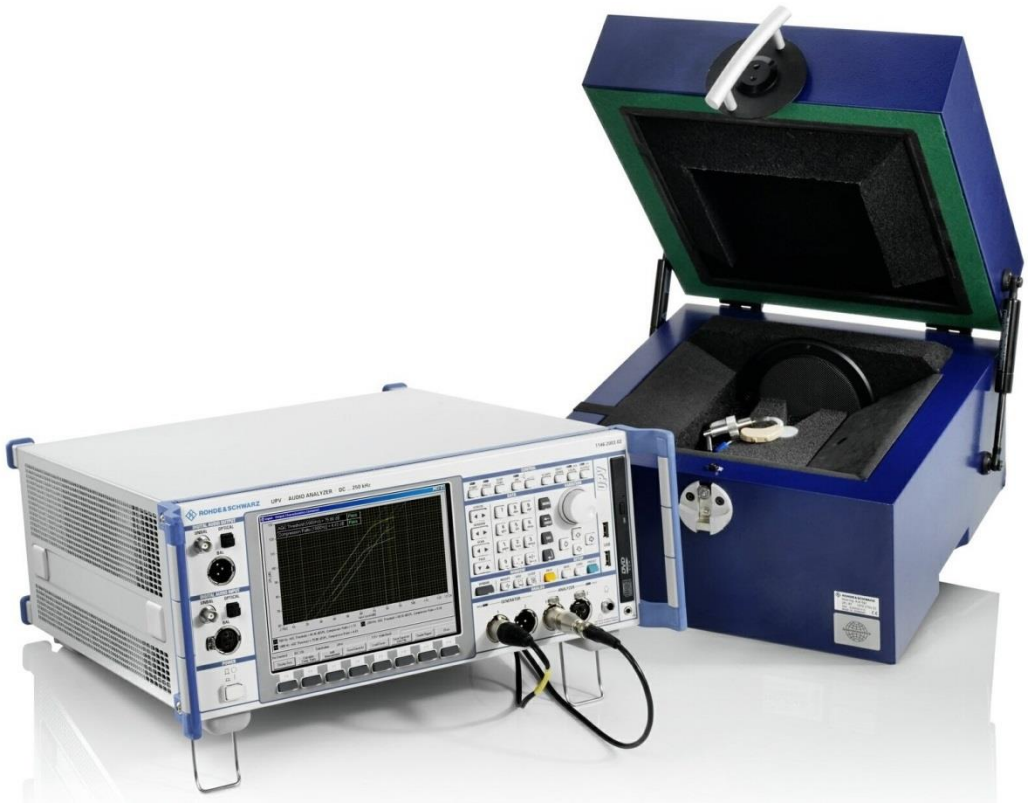
R&S®UPV-K7
Software for Hearing Aids Tests
Operating Manual



Version 2.0.0.20

1401.9353.12 – 04

Operating Manual

PAD-T-M: 3574.3259.02/01.00/CI/1/EN

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1401.9353.12 | Version 04 | R&S®UPV-K7

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol , e.g. R&S®UPV-K7 is indicated as R&S UPV-K7, or R&S®UPV is indicated as R&S UPV, etc.

Contents

1 Overview

Tests of basic properties of hearing aids are specified in standards IEC 60118 and ANSI S3.22. They comprise measurement of output sound pressure level, frequency responses, output SPL over input SPL, harmonic distortion, battery current drain and AGC settling.

Audio Analyzer R&S UPV with option R&S UPV-K7 provides a test system which, together with the necessary acoustic accessories, allows measurements according to IEC60118-0:1983, IEC60118-0:2015, IEC60118-1:1995, IEC60118-2:1983, IEC60118-6:1999, IEC60118-7:2005, IEC60118-9:1985 and ANSI S3.22-2003.

In addition to standard measurements it is possible to create own tests by customizing the available parameters.

With additional option R&S UPV-K71, tests according to IEC60118-15 using speech signal can be performed.

Automatic test sequences can be compiled from the available tests, and results are compiled for subsequent creation of test reports.

2 Preparation and Start of the Application Software

2.1 Required Measuring Instruments and Accessories

The Audio Analyzer R&S UPV with option R&S UPV-K7 is required for the measurements.

Acoustic devices such as measurement couplers, a calibrator and other accessories are required for the measurements. The following equipment from Brüel & Kjær or G.R.A.S. may be used:

Table 2-1: Acoustic accessories for hearing aid tests

Device	Description	Type (examples)
Hearing aid test box	Anechoic box with built-in sound source and induction loop, feed-throughs for the most important connection lines	R&S UPL-B7 or Interacoustics TBS25 or B&K 4232
Measurement microphone	¼" measurement microphone for measurement of artificial mouth output during calibration, to be inserted into IEC 126 2cc coupler, and for comparison measurement	B&K 4938 with B&K 2670 or G.R.A.S. 40BP with G.R.A.S. 26AC
Low-noise measurement microphone	½" measurement microphone with high sensitivity and low self-noise for speech tests according to IEC 60118-15.	G.R.A.S. 40AP with G.R.A.S. 26AC and right-angled adapter RA0001
IEC 126 coupler	Acoustic coupler according to IEC 126	Part of R&S UPL-B7 (with internal microphone or with ¼" microphone with preamplifier)
IEC 126 coupler for ½" microphone	Acoustic coupler according to IEC 126, for use with ½" microphone	G.R.A.S. RA0038
IEC 711 ear simulator (optional)	IEC 711 type occluded ear simulator with adapters for calibration and connection to the output of the DUT, with 1/2" - preamplifier	B&K 4157 & 2669 or G.R.A.S. RA0045
Acoustic calibrator	Sound level calibrator or pistonphone for calibrating the measuring microphones	B&K 4231 or G.R.A.S. 42AB
Microphone power supply	Power supply and preamplifier for the measuring microphone	B&K 2829, 5935L or 2690A0S2 or G.R.A.S. 12AD or 12AA

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.

Theoretically the reference microphone for sound source calibration and comparison measurement should be a free field type and the IEC 126 coupler should be used with a pressure field type. However with a ¼" microphone the frequency response difference is negligible up to at least 10 kHz.

When using a ½" pressure microphone as reference microphone, a good approximation of a flat free field response is achieved if the microphone is place such that the sound incidence is from 90 degrees relative to the microphone axis.

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

CAUTION

R&S UPV-K7 does not support the use of headphones.

Do not connect headphones to the R&S UPV during hearing aid tests. High level signals may be present at the headphone connector.

The audio analyzer must meet the following firmware requirements:

- R&S UPV firmware version 4.0.4 or higher
- License key R&S UPV-K7 installed
- For tests with speech-like signals according to IEC 60118-15, license key R&S UPV-K71 must be installed in addition.

2.2 Installing the Software

The application program requires key K7 to be installed. The application program and the key are installed in the factory in case a new R&S UPV is ordered together with this option. If the option is ordered separately, the key as well as the installation manual is part of the delivery.

For instructions on installation of the software and update of previous versions please see the release notes.

2.3 Test Setup

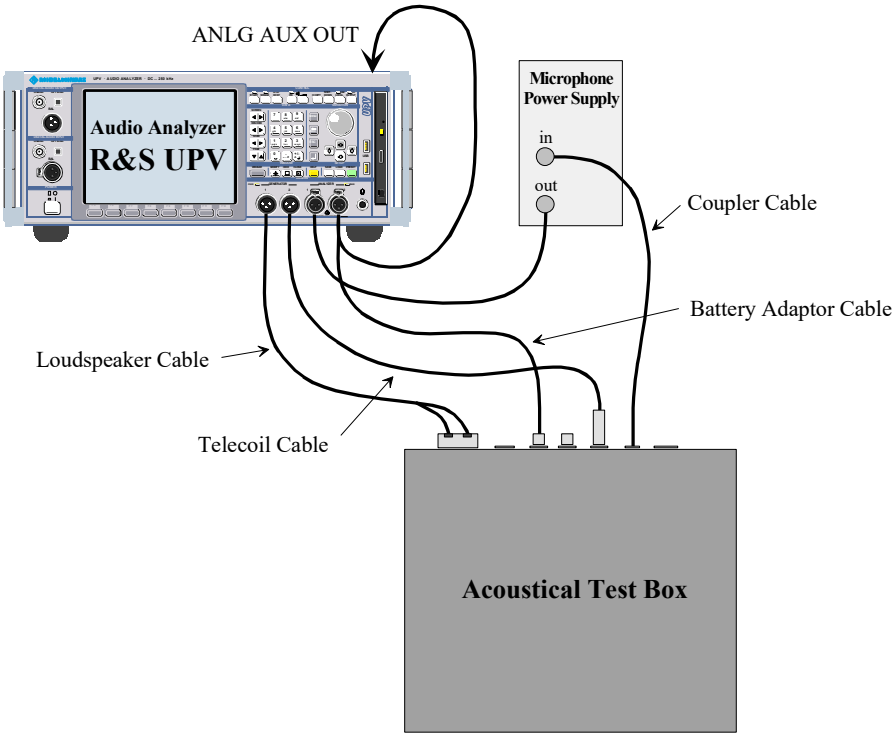

Figure 2-1 Test setup and connection of external components

The following cables are required to connect speaker, induction loop and battery voltage supply of the test box delivered with R&S UPL-B7 to the R&S UPV. The microphone signal from the microphone power supply may be connected to the analyzer input with a BNC cable and an R&S UP-Z1MF adapter. If a custom made BNC to XLR cable is used, it should be made following the schematics of the R&S UP-Z1MF adapter (see R&S UPV Manual, chapter “Configuring the Analog Analyzer”).

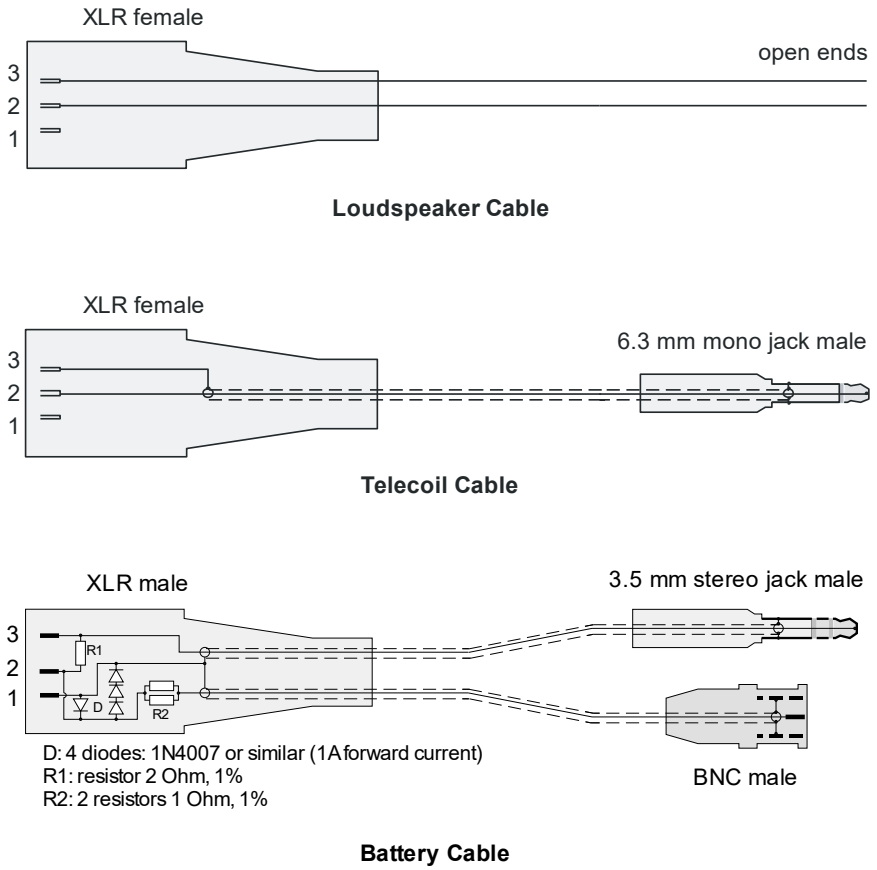

Figure 2-2 Connection cables for R&S UPL-B7 (Interacoustics TBS 25) test box

The cables shown in Figure 2-2 can be ordered as Accessory R&S UPV-Z7.

The cables of R&S UPL-B7 can be re-used for R&S UPV-K7. As the supply voltage is now provided by the “ANLG AUX OUT” on the rear panel of the R&S UPV, the following adapter is required in addition.

Figure 2-3 Adapter cable to connect the R&S UPL-B7 battery supply cable to the “ANLG AUX OUT” of the R&S UPV

2.4 Starting the Application Software

After installation, the program can be started by double-clicking the Icon “UPV-K7 Hearing Aid Tests” or by clicking “R&S UPV Applications → UPV-K7 Hearing Aid Tests” in the “Programs” menu.

At the fist start of the program, selection windows appear for the standard according to which the measurements should be made, and for the measurement coupler used.

The entered selections are stored with the settings and automatically loaded at the next start of the program.

At each start of the program, the ambient conditions temperature, relative humidity and atmospheric pressure are queried for protocol purpose. The entered values are not stored in the settings, because the ambient conditions are supposed to change with time. The query can be deselected and values can be changed any time in the “Options” menu.

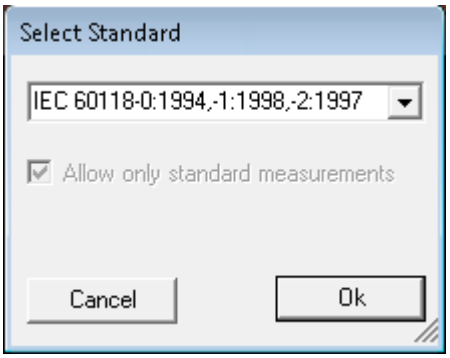

Figure 2-4 Query window for selection of applied standard

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.

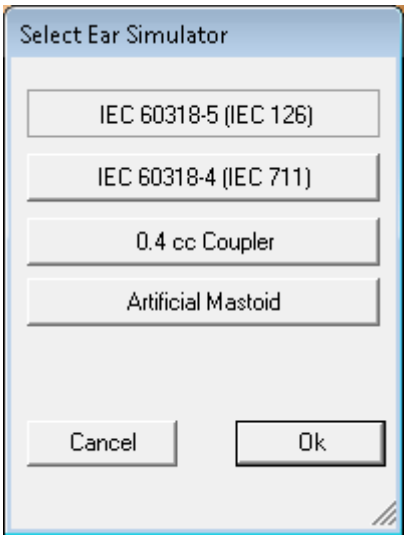

Figure 2-5 Query window for selection of ear simulator

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).

The next window to open is the input window for the ambient conditions temperature, relative humidity and atmospheric pressure.

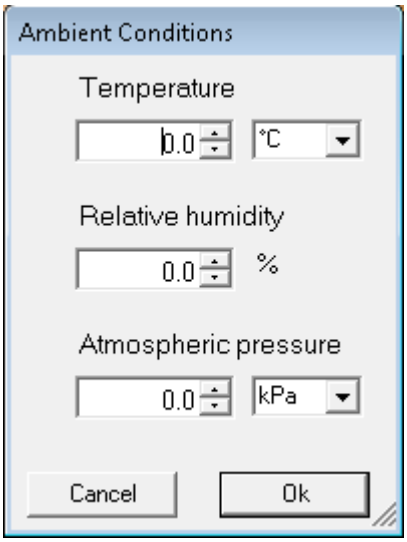

Figure 2-6 Query window for input of ambient conditions

The units can be switched between °C and °F and between kPa and mmHg, respectively. After the last of the three selection windows has been closed, the main window of the R&S UPV-K7 opens.

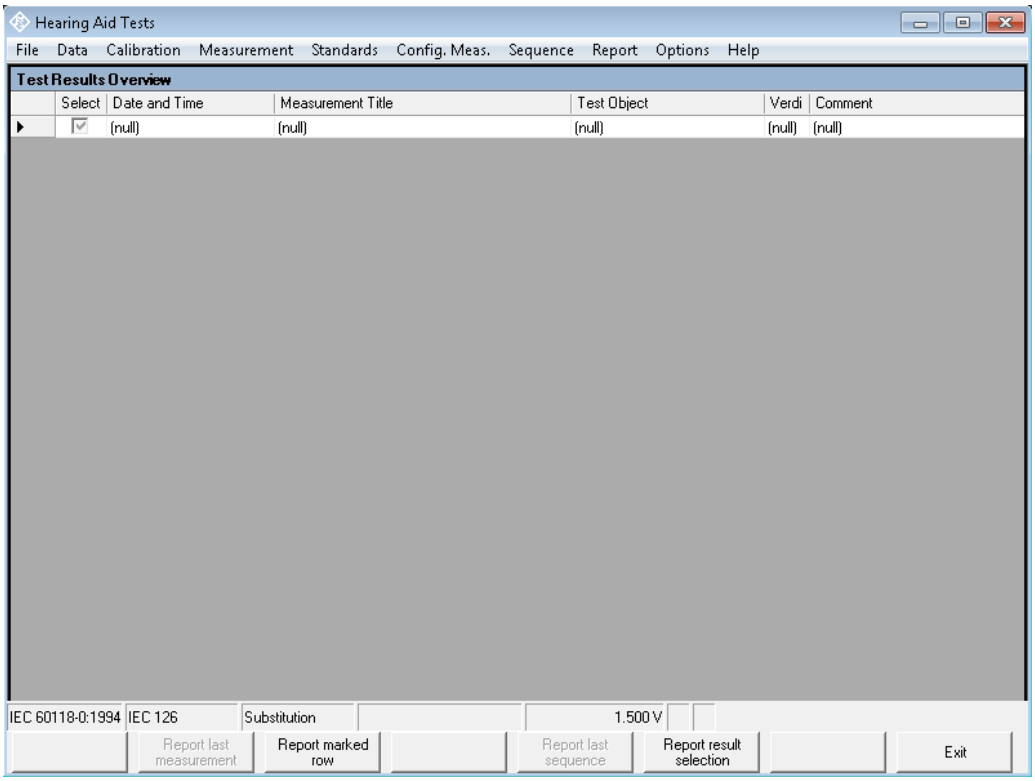

Figure 2-7 Main window after first start of the program

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.

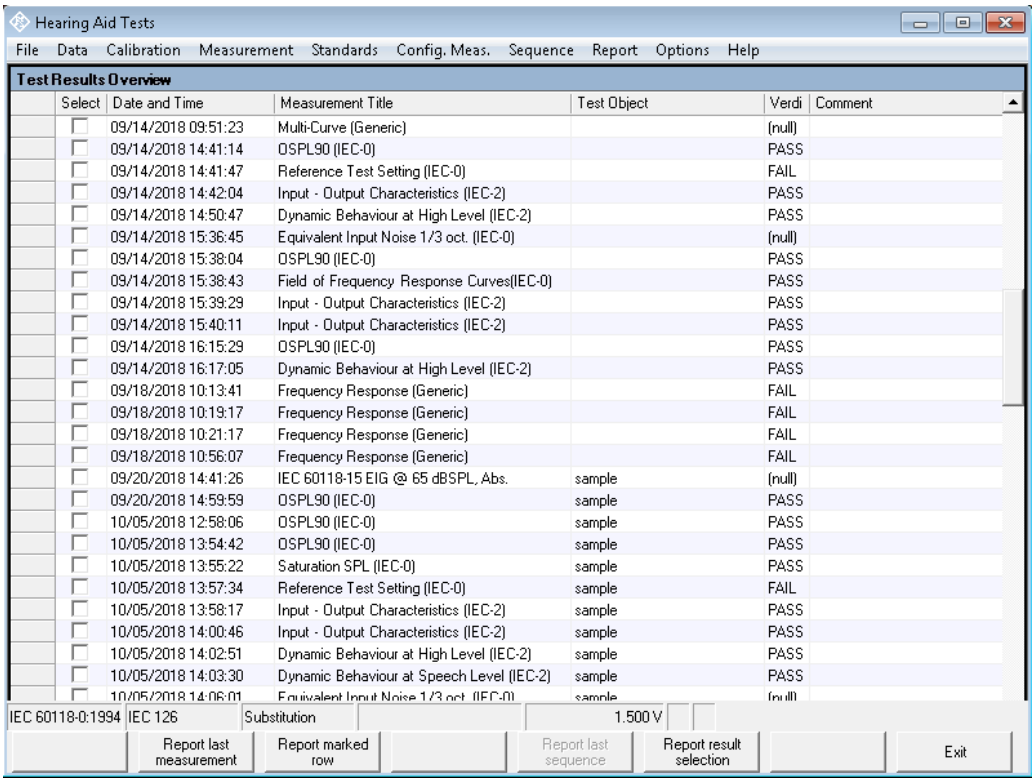

Figure 2-8 Main window with results

3 Operating Concept

3.1 Options (General settings)

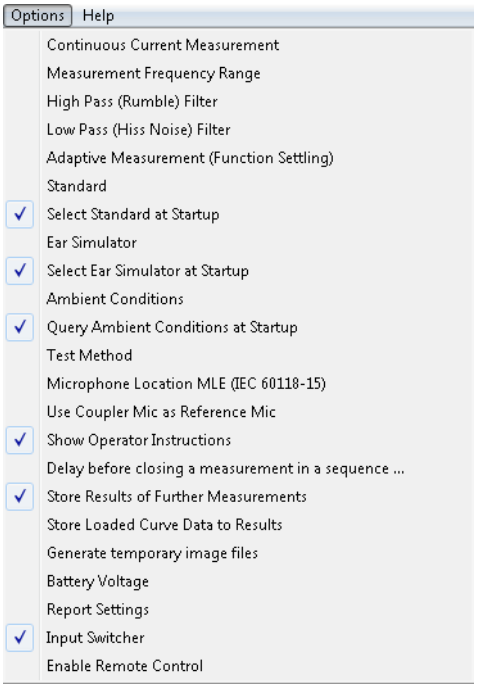

Figure 3-1 Options menu

The “Options” menu in the main window allows to change a set of general settings like ear simulator, test method and battery voltage, which are valid for all or at least a plurality of the tests.

