed with reference to 1 Pa. If the voltage measured is below 3 mV or fluctuating by more than 0.2 dB, an error message is displayed. Possible error sources are, for example, a switched-off microphone power supply or a disabled calibrator. In this case, the program requests that the test be repeated. After switching on the microphone power supply, wait approx. 20 s before restarting the measurement.

The measured reference value is stored in a file on the hard disk and used for all subsequent measurements when the same ear type 3.2L is used as currently selected.

Reading the Calibration Data of the Artificial Ear of Type 3.2L:

The frequency response of the artificial ear of type 3.2L is supplied on a floppy together with the artificial ear. The data is used for transforming the measurement values from the drum reference point to the ear reference point.

- Connect a USB floppy disk drive with the calibration disk to the R&S UPV, copy the file “OES_LL.ADA” from the manufacturer’s calibration disk to a USB stick or a CD-ROM or make this file available on a network drive via LAN.
- Call the routine “Calibration → DRP to ERP Correction → Type 3.2 Low leak”. Browse to the file “OES_LL.ADA” and click “Open”.

The calibration file is read. The modified data is stored on the R&S UPV hard disk. This procedure needs only be repeated after a change of the calibration data, e.g. after a recalibration of the ear by the manufacturer, or when the “3GPP” directory has been renamed or removed.

Calibration of Ear Type 3.2 High Leakage

- **Connect the sound level calibrator tightly to the artificial ear using the adapter DP0939 and switch on the calibrator.**
- **Select “Calibration → Artificial ear → Type 3.2 High Leak” from the main menu.**

For calibrators providing a sound pressure level of 114 dB (10 Pa), the checkbox “Calibration level increased by 20 dB” must be checked. In all other cases the checkbox must remain unchecked!

The output voltage of the microphone in the ear is measured and the sensitivity displayed with reference to 1 Pa. If the voltage measured is below 3 mV or fluctuating by more than 0.2 dB, an error message is displayed. Possible error sources are, for example, a switched-off

microphone power supply or a disabled calibrator. In this case, the program requests that the test be repeated. After switching on the microphone power supply, wait approx. 20 s before restarting the measurement.

The measured reference value is stored in a file on the hard disk and used for all subsequent measurements when the same ear type 3.2H is used as currently selected.

Reading the Calibration Data of the Artificial Ear of Type 3.2H:

The frequency response of the artificial ear of type 3.2H is supplied on a floppy together with the artificial ear. The data is used for transforming the measurement values from the drum reference point to the ear reference point.

- Connect a USB floppy disk drive with the calibration disk to the R&S UPV, copy the file "OES_HL.ADA" from the manufacturer's calibration disk to a USB stick or a CD-ROM or make this file available on a network drive via LAN.
- Call the routine "Calibration → DRP to ERP Correction → Type 3.2 High leak". Browse to the file "OES_HL.ADA" and click "Open".

The calibration file is read. The modified data is stored on the R&S UPV hard disk. This procedure needs only be repeated after a change of the calibration data, e.g. after a recalibration of the ear by the manufacturer, or when the "3GPP" directory has been renamed or removed.

Calibration of Ear Type 3.3

- **Connect the sound level calibrator tightly to the artificial ear using the adapter UA-1546 and switch the calibrator on.**
- **Select "Calibration → Artificial ear → HATS Type 3.3" from the main menu.**

For calibrators providing a sound pressure level of 114 dB (10 Pa), the checkbox "Calibration level increased by 20 dB" must be checked. In all other cases the checkbox must remain unchecked!

The output voltage of the microphone in the ear is measured and the sensitivity displayed with reference to 1 Pa. If the voltage measured is below 3 mV or fluctuating by more than 0.2 dB, an error message is displayed. Possible error sources are, for example, a switched-off microphone power supply or a disabled calibrator. In this case, the program requests that the test be repeated. After switching on the microphone power supply, wait approx. 20 s before restarting the measurement.

The measured reference value is stored in a file on the hard disk and used for all subsequent measurements when the same ear type 3.2L is used as currently selected.

Reading the Calibration Data of the Artificial Ear of Type 3.3:

Call the routine “Calibration → DRP to ERP Correction → Type 3.3 → From ITU-T P.57 Table 2b”. This procedure needs only be repeated when the “3GPP” directory has been renamed or removed.

Calibration of Ear Type 3.4

- **Remove the pinna and the ear canal simulator, connect the sound level calibrator tightly to the artificial ear using the short steel adapter and switch the calibrator on.**
- **Select “Calibration → Artificial ear → HATS Type 3.4” from the main menu.**

For calibrators providing a sound pressure level of 114 dB (10 Pa), the checkbox “Calibration level increased by 20 dB” must be checked. In all other cases the checkbox must remain unchecked!

The output voltage of the microphone in the ear is measured and the sensitivity displayed with reference to 1 Pa. If the voltage measured is below 3 mV or fluctuating by more than 0.2 dB, an error message is displayed. Possible error sources are, for example, a switched-off microphone power supply or a disabled calibrator. In this case, the program requests that the test be repeated. After switching on the microphone power supply, wait approx. 20 s before restarting the measurement.

The measured reference value is stored in a file on the hard disk and used for all subsequent measurements when the same ear type 3.2L is used as currently selected.

Reading the Calibration Data of the Artificial Ear of Type 3.4:

Call the routine “Calibration → DRP to ERP Correction → Type 3.4 → From ITU-T P.57 Table 2b”. This procedure needs only be repeated when the “3GPP” directory has been renamed or removed.

Calibration of Artificial Mouth

Before a mobile phone can be tested, the absolute sensitivity and frequency response of the artificial mouth have to be measured and corrected with the aid of a previously calibrated pressure-field microphone. The measuring microphone removed from artificial ear type 1 can be used for this purpose or an additional microphone capsule is screwed to the microphone preamplifier. The standard microphone is used as a reference for determining the frequency response of the mouth. The frequency response of the microphone can be ignored in the test frequency range (100 Hz to 8 kHz) (see also calibration certificate of microphone capsule).

Since interfering sound falsifies the corrections, the artificial mouth must be calibrated in the sound-proof test chamber.

First of all, the measuring microphone has to be calibrated.

- **Select a reference microphone type with “Calibration → Artificial mouth → Select reference mic”.**

For the selected microphone type, a device must be selected and calibrated (see above). This device must be connected to R&S UPV analyzer input 1 via power supply/conditioning amplifier.

If the selected reference microphone is a diffuse field type (e.g. B&K 4131 or 4134) or a microphone from a Type1 artificial ear, fit the microphone at right angles to the mouth at the mouth reference point (MRP) using the gauge supplied with the mouth (positioning at right angles is necessary because diffuse field or pressure-calibrated microphones have a flat frequency response to sound from random incident direction and therefore exhibit an emphasis on high frequencies with frontal sound incidence).

If the selected microphone is a free field microphone, it must be mounted in the axis of the sound outlet of the artificial mouth.

- **Call the calibration routine with “Calibration → Artificial mouth → LRGP ITU-T P.51” or “Calibration → Artificial mouth → HATS ITU-T P.58” from the main menu.**

The sound pressure generated at the MRP is set to exactly -4.7 dBPa in an automatic measurement routine at 1 kHz. The generator voltage required is stored in a file on the hard disk and used as a reference for all subsequent settings with the same artificial mouth. If the sound pressure cannot be adjusted to -4.7 dBPa, an error message is displayed with a request to check the connection of the artificial mouth and to repeat the measurement. A possible error source would be that the transformer supplied is not connected between the generator and the artificial mouth.

The uncorrected frequency response of the artificial mouth is measured and displayed. Next, the frequency response is measured with the inverse frequency response correction automatically selected in the generator (equalization). Residual errors caused by nonlinearities of the speaker in the mouth are measured and taken into account in the final equalization file as fine correction.

To verify the results, the absolute sound pressure versus frequency is measured at a sound pressure of 4.7 dBPa (reference value for most of the measurements). The absolute sound pressure at each frequency must be within a tolerance band of ± 0.2 dB. Correct calibration without interfering sound yields an almost straight line in the middle between the two limit lines.

Calibration of CMU Speech Coder

The calibration of the speech coder and decoder is necessary to be able to calculate absolute loudness. Calibration has to be performed only once and must be repeated only if the CMU used is replaced. If the CMU is equipped with model 14 of the Link Handler CMU-B21, GSM as well as WCDMA use the same paths. Calibration of the coder is therefore identical for both operating modes and need not be repeated when switching from GSM to WCDMA or vice versa.

If GSM / WCDMA and cdma2000® tests are done alternately, separate calibration devices have to be generated for the two link handlers (i.e. with and without the supplied adapter).

Note that encoder and decoder are handled as separate devices but calibrated with one routine.

Auxiliary settings required for calibration can be found in the CMU under Bit Stream (for GSM) and under BS Signal, Dedicated Channel, Voice settings (for WCDMA) (firmware version 3.50 or higher). Call the calibration routines with “Calibration → Codec” from the main menu.

The following information is displayed:

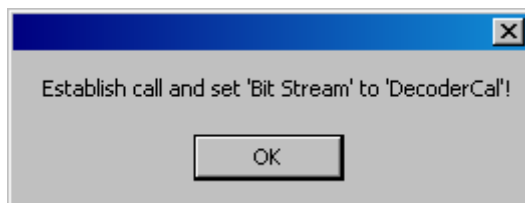


Fig. 12 Message box during decoder calibration

Set up a call to the mobile phone. Set bit stream or voice setting on the CMU to "Decoder Cal" and then click the “OK” button.

