

Application Note

AUDIO BREAKTHROUGH ASSEMBLY AND TEST SETUP

TS9982

Products:

- ▶ R&S®TS9982
- ▶ R&S®ELEMS-R
- ▶ R&S®ELEMS-ABT
- ▶ R&S®ABT Test Setup

Marcela Reyes | 1EA1 | Version 2.10 | 07.2022

<http://www.rohde-schwarz.com/appnote/1SL391>

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1 Telephone Test Head Assembly

Unfortunately, the B&K manual doesn't show explicit the assembly of the Telephone Test Head B&L 4602B. This chapter will show how to configure the Test Head for mobile phone measurements.

1. Mount bushing DS0884 with the two short M5 screws (YS 9209) onto the LRGP (DK1247) jig as shows below.



Fig. 1-1: Bushing DS0884, M5 screws and LRGP Jig

2. Mount LRGP subassembly to Telephone Test Head 4602B using the longer M5 screw (YS9215).

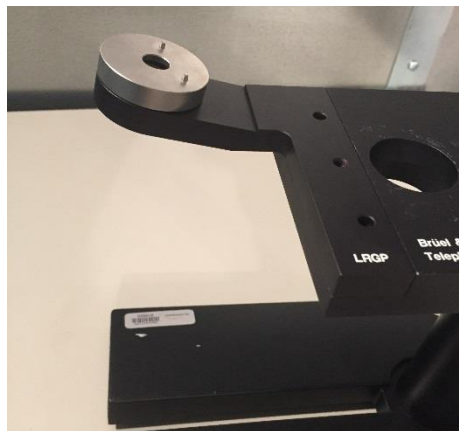


Fig. 1-2: LRGP subassembly mounted onto Telephone Test Head 4602B

3. Mount the Mouth Simulator 4227 with the aid of the Finger Screw UA 1227 onto the LRGP subassembly.



Fig. 1-3: Finger Screw inserted in LRGP subassembly

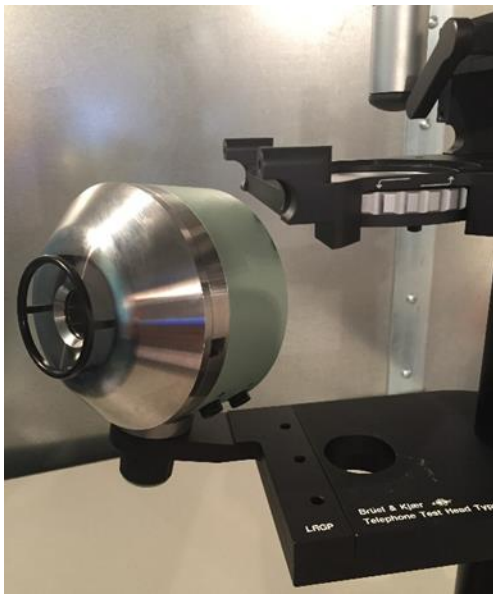


Fig. 1-4: Mouth Simulator mounted onto Telephone Test Head

4. Mount the four handset alignment rods (UA1400) with the help of the four clamps (DK1292) and four finger screws (UA 1422) to the Telephone Test Head.



Fig. 1-5: Handset alignment rods, finger screws and clamps

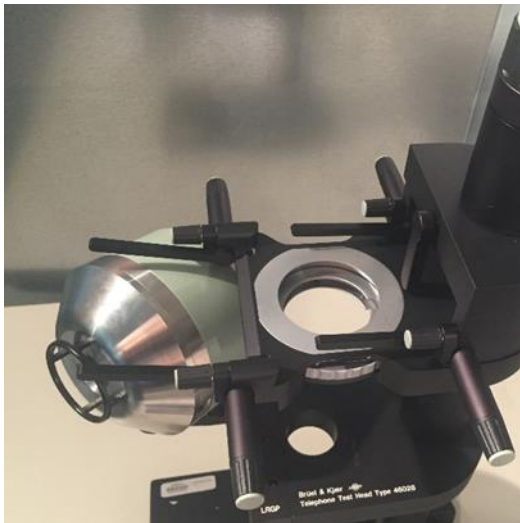


Fig. 1-6: Alignment rods mounted to Telephone Test Head

5. REMARK:

Positioning the phone on the Telephone Test Head can be difficult since the newer generation smart phone are relatively big and the space between the alignment rods is limited.

2 ABT Measurements acc. to ETSI 301 489

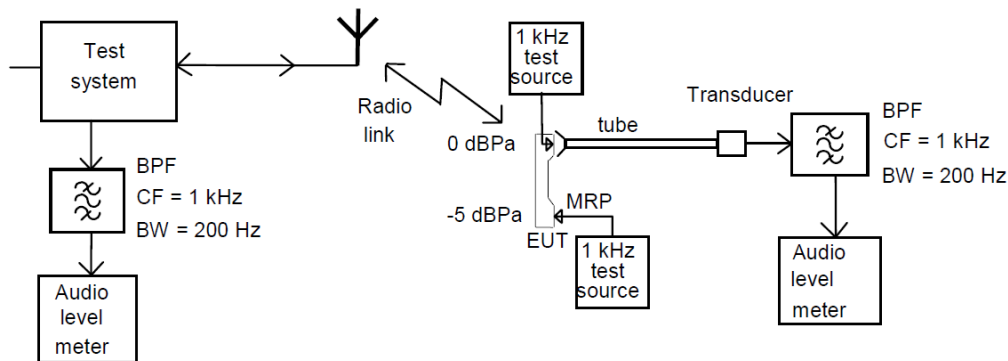
The parts of a mobile phone which are most susceptible to be affected by the EMS immunity field are the analogue circuits contained in the phone. This is because the immunity field is 1 kHz, 80 % AM modulated. Analogue circuits are implemented in the microphone section (voice pickup, uplink signal) and in the loudspeaker section of the phone (earphone signal generation, downlink signal). Hence, AF levels at 1 kHz are the measurement quantities best characterizing the EMS performance of the mobile phone's analog circuits. The measured levels will be noise levels referred to a suitable reference level.

The procedure for determining these reference levels is called [Audio Breakthrough Calibration](#) and involves a series of user interactions, which are described in the following chapters.

