Instruction Manual

43AA Ear Simulator Kit According to IEC 60318-1 & -2

43AA-S2 CCP Ear Simulator Kit According to IEC 60318-1 & -2

Revision History

Any feedback or questions about this document are welcome at **gras@GRASacoustics.com**.

Revision	Date	Description
1	17 August 2017	Extracted from Earbook as separate document.
2	1 June 2022	TEDS section added.

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Introduction

The 43AA and 43AA-S2 Ear Simulator Kit are complete test jigs for acoustically testing telephone handsets and earphones and complies with the following international requirements:

- IEC 60318 Electroacoustics – Simulators of human head and ear, Part 1 & 2
- ITU-T Recommendations P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

Components

43AA Ear Simulator Kit According to IEC 60318-1 & -2, externally polarized

The 43AA comprises the following main components:

- RA0039 IEC 60318 Ear Simulator
- 40AG ½″ Pressure Microphone, externally polarized
- 26AC ¼″ Preamplifier
- RA0052 Test Jig

43AA-S2 CCP Ear Simulator Kit according to IEC 60318-1 & -2, prepolarized

The 43AA-S2 comprises the following main components:

- RA0039 IEC 6018 Ear Simulator
- 40AO ½″ Pressure Microphone, prepolarized
- 26CB ¼″ Preamplifier
- RA0052 Test Jig

When assembled as shown in Fig. 1, it is ready for testing supra-aural earphones such as telephone handsets and headphones. Fig. 8 shows an exploded view of its user-serviceable components. The following mounting plate is also provided for testing circumaural earphones:

- GR0339 for testing circumaural earphones

This has to be mounted accordingly in place of the removable ring (GR0338) surrounding the entrance to the Ear Simulator (see Fig. 1). The concentric circles on GR0039 (Fig. 2) are provided to help place the earphone correctly in relation to the entrance to the Ear Simulator.

Fig. 1. *43AA Ear Simulator Kit assembled*

Fig. 2. *43AA shown with mounting plate GR0339 for testing circumaural earphones*

TEDS Compatibility

The prepolarized versions of ear simulator kits (43AA-S2 and 43AA-S10) are IEEE 1451.4 TEDS v. 1.0 compliant. If your measurement platform supports Transducer Electronic Data Sheets (TEDS), you will be able to read and write data like properties and calibration data.

Additional Equipment

43AA Ear Simulator Kit (with externally polarized microphone)

The following additional equipment is required for making measurements, see Fig. 3:

1) Power supply for the 26AC ¼″ Preamplifier, e.g., the GRAS 12AK Power Module)
2) Calibration source for the microphone, e.g., the GRAS 42AA Pistonphone or GRAS 42AP Intelligent 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 [1]:
   - logarithmically swept tones
   - pink noise

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

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

The audio analyzer 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 analyzer. Fig. 3 shows a block diagram of a possible set-up for making tests.

43AA-S2 Ear Simulator Kit (with prepolarized microphone)

A test set-up with the 43AA-S2 can be similar to that described above and shown in Fig. 3, except that a 12AL Power Module or 12AQ Power Module is used. Alternatively, the output from the 43AC-S2 can be fed directly into a CCP input of the analyzer/computer.

[1] For example from 50 Hz to 10 kHz

Test Procedure

A possible test set-up for testing with 43AA is shown below. For testing with the prepolarized 43AA-S2 the power module can be replaced by a 12AL/12AQ Power Module. Alternatively, the output can be fed directly to a CCP input of the analyzer.

