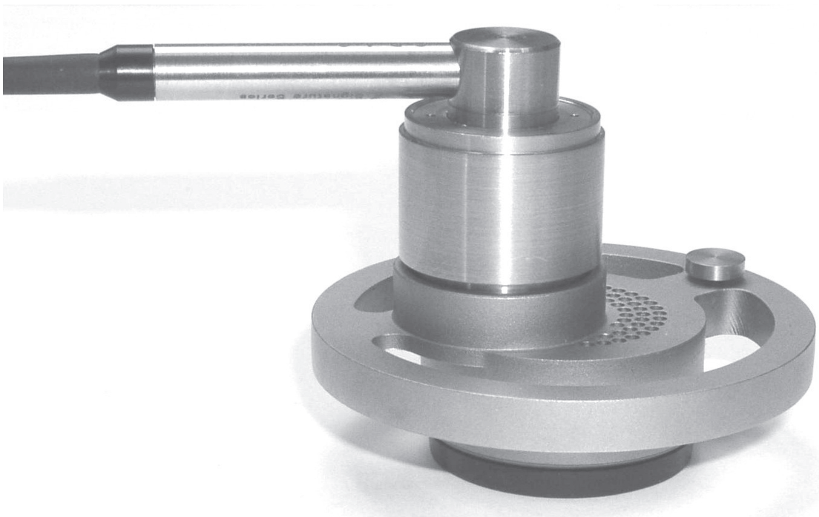
Instruction Manual

43AE Ear Simulator Kit According to ITU-T Rec. P57 Type 3.2

43AE-S1 Ear Simulator Kit According to ITU-T Rec. P57 Type 3.2, prepolarized



G.R.A.S.
SOUND & VIBRATION

Revision History

Revision	Date	Description
1	28 June 2017	Extracted from Earbook as separate document

Any feedback or questions about this document are welcome at gras@gras.dk.

Contents

G.R.A.S.
SOUND & VIBRATION

Introduction

The 43AE Ear Simulator Kit is for acoustically testing supra-aural[1] earphones, telephone handsets and loudspeakers, and complies with the following international requirements:

- ITU-T Recommendation P.57 (08/96) "Serie P: Telephone Transmission quality. Objective measuring apparatus: Artificial ears".

Components

43AE Ear Simulator Kit

The 43AE Ear Simulator comprises the following main components:

- RA0045 IEC 60318-4 Ear Simulator with 40AG microphone included, see page 4
- 26AC ¼" Preamplifier
- RA0001 ¼" - ½" Adapter
- RA0056 Low-leak Pinna Simulator
- RA0057 High-leak Pinna Simulator

43AE-S1 Ear Simulator Kit prepolarized

The 43AE-S1 uses the same componets as the 43AE except:

- RA0045 IEC 60318-4 Ear Simulator with 40AO microphone included.
- 26CB ¼" Preamplifier

When assembled as shown in Fig. 1, it is ready for testing supra-aural earphones, telephone handsets and loudspeakers.

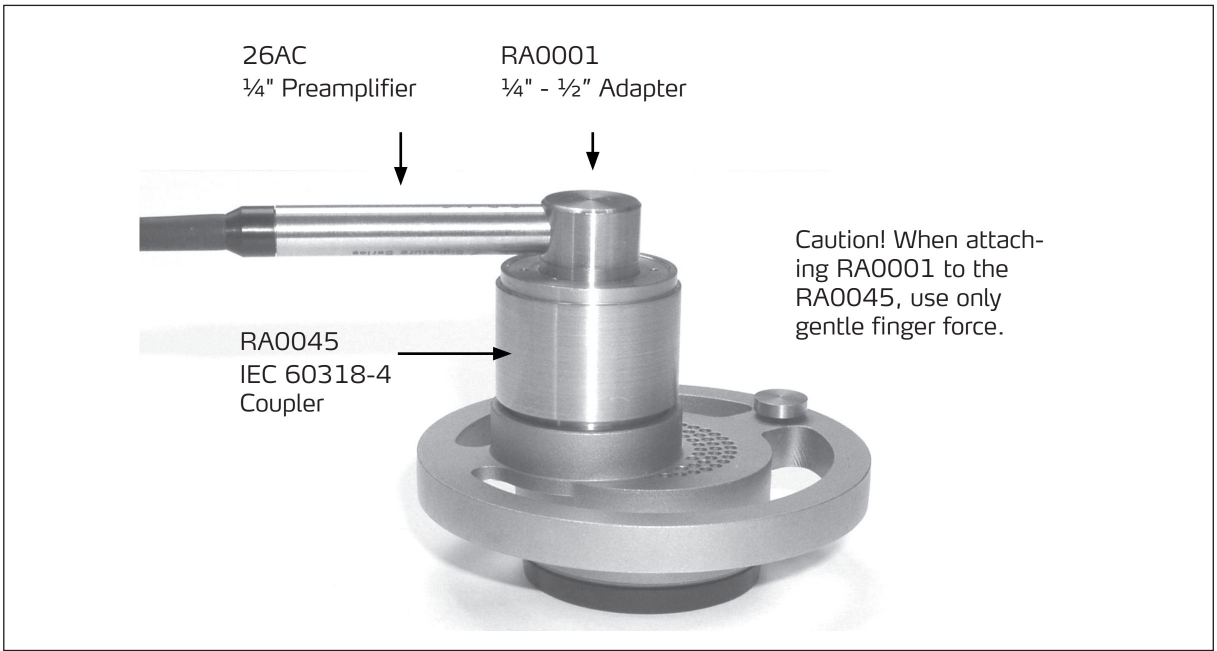


Fig. 1. *Assembled 43AE Ear Simulator Kit*

[1] An earphone applied externally to the ear

Fig. 2 shows an exploded view of its user-serviceable components.

