

Operating Manual



UMTS/GSM Mobile Phone Tests

R&S[®] UPV-K9

1402.0008.02

R&S[®] UPV-K91

1402.0108.02

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Printed in Germany



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Grouped Safety Messages







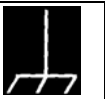

Make sure to read through and observe the following safety instructions!







All plants and locations of the Rohde & Schwarz group of companies make every effort to keep the safety standard of our products up to date and to offer our customers the highest possible degree of safety. Our products and the auxiliary equipment required for them are designed and tested in accordance with the relevant safety standards. Compliance with these standards is continuously monitored by our quality assurance system. The product described here has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards. To maintain this condition and to ensure safe operation, observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, the Rohde & Schwarz group of companies will be happy to answer them.

Furthermore, it is your responsibility to use the product in an appropriate manner. This product is designed for use solely in industrial and laboratory environments or, if expressly permitted, also in the field and must not be used in any way that may cause personal injury or property damage. You are responsible if the product is used for an intention other than its designated purpose or in disregard of the manufacturer's instructions. The manufacturer shall assume no responsibility for such use of the product.

The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and a basic knowledge of English. It is therefore essential that only skilled and specialized staff or thoroughly trained personnel with the required skills be allowed to use the product. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation. Keep the basic safety instructions and the product documentation in a safe place and pass them on to the subsequent users.

Symbols and safety labels

							
Observe product documentation	Weight indication for units >18 kg	Danger of electric shock	Warning! Hot surface	PE terminal	Ground	Ground terminal	Attention! Electrostatic sensitive devices

					
Supply voltage ON/OFF	Standby indication	Direct current (DC)	Alternating current (AC)	Direct/alternating current (DC/AC)	Device fully protected by double/reinforced insulation

Observing the safety instructions will help prevent personal injury or damage of any kind caused by dangerous situations. Therefore, carefully read through and adhere to the following safety instructions before putting the product into operation. It is also absolutely essential to observe the additional safety instructions on personal safety that appear in relevant parts of the product documentation. In these safety instructions, the word "product" refers to all merchandise sold and distributed by the Rohde & Schwarz group of companies, including instruments, systems and all accessories.

Tags and their meaning

DANGER	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	NOTICE indicates a property damage message.

In the product documentation, the word ATTENTION is used synonymously.

These tags are in accordance with the standard definition for civil applications in the European Economic Area. Definitions that deviate from the standard definition may also exist in other economic areas or military applications. It is therefore essential to make sure that the tags described here are always used only in connection with the related product documentation and the related product. The use of tags in connection with unrelated products or documentation can result in misinterpretation and thus contribute to personal injury or material damage.

Basic safety instructions

1. The product may be operated only under the operating conditions and in the positions specified by the manufacturer. Its ventilation must not be obstructed during operation. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products:
prescribed operating position is always with the housing floor facing down, IP protection 2X, pollution severity 2, overvoltage category 2, use only in enclosed spaces, max. operation altitude 2000 m above sea level, max. transport altitude 4500 m above sea level.
A tolerance of $\pm 10\%$ shall apply to the nominal voltage and of $\pm 5\%$ to the nominal frequency.
2. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed. The product may be opened only by authorized, specially trained personnel. Prior to performing any work on the product or opening the product, the product must be disconnected from the supply network. Any adjustments, replacements of parts, maintenance or repair must be carried out only by technical personnel authorized by Rohde & Schwarz. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, PE conductor test, insulation resistance measurement, leakage current measurement, functional test).
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens, e.g. nickel) such as aluminum cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties), consult a physician immediately to determine the cause.
4. If products/components are mechanically and/or thermally processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled, e.g. for disposal purposes, by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.

Grouped Safety Messages

5. If handling the product yields hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation.
6. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn life requires increased protection, pregnant women should be protected by appropriate measures. Persons with pacemakers may also be endangered by electromagnetic radiation. The employer/operator is required to assess workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the danger.
7. Operating the products requires special training and intense concentration. Make certain that persons who use the products are physically, mentally and emotionally fit enough to handle operating the products; otherwise injuries or material damage may occur. It is the responsibility of the employer to select suitable personnel for operating the products.
8. Prior to switching on the product, it must be ensured that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
9. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with earthing contact and protective earth connection.
10. Intentionally breaking the protective earth connection either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
11. If the product has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases, it must be ensured that the power plug is easily reachable and accessible at all times (corresponding to the length of connecting cable, approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply. If products without power switches are integrated in racks or systems, a disconnecting device must be provided at the system level.
12. Never use the product if the power cable is damaged. Check the power cable on a regular basis to ensure that it is in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by e.g. tripping over the cable or suffering an electric shock.
13. The product may be operated only from TN/TT supply networks fused with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
14. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket. Otherwise, this can result in sparks, fire and/or injuries.
15. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
16. For measurements in circuits with voltages $V_{\text{rms}} > 30 \text{ V}$, suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
17. Ensure that the connections with information technology equipment comply with IEC 950/EN 60950.
18. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
19. If a product is to be permanently installed, the connection between the PE terminal on site and the product's PE conductor must be made first before any other connection is made. The product may be installed and connected only by a license electrician.

Grouped Safety Messages

20. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused in such a way that suitable protection is provided for users and products.
21. Do not insert any objects into the openings in the housing that are not designed for this purpose. Never pour any liquids onto or into the housing. This can cause short circuits inside the product and/or electric shocks, fire or injuries.
22. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a thunderstorm) can reach the product. Otherwise the operating personnel will be endangered by electric shocks.
23. Rohde & Schwarz products are not protected against penetration of liquids, unless otherwise specified (see also safety instruction 1.). If this is not taken into account, there exists the danger of electric shock for the user or damage to the product, which can also lead to personal injury.
24. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product was moved from a cold to a warm environment.
25. Do not close any slots or openings on the product, since they are necessary for ventilation and prevent the product from overheating. Do not place the product on soft surfaces such as sofas or rugs or inside a closed housing, unless this is well ventilated.
26. Do not place the product on heat-generating devices such as radiators or fan heaters. The temperature of the environment must not exceed the maximum temperature specified in the data sheet.
27. Batteries and storage batteries must not be exposed to high temperatures or fire. Keep batteries and storage batteries away from children. Do not short-circuit batteries and storage batteries.
If batteries or storage batteries are improperly replaced, this can cause an explosion (warning: lithium cells). Replace the battery or storage battery only with the matching Rohde & Schwarz type (see spare parts list). Batteries and storage batteries must be recycled and kept separate from residual waste. Batteries and storage batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.
28. Please be aware that in the event of a fire, toxic substances (gases, liquids etc.) that may be hazardous to your health may escape from the product.
29. The product can be very heavy. Be careful when moving it to avoid back or other physical injuries.
30. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves).
31. Handles on the products are designed exclusively for personnel to hold or carry the product. It is therefore not permissible to use handles for fastening the product to or on means of transport such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport and for observing the safety regulations of the manufacturer of the means of transport. Noncompliance can result in personal injury or material damage.
32. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. The driver is always responsible for the safety of the vehicle. The manufacturer assumes no responsibility for accidents or collisions.
33. If a laser product (e.g. a CD/DVD drive) is integrated in a Rohde & Schwarz product, do not use any other settings or functions than those described in the product documentation. Otherwise this may be hazardous to your health, since the laser beam can cause irreversible damage to your eyes. Never try to take such products apart, and never look into the laser beam.
34. Prior to cleaning, disconnect the product from the AC supply. Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluent for cellulose lacquers.

Certified Quality System

DIN EN ISO 9001 : 2000
DIN EN 9100 : 2003
DIN EN ISO 14001 : 2004

DQS REG. NO 001954 QM UM

QUALITÄTSZERTIFIKAT

Sehr geehrter Kunde,
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DIN EN 9100:2003
DIN EN ISO 14001:2004



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* 0.14 €/Min within the German fixed-line telephone network, varying prices for the mobile telephone network and in different countries.



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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", are now available for measuring the acoustic characteristics of UMTS 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

Note: *The UPV firmware version must be 2.1.1.261 or higher.*

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 (UMTS), the option CMU-B69 is required. Wideband-AMR tests require option CMU-K46 for both GSM and/or WCDMA (UMTS).

Note: *The firmware level in the CMU200 must be 4.52 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
Handset fixture for Head and Torso simulator	Required to position the handset on the artificial head, and to apply a defined force with the earpiece against the pinna	
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 2690AOS2 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 LRGP test head (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.

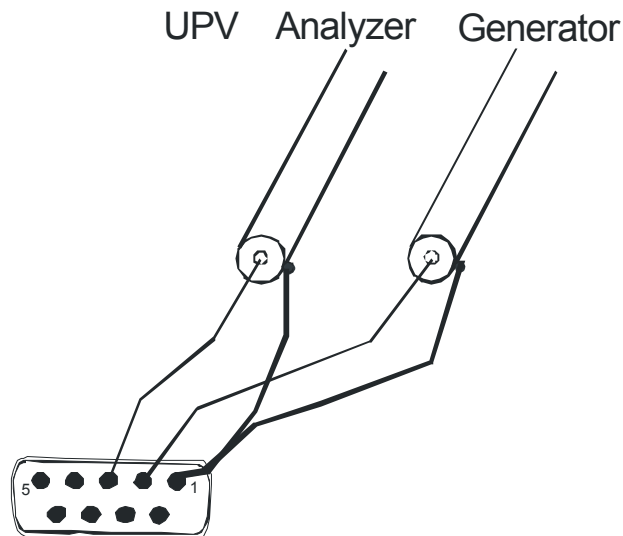


Fig. 1 Assignment of 9-contact speech connector on CMU front panel

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.

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

Note: 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.

Attention: An external power amplifier should be switched on after the R&S UPV-K9x 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.

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

Caution: R&S UPV-K9x 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 in the folder “UPV-K9x Software” on the installation CD supplied with the R&S UPV-K91 option. The audio analyzer must meet the following firmware requirements:

- R&S UPV firmware version 2.1.1.261 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 as well as the installation manual are part of the delivery.

It is recommended to copy the files UPV-K9x.msi, Config.ini, dotnetfx.exe, Setup.exe and Settings.ini from the folder “UPV-K9x Software” on the installation CD to drive D: on the R&S UPV hard disk drive, e.g. to a folder named “D:\R&S Software\UPV-K9x\Version x.y”. Run the file “Setup.exe” to start the installation. Follow the instructions of the installer on the screen.

To have full control over minimized windows, it is recommended to set the windows taskbar to “Auto-hide”, on top of other windows. Right-click on the Windows Start button and click “properties”.

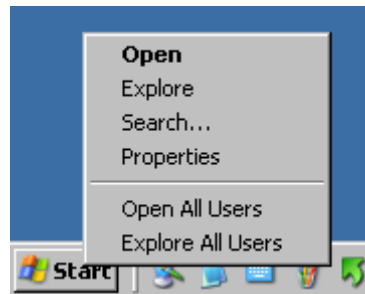


Fig. 2 Context menu for taskbar

In the properties window, click tab “Taskbar” and activate “Auto-hide the taskbar” and “Keep the taskbar on top of other windows”. Click “Apply” and close the window.

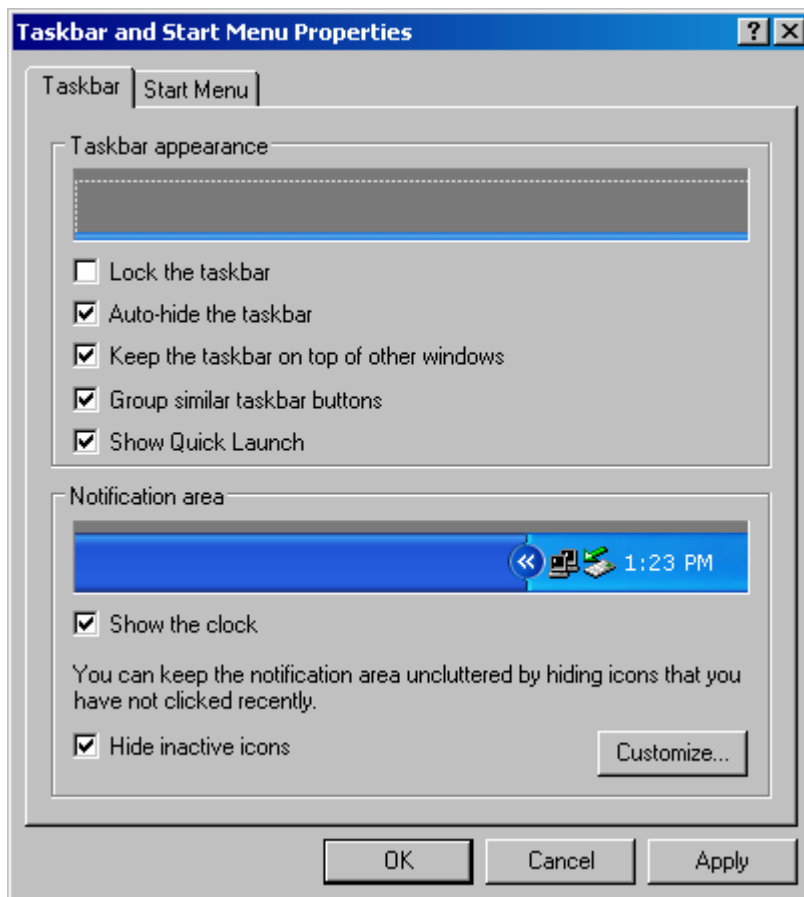


Fig. 3 Properties window for taskbar

Test Setup

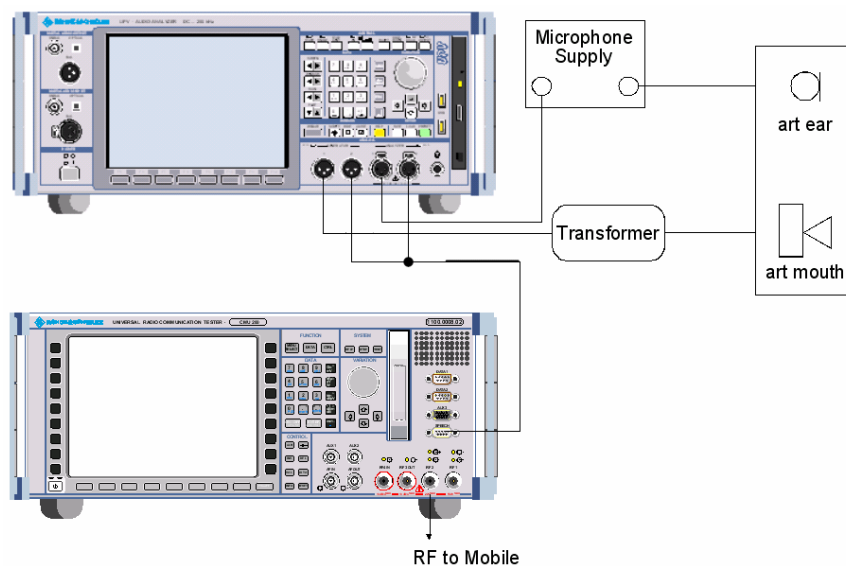


Fig. 4 Test setup and connection of external components

Starting the Application Software

After installation, the program can be started by double-clicking the Icon “UPV-K9x Mobile Phone Tests” or by clicking “R&S UPV Applications → UPV-K9x 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.

