# Instruction Manual

Artificial Ears, Ear Simulators, Couplers, and Mouth Simulators

Type 43AA
Type 43AB
Type 43AC
Type 43AD
Type 43AE
Type 43AF
Type RA0038
Type RA0113
Type RA0039
Type RA0045
Type RA0056
Type RA0057
Type RA0075
Type 44AA
Type 44AB

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# Artificial Ears, Ear Simulators, Couplers and Mouth Simulators

## Type 43AA

## Type 43AB

## Type 43AC

## Type 43AD

## Type 43AE

## Type 43AF

## Type RA0038

## Type RA0113

## Type RA0039

## Type RA0045

## Types RA0056 & RA0057

## Type RA0075

## Types 44AA & 44AB

Revision 17 March 2017

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# Chapter 1

## Artificial Ear Type 43AA

*Artificial Ear Type 43AA*

## 1.1 Introduction

The Artificial Ear Type 43AA is a complete test jig 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, 1998-07.
- ITU-T Recommendations P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

## 1.2 Components

The Artificial Ear Type 43AA comprises the following main components:

- Type RA0039 IEC 318 Ear Simulator (see Chapter 9)
- Type 40AG ½" Pressure Microphone, Wide Frequency
- Type 26AC ¼" Preamplifier (used with Adapter RA0001 instead of GR0010)
- Type RA0052 Test Jig

When assembled as shown in Fig. 1.1, it is ready for testing supra-aural [1] earphones such as telephone handsets and headphones. Fig. 1.9 shows an exploded view of its user-serviceable components.

The following mounting plate is also provided for testing circumaural [2] earphones:

- GR0339 for testing earphones fitted with fluid cushions

This has to be mounted accordingly in place of the removable ring (GR0338) surrounding the entrance to the Ear Simulator (see Fig. 1.2).

The concentric circles on GR0039 (Fig. 1.2) are provided to help place the earphone correctly in relation to the entrance to the Ear Simulator.

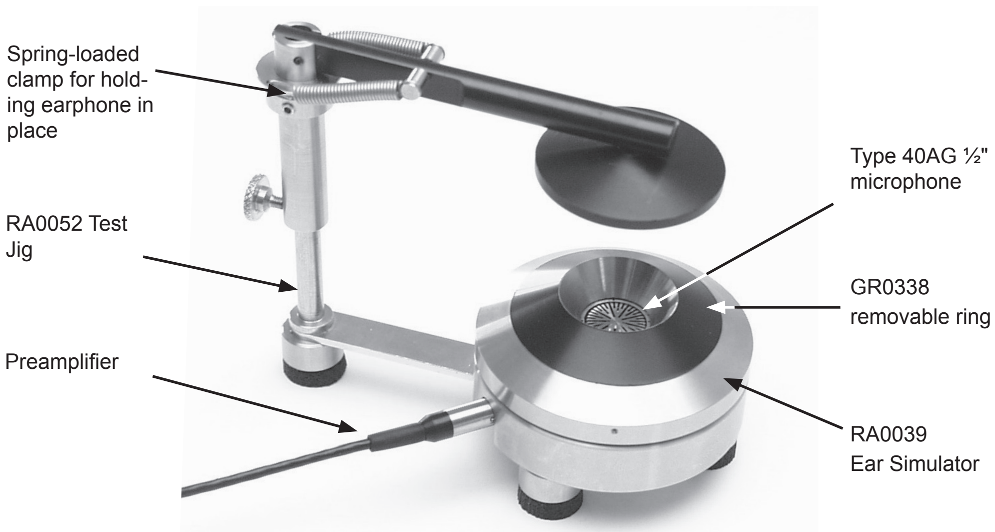



*Fig. 1.1 Assembled Artificial Ear Type 43AA*

[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

*Fig. 1.2 Type 43AA shown with mounting plate GR0339 for testing earphones fitted with fluid cushions*

## 1.3 Additional Equipment

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

1) Power supply for the ¼" Preamplifier Type 26AC,
e.g. the G.R.A.S. Power Module Type 12AK (see Fig. 1.3a)
2) Calibration source for the microphone,
e.g. the G.R.A.S. Pistonphone Type 42AA which produces 114 dB *re.* 20 *μPa* (10 Pa) at 250 Hz (see Fig. 1.3b)
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 analyser capable of one or both of the following:
   - wide band measurement
   - ⅓ octave-band measurement

The audio analyser receives, via the Type 12AK (see Fig. 1.3a), the signal picked up by the Artificial Ear, 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. 1.4 shows a block diagram of a possible set-up for making tests.

[3] For example from 50 Hz to 10 kHz


*Fig. 1.3    Showing a) Power Module Type 12AK and b) Piston-phone Type 42AA*

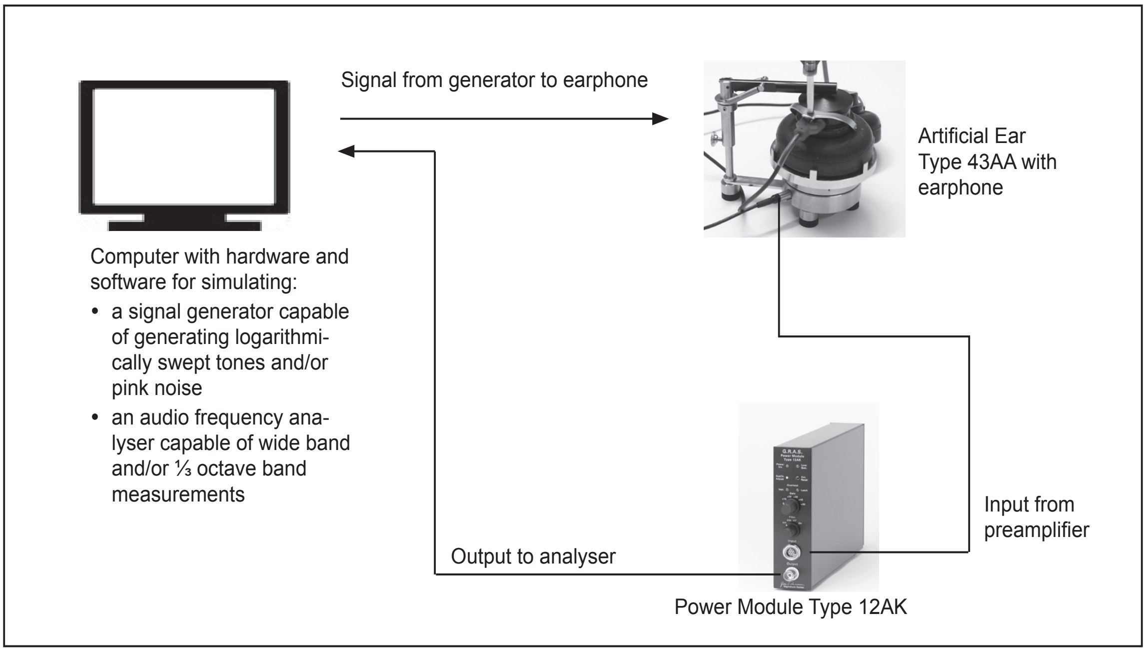



*Fig. 1.4    Block diagram of a complete set-up for making tests*

## 1.4 Test Procedure

### 1.4.1 General

The basic stages in the test procedure are:

1) Setting up the test jig, e.g. as shown in Fig. 1.4
2) Calibration using the G.R.A.S. Pistonphone Type 42AA
3) Mounting the earphone on the test jig (see examples shown in Fig. 1.5)
4) Applying a signal to the earphone and analysing the output from the Artificial Ear.
   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.


Telephone handset

Circum-aural earphone

*Fig. 1.5 Some examples of mounting the earphone on the test jig*

### 1.4.2 Setting up the Test Jig

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 Artificial Ear.

With the Artificial Ear assembled, e.g. as shown in Fig. 1.2, and everything switched on, proceed as follows:

1) Power Module Type 12AK
   - 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) 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.

### 1.4.3 Calibration

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

1) Snap the spring-loaded clamp (see Fig. 1.1) 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. 1.6).
4) Place the coupler of the Pistonphone over the microphone, push it gently down to the microphone stop and switch on.
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, adjust the analyser 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.

### 1.4.4 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 liquid cushioned 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.

### 1.4.5 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

and shows 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 $\beta T$ 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[4] on the generator.

The analyser will follow the response of the Artificial Ear to the earphone throughout the sweep and record and display the results accordingly (see example in Fig. 1.7).

**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[4] and wait until conditions are stable.
c) start the analyser.

The analyser will record the response of the Artificial Ear to the earphone for each ⅓ octave band and record and display the results accordingly (see example in Fig.1.8).

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

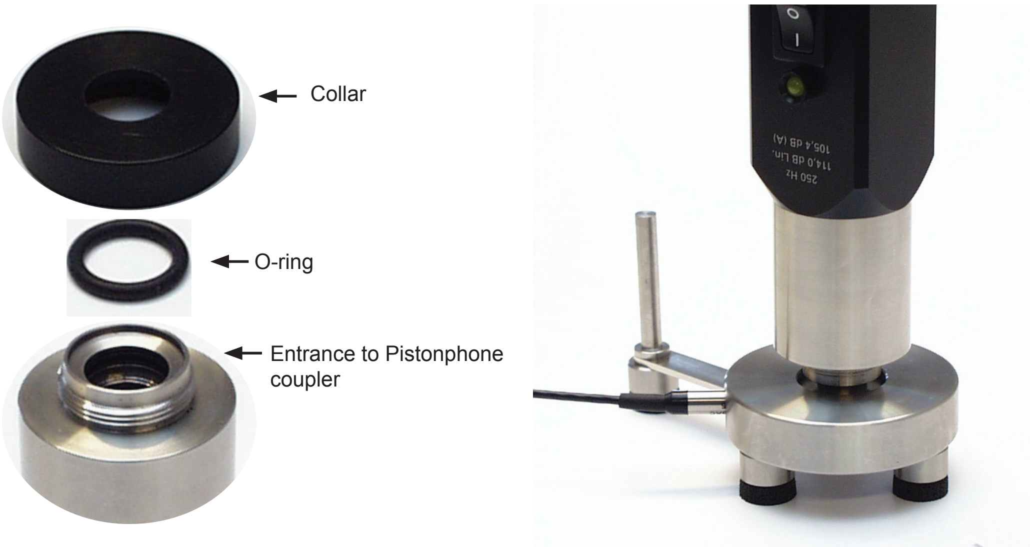



*Fig. 1.6 Calibration using the Pistonphone*
*a) Unscrew Pistonphone collar and remove O-ring.*
*b) Place coupler over microphone, push gently down to microphone stop*
*c) Switch on*