“Continuous current measurement” allows to measure the supply current at analyzer input 2. This option can only be selected with the substitution method. The value of the shunt resistor for the current measurement can be entered in the calibration menu. By default it is set to 2 Ω.

“Measurement frequency range” allows to enter the frequency range in which the sound source 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 sound source equalization.

“High pass (rumble) filter” allows to set a high pass filter which is active in most measurements except distortion measurements, battery current measurements and noise measurements. The edge frequency of the high pass filter can be set, and the filter can be activated and deactivated. The high pass filter is not applied to battery current measurements.

If “File defined” is deactivated, the edge frequency can be set in the “Limit frequency” field. The R&S UPV firmware then calculates the filter coefficients and the delay to account for the filter settling. If “File defined” is activated, a file with filter coefficients can be loaded using the “Browse” button. A measurement delay for the filter settling time can be set manually if the “Def. delay” checkbox is activated.

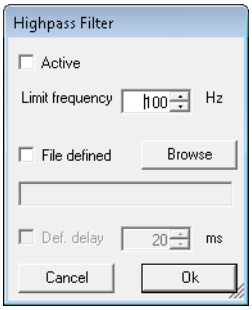

Figure 3-2 Input window for filter settings

“Low pass (hiss noise) filter” allows to set a low pass filter which is active in most measurements except battery current measurements and noise measurements. The edge frequency of the high pass filter can be set, and the filter can be activated and deactivated. The low pass filter is not applied to battery current and distortion measurements.

The settings in the “Lowpass Filter” window are according to those for the highpass filter.

With noise measurements, the filters from the “Options” menu are only applied to the gain measurement. The noise measurement has own parameters for the band limits of the noise level measurement.

Filters slow down the measurement. Therefore they should only be used if necessary. In particular a combination of selective measurement with high pass and / or low pass filter is not recommended.

“Adaptive measurement (function settling)” causes gain and level measurements to be repeated until the result has settled within a specified tolerance. This is helpful to assure that an AGC which is present in the signal path has adapted to the applied input signal of the hearing aid.

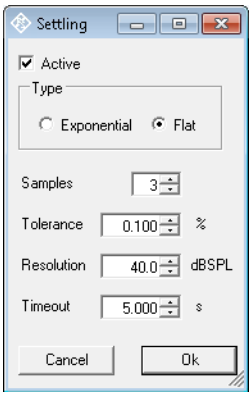

Figure 3-3 Input window for adaptive measurement

With the “Flat” type, measurements are repeated until the last “Samples” number of results are within the given “Tolerance” or the difference between two subsequent measurement results is below the “Resolution” value. The “Resolution” can be used to take into account the idle channel noise of hearing aid and measurement equipment.

The resolution value must be set high enough to take idle channel noise into account. If it is set too low, especially measurements with high gain at low input levels may be aborted due to invalid result values.

If the use of filters leads to slow measurements, the timeout value may have to be increased.

With the “exponential” type of settling, differences between the earlier results may be higher than specified, but the results must converge exponentially into the specified values.

If the settling time of the hearing aid is known, measurement may be faster with settling turned off. In this case the known settling time has to be entered as pre-delay in the measurement parameters of each measurement.

Function settling is generally not applied to battery current measurements. For harmonic distortion measurements the resolution is set fix to 0.01 % THD.

“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.

“Ambient conditions” allows to change the temperature, relative humidity and atmospheric pressure values for the protocol.

“Query ambient conditions at startup” causes the input window for the ambient condition to be opened at each start of the program.

“Test method” allows to select the method for setting the input sound pressure.

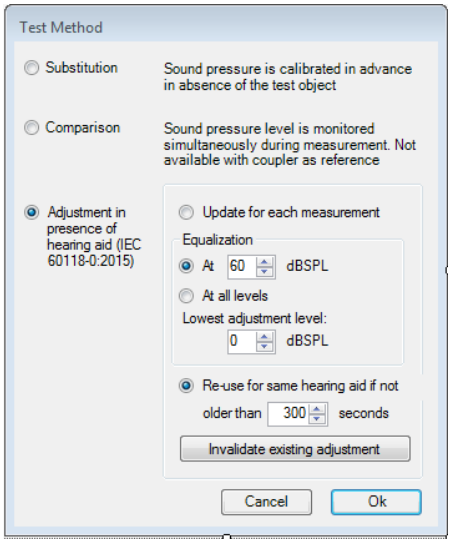

Figure 3-4: Window for selection of the test method

With “Substitution”, the nominally set SPL at the input of the hearing aid is assumed to be correct, due to the calibration of the sound source. With “Comparison”, the input SPL is measured simultaneously with the output SPL by the reference microphone in a two channel measurement, and results transfer measurements are corrected for the deviation of the input SPL from the nominal value. “Comparison” cannot be selected when the coupler microphone is used as reference microphone (see below). When the continuous current measurement is active, an input switcher is required for the “Comparison” method.

From IEC 60118-0:2015 it is required to adjust the input sound pressure level with the hearing aid under test present. For sweep measurements the input sound pressure level is measured with an extra sweep using the equalization and calibration value obtained with the last source calibration. The deviation is subtracted as correction from the existing values. There are options to do this for each input sound pressure level value required in the measurement (“Subst. each”) or to do it once with a specified default sound pressure level (“Subst. once”). As the measurement results from low input levels can be noisy, especially when a ¼” measurement microphone is used, it is possible to specify a minimum SPL. For all lower input levels, the sound pressure will be adjusted with the minimum level instead. The values obtained can be re-used as long as the same hearing aid is tested (i.e. the device under test is not changed in the “Data” menu), or updated for each measurement. Single values are fine-adjusted in this test mode with each measurement.

“Microphone Location MLE (IEC 60118-15)” allows to specify the location of the hearing aid. The respective frequency correction (“location effect”) according IEC 60118-8 is taken into account for speech tests according to IEC 60118-15.

- None: No location effect is taken into account
- BTE: Location effect for hearing aids worn behind the ear
- ITE: Location effect for hearing aids worn inside the concha
- ITC: Location effect for hearing aids inserted into the ear canal
- CIC: Location effect for hearing aids which are worn completely inside the ear canal.

“Use coupler mic as reference mic” allows to use the microphone of the IEC 126 coupler for sound source calibration. In this case the program applies the calibration value of the coupler microphone for the sound source calibration, and the reference microphone has to be connected to analyzer input 1 instead of analyzer input 2.

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

In Menu item **“Delay before closing a measurement in a sequence”** a time period can be defined for which the result of a completed measurement is shown during execution of a sequence, before the measurement window is closed and the next measurement in the sequence is started.

“Store results of further measurements” allows to include results obtained with the “Add measurement” softkey to the result database. All curves obtained this way will be reported in the same graph. This allows e.g. to measure responses depending on settings of the hearing aid, and to report them in a field of curves.

“Store Loaded Curve Data to results” includes curve data which is loaded with the button “Load Curve” to the result database such that the loaded curves will appear in the diagram of the respective report.

If **“Generate temporary image files”** is activated, each measurement stores a screenshot of the result graph in an image file called “”. The file can be queried by a remote control host after a remotely started testcase has finished. It is overwritten when the next measurement finishes successfully.

“**Battery voltage”** allows to specify the supply voltage for the hearing aid. If a supply voltage is specified in the parameters of a measurement, the general setting is overridden. This allows to measure response curves for different supply voltages within one sequence.

“Report settings” allows to define the type of information which should appear in the reports. For details on reporting, see section 7 Automatic Test Sequences below.

“Input Switcher” enables the use of a UPZ12 switcher, e.g. to switch the second analyzer input automatically between the output of a reference microphone measuring the input sound pressure of a hearing aid, and a shunt resistor for continuous current measurement.

If **“Enable Remote Control”** is active, remote controlled start of testcases and configuration via SCPI commands is possible. For details see section 9.

4 Calibration

4.1 Calibration Devices

R&S UPV-K7 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.

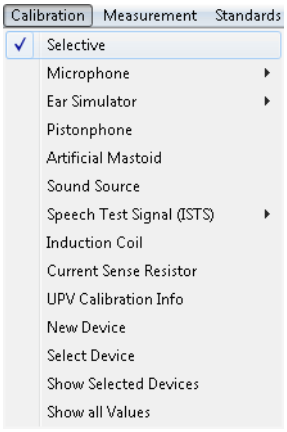

Figure 4-1 Calibration menu

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.

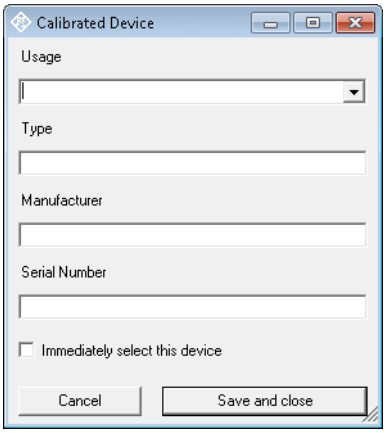

Figure 4-2 Input window for information about calibrated device

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

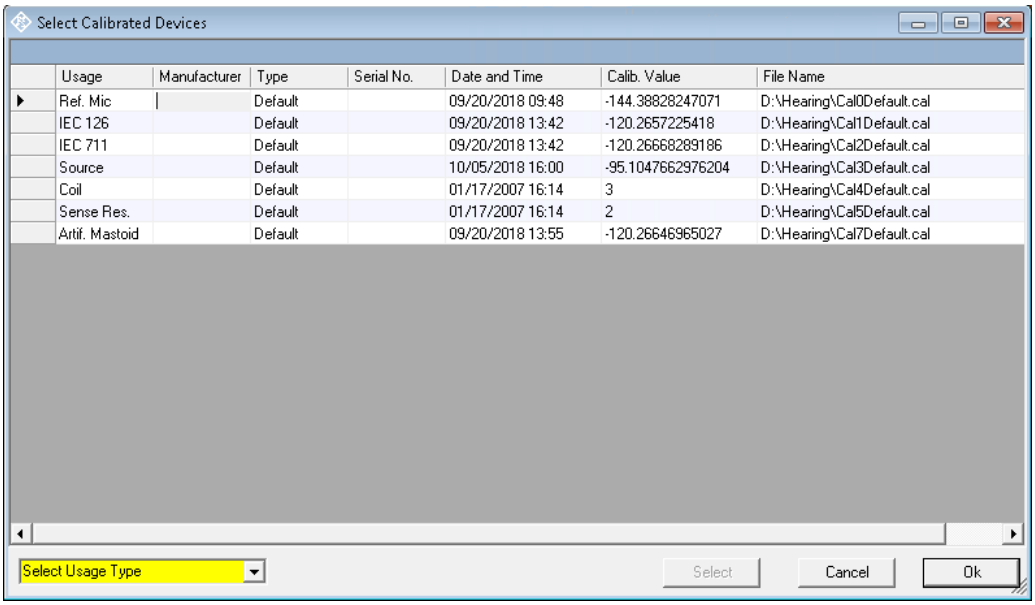

Figure 4-3 Window for selection of calibrated devices

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.

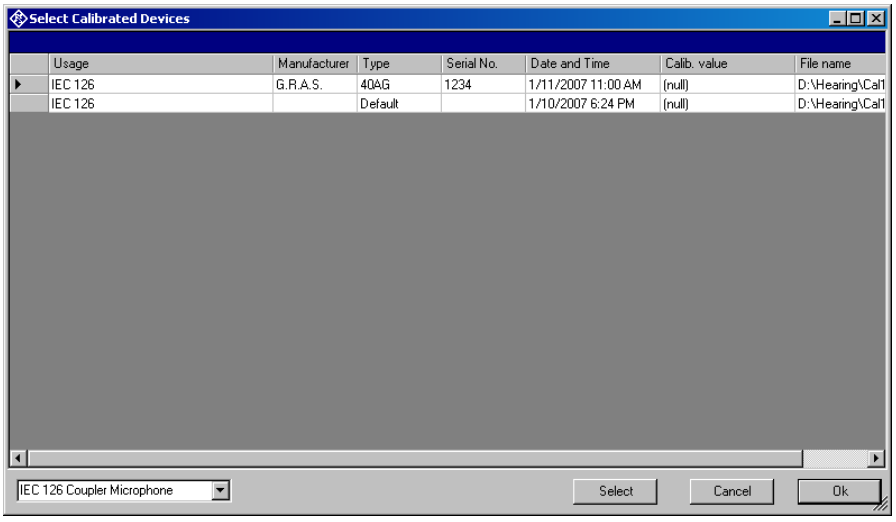

Figure 4-4 Selection window for particular device type (here IEC 126 coupler)

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-K7 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.

4.2 Microphone Calibration

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

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

► **Call the test routine with “Calibration → Microphone → 2 cc Coupler”, “Calibration → Microphone → Reference” or “Calibration → Microphone → 0.4 cc Coupler” from the main menu, depending on the microphone.**

First the nominal SPL of the calibrator has to be entered:

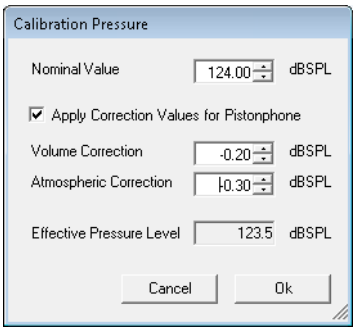

Figure 4-5 Input window for calibration SPL

Checkbox “Apply Correction Values for Pistonphone” allows to specify volume correction and atmospheric correction values which are added to the nominal calibration value to calculate the effective pressure level at the microphone during calibration. If this checkbox is checked, the default for the nominal calibration value is 124 dBPL. If the calibration values are deactivated, the default is 93.98 dBSPL.

If selective calibration is activated in the calibration menu, the frequency of the calibration signal has to be entered:

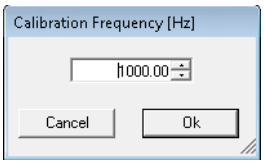

Figure 4-6 Input window for calibration frequency

If correction values for pistonphone are used, the default for the calibration frequency is 250 Hz. Otherwise the default calibration frequency is 1000 Hz.

After these settings have been confirmed, instructions for connecting the microphone are displayed, unless an input switcher is used. The reference microphone must be connected to analyzer input 2, coupler microphones must be connected to analyzer input 1.

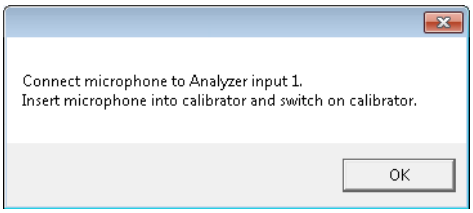

Figure 4-7 Connection instructions of microphone calibration

Subsequently, the output voltage of the microphone is measured and the sensitivity displayed with reference to 1 Pa. If a mere power supply without gain is used, the displayed sensitivity must approximately match the value in the calibration certificate of the microphone capsule (typical value for microphone capsule 4134 of artificial ear 4185 is approx. 12 mV/Pa, display = 120 mV/Pa). If a conditioning amplifier with 20 dB gain (recommended value) is used, the displayed sensitivity must be about 10 times higher. If the voltage measured is below 3 mV or instable, 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 calibration is repeated. After switching on the microphone power supply, wait approx. 20 s before starting the calibration again.

4.3 Calibration of Ear Simulator IEC 711

For calibration of the IEC 711 ear simulator, an adapter part must be screwed onto the simulator which allows it to be inserted into the calibrator like a ½" microphone. The calibration routine is started with "Calibration → Ear Simulator → IEC 711" and follows the course described above.

4.4 Entering correction values for Pistonphones

With the menu Item “Pistonphone” in the “Calibration” menu, volume and atmospheric correction values can be viewed and edited. In addition the default nominal level and calibration frequency for pistonphone use can be modified.

Volume correction values are specific to the different microphone or coupler types and can therefore be entered separately. The atmospheric correction value is common to all microphones and ear simulators.

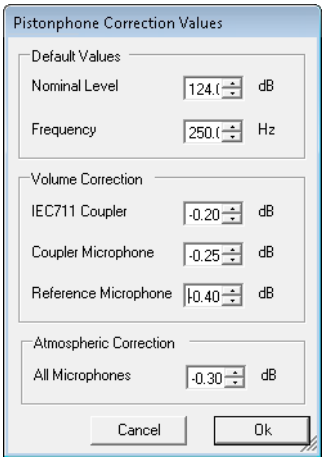

Figure 4-8 Input window pistonphone correction values

4.5 Calibration of Sound Source

Before a hearing aid can be tested, the absolute sensitivity and frequency response of the sound source have to be measured and corrected with the aid of a previously calibrated reference microphone. If “Use coupler mic as reference mic” is activated in the “Options” menu, the microphone of the IEC 126 coupler can be used for this purpose. The frequency response of the microphone can be ignored in the test frequency range (100 Hz to 10 kHz) (see also calibration certificate of microphone capsule). If a separate reference microphone is used, this has to be calibrated beforehand with “Calibration → Microphone → Reference”.

After starting the sound source calibration with “Calibration → Sound Source”, the calibration level can be defined. This allows to adapt the calibration to specific measurement levels. It is also possible to store calibrations for different levels using multiple calibration devices (see above).

The sound pressure generated at the point of the reference microphone is set to exactly the specified level 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 sound source. If the sound pressure cannot be adjusted to the specified value, an error message is displayed with a request to check the connection to the sound source and to repeat the measurement.

The uncorrected frequency response of the sound source 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 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 the specified sound pressure level. Correct calibration without interfering sound yields an almost straight line.

4.6 Calibration of the International Speech Test Signal (ISTS)

This item is only available with option R&S UPV-K71 installed.

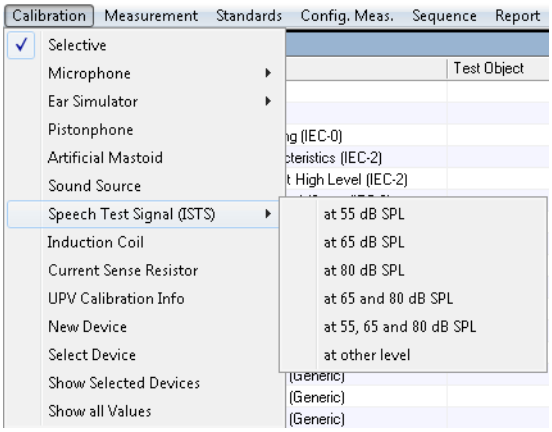

Figure 4-9 Submenu for ISTS calibration

The calibration function performs the following actions on the ISTS:

- Pre-filtering the speech signal with the inverse frequency response of the sound source (valid sound source calibration is prerequisite)
- Level alignment of the filtered signal
- Analysis of the long-term average spectrum and percentile spectra at the reference point and limit check in comparison to the requirements in IEC 60118-15.
- Analysis of the speech signal at the reference point as input signal to the hearing aid (according to IEC 60118-15). Raw results like 3rd octave spectra over time and selected intervals in each 3rd octave for given percentiles are stored in files for later use in the measurement function.
- Pre-filtering of the equalized signal according to the different microphone location effects.

Standard speech levels are 65 dBSPL, 80 dBSPL and optionally 55 dBSPL. Additionally calibration can also be performed at other levels if required. Especially for low levels like 55 dBSPL, a low-noise microphone is required to get correct values for the 30% percentile.

Before starting the ISTS calibration routine, either a coupler microphone or a reference microphone must be calibrated. If the coupler microphone is to be used for this calibration function, select “Options → Use coupler mic as reference mic”. The coupler microphone must be connected to analyzer input 1. If a separate reference microphone is to be used, “Options → Use coupler mic as reference mic” must be unchecked. The reference microphone must be connected to analyzer input 2.