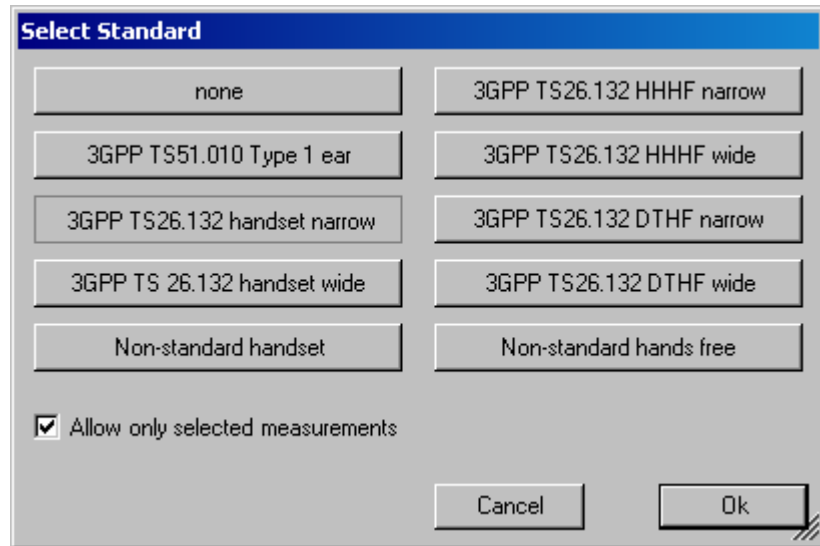


Fig. 5 Query window for selection of applied standard

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. “Non-standard handset” and “non-standard hands free” select handset or hands-free tests, respectively, which can be customized.

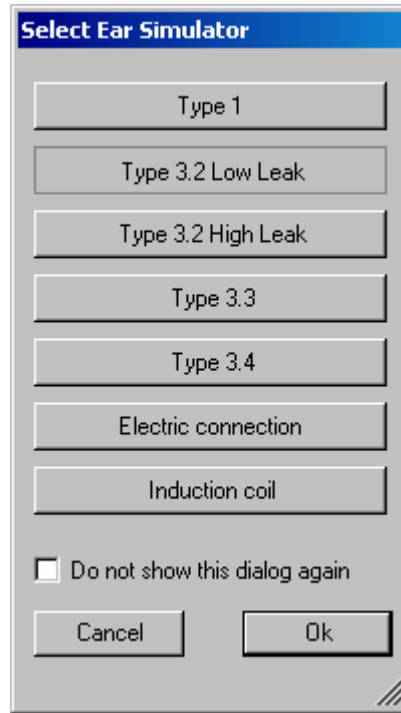


Fig. 6 Query window for selection of artificial ear

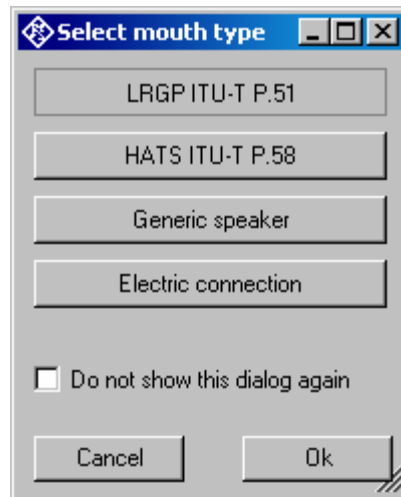


Fig. 7 Query window for selection of artificial mouth

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.

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 6:02:36 PM	3GPP Idle channel noise receiving	Sample test object	PASS	

Fig. 8 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.

By marking one of the results and clicking with the right mouse button on it, a context menu opens which allows to create a report of this result, delete the result or to export one of the curves in the result graph to an ASCII format.

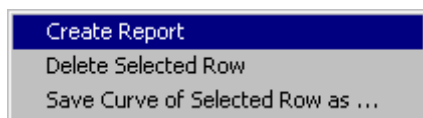


Fig. 9 Context menu of the result data grid

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)

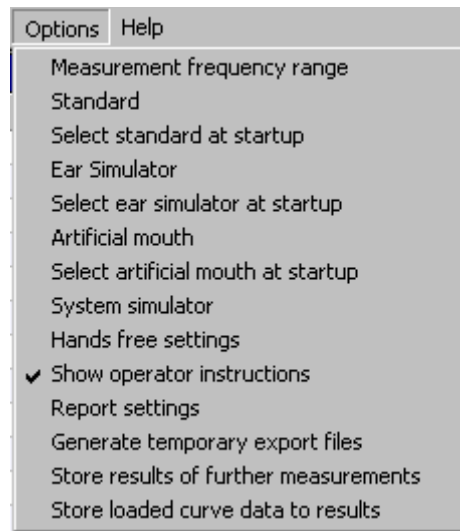


Fig. 10 Options menu

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.

“Hands free settings” allows to select the acoustic instruments used for hands free testing. It is possible to use an ITU-T P.51 artificial mouth together with a free field microphone, a HATS with one artificial ear or a HATS with two artificial ears. If two artificial ears are used, the decoder has to be disconnected from analyzer input 2 and the second artificial ear has to be connected to it for receiving measurements. Do not forget to re-connect the decoder for any measurement in sending direction.

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, “curve.exp” or “abscurve.exp” and “relcurve.exp” files with curve data in ASCII format.

If **“Store results of further measurements”** is checked, curves and calculated values like loudness ratings are also stored for additional measurements started with the “Add Measurement” key. They will appear in reports of the respective measurements.

If **“Store loaded curve data to results”** is checked, curves loaded from file with the “Load Curve” softkey are stored to the results database and will appear in reports of the respective measurements.

Attention: *Do not attempt to modify files with extensions “set”, “sup”, “xml”, “cal” “seq” or “mdf”, using a text editor. Any change with a text editor may make the files unusable and cause malfunction of the software.*

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.

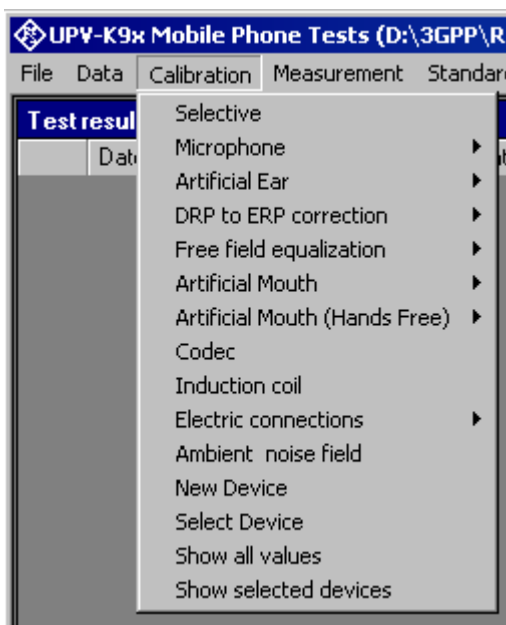


Fig. 11 Calibration menu

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. If the box “Immediately select this device” is checked, the device is selected for immediate use with the “Save, select and close” button.

The 'Calibrated Device' window contains the following fields and controls:

- Usage:** A dropdown menu.
- Type:** A text input field.
- Manufacturer:** A text input field.
- Serial Number:** A text input field.
- Immediately select this device
- Buttons:** 'Cancel' and 'Save and close'.

Fig. 12 Input window for information about calibrated device

Before a device can be calibrated or used, it must be selected. This can be done from the “Calibrated Device” input window if the checkbox “Immediately select this device” is checked. Existing devices may be selected with “Calibration → Select device” in the main menu. Clicking on this item opens a window with a table of all entered devices.

The 'Select Calibrated Devices' window displays a table of devices with the following columns: Usage, Manufacturer, Type, Serial No., Date and Time, Calib. value, and File name.

Usage	Manufacturer	Type	Serial No.	Date and Time	Calib. value	File name
► Ambient noise field		Default		08/29/2007 17:21	(null)	D:\3GPP\Ca
Decoder		Default		07/13/2006 17:50	(null)	D:\3GPP\Ca
Diffuse field microphone		Default		07/13/2006 17:57	(null)	D:\3GPP\Ca
Electric connection replacing decoder		Default		07/13/2006 17:54	(null)	D:\3GPP\Ca
Electric connection replacing ear		Default		10/11/2007 11:36	(null)	D:\3GPP\Ca
Electric connection replacing encoder		Default		07/13/2006 17:54	(null)	D:\3GPP\Ca
Electric connection replacing mouth		Default		07/13/2006 17:51	(null)	D:\3GPP\Ca
Encoder		Default		07/13/2006 17:51	(null)	D:\3GPP\Ca
Free field microphone		Default		06/07/2006 15:50	(null)	D:\3GPP\Ca
Generic speaker		Default		07/13/2006 16:33	(null)	D:\3GPP\Ca
HATS ITU-T P.58 Art. Mouth		Default		06/07/2006 15:47	(null)	D:\3GPP\Ca
HATS Type 3.3 Art. Ear		Default		06/07/2006 15:52	(null)	D:\3GPP\Ca
HATS Type 3.4 Art. Ear		Default		06/07/2006 15:54	(null)	D:\3GPP\Ca
Induction coil (input)		Default		07/13/2006 18:04	(null)	D:\3GPP\Ca
Input digital		Default		06/07/2006 15:49	(null)	D:\3GPP\Ca
LRGP ITU-T P.51 Art. Mouth		Default		07/13/2006 17:59	(null)	D:\3GPP\Ca
Output digital		Default		06/07/2006 15:50	(null)	D:\3GPP\Ca
Second Type 3.3 Art. Ear		Default		07/11/2007 15:09	(null)	D:\3GPP\Ca
Second Type 3.4 Art. Ear		Default		07/11/2007 15:09	(null)	D:\3GPP\Ca
Type 1 Art. Ear		Default		06/07/2006 15:51	(null)	D:\3GPP\Ca
Type 3.2 High Leak Art. Ear		Default		06/07/2006 15:51	(null)	D:\3GPP\Ca

At the bottom of the window, there is a dropdown menu labeled 'Select usage type first', and buttons for 'Select', 'Cancel', and 'Ok'.

Fig. 13 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.

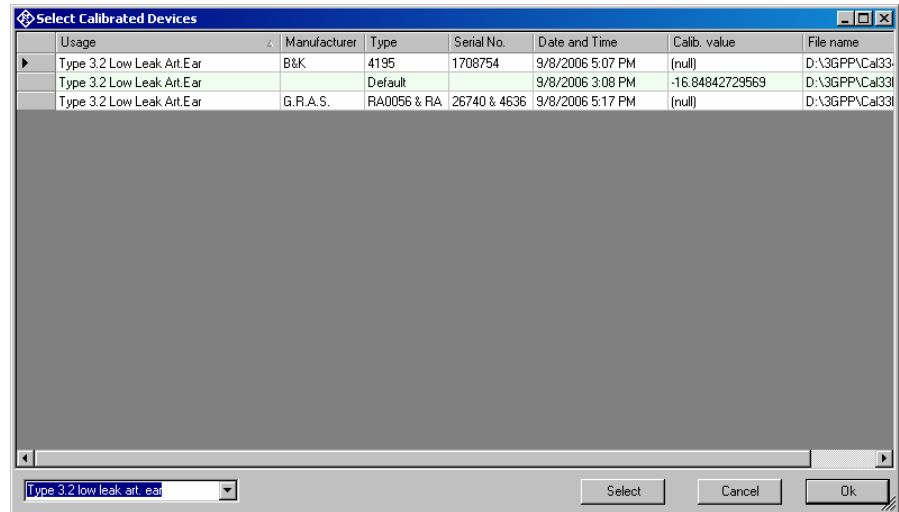


Fig. 14 Selection window for particular device type

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.

An overview of all selected calibration devices together with the calibration values is given under the menu item “Calibration → Show selected devices”.

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.

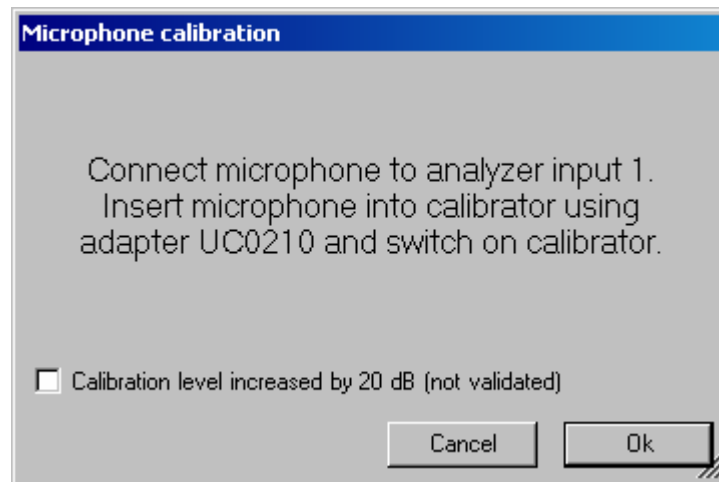


Fig. 15 Initial window of microphone calibration

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) . If a conditioning amplifier with 20 dB gain (recommended value) is used, the displayed sensitivity must be about 10 times higher (e.g. 120 mV/Pa). 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 starting the calibration again.

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 dB SPL or a sound pressure of 1 Pa at 1 kHz.

Calibration of Ear Type 1

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

Attention: 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). If a conditioning amplifier with 20 dB gain (recommended value) is used, the displayed sensitivity must be about 10 times higher (e.g. 120 mV/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 calibration.

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 calibration.

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 calibration.

The measured reference value is stored in a file on the hard disk and used for all subsequent measurements when the same ear type 3.3 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 calibration.

The measured reference value is stored in a file on the hard disk and used for all subsequent measurements when the same ear type 3.4 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 for Handset Tests

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 free-field or diffuse-field (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 and WCDMA and use different link handlers, 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 4.52 or higher). Call the calibration routines with “Calibration → Codec” from the main menu.

The following information is displayed:

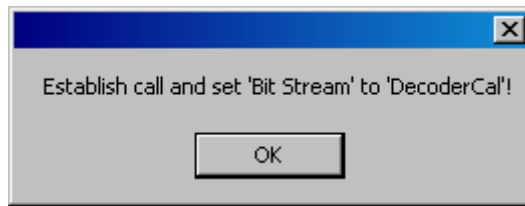


Fig. 16 Message box during decoder calibration

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:

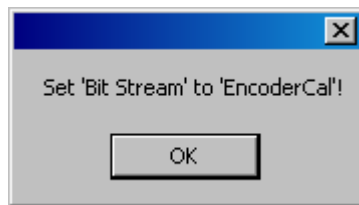


Fig. 17 Message box during encoder calibration

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.

