GRAS

An Axiometrix Solutions Brand

Instruction Manual

43AD Ear Simulator Kit According to ITU-T Rec. P57 Type 1

43AD-S1 Ear Simulator Kit According to ITU-T Rec. P57 Type 1, prepolarized

Revision History

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

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

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Introduction

The 43AD Ear Simulator Kit is a complete assembly 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: Ear simulator for the calibration of supra-aural earphones.
- ITU-T Recommendations P.57 Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

The 43AD is acoustically similar to the 43AA. The main difference is that 43AD is quicker to use when testing is part of the production process (e.g. mobile phones). It can also be calibrated rapidly.

43AD Ear Simulator Kit is also available in a prepolarized version, the 43AD-S1.

TEDS Compatibility

The prepolarized version, 43AA-1 is 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.

Components

43AD Ear Simulator Kit According to ITU-T Rec. P57 Type 1, ext. polarized

The 43AD comprises the following main components:

- RA0039 IEC 60318-1 Ear Simulator, see page 12
- 40AG ½″ Pressure Microphone
- 26AK ½″ Preamplifier
- AA0008 3 m Extension Cable
- GR0332 Snap Coupling (female)
- GR0336 Snap Coupling (male)

43AD-S1 Ear Simulator Kit According to ITU-T Rec. P57 Type 1, prepolarized

The 43AD-S1 comprises the following main components:

- RA0039 IEC 60318-1 Ear Simulator, see page 12
- 40AO ½″ Pressure Microphone, prepolariced
- 26CA ½″ CCP Preamplifier
- AA0034 2 m BNC Cable
- GR0332 Snap Coupling (female)
- GR0336 Snap Coupling (male)

When assembled as shown in Fig. 1, it is ready for testing supra-aural [1] earphones such as telephone handsets and headphones. Fig. 7 on page 10 shows an exploded view of its user-serviceable components. The following mounting plate is also provided for testing circumaural[2] earphones:

- GR0339 for testing circumaural earphones

It has to be mounted accordingly in place of the removable ring (GR0338) surrounding the entrance to the Ear Simulator, see Fig. 2.

[1] An earphone applied externally to the ear

[2] An earphone with a cavity large enough to cover the region of the head which includes the ear. The concentric circles on the GR0039 (Fig. 2) are provided to help place the earphone correctly in relation to the entrance to the Ear Simulator.