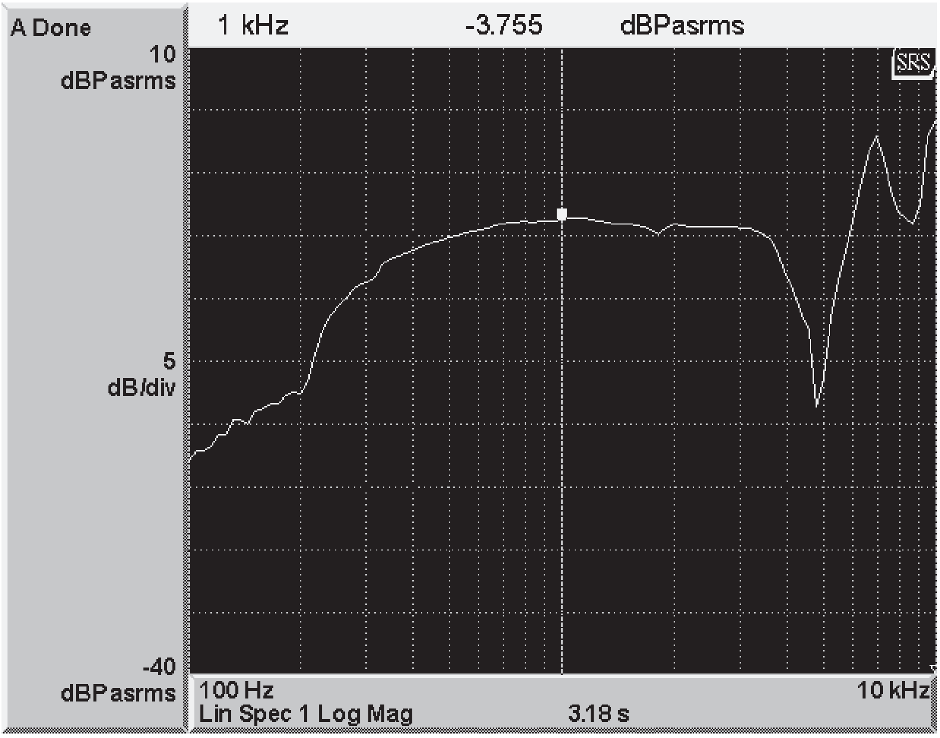



*Fig. 1.7 Example of test results using a swept tone*

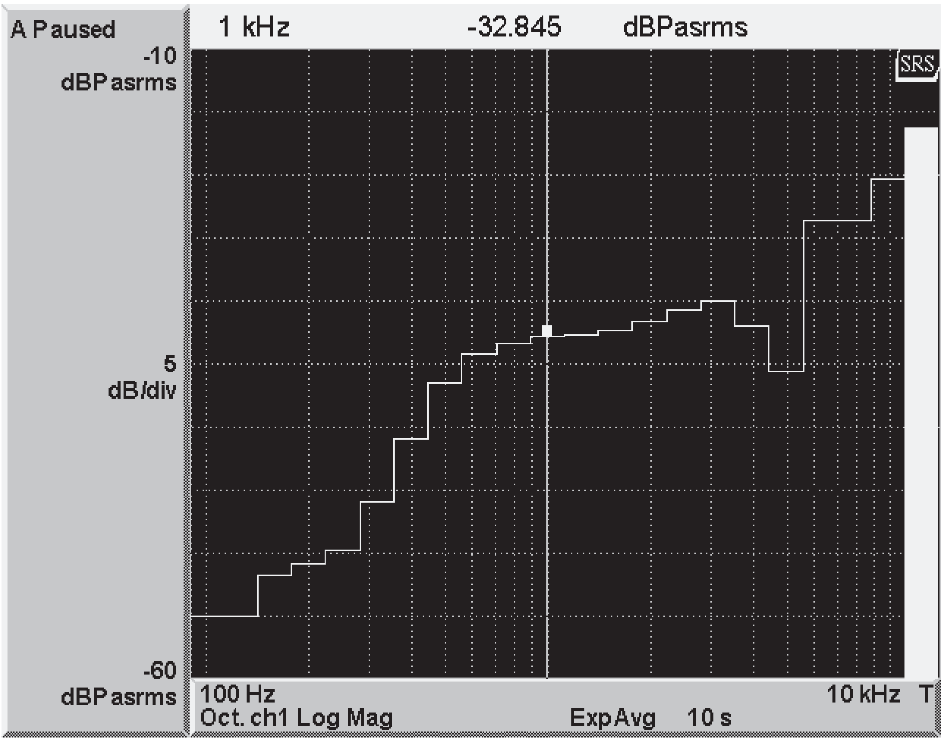



*Fig. 1.8 Example of test results using ⅓ octave-band analyses*

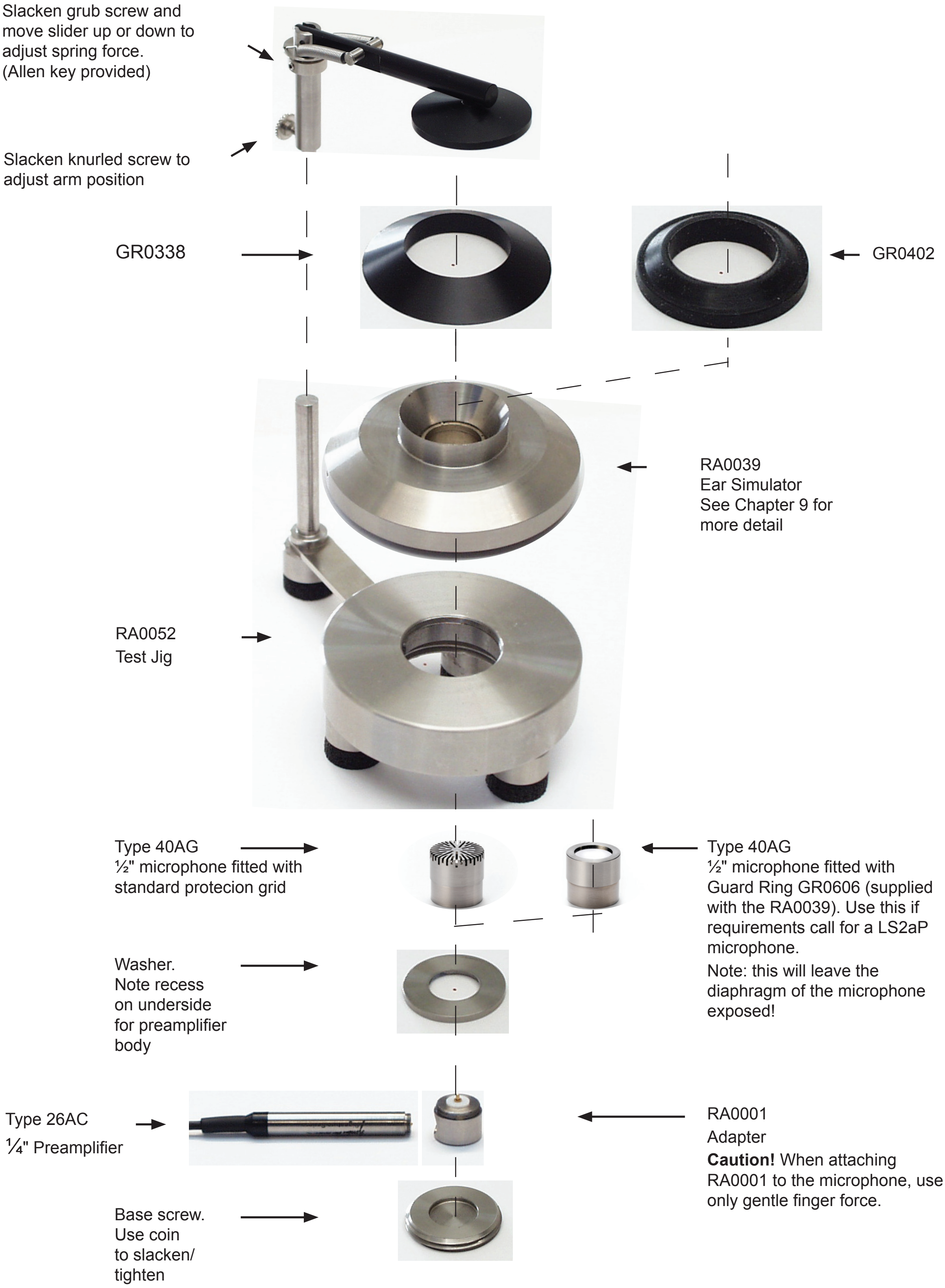



*Fig. 1.9 Exploded view of the user-serviceable components of the Artificial Ear Type 43AA (mounting plates omitted for clarity)*

# Chapter 2
## Artificial Ear Type 43AB

*Artificial Ear Type 43AB*

## 2.1 Introduction

The Artificial Ear Type 43AB is a complete test jig for acoustically testing insert type hearing aids and complies with the following international and national requirements:

- IEC 60126 Ed. 2.OB IEC reference coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts (formerly IEC 126 )
- ANSI S3.7-1973 American National Standard for Coupler Calibration of Earphones

## 2.2 Components

The Artificial Ear Type 43AB comprises the following main components:

- Type RA0038 IEC 126 2 $cm^3$ Coupler (see also Chapter 7)
- Type 40AG ½" Pressure Microphone, Wide Frequency
- Type 26AC ¼" Preamplifier (used with Adapter RA0001 instead of GR0010)
- Type RA0052 Test Jig

When assembled as shown in Fig. 2.1, it is ready for testing insert type hearing aids. Fig. 2.3 shows an exploded view of its user-serviceable components.

Tube Adapters are also provided with the coupler for holding in place the tube carrying the signal from the acoustic output of the hearing aid.