2.1 Hardware set up of Audio Breakthrough Calibration

ETSI EN 301 489 states that the audio levels measured for monitoring the EuT's response to an EMC immunity field shall be referred to reference levels. These shall be the audio levels measured with defined useful signals applied to the EuT.

The following picture, which has been taken from the standard, shows the general setup of the EuT and suitable accessories for making these reference (calibration) measurements.



NOTE: The EUT is in position during calibration of the uplink, but not during calibration of the downlink where the EUT is replaced by the 1 kHz test audio source. During calibration of the uplink the mouthpiece shall be placed with respect to the MRP in a way representing intended use.

Fig. 2-1: ETSI 301 489-7 V1.3.1, Calibration set-up for portable equipment.

The procedure for calibrating the audio reference levels needs many manual user interactions and can be automated only to a small degree. R&S® ELEKTRA supports the user by guiding him through the process with suitable message boxes. The equipment necessary for this procedure is supplied with the Test System and listed below:

- ▶ Acoustic Calibrator. Generates a very precise 1 kHz signal with 0 dBPa sound pressure level if a suitable microphone is plugged into its sound outlet.
- ▶ Pressure microphone. Specially designed for fitting into the calibrator's outlet. Used for taking the calibrated 0 dBPa measurement.
- ▶ Artificial Mouth Simulator. Driven by an external AF signal. Generates acoustic signals of frequency equal to the driving signal's frequency and with an amplitude proportional to the driving signals amplitude.
- ▶ Pressure microphone. Used for measuring audio levels in an acoustic tube (standing waves).
- ▶ Acoustic tube. Made of rubber. Is adapted to the mobile phone's earphone and picks up the signal from there leading it to the probe microphone.
- ▶ Dual-channel audio amplifier. Used for amplifying both microphones' output signals.
- ▶ Telephone Test Head
- ▶ Shielded Audio Breakthrough case. During an immunity test, the items which must be near the EuT (probe microphone and audio amplifier) are put into this box in order to avoid that they are affected by the immunity field. The box has a feedthrough for the acoustic tube and two RF connectors for two cables taking the audio amplifier's output signals to the audio analyzer.
- ▶ Audio Analyzer, e.g. R&S® UPV or R&S® UPP
- ▶ Radio Communication Tester, e.g. R&S® CMW500
- ▶ Audio Amplifier
- ▶

Over the next several pages the different measurement steps are explained in detail.

2.1.1 Artificial Mouth Calibration

In order to generate a calibrated sound pressure level from the artificial mouth the voltage necessary to generate this sound pressure must be determined.

In this two-step process first a calibrated acoustic calibrator with 0 dBPa output pressure will be used as reference. The reference microphone is inserted into the calibrator and the voltage at the output of the reference microphone is measured.

In the second step the reference microphone is attached via an adapter plate to the artificial mouth.

One has to be careful that the reference microphone is attached perpendicular to the artificial mouth.

Once this is done the input voltage at the artificial mouth is increased until the voltage measured at the reference microphone equals the voltage measured in the first step - 5 dBPa.

Last but not least the voltage to be applied to the artificial mouth during the immunity test is saved. The measurement is performed at an AF frequency of 1 KHz per standard.

The equipment used for this part is:

- ▶ Audio Analyzer R&S® UPV or UPP
- ▶ Audio Amplifier
- ▶ Sound Level Calibrator B&K 4231
- ▶ Sound Pressure Microphone 1 (Reference Microphone) B&K 4192
- ▶ Artificial Mouth Simulator B&K 4227
- ▶ Several cables and adapters.