The actual voltage at the decoder output of the CMU is now measured for a digital full-scale signal and the required correction value is calculated and saved in the R&S UPV. The following request is then displayed:

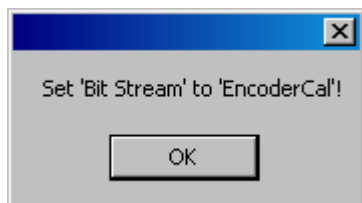


Fig. 13 Message box during encoder calibration

After the “OK” button has been clicked, the input sensitivity of the speech coder is measured and the input voltage required for digital full scale is measured at the speech coder and saved in the R&S UPV

5 Data Entry for Reporting

Operator

Under “Data→Operator” an operator’s name can be entered which is stored in association with all calibration and measurement results. If “Operator” is activated in the report settings, the name will appear in all reports about these measurements.

Test object

Under “Data → Test object → New” a description of the device under test can be entered.

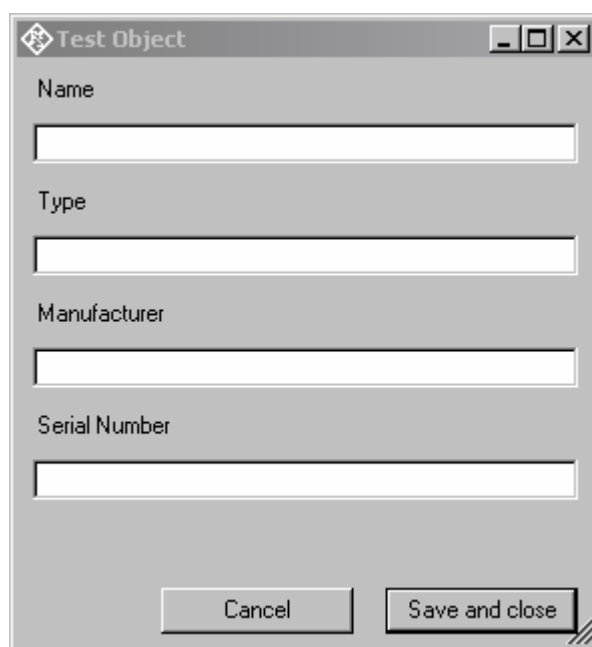
The image shows a software dialog box titled "Test Object". It has a standard window title bar with a diamond-shaped icon on the left and minimize, maximize, and close buttons on the right. The dialog contains four text input fields, each with a label above it: "Name", "Type", "Manufacturer", and "Serial Number". At the bottom of the dialog, there are two buttons: "Cancel" on the left and "Save and close" on the right. The dialog box is set against a light gray background.

Fig. 14 Window for input of information about a test object

With “Data → Test object → Select” one of the entered test objects can be selected. The data of this selected test object will be stored in association with all measurements and appear on the associated reports if “DUT information” is activated in the report settings.

6 Measurements

General

Special problems caused by the coding and decoding algorithms of mobile phones are encountered when measuring acoustic characteristics. Vocoders are used to attain the lowest possible data rate. Mobile phone voice codecs are optimized for transmitting human speech with low data rate. Not the actual voice signals but only the filter and fundamental parameters required for signal reconstruction are transmitted.

Purely sinusoidal tones normally used for audio measurements cannot be transmitted with such a system. Therefore, the coder and decoder had initially been excluded from the measurement, which required a specially prepared test mobile phone with a specific test interface.

In commercially available mobile phones, this interface is not accessible; measurements during normal operation can therefore only be performed via the air interface with the speech coder and decoder included. With 3rd generation mobile phones a digital audio interface is no longer provided even for type-approval testing. As mentioned above, measurements using sinusoidal tones cannot be performed because the static sinusoidal input signal becomes a more or less stochastic output signal as a result of coding, particularly in the medium and high audio frequency ranges.

Signals similar to voice therefore have to be used for the measurement, i.e. either artificial voice according to ITU-T P.50 or a multitone signal according to ITU-T P.501 is possible. At the same time, modulation of the signal in time must largely correspond to voice, since many modern mobile phones use algorithms for interference suppression which use the modulation to distinguish the useful from the interfering signal.

The test routines in the R&S UPV-K91 use an amplitude-modulated multitone signal according to ITU-T P.501 as described in 3GPP TS 26.132 for echo loss measurement.

Functionality and control of the measurement macros



Fig. 15 Example of a measurement window

When a measurement macro is started, e.g. from the “Measurement” menu, the standardized measurement is immediately executed. With a single measurement, the window of the measurement macro stays open after the measurement is terminated. At that time, the following functionality is available:

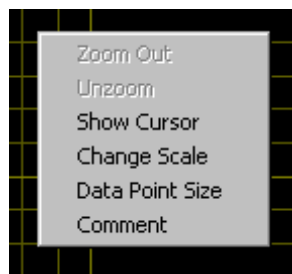


Fig. 16 Context menu of the graph window

Zooming

When the “Shift” key on the keyboard is pressed, the mouse cursor changes to the zoom cursor. When the left mouse button is pressed, a rectangle can be marked in the graph. As soon as the left mouse button is released, the graph is zoomed into the area of the marked rectangle

“Zoom Out” in the graph context menu reverses the last zooming step. “Unzoom” zooms completely out to the original scaling.

Changing the Scale of the Graph

“Change Scale” in the context menu opens a window in which the upper and lower bounds of both axes can be entered by numbers.

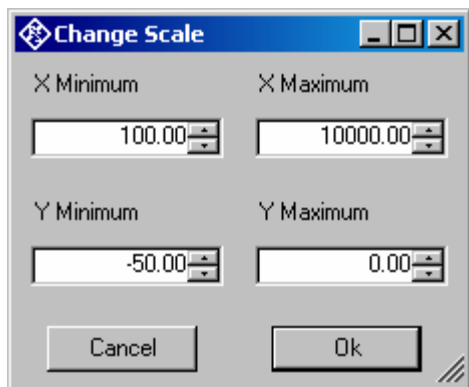


Fig. 17 Window for changing the scale of the graph

Cursor

When the item “Show Cursor” is marked in the graph context menu, a cursor is displayed which can be dragged along the graph with the mouse. X and Y values of the data points below the cursor are displayed.

Data Point Size

“Data Point Size” in the graph context menu opens a window in which the size of marks at the measured data points can be specified. Moving the mouse cursor over one of the marks causes the associated X and Y values to be displayed.

Making Additional Measurements

The softkey “Add Measurement” triggers another measurement according to the specification of the test. Loudness ratings and noise values are calculated and displayed in the legend. However, limits are not checked, and the report shows only the original results.

This function can e.g. be used to find the correct volume setting to pass nominal RLR. It can further be used for adjustments in the device under test.

Storing and Loading Curves

All curves in the graph can be stored to an ASCII file, and such curves can be loaded back into the graph. The softkey “Store Curve” opens a window in which a combo box offers choice between the legends of all curves in the graph. The curve associated in which the selected entry is stored to the file at the specified location.

Storing Curves as Limit Curves

With “Store As Limit Curve” a curve can be selected and stored into a R&S UPV format limit file with a specified shift in Y axis direction. This functionality can be used to generate limit curves from “golden” devices for evaluation purpose.

Entering a Comment

With the softkey “Enter Comment” or the item “Comment” in the graph context menu, a comment can be entered and edited which will appear in the report about the respective measurement.

Creating a Report

The softkey “Create Report” causes a report to be prepared. The report preview window (see below) opens and shows the preview of the report. Buttons in the preview window allow to print the report or to export it to PDF, WORD, EXCEL or Rich Text format.

Closing the Measurement Window

The softkey “Close” closes the measurement window. The control is returned to the R&S UPV-K9 main window. All relevant data associated with the measurement is imported to the results data. A new entry appears for the measurement as new row on the bottom of the overview data grid in the main window.

Notes on Individual Measurements

Sending Frequency Response and Loudness Rating

(“3GPP Sending Handset”)

Sending Frequency Response

The sending frequency response is specified as the transmission ratio in dB of the voltage at the decoder output to the input noise pressure at the artificial mouth.

The mobile phone under test is installed in the LRGP (loudness rating guard-ring position) according to ITU-T P.76, and the receiver is sealed to the artificial ear.

Tones with a sound pressure of -4.7 dBPa are created with the artificial mouth at the MRP (mouth reference point), and the corresponding output voltage is measured at the CMU speech decoder output and evaluated.

The sending frequency response must be within the limit lines specified according to table 1 of 3GPP TS 26.131. The absolute sensitivity is not yet taken into account.

Table 1 Limit lines according to table 1 of 3GPP TS 26.131

Frequency (Hz)	Upper limit (dB)	Lower limit (dB)
100	-12	
200	0	
300	0	-12
1000	0	-6
2000	4	-6
3000	4	-6
3400	4	-9
4000	0	

The offset of the measured frequency response to the upper or lower limit line is calculated and then the whole limit template is shifted to be centered with respect to the measured curve. Then another limit check is performed. If the shifted curve is now within the limit lines, PASS is output, otherwise FAIL is displayed. The limit check is performed at each measured frequency. If the measured value and the end point of a limit line are not at the same frequency, it may happen that the trace slightly crosses a corner of the limit line although there are no limit violations. The remaining margin is displayed. A negative margin shows the amount of limit violation.

Sending Loudness Rating

The sending loudness rating (SLR) takes into account the absolute loudness in the transmit direction and weights the tones in compliance with the normal sensitivity of the average human ear.

To this end, the frequencies (Hz) of bands 4 to 17 are evaluated according to table 1 of ITU-T P.79.