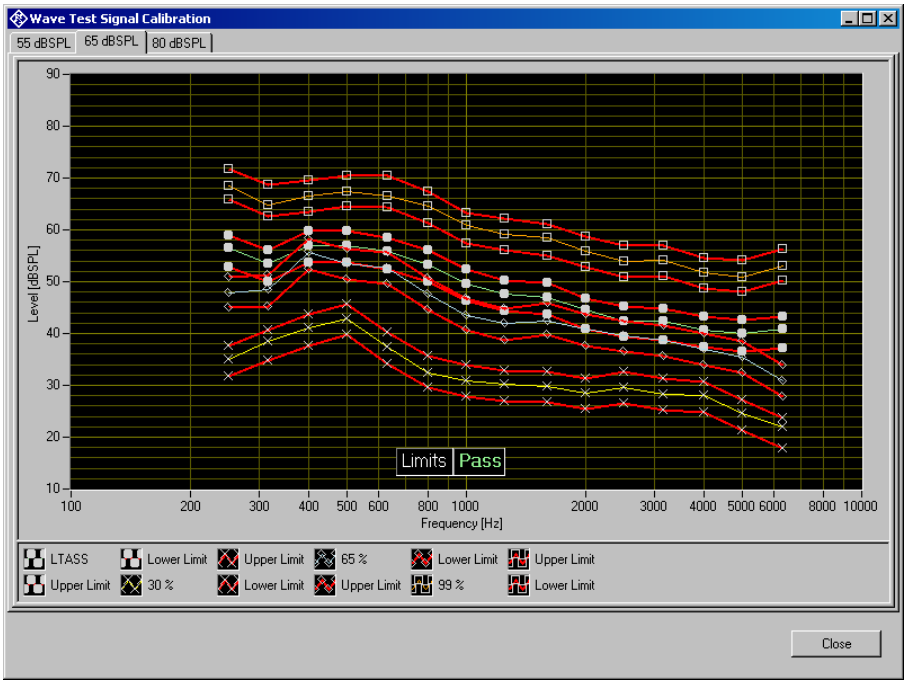

Figure 4-10 ISTS calibration result

For each calibrated speech level, the window contains a tab with a result graph. Each result graph shows long-term average speech spectrum (LTASS) and percentile levels for this speech level, together with limits calculated from the nominal levels given in IEC 60118-15 for the ISTS at 65 dBSPL speech level ±3 dB.

The calibration is valid even if not all limits are passed. Particularly ad 55 dBSPL it might be difficult to pass the limits for the 30% percentile.

4.7 Calibration Value for Induction Coil

The sensitivity H/I for the induction coil used for hearing aid tests with inductive input can be entered under menu Item “Induction Coil” in the “Calibration” menu.

Refer to the data sheet of the test box for induction coil sensitivity and resistance.

5 Data Entry for Reporting

5.1 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.

5.2 Test Object

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

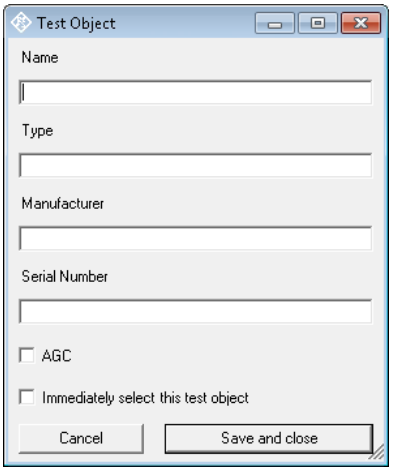

Figure 5-1 Window for input of information about a test object

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

6 Measurements

6.1 Functionality and Control of the Measurement Macros

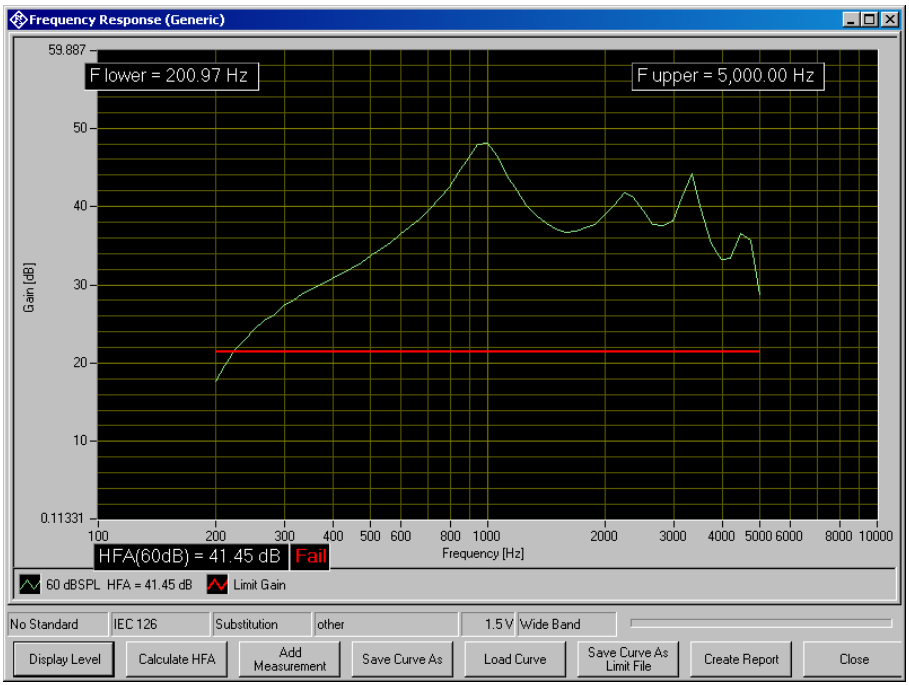

Figure 6-1 Example of a measurement window

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:

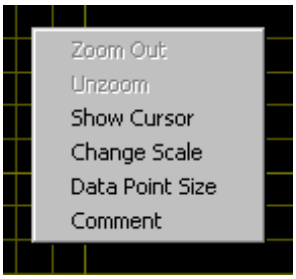

Figure 6-2 Context menu of the graph window

6.1.1 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.

6.1.2 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.

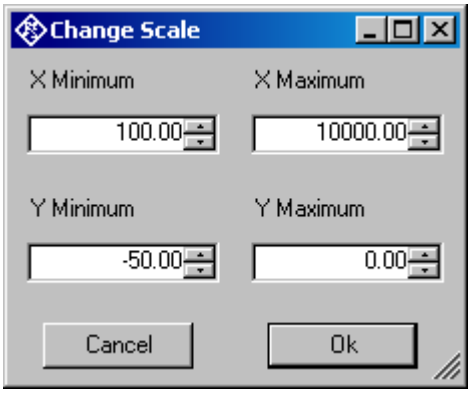

Figure 6-3 Window for changing the scale of the graph

6.1.3 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.

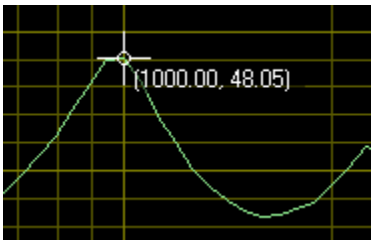

Figure 6-4 Cursor with data display

6.1.4 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.

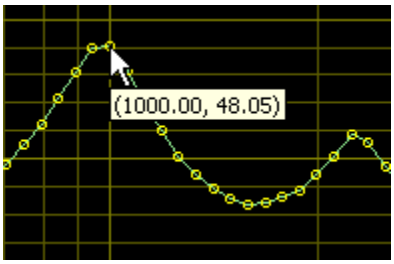

Figure 6-5 Data points with data display

6.1.5 Performing Additional Measurements

The softkey "Add Measurement" triggers another measurement according to the specification of the test. Loudness ratings and noise values are calculated and displayed in the legend. However, limits are not checked. This function can e.g. be used to compare different settings in a device under test.

If the item "Store results of further measurements" is activated in the "Options" menu, graphs and result values obtained with this functionality are added to the results database and will appear later in reports on this measurement. All curves obtained within the same measurement will appear in the report in the same graph.

6.1.6 Storing and Loading Curves

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

6.1.7 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. Regarding the use of such limit curves see section 6.2 Customizing Measurements below.

6.1.8 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.

6.1.9 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. For details see section 8.10 Preview Window below.

6.1.10 Generating a Landscape Report

Landscape reports are only available for frequency response graphs. They show the result graph together with the measurement title and information about the tested hearing aid and about the operator. The layout and scale is fixed and cannot be configured.

A landscape report can be generated from the measurement window by right-clicking into the result graph of a frequency response measurement and selecting “Create Landscape Report” from the context menu.

6.1.11 Closing the Measurement Window

The softkey “Close” closes the measurement window. The control is returned to the R&S UPV-K7 main window. All relevant data associated with the measurement is imported to the results database. A new entry appears for the measurement as new row on the bottom of the overview data grid in the main window.

6.2 Customizing Measurements

The first item in the “Measurement” menu which is called “Settings” opens a sub-menu with all available measurements in it. Clicking on a measurement in this sub-menu opens a window which allows to change parameters of the selected measurement.

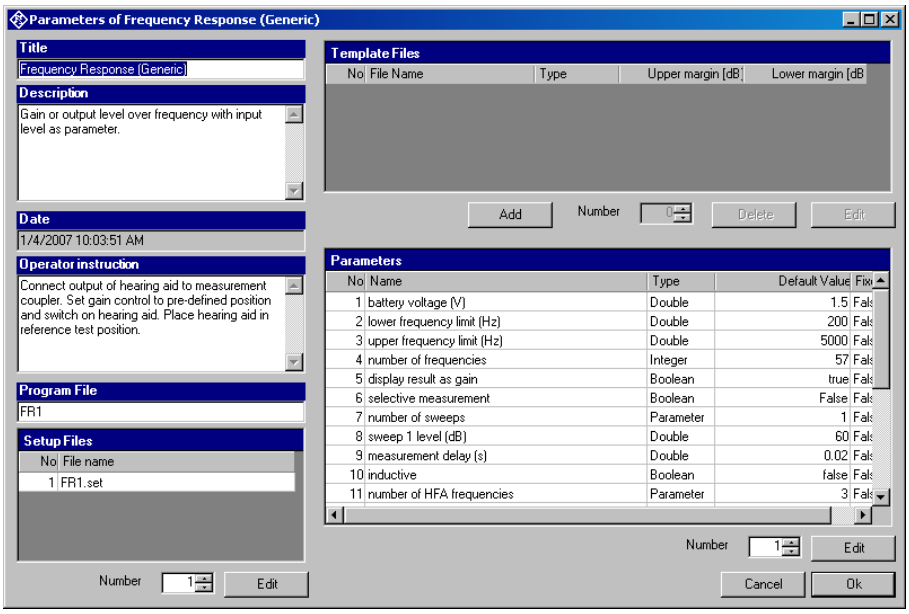

Figure 6-6 Measurement setup window

The “Title” appears in the measurement menu and forms the heading of the report.

The “Description” can be chosen to be included into the report.

“Date” shows the date of the last change to this measurement definition.

“Operator instruction” is the text displayed before the start of each measurement, provided that the item “Show operator instructions” is activated in the “Options” menu.

The entry in the field “Program File” designates the measurement type and must not be changed.

The field “Setup Files” specifies the R&S UPV setups used by the measurement. The specified file can be replaced by a user defined file but the number of setups is defined by the measurement type. The customized setup file must be stored in folder `D:\Hearing`. It is recommended to generate customized setups by copying existing ones. Note that changes in the setup like changing the analysis function or generator signal may cause malfunction of the measurement. Some parameters of the setup might be overwritten by the macro during the measurement run.

The field “Template files” specifies limit template curves for the response curve. The buttons “Add” or “Edit” produce the following input window:

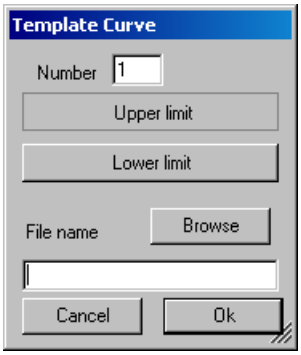

Figure 6-7 Input window for limit template curve

The radio buttons allow to determine whether the given curve should be used as upper limit, lower limit or for information only (no limit check). The field “File name” must contain the path name of the file. To generate a new limit curve file, use the softkey “Save as limit curve” of the respective measurement window or copy and edit an existing limit file using a text editor.

All other available parameters of a measurement definition are shown in the “Parameters” data grid. The rightmost column with the headline “Fixed” displays whether the respective parameter can be changed by the operator or not. In “generic” measurements all parameters may be changed. In measurements which follow standards, only parameters which are not determined by the standard may be changed by the operator. The “Edit” button opens an input window for the parameter in the line specified in “Number”:

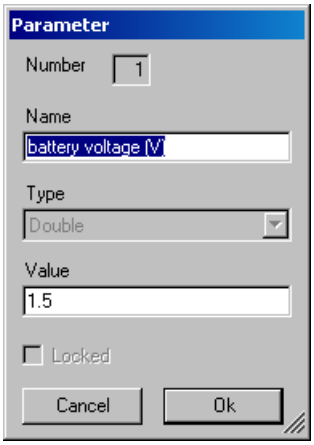

Figure 6-8 Input window for parameter value

Alternatively this input window can be opened by double-clicking on the row header of the parameter to be edited.

“Name” appears in the report and explains the meaning of the parameter. “Type” is determined by the measurement routine and cannot be changed. In the field “Value” a value must be entered which conforms with the syntax rules of the selected data type. The syntax is checked automatically when the text box is left. However there is no check for the allowable range of the value. Entering inadequate values (e.g. too high levels, negative frequencies) may cause malfunction of the measurement.

Tables in section 6.3 list the available parameters for each measurement routine. Some of the parameters are optional. They are marked with “Optional_i:” in the explanation column, wherein i stands for a consecutive numbering. The following rules apply for optional parameters:

- For each value of i, all or none of the parameters marked with “Optional_i” must be present
- If optional parameters marked with “Optional_j” are present, all optional parameters marked with “Optional_i” for values i < j must also be present.

6.3 Notes on Individual Measurements

6.3.1 Frequency Response Measurement

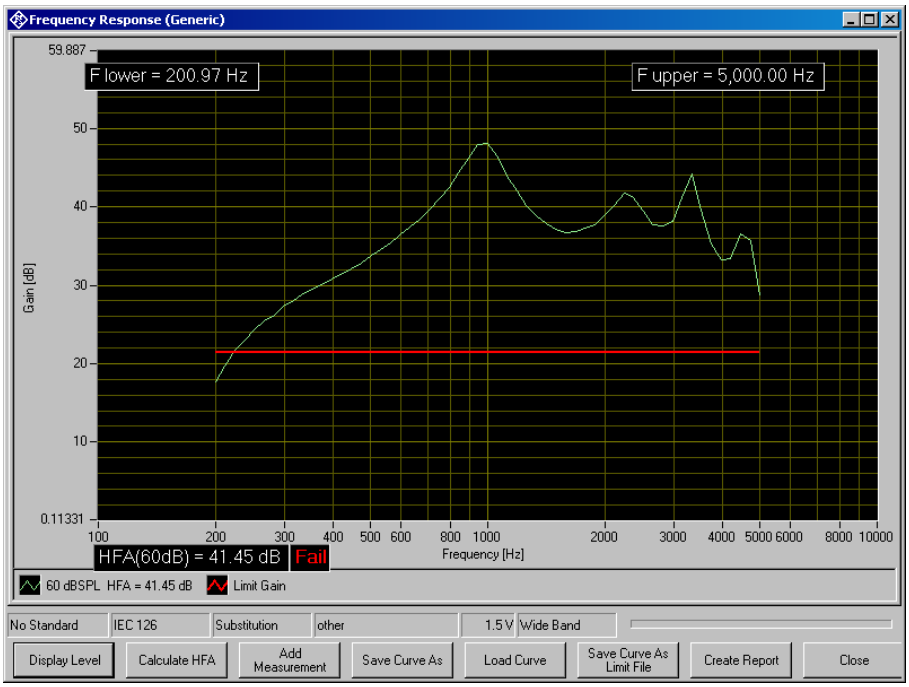

Figure 6-9 Display window of frequency response measurement

The softkey “Display Level” or “Display Gain”, respectively, allows to toggle between gain and level in the Y axis of the graph. The button “Calculate HFA” allows to calculate a high frequency average or special frequency average from one of the displayed curves:

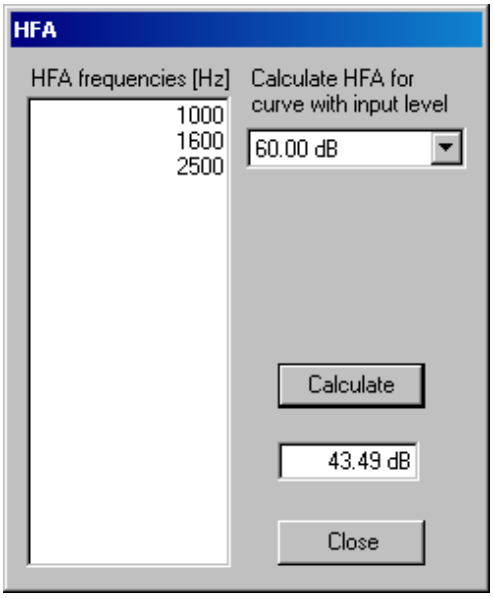

Figure 6-10 Input window for HFA calculation

In the text box on the left side the HFA frequencies are entered in separate lines. In the combo box top right, one of the existing curves is chosen. When the button “Calculate” is clicked, the text box below shows the associated HFA value.

The following table lists all available parameters in the generic frequency response measurement:

Table 6-1 Available parameters for frequency response measurements

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
lower frequency limit (Hz)	Double	200	Start frequency of sweep
upper frequency limit (Hz)	Double	5000	Stop frequency of sweep
number of frequencies	Integer	57	Number of sweep points
display result as gain	Boolean	True	„True“: Gain on Y axis, „False“: SPL on Y axis
selective measurement	Boolean	false	„True“: Selective measurement with fast 3rd octave filter
number of sweeps	Parameter count	1	Number of sweeps with level as parameter
sweep 1 level (dB)	Double	60	Sweep level for each sweep (dBSPL or dB re 1 mA/m)

Name	Type	Value	Explanation
measurement delay (s)	Double	0.02	Pre-delay between sweep Step and measurement trigger, allows for settling of the DUT (e.g. AGC)
inductive	Boolean	false	“False”: Acoustic input, “True”: Inductive input
number of HFA frequencies	Parameter count	3	Number of frequencies averaged in the high frequency average
HFA frequency 1 (Hz)	Double	1000	
HFA frequency (Hz)	Double	1600	
HFA frequency (Hz)	Double	2500	
HFA upper limit (dB)	Double	30	Upper limit for limit check
HFA lower limit (dB)	Double	10	Lower limit for limit check
check limit for sweep no.	Byte	1	“0“ means: “don’t check”
calc. freq. range for swp. no	Byte	1	“0“ means: “don’t calculate”
level difference (dB)	Double	20	Level difference between HFA level and frequency response limit points
check frequency range limits	Boolean	True	Determines whether the frequency range is checked against the limits given below
max. lower frequency (Hz)	Double	500	
min. upper frequency (Hz)	Double	3500	
display curve maximum	Boolean	True	Stipulates whether the absolute curve maximum should be determined
lower limit of max. (dB)	Double	0	
upper limit of max. (dB)	Double	40	
check max limits for swp. no	Byte	1	“0“ means: “don’t check”
calculate MASL for sweep no.	Byte	0	Optional_1. Determines for which sweep the MASL should be calculated. 0 means “no calculation”.
check MASL limits	Boolean	False	Optional_1. Determines whether a limit check should be performed on the MASL.
MASL lower limit (dB)	Double	0	Optional_1.
MASL upper limit (dB)	Double	100	Optional_1.

Name	Type	Value	Explanation
electric input	Boolean	False	Optional_2. Set to “True”: The test signal is fed on the electric input of the hearing aid. The sweep levels are specified relative to -54 dBV.
maximum voltage (V)	Double	1	Optional_2. Voltage limit for protection of the electric input of the hearing aid.

If for example only an upper limit should be checked but not the corresponding lower one, select the lower limit low enough to be always passed.