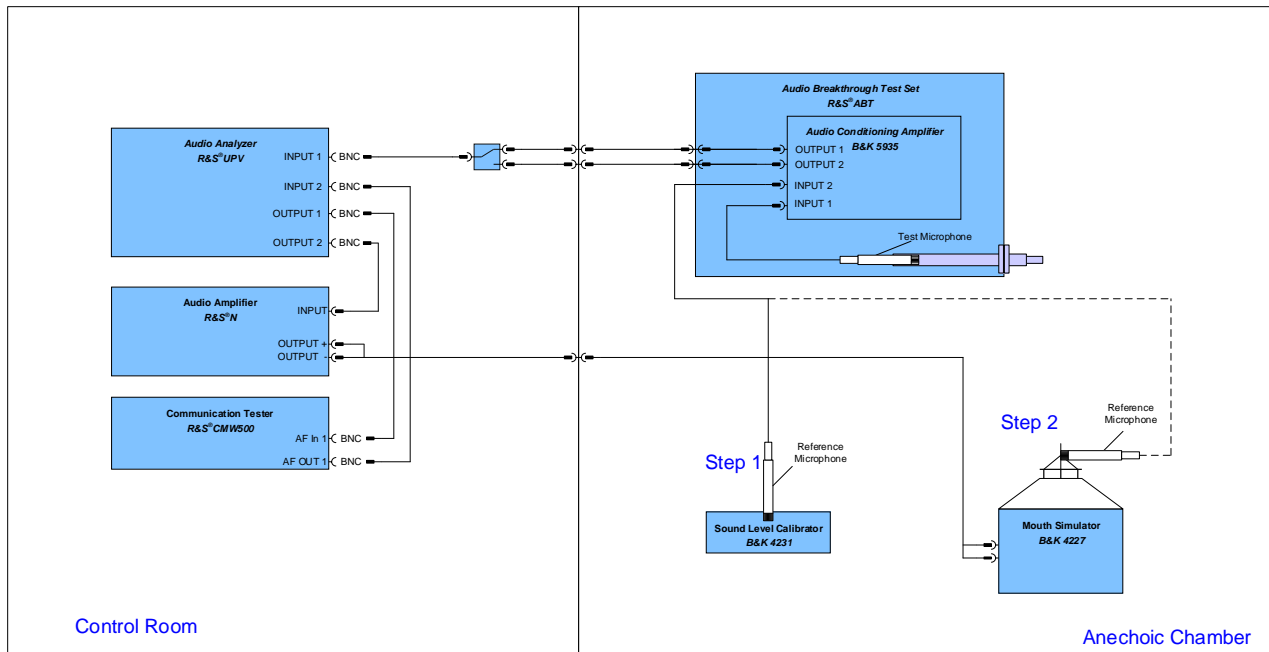


Fig. 2-2: Block Diagram of Artificial Mouth Simulator calibration

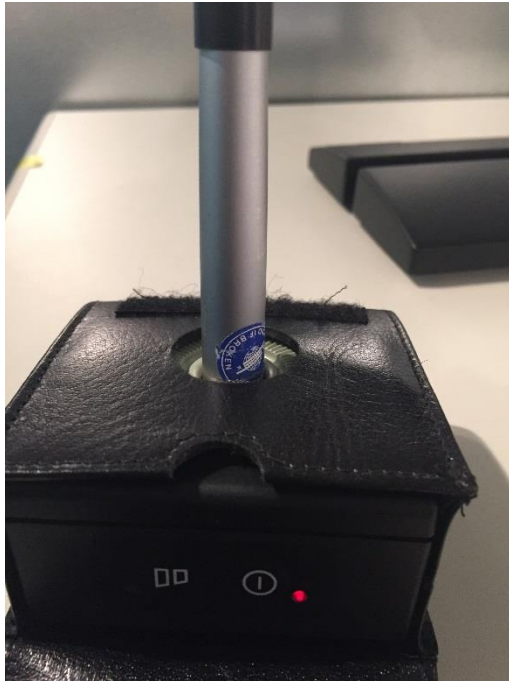


Fig. 2-3: Reference Microphone inserted into sound calibrator

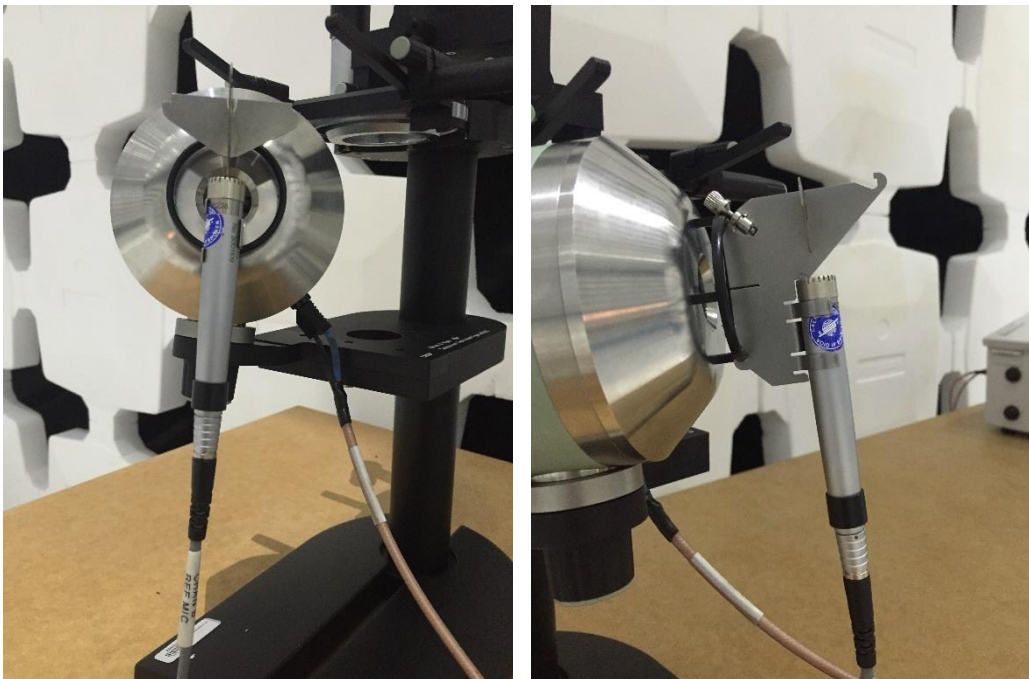
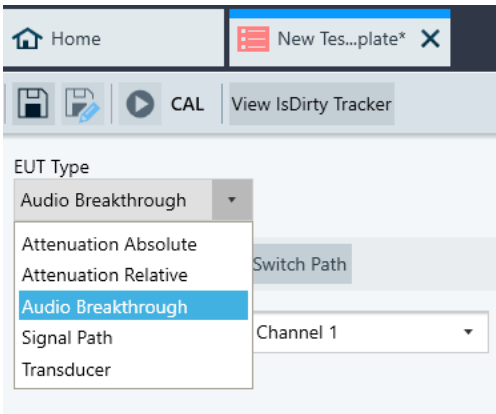


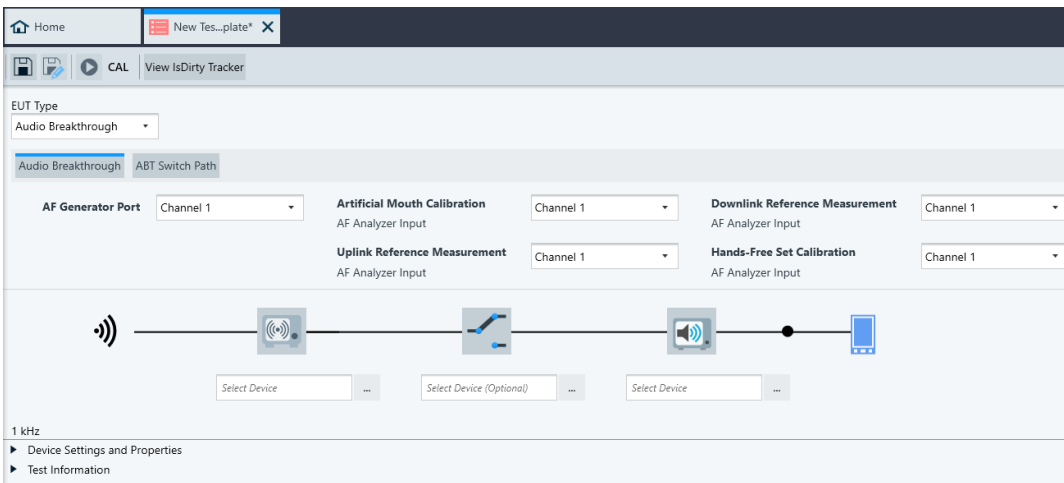
Fig. 2-4 and Fig. 2-5: Reference Microphone attached to Artificial Mouth.