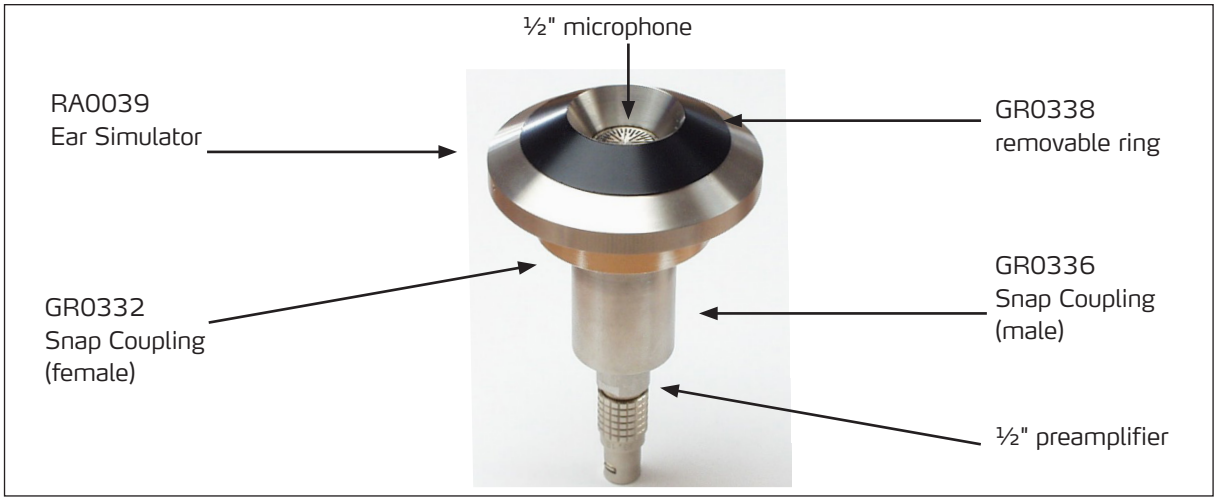

Fig. 1. *Assembled 43AD/43AD-S1 Ear Simulator Kit*

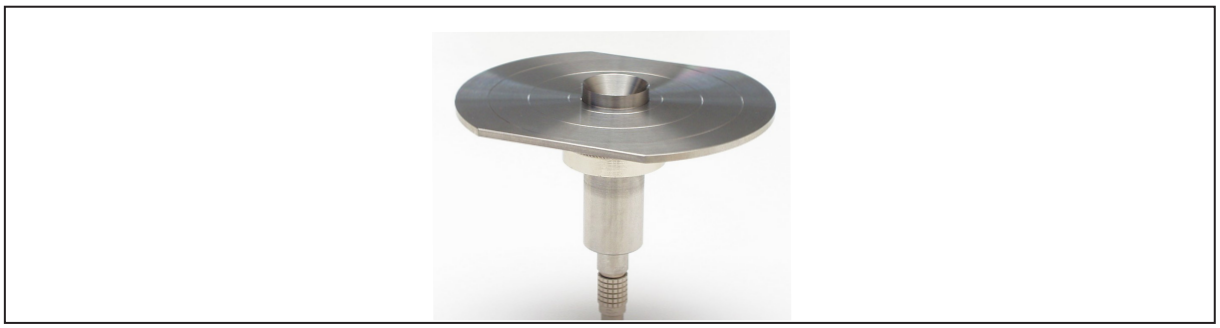

Fig. 2. *43AD shown with mounting plate GR0339 for testing earphones fitted with fluid cushions (circum-aural)*

Ground Loops

In certain test set-ups, particularly if they are automated, there can be a risk of ground loops passing through the artificial ear and resulting in extraneous noise in the test results. If this is a likely problem, please contact G.R.A.S. before ordering. The solution will be to use the prepolarized version with protective grid and male snap coupling made of plastic.

Additional Equipment

43AD Ear Simulator Kit, externally polarized

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

1) Power supply for the 26AK ½" Preamplifier, e.g. the G.R.A.S. 12AK Power Module.
2) Calibration source for the microphone,
   e.g. the G.R.A.S. 42AA or 42AP 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[3]:
   - 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 (see Fig. 3), 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.

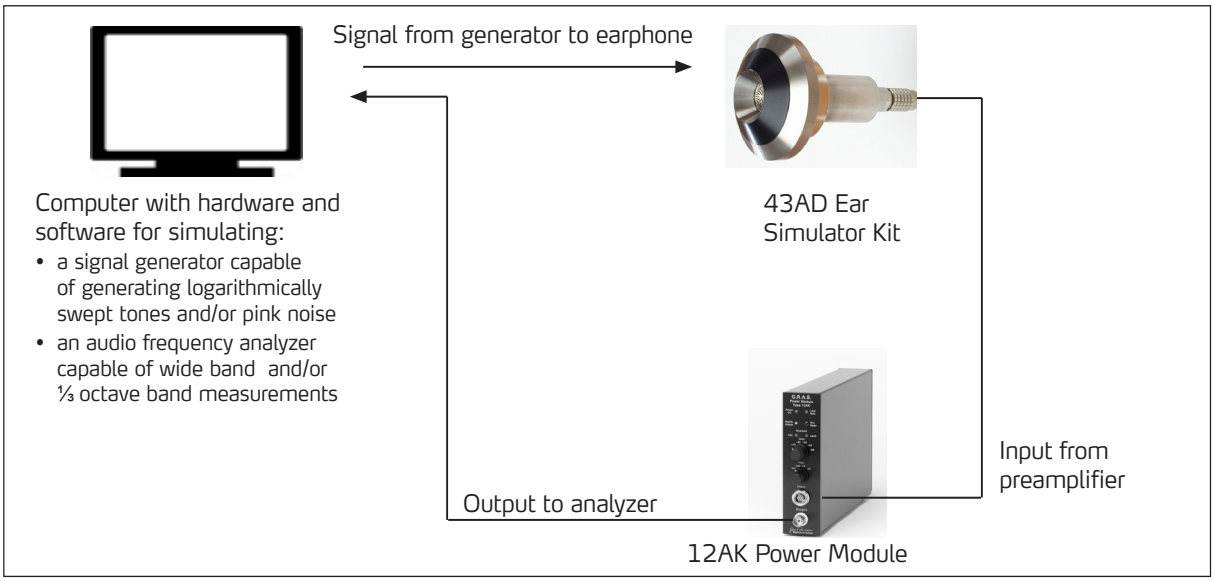

Fig. 3. *Block diagram of a complete set-up for making tests with the externally polarized 43AD. With the 43AD-S1, the 12AL or 12AQ Power module can be used, or you can connect directly to a CCP input of the analyzer.*

[3] For example from 50 Hz to 10 kHz

43AD-S1 Ear Simulator Kit, (with prepolarized microphone)
A test set-up with the 43AD-S1 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-S1 can be fed directly into a CCP input of the analyzer/computer.

Test Procedure

The 4 stages of the Test Procedure

Using the mobile phone 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 using the G.R.A.S. 42AA or 42AP Pistonphone
3) Placing the Ear Simulator over the earpiece of the mobile phone (see example in Fig. 6)
4) Applying a signal to the mobile phone and analysing the output from the microphone. Depending on requirements, the signal applied to the mobile phone could be:
   - a swept tone, e.g. under laboratory conditions
   - pink noise, e.g. during mass production of mobile telephones

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 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.