Table 2 Frequencies (Hz) of bands 4 to 17 according to table 1 of ITU-T P.79

200	1000
250	1250
315	1600
400	2000
500	2500
630	3150
800	4000

The sensitivity at each frequency is defined as the ratio dBV/Pa referenced to the rated internal level in dBm0, and the sending loudness rating is calculated according to formula 5-1 of ITU-T P.79. Note that loudness rating values are loss values, i.e. a high loudness rating values indicates a low gain and a low loudness rating value indicates a high gain.

Due to the input sensitivity tolerance of the CMU speech coder, the individual sensitivity of the CMU used has to be taken into account in order to calculate the sending loudness rating (see calibration routines). According to 3GPP TS 26.131, the sending loudness rating should be between 5 dB and 11 dB, with lower dB values corresponding to greater loudness (5 dB = maximum loudness, 11 dB = minimum loudness). The measured SLR is indicated in a window in the frequency response display and checked for compliance with these limits. In addition to the numeric value, either PASS or FAIL is displayed.

The general PASS or FAIL information is obtained from the limit check of the frequency response curve and the loudness rating. PASS is output only if both the curve and the loudness value are within tolerances.



Fig. 18 Sending frequency response with SLR value displayed

Receiving Frequency Response and Loudness Rating

(“3GPP Receiving Handset, nom. Vol.”, “3GPP Receiving Handset, max, “Vol.” 3GPP Receiving Handset, min. Vol.”)

The following three measurement definitions are available, as the permissible limit values of the loudness rating depend on the volume set in the mobile phone under test: “3GPP Receiving Handset, nom. Vol” checks loudness rating limits for nominal loudness setting and at the same time compliance with the frequency response limit template. “3GPP Receiving Handset, max. Vol.” checks the receiving loudness rating at the highest volume setting against a minimum. “3GPP Receiving Handset, min. Vol.” checks the receiving loudness rating at the lowest volume setting against a maximum. *(Note: As the loudness rating is a loss value, a high RLR is associated with a soft speech signal and a low RLR is associated with a loud speech signal).*

Receiving Frequency Response

The receiving frequency response is specified as the transmission ratio in dB of the sound pressure in the artificial ear to the input voltage at the speech coder input of the CMU. The measured sound pressure is referenced to the ear reference point (ERP). For ear type 1, the measuring microphone is directly applied to the ERP and no further correction is required. For ear types 3.x, the measuring microphone is applied to the drum reference point (DRP), which is the reason why any measured value has to be converted to the ERP by means of calibration factors. According to 3GPP TS 26.132, the measurement may be referenced to the drum reference point (DRP) even in special cases. For this purpose there are separate measurements supplied with R&S UPV-K91.

The mobile phone under test is installed in the LRGP (ITU-T P.76) or on the HATS. In case of ear type 1, the receiver is sealed to knife edge of the

artificial ear. In case of ear type 3.2, the receiver is sealed to the rubber gasket of the artificial ear. If the low leak version of this ear type is used, care must be taken that the defined leak opening at the circumference of the artificial ear is not accidentally covered.

The speech coder is driven such that tones with a system reference level of -16 dBm0 are obtained. The sound pressure in the artificial ear is measured and evaluated.

Ear type 1 will no longer be used for measurements on 3GPP mobile phones. Therefore, 3GPP TS 26.131 defines limit values only for ear types 3.x, whereas the limit values specified in 3GPP TS 51.010 (previously GSM 11.10) are still valid for ear type 1.

Table 3 Limit lines according to table 30.2 of 3GPP TS 51.010 (ear type 1)

Frequency (Hz)	Upper limit (dB)	Lower limit (dB)
100	-12	
200	0	
300	2	-7
500	*	-5
1000	0	-5
3000	2	-5
3400	2	-10
4000	2	

* Intermediate values are obtained by drawing a straight line between the specified values and using a logarithmic frequency scale and a linear dB scale.

Use tests “3GPP GSM Rel. 4 Receiving Handset, nom. Vol”, “3GPP GSM Rel. 4 Receiving Handset, max. Vol”, “3GPP GSM Rel. 4 Receiving Handset, min. Vol” for receiving tests with type 1 artificial ear.

When ear type 1 is used, the receiving frequency response must be within the limit lines specified in table 30.2 of 3GPP TS 51.010. When ear type 3.x is used, it must be within the limit lines specified in table 2 of 3GPP TS 26.131. In the frequency response curve, the limit template is shifted to be centred with respect to the displayed absolute sensitivity.

Table 4 Limit lines according to table 2 of 3GPP TS 26.131 (ear type 3.x)

Frequency (Hz)	Upper limit (dB)	Lower limit (dB)
70	-12	
200	2	
300	*	-9
500	*	*
1000	*	-7
3000	*	*
3400	*	-12
4000	2	

* Intermediate values are obtained by drawing a straight line between the specified values and using a logarithmic frequency scale and a linear dB scale.

The margins of the measured frequency response to the upper and lower limit lines are calculated separately, and then the whole template is shifted such that the resulting margins to upper and lower limit are equal. Then another limit check is performed. If the shifted curve is now within the limit lines, PASS is output, otherwise FAIL is displayed. The limit check is performed at each measured frequency. If the measured value and the end point of a limit line are not at the same frequency, it may happen that the trace slightly crosses a corner of the limit line although there are no limit violations. The remaining margin is displayed. A negative margin shows the amount of limit violation.

Receiving Loudness Rating

The receiving loudness rating (RLR) takes into account the absolute loudness in the receive direction and weights the tones in compliance with the difference between an average speech spectrum and the normal threshold of hearing in quiet of the average human ear.

To this end, the frequencies (Hz) of bands 4 to 17 are evaluated according to table 1 of ITU-T P.79.

Table 5 Frequencies (Hz) of bands 4 to 17 according to table 1 of ITU-T P.79

200	1000
250	1250
315	1600
400	2000
500	2500
630	3150
800	4000

The sensitivity at each frequency is specified as the ratio dBPa/V referenced to the rated internal level, and the receiving loudness rating is calculated according to formula 5-1 of ITU-T P.79.

Due to the input sensitivity tolerance of the CMU speech decoder, the individual sensitivity of the CMU used has to be taken into account in order to calculate the receiving loudness rating (see section "Calibration" above).

The receiving loudness rating depends on the receiving loudness set on the mobile phone under test and, according to 3GPP TS 26.131, should be between -1 dB and +5 dB at a rated loudness setting, with lower dB values corresponding to a higher loudness.

The RLR must not fall below -13 dB when maximum loudness is set on the mobile phone. To prevent damage to the human ear, the maximum receiving loudness must not exceed a certain value.

The measured RLR is indicated in a window in the frequency response display and checked for compliance with these limits. In addition to the numeric value, either PASS or FAIL is displayed.

With “3GPP Receiving Handset, nom. Vol”, the general PASS or FAIL information is obtained from the limit check of the frequency response curve and the loudness rating. PASS is output only if both the curve and the loudness value are within tolerances.

“3GPP Receiving Handset, max. Vol” checks only the RLR against a minimum of -13 dB. The frequency response curve is shown for information only.

“3GPP Receiving Handset, min. Vol” checks the RLR against a maximum of +18 dB.

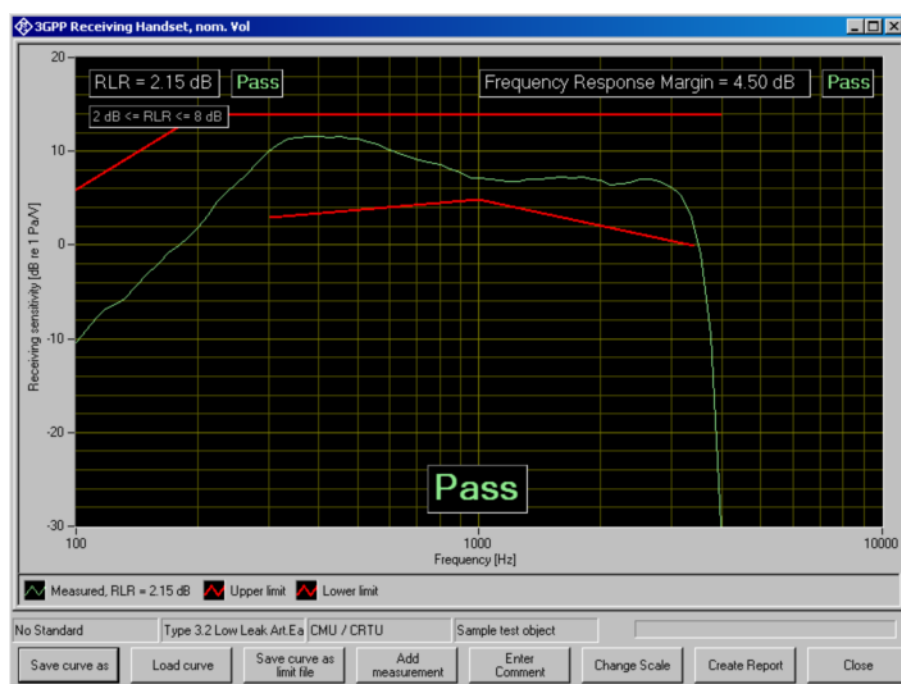


Fig. 19 Receiving frequency response with RLR value displayed

Sidetone Masking Rating (STMR)

(“3GPP Sidetone masking rating”)

The sidetone path is the deliberate output of a part of the signal picked up by the microphone to the phone’s receiver. This is to create a natural hearing impression for the person speaking on the phone as is encountered under normal conditions involving an acoustic path between mouth and ear.