R&S® ELEKTRA with option ELEMS-ABT supports audio breakthrough calibration. The utility, which guides the user through the calibration process can be found in

'Test Template' -> 'CAL' -> 'EUT Type' -> 'Audio Breakthrough'.



After opening the Audio Breakthrough Calibration Template, the user will see the following window:



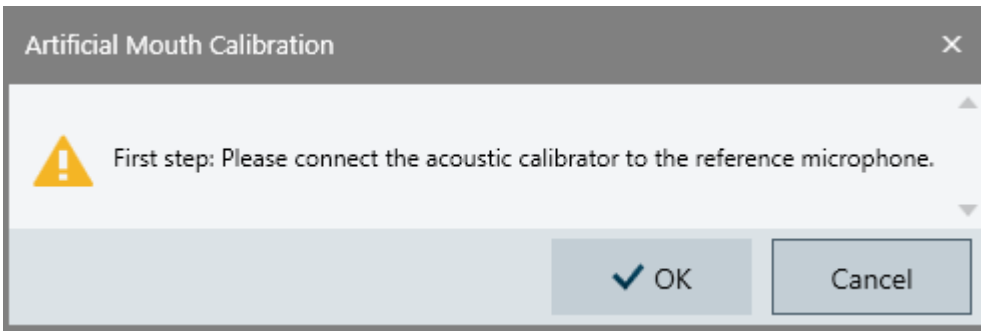
In this interface it is possible to add and configure the instruments:

- ▶ Audio Analyzer R&S® UPV or UPP
- ▶ Communication Tester R&S® CMW500
- ▶ Switch Unit (Optional)

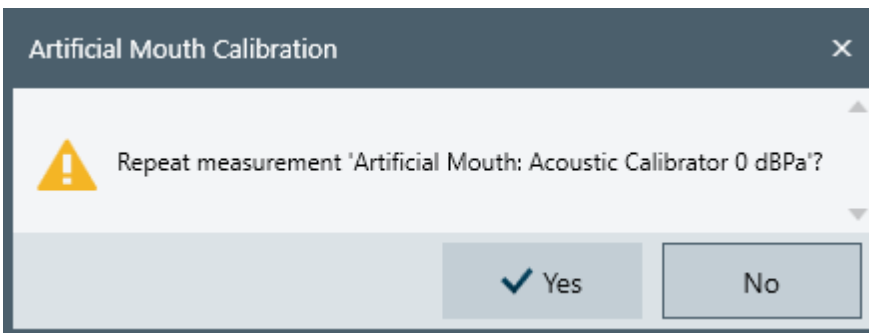
After saving the Cal Template, it will be possible to start the Test. The Audio Breakthrough Calibration Test interface looks like the following window:

Name	Measurement Results	Current	Previous	Delta	Unit	Time
1	Artificial Mouth: Acoustic Calibrator 0 dBPa	0,000	0,000	0,000	V	
2	Artificial Mouth: Generator Level for -5 dBPa	0,000	0,000	0,000	V	
3	Uplink Reference Value	0,000	0,000	0,000	dBµV	
4	Mobile Downlink Reference Value	0,000	0,000	0,000	dBµV	
5	Mobile Speaker Audio Level	0,000	0,000	0,000	dBµV	
6	Hands-Free Speaker Audio Level	0,000	0,000	0,000	dBµV	
7	Difference between Mobile and Hands-Free Speaker	0,000	0,000	0,000	dB	
8	Hands-Free Downlink Reference Value	0,000	0,000	0,000	dBµV	

When the test is started, the user would be prompted to perform the setup as shown in 2.1.1, Artificial Mouth Calibration.



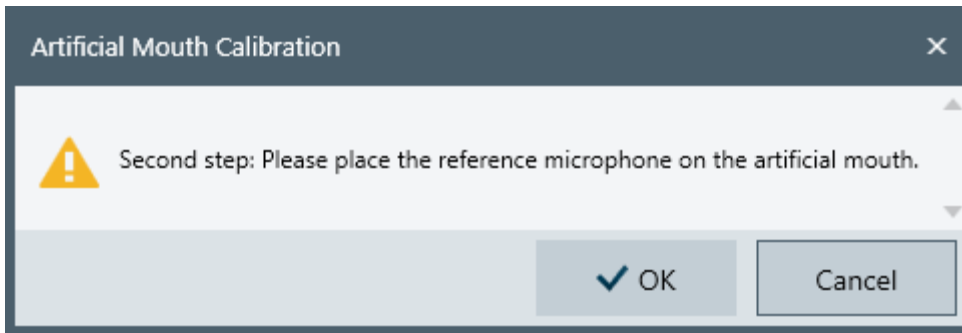
After pressing 'OK' the reference measurement will be performed. Once R&S® ELEKTRA has collected the data the operator will be asked if the reference measurement should be repeated in case the result is not as expected.



If the user is satisfied with the measurement result the second step of the artificial mouth calibration can be performed.

The user is prompted to mount the reference microphone to the artificial mouth as shown in Fig. 2-4 and Fig. 2-5: Reference Microphone attached to Artificial Mouth.

Once this task has been performed the operator can continue with 'OK'.



After the successful generation and measurement of sound pressure level on the artificial mouth the first part of the Audio Breakthrough calibration has been completed and the next stage can be entered.

2.1.2 Uplink Reference Measurement

If not already done, the artificial mouth has to be mounted to the Telephone Test Head B&K 4602B. The EUT has to be correctly positioned on the Telephone Test Head.

Before the uplink reference measurement can be performed a radio link from the communication tester to the EUT has to be established.

During the Uplink reference measurement, a sound level of - 5 dBPa will be generated at the front of the artificial mouth. The AF Generator voltage, which was determined in 2.1.1, will be used for this reference measurement.

The EUT will pick up the sound and transmit it as useful signal to the communication tester, e.g. CMW500. The CMW500 will demodulate the 1 kHz tone and the signal is routed to the audio analyzer, e.g. UPV. The UPV will measure the voltage of the demodulated signal. The value is saved as the Audio Reference Level for the uplink corresponding to - 5 dBPa sound pressure level.

The equipment used for this part is:

- ▶ Audio Analyzer R&S® UPV or R&S® UPP
- ▶ Audio Amplifier
- ▶ Communication Tester R&S® CMW500
- ▶ Communication Antenna
- ▶ Artificial Mouth Simulator B&K 4227
- ▶ Telephone Test Head B&K 4602B
- ▶ Several cables and adapters.