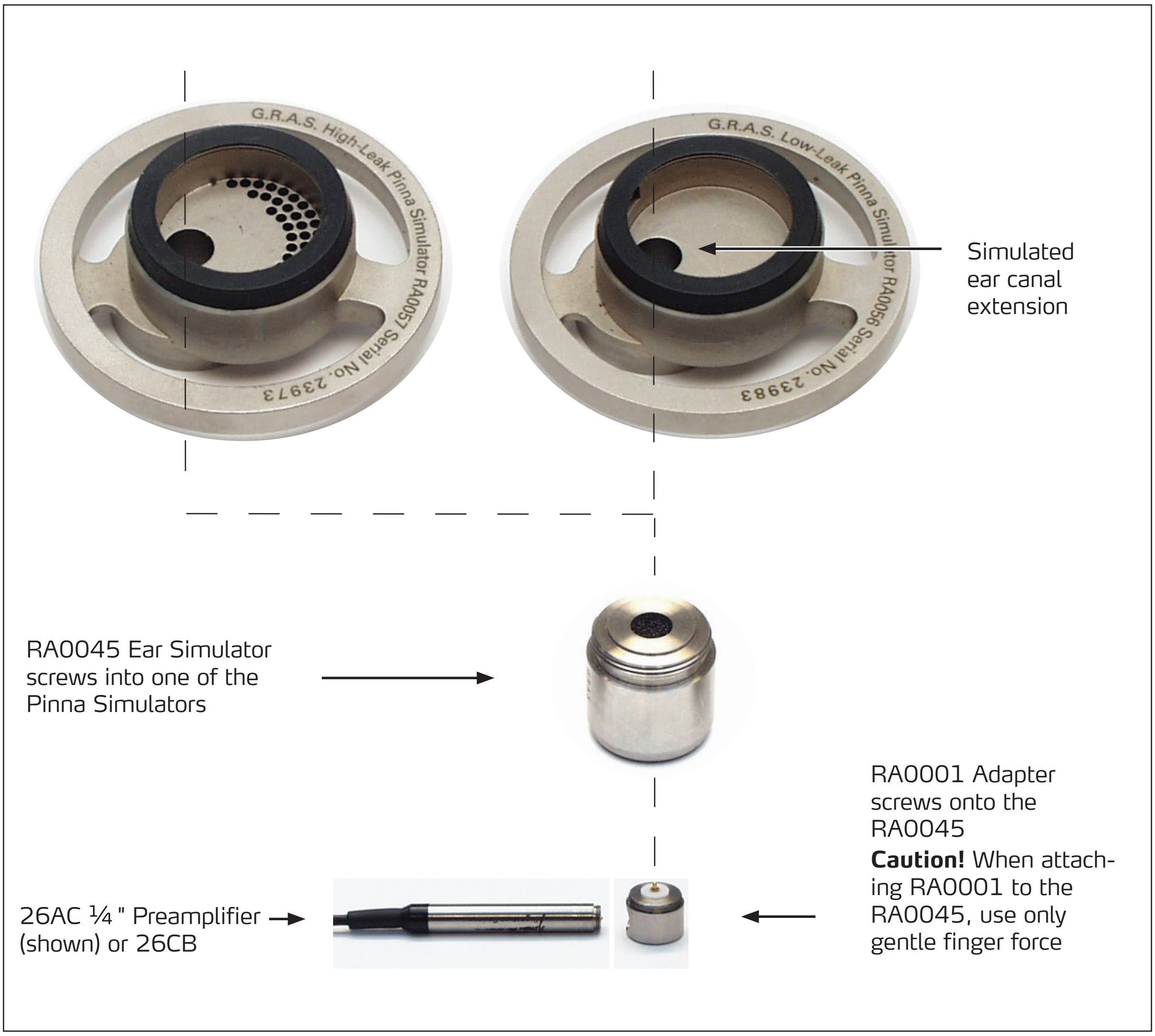


Fig. 2. *Exploded view of all the user-serviceable components of the 43AE Ear Simulator Kit*

Additional Equipment

The following additional equipment is required for making the necessary measurements:

1) Power supply for the 26AC,¼" Preamplifier
e.g. the G.R.A.S. 12AK Power Module.
2) Calibration-check source for the Ear Simulator, e.g. the G.R.A.S. 42AA Pistonphone which produces 114 dB re. 20 µPa (10 Pa) at 250 Hz
3) Audio signal generator capable of generating one or more of the following within the audio frequency range[2]:

- logarithmically swept tones
- pink noise

This audio signal is fed (directly or indirectly) to the earphone.

4) Audio frequency analyser capable of one or both of the following:
   - wide band measurement
   - ⅓ octave-band measurement

The audio analyser receives, via the 12AK, the signal picked up by the Ear Simulator, and, depending on whether this is a swept tone or pink noise, will:

a) measure the response of the earphone to the swept tone

Or

b) measure the response of the earphone to the pink noise in terms of ⅓ octave bands

Items 3 and 4 could be combined in the same unit, e.g. a computer fitted with suitable hardware and software for A/D and D/A conversions in order to simulate both a signal generator and an analyser. Fig. 3 shows a block diagram of a possible set-up for making tests.