The mobile phone under test is installed in the LRGP (ITU-T P.76), and the receiver is sealed to the artificial ear.

The STMR can only be measured according to standard using ear type 3.2 (low leakage) (“3GPP Sidetone masking rating”) or ear type 1 (3GPP TS 51.010 only) (“3GPP GSM Rel. 4 Sidetone Masking Rating”). Measurements with other ear types can be performed for comparison.

The artificial mouth generates tones with a sound pressure of -4.7 dBPa at the MRP (mouth reference point), and the sound pressure is measured in the artificial ear.

The attenuation of the sidetone path is determined at each frequency according to table 1 of ITU-T P.79, and the sidetone masking rating (STMR) is calculated according to formula 5-1 of ITU-T P.79 with the weighting factors of table 3 of ITU-T P.79 taken into account. In addition, the gain of the sidetone path is displayed as a curve.

When the phone is set to rated receiving loudness, the STMR should be within 13 dB and 23 dB according to 3GPP TS 26.131.



Fig. 20 Typical measurement of sidetone masking rating

Echo Loss (TCLw)

(“3GPP Echo loss with training”)

The echo loss is the attenuation between the speech coder input and the speech decoder output (gain of speech coder + decoder = 1). Normally the echo loss is caused by internal acoustic coupling between the telephone receiver and the microphone. Since the echo considerably reduces the sound transmission quality, it must not exceed a certain value.

The mobile phone under test is suspended in free air in the anechoic test chamber (previous specifications used the LRGP).

A modulated multitone signal according to ITU-T P.501 is generated as a test signal and applied to the speech coder. First, the spectral energy distribution of the generated signal is measured in the third-octave bands from 200 Hz to 4 kHz. Then, the spectral distribution in the output signal of the speech decoder is measured. The echo loss is calculated from the differences of the bands according to ITU-T G.122. According to 3GPP TS26.132, the mobile phone under test has to be fed for approx. 10 s with the male and female version of artificial voice according to ITU-T P.50 prior to this measurement. This training sequence is to facilitate optimization for potential echo cancellers. A quicker test without training sequence is available as “3GPP Echo loss without training”.

The actual gain of the speech coder and decoder must also be considered in the result. This value is available in the CMU after calibration of the coder. In addition, the attenuation of the echo path is displayed as a curve.

3GPP TS 26.131 specifies an echo loss of at least 46 dB; mobile phones with good echo cancellers can meet this requirement. Since the microphone of the mobile phone under test also picks up any side noise and treats it like an echo, it is essential that the test chamber is well shielded against external noise.

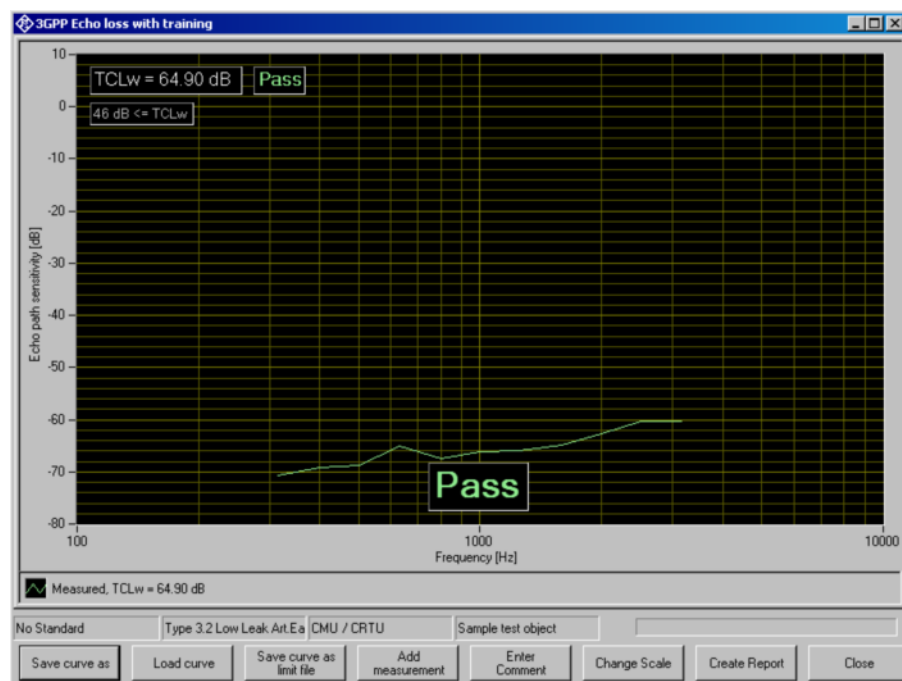


Fig. 21 Typical result of echo loss measurement

Stability Margin

(“3GPP Stability margin”)

The stability margin is measured to test the susceptibility of the phone to acoustic feedback and instability.

For the test, the telephone is placed on an even, hard board with the receiver and microphone pointing downwards.

A loop is closed in the R&S UPV between the receiving and the voice channel, and an overall gain of 6 dB is set. The gain of the coder is automatically taken into account (see also Echo Loss).

To activate the loop, a noise signal of -10 dBm0 in line with ITU-T O.131 is applied for 1 s and then switched off, with the loop remaining closed.

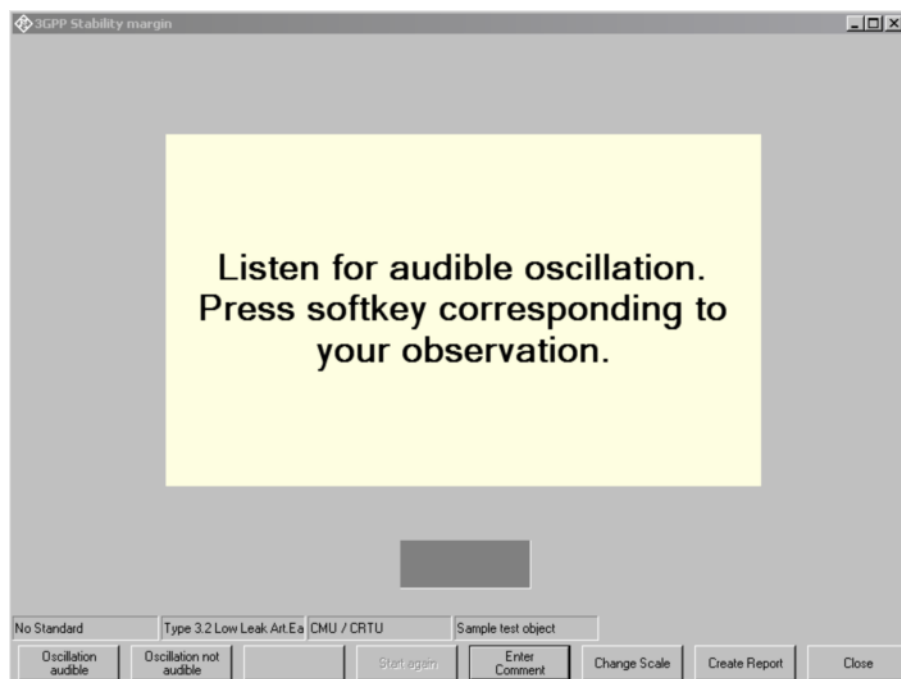


Fig. 22 Window during stability margin test

The test person has to listen to determine whether any resonances or oscillations are produced. If there are no oscillations, the minimum requirements according to 3GPP TS 26.131 for a stability margin of 6 dB are met.

Sending Distortion

(“3GPP Distortion sending, Rel. 4/5”, “3GPP Distortion sending, Rel. 6”)

The SINAD ratio in the transmit path is measured as a function of the sound level.

A pulsed sinusoidal tone of 1015 Hz with a pulse length of approx. 340 ms is used for the measurement. At this frequency, coding yields a sufficiently stable output signal. Voice recognition continues to be active in the mobile phone under test due to this pulsating signal.

The mobile phone under test is installed in the LRGP (ITU-T P.76), and the receiver is sealed to the artificial ear.

The test signal is generated with the artificial mouth at the MRP (mouth reference point) and the SINAD value of the received signal is measured at the CMU decoder output.

The acoustic reference level (ARL) is defined as the sound pressure which creates a signal level of -10 dBm0 in the transmit channel. An automatic routine varies the sound pressure at the artificial mouth until the desired level is attained. This value is then used as a reference for determining the SINAD value versus level.

The SINAD value is measured at sound pressures between -35 dB and +10 dB relative to the acoustic reference level (ARL) and compared with the limits specified in table 7 of 26.131 of 3GPP.

Signal processing of a modern mobile phone comprises a voice activity detector which determines whether a voice signal is present or whether the sending signal just comprises background noise. With such mobile phones the sending distortion test according to 3GPP TS 26.132 before release 6.0.0 may be failed at low levels because the 1 kHz sinewave test signal is classified as background noise and suppressed. For this reason the sending distortion measurement according to release 6.0.0 and onwards omits levels below -25 dB and starts at high test tone levels gradually reducing the level. For this release, use “3GPP Distortion sending, Rel. 6”, for earlier releases use “3GPP Distortion sending, Rel. 4/5”.

Table 6 Limit lines specified in table 7 of 3GPP TS 26.131

dB relative to ARL	Level ratio
-25 dB	26.6 dB
-20 dB	30.7 dB
-10 dB	33.3 dB
0 dB	33.7 dB
7 dB	31.7 dB
10 dB	25.5 dB

The measurement is performed up to a maximum sound pressure of 10 dBPa at the artificial mouth if the value 10 dB relative to ARL with 10 dBPa cannot be attained. The actual trace may therefore end at a lower pressure. This occurs for mobile phones under test which have a low sensitivity in the transmit direction.