## 2.3 Additional Equipment

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

1) Power supply for the ¼" Preamplifier Type 26AC,
e.g. the G.R.A.S. Power Module Type 12AK (see Fig. 1.3a)
2) Calibration source for the microphone,
e.g. the G.R.A.S. Pistonphone Type 42AA which produces 114 dB *re.* 20 *μPa* (10 Pa) at 250 Hz (see Fig. 1.3b)

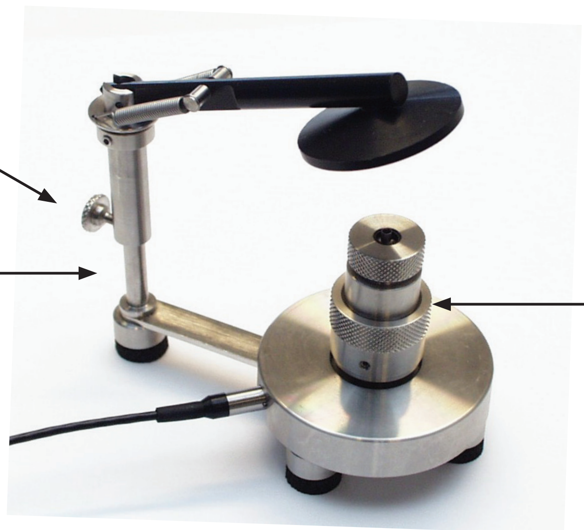



*Fig. 2.1 Assembled Artificial Ear Type 43AB*

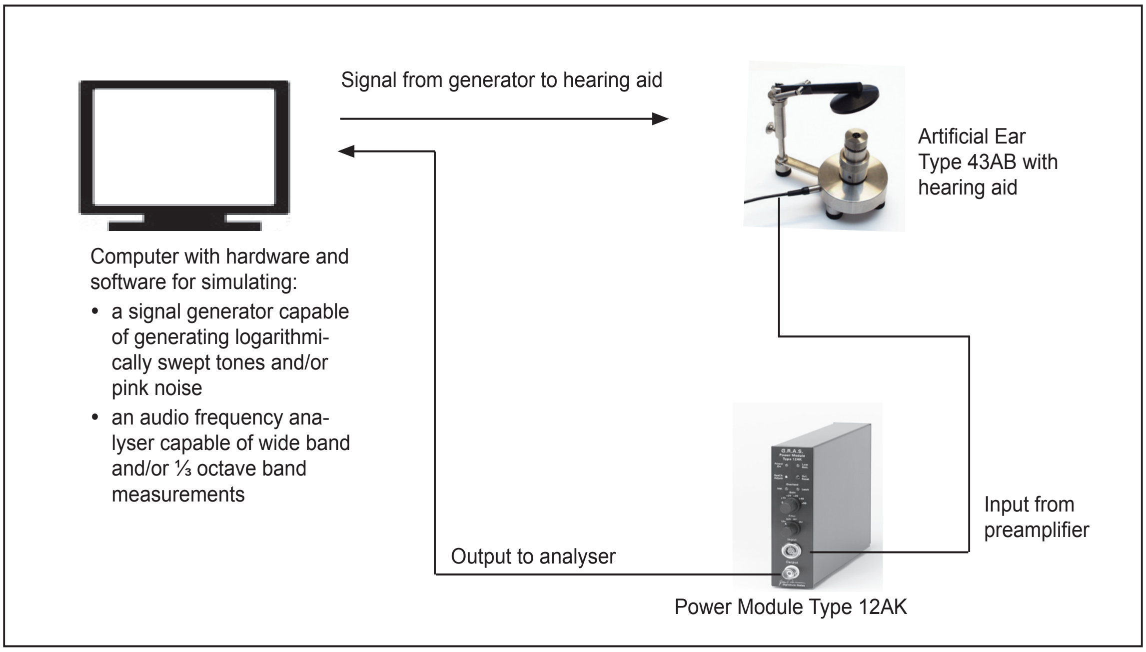



*Fig. 2.2 Block diagram of a complete set-up for making tests*

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 hearing aid.
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 Type 12AK (see Fig. 1.3a), the signal picked up by the Artificial Ear, 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. 2.2 shows a block diagram of a possible set-up for making tests.

## 2.4 Test Procedure

### 2.4.1 General

The basic stages in the test procedure are:

1) Setting up the test jig, e.g. as shown in Fig. 2.2
2) Calibration using the G.R.A.S. Pistonphone Type 42AA
3) Mounting the hearing aid on the test jig (see examples shown in Fig. 7.2)
4) Applying a signal to the hearing aid and analysing the output from the Artificial Ear.

[1] For example from 50 Hz to 10 kHz

Depending on requirements, the signal applied to the hearing aid could be:

- a swept tone, e.g. under laboratory conditions
- pink noise, e.g. during mass production of hearing aids

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.

### 2.4.2 Setting up the Test Jig

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

With the Coupler Type RA0038 assembled as shown in one of the examples in Chapter 7 and everything switched on, proceed as follows:

1) Power Module Type 12AK

- 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 hearing aid.

2) Hearing aid

- Connect the hearing aid 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 hearing aid.

### 2.4.3 Calibration

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

1) Snap the spring-loaded clamp (see Fig. 1.1) to its upright position, or remove it.
2) Remove the Coupler from the test jig. The microphone is now accessible.
3) Unscrew the collar of the Pistonphone and remove the O-ring (see Fig. 1.6).
4) Place the coupler of the Pistonphone over the microphone, push it gently down to the microphone stop and switch on.
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, adjust the analyser 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) Replace the Coupler back in the test jig.
9) Re-assemble the Pistonphone.

### 2.4.4 Mounting the Hearing Aid on the Test Jig

See Chapter 7.

### 2.4.5 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

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 $\beta T$ 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 [2] on the generator.

The analyser will follow the response of the Artificial Ear to the hearing aid throughout the sweep and record and display the results accordingly (see example in Fig. 1.7).

**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 [2] 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 (see example in Fig.1.8).

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

[2] For example from 50 Hz to 10 kHz

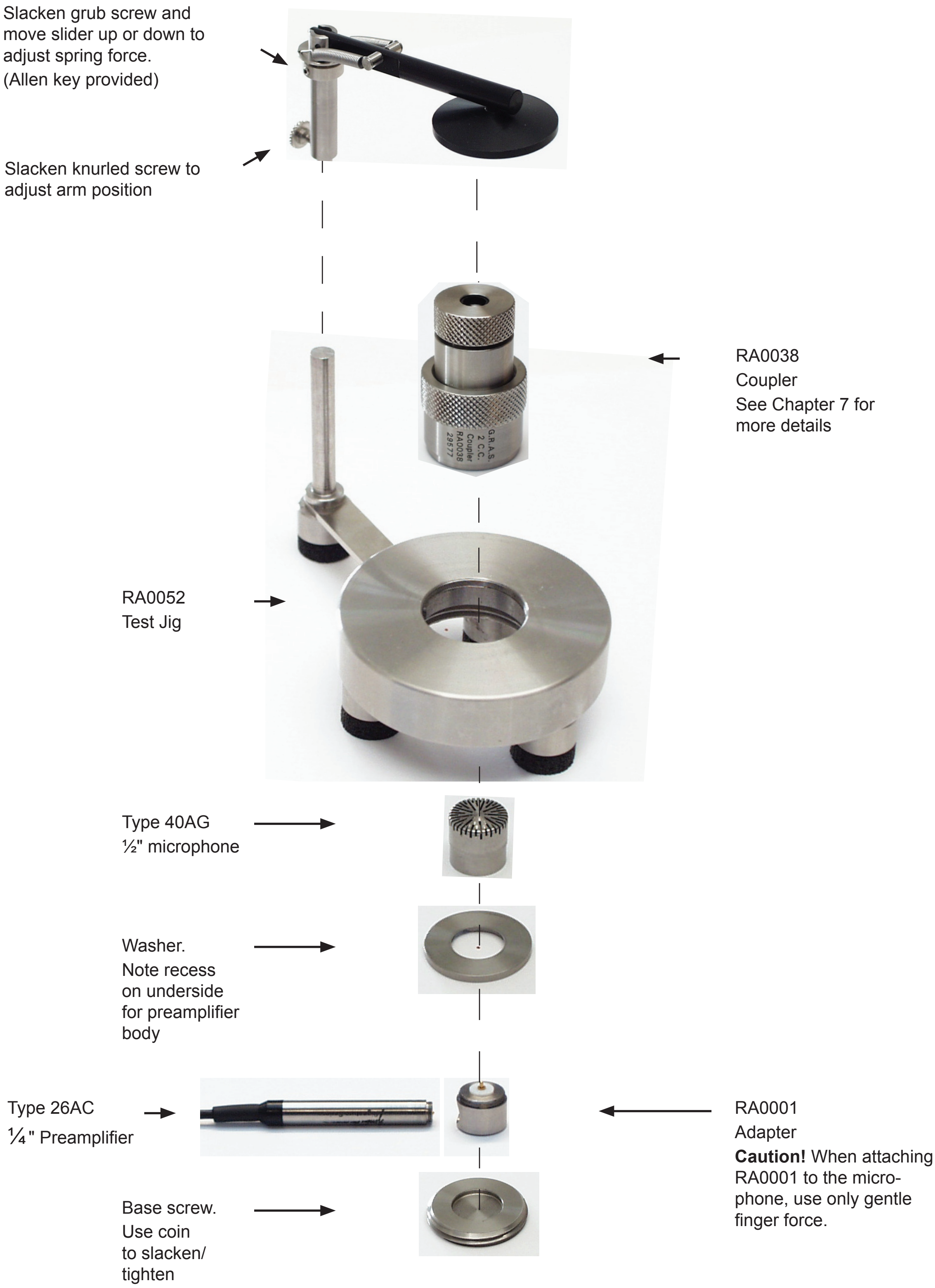



*Fig. 2.3 Exploded view of the user-serviceable components of the Artificial Ear Type 43AB*

# Chapter 3

## Artificial Ear Type 43AC

*Artificial Ear Type 43AC*

## 3.1 Introduction

The Artificial Ear Type 43AC is a complete test jig for acoustically testing earphones coupled to the ear via inserts such as tubes and ear moulds and complies with the following international requirements:

- IEC 60711 Ed. 1.OB Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts (formerly IEC 711)
- ITU-T Recommendations P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

## 3.2 Components

The Artificial Ear Type 43AC comprises the following main components:

- Type RA0045 IEC 60711 Ear Simulator with microphone included (see Chapter 10)
- Type 26AC ¼" Preamplifier (used with Adapter RA0001 instead of GR0010)
- Type RA0052 Test Jig

When assembled as shown in Fig. 3.1, it is ready for testing insert earphones. Fig. 3.4 shows an exploded view of its user-serviceable components.