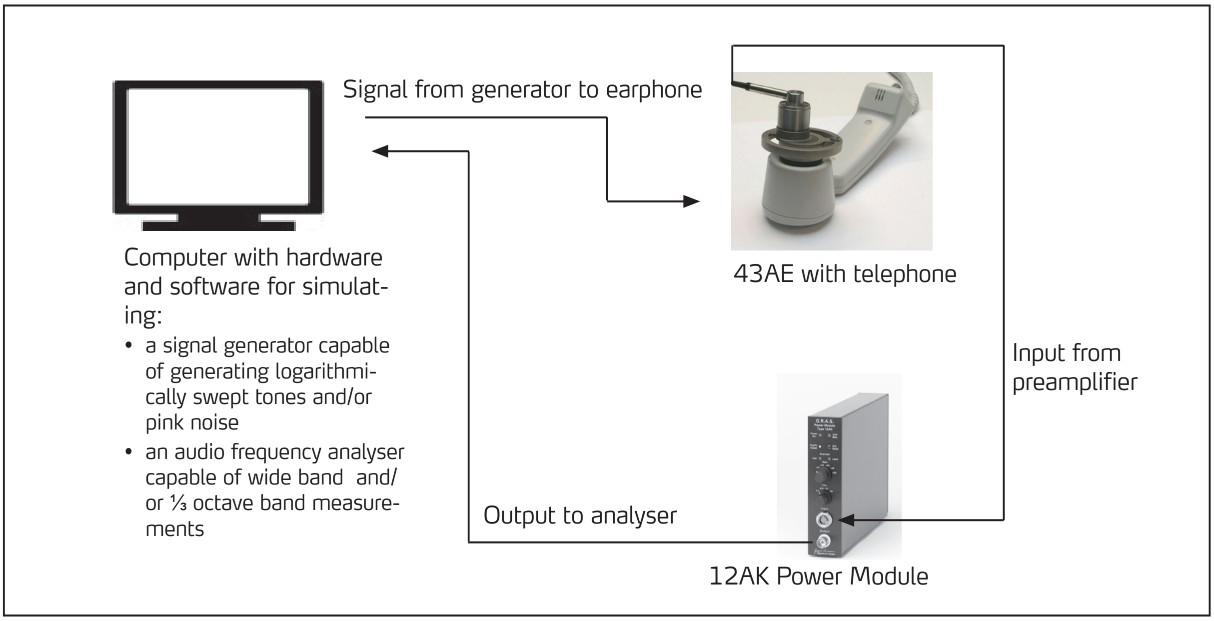


Fig. 3. *Block diagram of a complete set-up for making tests*

[2] For example from 50 Hz to 10 kHz

The 4 stages of the Test Procedure

Using the telephone as a typical example, the basic stages in the test procedure are:

1) Setting up the Ear Simulator, e.g. as shown in Fig. 3
2) Calibration check using the G.R.A.S. 42AA Pistonphone with a special adapter for the 43AE
3) Placing the Ear Simulator over the earpiece of the telephone (see example in Fig. 4)
4) Applying a signal to the telephone and analysing the output from the microphone.
   Depending on requirements, the signal applied to the telephone could be:
   • a swept tone, e.g. under laboratory conditions
   • pink noise, e.g. during mass production of telephones
   Pink noise testing is usually quicker, and more economical, than using swept tones.

The following sections deal in more detail with each stage of the test procedure.

1: Setting up the Ear Simulator

Note: the terms generator and analyser refer to a set up which simultaneously sends the test signal to the earphone and analyses the signal picked up by the Ear Simulator.

With the Ear Simulator assembled and everything switched on, proceed as follows:

1) 12AK Power Module
   • Connect the free end of the preamplifier cable to the Lemo **Input** socket.
   • Connect, via a suitable cable, the BNC **Output** to the input of the analyser.
   • Select **Lin**.
   • Select a **Gain** that is within the input range of the analyser.
2) Telephone
- Connect the earphone of the telephone to the signal output of the generator.
3) Adjust the signal output level from the generator to lie within the normal working range of the earphone.

Fig. 4. *Place the Ear Simulator centrally over the earpiece of the telephone*

2: Calibration

Important! do not extract the microphone housed in the RA0045 Ear Simulator since this will invalidate the factory calibration. If it ever becomes necessary to extract the microphone, use the special tool RA0071 available from G.R.A.S.
The following procedure, using a G.R.A.S. Pistonphone, should preferably be carried out at the following times:

a) before a first-time use of the 43AE to establish a baseline for subsequent checks
b) thereafter at appropriate intervals to check for repeatability

The Pistonphone must be fitted with a 1” Microphone Coupler RA0023 and used with a special Adapter RA0119 for the 43AE, both available from G.R.A.S.

1) The set up for the calibration check is shown Fig. 5.
2) Make sure that the rubber seal of the Pinna Simulator seats firmly inside the Adapter.
3) Switch the Pistonphone on.
4) Set the Gain on the 12AK to 0.
5) Set the analyser to either wide band or to the ⅓ octave band whose centre frequency is 250 Hz.
6) When conditions are stable, note the reading in millivolts.
   For a microphone of nominal sensitivity (12.5 mV/Pa) and a nominal Pistonphone signal of 114 dB, an approximate value for the Low-leak Pinna Simulator RA0056 is:
   ▪ 95 mV (representing a drop of ≈2.4 dB)
7) Repeat, if required, with the High-leak Pinna Simulator RA0057 fitted, a corresponding approximate value is:
   ▪ 15 mV (representing a drop of ≈18.4 dB)

Fig. 5. *Calibration-check set-up. Make sure that the rubber seal of the Pinna Simulator seats firmly inside the Pistonphone Adapter*

3: Placing the Ear Simulator on the Earpiece/Earphone

In cases of production testing, this is normally taken care of automatically. Whether automatic or manual, the Ear Simulator must be centrally placed over the earpiece/earphone being tested so that the sound is transmitted directly into the Ear Simulator. See example in Fig. 4.

4: Applying the Test Signal

The following describes typical procedures for applying:

a) a swept signal
b) pink noise
and refers to some typical results.

In both cases, it is assumed that the generator and analyser work to produce constant-confidence results (i.e. maintaining a constant βT product) in real time throughout the frequency range of interest and make the measurement data available graphically and numerically.

Swept Signal

With everything set up as described above, proceed as follows:

a) set the generator to oscillator mode
b) set the analyser to flat response
c) initiate a constant-level logarithmic sweep [3] on the generator.
The analyser will follow the response of the Ear Simulator to the earphone throughout the sweep and record and display the results accordingly.