Calibration of Ambient Noise Field

For the calibration of the noise field for ambient noise rejection tests, all obstacles (test head or HATS, Telephone etc.) have to be removed from the test chamber. For the generation of the noise field, additional equipment is necessary. The noise field should have sufficient homogeneity (sound pressure level independent of place) and diffuseness (randomly incident sound at the place of the microphone). This can either be achieved in a reverberation room with omni-directionally radiating sound source or in an anechoic room with a number of uncorrelated noise sources. Limited homogeneity can be achieved in the centre between two speakers. For good diffuseness a minimum of four speakers distributed in different spatial directions are required.

A diffuse field or pressure field microphone must be positioned at the spot of the mouth reference point of the (removed) test head or HATS.

The menu Item Calibration → Ambient noise field opens the following window:

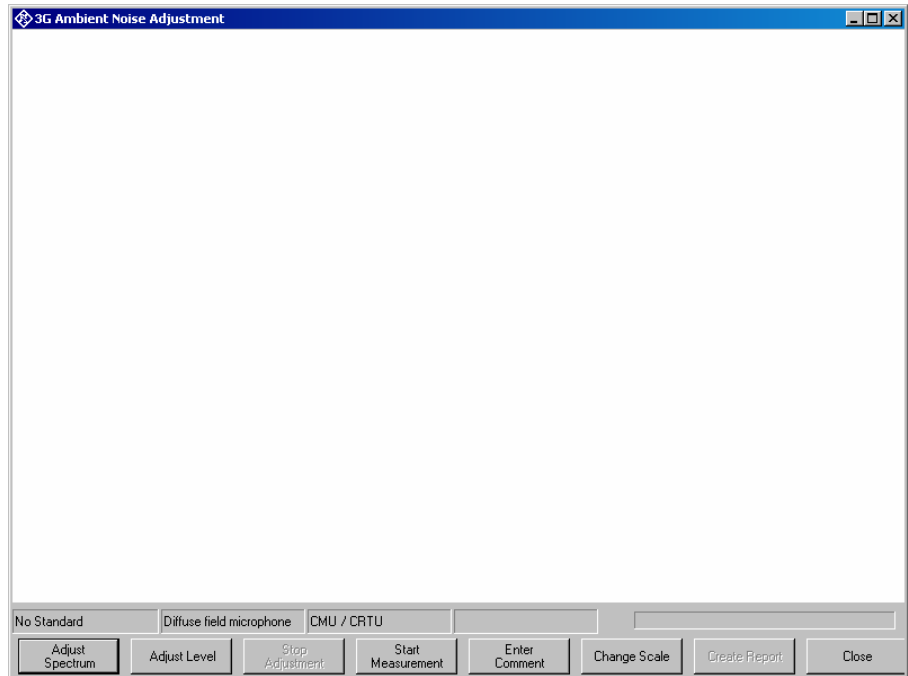


Fig. 18 Measurement window for ambient noise field calibration.

The button “Adjust Spectrum” starts a continuous spectrum measurement which allows to adjust the spectrum of the noise, e.g. using equalizers. The template is centred around the curve irrespective of the absolute level.

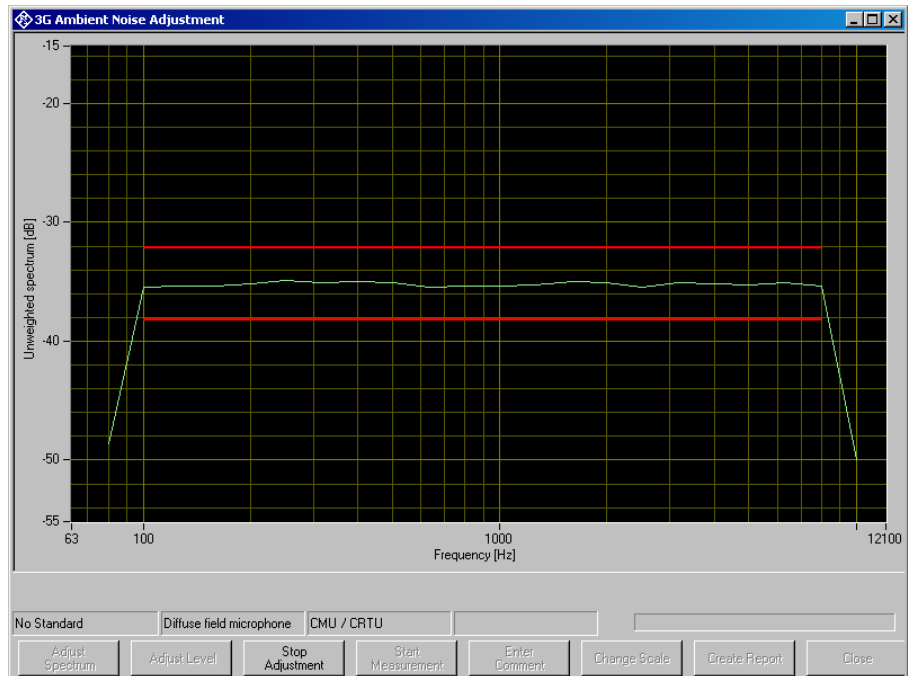


Fig. 19 Measurement window for spectrum adjustment.

The continuous spectrum measurement can be aborted by clicking “Stop Adjustment”.

The button “Adjust level” starts a continuous level measurement. If a multitude of sources is used, each source must produce a sound pressure level of $-24 \text{ dBPa} - 3 * \text{LOG } n \text{ dB}$, whereby n is the number of noise sources.

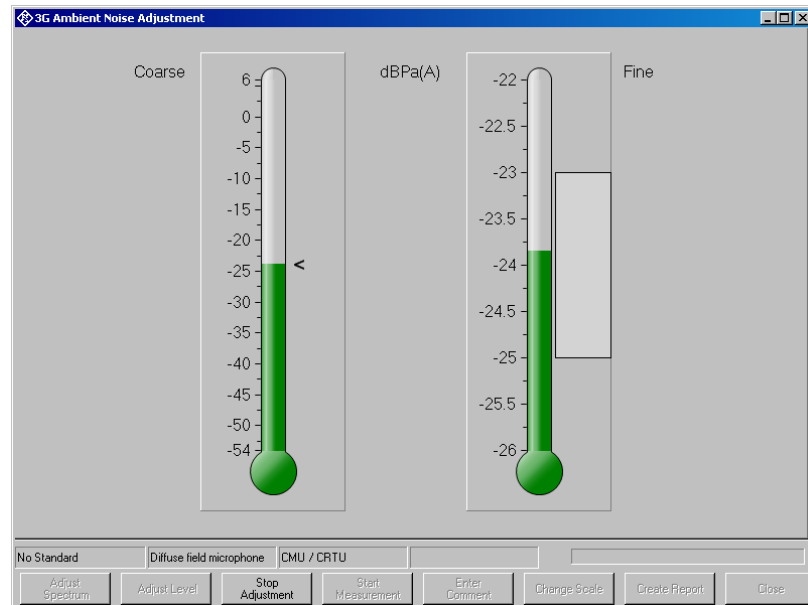


Fig. 20 Measurement window for level adjustment.

The left thermometer column gives a coarse overview. The right column has an enlarged scale for fine adjustment.

The continuous level measurement can be aborted by clicking “Stop Adjustment”.

Once the noise field has been adjusted, the result can be documented by pressing “Start Measurement”. Although there is no calibration value to be used in the ambient noise rejection measurement, the level is stored and can be included for reference in the measurement report.

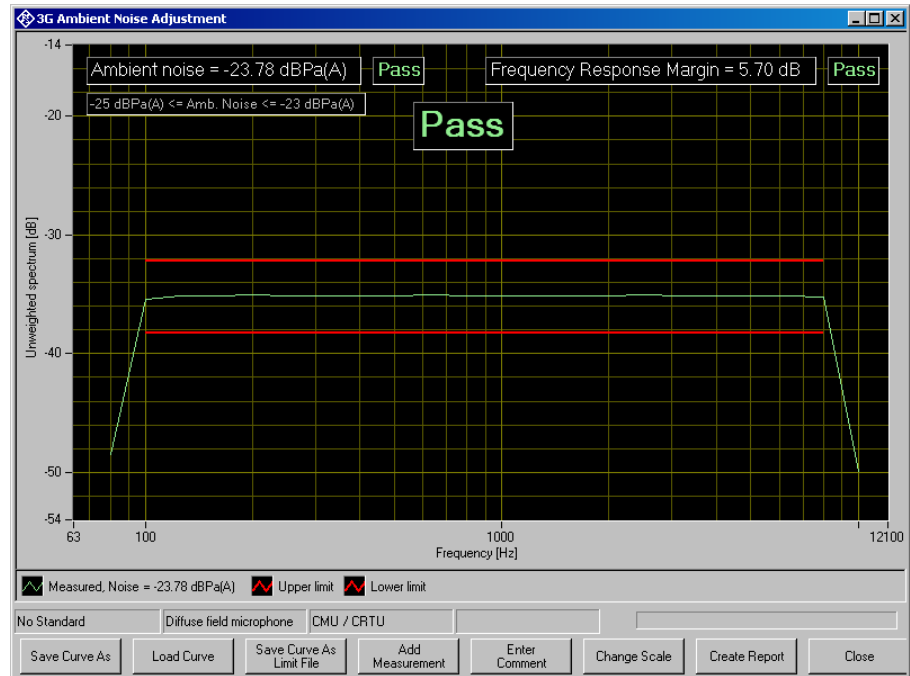


Fig. 21 Result of ambient noise calibration.

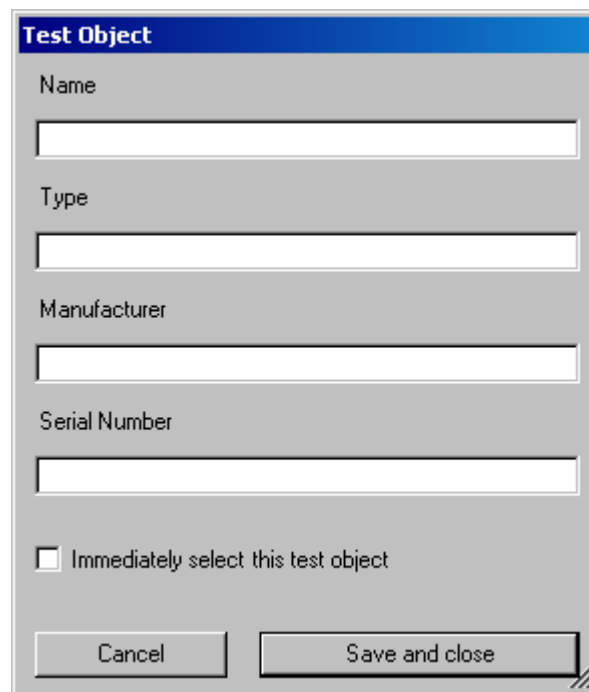
5 Data Entry for Reporting

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 dialog box titled "Test Object" with a blue header. It contains four text input fields: "Name", "Type", "Manufacturer", and "Serial Number". Below these fields is a checkbox labeled "Immediately select this test object". At the bottom of the dialog are two buttons: "Cancel" and "Save and close".

Fig. 22 Window for input of information about a test object

If the checkbox “Immediately select this test object” is checked, the test object associated with the entered data is automatically selected upon closing the window. 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.

A previously entered test objects can be selected with “Data → Test object → Select”.

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.

Starting measurements

Measurements can be started from the “Measurement” menu. This menu contains either all available measurements, or the measurements belonging to the selected standard if the checkbox “Allow only selected measurements” in the “Options → Select standard” window is checked.

The menu “Standards” allows to start any measurement, whereby the measurements are structured into submenus according to the standards to which they belong. This allows a quick and easy access to all available measurements.

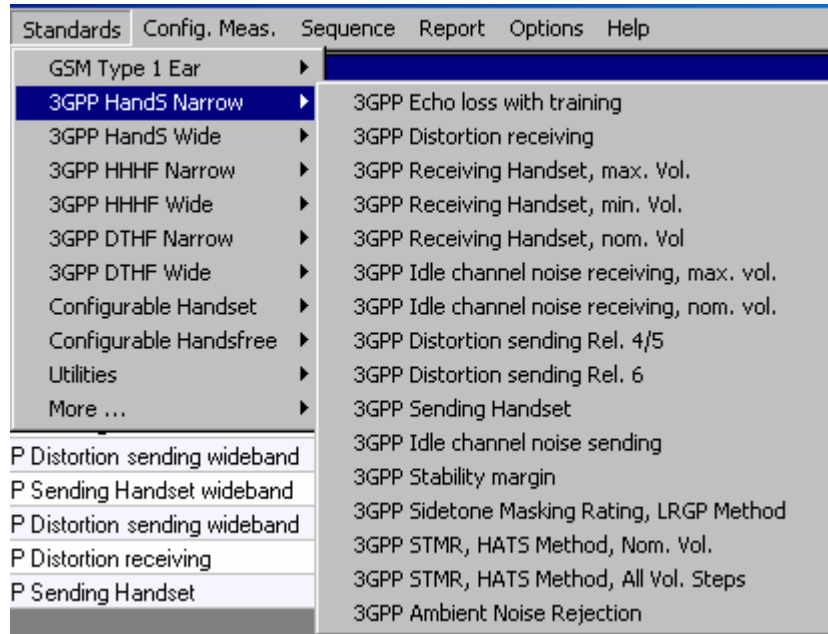


Fig. 23 “Standards” menu with submenu for narrow band handset tests according to 3GPP TS 26.132.

A third possibility to start a single measurement is the button “Run highlighted as single measurement” in the sequence menu (see chapter 7 below).

Functionality and control of the measurement macros



Fig. 24 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:

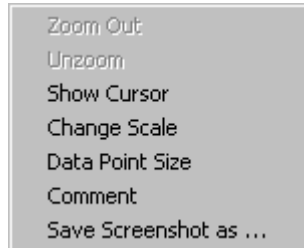


Fig. 25 Context menu of the graph window

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.

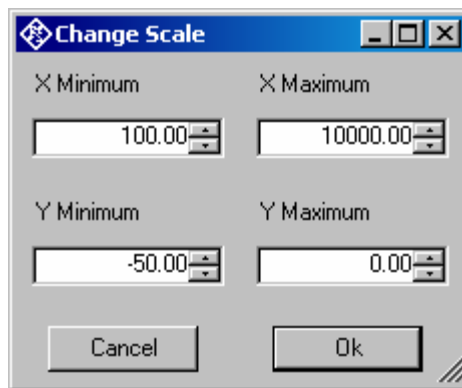


Fig. 26 Window for changing the scale of the graph

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.

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.

Storing a Hardcopy of the Graph

With the menu item “Save Screenshot as ...” in the graph context menu, a hardcopy of the current graph window with all numeric displays, legend etc. can be stored as image. The current view of the graph including additional curves, current scaling and size is copied. However, colours are inverted to a printer-friendly colour set.