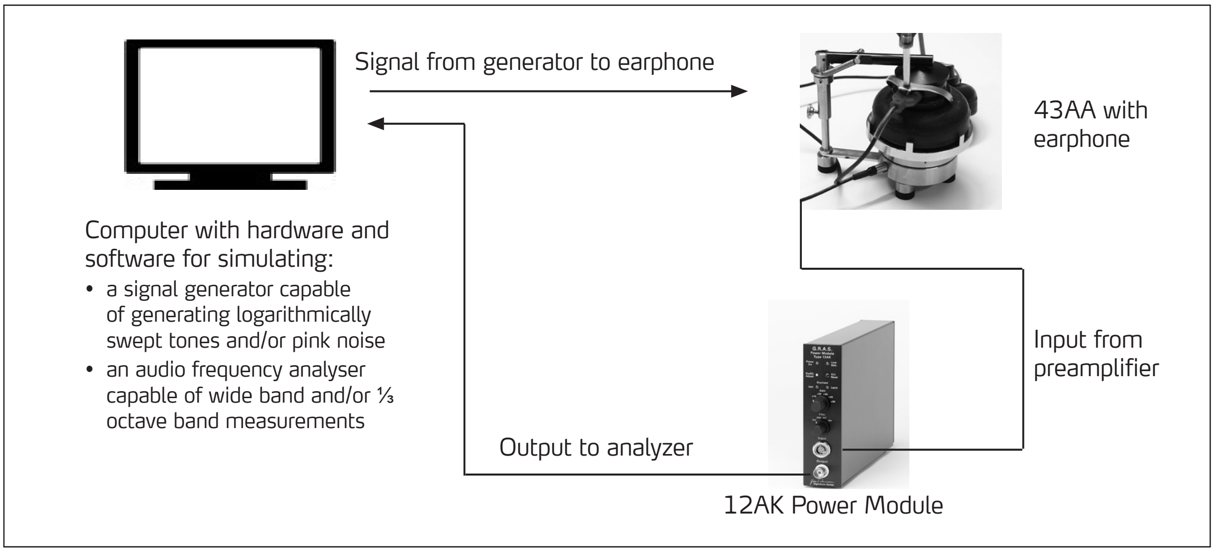

Fig. 3. *Block diagram of a complete set-up for making tests with the 43AA. With the 43AA-S2, the 12AL or 12AQ Power module must be used, unless you connect directly to the CCP input of the computer/analyzer.*

Overview: The 4 stages of the Test Procedure

The basic stages in the test procedure are:

1) Setting up the test jig, e.g., as shown in Fig. 3.
2) Calibration using the GRAS 42AA Pistonphone or GRAS 42AP Intelligent Pistonphone
3) Mounting the earphone on the test jig (see examples shown in Fig. 4)
4) Applying a signal to the earphone and analyzing the output from the Ear Simulator. Depending on requirements, the signal applied to the earphone could be:
   - a swept tone, e.g., under laboratory conditions
   - pink noise, e.g., during mass production of mobile 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 Test Jig

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

Telephone handset | Circum-aural earphone

Fig. 4. *Some examples of mounting the earphone on the test jig*

With the 43AA assembled, e.g., as shown in Fig. 3 and everything switched on, proceed as follows:

1) Power Module
   - Connect the free end of the preamplifier cable to the **Input** socket.
   - Connect, via a suitable cable, the BNC **Output** to the input of the analyzer.
   - Select **Lin**.
   - Select a **Gain** that is within the input range of the analyzer.
2) Earphone
   - Connect the earphone 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.

2: Calibration

For this, access to the microphone is necessary. This means partially dismantling the test jig.

1) Snap the spring-loaded clamp (see Fig. 1) to its upright position, or remove it.
2) Unscrew the Ear Simulator and carefully remove it from the test jig. The microphone is now accessible.
3) Unscrew the collar of the Pistonphone and remove the O-ring (see Fig. 5).
4) Place the coupler of the Pistonphone over the microphone, push it gently down to the microphone stop and switch on.
5) Set the analyzer to either wide band or to the ⅓ octave band whose centre frequency is 250 Hz.
6) When conditions are stable, adjust the analyzer so that it correctly gauges the Pistonphone signal (nominally 114 dB *re.* 20 *μPa*). See Pistonphone manual for making barometric corrections.
7) Switch the Pistonphone off and remove it from the microphone.
8) Screw the Ear Simulator carefully back in place; do not use excessive pressure.
9) Re-assemble the Pistonphone.

3: Mounting the Earphone on the Test Jig

You may have to detach the earphone from its yoke before proceeding.

1) Place the earphone centrally on the mounting plate so that it transmits directly into the Ear Simulator.

   Note:

   For circumaural earphones, use the concentric circles on the mounting plate GR0339 for guidance.

2) If necessary, use the spring-loaded clamp to hold the earphone in place.

4: Applying the Test Signal and Analysing the Output from the Microphone

The following describes typical procedures for applying:

a) a swept signal

b) pink noise

In both cases, it is assumed that the generator and analyzer 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 analyzer to flat response

c) initiate a constant-level logarithmic sweep [4] on the generator.

   The analyzer will follow the response of the Ear Simulator to the earphone throughout the sweep and record and display the results accordingly (see example in Fig. 6).

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 analyzer to ⅓ octave-band mode [4] and wait until conditions are stable.

c) start the analyzer.

   The analyzer will record the response of the Ear Simulator to the earphone for each ⅓ octave band and record and display the results accordingly (see example in Fig. 7).