### 3.2.1 Accessories

Various accessories are included for the following:

Hearing aids either coupled to the ear via tube inserts or placed in the ear (see Fig. 3.5)

- GR0435 In-ear Adapter
- GR0436 Tube stud
- GR0437 Ear-mould Simulator
- GR0438 Union nut
- GR0440 Tube stud

Calibration (see Figs. 3.6 and 3.7)

- GR0433 Calibration Adapter
- GR0434 Stop Washer

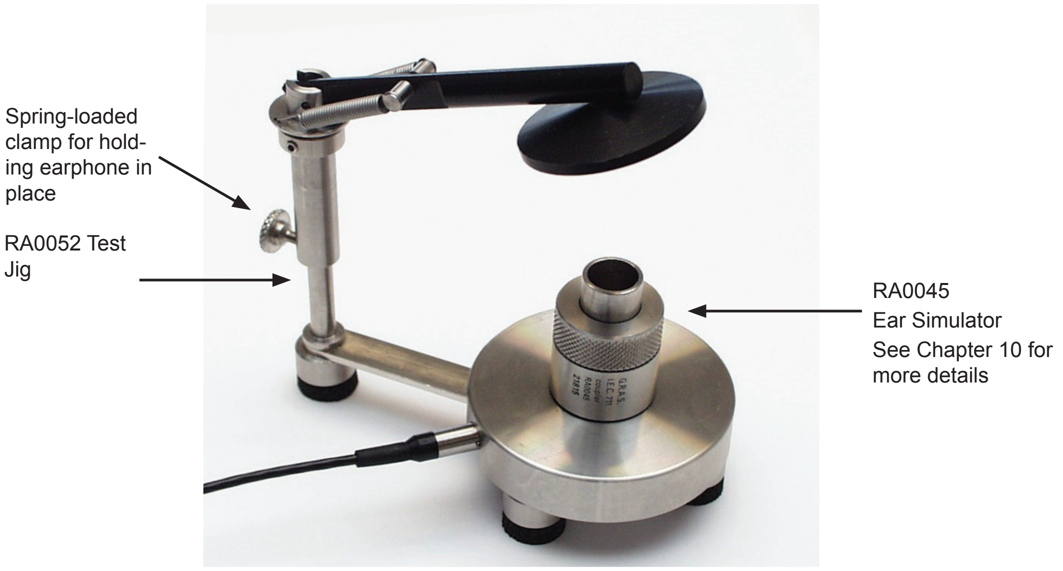



*Fig. 3.1 Assembled Artificial Ear Type 43AC*

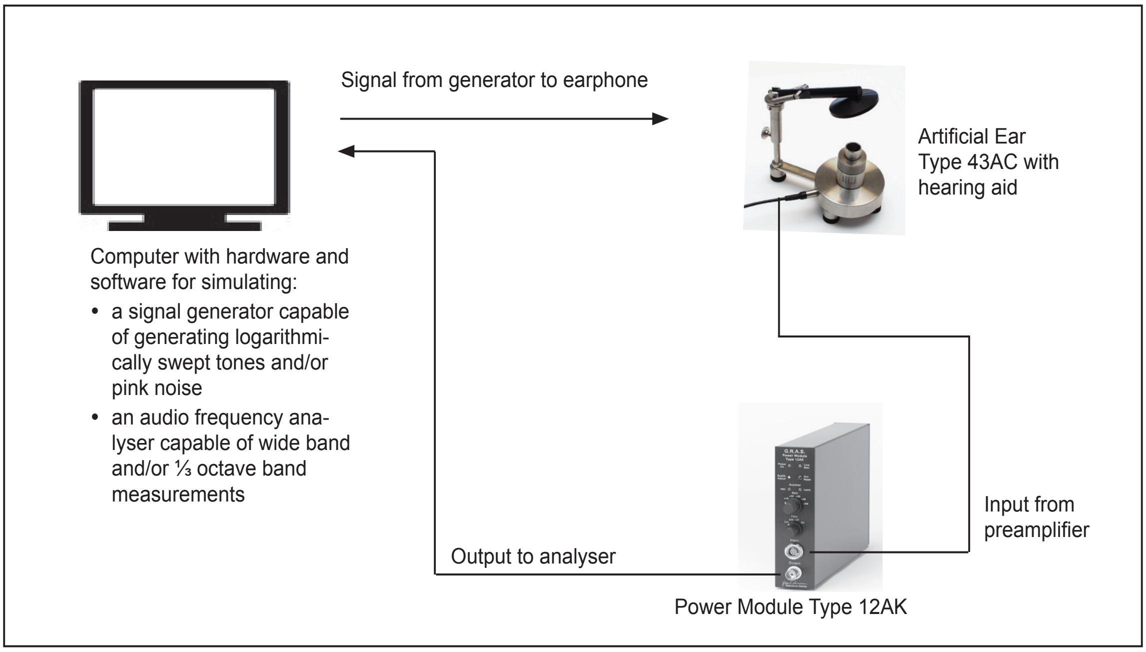



*Fig. 3.2 Block diagram of a complete set-up for making tests*

## 3.3 Additional Equipment

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

1) Power supply for the ¼" Preamplifier Type 26AC,
e.g. the G.R.A.S. Power Module Type 12AK (see Fig. 1.3a)
2) Calibration source for the microphone,
e.g. the G.R.A.S. Pistonphone Type 42AA which produces 114 dB *re.* 20 *µPa* (10 Pa) at 250 Hz (see Fig. 1.3b)
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 analyser capable of one or both of the following:
   - wide band measurement
   - ⅓ octave-band measurement

The audio analyser receives, via the Type 12AK (see Fig. 1.3a), the signal picked up by the Artificial Ear, 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. 3.2 shows a block diagram of a possible set-up for making tests.

[1] For example from 50 Hz to 10 kHz

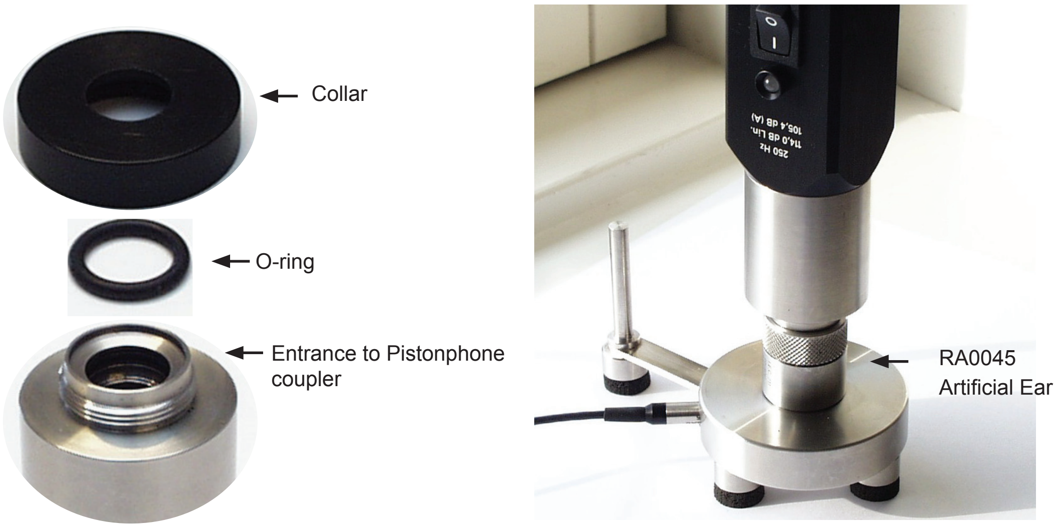



*Fig. 3.3 Calibration using the Pistonphone*
*a) Unscrew Pistonphone collar and remove O-ring.*
*b) Place coupler over RA0045, push gently down to the stop*
*c) Switch on*

## 3.4 Test Procedure

### 3.4.1 General

The basic stages in the test procedure are:

1) Setting up the test jig, e.g. as shown in Fig. 3.2
2) Calibration using the G.R.A.S. Pistonphone Type 42AA
3) Mounting the earphone on the test jig.
4) Applying a signal to the earphone and analysing the output from the microphone.
   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 earphones

   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.

### 3.4.2 Setting up the Test Jig

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 Artificial Ear.

With the Ear Simulator Type RA0045 assembled as shown in one of the examples in Chapter 10 and everything switched on, proceed as follows:

1) Power Module Type 12AK
   - 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 earphone.
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.

### 3.4.3 Calibration

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 (see also section 10.4). This, in effect, increases the coupler volume such that the signal from the Pistonphone will be reduced by 1.03 dB [2].

1) Snap the spring-loaded clamp (see Fig. 3.1) to its upright position, or remove it.
2) Unscrew the collar of the Pistonphone and remove the O-ring (see Fig. 3.3).
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.

### 3.4.4 Mounting the Earphone on the Test Jig

**Insert Earphones**

For the coupler configured as shown in Fig. 3.1 (RA0045) and as described in Chapter 10, the earphone is inserted directly into the tapered opening of the GR0408 (External-ear Simulator).

**Occluded-ear Simulation**

For hearing aids coupled to the ear via tube inserts, see Fig. 3.5.

### 3.4.5 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

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 $\beta T$ 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 Artificial Ear to the earphone throughout the sweep and record and display the results accordingly (see example in Fig. 1.7).

[2] For a B&K pistonphone with a ½" coupler, the signal will be reduced by 0.66 dB.