Pink noise

With everything set up as described above, proceed as follows:

a) set the generator to pink noise mode and start generating.
b) set the analyser to ⅓ octave-band mode [3] and wait until conditions are stable.
c) start the analyser.
The analyser will record the response of the Ear Simulator to the earphone for each ⅓ octave band and record and display the results accordingly.

In both cases, curves showing the upper and lower tolerance levels for the frequency range of interest could be superimposed on the graphical displays.

[3] For example from 50 Hz to 10 kHz

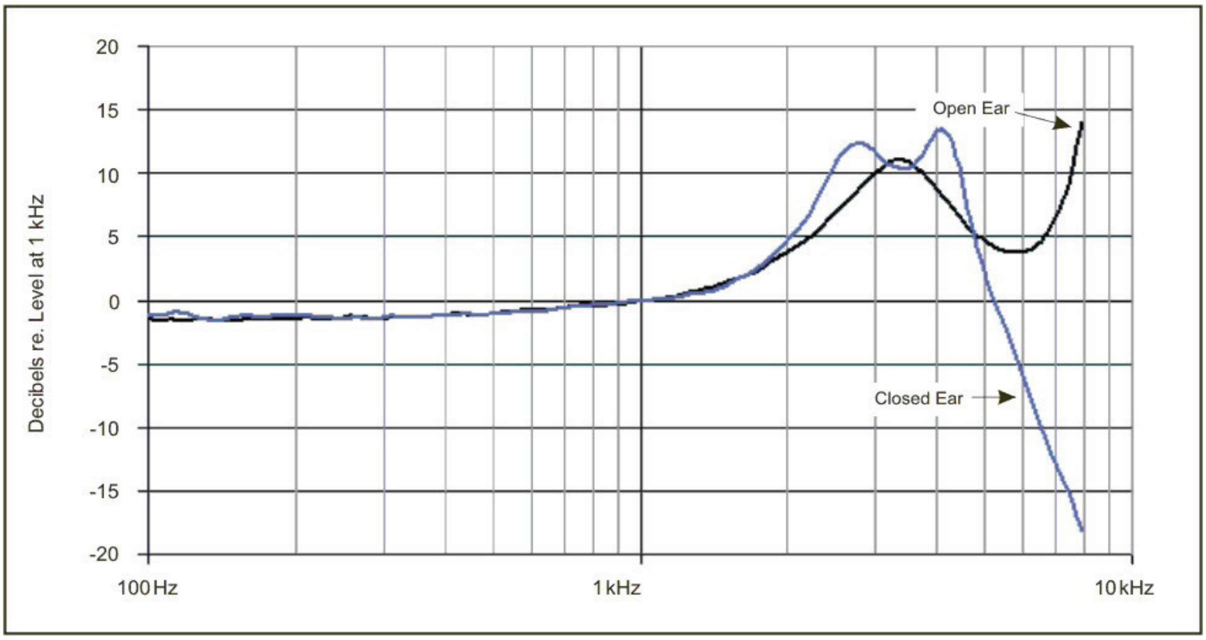


Fig. 6. *Frequency response curves of the 43AE fitted with a low-leak pinna simulator re. 1 kHz.*

Frequency Response of the 43AE

For measurement purposes, the 43AE is a simulation of an ear drum, ear canal and pinna[4].

The diaphragm of the built-in microphone simulates the ear drum and occupies the position known as the DRP[5]. The simulated ear canal is the hole through which sound reaches the microphone (see Fig. 2). The ERP[6] lies at the entrance of the outer ear. It is also used as the listening point for the handset of a telephone (see Fig. 7 and Fig. 8).

Fig. 5.6 shows the frequency response of an IEC 60711 Ear Simulator Type 43AE fitted with a Low-leak Pinna Simulator RA0056 for both open and closed-ear conditions. At any given frequency f, the corresponding difference Δ_f between the sound levels at the ERP and DRP is given as follows:

$$\Delta_f = DRP_{L,f} - ERP_{L,f}$$

In certain cases, for example when testing telephones, $ERP_{L,f}$ could be of interest since it represents the signal originating from the ear piece of a telephone, whereas the microphone buried in the ear simulator is exposed to, and measures, $DRP_{L,f}$.