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

[4] For example from 50 Hz to 10 kHz

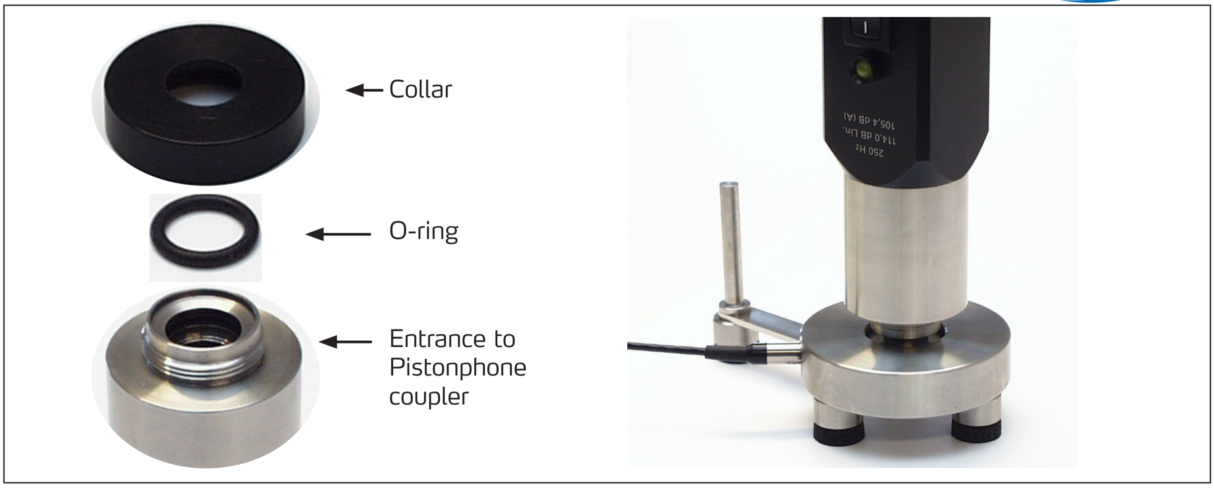

Fig. 5. Calibration using the Pistonphone.
a) Unscrew Pistonphone collar and remove O-ring.
b) Place coupler over microphone, push gently down to microphone stop
c) Switch on

Examples of test results using swept tones and ⅓ octave band analysis are shown below.