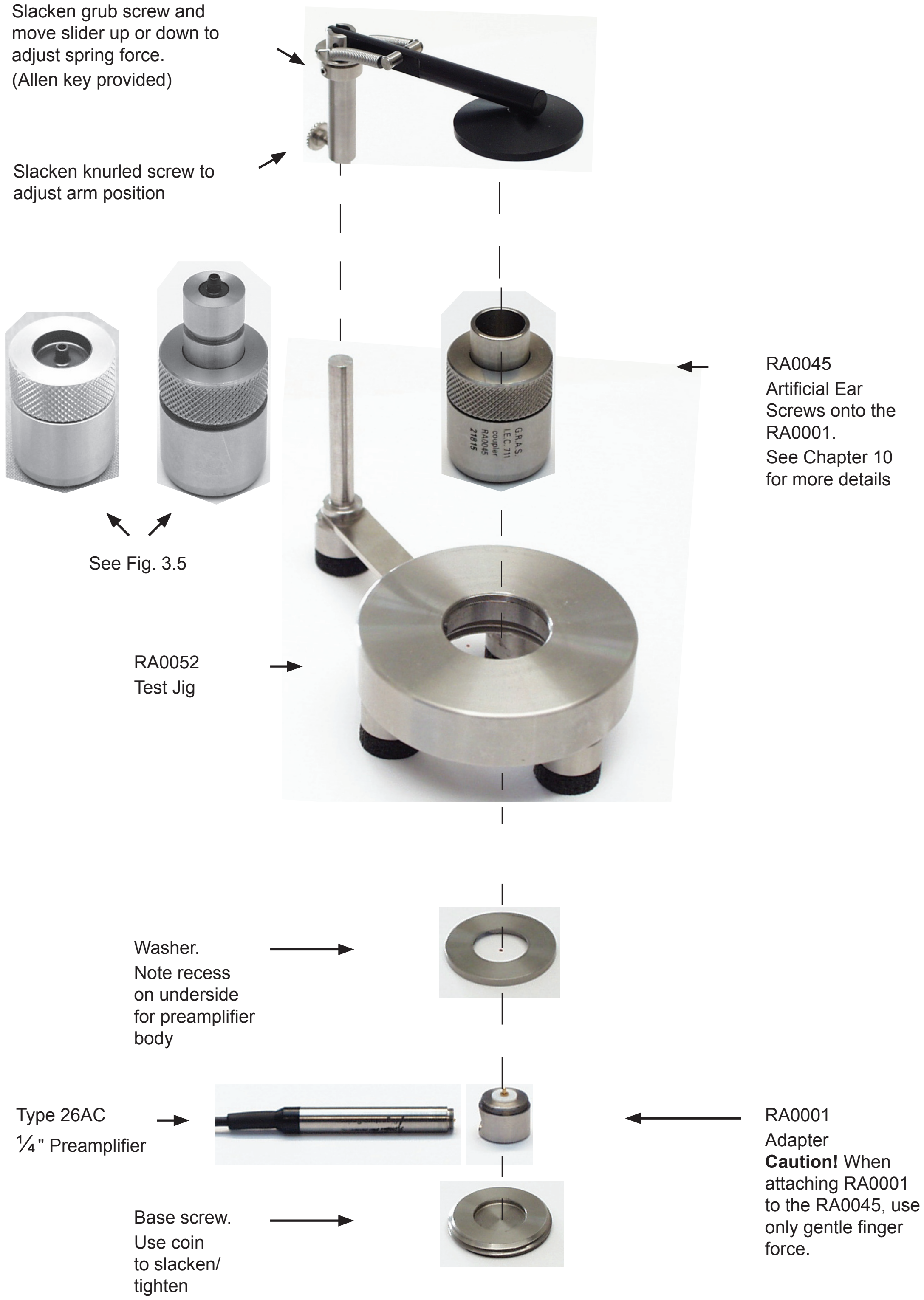



*Fig. 3.4 Exploded view of the user-serviceable components of the Artificial Ear Type 43AC*

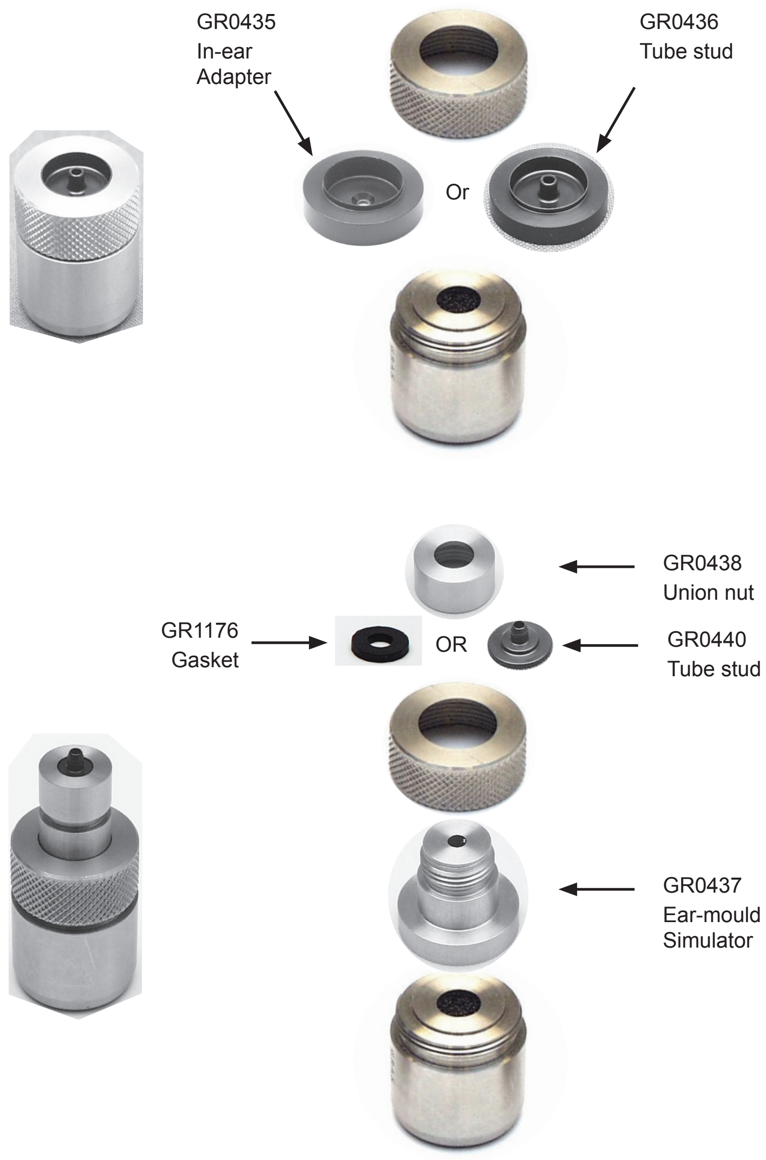



*Fig. 3.5    Assembled and exploded views of the Ear Simulator itemising user-serviceable accessories for testing earphones either coupled to the ear via tube inserts or placed in the ear*

**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 (see example in Fig.1.8).

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

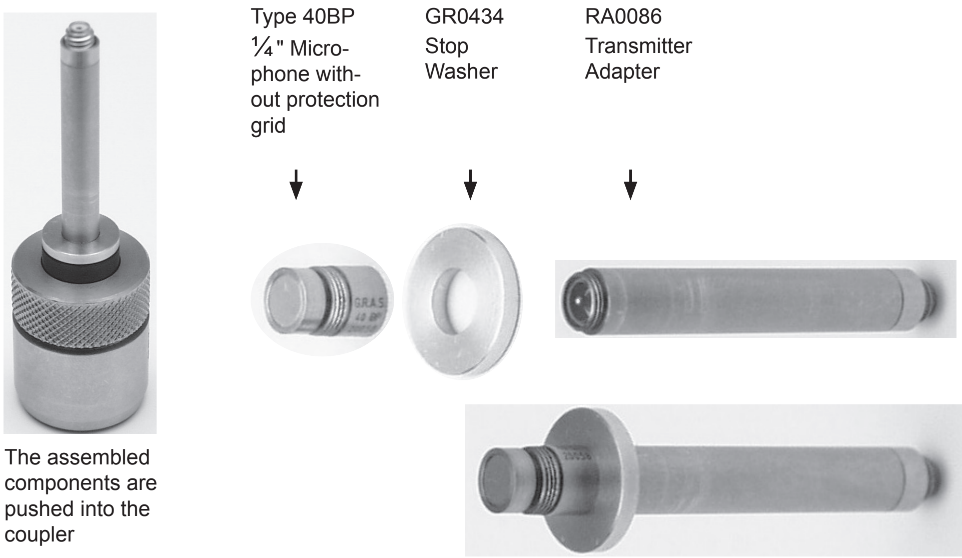



*Fig. 3.7 Assembled and exploded views showing how the GR0434 is used when calibrating the coupler. Types 40BP and RA0086 are available from G.R.A.S.*

## 3.5 Calibration of the IEC 60711 Coupler RA0045

An individual calibration chart is provided with each G.R.A.S. IEC 60711 Coupler RA0045. This section briefly describes how each coupler is calibrated. Figs. 3.6 shows how to configure the coupler for calibration using the accessories provided, and Fig. 3.7 shows how these should be used with:

- ¼" Microphone Type 40BP
- Transmitter Adapter RA0086

The ¼" microphone is used as a high-impedance sound source. The complete set-up is shown in Fig. 3.8. The computer in Fig. 3.8 is capable of concurrently generating and measuring audio

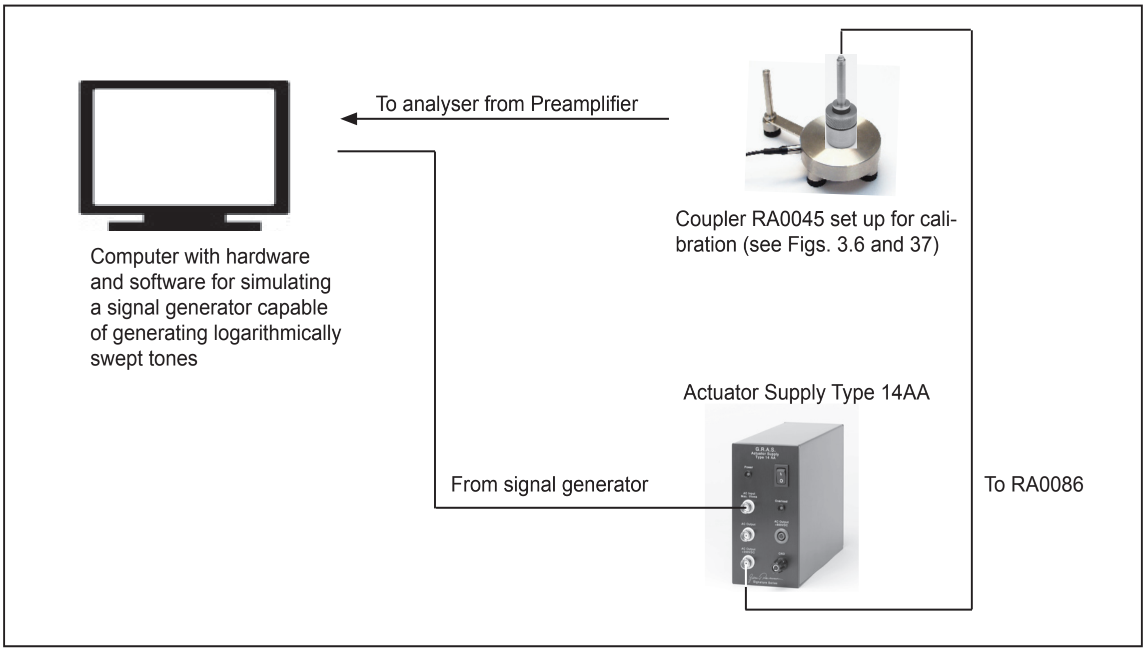



*Fig. 3.8 Block diagram of a complete set-up for calibration*

frequency signals. The Actuator Supply Type 14AA 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. 3.8. 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. 3.9 (see also Fig. 10.3).