If the measured trace is above the limit line, PASS is output, otherwise FAIL is displayed.



Fig. 23 Sending distortion measurement

Receiving Distortion

(“3GPP Distortion receiving”)

The SINAD ratio in the receiving path is measured as a function of the acoustic signal level.

A pulsed sinusoidal tone of 1015 Hz is used for the measurement. At this frequency, coding yields a sufficiently stable output signal.

Voice recognition continues to be active in the mobile phone under test due to this pulsating signal.

The mobile phone under test is installed in the LRGP (ITU-T P.76), and the receiver is sealed to the artificial ear.

The test signal is applied to the input of the CMU speech coder, and the SINAD value of the sound pressure in the artificial ear is measured with psophometric weighting according to ITU-T G.714.

The SINAD value of the sound pressure is measured at levels between -45 dBm0 and 0 dBm0 and compared with the limits given in table 8 of 3GPP TS 26.131.

Table 7 Limit lines specified in table 8 of 3GPP TS 26.131

Level	Level ratio
-45 dBm0	17.5 dB
-40 dBm0	22.5 dB
-30 dBm0	30.5 dB
-20 dBm0	33.0 dB
-10 dBm0	33.5 dB
-3 dBm0	31.2 dB
0 dBm0	25.5 dB

The measurement is performed up to a maximum sound pressure of 10 dBPa in the artificial ear; the actual trace may end at an earlier point.

If the operator desires to see the receiving distortion value at the point exceeding 10 dBPa, this can be achieved by pressing the “add measurement” button. This causes the measurement to be repeated at all specified levels. The second measurement is not taken into account for reporting and Pass/Fail decision.

If the measured trace is above the limit line, PASS is output, otherwise FAIL is displayed.

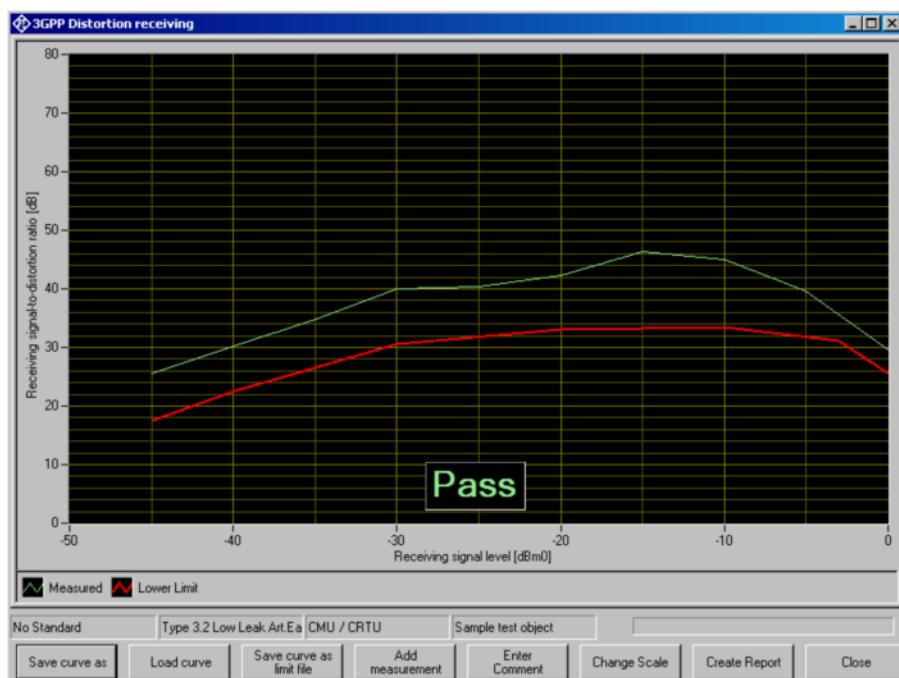


Fig. 24 Typical result of receiving distortion measurement

Idle Channel Noise Sending

("3GPP Idle channel noise sending")

The noise voltage at the speech decoder output is measured with the phone set up in a quiet environment (<30 dB(A)).

The mobile phone under test is installed in the LRGP (ITU-T P.76), and the receiver is sealed to the artificial ear.

The decoder output voltage is measured, weighted psophometrically according to ITU-T G.223 and recalculated for the internal level in dBm0p.

To keep the mobile phone under test in the normal operating mode, a pulsed signal is applied. The noise level is measured during the signal pauses. The voice activity decoder (VAD) is activated and the mobile phone remains in the active normal sending mode.

The idle noise level should not exceed -64 dBm0p. The measured noise voltage is also displayed as a spectrum, making it easier to find causes if the limit value is exceeded.

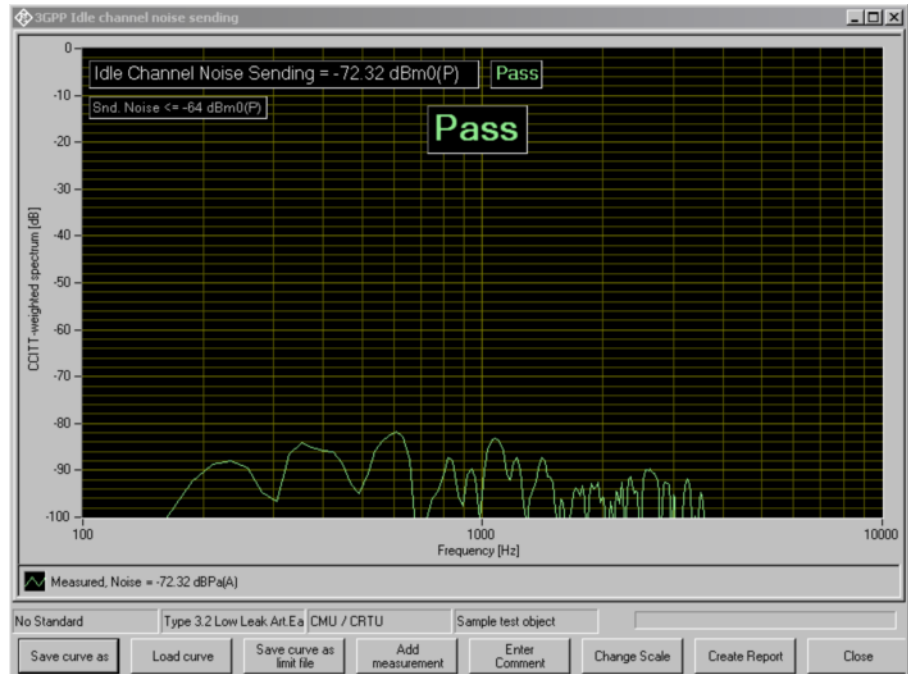


Fig. 25 Typical result of sending noise measurement

Idle Channel Noise Receiving

(“3GPP Idle channel noise receiving, nom. Vol”, “3GPP Idle channel noise receiving, max. Vol”)

The sound pressure in the artificial ear is measured with the phone set up in a quiet environment.

The mobile phone under test is installed in the LRGP (ITU-T P.76), and the receiver is sealed to the artificial ear.

The sound pressure in the artificial ear is measured with A-weighting on.

To keep the mobile phone under test in the normal operating mode, a pulsed signal is applied to the speech coder input. The noise level is measured during the signal pauses. The voice activity decoder is activated and the mobile phone remains in the active normal receiving mode.

With rated loudness set on the mobile phone, the sound pressure should not exceed -57 dBPa(A). In this case use test “3GPP Idle channel noise receiving, nom. Vol”.

At maximum receiving loudness, the sound pressure should not exceed -54 dBPa(A). In this case use test “3GPP Idle channel noise receiving, max. Vol”.

The measured noise voltage is also displayed as a spectrum, making it easier to find causes if the limit value is exceeded.

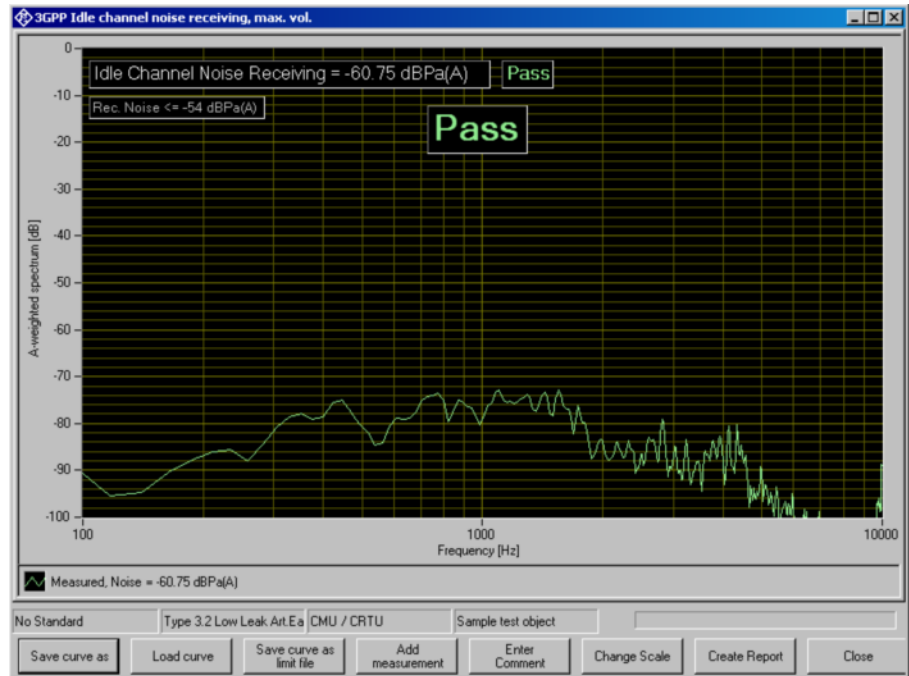


Fig. 26 Typical result of receiving noise measurement

This measurement makes high demands on the sound insulation of the test chamber and the S/N ratio of the measuring microphone including preamplifier in the artificial ear. A comparison measurement with the test mobile phone switched off or without a DUT shows the measurement reserves of the test equipment. Due to the inherent noise of the Audio Analyzer R&S UPV, measurements can be made to about -80 dBPa(A) at 0 dB microphone gain, and even to lower values when a higher microphone gain is set.