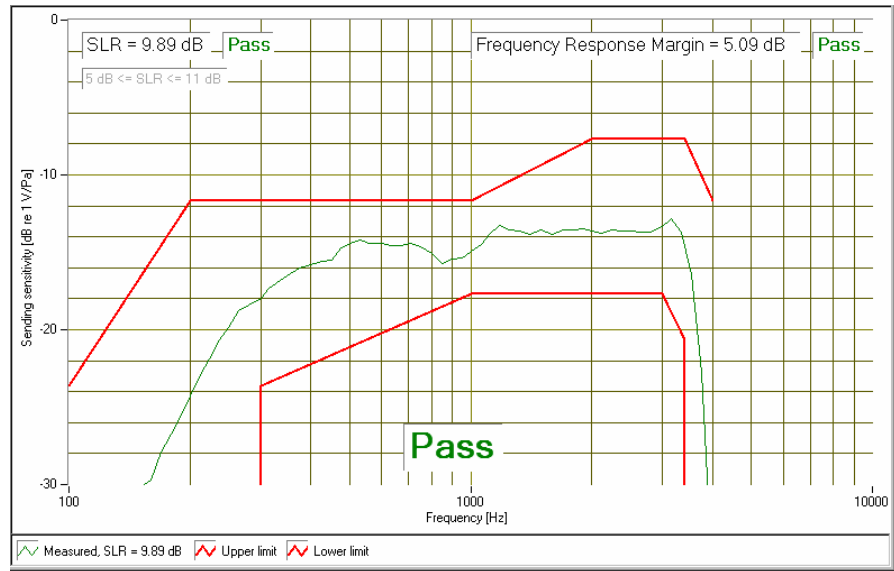


Fig. 27 Hardcopy of measurement graph

Making Additional Measurements

The softkey “Add Measurement” triggers another measurement according to the specification of the test. Loudness ratings and other result values like total noise level are calculated and displayed in the legend. The additional curves and results will appear in the report if item “Store results of further measurements” had been activated before the measurement was started. However, limits are not checked for additional measurements.

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 (*.tra), and such curves can be loaded back into the graph. For easy import to Excel the csv format is also offered. 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 with the specified format at the specified location.

If the “Options” menu item “Store loaded curves to results database” is checked, loaded curves are stored together with the measurement results and will appear in reports about the measurement.

Frequency response curves may also be stored as (relative!) UPL-compatible trace files.

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.

Deleting Additional Curves in the Measurement Graph

By pressing or clicking “Delete Curve”, an additional curve in the measurement graph can be removed. A window pops up with a combo box in which the curve to be deleted can be selected. Note that it is not possible to delete the curve of the first measurement, as this is the measurement for which the verdict is given. The selected curve disappears from the graph on the screen and is removed from the database such that it does not appear in reports anymore.

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 Handset 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 acc. 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. 28 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	-10	
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 acc. 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. 29 Receiving frequency response with RLR value displayed

Sidetone Masking Rating (STMR)

(“3GPP STMR, LRGP Method”, “3GPP STMR, HATS Method”)

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.

Up to release 7.0 the STMR can only be measured according to standard using ear type 3.2 (low leakage) (“3GPP STMR, LRGP Method”). Up to release 4, ear type 1 may alternatively be used for 3GPP TS 51.010 only (“3GPP GSM Rel. 4 Sidetone Masking Rating”). For these tests the mobile phone under test is installed in the LRGP (ITU-T P.76), and the receiver is sealed to the artificial ear.

From release 7.1 it is also possible to use ear type 3.3 or 3.4 for this test. “3GPP STMR, HATS Method, Nom. Vol” has to be passed in the nominal setting of the user volume control. “3GPP STMR, HATS Method, All Vol. Steps” has to be passed in all (other) settings of the volume control.

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 nominal receiving loudness, the STMR should be within 13 dB and 23 dB according to 3GPP TS 26.131 when the LRGP method is applied. With the HATS method, the target STMR is between 12 dB and 20 dB at nominal volume setting. At all other volume settings, the STMR must not be below 8 dB with the HATS method.

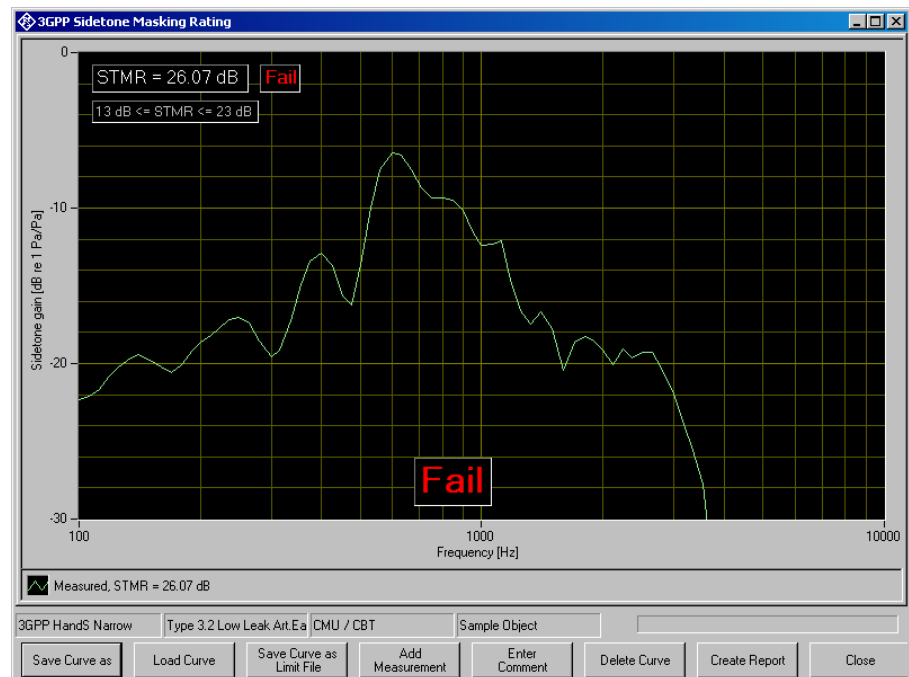


Fig. 30 Typical measurement of sidetone masking rating

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.

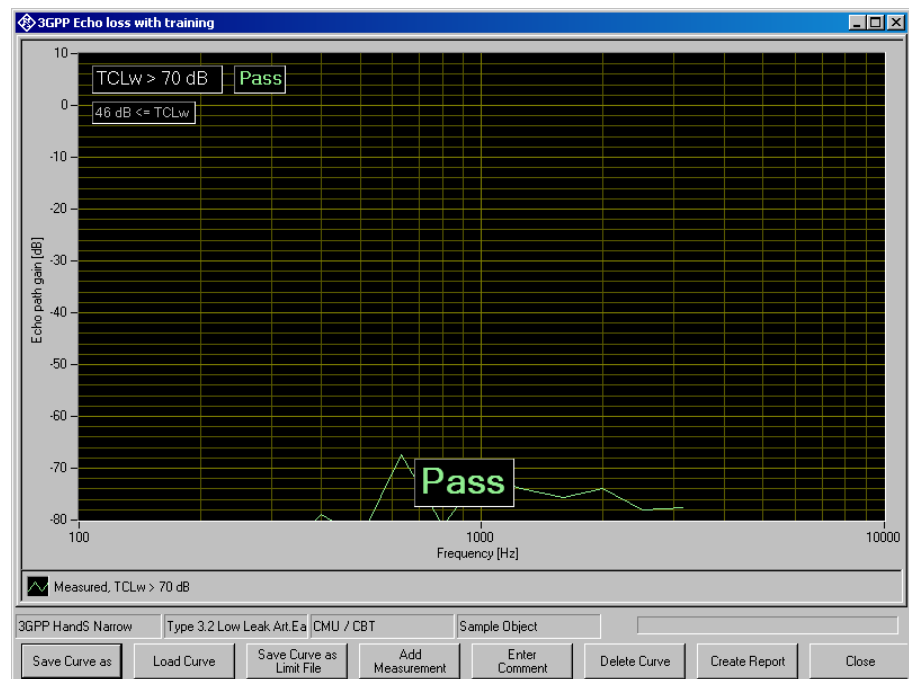


Fig. 31 Typical result of echo loss measurement

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.

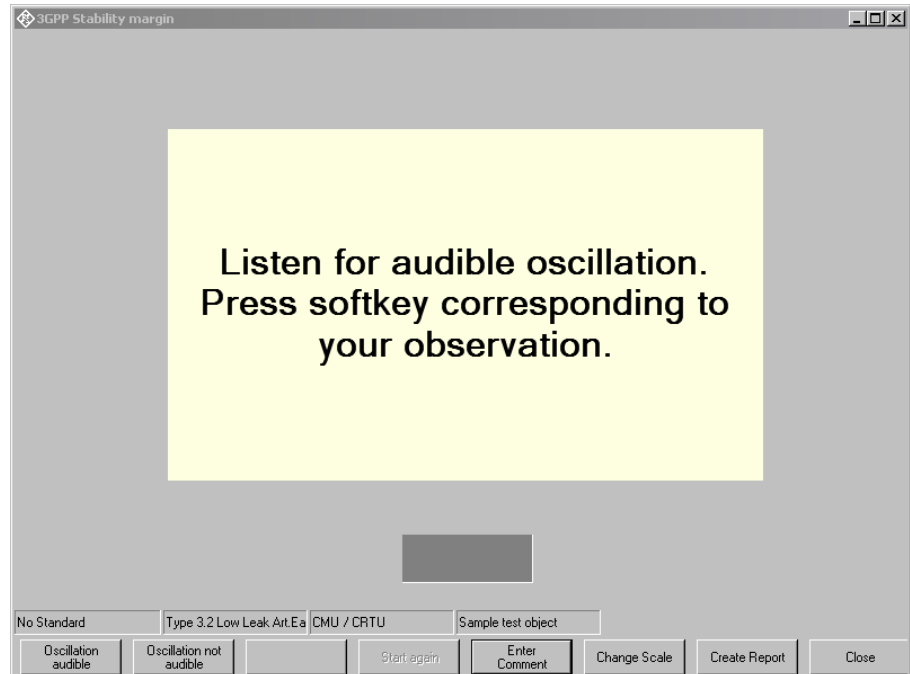


Fig. 32 Window during stability margin test

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. 33 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. 34 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 and recalculated for the internal level in dBm0p.

For the narrow band test, the weighting is done psophometrically according to ITU-T G.223. For the wideband version of the test, A weighting according to IEC 60651 is applied.

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.

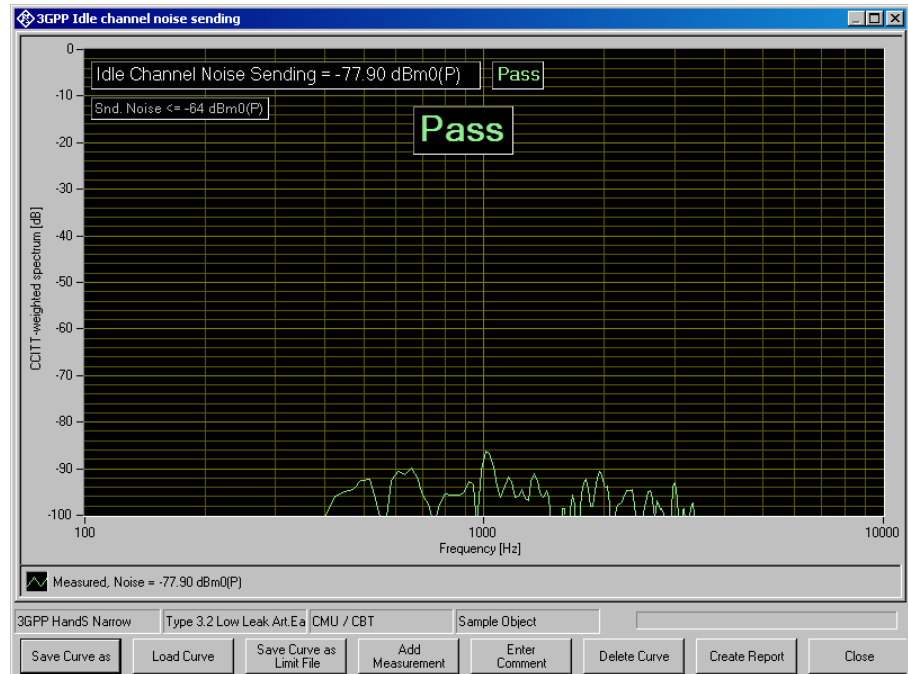


Fig. 35 Typical result of sending noise measurement

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.

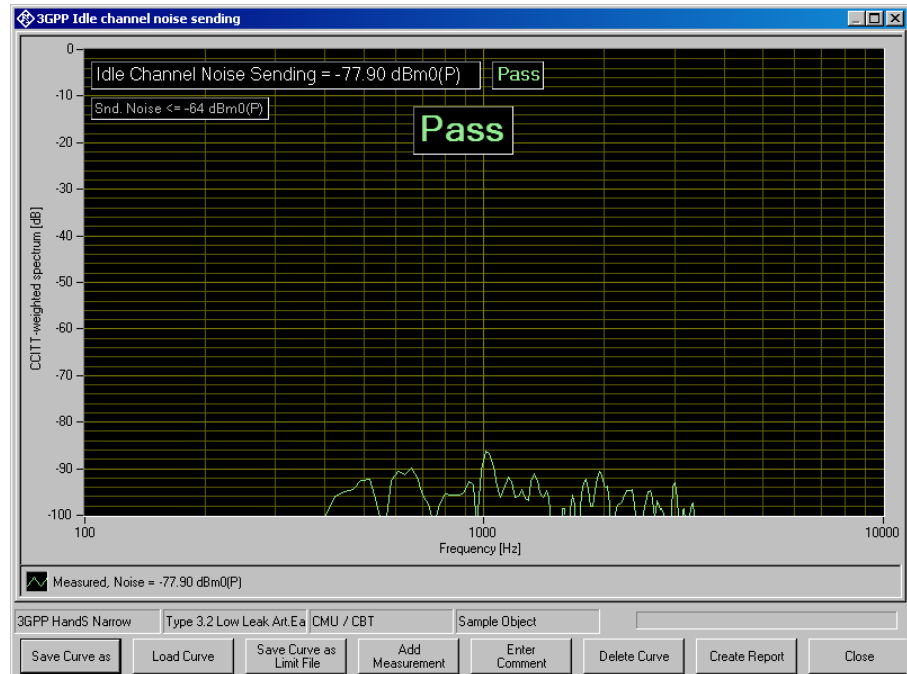


Fig. 36 Typical result of receiving noise measurement

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.

Ambient Noise Rejection

Ambient noise rejection describes the weighted ratio of voice signal transmission to noise in the environment. An ANR value >0 dB means that voice as the useful signal is transmitted more loudly than any ambient noise. The minimum requirement according to 3GPP TS 26.131 is $ANR > -3$ dB. A value ≥ 3 dB should at least be attained.