4 The part of the outer ear that projects from the head
5 (ear)Drum Reference Point
6 Ear Reference Point

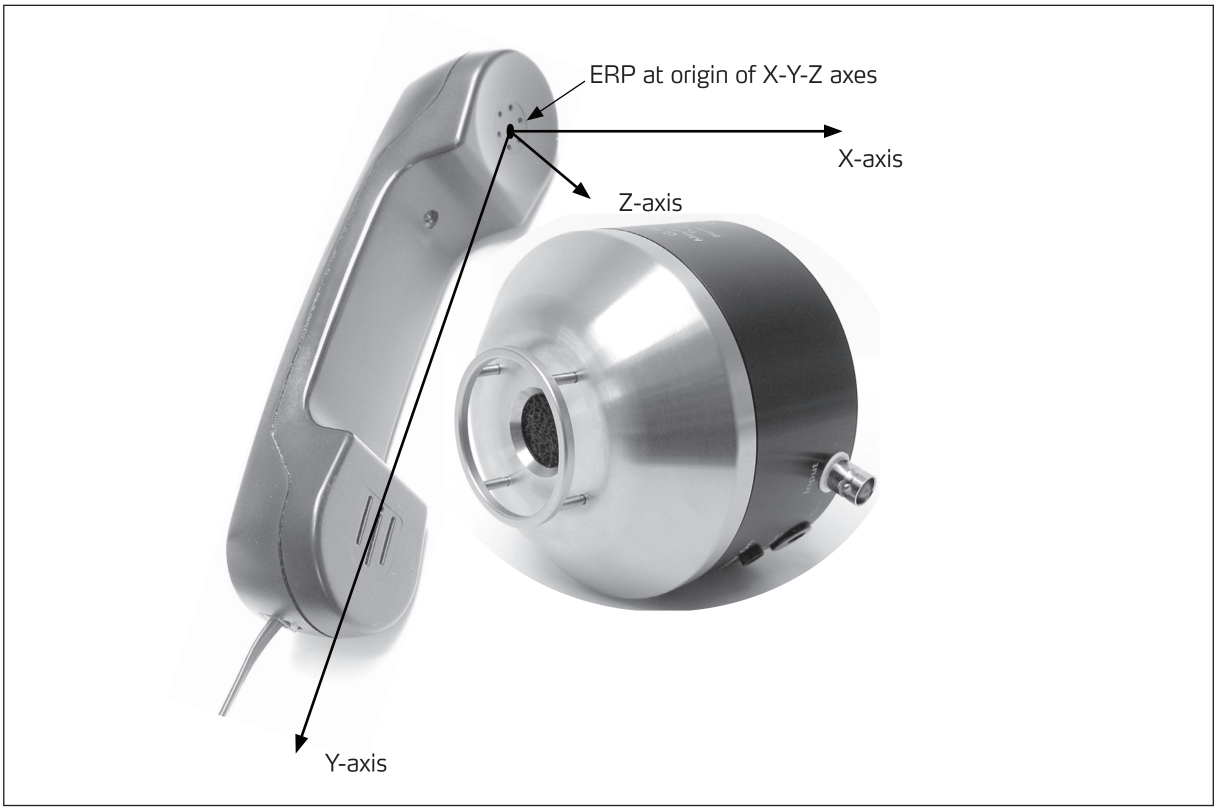


Fig. 7. *Showing the basic configuration for testing the microphone of a telephone handset. The ear piece lies in the plane of the Y-Z axes. See Fig. 8 for geometrical details*

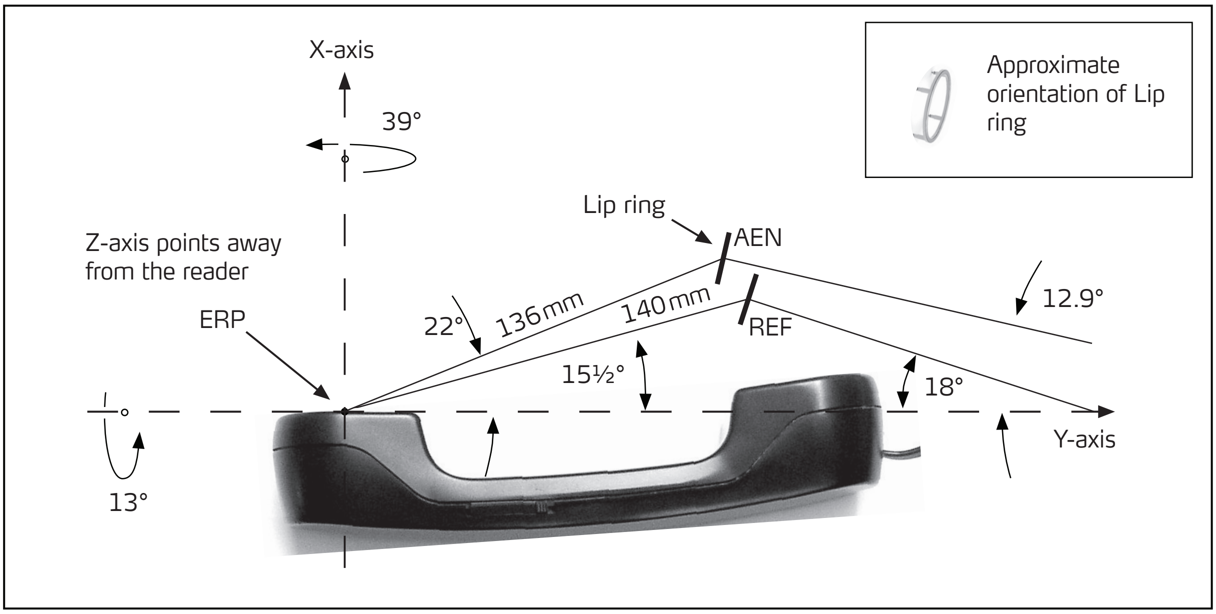


Fig. 8. *Showing where the Lip-ring should be for both AEN and REF positions. The angular distances of 39° and 13° (in that order) will move the handset from the AEN postion to the LRGP*

Warranty, Service and Repair

Calibration

Before leaving the factory, all G.R.A.S. products are calibrated in a controlled laboratory environment using traceable calibration equipment.

We recommend a yearly recalibration at minimum, depending on the use, measurement environment, and internal quality control programs.

We recommend calibration prior to each use to ensure the accuracy of your measurements.

Warranty

Damaged diaphragms in microphones can be replaced. The microphone diaphragm, body, and improved protection grid are made of high-grade stainless steel, which makes the microphone resistant to physical damage, as well as corrosion caused by aggressive air or gasses. This, combined with the reinforced gold-plated microphone terminal which guarantees a highly reliable connection,enables G.R.A.S. to offer 5 years warranty against defective materials and workmanship.

The warranty does not cover products that are damaged due to negligent use, an incorrect power supply, or an incorrect connection to the equipment.

Service and Repairs

All repairs are made at G.R.A.S. International Support Center located in Denmark. Our Support Center is equipped with the newest test equipment and staffed with dedicated and highly skilled engineers. Upon request, we make cost estimates based on fixed repair categories. If a product covered by warranty is sent for service, it is repaired free of charge, unless the damage is the result of negligent use or other violations of the warranty. All repairs are delivered with a service report, as well as an updated calibration chart.

Manufactured to conform with:

CE marking directive:
93/68/EEC

WEEE directive:
2002/96/EC

RoHS directive:
2002/95/EC

G.R.A.S. Sound & Vibration continually strives to improve the quality of our products for our customers; therefore, the specifications and accessories are subject to change.