The following standard conformal tests are based on the frequency response measurement routine:

Frequency Response @ 60 dBSPL (IEC-0)

Frequency Response (IEC-0:2015)

Field of Frequency Response Curves (IEC-0)

Frequency Response (ANSI)

Frequency Response (IEC-7)

Frequency Response Induction (ANSI)

Frequency Response Induction (IEC-1)

Frequency Response Induction (IEC-0:2015)

Full-On Frequency Response Induction (IEC-0:2015)

Full-On Gain 50 dB (IEC-0)

Full-On Gain 60 dB (IEC-0)

Full-On Gain (IEC-0:2015)

Full-On Gain (IEC-7)

Response Curve at Maximum Gain (IEC-1)

Full-On Gain (ANSI)

Output SPL at Maximum Gain, Induction (IEC-1)

OSPL90 (ANSI)

OSPL90 (IEC-7)

OSPL 90 (IEC-0)

OSPL 90 (IEC-0:2015)

6.3.2 Multi-Curve Measurement

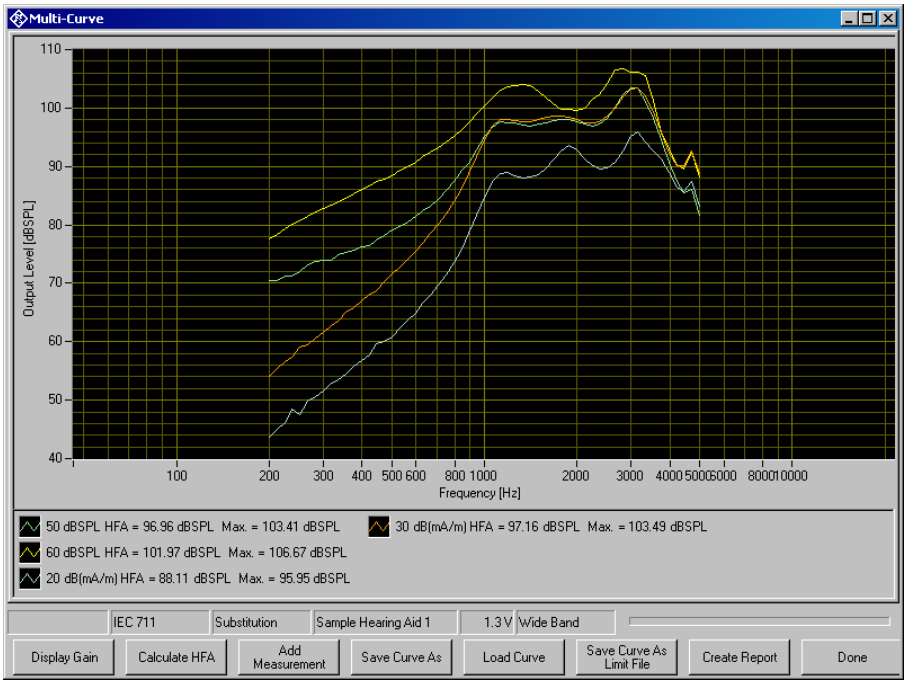

Figure 6-11 Display window of multi-curve measurement

The multi-curve measurement is found in “Standards → Utilities”. It is similar to frequency response measurements and allows measurement and display of acoustic and inductive frequency responses in one window. Unlike other measurements, the multi-curve measurement does not automatically start a sweep when it opens. All sweeps are started by the user using the “Add Measurement” button, even within sequences. Therefore this window does not close automatically within a sequence but has to be closed using the “Done” button.

The following table lists all available parameters available for configuration of the multi-curve measurement:

Table 6-2 Available parameters for multi-curve measurement

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
lower frequency limit (Hz)	Double	200	Start frequency of sweep
upper frequency limit (Hz)	Double	5000	Stop frequency of sweep
number of frequencies	Integer	57	Number of sweep points

Name	Type	Value	Explanation
display result as gain	Boolean	False	„True“: Gain on Y axis, „False“: SPL on Y axis
selective measurement	Boolean	True	„True“: Selective measurement with fast 3rd octave filter
measurement predelay (s)	Double	0.02	Pre-delay between sweep Step and measurement trigger, allows for settling of the DUT (e.g. AGC)
number of HFA frequencies	Parameter count	3	Number of frequencies averaged in the high frequency average
HFA frequency 1 (Hz)	Double	1000	
HFA frequency (Hz)	Double	1600	
HFA frequency (Hz)	Double	2500	
HFA upper limit (dB)	Double	30	Upper limit for limit check
HFA lower limit (dB)	Double	10	Lower limit for limit check
determine maximum gain	Boolean	True	Stipulates whether the absolute curve maximum should be determined
show operator instruction	Boolean	True	Determines whether the operator should be prompted to switch the hearing aid between microphone and telecoil mode
selective acoustic measurement	Boolean	True	Optional_1: Activates selective measurement for acoustic input only
selective induction measurement	Boolean	True	Optional_1: Activates selective measurement for induction input only
preset parameters	Boolean	False	Optional_2: Determines whether to use the following two parameters or not
preset induction	Boolean	False	Optional_2: If “True”, each additional measurement (Button “Add Measurement” clicked) offers inductive measurement first
preset level (dB)	Double	60	Optional_2: Each additional measurement (Button “Add Measurement” clicked) offers the level value specified here first
lock parameters	Boolean	False	Optional_2: The settings of the previous two parameters are forced. The user cannot change them in the user interface.
curve text	String		Optional_2: Default for the curve name offered when button “Add Measurement” is clicked. This text is complemented with numbering of the measured curves.

When the “Add Measurement” button is clicked, an entry window for the level of the next sweep opens.

The input to the hearing aid can be switched between acoustic and inductive signal. For acoustic input the level is set in dBSPL. For inductive input the level can be entered in mA/m or dB(mA/m). If there are already sweeps present in the graph, the input window always opens with the settings done for the last sweep. In addition buttons are provided for increasing or decreasing the level from the previous sweep by 1, 5 or 10 dB.

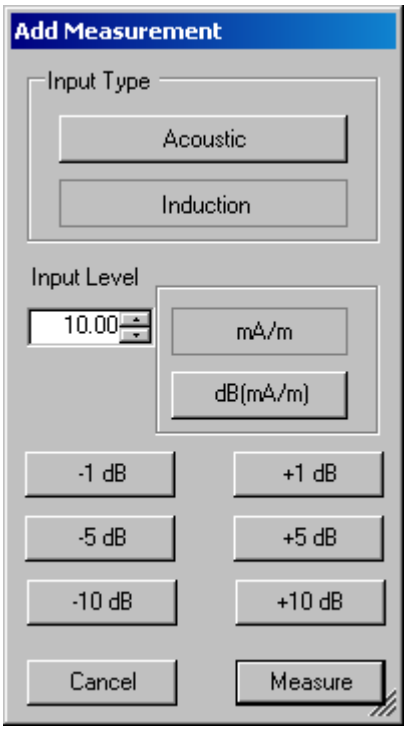

Figure 6-12 Entry window for sweep level in Multi-curve measurements

6.3.3 Saturation Sound Pressure Level Measurement

Figure 6-13 Display window of saturation sound pressure level measurement

The saturation sound pressure level measurement performs the specified number of level sweeps and records the maximum level obtained in each sweep.

The following table lists all available parameters in the generic saturation sound pressure level measurement:

Table 6-3 Available parameters for saturation SPL measurements

Name	Type	Value	Explanation
battery voltage (V)	Double	1.5	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
lower frequency limit (Hz)	Double	200	Start frequency of sweep
upper frequency limit (Hz)	Double	8000	Stop frequency of sweep
number of frequencies	Integer	65	Number of sweep points
lowest input level (dB)	Double	60	Start level of sweep (dBSPL or dB re 1 mA/m)
highest input level (dB)	Double	90	Stop level of sweep (dBSPL or dB re 1 mA/m)
number of levels	Integer	31	Number of level steps in sweep
selective measurement	Boolean	false	„True“: Selective measurement with fast 3rd octave filter

Name	Type	Value	Explanation
measurement delay (s)	Double	0.02	Pre-delay between sweep Step and measurement trigger, allows for settling of the DUT (e.g. AGC)
inductive	Boolean	false	“False”: Acoustic input, “True”: Inductive input
display curve maximum	Boolean	True	Optional_1: Stipulates whether the absolute curve maximum should be determined
lower limit of max. (dB)	Double	130	Optional_1
upper limit of max. (dB)	Double	150	Optional_1
check max limits	Boolean	true	Optional_1: Stipulates whether pass / fail check takes place

The only standard conformal test based on the saturation SPL measurement routine is Saturation SPL (IEC-0).

6.3.4 Harmonic Distortion Measurement

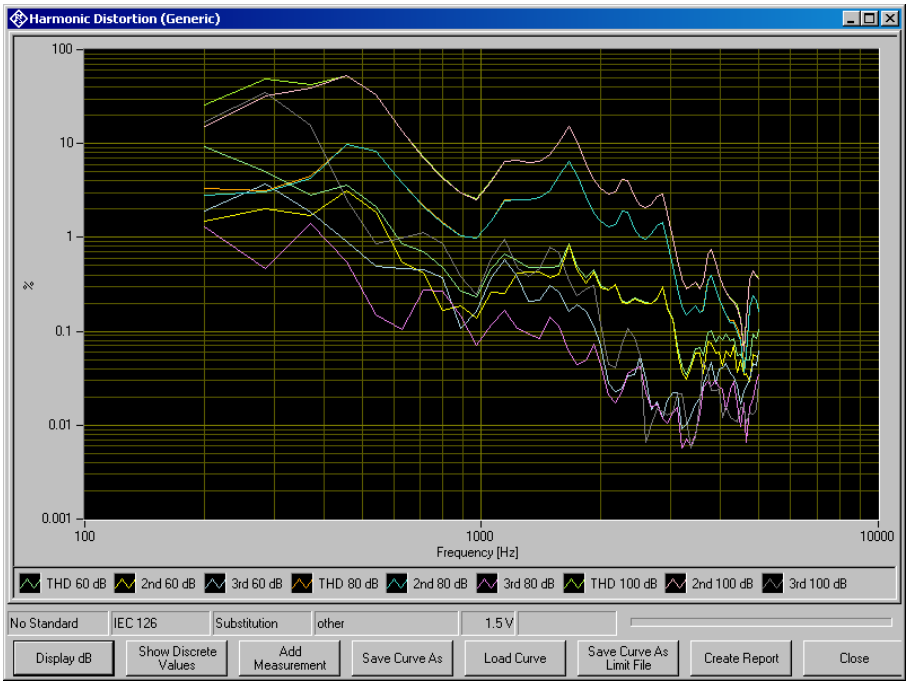

Figure 6-14 Curve display of harmonic distortion measurement

The softkey “Display dB” or “Display %”, respectively, allows to toggle between both Y axis units. The softkey “Show Discrete Values” or “Show Curves”, respectively, allows to toggle between curve display and result data table provided that discrete values or curves, respectively, have been measured.

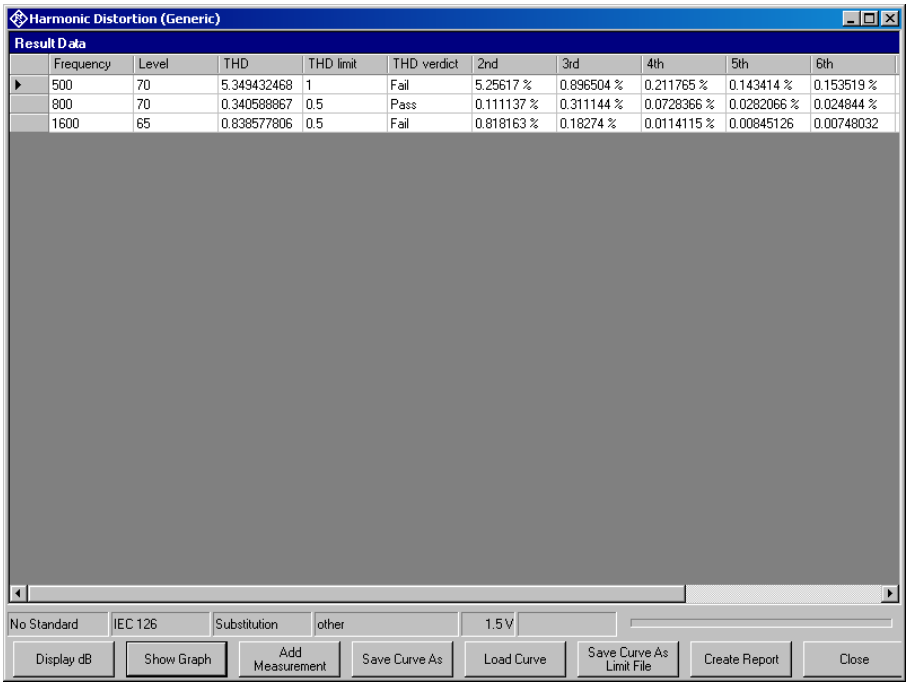

Figure 6-15 Data table display of harmonic distortion measurement

The following table lists all available parameters in the harmonic distortion measurement:

Table 6-4 Available parameters for harmonic distortion measurements

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
lower frequency limit (Hz)	Double	200	Start frequency of sweep
upper frequency limit (Hz)	Double	5000	Stop frequency of sweep
number of frequencies	Integer	57	Number of sweep points
display result in dB	Boolean	false	“False”: Y axis and values in %, “True”: Y axis and values in dB
number of sweeps	Parameter count	3	Number of sweeps with level as parameter
sweep 1 level (dB)	Double	60	(dBSPL or dB re 1 mA/m)
sweep 2 level (dB)	Double	80	(dBSPL or dB re 1 mA/m)
sweep 3 level (dB)	Double	100	(dBSPL or dB re 1 mA/m)
measurement delay (s)	Double	0.01	Pre-delay between sweep Step and measurement trigger, allows for settling of the DUT (e.g. AGC)

Name	Type	Value	Explanation
induction	Boolean	false	“False”: Acoustic input, “True”: Inductive input
show thd	Boolean	true	Stipulates whether the thd curve is displayed
show 2nd	Boolean	true	Stipulates whether curve of 2nd harmonic is displayed
show 3rd	Boolean	true	Stipulates whether curve of 3rd harmonic is displayed
show 4th	Boolean	false	Etc.
show 5th	Boolean	false	
show 6th	Boolean	false	
show 7th	Boolean	false	
show 8th	Boolean	false	
show 9th	Boolean	false	
check limit for sweep no.	Byte	0	Stipulates whether limit curve is checked. “0” means no limit check
number of discrete points	Parameter count	3	Number of discrete measured values
point 1 (Hz), (dB), limit %	String	500, 70, 1	Value triples specifying measurements and upper limits for THD
point 2 (Hz), (dB), limit %	String	800, 70, 0.5	
point 3 (Hz), (dB), limit %	String	1600, 65, 0.5	
check limits	Boolean	true	Stipulates whether limits are checked in discrete measurements
number of limits	Parameter count	3	Optional_1: Must be equal to the number of discrete measured values. Allows to specify the limits separately from frequency and level.
THD upper limit 1 (%)	Double	1	Optional_1: upper THD limit for the first discrete measurement point in %
THD upper limit 2 (%)	Double	0.5	Optional_1: upper THD limit for the second discrete measurement point in %
THD upper limit 3 (%)	Double	0.5	Optional_1: upper THD limit for the third discrete measurement point in %

The following standard conformal tests are based on the harmonic distortion measurement routine:

Harmonic Distortion (IEC-0)

Harmonic Distortion (IEC-0:2015)

Harmonic Distortion Induction (IEC-0:2015)

Harmonic Distortion (IEC-7)

Harmonic Distortion (ANSI)

6.3.5 Intermodulation Distortion Measurement

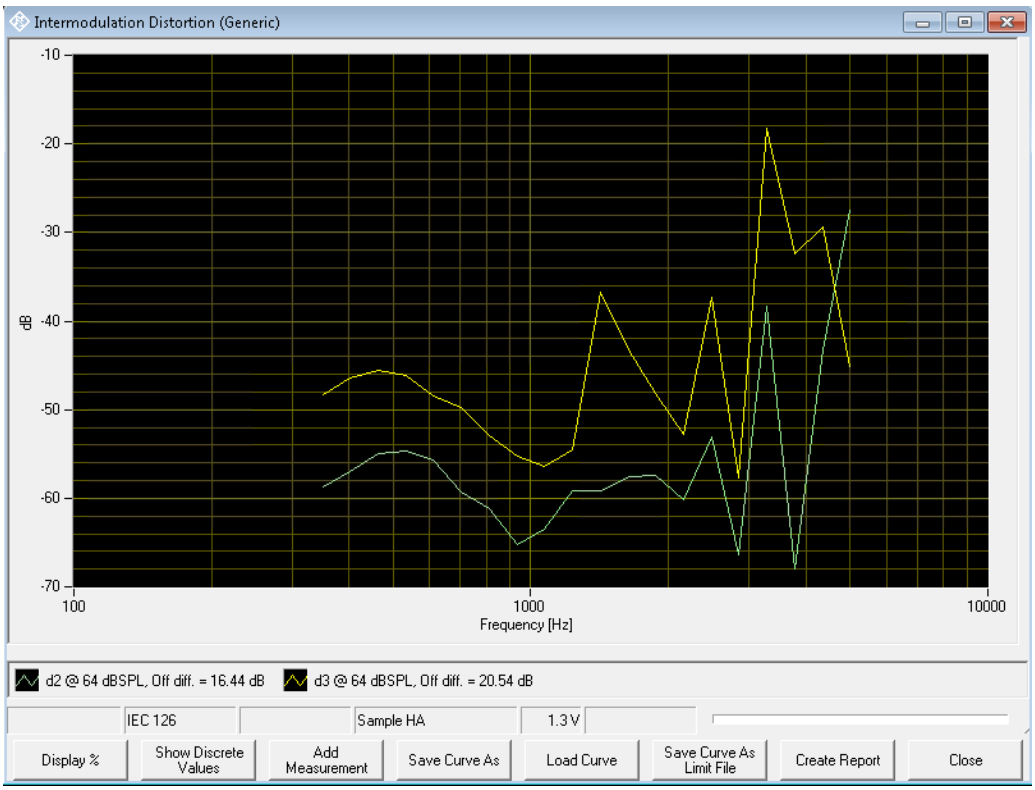

Figure 6-16 Curve display of intermodulation distortion measurement

The softkey “Display dB” or “Display %”, respectively, allows to toggle between both Y axis units. The softkey “Show Discrete Values” or “Show Curves”, respectively, allows to toggle between curve display and result data table provided that discrete values or curves, respectively, have been measured.

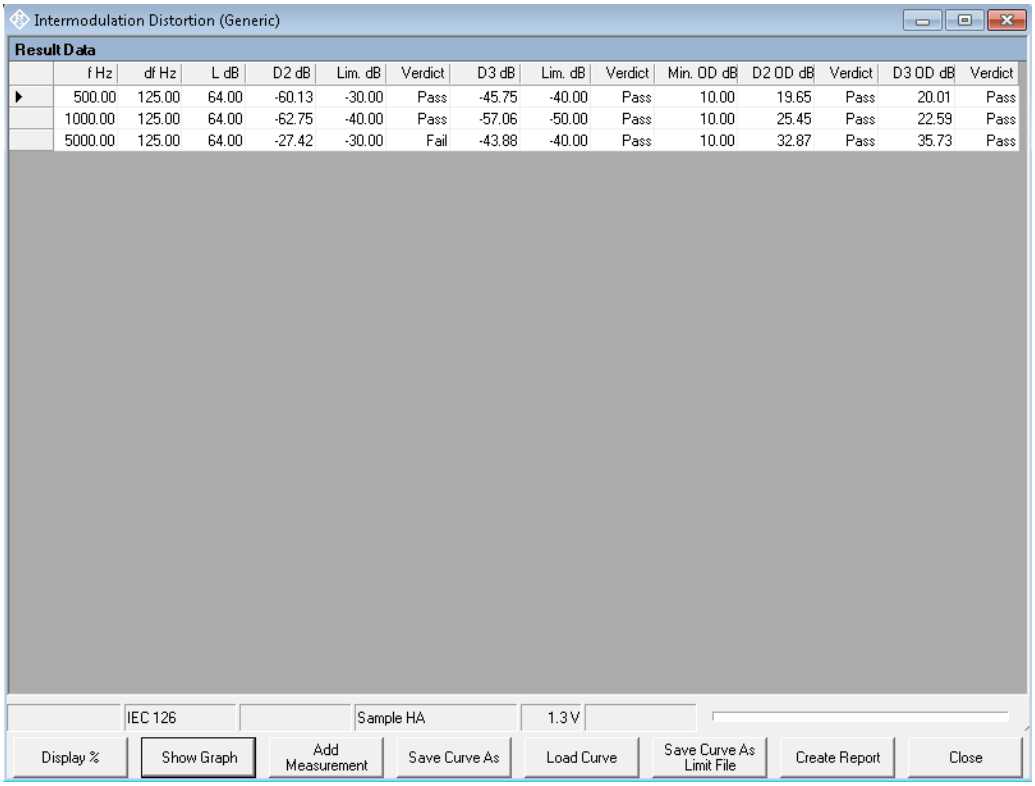

Figure 6-17 Data table display of intermodulation distortion measurement

The following table lists all available parameters in the intermodulation distortion measurement:

Table 6-5 Available parameters for intermodulation distortion measurements

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
lower f2 frequency limit (Hz)	Double	350	Start frequency of sweep
upper f2 frequency limit (Hz)	Double	8000	Stop frequency of sweep
difference frequency (Hz)	Double	125	Frequency separation of test tone pair
number of frequencies	Integer	15	Number of sweep points
check with f2 off	Boolean	True	Plausibility check with upper test tone muted shows noise level in the measurement
off difference (dB)	Double	10	Minimum difference between distortion result an noise result measured with upper test tone muted
display result in dB	Boolean	false	“False”: Y axis and values in %, “True”: Y axis and values in dB