7 Automatic Test Sequences

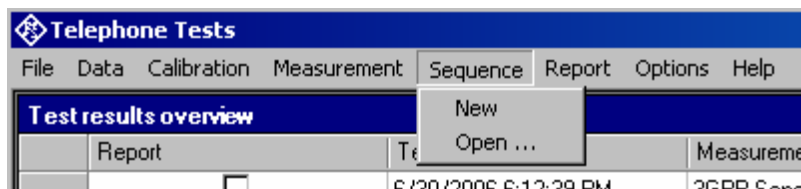


Fig. 27 Sequence menu

Creating and Editing a Sequence

The menu item “Sequence → New” first produces a window where a name for the new sequence has to be entered. Subsequently the sequence window opens.

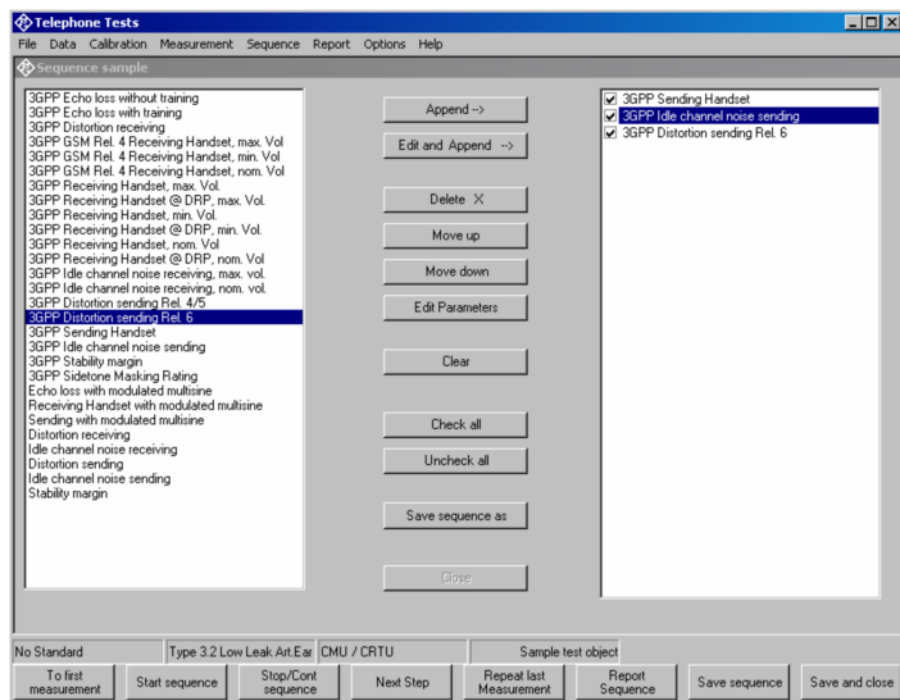


Fig. 28 Sequence window

Initially the right checked list box is empty. The list box on the left side displays all available measurement definitions. A measurement is appended to the sequence by highlighting it in the list box on the left side and clicking the “Append” button. Subsequently a measurement, which is highlighted in the checked list box on the right side, can be moved within the sequence using the buttons “Move up” and “Move down” and deleted from the sequence with the “Delete X” button. For non-standard measurements which allow to change parameters like limit curves, it is possible to edit the parameters before appending the measurement to the sequence. This is done by clicking the button “Edit and append”. It is for example possible to assemble a test sequence which contains stability margin tests with different loop gains.

Opening an Existing Sequence

The menu item “Sequence → Open ...” opens a file selector for specifying the sequence to be loaded. The sequence window opens with the specified sequence loaded. The sequence can then be edited and/or run.

Running a Sequence

When the softkey “Start sequence” is pressed, all checked measurements in the right list box are executed in sequence. The state of the checkboxes may be altered by marking a measurement and then clicking on the checkbox.

Reporting on Sequence Results

A report on all executed measurements of the last run sequence is prepared and displayed after the “Report Sequence” softkey has been pressed. After the sequence window has been closed, a report on the last sequence can be obtained by pressing the “Report last sequence” softkey in the main window.

8 Reporting, Storing, Loading and Deleting Results

Result Files

Measurement results are stored together with all associated data in XML files. Separate files can be used for different projects or operators. They can be archived together with other project data and re-opened later for generating reports.

It is recommended to keep result files small and to generate backups at frequent intervals.

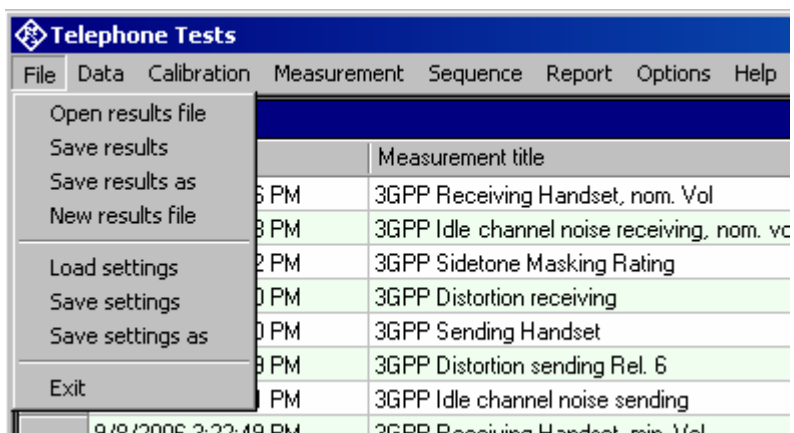


Fig. 29 File menu

A new (empty) result file can be created with “File → New Result File” from the main menu.

An existing result file can be opened with “File → Open Result File” from the main menu.

A currently opened result file can be stored under a new name with “File → Store results as” from the main menu.

Report Settings

With “Report → Settings” or “Options → Report settings”, a selection can be made of data which should appear in the reports. Thus, information which is the same for a larger number of measurements does not have to be printed with every report again.

Generating a Single Report

A report on a single measurement result can be generated from the window of a measurement macro by clicking or pressing the softkey “Generate report”.

From the result overview of the main window, a report on a single measurement can be generated by marking the row with the selected result by clicking on the row header to the left, right-clicking into the data grid and selecting “Generate report” from the context menu.

Subsequently data associated with the selected measurement is assembled, a graph for existing curve data is generated, and the preview window is opened. Depending on the amount of measurement data, this may take a few seconds.

Generating a Sequence Report

A report on a sequence of measurements can be generated from the sequence window by clicking or pressing the softkey "Report sequence".

Once the sequence window has been closed, a report on the last executed sequence can be generated by selecting "Report → Last sequence" from the main menu. Reports about previous sequences can be generated as single reports on the measurements of this sequence, as all results appear in the overview data grid in the main window.

Preview Window

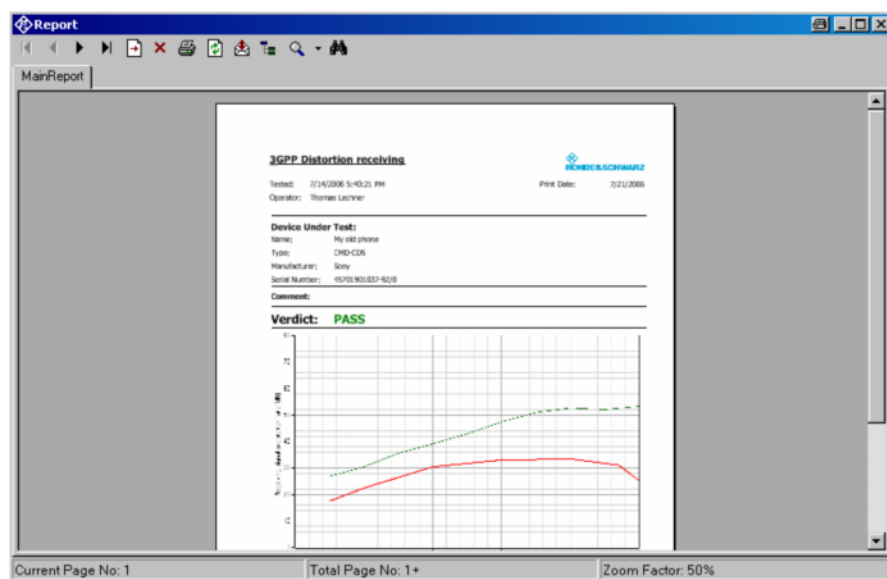


Fig. 30 Report preview window

The main area of the preview window shows a preview of the report as it will be printed or appear in an exported PDF file. If the report comprises more than one page, the pages can be browsed using the buttons



To open the print dialog for installed windows printers click



To open a file selector for export of the report to PDF, WORD, EXCEL or Rich Text format, click



The scale of the document in the preview can be adjusted with

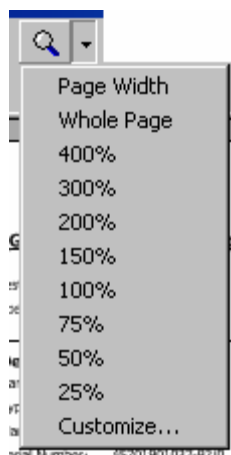


Fig. 31 Scale menu of the preview window

Storing and Loading Curves

Measured curves can be stored from and loaded into the graph of a measurement macro (see above). This allows easy import into spreadsheets as well as direct comparison of curves measured at different times or places. Measured curves can also be stored in a R&S UPV limit file for use as a limit curve either in a R&S UPV sweep graph or in the graph of a R&S UPV-K9 window. This allows e.g. to derive tolerance schemes from “golden devices”. The measured curve can be arbitrarily shifted before being stored.