Appendix

The RA0045/RA0045-S1 Ear Simulator

Introduction

The RA0045/RA0045-S1 Ear Simulator is for making acoustic measurements on earphones coupled to the human ear by ear inserts such as tubes, ear moulds or ear tips. It is delivered with a built-in 40AG ½" pressure microphone and an individual calibration chart for the coupler-microphone combination.

Important! do not extract the microphone housed in the RA0045 since this would invalidate the factory calibration.

The ear simulator complies with the following international requirements:

- IEC 60318-4 Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts
- ITU-T Recommendations P.57 Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

Components

It comprises the following user-serviceable components:

- GR0407 Ear Simulator Housing
- GR0408 External-ear Simulator
- GR0409 Union Nut

The RA0045 is delivered as shown in Fig. 9, to the left. An exploded view of its user-serviceable components is shown in Fig. 9, to the right.

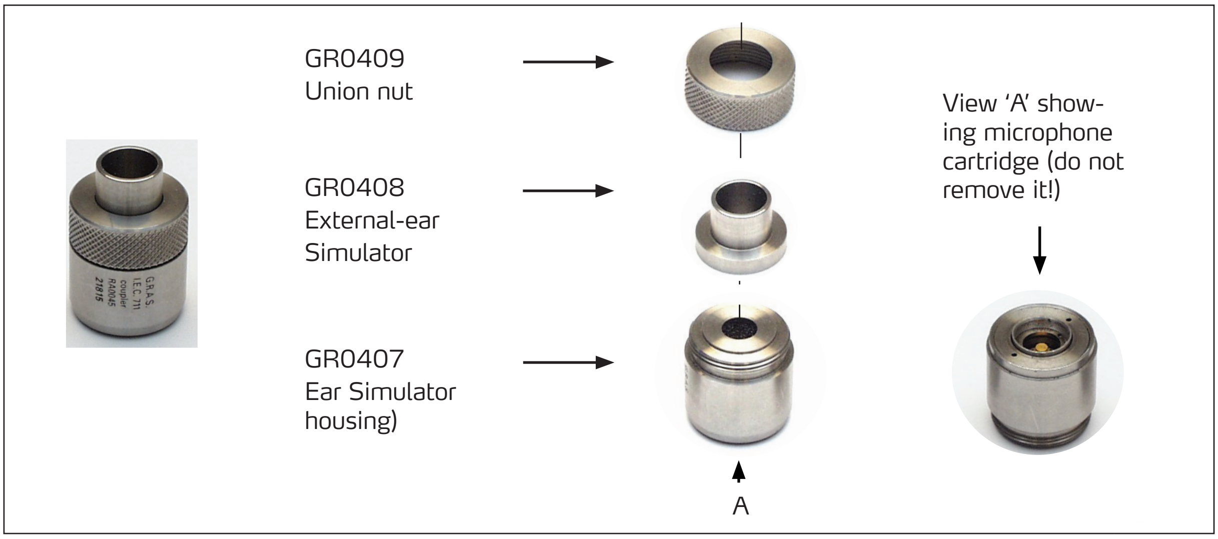


Fig. 9. *RA0045/RA0045-S1 Ear Simulator as delivered (left) and its user serviceable parts*

Preamplifiers

With the 43AE, the externally polarized RA0045 is delivered with a standard preamplifier, e.g. a 26AC ¼" Preamplifier fitted with an adapter.

With the 43AE-S1 the prepolarized RA0045-S1 is delivered with the 26CB ¼" Preamplifier fitted with an adapter.

Characteristics

The acoustic input impedance of the RA0045 closely resembles that of the human ear and, as a result, loads a sound source in very much the same way.

It can be used with:

- Low-leak Pinna Simulator Type RA0056.
- High-leak Pinna Simulator Type RA0057

in accordance with ITU-T Recommendation P.57 (08/96) "Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears ", Type 3.1-3.4.

The RA0045 embodies a number of carefully designed volumes connected via well-defined and precisely tuned resistive grooves. In an equivalent electrical circuit, capacitors would represent the volumes, and inductance and resistance would represent respectively air mass and air flow within the resistive groves. Fig. 10 shows a typical coupler frequency response of the RA0045.

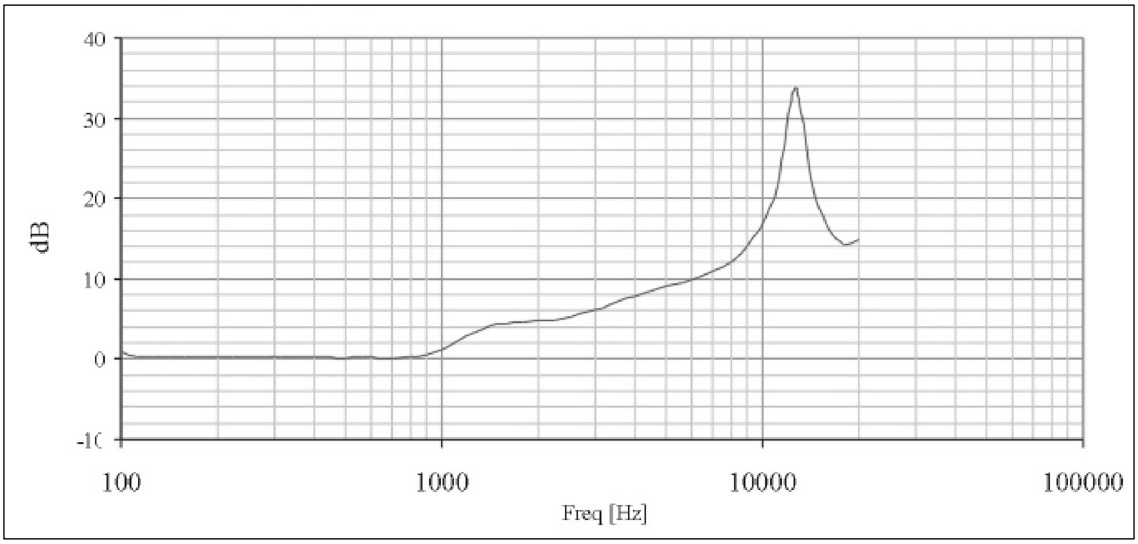


Fig. 10. *Type RA0045 - typical coupler frequency response re. 500 Hz*

The input impedance is measured using a special impedance probe as described in ITU-T Recommendations P.57 (08/96). This measures the impedance of the RA0045 as seen from the Ear Reference Point (ERP). The impedance is defined as the ratio of the sound pressure at the ERP to the corresponding particle velocity. The sound pressure is measured with a probe microphone while a constant particle velocity is maintained via a high acoustic impedance sound source.