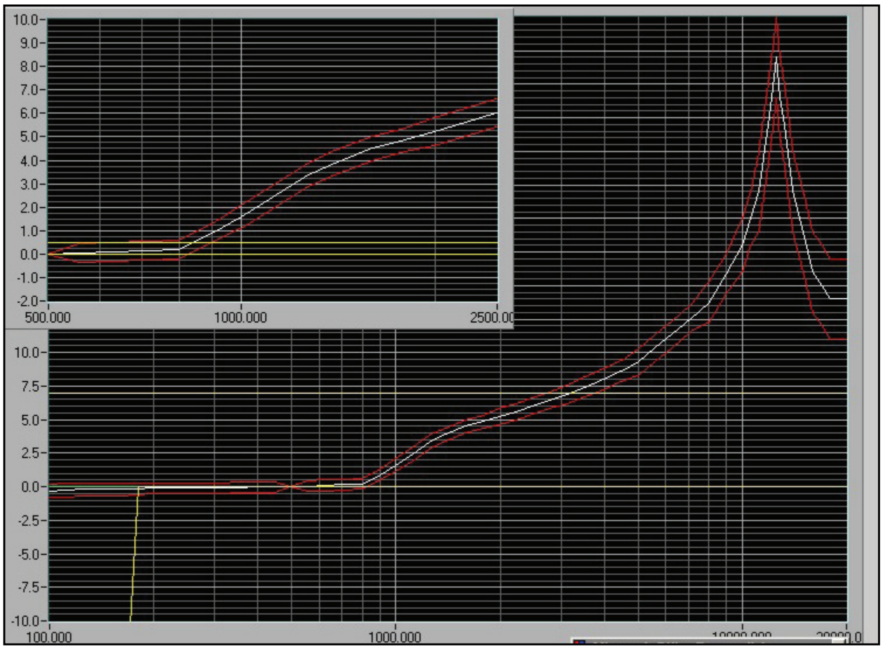



*Fig. 3.9 Example of a calibration result using a swept tone*

# Chapter 4

## Artificial Ear Type 43AD

*Artificial Ear Type 43AD*

## 4.1 Introduction

The Artificial Ear Type 43AD 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, 1998-07.
- ITU-T Recommendations P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

The Artificial Ear Type 43AD is acoustically similar to the one described in Chapter 1 (Type 43AA) and, as such, can be used similarly. The chief difference is that it is quicker to use when testing is part of the production process (e.g. mobile 'phones). It can also be calibrated rapidly.

## 4.2 Components

The Artificial Ear Type 43AD comprises the following main components:

- Type RA0039 IEC 318 Ear Simulator (see Chapter 9)
- Type 40AG ½" Pressure Microphone, Wide Frequency
- Type 26AK ½" Preamplifier
- AA0008 3 m Extension Cable
- GR0332 Snap Coupling (female)
- GR0336 Snap Coupling (male)

When assembled as shown in Fig. 4.1, it is ready for testing supra-aural [1] earphones such as telephone handsets and headphones. Fig. 4.7 shows an exploded view of its user-serviceable components.

The following mounting plate is also provided for testing circumaural [2] earphones:

- GR0339 for testing earphones fitted with fluid cushions

This has to be mounted accordingly in place of the removable ring (GR0338) surrounding the entrance to the Ear Simulator (see Fig. 4.2).


*Fig. 4.1 Assembled Artificial Ear Type 43AD*

[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

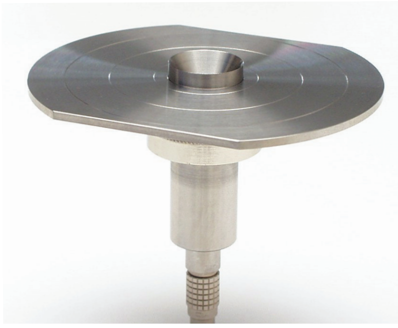


*Fig. 4.2 Type 43AD shown with mounting plate GR0339 for testing earphones fitted with fluid cushions (circum-aural)*

The concentric circles on the GR0039 (Fig. 4.2) are provided to help place the earphone correctly in relation to the entrance to the Ear Simulator. Fig. 1.5 shows examples of these mounting plates in use.

### 4.2.1 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 an Artificial Ear Type 43AD. The solution will be to:

| | | |
|---|---|---|
| *a)* | Substitute the GR0036 by a GR0597 | (GR0597 is a plastic version of the male snap coupling) |
| *b)* | Substitute the Type 40AG by a Type 40A0-P | (Type 40A0-P is a ½" prepolarised pressure microphone, wide frequency, with a plastic protection grid) |

The GR0597 and the Type 40AO-P will not allow any stray currents to flow through the artificial ear.

**Note:** the Type 40AO-P does not require external polarisation; if used with a G.R.A.S. Power Module, select 0 V polarisation.

## 4.3 Additional Equipment

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

1) Power supply for the ½" Preamplifier Type 26AK,
   e.g. the G.R.A.S. Power Module Type 12AK (see Fig. 1.3a)
2) Calibration source for the microphone,
   e.g. the G.R.A.S. Pistonphone Type 42AA which produces 114 dB *re.* 20 *μPa* (10 Pa) at 250 Hz (see Fig. 1.3b)
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 analyser capable of one or both of the following:

[3] For example from 50 Hz to 10 kHz

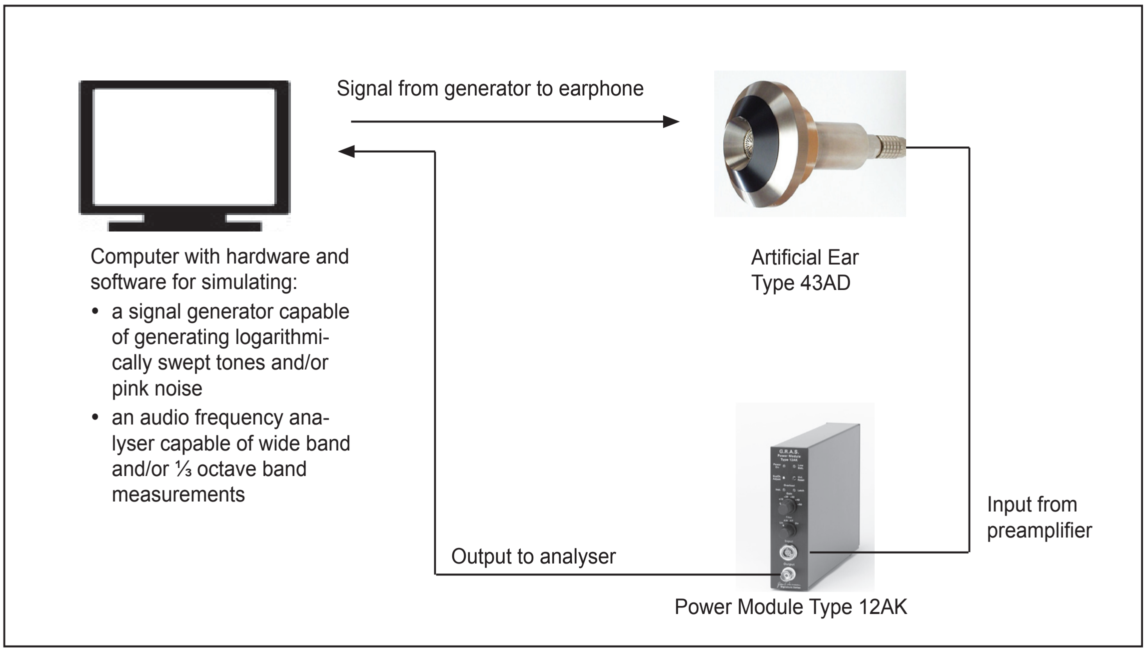



*Fig. 4.3  Block diagram of a complete set-up for making tests*


*Fig. 4.4  Place the Artificial Ear centrally over the earpiece of the mobile 'phone*

- wide band measurement
- ⅓ octave-band measurement

The audio analyser receives, via the Type 12AK (see Fig. 1.3a), the signal picked up by the Artificial Ear, 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. 4.3 shows a block diagram of a possible set-up for making tests.


*Fig. 4.5 Showing the two halves of the snap coupling to give quick access to the microphone*

*Fig. 4.6 Gently push the microphone into the Pistonphone's coupler until it reaches the stop*

## 4.4 Test Procedure

### 4.4.1 General

Using the mobile 'phone as a typical example, the basic stages in the test procedure are:

1) Setting up the Artificial Ear, e.g. as shown in Fig. 4.3
2) Calibration using the G.R.A.S. Pistonphone Type 42AA
3) Placing the Artificial Ear over the earpiece of the mobile 'phone (see example in Fig. 4.4)
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

   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.

### 4.4.2 Setting up the Artificial Ear

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 Artificial Ear.

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

1) Power Module Type 12AK

- 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) Mobile ‘phone
   - Connect the earphone of the mobile ‘phone 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.

### 4.4.3 Calibration

For this, access to the microphone is necessary.

1) Twist open the two halves of the snap coupling as shown in Fig. 4.4.
2) Gently push the microphone into the Pistonphone’s coupler until it reaches the stop.
3) Switch the Pistonphone 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 dB). See Pistonphone manual for making barometric corrections.
6) Switch the Pistonphone off and remove it from the microphone.
7) Re-assemble the Artificial Ear.