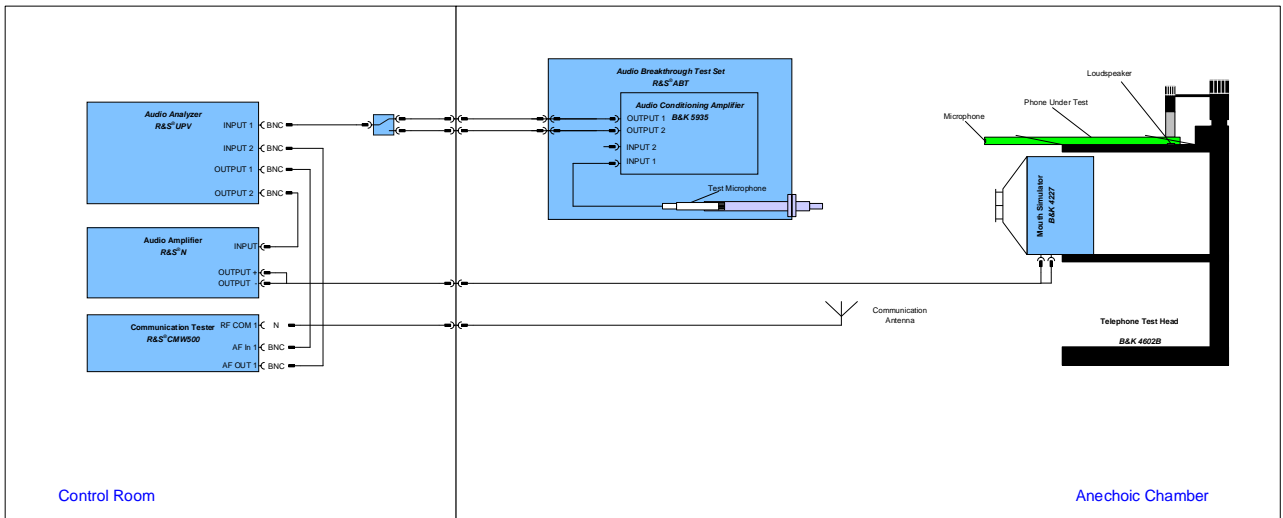
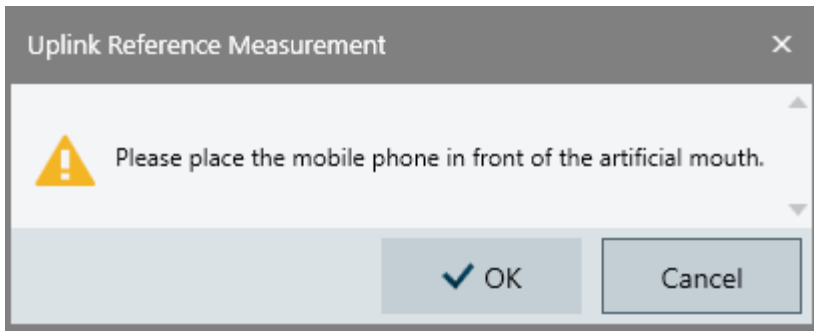


Fig. 2-6: Block Diagram of Uplink calibration

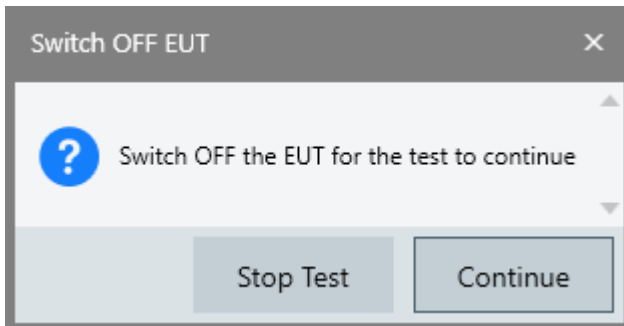


Fig. 2-7 and Fig. 2-8: EUT mounted to Telephone Test Head for Uplink Calibration.

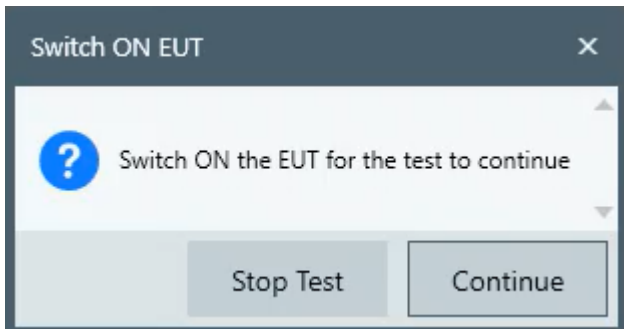
After mounting the EUT to the Telephone Test Head as described in chapter 2.1.2 as well as shown Fig. 2-7 and Fig. 2-8: EUT mounted to Telephone Test Head for Uplink Calibration.



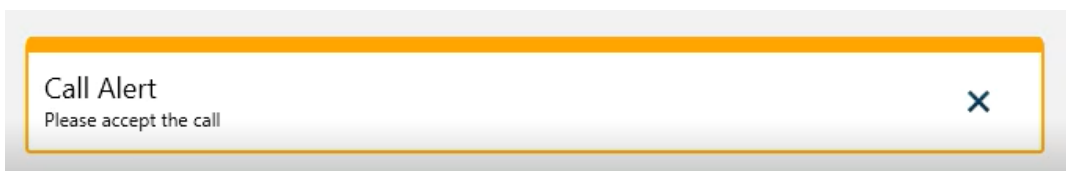
A call from the communication tester to EUT has to be established.
First it will be necessary to switch off the EUT. (To put the device in airplane mode)



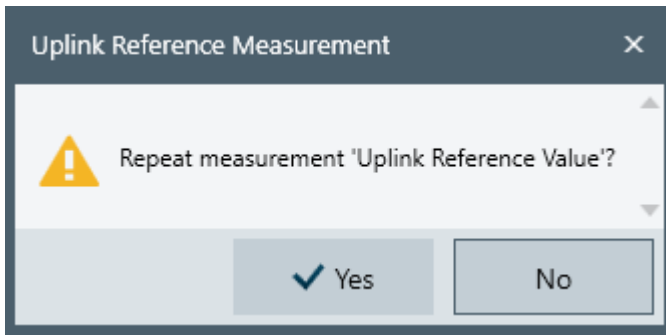
When the signal has been established by the R&S[®] CMW500, the user is asked to turn the EUT back on.