Name	Type	Value	Explanation
number of sweeps	Parameter count	1	Number of sweeps with level as parameter
sweep 1 f1, f2 level (dB)	Double	61	(dBSPL or dB re 1 mA/m) for each test tone
measurement delay (s)	Double	0.01	Pre-delay between sweep Step and measurement trigger, allows for settling of the DUT (e.g. AGC)
induction	Boolean	false	“False”: Acoustic input, “True”: Inductive input
check d2 limit for sweep no.	Byte	0	Stipulates against which of the sweeps the limit curve is checked. “0” means no limit check
check d3 limit for sweep no.	Byte	0	Stipulates against which of the sweeps the limit curve is checked. “0” means no limit check
number of discrete points	Parameter count	3	Number of discrete measured values
point 1 f2 (Hz), Δf (Hz), (dB), d2 limit (%), d3 limit (%)	String	500, 125, 61, 1, 1	Value quintuples specifying upper frequency, frequency spacing, level of each tone, upper limits for 2nd order and 3rd order distortion products.
point 2 f2 (Hz), Δf (Hz), (dB), d2 limit (%), d3 limit (%)	String	800, 125, 61, 0.5, 0.5	
point 3 f2 (Hz), Δf (Hz), (dB), d2 limit (%), d3 limit (%)	String	1600, 125, 61, 0.5, 0.5	
check limits	Boolean	False	Stipulates whether limits are checked in discrete measurements
number of limits	Parameter count	3	Optional_1: Must be equal to the number of discrete measured values. Allows to specify the limits separately from frequency and level. If limits are specified separately, only the first three values out of each quintuple are evaluated for each discrete measurement point.
d2 limit 1 (%), d3 limit 1 (%)			Optional_1: upper distortion limits for the first discrete measurement point in %
d2 limit 2 (%), d3 limit 2 (%)			Optional_1: upper distortion limits for the second discrete measurement point in %
d2 limit 3 (%), d3 limit 3 (%)			Optional_1: upper distortion limits for the third discrete measurement point in %

The following standard conformal tests are based on the intermodulation distortion measurement routine:

Intermodulation Distortion (IEC-0)

Intermodulation Distortion (IEC-0:2015)

6.3.6 Measurement of Dynamic Behaviour (AGC Settling)

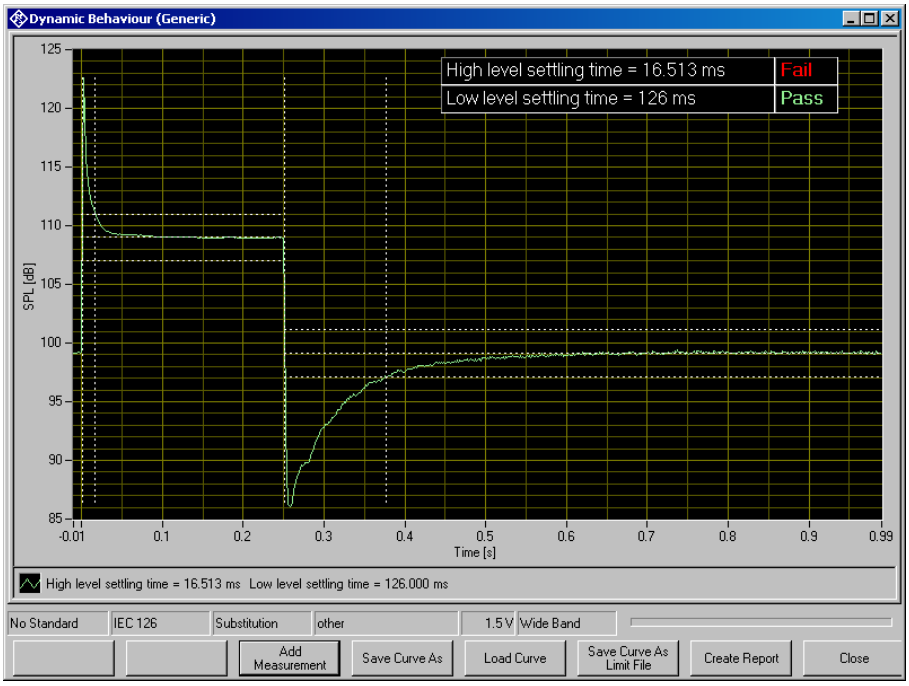

Figure 6-18 Measurement window for dynamic behaviour

The dynamic behaviour measurement inputs a step-up and step-down burst of a sinewave signal to the hearing aid. The output sound pressure level of the hearing aid is plotted over time. The settling time is the time elapsing from the level step until the level settles within a defined tolerance band around the final output level. The tolerance bands and the settling periods are indicated in the graph with dotted lines.

The following standard conformal tests are based on the dynamic behaviour measurement routine:

Dynamic Behaviour (IEC-0:2015)

Dynamic Behaviour at High Level (IEC-2)

Dynamic Behaviour at Speech Level (IEC-2)

Dynamic Behaviour (IEC-7)

Dynamic Behaviour (ANSI)

The following table lists all available parameters in the generic dynamic behaviour measurement:

Table 6-6 Available parameters for dynamic behaviour measurements

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
test frequency (Hz)	Double	2000	Frequency of sine burst tone
high level (dB)	Double	80	High level of sine burst (dBSPL or dB re 1 mA/m)
low level (dB)	Double	55	Low level of sine burst (dBSPL or dB re 1 mA/m)
on time (s)	Double	0.25	Duration of high level
interval (s)	Double	1	Period duration of sine burst
selective measurement	Boolean	False	“True”: Signal filtered with one octave width around test tone frequency
induction	Boolean	false	“False”: Acoustic input, “True”: Inductive input
store diagram	Boolean	true	“False”: Only values are stored in the database (saves disk space), “True” compressed curve is stored in the database
display dB	Boolean	true	“False”: Sound pressure on Y axis, “True”: SPL on Y axis
attack tolerance (dB)	Double	2	Settling time is determined as the time after which the curve approaches the steady value closer than this difference
attack time lower limit (ms)	Double	20	Lower limit of high settling time for limit check
attack time upper limit (ms)	Double	150	Upper limit of high settling time for limit check
release tolerance (dB)	Double	2	Settling time is determined as the time after which the curve approaches the steady value closer than this difference
release time lower limit (ms)	Double	50	Lower limit of low settling time for limit check
release time upper limit (ms)	Double	300	Upper limit of low settling time for limit check
check limits	Boolean	true	Stipulates whether limits of settling times are checked
burst-on delay (ms)	Double	5	Optional_1: Time delay between the start of the acquisition and the start of the high level burst

6.3.7 Measurement of Input-Output Characteristics

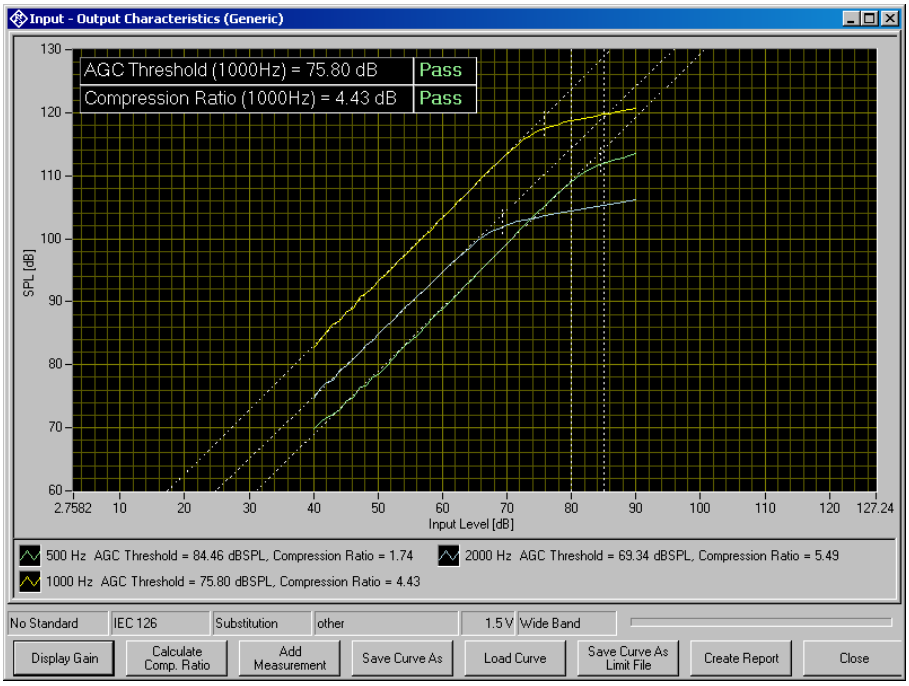

Figure 6-19 Measurement window for input-output characteristics

The softkey “Display Gain” or “Display Level”, respectively, toggles the Y axis data between gain and sound pressure level. With the softkey “Calculate Comp. Ratio” a compression ratio may be calculated for any of the measured curves.

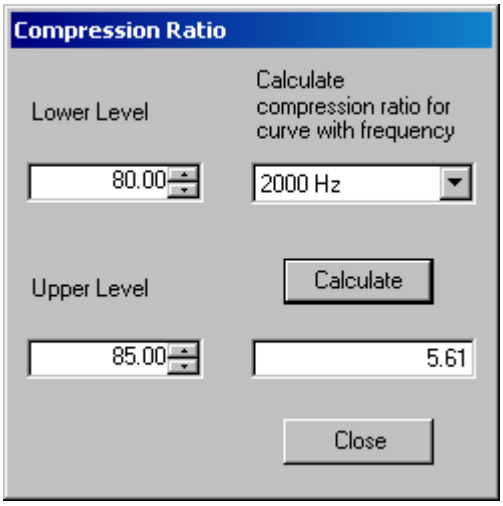

Figure 6-20 Window for calculation of compression ratio

With “Lower Level” and “Upper Level” the input levels for the compression ratio calculation are determined. The combo box top right selects one of the measured curves. When the button “Calculate” is clicked, the compression ratio is calculated and displayed in the text box below.

The following table lists all available parameters in the generic input-output measurement:

Table 6-7 Available parameters for input-output measurements

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
lowest input level (dB)	Double	40	Start level of sweep (dBSPL or dB re 1 mA/m)
highest input level (dB)	Double	90	Stop level of sweep (dBSPL or dB re 1 mA/m)
number of level steps	Integer	50	Number of level steps in sweep
display result as gain	Boolean	false	“False”: Level on the Y axis, “True”: Gain on the Y axis
selective measurement	Boolean	False	“True”: selective measurement with fast 3rd octave filter
number of sweeps	Parameter count	3	Number of sweeps with frequency as parameter
sweep 1 frequency (Hz)	Double	500	
sweep 2 frequency (Hz)	Double	1000	
sweep 3 frequency (Hz)	Double	2000	
measurement delay (s)	Double	0.05	Pre-delay between sweep Step and measurement trigger, allows for settling of the DUT (e.g. AGC)
induction	Boolean	false	“False”: Acoustic input, “True”: Inductive input
calculate values	Boolean	true	“True”: AGC threshold and compression ratio are determined for each curve
AGC threshold upper limit (dB)	Double	80	Upper limit for limit check of AGC threshold
AGC threshold lower limit (dB)	Double	60	Lower limit for limit check of AGC threshold
compression input level 1 (dB)	Double	80	Lower input level for compression ratio calculation (dBSPL or dB re 1 mA/m)
compression input level 2 (dB)	Double	85	Higher input level for compression ratio calculation (dBSPL or dB re 1 mA/m)
compression ratio upper limit	Double	8	Upper limit for limit check of compression ratio

Name	Type	Value	Explanation
compression ratio lower limit	Double	4	Lower limit for limit check of compression ratio
check limit for curve no.	Byte	2	“0” means “don’t check”

The following standard conformal tests are based on the measurement routine for input-output characteristics:

Input-Output characteristics (IEC-0:2015)

Input-Output characteristics (IEC-2)

Input-Output characteristics (IEC-7)

Input-Output characteristics (ANSI)

6.3.8 Measurement of Equivalent Input Noise

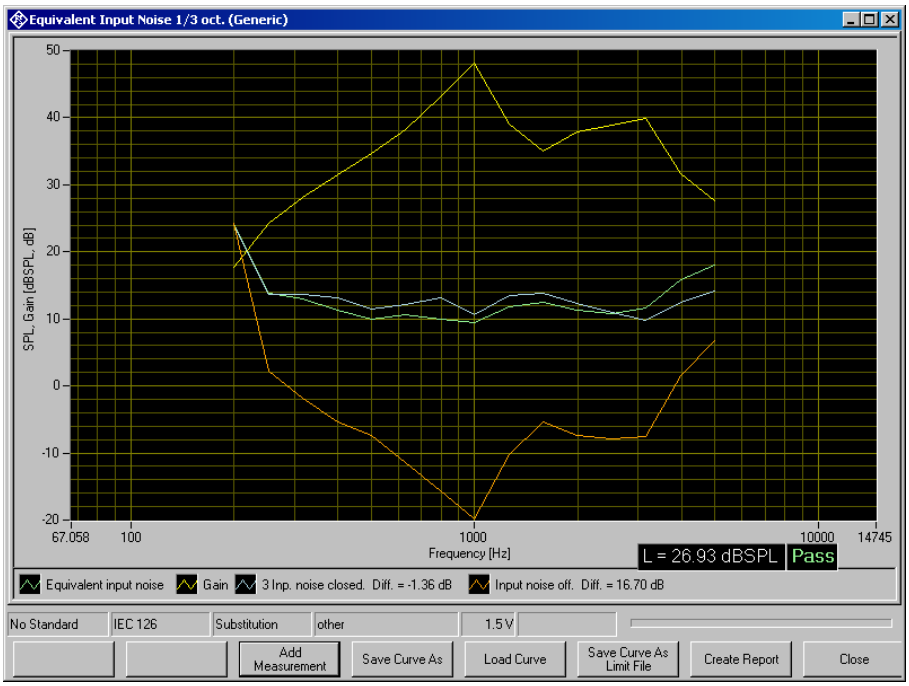

Figure 6-21 Measurement window for equivalent input noise

The test routine for equivalent input noise determines the gain at an average of pre-defined frequencies. The output noise is measured, and the equivalent input noise is determined by subtracting the gain from the output noise level. In addition to the wideband input noise, it is optionally possible to measure the 3rd octave spectrum of the equivalent input noise.

Additional measurements can be performed with sealed input and with hearing aid switched off. The equivalent input noise with sealed input should not differ significantly from that measured with open input because otherwise the noise must be assumed to be picked up from the acoustic environment. The noise measured with hearing aid switched off should be significantly lower than the measured equivalent input noise, because otherwise the noise must be assumed to be at least partly generated by the coupler microphone.

The following table lists all available parameters in the generic measurement of equivalent input noise:

Table 6-8 Available parameters for equivalent input noise measurements

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
lower cutoff freq. (Hz)	Double	175	Lower band limit for wideband noise measurement
upper cutoff frequency (Hz)	Double	5650	Upper band limit for wideband noise measurement
gain test input level (dB)	Double	60	Level for measurement of gain (dBSPL or dB re 1 mA/m)
integration time (s)	Double	1	Integration time for noise measurement
predelay (s)	Double	0	Pre-delay between sweep Step and measurement trigger, allows for settling of the DUT (e.g. AGC)
induction	Boolean	False	“False”: Acoustic input, “True”: Inductive input
number of HFA frequencies	Parameter count	1	Number of frequencies averaged for gain measurement
HFA frequency 1 (Hz)	Double	1600	
check closed input	Boolean	True	“True”: Repeat noise measurement with sealed input and check level difference
max level difference (dB)	Double	1	Maximum acceptable noise level difference between input open and input sealed
check off	Boolean	True	“True”: Repeat noise measurement with hearing aid switched off
min. level difference (dB)	Double	10	Minimum acceptable noise difference between hearing aid switched of and hearing aid switched on with input open
maximum noise level (dBSPL)	Double	40	Maximum noise level for pass/fail check

Name	Type	Value	Explanation
check limits	Boolean	True	Stipulates whether limit should be checked
display spectrum	Boolean	True	Optional_1: “True”: Noise spectrum is measured with a sweep of a fast 3rd octave filter
lower frequency (Hz)	Double	200	Optional_1: Lowest 3rd octave center frequency
upper frequency (Hz)	Double	5000	Optional_1: Highest 3rd octave center frequency
number of frequencies	Double	15	Optional_1: Number of 3rd octaves measured, must match the number of 3rd octaves including the lowest and highest one
show curve as spectrum display	Boolean	True	Optional_2: The graph is displayed as spectrum curve
use 1/n-octave measurement	Boolean	True	Optional_3: It “True”, the 1/n octave measurement is used instead of a sweep of the RMS selective measurement. Requires option UPV-K6.
aperture (s)	Double	5	Optional_3: Acquisition time in seconds for 1/n octave measurement
check noise at input	Boolean	True	Optional_4: Checks the background noise at the microphone input, using the reference microphone. Beware of the inherent noise of the reference microphone!
min. difference to input noise (dB)	Double	10	Optional_4: Minimum difference between equivalent input noise and background noise at the reference microphone

The following standard conformal tests are based on the measurement routine for equivalent input noise:

Equivalent Input Noise 1/3 oct. (IEC-0)

Equivalent Input Noise (IEC-0:2015)

Equivalent Input Noise 1/3 oct. (IEC-0:2015)

Equivalent Input Noise (IEC-7)

Equivalent Input Noise (ANSI)

6.3.9 Battery Current Measurement

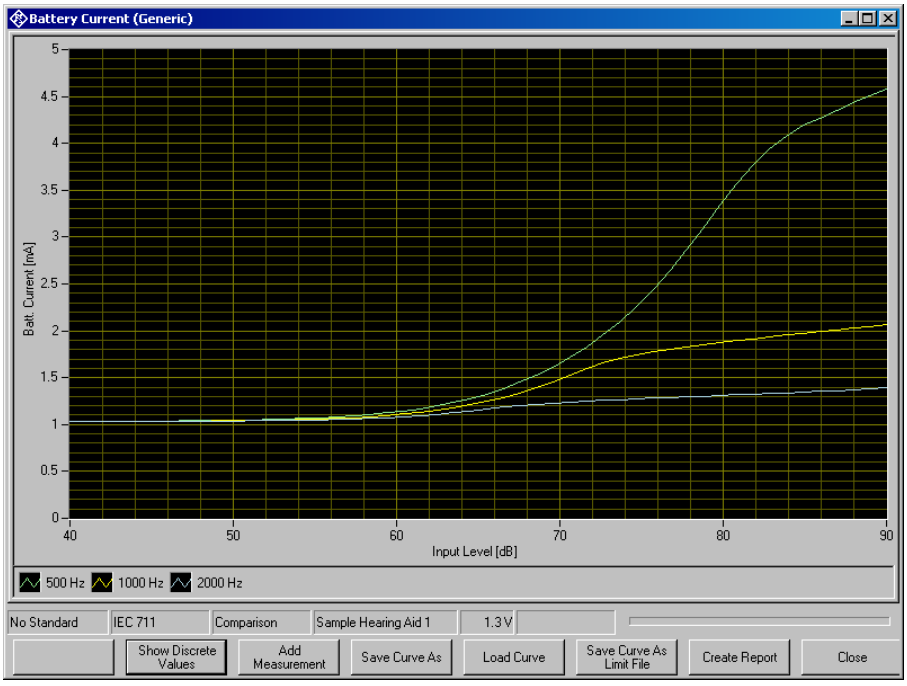

Figure 6-22 Graphic display of battery current measurement

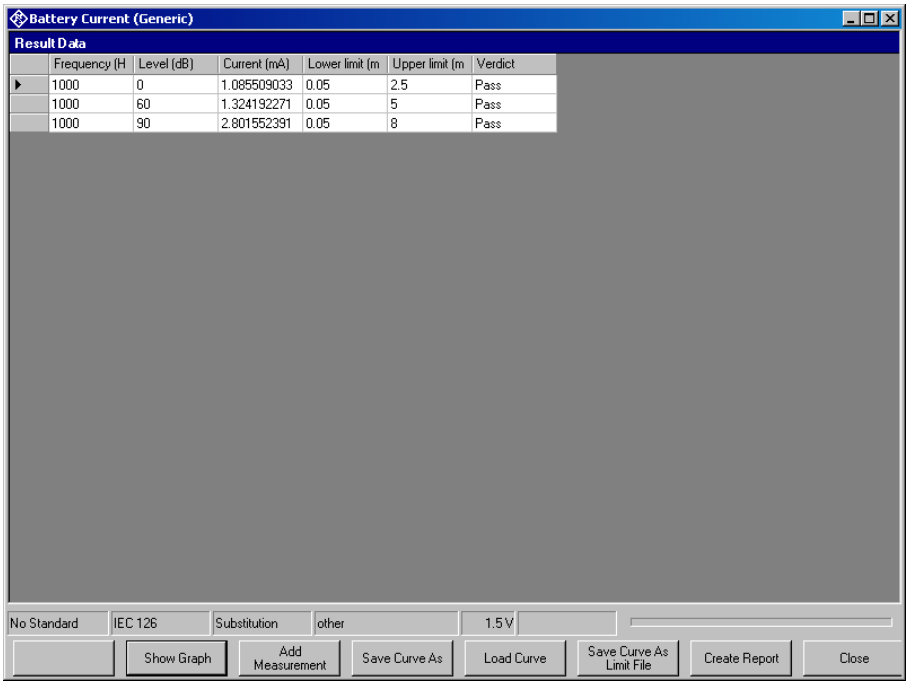

Figure 6-23 Value table display of battery current measurement

The softkey “Show Discrete Values” or “Show Graph”, respectively, toggles between the graph view and the data table view of the measurement window.