To perform this measurement, a homogeneous noise field for simulating the noise in the environment has to be generated. This sound field must be generated by additional loudspeakers and noise generators. To obtain a sufficiently homogeneous sound field, several uncorrelated generators and loudspeakers are required. The use of 2 to 8 generators and loudspeakers is common practice. The noise sources have to generate pink noise (spectral power density $\sim 1/f$). The permissible error in the relevant third-octave bands must be smaller than ± 3 dB with the frequency response of the loudspeakers used also being taken into account.

This adjustment and testing of the sound field is done as a calibration process (see section 4 above). With sufficient long-term stability of the noise generators and loudspeakers it can be used for a number of subsequent tests. Alignment of the noise field has to be repeated if anything in the setup of the noise sources (loudspeaker position, amplifier gain etc.)

is changed. Furthermore it is recommended to check the noise field in regular intervals.

After the noise field calibration, the artificial mouth and the artificial ear must be installed again for the actual measurement of ANR. The MRP must be installed at the same position as the reference microphone had during the calibration of the noise field.

The mobile phone under test is installed in the LRGP (ITU-T P.76) or on the HATS (ITU-T P.58). If installed on the LRGP, the receiver is sealed to the artificial ear.

Set up a call to the CMU and set the bit stream to "Handset Low" (GSM) or the dedicated channel voice to "Speechcodec Low" (WCDMA).

At first the noise spectrum picked up by the phone and sent on the uplink is measured. After completion of the measurement, the request to switch off the noise field will be displayed on the screen. If this is confirmed, the speech sending sensitivity will be measured automatically and the ANR value will be calculated afterwards.

The ANR value must exceed -3 dB.

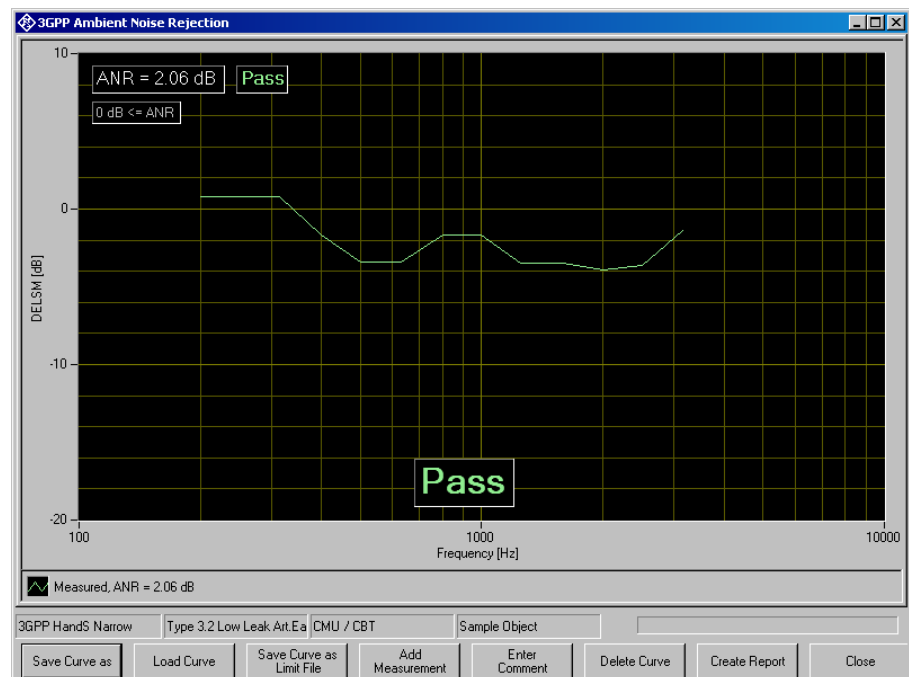


Fig. 37 Typical result of ambient noise rejection measurement

The graph displays the difference of the room noise sensitivity and the speech sending sensitivity (DELSM) for information.

Notes on Hands-Free Measurements

General Remarks

The standards 3GPP TS 26.131 and TS 26.132 define requirements and test specifications for the tests of the acoustic behaviour of the mobile phone in this mode, but not all details are specified yet.

UPV-K91 3GPP Mobile Phone tests provide test cases for handheld hands-free and desktop hands-free mode with narrow band and wideband speech. Test specifications and limits for hands free car kits are the same as for desk top hands-free terminals.

Hands-free tests with UPV-K91 support the use of either artificial mouth according to ITU-T P.51 together with a free field measurement microphone or alternatively the use of a HATS with type 3.3 or 3.4 artificial ear and artificial mouth according to ITU-T P.58.

Test Setup

All tests must be performed in an anechoic room. Background noise must be less than 24 dB SPL(A). Furthermore the room should be big enough and its walls should have sufficient absorption to provide nearly free-field conditions at the hands-free reference point. Not all test boxes which are appropriate for handset tests can be used for hands free measurements.

If a free-field microphone with a discrete P. 51 mouth is used, it should be configured to the Handheld hands-free UE as per Figure 12 for receiving measurements and Figure 13 for sending measurements. The measurement instrument should be located at a distance d_{HF} from the centre of the visual display of the mobile station. The distance d_{HF} is specified by the manufacturer.

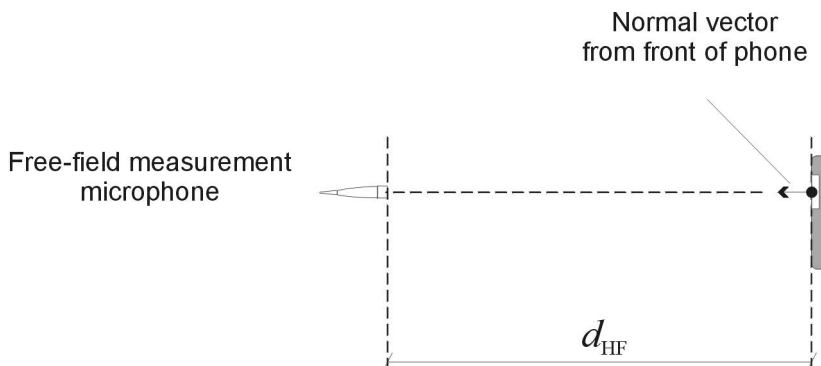


Fig. 38 Configuration of handheld hands-free UE, free-field microphone for receiving measurements

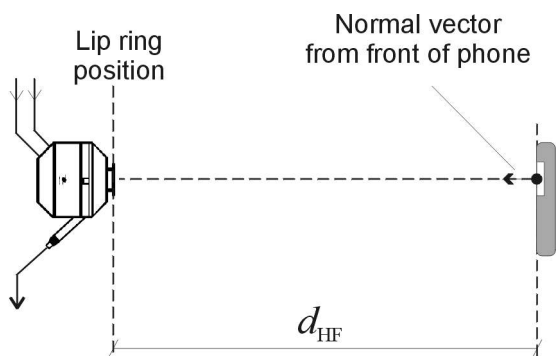


Fig. 39 Configuration of handheld hands-free UE, free-field microphone for receiving measurements

If a HATS is used, the measurement can either be performed binaurally (with two artificial ears and correction of the RLR by 6 dB) or monaural.

The selection of acoustic accessories used for the hands free tests can be entered in menu item “Options → Hands free settings”.

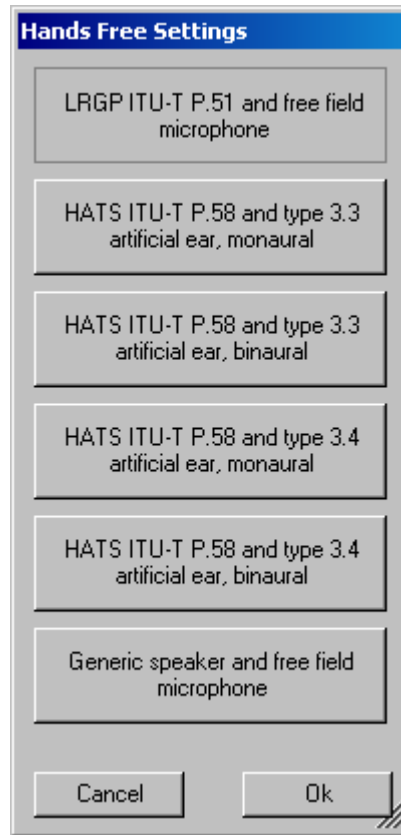


Fig. 40 Hands free settings

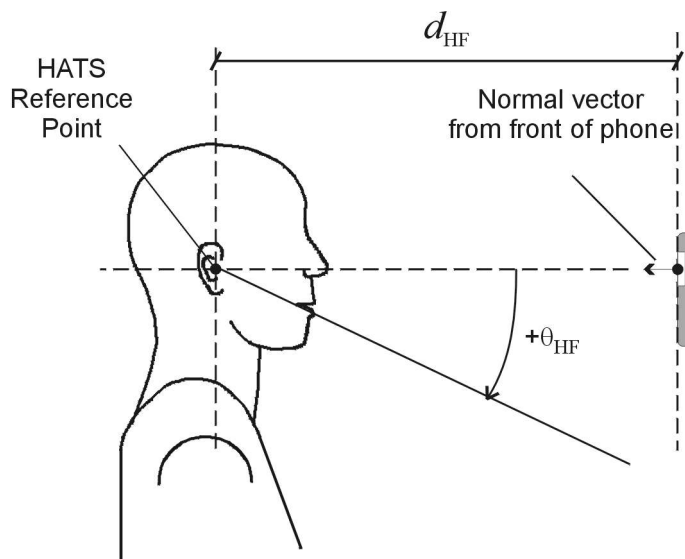


Fig. 41 Configuration of handheld hands-free UE with HATS

For desk top hands-free it is referred to ITU-T P. 340 (<http://www.itu.org>) for the use of free field microphone and discrete P.51 mouth. The hands free terminal should be placed on a table of approximately 1 m² with the centre of its front edge 400 mm perpendicularly from the centre of the front edge of the table. The surface area should not be less than 0.96 m² and its width should not be less than 0.8 m. The front centre of the measuring microphone or centre of the lip ring, respectively, should be placed 300 mm above the centre of the front edge of the table with the axis of the microphone or artificial mouth inclined towards the centre of the front edge of the hands-free terminal.

For the use of a HATS with both types of hands-free terminals it is referred to ITU-T P.581. For handheld hands free the setup of ITU-T P.581 corresponding to “portable hands-free” should be used. For desk top hands-free, the centre of the lip ring is positioned as described above, but the axis of the artificial mouth should be horizontal.

Acoustic Calibration for Hands Free Tests

The calibration for the free field microphone or type 3.3 or type 3.4 HATS ear, respectively, is done as described in chapter 4 above.

For binaural measurements, the second artificial ear has to be calibrated accordingly, using the sub-item “Second Type 3.3 ear” or “Second type 3.4 ear”, respectively, in “Calibration → Artificial Ear”. Note that the second artificial ear must be connected to Analyzer input 2 instead of the CMU connection.

According to 3GPP TS 26.132 free field equalization has to be taken into account. Free field data can either be imported as an average table from the standard or from an individual calibration disk, using the menu item “Calibration → Free field equalization”.

The calibration of the artificial mouth for hands free tests comprises two additional steps. After the level has been adjusted and the frequency response has been equalized at the MRP, the reference microphone has to be repositioned at the so-called Hands-Free Reference Point (HFRP or HATSHFRP).

For the mouth according to ITU-T P.51 the HFRP is in 50 cm distance from the lip ring on the axis of the mouth. The calibration has to be performed at this point independent of the measuring distance currently used.

The HATS HFRP is stipulated in ITU-T P.581. It is one of the points 11 to 17 defined in table 6a of ITU-T P.58. It should be on the axis which is closest to the actual axis from the lip ring to the microphone under test. The distance is always 50 cm from the lip ring. The axis may be azimuthally centric (i.e. 0° horizontally) with an elevation (vertical) angle of 0°, ±15° or ±30°. Points 16 and 17 are located on an axis with 0° elevation and an azimuth angle of 15° or 30°.

The level at this point is adjusted to -28.7 dBPa. For the last step, the reference microphone is returned to the MRP, and the level and spectrum at the MRP are measured as reference for the transfer function calculation.

The mouth calibration for hands-free tests is started with the menu item “Calibration → Artificial Mouth (Hands Free)”. This procedure comprises the mouth calibration for handset tests and has also effect on subsequent handset tests with the same individual artificial mouth.

“Utilites” Measurements

This item of the “Standards” menu contains useful measurements which are either from other standards or for checking test conditions.

Sidetone Distortion

A sidetone distortion test is specified in 3GPP TS 51.010 30.8 for measurements using the DAI. As the downlink conveys only silence during this test, it is more or less independent of the kind of transmission between system simulator and mobile. The sidetone distortion test determines 3rd order harmonic distortion at a given set of frequencies (in the case of TS 51.010 at 315, 500 and 1000 Hz) with a level of -4.7 dBPa at the MRP. The third order harmonic distortion is required to be less than 10 % (-20 dB) at all frequencies.

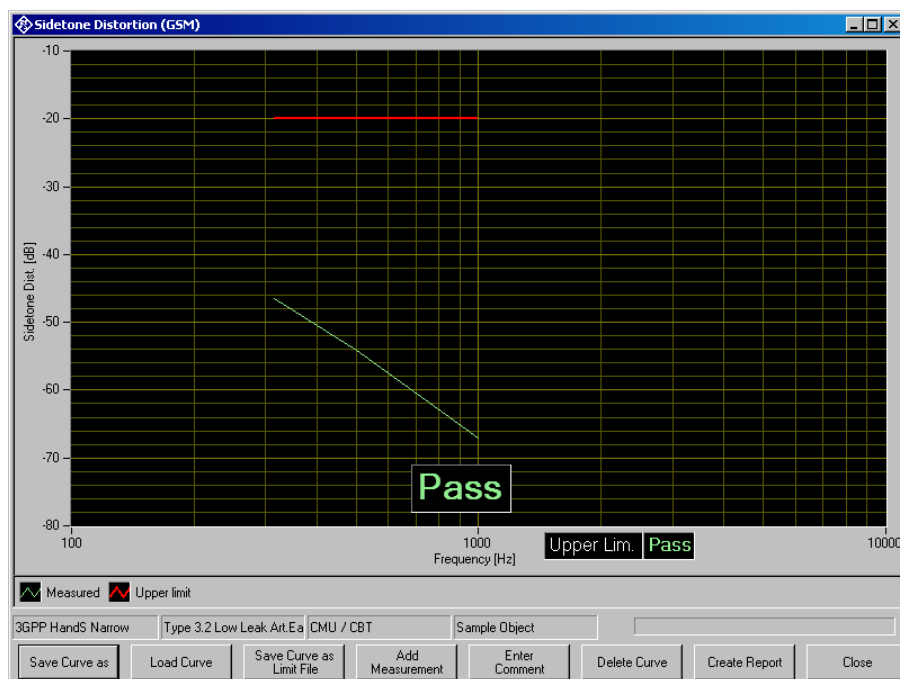


Fig. 42 Sidetone distortion test

Gain Variation Tests

Gain variation tests in sending and receiving direction are specified in 3GPP TS 43.050 Annex C.5. The limits given in TS 43.050, sections 3.9.1 and 3.9.2 are meant for measurement over DAI and cannot be fulfilled when a Codec is in the transmission chain. The configurable versions of the gain variation tests allow to define specific limit curves.