When the EUT is connected to the R&S[®] CMW500, a call connection is established between these two devices.



Once this has been done the uplink reference value measurement will be performed.



If the operator is satisfied with the measurement result the Downlink calibration can be started.

2.1.3 Downlink Calibration

During the calibration of the Downlink no EUT is in position.

The AF generator of the Audio Analyzer drives the Artificial Mouth with the 0 dBPa driving value calibrated in the Artificial Mouth Calibration step. The sound signal will be transmitted through the acoustic tube the second Microphone (Test Microphone) and the AF level will be measured by the Audio Analyzer.

One has to be careful that the acoustic tube is attached 'head on' to the artificial mouth.

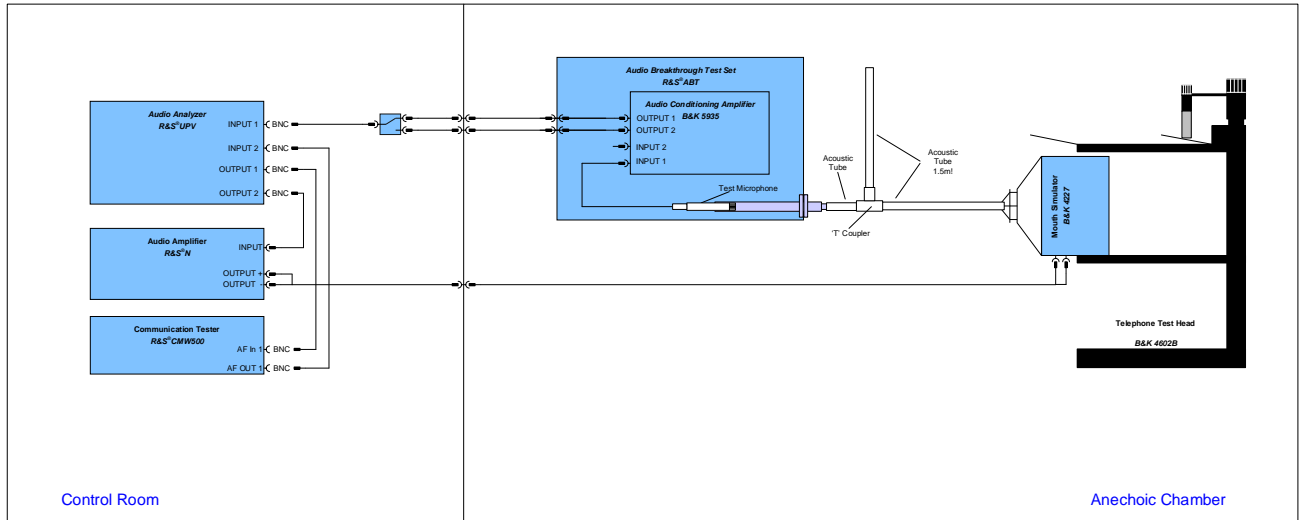


Fig. 2-9: Block Diagram of Downlink calibration

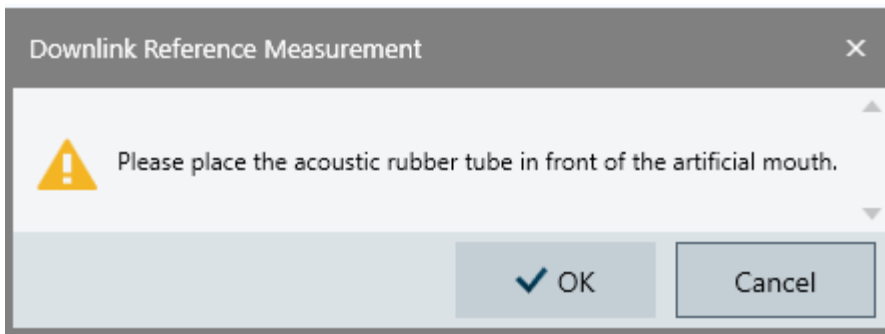


Fig. 2-10 and Fig. 2-11: Setup of Downlink Calibration

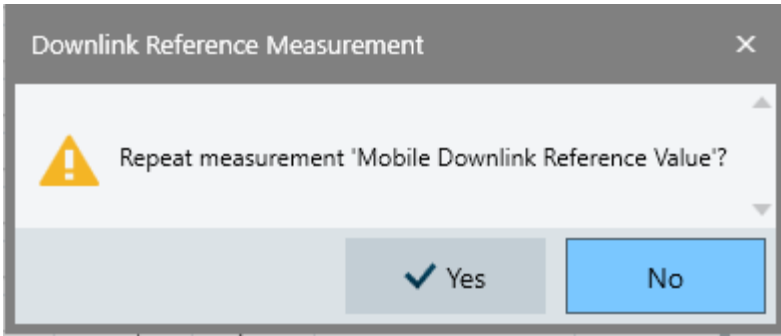
For this calibration step NO EUT has to be in place.

After mounting the acoustic tube to the artificial mouth as described in chapter 2.1.3 as well as shown in Fig. 2-10 and Fig. 2-11: Setup of Downlink Calibration the measurement can be performed.

R&S® ELEKTRA will prompt the user to mount the acoustic tube to the artificial mouth.



After acknowledging with 'OK' the measurement will be performed. If the operator is satisfied with the result he can continue with the next calibration step by pressing 'NO'.



2.1.4 Hands-free Set Calibration

The calibration of head phones or hands-free sets is a two-step process.

It is advisable to setup the phone like for a EUT test on the Telephone Test Head.

Before the calibration process can be started a call needs to be established from the communication tester to the EUT.

For the first step the acoustic tube needs to be positioned on the loudspeaker of the phone like for a normal immunity test. The AF generator of the Audio Analyzer sends an AF signal to the communication tester, which transmits the signal to the EUT. The EUT receives and demodulates this useful signal and the tone will be transmitted through the acoustic tube to the test microphone located in the audio breakthrough test set. From there the signal travels to the Audio Analyzer, which measures the level of the 1 kHz tone.