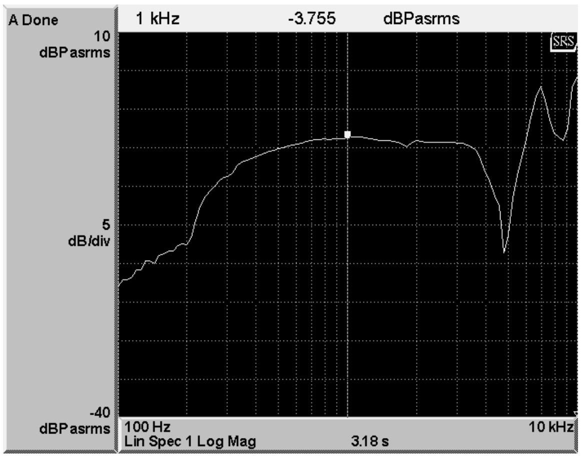

Fig. 6. Example of test results using a swept tone

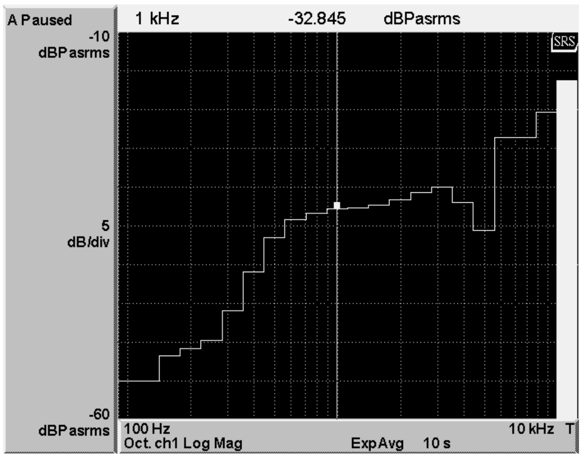

Fig. 7. Example of test results using ⅓ octave-band analyses

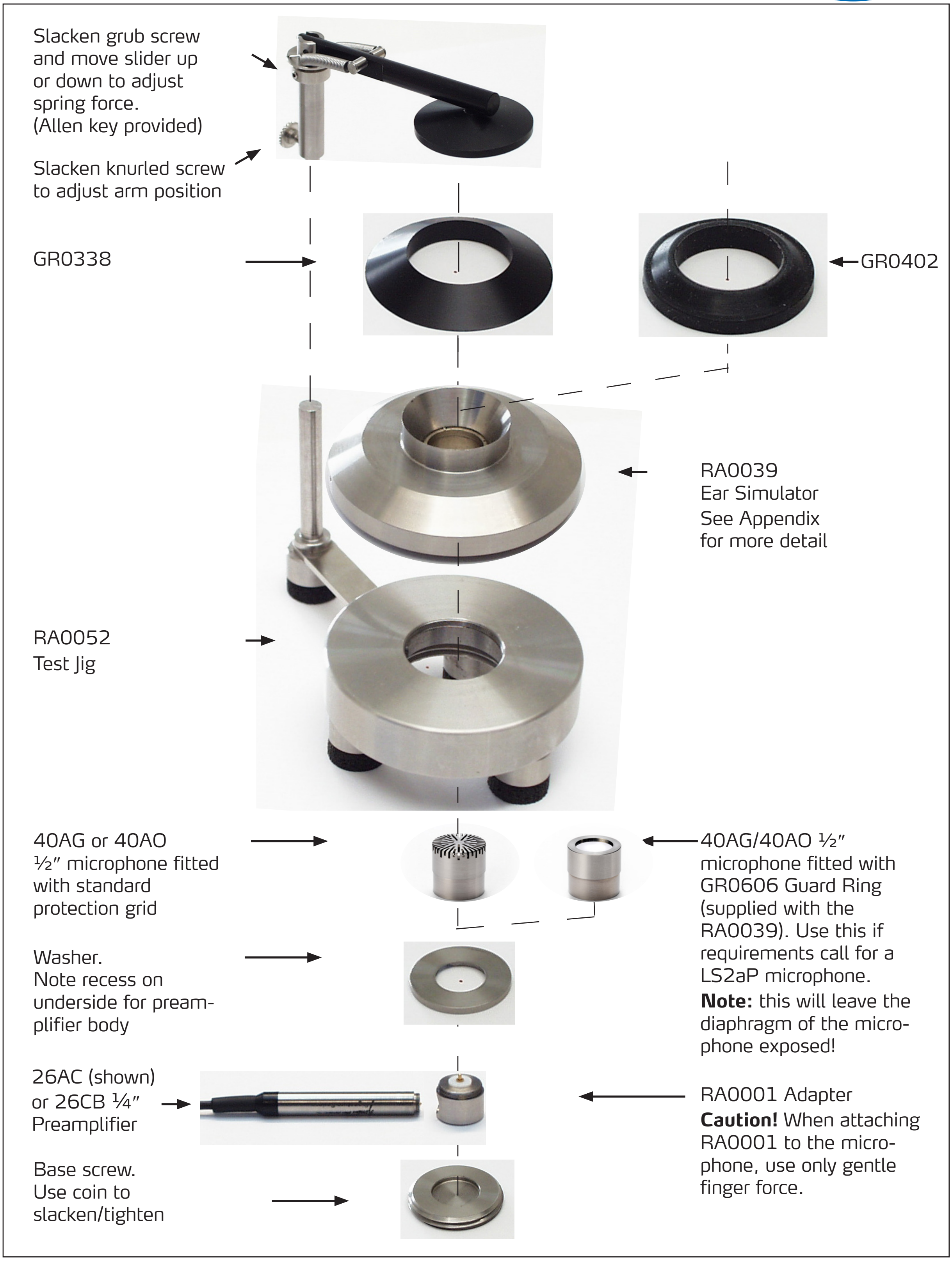

Fig. 8. *Exploded view of the user-serviceable components of the 43AA/43AA-S2 (mounting plates omitted for clarity)*

Warranty, Service and Repair

Calibration

Before leaving the factory, all GRAS 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 GRAS 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 GRAS 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

GRAS 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 RA0039 Ear Simulator

Introduction

The RA0039 IEC 60318-1 Ear Simulator uses a ½″ microphone, e.g., the GRAS 40AG. The artificial ear complies with the following international requirements:

- IEC 60318 Electroacoustics – Simulators of human head and ear - Part 1: Ear simulator for the calibration of supra-aural earphones.
- ITU-T Recommendations P.57 Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

It is also part of the 43AA and 43AD Ear Simulator Kits

Components

The RA0039 comprises the following user-serviceable components:

- GR0335 Body of Ear Simulator
- GR0338 Removable Ring
- GR0402 Removable Ring
- GR0606 Guard Ring

GR0606 is a substitute for the normal protection grid of the 40AG Microphone if requirements call for a LS2aP microphone. **Note:** this will leave the diaphragm of the microphone exposed!