The following table lists all available parameters in the generic battery current measurement:

Table 6-9 Available parameters for battery current measurements

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
lowest input level (dB)	Double	40	Start level of sweep (dBSPL or dB re 1 mA/m)
highest input level (dB)	Double	90	Stop level of sweep (dBSPL or dB re 1 mA/m)
number of level steps	Integer	50	Number of level steps in sweep
number of sweeps	Parameter count	3	Number of sweeps with frequency as parameter
sweep 1 frequency (Hz)	Double	500	
sweep 2 frequency (Hz)	Double	1000	
sweep 3 frequency (Hz)	Double	2000	
measurement delay (s)	Double	0.05	Pre-delay between generator setting and measurement trigger, allows for settling of the DUT (e.g. AGC)
induction	Boolean	false	“False”: Acoustic input, “True”: Inductive input
check limits for curve no	Byte	2	“0” means “don’t check”
number of discrete points	Parameter count	3	Number of discrete measured values
point 1 (Hz), (dB), lower limit, upper limit	String	1000, 0, 0.05, 2.5	Value quadruples specifying measurement frequency and level, lower and upper limits in mA
point 2 (Hz), (dB), lower limit, upper limit	String	1000, 60, 0.05, 5	
point 3 (Hz), (dB), lower limit, upper limit	String	1000, 90, 0.05, 8	
check limits	Boolean	true	Stipulates whether limits are checked in discrete measurements
average count	Byte	5	Number of averaged DC measurements

Name	Type	Value	Explanation
number of limit pairs	Parameter count	3	Optional_1: Number of pairs of lower and upper limit for the battery current. Must be equal to the number of discrete points. Allows to specify the limits separately from the measurement points.
low. limit 1 (mA), upp. limit 1 (mA)	String	0.05, 5	Lower and upper limit for the measurement results of the measurement points specified above. If limits are specified here, third and fourth value of the quadruples for the discrete points are not evaluated.
low. limit 2 (mA), upp. limit 2 (mA)	String	0.05, 5	
low. limit 3 (mA), upp. limit 3 (mA)	String	0.05, 8	

The following standard conformal tests are based on the battery current measurement routine:

Battery Current (IEC-0)

Battery Current (IEC-0:2015)

Battery Current (IEC-7)

Battery Current (ANSI)

6.3.10 Speech Test according to IEC 60118-15

This test requires option key UPV-K71. Prerequisite is valid ISTS calibration data. Purpose of the test is the characterization of fitted hearing aids using a speech-like signal.

The International Speech Test Signal (ISTS) has been composed from segments shorter than 500 ms, taken from recordings with 21 female speakers in six different languages (American English, Arabic, Chinese, French, German and Spanish). Segments are mounted in sections of 10 or 15 seconds with pauses in between. The total length of the test signal used in this software is 60 seconds.

The ISTS is equalized and pre-filtered as described in the section 4 Calibration. Recordings of the signal at the input and output of the hearing aid are analyzed using the following steps:

- Input and output signal are time-aligned by a cross-correlation delay measurement
- Both signals are filtered in third-octave bands with centre frequencies from 250 Hz to 6300 Hz
- The RMS value within each 3rd-octave band is determined in sections of 125 ms length, overlapping by a factor of 2 such that a level value is obtained every 62.5 ms

- A percentile analysis of the input signal is performed on the levels pertaining to each third octave band (done during calibration).
- Within each third octave band, time sections are identified having a level within ±3 dB of certain percentile values (done during calibration). As a standard, the 30th, 65th and 99th percentile are used. The 99th percentile is defined as the level to which 99% of the samples are lower and 1 % of the samples are higher in level.
- For each combination of percentile and third-octave band, the percentile gain is determined by subtracting the input level from the output level of each selected section, and averaging the level difference in all selected sections of this percentile/third-octave band combination.
- For “Estimated Insertion Gain”, the open-ear gain given in IEC 60118-8:2005 is subtracted from the gain result and correction values for the difference between open-ear sensitivity and 2cc coupler results are added to the output level values.

Usually multiple graphs result from one test run:

- Gain calculated from the long-term average speech spectra (“LTASS gain”) at different speech levels
- Gain calculated from selected sections for certain percentiles (“Speech gain”), one graph for each speech level
- If the delay is determined for each third-octave band separately, the delay can also be plotted over frequency.

All graphs are contained within a tab control, where the tabs on top allow to switch between the graphs. The softkeys / buttons on bottom of the window are context sensitive, as far as applicable.

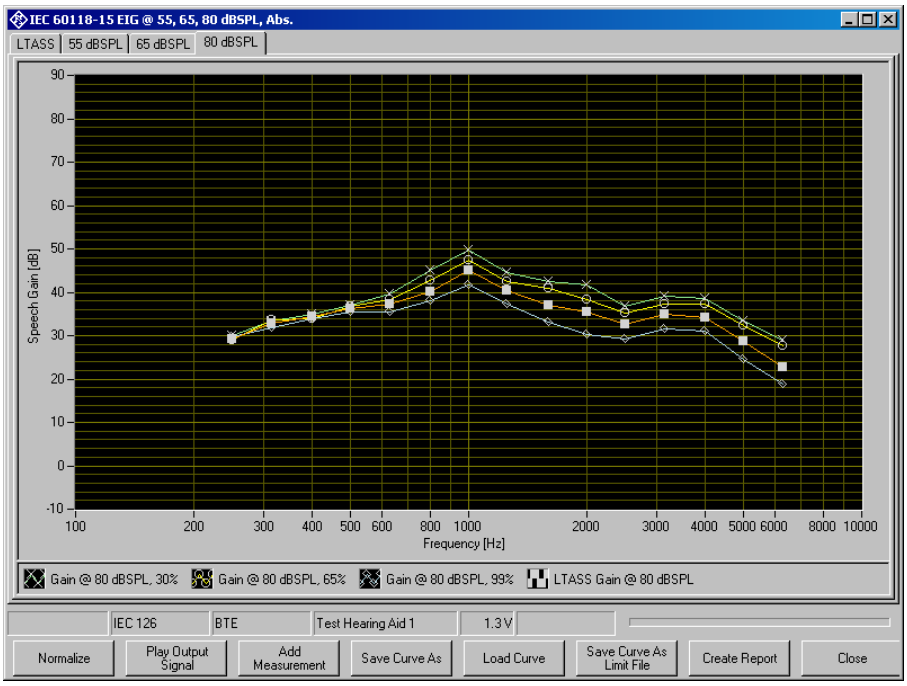

Figure 6-24 Display of speech test

The “Play Output Signal” button allows to listen to the output signal of the hearing aid. The speech level can be selected, whereas the speech level which is currently on display is pre-selected.

Level and output volume can be set in the following window:

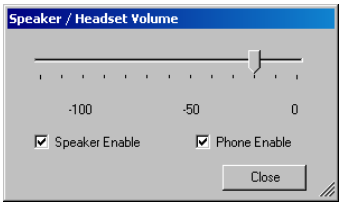

Figure 6-25 Volume control for replay of output signal

CAUTION

When using a headset, beware of excessive sound pressure. Take off and / or disconnect the headset after listening and before starting a new test.

The following table lists all available parameters in the generic speech test:

Table 6-10 Available parameters for speech tests

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
Induction	Boolean	False	Must always be “False”
lowest band	Byte	4	Lowest analyzed 3rd-octave band. Band 0 corresponds to 100 Hz.
highest band	Byte	18	Highest analyzed 3rd-octave band. Band 20 corresponds to 10 kHz
test signal (without file extension)	String	ISTS-V1.0_60s_16bit_48kHz Currently only this signal file is supported.	
analysis start time (s)	Double	15	Length of settling time.
analysis length (s)	Double	45	Length of analyzed time interval which starts after completion of settling time.
microphone location	String	SELECTED	Microphone location effect to be taken into account:

Name	Type	Value	Explanation
			“SELECTED” means MLE selected in Options. Other values: “NONE”, “BTE”, “ITE”, “ITC”, “CIC”
number of signal levels	Parameter count	3	Number of signal levels to be tested
signal level 1 (dBSPL)	Double	55	Average signal level
signal level 2 (dBSPL)	Double	65	Average signal level
signal level 3 (dBSPL)	Double	80	Average signal level
frequency-dependent delay	Boolean	False	Specifies whether the delay should be determined frequency-selective
show freq.-dep. delay	Boolean	False	Specifies whether frequency dependent delay should be plotted in an extra graph
add OES2CCD for 2cc coupler	Boolean	False	Specifies whether correction values should be applied for 2cc coupler
subtract OEG	Boolean	False	Specifies whether open-ear gain values from IEC 60118-8:2005 Annex B should be subtracted from the gain results
show LTASS gain	Boolean	True	Specifies whether the LTASS gains should be shown in an own diagram
normalize to level (dBSPL) ...	Double	0	Specifies the LTASS gain curve to which all curves should be normalized. “0” means no normalization.
show speech gain	Boolean	True	Specifies whether the percentile gain curves should be shown in a separate diagram for each tested speech level.
number of percentiles	Parameter count	3	Specifies number of percentiles for which a speech gain is determined
percentage 1 (%)	Single	30	Selected percent value of first percentile.
percentage 2 (%)	Single	65	Selected percent value of second percentile.
percentage 3 (%)	Single	99	Selected percent value of third percentile.

Name	Type	Value	Explanation
include LTASS gain	Boolean	True	Specifies whether the LTASS gains should be shown in the speech gain diagrams
normalize to LTASS gain	Boolean	False	Specifies whether the percentile gains at each level should be normalized to the LTASS gain at the respective level

The following standard conformal tests are based on the speech test routine (EIG = Estimated Insertion Gain, CG = Couple Gain):

IEC 60118-15 EIG @ 55, 65, 80 dBSPL, Abs.

IEC 60118-15 EIG @ 55, 65, 80 dBSPL, Rel.

IEC 60118-15 EIG @ 65, 80 dBSPL, Abs.

IEC 60118-15 EIG @ 65, 80 dBSPL, Rel.

IEC 60118-15 EIG @ 55 dBSPL, Abs.

IEC 60118-15 EIG @ 55 dBSPL, Rel.

IEC 60118-15 EIG @ 65 dBSPL, Abs.

IEC 60118-15 EIG @ 65 dBSPL, Rel.

IEC 60118-15 EIG @ 80 dBSPL, Abs.

IEC 60118-15 EIG @ 80 dBSPL, Rel.

IEC 60118-15 CG @ 55, 65, 80 dBSPL, Abs.

IEC 60118-15 CG @ 55, 65, 80 dBSPL, Rel.

IEC 60118-15 CG @ 65, 80 dBSPL, Abs.

IEC 60118-15 CG @ 65, 80 dBSPL, Rel.

IEC 60118-15 CG @ 55 dBSPL, Abs.

IEC 60118-15 CG @ 55 dBSPL, Rel.

IEC 60118-15 CG @ 65 dBSPL, Abs.

IEC 60118-15 CG @ 65 dBSPL, Rel.

IEC 60118-15 CG @ 80 dBSPL, Abs.

IEC 60118-15 CG @ 80 dBSPL, Rel.

Furthermore the test software provides non-standard short tests with a settling time of 5 seconds and an analysis time of 15 seconds:

Short EIG @ 55, 65, 80 dBSPL, Abs.

Short EIG @ 55, 65, 80 dBSPL, Rel.

Short EIG @ 65, 80 dBSPL, Abs.

Short EIG @ 65, 80 dBSPL, Rel.

Short EIG @ 55 dBSPL, Abs.

Short EIG @ 55 dBSPL, Rel.

Short EIG @ 65 dBSPL, Abs.

Short EIG @ 65 dBSPL, Rel.

Short EIG @ 80 dBSPL, Abs.

Short EIG @ 80 dBSPL, Rel.

Short CG @ 55, 65, 80 dBSPL, Abs.

Short CG @ 55, 65, 80 dBSPL, Rel.

Short CG @ 65, 80 dBSPL, Abs.

Short CG @ 65, 80 dBSPL, Rel.

Short CG @ 55 dBSPL, Abs.

Short CG @ 55 dBSPL, Rel.

Short CG @ 65 dBSPL, Abs.

Short CG @ 65 dBSPL, Rel.

Short CG @ 80 dBSPL, Abs.

Short CG @ 80 dBSPL, Rel.

The short tests are meant to speed up alignment procedures and quick tests, whereas precise testing according to the standard requires the full analysis time of 45 seconds after a settling time of 15 seconds.

6.3.11 Routine for Reference Test Gain Setting

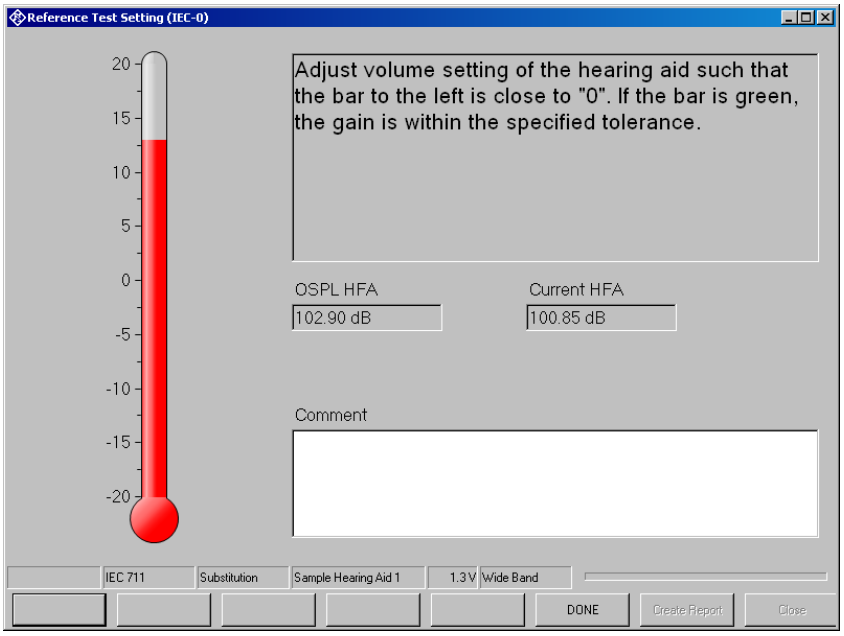

Figure 6-26 Initial display of the routine for reference test gain setting

At start of the macro, the full-on gain or output SPL is measured and averaged at the specified HFA frequencies. From this value a target level is calculated.

The gain of the hearing aid at the specified frequencies is repeatedly measured until the “STOP” button is clicked. The thermometer shows the deviation from the target value. If the deviation becomes smaller than 3 dB, the scale is enlarged. The colour of the thermometer is red as long as the deviation is higher than the allowed tolerance and turns green as soon as the deviation is within tolerance.

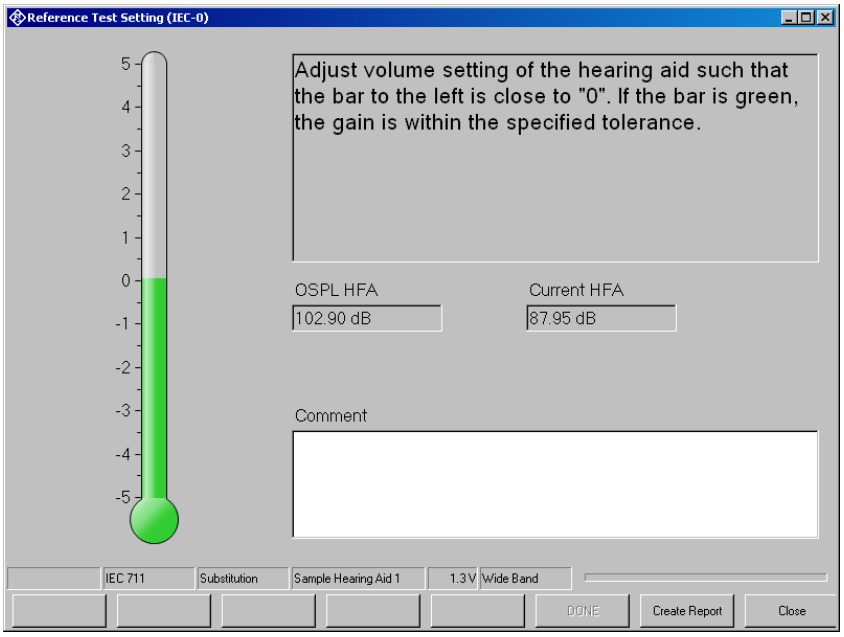

Figure 6-27 Display of the routine for reference test gain setting, adjusted

In remote control this routine writes the deviation of the current adjustment value from the target together with tolerances and verdict continuously to string buffer 21 and waits for an input. Write “continue” to string buffer 20 in order to start one more measurement after modifying the gain of the hearing aid under test. Write “done” to string buffer 19 when the adjustment is finished. The RTS value after adjustment can then be found in string buffer 21.

A comment to be printed with the report (e.g. setting of the gain control) may be entered in the “Comment” field.

The following table lists all available parameters for reference test gain setting:

Table 6-11 Available parameters for the reference test gain setting

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
selective measurement	Boolean	false	“True”: selective measurement with fast 3rd octave filter
OSPL as gain	Boolean	false	Stipulates whether the full-on value is measured as gain or as level
OSPL (dB)	Double	90	Input level for the full-on measurement
RTS as gain	Boolean	true	Stipulates whether the value during adjustment is measured as gain or as level
RTS level (dB)	Double	60	Input level during adjustment (dBSPL or dB re 1 mA/m)
measurement delay (s)	Double	0	Pre-delay between generator setting and measurement trigger, allows for settling of the DUT (e.g. AGC)
induction	Boolean	false	“False”: Acoustic RTS input, “True”: Inductive RTS input, OSPL measurement is always acoustic
number of HFA frequencies	Parameter count	3	Number of frequencies averaged for gain measurement
HFA frequency 1 (Hz)	Double	1000	
HFA frequency 2 (Hz)	Double	1600	
HFA frequency 3 (Hz)	Double	2500	
level difference (dB)	Double	-77	Difference between target value and full-on value
upper tolerance (dB)	Double	1.5	Maximum allowed difference between value during adjustment and target value

Name	Type	Value	Explanation
lower tolerance (dB)	Double	-1.5	Minimum allowed between value during adjustment and target value
store RTS OSPL during sequence	Boolean	False	If “True”, the measured RTS OSPL is stored for later use during a running sequence, e.g. for reference test setting induction
use stored RTS OSPL	Boolean	False	If “True” and a stored RTS OSPL exists, this stored value is used instead of performing a new OSPL measurement.

The following standard conformal tests are based on the reference test gain setting routine:

Reference Test Setting (IEC-0)

Reference Test Setting (IEC-0:2015)

Gain Adjustment Induction (IEC-0:2015)

Gain Adjustment Induction (IEC-1)

Reference Test Setting (IEC-7)

Reference Test Setting (ANSI)

6.3.12 Routine for Alignment of the Hearing Aid in the Magnetic Field

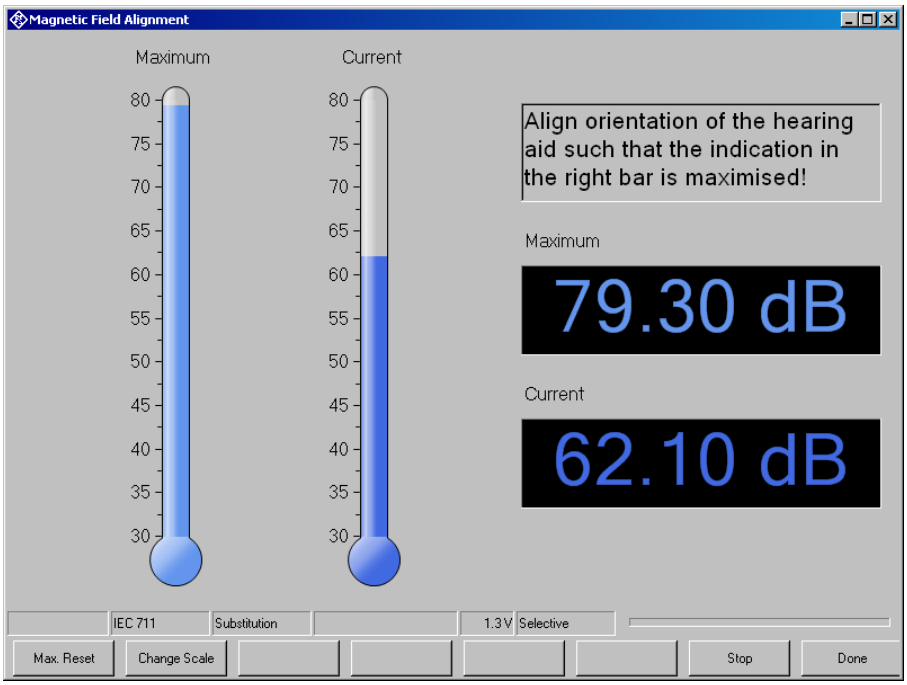

Figure 6-28 Display of the routine for magnetic field alignment

This routine shows the output SPL of the hearing aid with a defined magnetic field strength in real time on a graphic thermometer display and on a numeric display. In addition a “maximum hold” display is provided. The maximum reading can be reset by clicking the “Max. Reset” button. The range of the graphic displays can be adapted using the “Change Scale” button.

The “Stop” button stops the continuous measurement and leaved the window open. The “Done” button stops the continuous measurement and closes the window.