In the second step the hands-free set is connected to the EUT and the acoustic tube is moved from the EUT to the hands-free set or headphone. The measurement of the first step is repeated.

The difference between both measurements is the amplification of the hand-free set or earphone and will be stored.

This difference is added to the downlink reference value during an immunity test if the EUT to be tested is connected to the hands-free set or earphone.

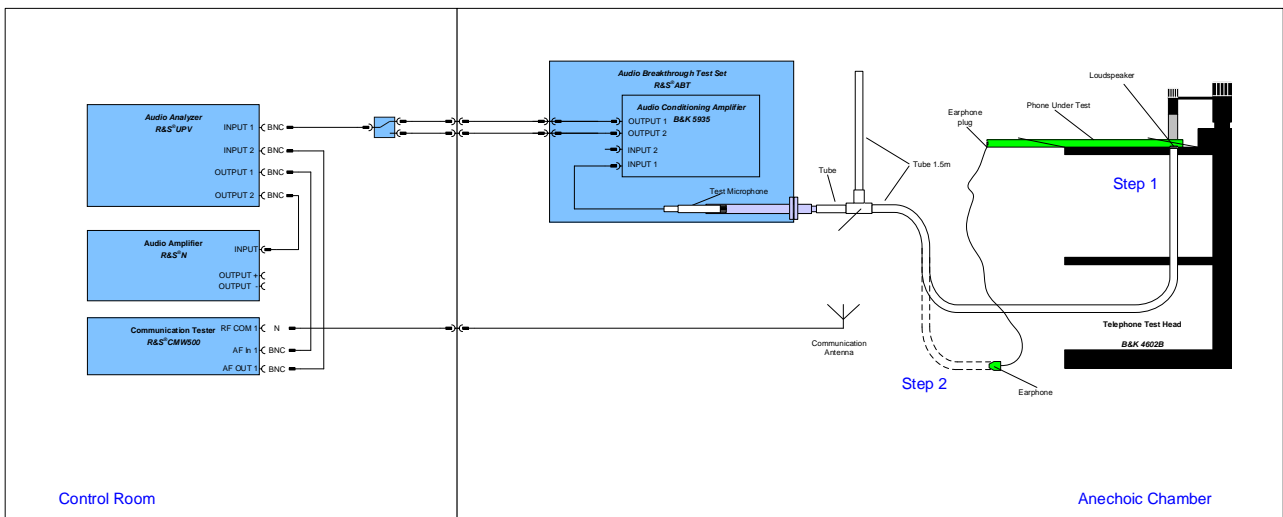


Fig. 2-12: Block Diagram of hands-free calibration

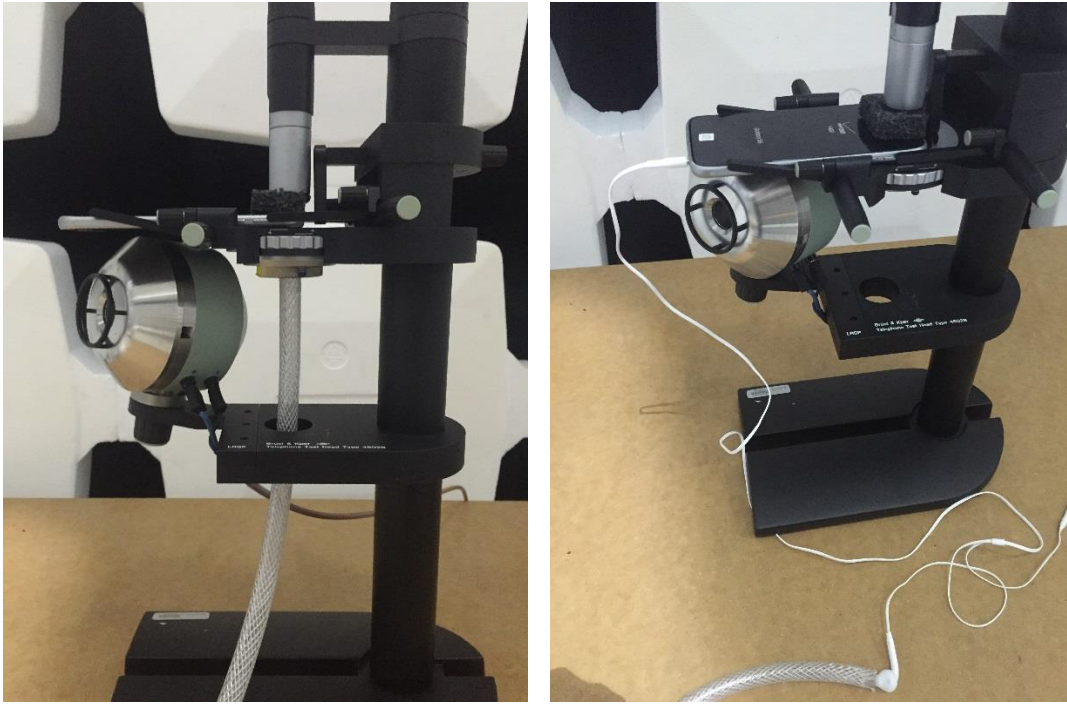
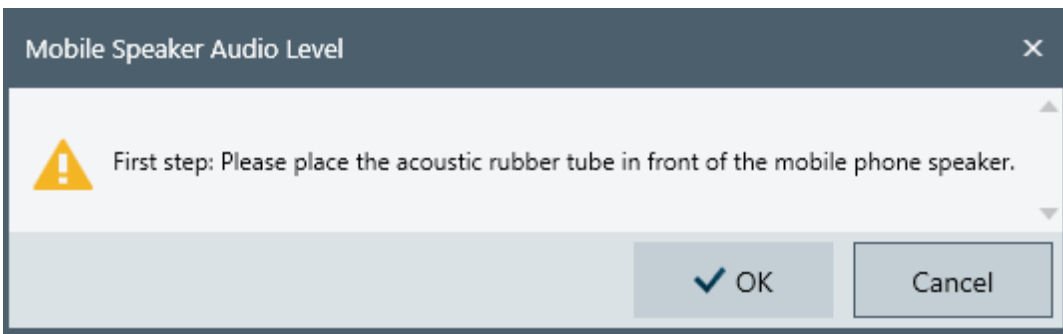