Level Calibration

This paragraph describes level calibration using a pistonphone. This is the kind of calibration you would most often perform prior to measuring. How to perform a frequency calibration is described on page 16.

Do not attempt to remove the microphone from the RA0045. You will be calibrating the RA0045 as a whole with a Pistonphone fitted with a ½" coupler. This, in effect, increases the coupler volume such that the signal from the Pistonphone will be reduced by 1.03 dB .

1) Snap the spring-loaded clamp (see Fig. 1) to its upright position, or remove it.
2) Unscrew the collar of the Pistonphone and remove the O-ring (see Fig. 11).

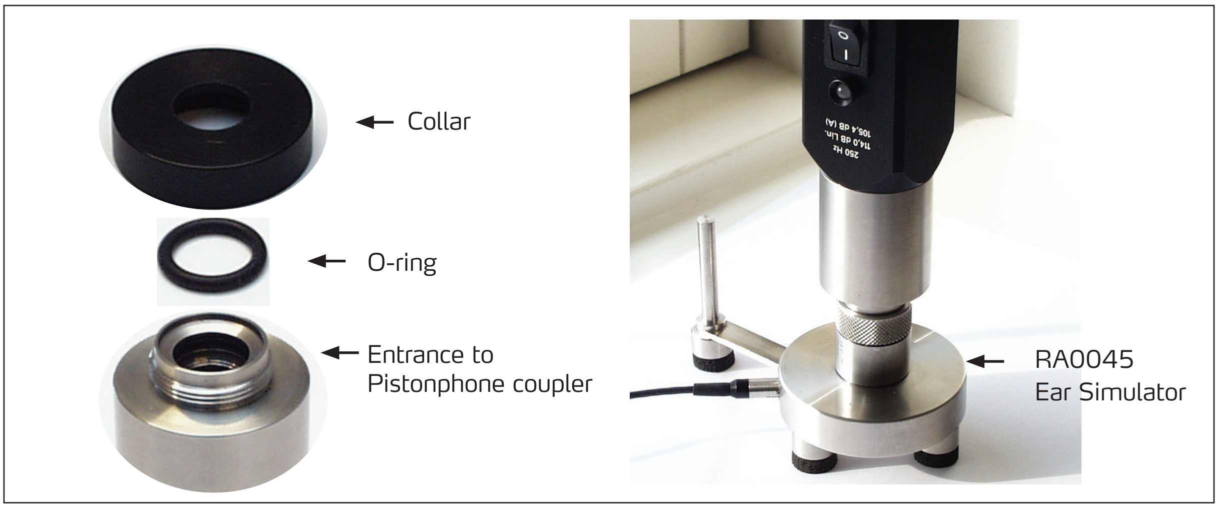


Fig. 11. *Calibration using the Pistonphone*

a) Unscrew Pistonphone collar and remove O-ring.
b) Place coupler over RA0045, push gently down to the stop
c) Switch on

3) Place the coupler of the Pistonphone over the RA0045, push it gently down to the stop and switch on.
4) Set the analyser to either wide band or to the ⅓ octave band whose centre frequency is 250 Hz.
5) When conditions are stable, adjust the analyser so that it correctly gauges the Pistonphone signal (nominally 114 - 1.03 = 112.97 dB). See Pistonphone manual for making barometric corrections.
6) Switch the Pistonphone off and remove it from the RA0045.
7) Re-assemble the pistonphone.

Frequency Calibration of the RA0045/RA0045-S1

This section describes how to perform a frequency calibration using a 40BP ¼" Microphone as sound source. Fig. 12 shows how to configure the coupler for calibration using the accessories provided, and Fig. 13 shows how these should be used with:

- 40BP ¼" Microphone
- RA0086 Transmitter Adapter

Fig. 12. *Assembled and exploded views of the coupler itemising user-serviceable accessories for individual calibration*

The ¼" microphone is used as a high-impedance sound source. The complete set-up is shown in . The computer in Fig. 14 is capable of concurrently generating and measuring audio frequency signals. The 14AA Actuator Supply receives a swept tone generated by the computer and sends this, superimposed on a polarisation voltage of 200 VDC, to the coupler mounted in the jig, also shown in Fig. 14. The coupler picks up the resulting audio signal and sends this back to the computer which traces out and displays the coupler response. An example of a displayed response is shown in .