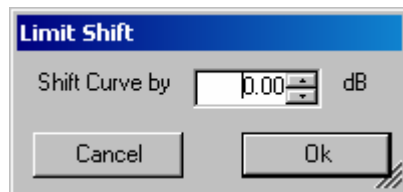


Fig. 32 Input window for defining a shift of a measured curve for storage as limit curve

ASCII Result Files

When the item “Generate temporary export files” in the “Options” menu is checked, the standard tests generate “abscurve.exp”, “relcurve.exp” and “result.exp” files similar to those generated by UPL-B9. These files are always deleted and overwritten by subsequent tests.

Deleting Results

It may be desirable to delete results of selected measurements from the result file, e.g. because the measurement was repeated due to a missing call to the mobile, a wrong setting etc. To delete the result of a particular measurement, mark the row for the selected measurement in the data grid of the main window by clicking on the row header to the left, right-click into the data grid and select “Delete result” from the context menu. After confirmation by the operator, the selected row of the result overview will be deleted from the result file together with all associated data.

9 Terminating the Application

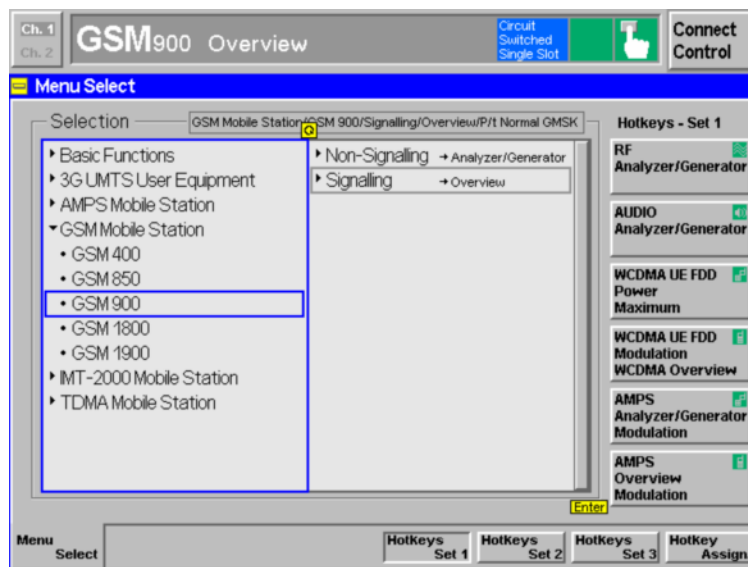
The measurement can be terminated from the main window with the “Exit” softkey. This causes the result file to be written to the hard disk.

10 Appendix A Settings on the Radio Communication Tester CMU200

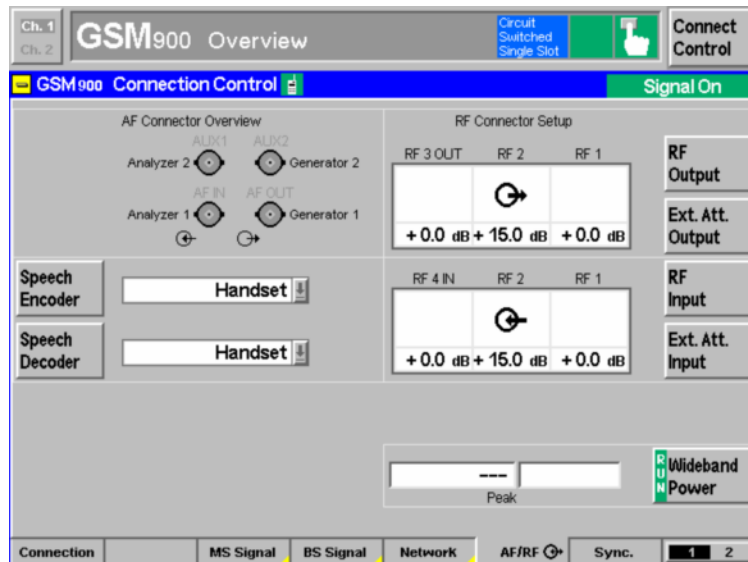
Firmware 3.50

Settings for GSM:

Selection of the GSM band:

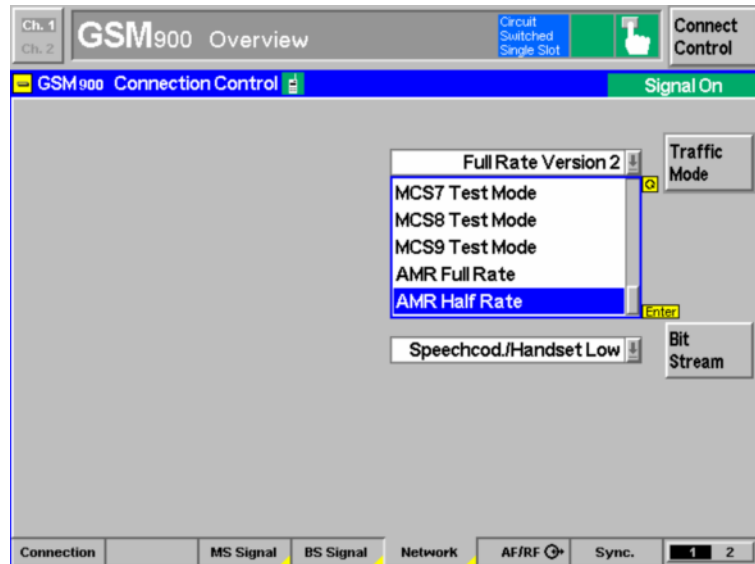
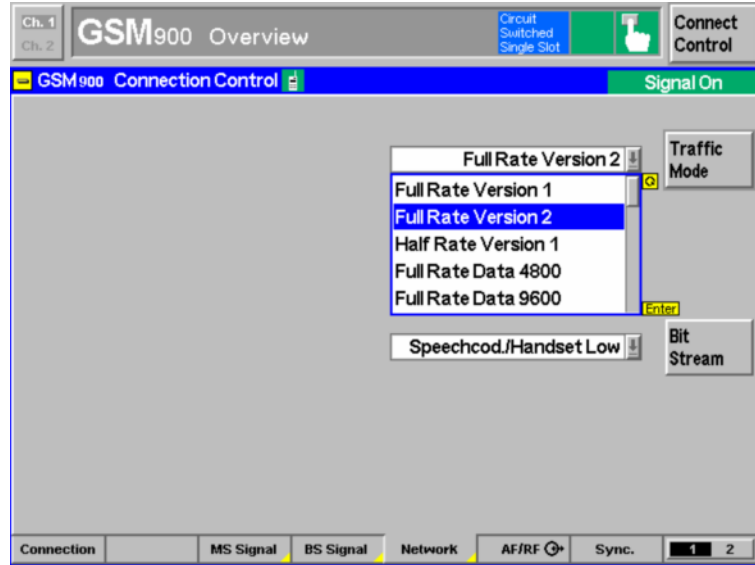


Taking a coupling loss of the antenna coupler into account:

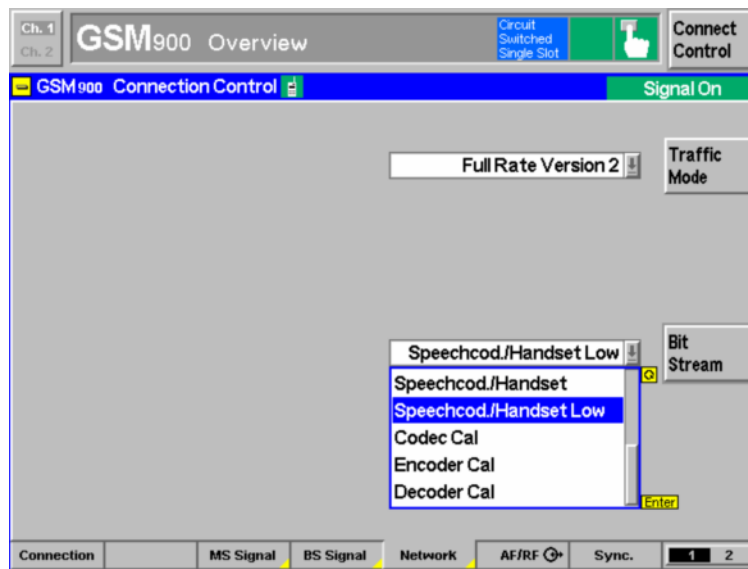


Acoustic Measurements on Mobile Phones

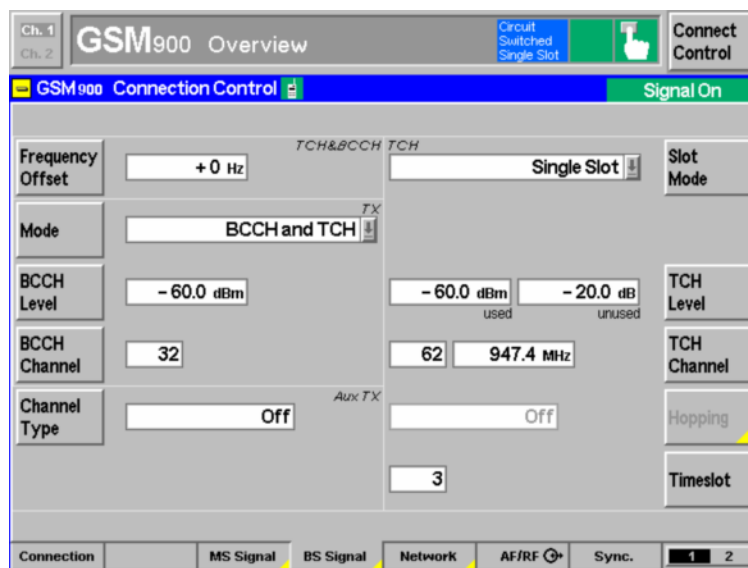
Selection of the FR (full rate version 1), EFR (full rate version 2), HR (half rate version 1), AMR full rate or AMR half rate speech coder:



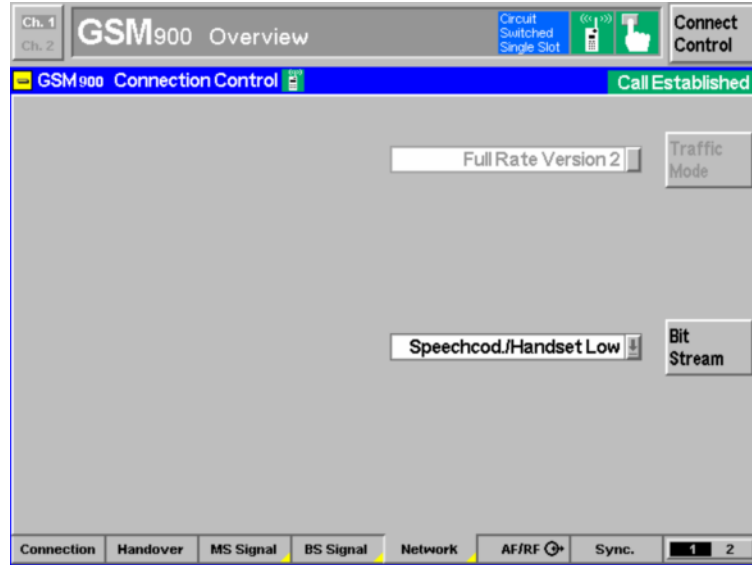
Selection of the Bit Stream Handset Low setting for the measurements or Decoder Cal and Encoder Cal for the calibration:



Setting of the desired TCH and BCCH levels:

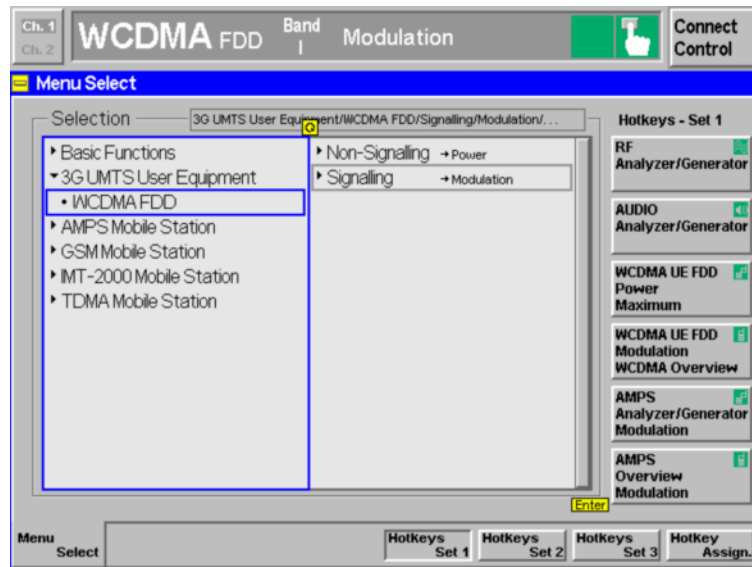


Typical setting with EFR speech coder (corresponds to AMR 12.2) for measurements in the call established status:

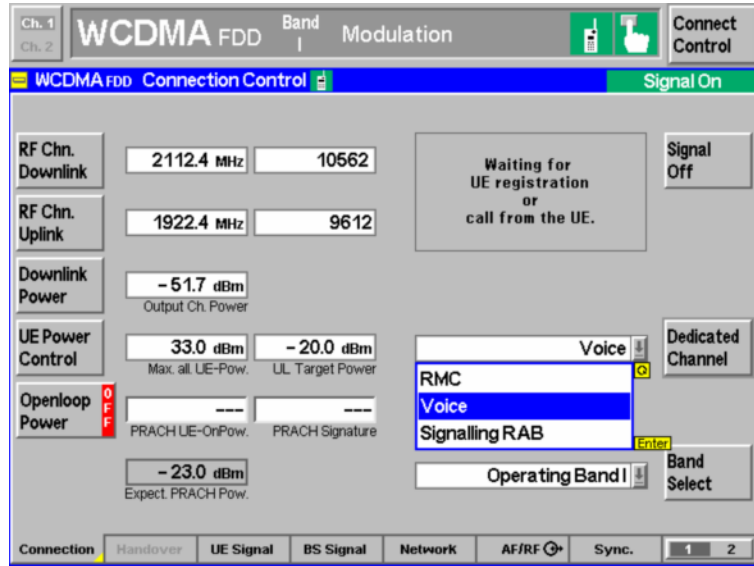


Settings for UMTS WCDMA FDD:

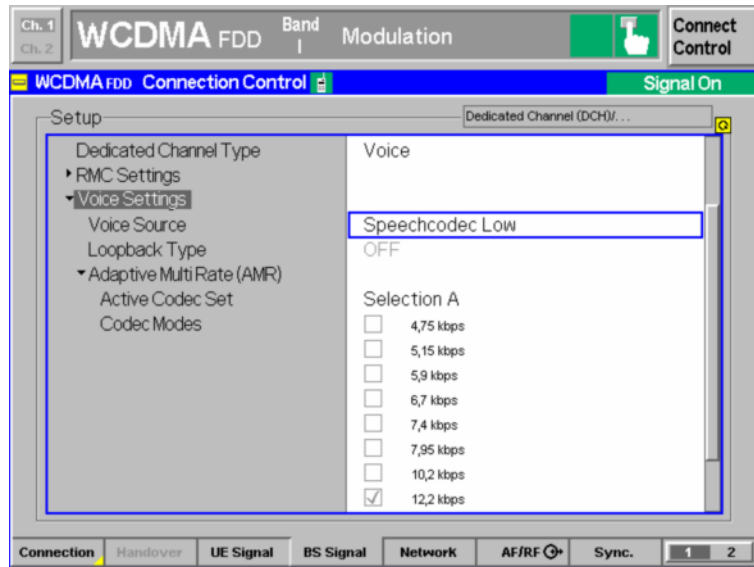
Selection of mode:



Setting dedicated channel to voice:



Selection of the Speechcodec Low setting and AMR Bit Rate for the measurements or Decoder Cal and Encoder Cal for the calibration (selection is possible only if call is deactivated):



Mobile phone registered status, codec settings possible:

The screenshot shows the 'WCDMA FDD Connection Control' interface in 'Registered' status. The top bar displays 'WCDMA FDD Band 1 Modulation' and 'Connect Control'. The main area contains several control panels:

- RF Chn. Downlink:** 2112.4 MHz, 10562
- RF Chn. Uplink:** 1922.4 MHz, 9612
- Downlink Power:** -51.7 dBm (Output Ch. Power)
- UE Power Control:** 33.0 dBm (Max. all UE-Pow.), -20.0 dBm (UL Target Power)
- Openloop Power:** -23.0 dBm (Expect. PRACH Pow.)

Additional controls include 'Signal Off', 'Unregister', 'Connect UE', 'Dedicated Channel', and 'Band Select'. A central instruction box says: 'Make a call from the UE or press the "Connect UE" key.' The bottom status bar shows 'Connection Handover UE Signal BS Signal Network AF/RF Sync.' with a '1 2' indicator.

Call active (connected) status for the measurements:

The screenshot shows the 'WCDMA FDD Connection Control' interface in 'Connected' status. The top bar displays 'WCDMA FDD Band 1 Modulation' and 'Connect Control'. The main area contains several control panels:

- RF Chn. Downlink:** 2112.4 MHz, 10562
- RF Chn. Uplink:** 1922.4 MHz, 9612
- Downlink Power:** -51.7 dBm (Output Ch. Power)
- UE Power Control:** 33.0 dBm (Max. all UE-Pow.), -20.0 dBm (UL Target Power)
- Openloop Power:** -23.0 dBm (Expect. PRACH Pow.)

Additional controls include 'Signal Off', 'Unregister', 'Disconnect UE', 'Dedicated Channel', and 'Band Select'. A central instruction box says: 'Disconnect the UE by pressing the "Disconnect UE" key.' The bottom status bar shows 'Connection Handover UE Signal BS Signal Network AF/RF Sync.' with a '1 2' indicator.