### 4.4.4 Placing the Artificial Ear to the Earpiece/Earphone

In cases of production testing, this is normally taken care of automatically. Whether automatic or manual, the Artificial Ear 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.

Note:

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

### 4.4.5 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

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 $\beta\, T$ 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[4] on the generator.

The analyser will follow the response of the Artificial Ear to the earphone throughout the sweep and record and display the results accordingly (see example in Fig. 1.7).

**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 [4] 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 (see example in Fig.1.8).

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

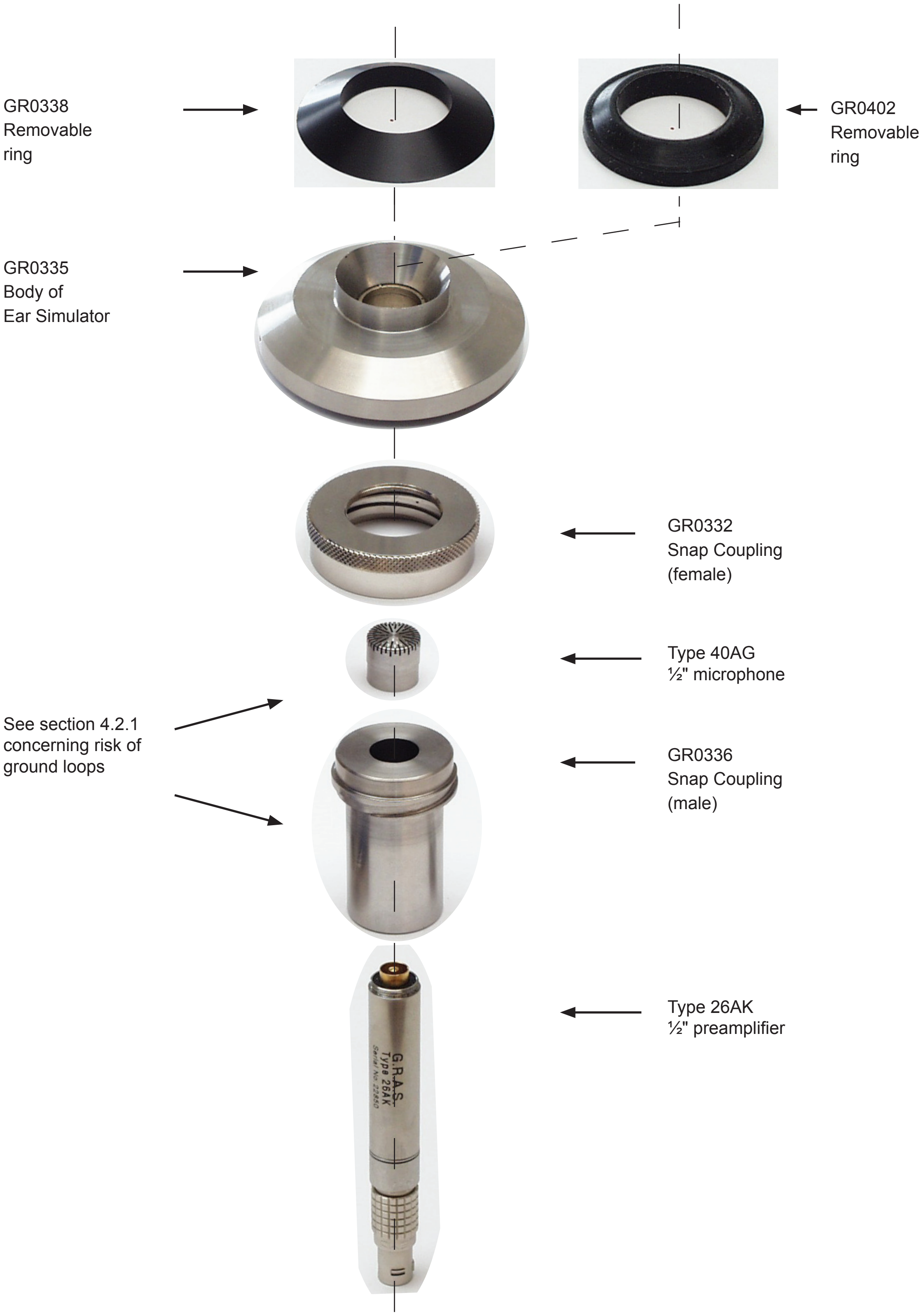
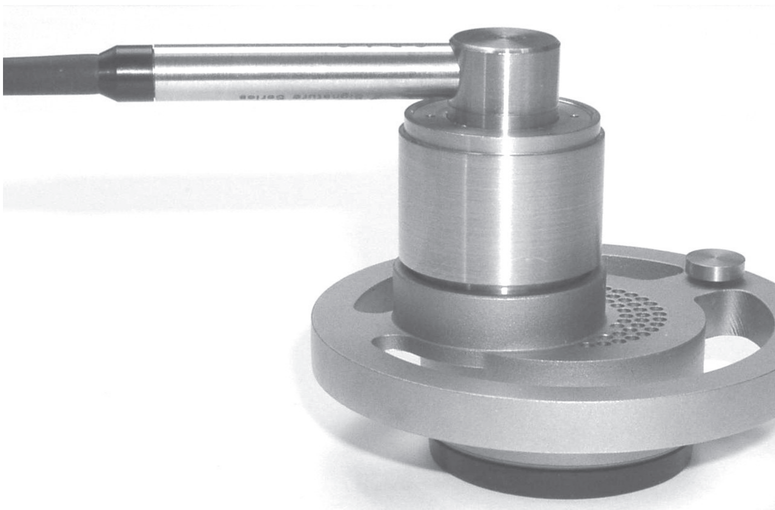



*Fig. 4.7 Exploded view of all the user-serviceable components of the Artificial Ear Type 43AD (mounting plates and extension cable omitted for clarity)*

# Chapter 5
## IEC 60711 Ear Simulator Type 43AE



*IEC 60711 Ear Simulator Type 43AE*

## 5.1 Introduction

The IEC 60711 Ear Simulator Type 43AE 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”.

## 5.2 Components

The IEC 60711 Ear Simulator Type 43AE comprises the following main components:

- Type RA0045 IEC 60711 coupler with microphone included (see Chapter 10)
- Type 26AC ¼" Preamplifier (used with Adapter RA0001 instead of GR0010)
- Type RA0001 ¼" - ½" Adapter
- Type RA0056 Low-leak Pinna Simulator
- Type RA0057 High-leak Pinna Simulator

When assembled as shown in Fig. 5.1, it is ready for testing supra-aural earphones, telephone handsets and loudspeakers. Fig. 5.5 shows an exploded view of its user-serviceable components.

## 5.3 Additional Equipment

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

1) Power supply for the ¼" Preamplifier Type 26AC, e.g. the G.R.A.S. Power Module Type 12AK (see Fig. 1.3a)
2) Calibration-check source for the Ear Simulator, e.g. the G.R.A.S. Pistonphone Type 42AA which produces 114 dB *re.* 20 *µPa* (10 Pa) at 250 Hz (see Fig. 1.3b)

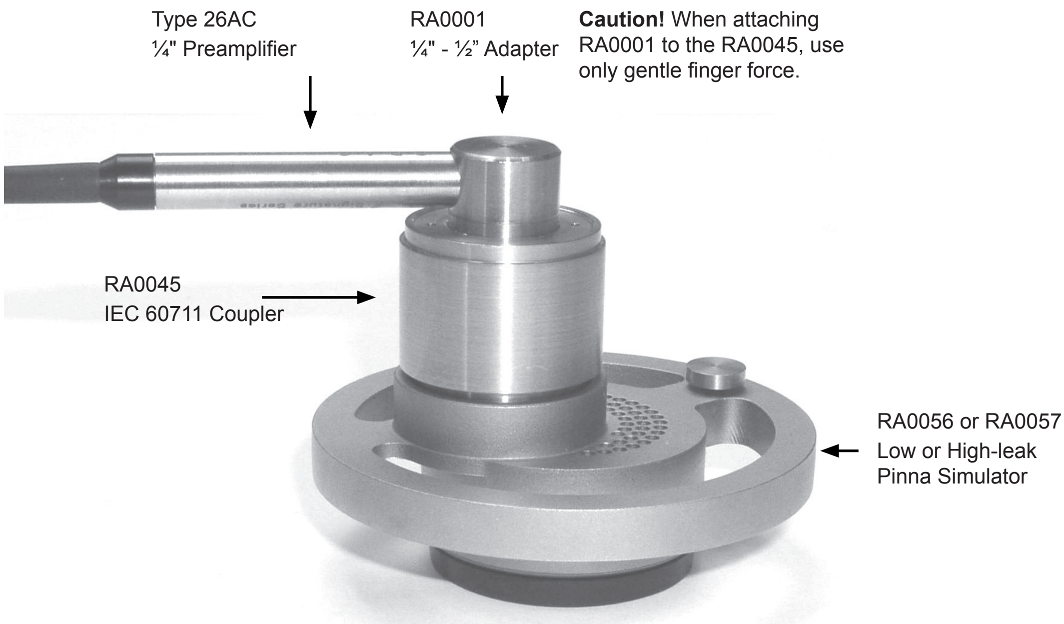



*Fig. 5.1 Assembled IEC 60711 Ear Simulator Type 43AE*

[1] An earphone applied externally to the ear

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 Type 12AK (see Fig. 1.3a), 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. 5.2 shows a block diagram of a possible set-up for making tests.

## 5.4 Test Procedure

### 5.4.1 General

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. 5.2
2) Calibration check using the G.R.A.S. Pistonphone Type 42AA with a special adapter for the Type 43AE
3) Placing the Ear Simulator over the earpiece of the telephone (see example in Fig. 5.3)
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.

### 5.4.2 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) Power Module Type 12AK
    - 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.