The following table lists all available parameters for magnetic field alignment:

Table 6-12 Available parameters for magnetic field alignment

Name	Type	Value	Explanation
Selective	Boolean	True	“True”: selective measurement with fast 3rd octave filter
induction	Boolean	True	“False”: Acoustic input, “True”: Inductive input,
number of HFA frequencies	Parameter count	1	Number of frequencies averaged for gain measurement
HFA frequency 1 (Hz)	Double	1600	
Input level (dB re 1 mA/m)	Double	20	Magnetic field strength for inductive input SPL for acoustic input
level scale maximum (dBSPL)	Double	80	Initial upper end of the graphic display
level scale minimum (dBSPL)	Double	30	Initial lower end of the graphic display

6.3.13 Electric Input Sensitivity Measurement

This measurement determines the electric input sensitivity by comparison with the acoustic gain.

Table 6-13 Available parameters for electric input sensitivity measurement

Name	Type	Value	Explanation
battery voltage (V)	Double	0	Supply voltage provided at ANLG AUX OUT. Overrides the general setting. “0 V “ means “use voltage from general setting”.
measurement delay (s)	Double	0.02	Pre-delay between sweep Step and measurement trigger, allows for settling of the DUT (e.g. AGC)
selective measurement	Boolean	True	„True“: Selective measurement with fast 3rd octave filter

Name	Type	Value	Explanation
acoustic reference level (dBSPL)	Double	70	Input level used to determine the output SPL with acoustic input
electric target level (dBV)	Double	-54	Initial voltage to the electric input of the hearing aid for starting the adjustment loop
adjustment tolerance (dB)	Double	0.05	Criterion for ending the adjustment loop. The adjustment is finished when the deviation is lower than the specified tolerance.
maximum input voltage (V)	Double	1	Voltage limit for protection of the electric input of the hearing aid.
number of HFA frequencies	Parameter count	1	Number of frequencies averaged for output SPL measurement
HFA frequency 1 (Hz)	Double	1600	
upper input sensitivity limit (dBV)	Double	-48	Upper limit for the sensitivity result of the electric input
lower input sensitivity limit (dBV)	Double	-60	Lower limit for the sensitivity result of the electric input
check limits	Boolean	False	Stipulates whether limits are checked in discrete measurements
lower frequency limit (Hz)	Double	200	Optional_1: Start frequency of optional sweep
upper frequency limit (Hz)	Double	5000	Optional_1: Stop frequency of optional sweep
number of frequencies	Integer	57	Optional_1: Number of sweep points for optional sweep
number of sweeps	Parameter count	1	Optional_1: Number of sweeps with level as parameter
sweep 1 level (dB)	Double	0	Optional_1: Sweep level for each sweep (dB re measured electric input sensitivty)
Display curve maximum	Boolean	False	Optional_2: Stipulates whether the absolute curve maximum should be determined

The following standard conformal tests are based on the electric input sensitivity measurement routine:

Electric Input Sensitivity (IEC-0:2015)

Electric Input Sensitivity @ 1600 Hz (IEC-6)

Electric Input Sensitivity @ 2500 Hz (IEC-6)

6.3.14 Create Report

This item is not a measurement. It is found in the tree view of the sequence window and can be inserted into sequences for automatic generation of a report. It can also be called remotely.

Table 6-14 Available parameters for report creation

Name	Type	Value	Explanation
report type	String		Single Report | Sequence Report | Landscape Report | One-Page Report
subtype	String		Standard for one-page report: IEC60118-0 | IEC60118-7 | ANSI S3.22 | IEC60118-0:2015
prompt for execution	Boolean	True	„True“: the report is created after a user prompt
preview	Boolean	True	Optional_1: If „True“, a preview of the report preview opens after the report has been created. If the “Optional_1” parameters are missing, the preview always opens and the report is never stored automatically.
store	Boolean	false	Optional_1: If „True“, the report is stored in the specified file format with a file name which is automatically created
file format	string		Optional_1: See Table 6-15

Table 6-15 Available report file formats

File extension	File format
pdf	Portable document format
no	No format
cr	Crystal Report
rtf	Rich text
ertf	Editable rich text
csv	Character-separated values
docx	Word for Window document
txt	ASCII text
xlsx	Excel workbook
xls	Excel workbook

File extension	File format
xlsr	Excel record
tab	Tab-separated text
html32	HTML 3.2 document
html40	HTML 4.0 document
xml	XML document
rptr	Read-only Crystal Report

6.3.15 Set Switcher

This item is not a measurement. It is found in the tree view of the sequence window and can be inserted into sequences for changing the switcher settings and selecting calibration values for connected acoustic equipment.

Typically the switcher should be deactivated in the “Options” menu when this function is utilized. Otherwise the switcher settings will be overridden by the switcher control of the measurement functions.

Table 6-16 Available parameters for switcher control

Name	Type	Value	Explanation
Operation	String	Switcher	Do not change!
Input channel for output A	Byte		The channel to be connected to output A. “0” means "do not change".
Input channel for output B	Byte		The channel to be connected to the output B. “0” means "do not change".
Calibration type code 1	Byte		Type code for the first calibration assignment to be changed. See Table 6-17
Calibration file name 1	string		Relative file name of calibration file
Calibration type code 2	Byte		Type code for the first calibration assignment to be changed. See Table 6-17
Calibration file name 2	string		Relative file name of calibration file

Table 6-17 Calibration type codes

Code	Meaning
0	Reference microphone
1	2 cm^3 coupler microphone
2	Ear simulator
3	Sound source
4	Induction coil
5	Current sense resistor
6	n. a.
7	Artificial mastoid
8	0.4 cm^3 coupler microphone

6.3.16 Start Executable

This item is not a measurement. It is found in the tree view of the sequence window and can be inserted into sequences for starting a measurement, e.g. in order to change settings of a hearing aid under test.

The executable is called with the specified command line parameters. The sequence waits for the executable to terminate. If a result file is specified, the contents of the result file are adopted for the UPV-K7 result database.

Table 6-18 Available parameters for report creation

Name	Type	Value	Explanation
Operation	String	Run Executable	Do not change!
absolute path name	Boolean	False	“False”: The file is located in “D:\Hearing”. Only the file name itself is specified. “True”: The file name contains the complete path information.
program file name	String		The file name or path name of the executable

Name	Type	Value	Explanation
Results file name	String		Name of the file containing the results of the call of the executable, to be integrated with the UPV-K7 results. The file name is relative and the file must be found in folder “D:\Hearing”. If the file name ends with “.txt”, the contents of the file are appended as comment in the result of the call of the executable. If the file name ends with “.xml”, the contents consolidated with the UPV-K7 database. The data set structure must comply with the structure of the UPV-K7 database.
number of command line parameters	Parameter count	1	Number of command line parameters specified for the call of the executable.
Command line parameter 1	String		Parameter to be added to the command line calling the executable.

7 Automatic Test Sequences

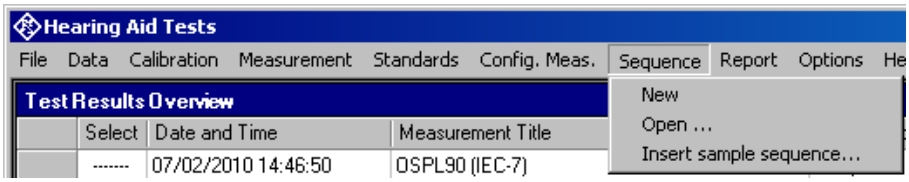

Figure 7-1 Sequence menu

7.1 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.

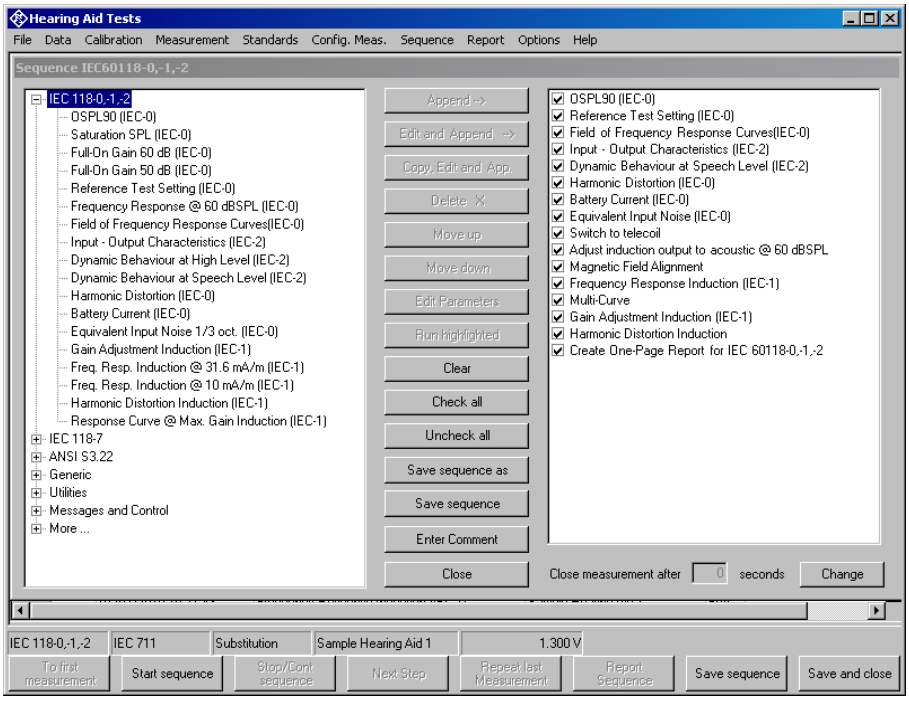

Figure 7-2 Sequence window

Initially the right checked list box is empty. The list box on the left side displays all available measurement definitions, sorted by standards like 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. It is possible to edit parameters which are not defined by the standard 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 repeats a certain test with different battery voltages.

7.2 Opening an Existing Sequence

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

7.3 Using a Sample Sequence

Sample sequences are provided in the folder “C:\Program Files\Rohde&Schwarz\UPV-K7 Hearing Aid Tests”. Before being edited or run, the files should be copied to the current “D:Hearing” directory. This can be done with menu item “Sequence → Insert sample sequence.

Sample sequences are provided for measurements according to IEC 60118-0,-1,-2, according to IEC 60118-0:2015, according to IEC 60118-7 and according to ANSI S3.22. They can be used for collecting the data for the one-page reports.

7.4 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. Each measurement window may be kept open for a time period defined in “Options → Delay before closing a measurement in a sequence …”. This value can also modified on the bottom right corner of the sequence window. In addition, a screenshot of each terminated measurement is copied to a new tab in the sequence results overview:

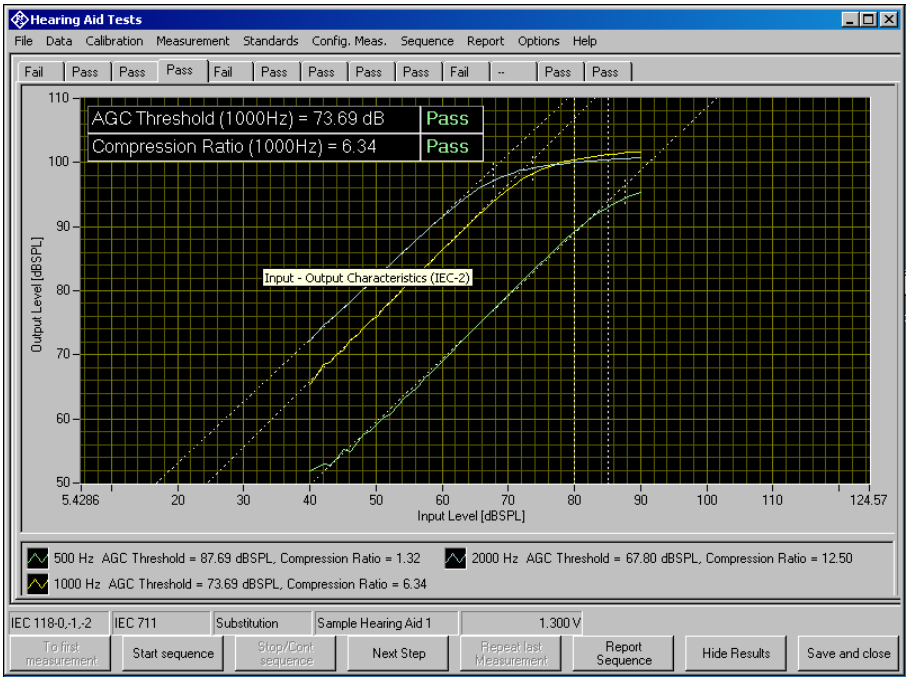

Figure 7-3 Sequence results window

The view can be toggled between results and sequence by using the “Hide Results” / “Show Results” button, respectively. Each tab indicates the verdict (“Pass” or “Fail”) of the respective result. If the mouse is hovered into the visible screenshot, the tooltip displays the measurement title. Alternatively the tabs can also be configured in the context menu to show the titles of the measurements.

7.5 Running a Single Measurement within a Sequence

When the softkey “Run highlighted” is pressed, the measurement currently selected in the right checked list box is executed regardless of its checked state. Results are added to the result database, however the measurement started this way will not appear in the sequence report. This allows to use sequences as customized sets of measurements which can be stored and opened later again.

7.6 Reporting on Sequence Results

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

8 Reporting, Storing, Loading and Deleting Results

8.1 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.

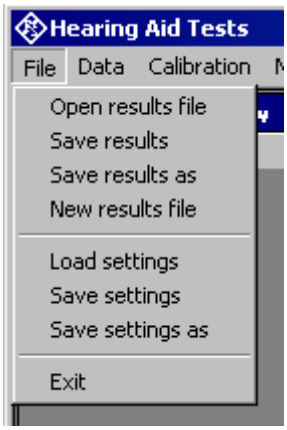

Figure 8-1 File menu

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 → Save results as” from the main menu.

8.2 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.

8.3 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.

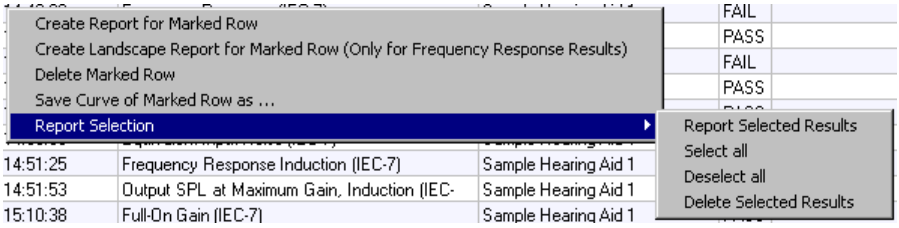

Figure 8-2 Results context menu

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.

8.4 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.

8.5 Configuring the Landscape Report

Menu item “Report → One-Page Report Settings” opens the following input window:

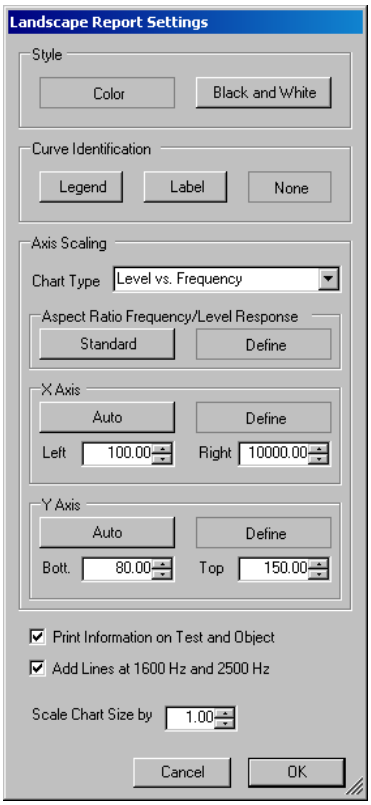

Figure 8-3 Data entry window for settings of the landscape report

“Style” allows to choose between black-and-white and Color output.

“Curve Identification” specifies how to include the parameter Values for the curves: in a legend below the graph, in a label inside the graph area or not at all.

“Axis Scaling” can be configured for each combination of x axis unit and y axis unit separately. “Standard” means automatic scaling to achieve the y axis to x axis ratio defined in IEC 60118-0. “Define” enables the input fields below.

In the **“X Axis”** and **“Y Axis”** fields, the scaling of each axis can be defined for the specified combination of axis units. “Auto” uses the scaling from the result dataset. “Define” enables the controls for the maximum and minimum values.

The checkbox **“Print Information on Test and Object”** enables inclusion of the measurement title and information about the tested hearing aid and about the operator.

“Add Lines at 1600 Hz and 2500 Hz” enables inclusion of auxiliary vertical lines at these frequencies, provided that the x axis unit is frequency.

Furthermore, the chart size can be scaled between 0.5 and 1.2. Information text is included only with scale factors up to 1.0. A scale factor of 1.2 causes the graph to fill the whole A4 landscape page.

8.6 Generating a Landscape Report

A landscape report shows the result graph on an A4 landscape page. A landscape report can be generated from the measurement window by right-clicking into the result graph of a frequency response measurement and selecting “Create Landscape Report” from the context menu. Furthermore a Landscape report can be created from the results overview data grid in the main window by marking a row in the results overview by clicking into the row header, right-clicking into the results data grid and selecting “Create Landscape Report for Marked Row”.

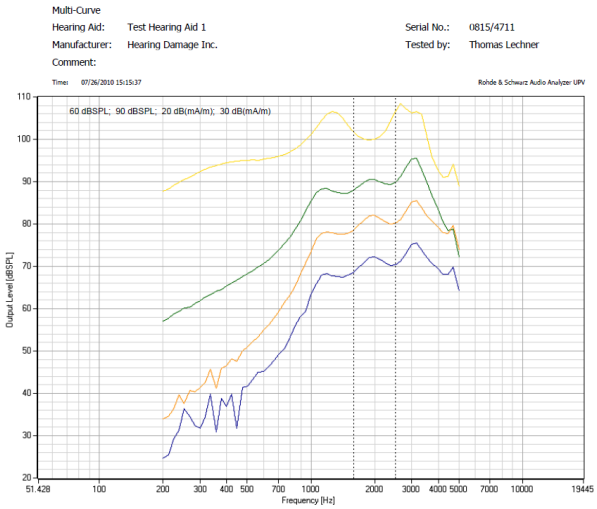

Figure 8-4 Sample landscape report

8.7 Selection Report

A report on a selection of measurements can be generated from the results overview data grid in the main window by marking the rows with the desired results in the “Select” column and choosing item “Report Selection → Report Selected Results” (see Figure 7-1). Rows marked with “XXXXX” in the “Select” column will be added to the report. The selection can be toggled by clicking into the respective “Select” cells. Note that another cell must be clicked before the same cell can be toggled again.

8.8 Configuring the One-Page Report

Menu item “Report → One-Page Report Settings” opens the following input window:

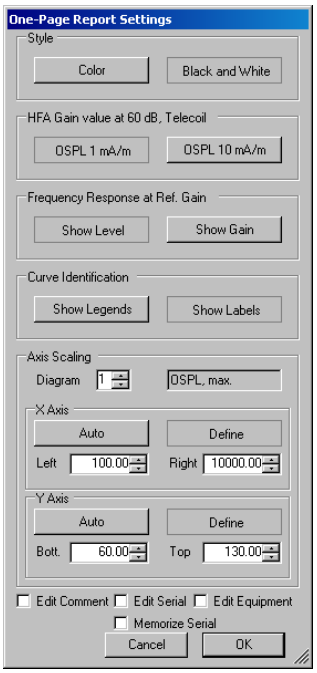

Figure 8-5 Data entry window for settings of the one-page report

“Style” allows to choose between black-and-white and “Color” output.

“HFA Gain vale at 60 dB, Telecoil” selects whether the output sound pressure level measured at HFA/ref. frequency with 10 mA/m is displayed in column” Setting Telecoil” and row “Gain @ 60 dB @ REF, OSPL(1mA/m, ref.)”, or whether a virtual value at 1 mA/m is displayed, calculated from a measured value of 10 mA/m or 31.6 mA/m by subtracting 20 dB or 30 dB, respectively.

In “Frequency Response at Ref. Gain” it can be chosen whether the second diagram shows output sound pressure level values or gain values.

In **“Curve Identification”** it is possible to choose between legends below the respective graph (advantageous with color plots) and labels inside the graphs (compatible with printouts from the UPL-B7 application program “HEARPRO”.

The scaling of each graph can be configured in the **“Axis Scaling”** field. The diagram is chosen with the numeric entry control, and the textbox besides shows the title of the chosen graph. Autoscaling optimizes the size of the curves while preserving the aspect ratio between the axes (10 dB on Y axis equals 10 dB on X axis for input-output curves and 50 dB on Y axis equals 1 logarithmic frequency decade on the x axis for frequency response graphs) like specified in IEC 60118-0 section 8 and in IEC 60263.

Checkboxes **“Edit Comment”**, **“Edit Serial”**, **“Edit Equipment”** cause the respective information to be displayed for editing during generation of the report. If **“Memorize Serial”** is checked, the serial number is not taken from the information about the selected test object but can be entered during generation of the report. To ease entry of consecutive serial numbers, the last entered number is always memorized and displayed as suggestion for the next instance of the report.

8.9 Generating a One-Page Report

One-page reports are available for standards IEC 60118-0,-1,-2, IEC 60118-7 and ANSI S3.22. They can be generated for the test object selected in “Data → Test object → Select” or for the test object selected in “Report → Select by Object”.