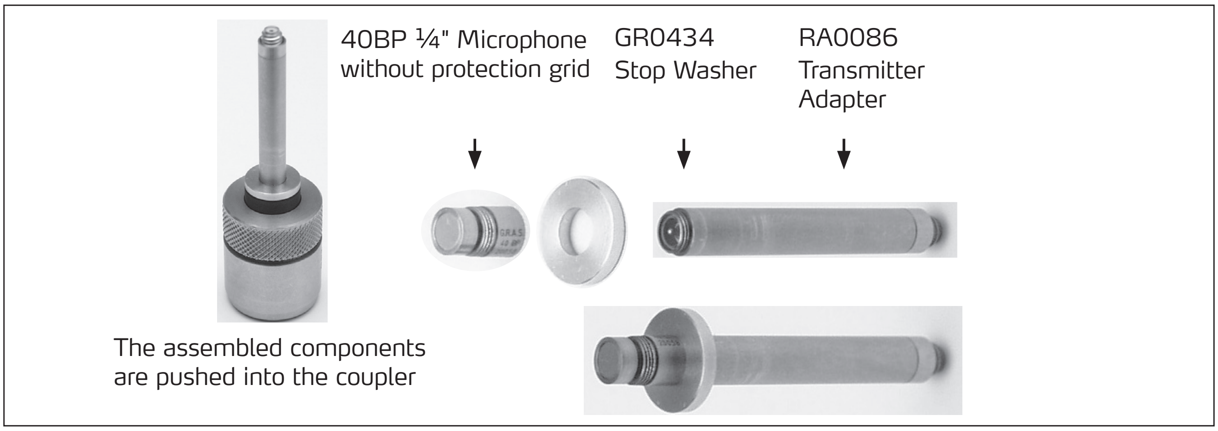


Fig. 13. *Assembled and exploded views showing how the GR0434 is used when calibrating the Ear Simulator. 40BP and RA0086 are available from G.R.A.S.*

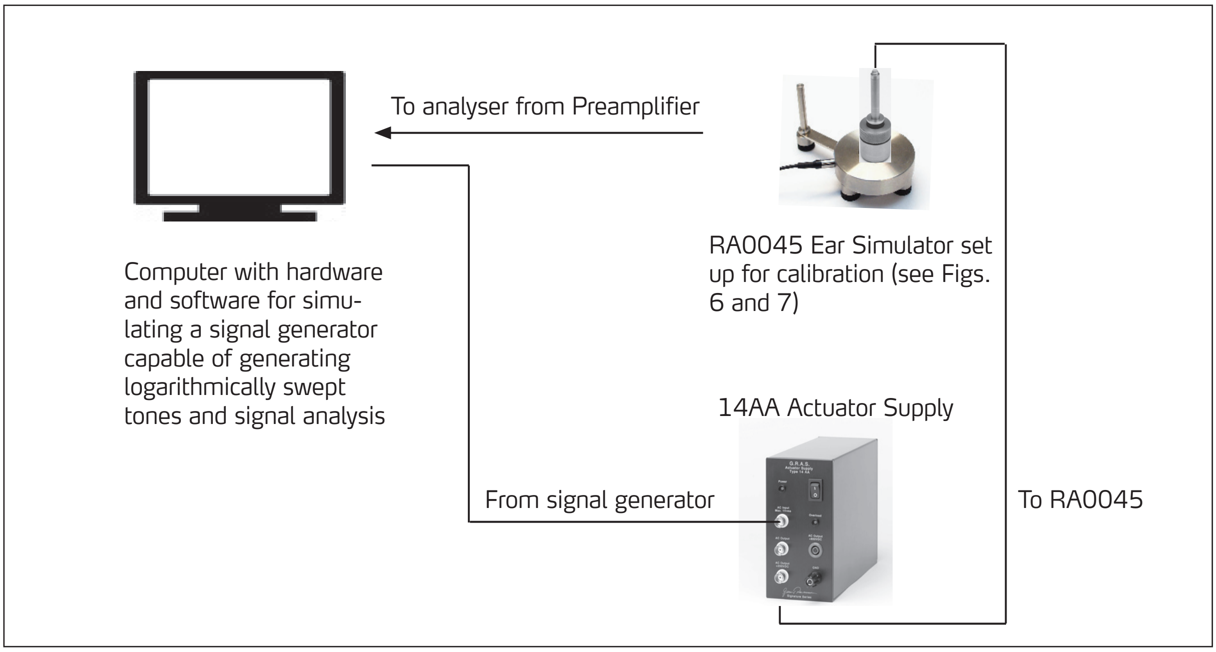


Fig. 14. *Block diagram of a complete set-up for calibration*

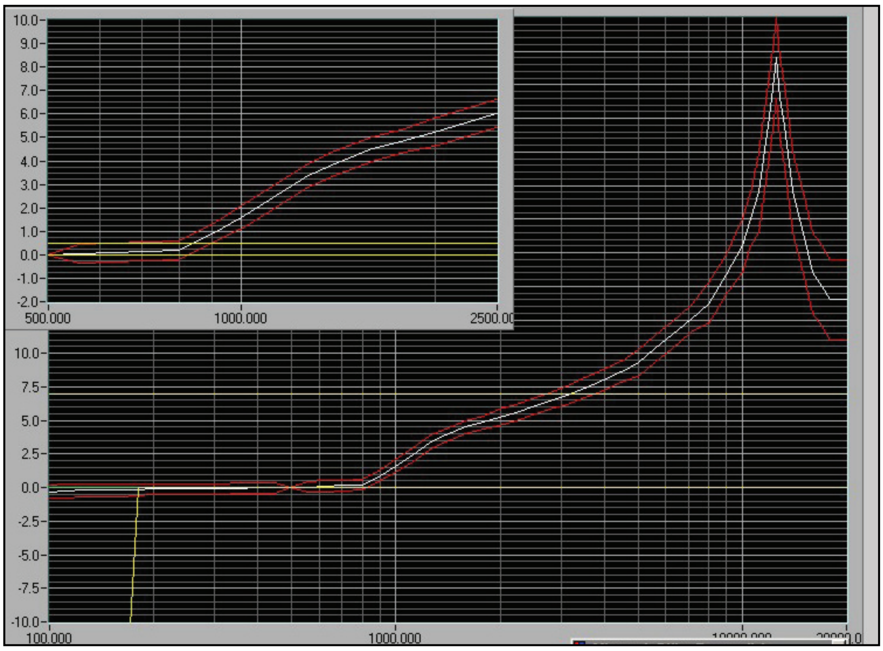


Fig. 15. *Example of a calibration result using a swept tone*