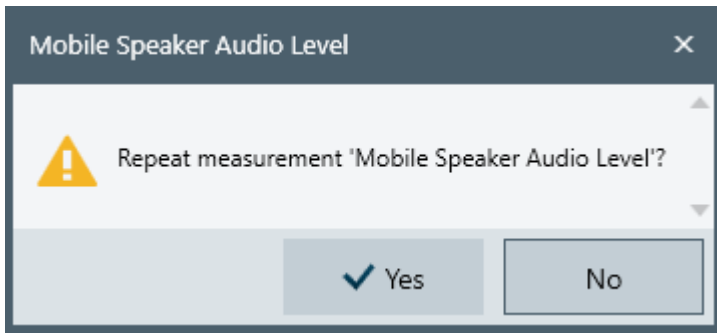
Fig. 2-13 and Fig. 2-14: Setup of Step 1 and Step 2 of hands-free calibration.

The calibration of head phones or hands-free sets is a two-step process. A more detailed description of the test can be found in 2.1.4.

For the first step R&S® ELEKTRA requests the operator to install the EUT, place the acoustic tube onto the internal loudspeaker of the phone and setup a call. Pictures of the setup of the first and second step can be found in Fig. 2-13 and Fig. 2-14: Setup of Step 1 and Step 2 of hands-free calibration.

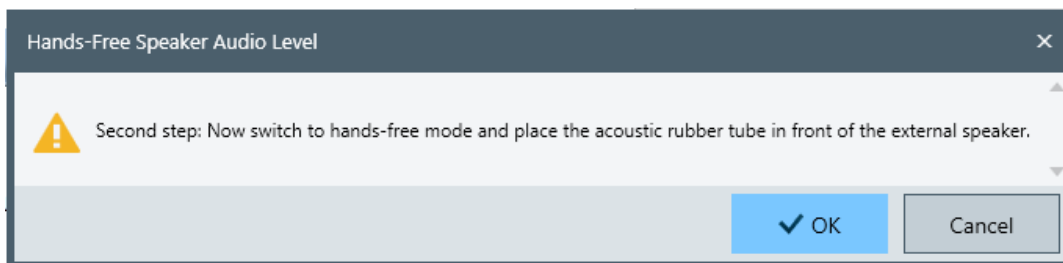


After pressing 'OK' the measurement is performed and the user is asked if he is satisfied with the result. By clicking on 'NO' the user acknowledges that the result is as expected and the second step of the calibration will be entered.



Refer to Fig. 2-13 and Fig. 2-14: Setup of Step 1 and Step 2 of hands-free calibration. for the setup of the second step.

Once the setup has been done the user can proceed with 'OK'



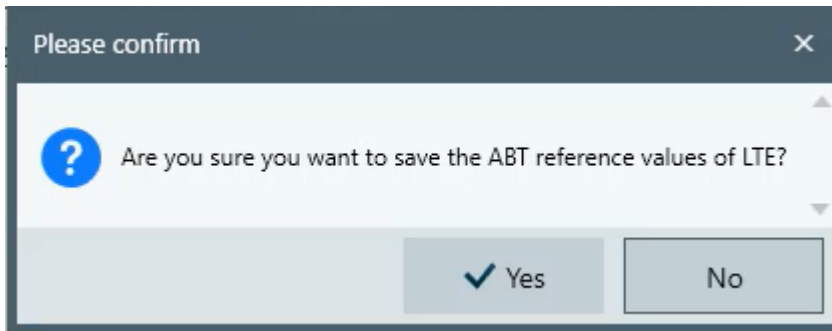
As in all previous steps the user can repeat the measurement if the result is not reasonable. If the test result seems to be acceptable the audio breakthrough calibration is finished.

2.1.5 Saving of calibration results

Last but not least the calibration results need to be saved.

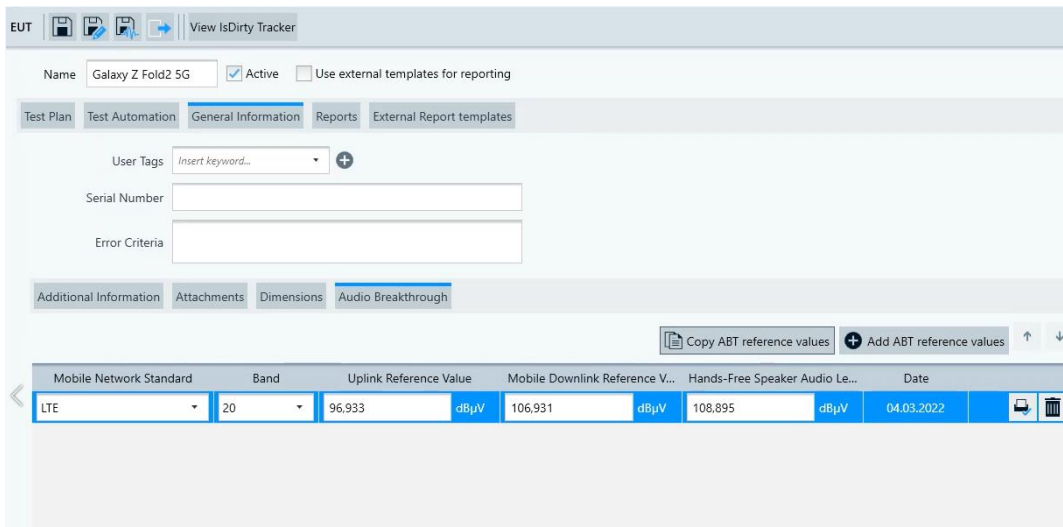
The calibration values are saved into a 'EUT Information', where the test is stored!

After pressing 'Save Values', a check is made to ensure that there is no data of the same technology already saved in the EUT. If this is the case, it will ask whether this data should be replaced.



This information is listed and can be adjusted, deleted or added in:

'EUT' -> 'General Information' -> 'Audio Breakthrough'.



Mobile Network Standard	Band	Uplink Reference Value	Mobile Downlink Reference V...	Hands-Free Speaker Audio Le...	Date
LTE	20	96.933 dBμV	106.931 dBμV	108.895 dBμV	04.03.2022

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