The RA0039 is delivered as shown in Fig. 9. An exploded view of its user-serviceable components is shown in Fig. 10.

It uses a ½″ pressure microphone such as the GRAS 40AG with a 26AK ½″ Preamplifier or ¼″ Preamplifier 26AC fitted with RA0001 Adapter. If ordered with a microphone, the RA0039 will be calibrated with the specific microphone and delivered with the resulting calibration chart.

Fig. 9. *RA0039 Ear Simulator as delivered*

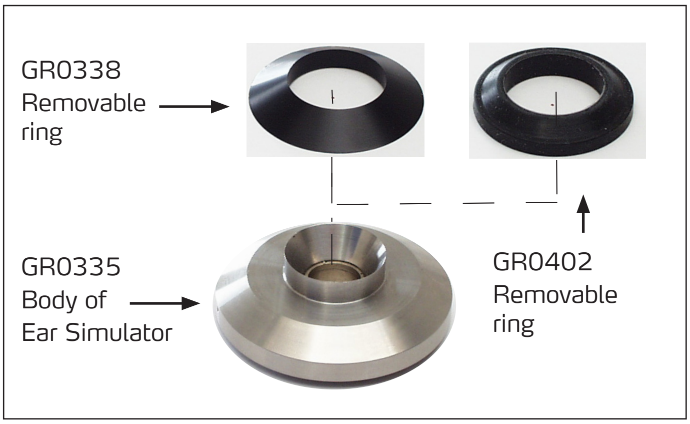

Fig. 10. *Exploded view of all the user-serviceable components of the RA0039*

Characteristics

The acoustic input impedance of the RA0039 closely resembles that of the human ear and, as a result, loads a sound source in very much the same way.

The RA0039 embodies a number of carefully designed volumes connected via well-defined and precisely tuned capillary tubes. In an equivalent electrical circuit (see Fig. 11), capacitors would represent the volumes, and inductance and resistance would represent respectively air mass and air flow within the capillary tubes. The input impedance (see Fig. 12) is measured using a special impedance probe as described in ITU-T Recommendations P.57. This measures the impedance of the RA0039 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.

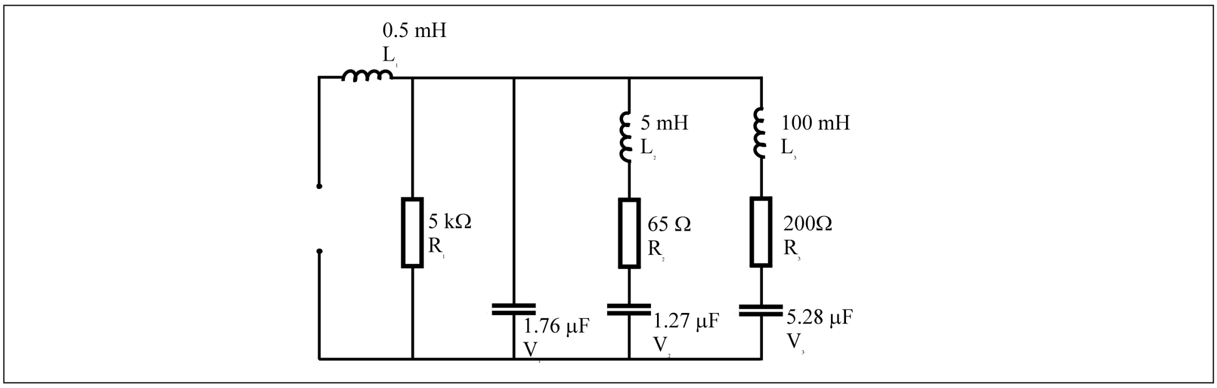

Fig. 11. *RA0039 lumped parameter model*

The absolute sensitivity of the RA0039 at 1kHz is given both as the Open Ear Sensitivity and the Closed Ear Sensitivity. The Open Ear Sensitivity is the ratio of the output signal from the preamplifier to the input pressure signal at the ERP with open coupler. The Closed Ear Sensitivity is the ratio of the output signal from the preamplifier to the input pressure signal at the ERP with closed coupler.

Fig. 12. *RA0039 acoustic input impedance*

Fig. 13. *RA0039 closed-coupler frequency response*