With the 43AD assembled 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) Mobile phone
   - Connect the earphone of the mobile phone to the signal output of the generator.
3) Adjust the output level of the generator to lie within the normal working range of the earphone.

With the 43AD-S1, a 12AL Power Module or 12AQ Power Module can be used.

2: Calibration

For this, access to the microphone is necessary.

1) Twist open the two halves of the snap coupling as shown in Fig. 4.
2) Gently push the microphone into the Pistonphone's coupler until it reaches the stop.
3) Switch the Pistonphone on.
4) Set the analyzer to either wide band or to the ⅓ octave band whose centre frequency is 250 Hz.
5) When conditions are stable, adjust the analyzer so that it correctly gauges the Pistonphone signal (nominally 114 dB). See Pistonphone manual for making barometric corrections.
6) Switch the Pistonphone off and remove it from the microphone.
7) Re-assemble the Ear Simulator.

Fig. 4. *Showing the two halves of the snap coupling to give quick access to the microphone*

Fig. 5. *Gently push the microphone into the Pistonphone's coupler until it reaches the stop*

3: Placing the Ear Simulator over the Earpiece/Earphone

In production testing, this is normally automated. The 43AD must be centrally placed over the earpiece/earphone so that the sound is transmitted directly into the 43AD. See example in Fig. 6.

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

Fig. 6. *Place the Ear Simulator centrally over the earpiece of the mobile phone*

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.

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.

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. 7. *Exploded view of all the user-serviceable components of the 43AD (mounting plates and extension cable omitted for clarity)*

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 RA0039 Ear Simulator IEC 60318-1

Introduction

The RA0039 IEC 318 Ear Simulator uses a ½" microphone, e.g. the externally polarized G.R.A.S. 40AG or the prepolarized G.R.A.S 40AO. 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.

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. 8. An exploded view of its user-serviceable components is shown in Fig. 9.

It uses a ½" pressure microphone such as the G.R.A.S. 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.

For a prepolarized setup, a 40AO microphone and a 26CB preamplifier are used.

Fig. 8. *RA0039 Ear Simulator as delivered*

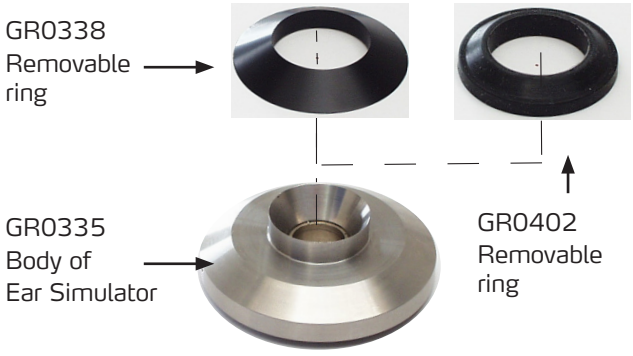

Fig. 9. *Exploded view of all the user-serviceable components of the RA0039*

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. 10), 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. 11) is measured using a special impedance probe as described in ITU-T Recommendations P.57 (08/96). 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.

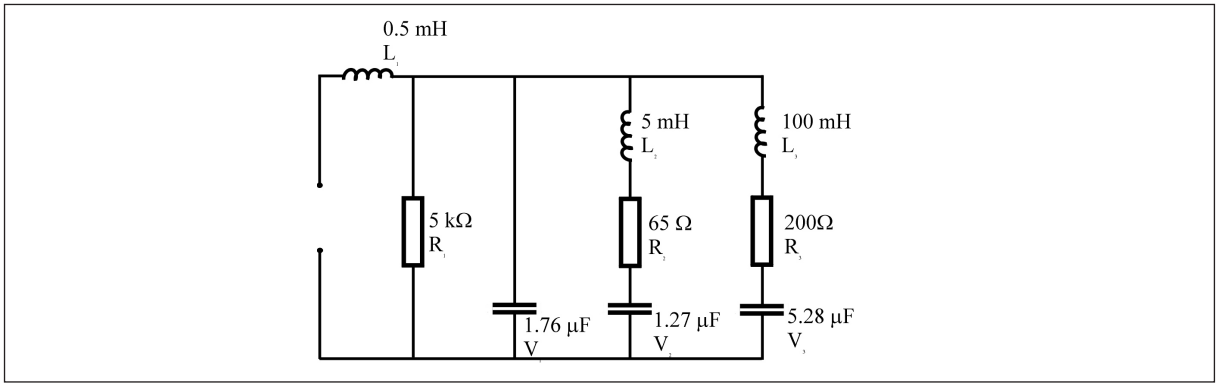

Fig. 10. *RA0039 lumped parameter model*

The 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. 11. *RA0039 acoustic input impedance*

Fig. 12. *RA0039 closed-coupler frequency response*