Furthermore a one-page report can be generated from a sequence by inserting a respective control item at the end of the sequence.

To assemble a one-page report, the report generator looks for the latest results for the selected test object, with certain test names as listed below. If the one-page report is generated from a sequence, however, it uses only results obtained during the latest run of this sequence.

Table 8-1 Measurement titles of the data sources for the one-page report

	IEC 60118-0,-1,-2	**IEC 60118-0:2015**	**IEC 60118-7**	**ANSI S3.22**
1	OSPL90 (IEC-0)	OSPL90 (IEC-0:2015)	OSPL90 (IEC-7)	OSPL90 (ANSI)
2	Field of Frequency Response Curves (IEC-0)	Frequency Response (IEC-0:2015)	Frequency Response (IEC-7)	Frequency Response (ANSI)
3	Frequency Response Induction (IEC-1) **or** Freq. Resp. Induction @ 10 mA/m (IEC-1) **or** Freq. Resp. Induction @ 31.6 mA/m (IEC-1)	Frequency Response Induction (IEC-0:2015)	Frequency Response Induction (IEC-7)	Frequency Response Induction (ANSI)
4	Response Curve @ Max. Gain Induction (IEC-1)	Full-On Frequency Response Induction (IEC-0:2015)	Output SPL at Maximum Gain, Induction (IEC-7)	Output SPL at Maximum Gain, Induction (ANSI)
5	Multi-Curve	Multi-Curve	Multi-Curve	Multi-Curve
6	Equivalent Input Noise (IEC-0)	Equivalent Input Noise (IEC-0:2015)	Equivalent Input Noise (IEC-7)	Equivalent Input Noise (ANSI)
7	Harmonic Distortion (IEC-0)	Harmonic Distortion (IEC-0:2015)	Harmonic Distortion (IEC-7)	Harmonic Distortion (ANSI)
8	Harmonic Distortion Induction	Harmonic Distortion Induction (IEC-0:2015)	Harmonic Distortion Induction	Harmonic Distortion Induction
9	Battery Current (IEC-0)	Battery Current (IEC-0:2015)	Battery Current (IEC-7)	Battery Current (ANSI)
10	Dynamic Behaviour at Speech Level (IEC-2)	Dynamic Behaviour (IEC-0:2015)	Dynamic Behaviour (IEC-7)	Dynamic Behaviour (ANSI)
11	Input-Output Characteristics (IEC-2)	Input - Output Characteristics (IEC-0:2015)	Input-Output Characteristics (IEC-7)	Input-Output Characteristics (ANSI)

The following figure illustrates which of the above measurements serves as data source for the respective areas of the one-page report:

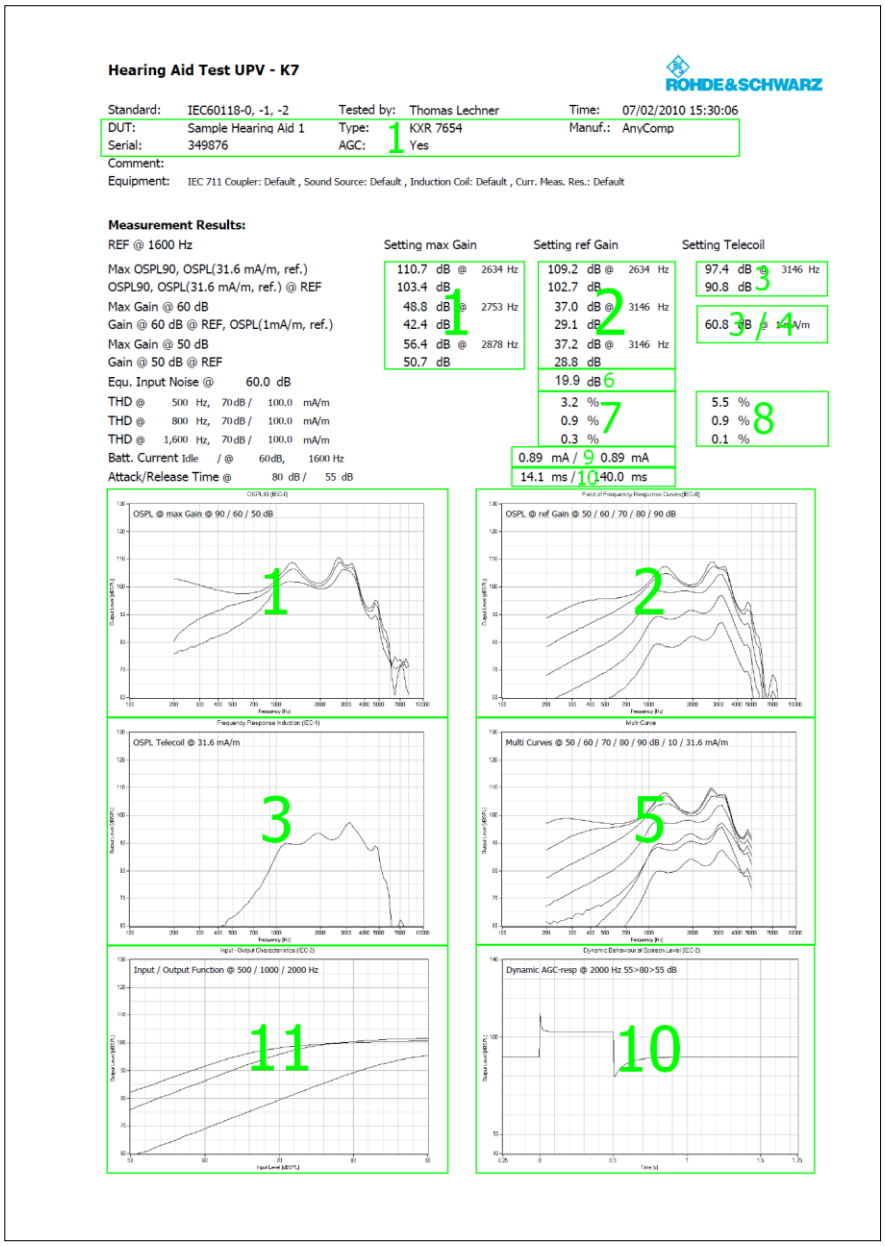

Figure 8-6 Data sources for one-page report (refer to Table 6-12)

8.10 Preview Window

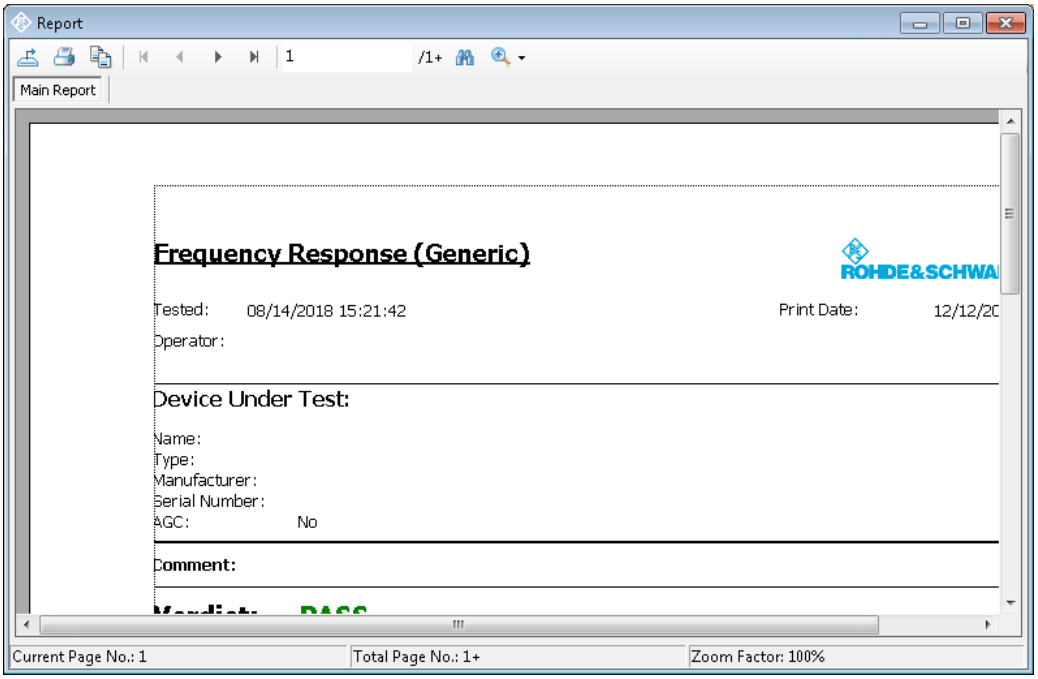

Figure 8-7 Report preview window

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

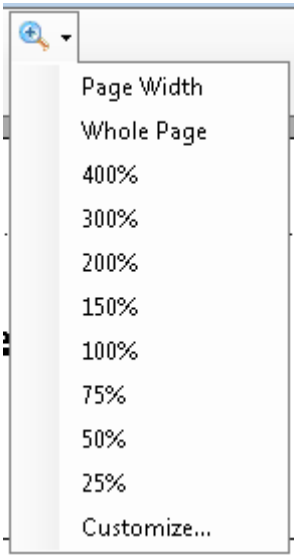

Figure 8-8 Scale menu of the preview window

8.11 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-K7 window. This allows e.g. to derive tolerance schemes from “golden devices”. The measured curve can be arbitrarily shifted before being stored.

Figure 8-9 Input window for defining a shift of a measured curve for storage as limit curve

Measured curves can be stored out of the results overview to an ASCII file by right-clicking into the results overview and selecting “Save Curve of Marked Row as …”. If the result contains more than one result, the user can select which curve is to be stored, or alternatively choose to store all measured curves into a common file. The file format can be tab separated (“*.txt”) or comma separated (“*.csv”). *.csv files can be directly opened in spreadsheet applications like MS Excel by double-clicking the file. Tab separated text files can also be imported into spreadsheets.

8.12 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 the hearing aid being switched off, 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 (except data also associated with other measurement results).

A set of results may be selected in the “Select” column of the results data grid and commonly deleted using the context menu item “Report Selection → Delete Selected Results”.

8.13 Automatic Backup and Restoration of the Results File

To speed up the execution of sequences, the result file is only saved when the program is closed. However, backups of the result file called “*.xml~1” and “*.xml~2” are stored alternately after termination of each single measurement and after termination of each sequence (“*” stands for the name of the results file without extension). If the program is ended without closing it properly, or if the result file is not existing anymore, the R&S UPV-K7 will by the time of its next start offer to restore the result file from the latest backup file:

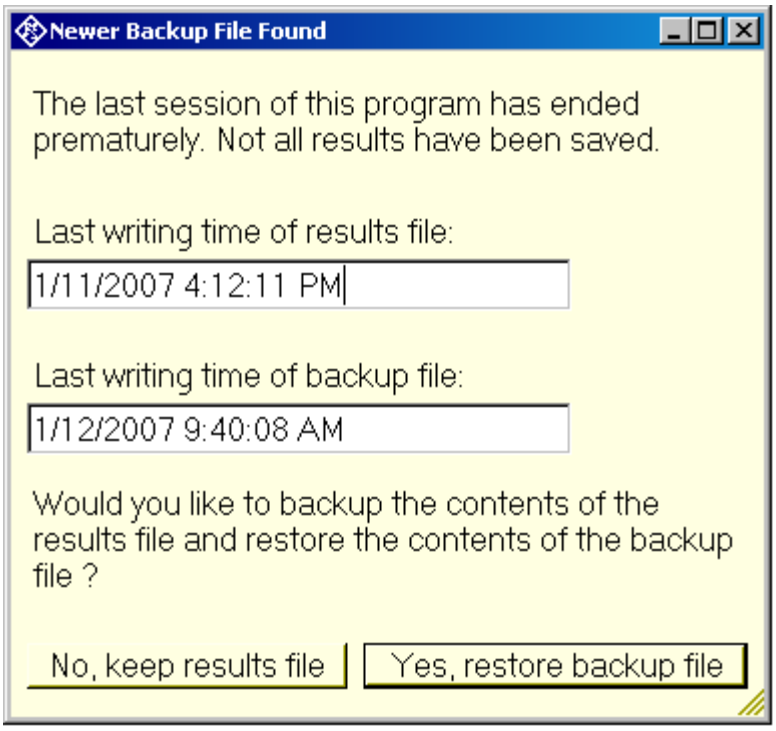

Figure 8-10 Restoration of data from backup file

If it is chosen to restore the result file from the backup, the supposedly damaged result file is copied do “*.xml~3” before the backup file is copied to the original name of the results file.

9 Remote Control

9.1 Preparations

1. Start the K7 test program on the R&S UPV.
2. In the “Options” menu, deactivate item “Show operator instructions”.
3. In the “Options” menu, deactivate item “Continuous Current Measurement”.
4. Activate “Enable remote control” in the Options menu. Remote control is always disabled after start of the UPV-K7 program.
5. If it is desired to download screenshots from the R&S UPV to the host, activate also “Generate temporary image files” in the Options menu.
6. Do all necessary settings and calibrations as would be done for manual control.

9.2 String Buffers and Data Buffers

For handing data between macros or application programs and a remote control host, the UPV firmware provides up to 1024 string buffers and up to 1024 data buffers.

String buffers can be written with SCPI command

SYSTem:MEMory:STRing<n3> <string>

and read out with SCPI command

SYSTem:MEMory:STRing<n3>?

Data buffers can be written with SCPI command

SYSTem:MEMory:DATA<n3> <data>

and read out with SCPI command

SYSTem:MEMory:DATA<n3>?

<n3> = 1 to 1024 for all operations above.

The UPV-K7 program uses string buffers 1 to 6 for communicating status information to the remote control host and string buffers 11 to 20 for communicating control information from the host to the UPV-K7 program. String buffers from 21 onwards are used for communicating result values.

Table 9-1: Contents of string buffers

Buffer No.	Content
1	Measurement Title
2	Measurement Date and Time
3	Total Verdict

Buffer No.	Content
4	Status
5	Error Message
6	Control Message
7	Not used
8	Not used
9	Not used
10	Not used
11	Control: Parameter 1
12	Control: Parameter 2
13	Control: Parameter 3
14	Control: Parameter 4
15	Control: Parameter 5
16	Control: Parameter 6
17	Control: Parameter 7
18	Control: Command
19	Control: Done
20	Control: Continue

A comprehensive description of string and trace buffer contents, depending on the type of test, is available in file “UPV-K7_Buffers.xlsx”.

9.3 Sending a Remote Control Command

A remote control command is always written into string buffer 18. Related parameters are written to string buffers 11 to 17. Note that the parameters have to be written first and the command in string buffer 18 last because the command starts the remote controlled action.

Table 9-2: Remote control commands

Command	Explanation
DUT	Changes the DUT information for report and results database.
VBatt	Sets the global battery voltage. This value can be overridden by battery voltage values specified in test definitions.
SupplyCurrent	Starts a supply current measurement.
Environmental	Enters static air pressure, room temperature and relative humidity values for the reports.
FR1	Starts a frequency response measurement according to the measurement definition file specified in string buffer 11.
RTS1	Starts the test gain setting tool according to the measurement definition file specified in string buffer 11.
LS1	Starts a level sweep (input-output curve) measurement according to the measurement definition file specified in string buffer 11.
NOISE1	Starts a measurement of equivalent input noise according to the measurement definition file specified in string buffer 11.
DF1	Starts a measurement of harmonic distortion according to the measurement definition file specified in string buffer 11.
DDIST1	Starts an intermodulation distortion measurement according to the measurement definition file specified in string buffer 11.
BCL1	Starts a battery current measurement according to the measurement definition file specified in string buffer 11.
DYN1	Starts a measurement of dynamic behavior according to the measurement definition file specified in string buffer 11.
SSPL1	Starts a measurement of saturation SPL according to the measurement definition file specified in string buffer 11.

Command	Explanation
FRI1	Starts a frequency response measurement with inductive coupling and calculation of ETLS according to the measurement definition file specified in string buffer 11.
SPEECH	Starts a speech test according to the measurement definition file specified in string buffer 11.
MC1	Starts a frequency response measurement according to the measurement definition file specified in string buffer 11.
REP1	Generates a report according to the definition file specified in buffer 11.
AT1	Starts the alignment tool according to the measurement definition file specified in buffer 11.
ESENS	Starts a measurement of electric input sensitivity according to the measurement definition file specified in string buffer 11.
SCONT	Can be used to run an external executable according to the definition file specified in buffer 11.

9.4 Remote Controlled Settings

9.4.1 Selecting a device under test

To be able to assign results later to tested devices, and to generate reports containing information about the tested device, it is possible to select a device and also to enter new information about the current device under test remotely.

The remote command to be stored in string buffer 18 for changing the information about the test object is “DUT”.

If buffer 11 contains the string “new”, a new data set is generated using the data from buffers 12 to 16. The data must be stored to the string buffers as follows:

Table 9-3: Contents of string buffers for generating a new test object data set.

Buffer No.	Content
12	Device name (String)
13	Device type (String)
14	Device manufacturer (String)
15	Device serial number (String)
16	AGC (“true” or “false”)

If the data set has been generated successfully, a date and time string serving as a key to the data set is returned in string buffer 2. This date and time string is required later to re-select the test object.

If buffer 11 contains the string “select”, the test object data set pertaining to the date and time string provided in buffer 12 is selected to be reported as test object with the subsequent tests.

9.4.2 Setting the supply voltage

Remote command “VBatt” in string buffer 18 causes the supply voltage at the analog aux output to be set to the value specified in string buffer 11. The voltage range is limited between 0 V and +3 V.

9.4.3 Setting the environmental values for the reports

Remote command “Environmental” in string buffer 18 sets the air pressure, humidity and temperature values assigned to the subsequent measurement results. It is recommended to use the formatting shown in the examples of the following table.

Table 9-4: Parameters for environmental values

Buffer No.	Meaning	Example
12	Temperature	21 °C 67 °F
13	Relative humidity	53 %
14	Static air pressure	101 kPa 758 mmHg

9.4.4 Measuring the supply current

With remote command “SupplyCurrent” in string buffer 18, a simple supply current measurement, similar to the continuous current measurement available without remote control, can be started. An optional limit check is available with the following parameters:

Table 9-5: Parameters for supply current measurement

Buffer No.	Meaning	Format
12	Lower limit (mA)	Floating point number
13	Upper limit (mA)	Floating point number
14	Check limits	Boolean (“true” or “false”)

9.4.5 Generating a report and storing it to a file

To generate a report, a definition file configuring the report has to be present. The report generation is started with the path name of the definition file in string buffer 11 and command “REP1” in string buffer 18.

9.5 Starting a Measurement

To start a measurement, store the path name of the measurement definition to string buffer 11 and then the shortcut for the appropriate measurement dll as listed in table Table 9-2 to string buffer 18. The shortcut can be seen in the parameters window (see section 6.2).

9.6 Continue and Done

Adjustments like Reference Test Setting require a confirmation from the operator that the requested operation, like e.g. setting the gain control, has been completed. If an action is requested from the operator, the prompt text is stored in string buffer 6. As soon as this text appears in string buffer 6, the execution of the measurement is halted and the status text in string buffer 4 changes to “Waiting for input”. After the operator has completed the requested action, the controlling program has to store the string “continue” in string buffer 20.

“Continue” is also used to start a new sweep in the Multi-curve measurement.

To close a measurement like Multi-curve which does not close automatically in remote mode, string “Done” has to be stored to string buffer 19.

9.7 Reading the Results

After a measurement has terminated, status information is available in string buffers 1 to 6. Global result values are available in string buffers 21 to 30. Per-sweep result values are stored from buffer 31 onwards. Each result value is stored as comma-delimited string in the order < Name, Unit, Value, Lower Limit, Upper Limit, Limit checked (True / False), Verdict (Pass / Fail / not checked) >.

Measured curves are stored as comma-delimited strings in trace buffers starting from trace buffer 11 (X values) and 12 (Y values). Trace buffers with odd number contain X values, trace buffers with even numbers contain Y values.

If limit curves exist, they are available in trace buffers 1 to 4.

For details on result data in string buffers and trace buffers, depending on the measurement function, see file “UPV-K7_Buffers.xlsx”.

Contents of string buffers are queried with SCPI command

SYSTem:MEMory:STRing<n3>?

Contents of trace buffers can be queried with SCPI command

SYSTem:MEMory:DATA<n3>?

<n3> = 1 to 1024 is the buffer number as specified in the tables above and in file “UPV-K7_Buffers.xlsx”.

9.8 Status of the remotely started measurement function

The remote control host can monitor the state of the measurement program by reading the content of string buffer 4. The meaning of the strings returned is explained in Table 9-6.

Table 9-6: Status strings

Status String	Explanation
Idle	The measurement program is currently inactive. A new measurement can be started.
Measurement running	A measurement has been started and has not yet finished.
Error occured	The running measurement caused an error. See the error string provided in string buffer 5.
Waiting for input	The measurement execution has been halted, e.g. for some input or for control of the DUT. To continue the measurement execution, write “continue” to string buffer 20. If the program is waiting to be closed, e.g. because no additional sweep is required, write “done” to string buffer 19.

10 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.

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