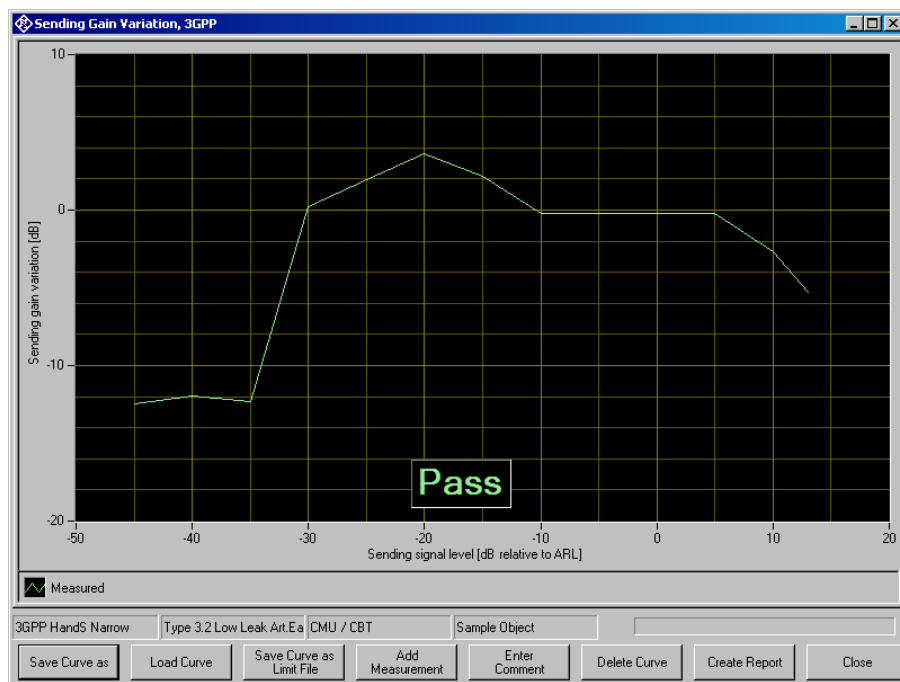


Fig. 43 Sending gain variation test

Delay Measurements

Sending and receiving delay can only be measured end-to-end, i.e. from the acoustic origin of the artificial mouth to the decoder output of the system simulator or from the encoder input of the system simulator to the DRP. The measurements offered with R&S UPV-K91 allow to subtract the estimated delay of the CMU from the total measured value. As the data is interleaved on the air interface, no exact time instance can be determined when the audio data are transmitted between mobile phone and system simulator. The values used in the present measurements are estimations with an uncertainty of about 10 ms. The delay measurement is performed for a given set of frequencies, and an average is calculated over all frequencies.

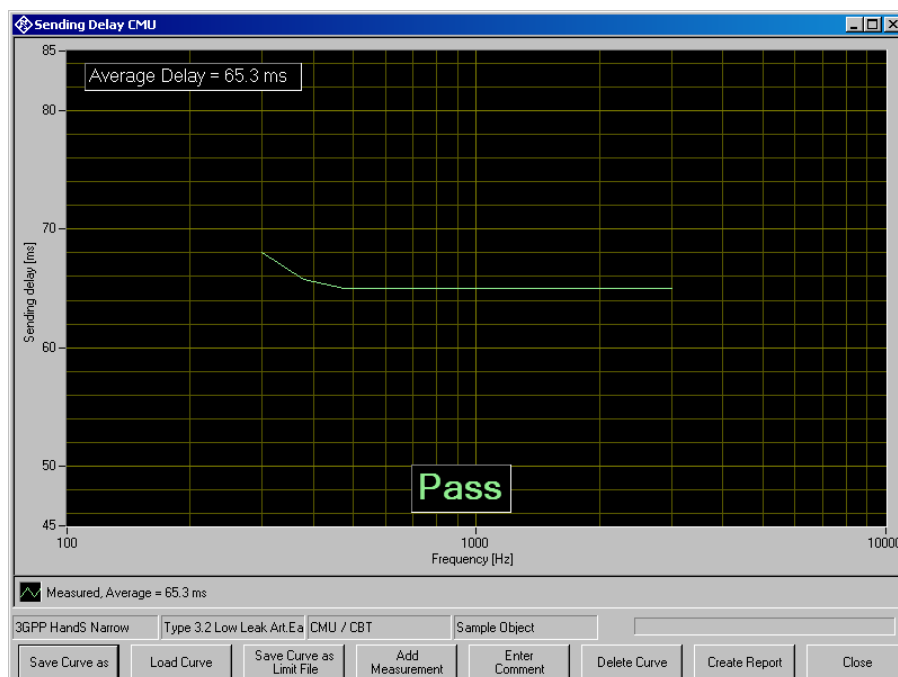


Fig. 44 Sending delay measurement

Background Noise Measurements

3GPP TS 26.132 demands the background noise in the test room to be below -64 dBPa(A) for idle channel noise measurements and below -30 dBPa(A) for all other handset measurements. For hands free measurements the background noise needs to be below -70 dBPa. The background noise measurements offered in R&S UPV-K91 check the overall noise level against these limits and display the spectrum of the noise. A lower limit assures that the test is not erroneously passed if no microphone is connected or the microphone supply is switched off.

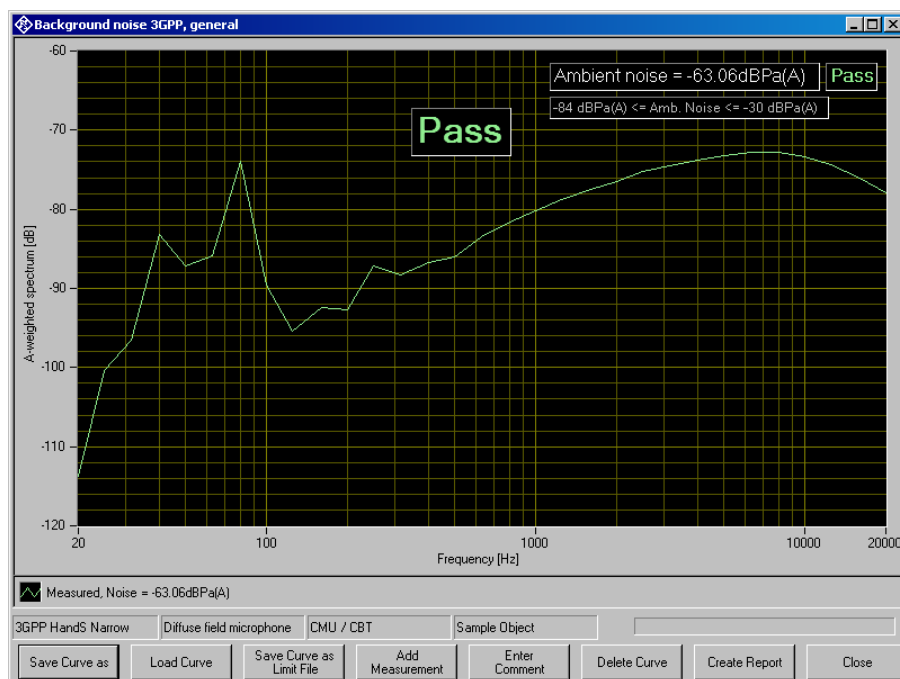


Fig. 45 Background noise measurement

If the noise in the test room does not fulfil the requirements it may first be attempted to remove noise sources in the vicinity of the test chamber. If no further reduction is possible, the sound isolation of the chamber should be improved. This can be achieved e.g. by heavier walls. Low frequency noise may possibly be conducted as structure borne sound, which may be reduced by an isolating support of the chamber. High frequency noise can be caused by a leakage e.g. at the door and may be reduced by an improved gasket.

7 Customizing Measurements

Measurements which implement a test case of a standard are locked and cannot be edited. However, for each measurement type there is also a configurable measurement provided, in which the limits can be customized. The parameters of the measurements are accessible through the menu item "Config. Meas."

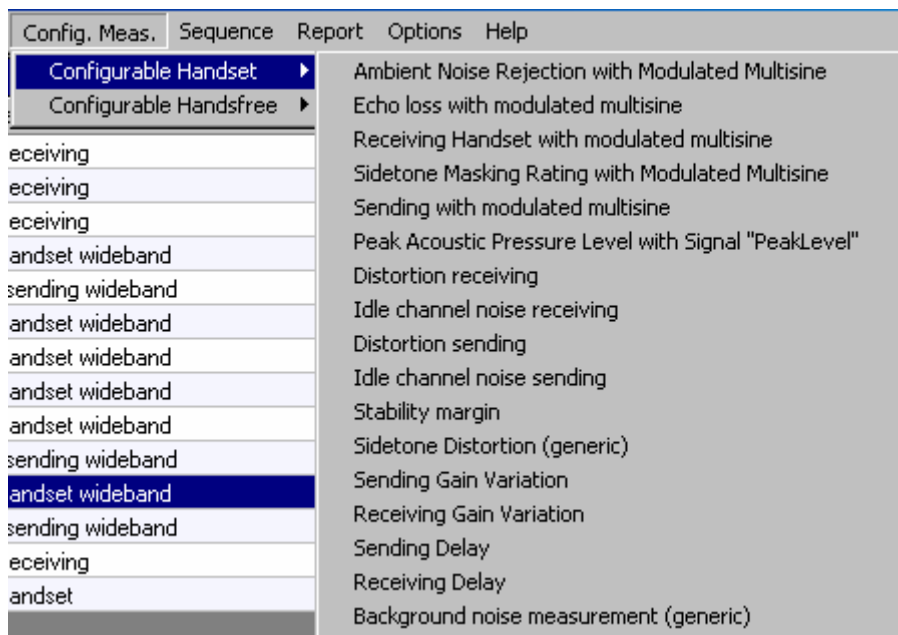


Fig. 46 Measurement configuration menu

Clicking on one of the entries opens a window in which all parameters can be viewed and most of them can be customized:

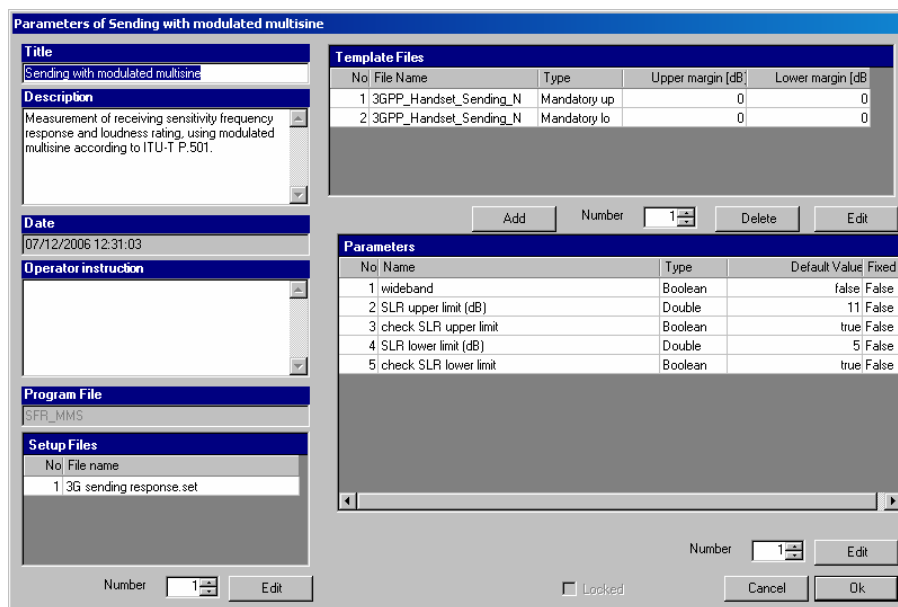


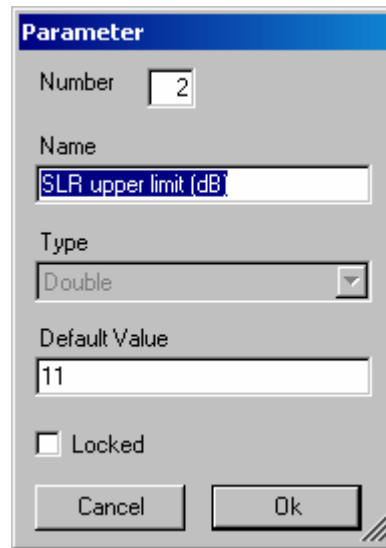
Fig. 47 Measurement parameters window

As Sequences create copies of the parameter files, each instance of a measurement in a sequence can have different settings which remain independent of the setting of this measurement in the main window and in other sequences. It is for example possible to compile a sequence with a number of stability margin tests having different loop gain.

The titles of the tests and the messages displayed to the operator before start of the measurement can also be edited in the “Parameters” window.

Editing Parameters

Parameters can be edited by entering their number in the “number” field below the data grid and clicking “Edit”.



The image shows a dialog box titled "Parameter" with a blue header. It contains several input fields and a checkbox. The "Number" field has the value "2". The "Name" field has the text "SLR upper limit (dB)". The "Type" dropdown menu is set to "Double". The "Default Value" field has the value "11". There is a checkbox labeled "Locked" which is currently unchecked. At the bottom of the dialog are two buttons: "Cancel" and "Ok".

Fig. 48 Entry window for parameters

Note that the type conformity of the entered value is checked, but not the value itself against any range limits.

Editing Limit Curves

Clicking “Add” or “Edit” below the data grid for the limit curves opens the window for selecting limit files.

Note that currently only “mandatory” limit curves are supported. Most of the measurement allow to specify either lower limits or upper limits or both. An exception is formed by the sending response and receiving response measurements. As the limit template is centered around the measured curve with these measurements, upper and lower mandatory limits have to be specified pair-wise.

An exiting limit file can be selected using the “browse” button. New limit files can be created by copying an existing limit file and editing the copy with a text editor (“Send to → Notepad” in the context menu of the file in the windows explorer). The number of data points on the curve must be specified in the “Datacount” line.

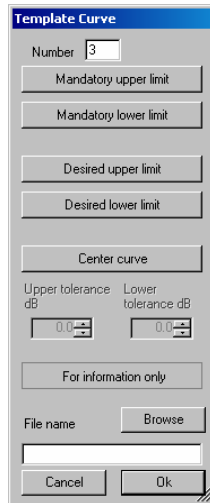


Fig. 49 Entry window for selecting limit curves

8 Measurements with electric connections

Introduction

Usually the mobile under test is connected via RF connection to the CMU and via acoustic interfaces (artificial mouth and ear) to the R&S UPV. Therefore no intrusion in the mobile device is required.

There may, however, be cases during the design process of a mobile phone where the usual interfaces are not available:

- if a mechanic mockup is to be measured just with the acoustic components but without the rest of the circuitry
- if a circuit of a mobile phone is to be measured without acoustic components
- if a hands free kit or headset is to be measured without mobile phone
- if the hands free or headset connection of a mobile phone is to be measured without hands free kit or headset, respectively.

In these cases either coder and decoder or artificial ear and artificial mouth may be replaced by direct electrical connections to the R&S UPV. To use electric connections, select "Electric connection" in the respective item of the "Options" menu.

Calibration values for electric connections

Electrical connections cannot be calibrated. Instead a virtual sensitivity has to be entered for each type of electrical connection under "Calibration → Electric connections → ...".

Electric connection replacing artificial ear

R&S UPV Analyzer input 1 is directly connected to the earpiece amplifier output.

A nominal sensitivity of the receiver (earpiece speaker) for which the circuit is intended has to be entered in dB re 1 Pa/V.

Electric connection replacing artificial mouth

R&S UPV generator output 1 is directly connected to the microphone input of the mobile phone circuit.

A nominal sensitivity of the microphone for which the circuit is intended has to be entered in dB re 1 V/Pa.

Electric connection replacing encoder

R&S UPV generator output 2 is directly connected to a earpiece or headset speaker or to the speech input of a hands free kit.

A nominal full scale output voltage (output voltage corresponding to digital full scale) of the circuit intended to drive the speaker or car kit has to be entered.

Electric connection replacing decoder

R&S UPV analyzer input 2 is directly connected to a microphone or to the speech output of a hands free kit.

A nominal full scale input voltage (input voltage corresponding to digital full scale) of the respective microphone or speech input has to be entered.

Performing the measurements

After applying the settings in the “Options” menu and after entering appropriate calibration values for the electric connections in use, the measurements may be started as usual.

Some parts of the standard require the use of particular artificial ears for particular measurements. Therefore the checkbox “Allow only selected measurements” should be unchecked in “Options → Standard”.

For sending tests, the output voltage range in the R&S UPV is set to a large value in order to be able to drive the speaker of the artificial mouth. In rare cases sending distortion and/or sending noise results may be degraded with electric connections if a low microphone sensitivity is entered. In this case please contact R&S support.

9 Automatic Test Sequences

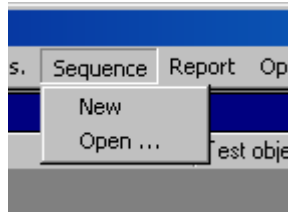


Fig. 50 Sequence menu

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.

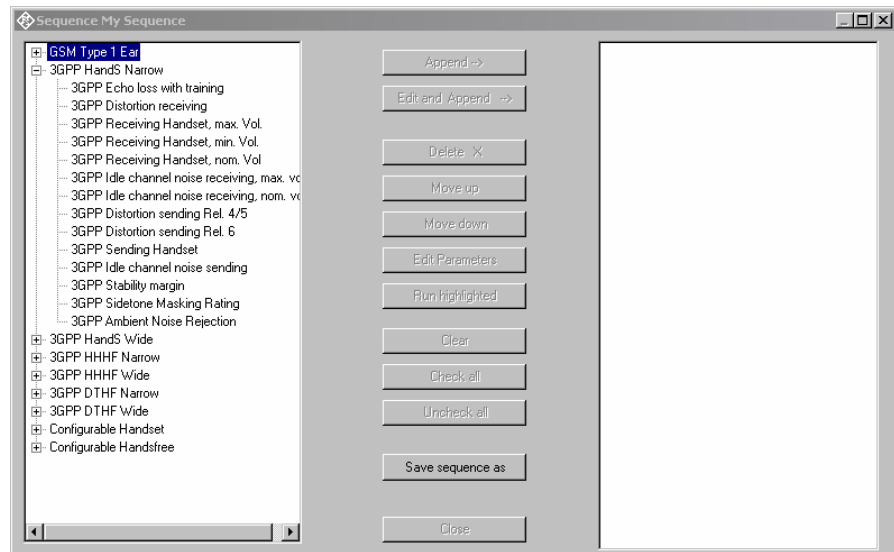


Fig. 51 Sequence window

Initially the right checked list box is empty. The tree view box on the left side displays all available measurement definitions structured according to the standards, similar to their order in the “Standards” menu. A measurement is appended to the sequence by highlighting it in the tree view 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 file is usually found in a subfolder of D:\3GPP with the same name as the sequence. 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.

A running sequence may be interrupted with the softkey “Stop / Cont Sequence” which stops the execution after the currently running measurement.

Running a Single Measurement out of a Sequence

A single measurement of a sequence may be started by highlighting the measurement in the right checked list box and clicking the button “Run Highlighted”.

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.

10 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.

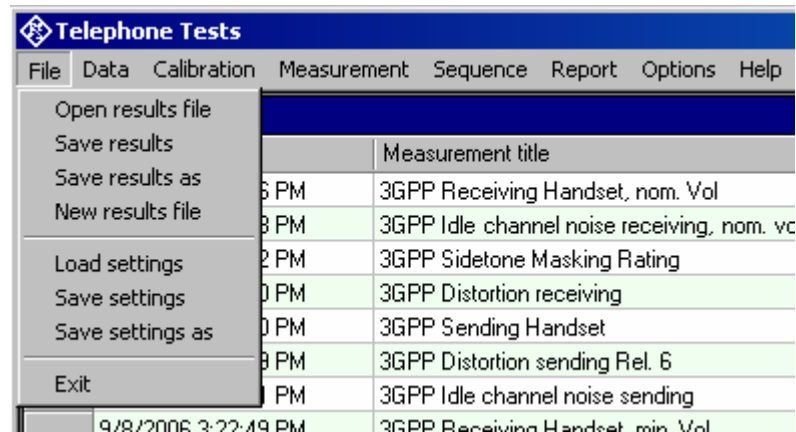


Fig. 52 File menu

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

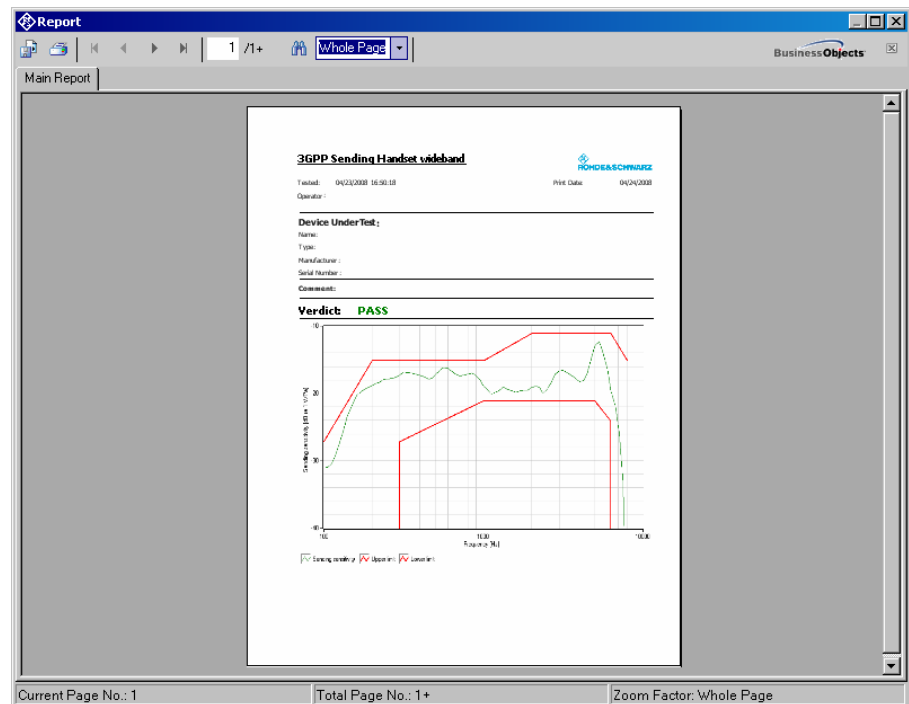


Fig. 53 Report preview window

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

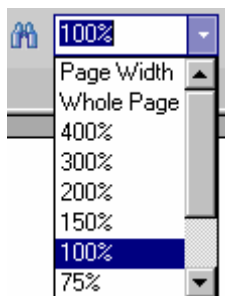


Fig. 54 Scale menu of the preview window

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/K91 window. This allows e.g. to derive tolerance schemes from “golden devices”. The measured curve can be arbitrarily shifted before being stored.

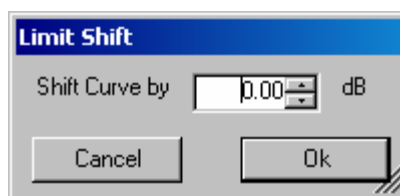


Fig. 55 Input window for defining a shift of a measured curve for storage as limit curve

Furthermore curves can be exported from the main results window by marking the result in the data grid, right-clicking on it and choosing the item “Save curve of selected row as ...” in the context menu.

ASCII Result Files

When the item “Generate temporary export files” in the “Options” menu is checked, the standard tests generate “curve.exp” or “abscurve.exp” and “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.

11 Terminating the Application

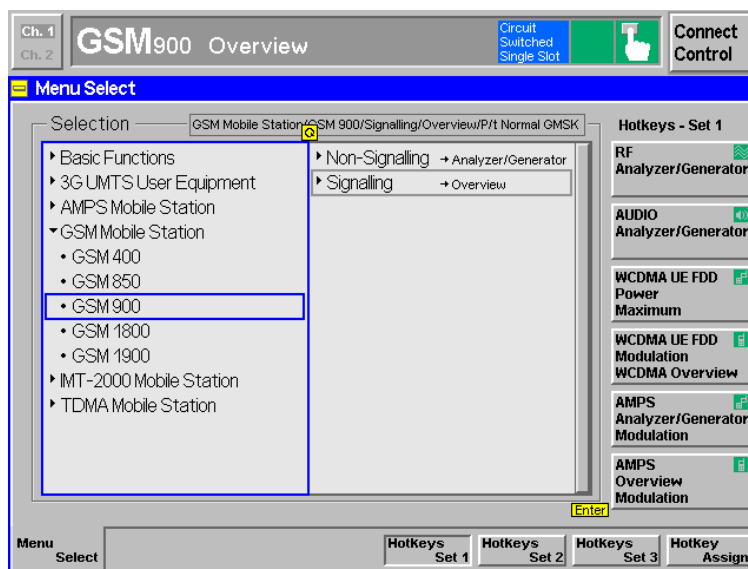
The measurement can be terminated from the main window with the “Exit” softkey. This causes the result file to be written to the hard disk.

Appendix A Settings on the Radio Communication Tester CMU200

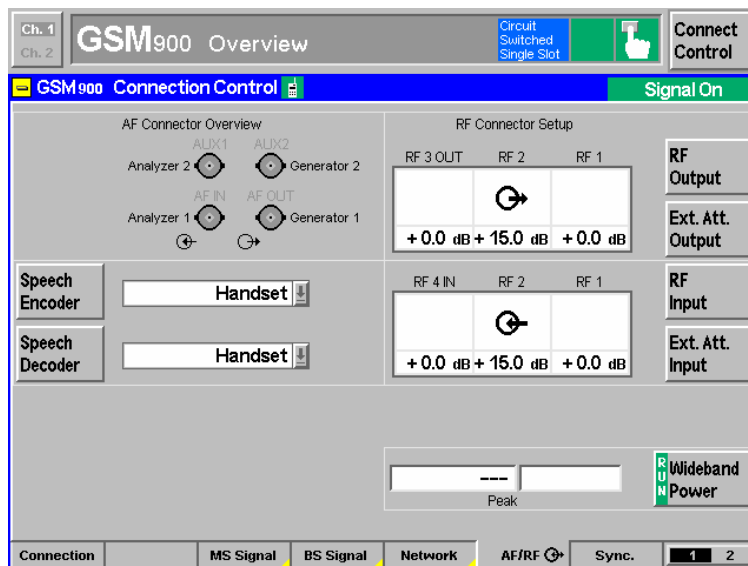
Firmware 4.52

Settings for GSM:

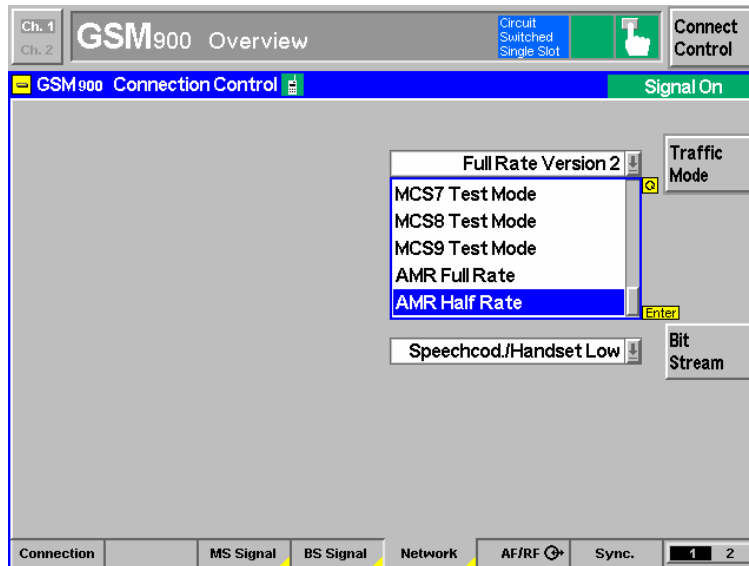
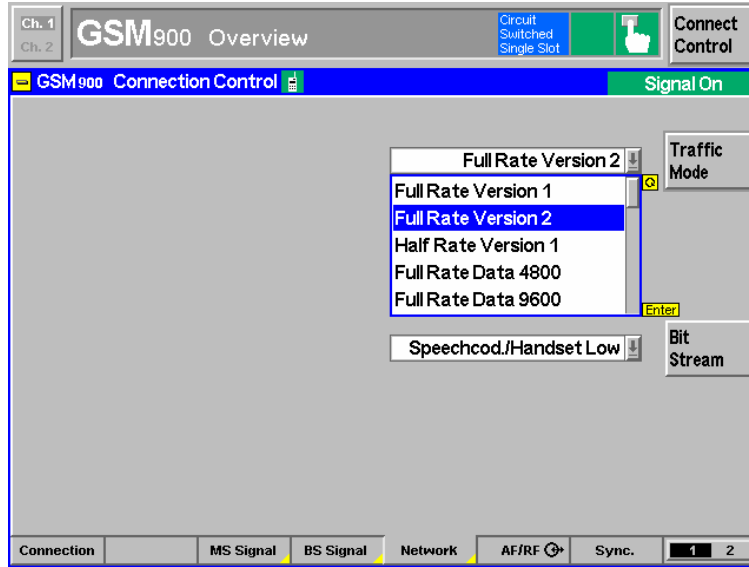
Selection of the GSM band:



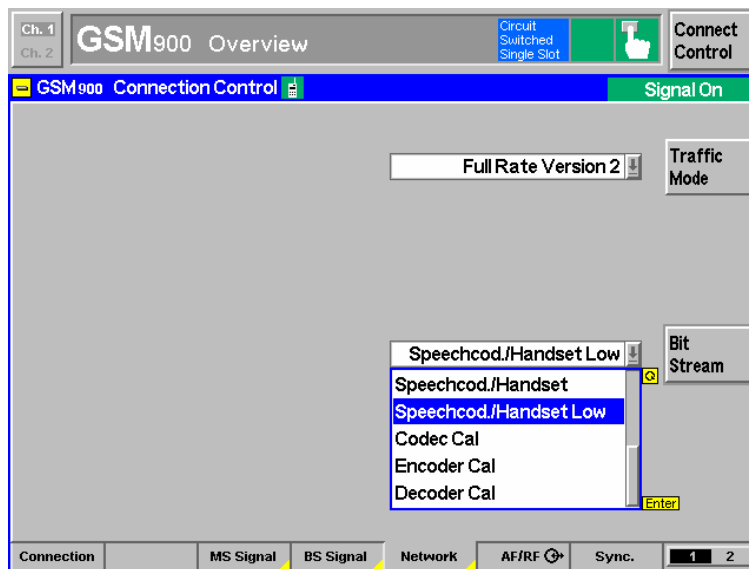
Taking a coupling loss of the antenna coupler into account:



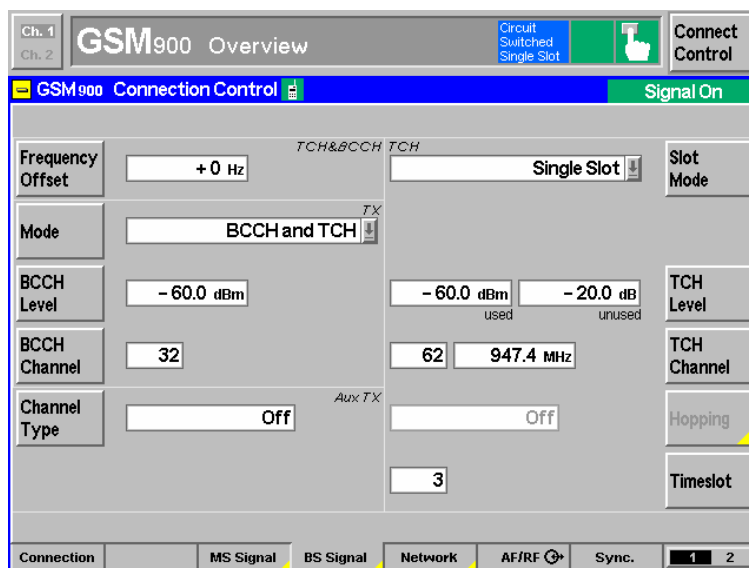
Select EFR (full rate version 2), HR (half rate version 1), AMR full rate or AMR half rate speech coder:



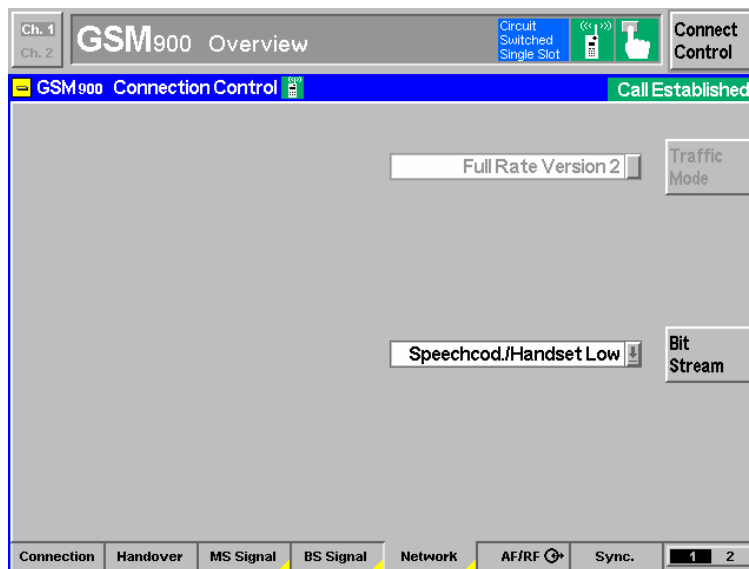
Selection of the Bit Stream Handset Low setting for the measurements or Decoder Cal and Encoder Cal for the calibration:



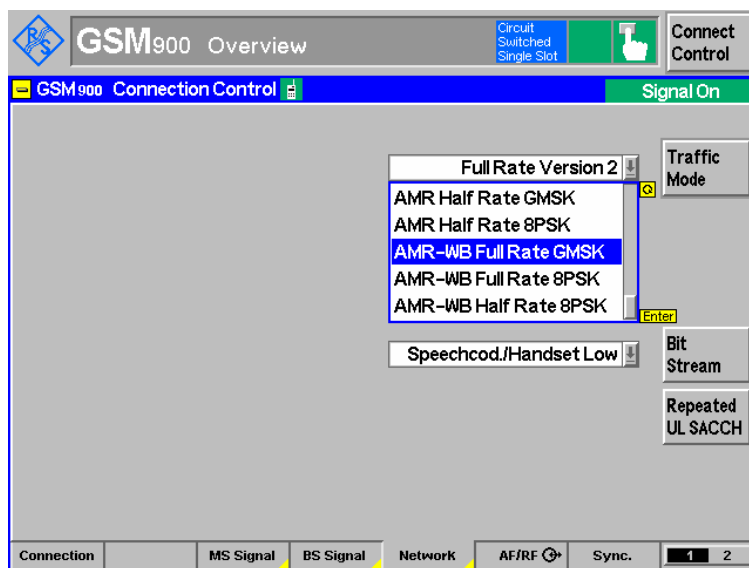
Setting of the desired TCH and BCCH levels:



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

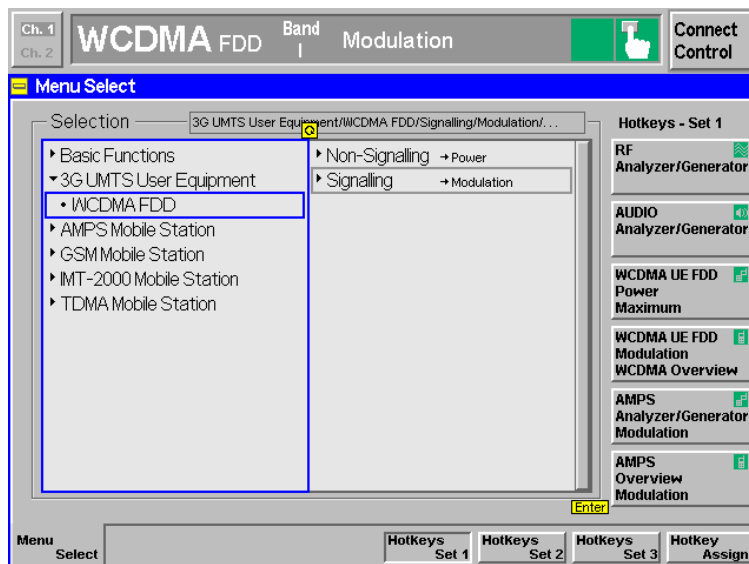


Settings for WB-AMR:

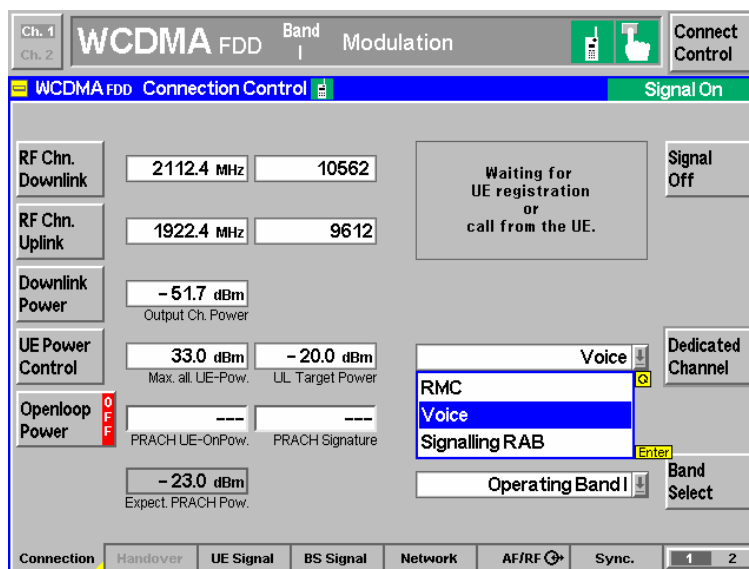


Settings for UMTS WCDMA FDD:

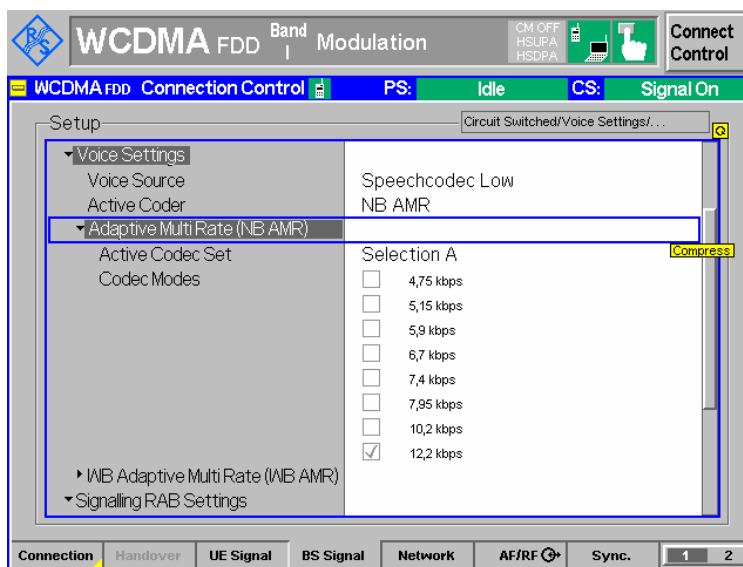
Selection of mode:



Setting dedicated channel to voice:

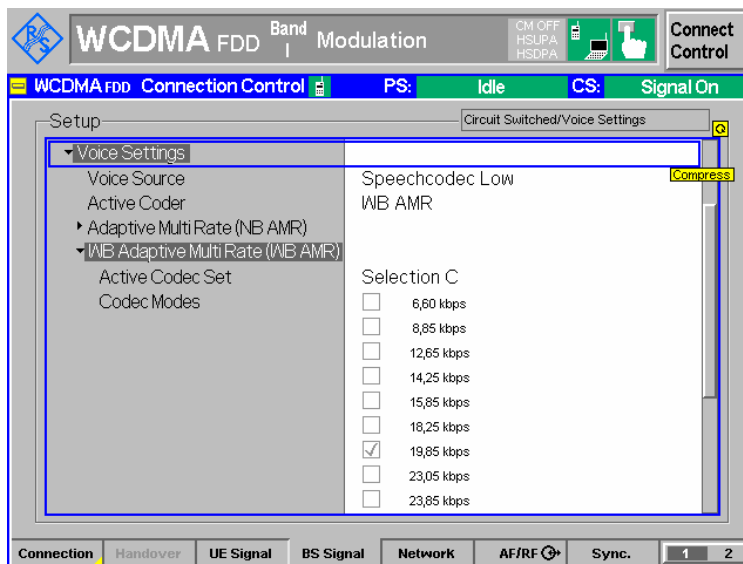


Selection of the Narrowband AMR Speechcodec Low setting and AMR Bit Rate for the measurements or Decoder Cal and Encoder Cal for the calibration (selection is possible only if call is deactivated):



3GPP Ts 26.132 specifies 12.2 kbps bit rate for audio testing with the NB AMR codec.

Selection of the Wideband AMR 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). 3GPP TS 26.132 specifies 19.85 kbps for audio with the WB AMR codec:



Mobile phone registered status, codec settings possible:

The screenshot shows the 'WCDMA FDD Connection Control' interface in a 'Registered' state. The top bar includes 'Ch. 1', 'Ch. 2', 'WCDMA FDD', 'Band 1', and 'Modulation'. A 'Connect Control' button is visible in the top right. 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). A dropdown menu is set to 'Voice'.
- Openloop Power:** PRACH UE-OnPow. and PRACH Signature fields are empty. Expect. PRACH Pow. is -23.0 dBm.

On the right side, there are buttons for '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.' At the bottom, a 'Connection' bar shows 'Handover', 'UE Signal', 'BS Signal', 'Network', 'AF/RF', and 'Sync.' with a status indicator '1 2'.

Call active (connected) status for the measurements:

The screenshot shows the 'WCDMA FDD Connection Control' interface in a 'Connected' state. The top bar is identical to the previous screenshot. The main area contains the same control panels, but with a different central instruction box: 'Disconnect the UE by pressing the "Disconnect UE" key.' The buttons on the right are now 'Signal Off', 'Unregister', 'Disconnect UE', 'Dedicated Channel', and 'Band Select'. The 'Connection' bar at the bottom remains the same.

Appendix B Troubleshooting

Damaged setup file is reported

Copy "Settings.sup" from C:\Program Files\Rohde&Schwarz\UPV-K9x Mobile Phone Tests" to "D:\3GPP", overwriting the damaged file of the same name. Alternatively, "D:\3GPP\settings.sup" may just be deleted. Subsequently all settings in the "Options" menu have to be re-done and for all used calibration types calibrated devices have to be selected again.

Damaged results file is reported

There are backup files available of the file containing the test results, with appendix ~1 and ~2 to the file name of the results file (usually "D:\3GPP\Results.xml"). If the results file cannot be opened for some reason, the later backup file can be renamed by removing the respective ~1 or ~2 extension, and opened subsequently. It is recommended to store the damaged results file under a different name.

A test is not starting properly

Re-select devices for the calibration types required for the respective test, using menu item Calibration → Select device. If this does not solve the problem, copy all files from "C:\Program Files\Rohde&Schwarz\UPV-K9x mobile phone tests\3GPP files\Overwrite" to "D:\3GPP", overwriting the existing files therein.

A calibration value is missing or no device is selected for a required calibration type

If re-selecting the calibration device and re-calibrating it does not help, create a new device with "Calibration → New device". Tick the "Immediately select this device" box before clicking the "Ok" button and do the calibration for this device. All selected devices and their calibration values can be checked with "Calibration → Show selected devices".

The receiving noise test produces an overrange error

Reduce the gain of the conditioning amplifier in the signal path of the artificial ear and re-try the test.

ARL for the sending distortion test cannot be adjusted

First, try a sending test to see if the connection to the mobile is existing. If the RLR value is too high, the sending sensitivity of the mobile under test may be too low to adjust the ARL. If there is no signal in the sending test (SLR > 60 dB) check the connection between CMU and mobile. If no signal from the artificial mouth is audible during the sending test, check the signal path between R&S UPV and artificial mouth. Re-calibrate the artificial mouth.

Other problems of unknown reason

If the problem cannot be solved with the information given above, the folder "D:\3GPP" can be renamed or deleted. At the next start of the application, this folder is created anew with all files in default state.

Attention: *Store a backup copy of the results file in a different folder before deleting "D:\3GPP".*

Note: *Subsequently all settings in the Options menu and all data entries have to be re-done, all calibrated devices have to be created and calibrated again.*