[2] For example from 50 Hz to 10 kHz

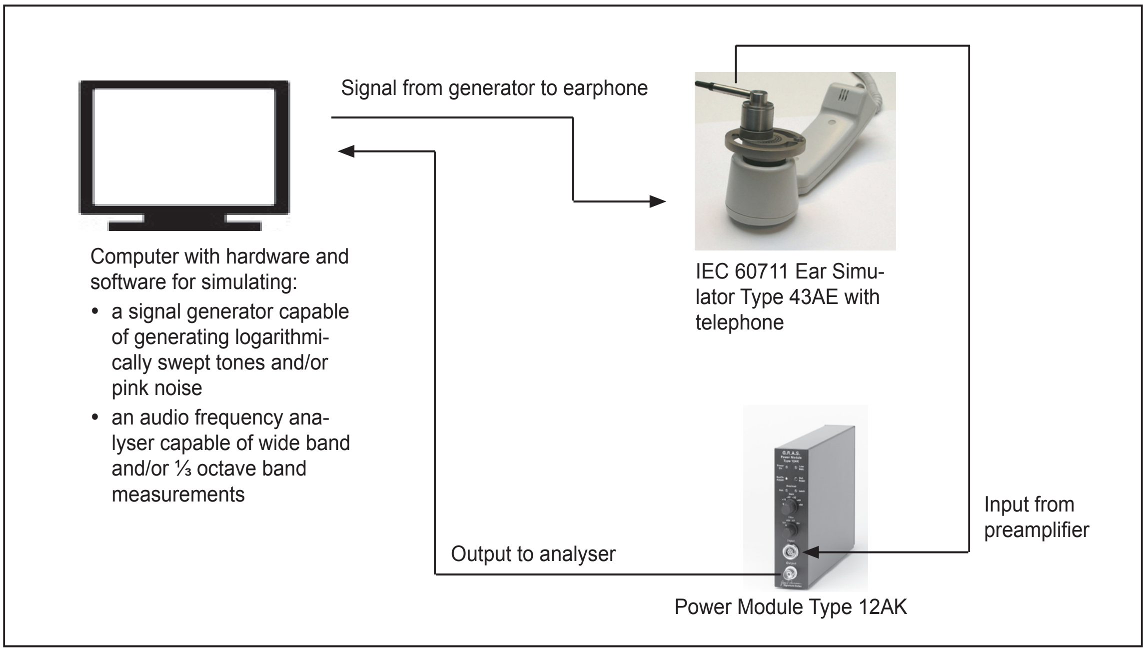



*Fig. 5.2 Block diagram of a complete set-up for making tests*

*Fig. 5.3 Place the Ear Simulator centrally over the earpiece of the telephone*

### 5.4.3 Calibration Check

**Important!** do not extract the microphone housed in the RA0045 Coupler since this could invalidate the factory calibration of the Coupler. 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 Type 43AE to establish a baseline for subsequent checks

*b)* thereafter at appropiate 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 Type 43AE, both available from G.R.A.S.

1) The set up for the calibration check is shown Fig. 5.4.
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 Type 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. 5.4 Calibration-check set-up. Make sure that the rubber seal of the Pinna Simulator seats firmly inside the Pistonphone Adapter*

### 5.4.4 Placing the Ear Simulator to 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. 5.3.

### 5.4.5 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

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 $\beta T$ 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

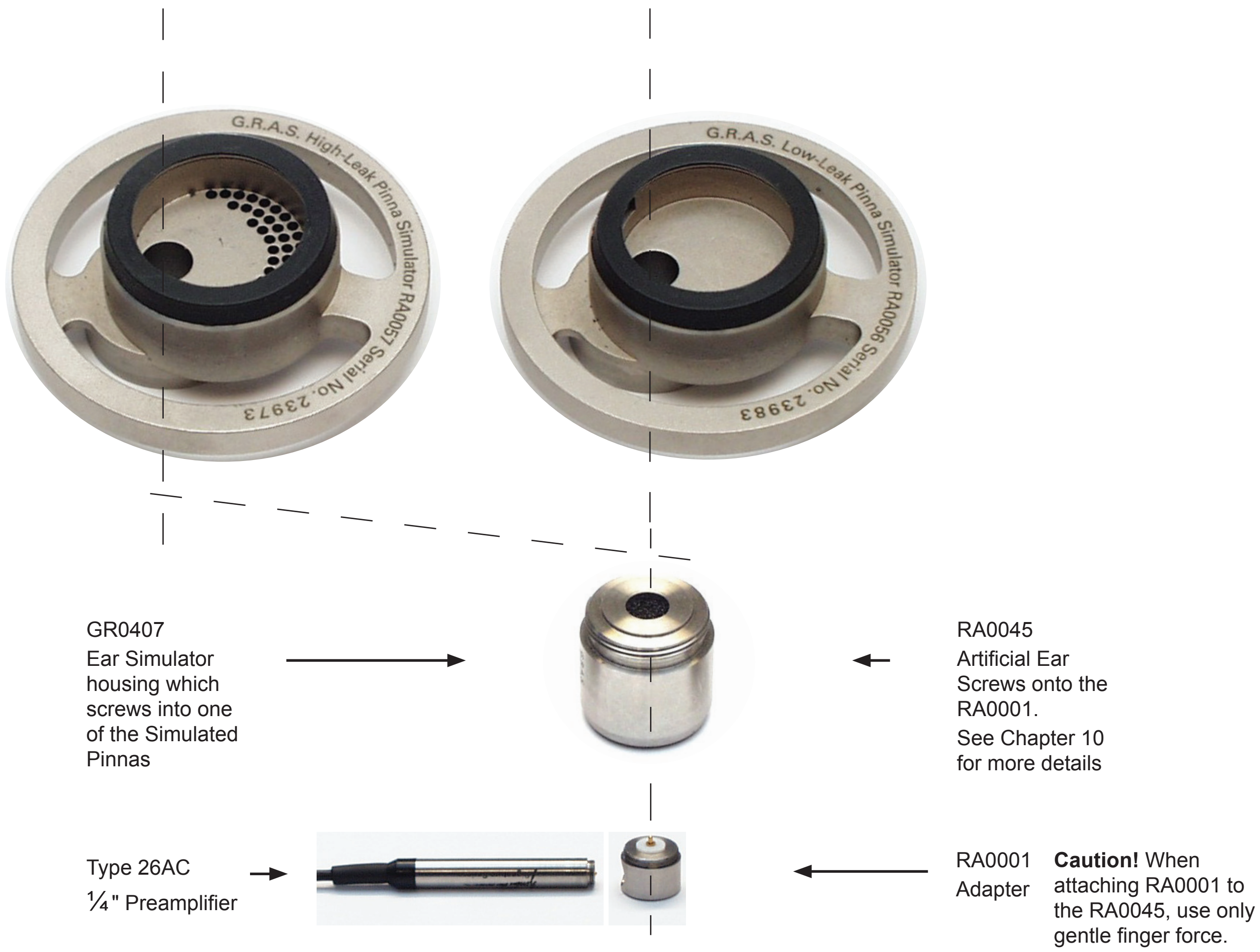



*Fig. 5.5   Exploded view of all the user-serviceable components of the Ear Simulator Type 43AE*

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 (see example in Fig. 1.7).

**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 (see example in Fig.1.8).

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

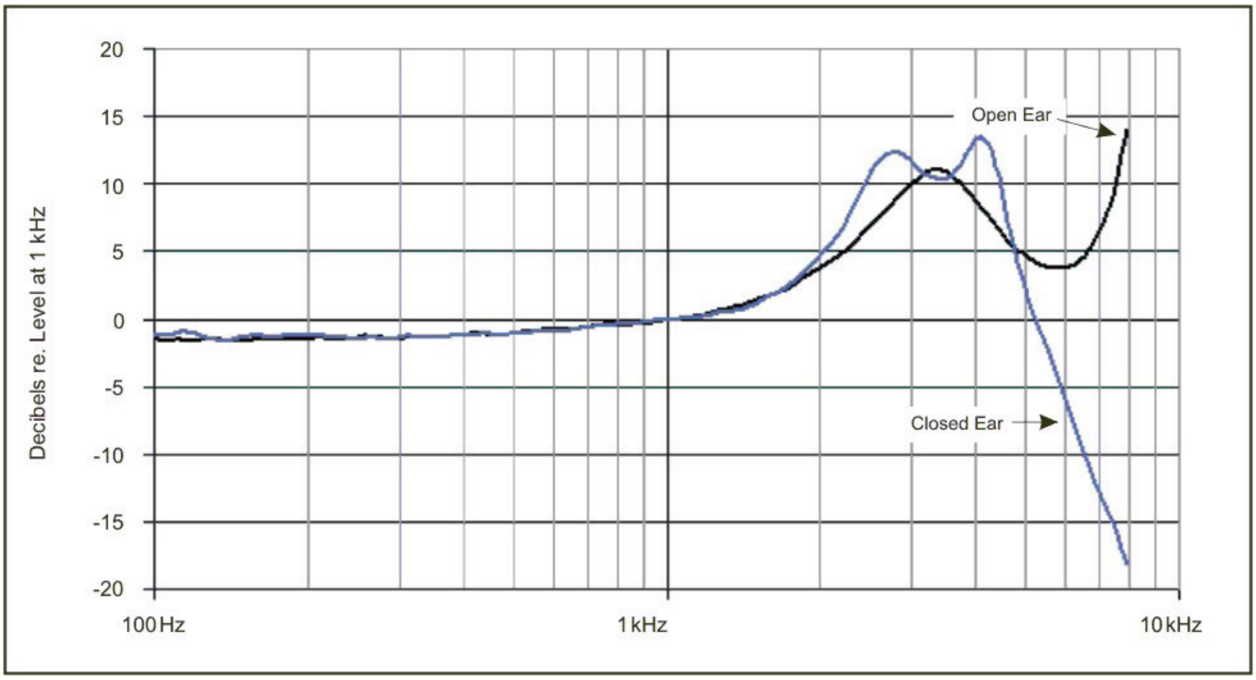



*Fig. 5.6 Frequency response curves of the Type 43AE fitted with a low-leak pinna simulator re. 1 kHz.*

## 5.5 Frequency Response of the Type 43AE

For measurement purposes, the IEC 60711 Ear Simulator Type 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. 11.1). 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 Figs. 13.4 and 13.5).

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 $\Delta_f$ 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

# Chapter 6
## Artificial Ear Type 43AF


*Artificial Ear Type 43AF*

## 6.1 Introduction

The Artificial Ear Type 43AF is a complete test jig for acoustically testing telephone handsets and earphones and complies with the following international requirements:

- ANSI S 3.7 – 1995 – American National Standard for Testing Earphones.

## 6.2 Components

The Artificial Ear Type 43AF comprises the following main components:

- Type RA0075 NBS 9A Coupler (see Chapter 12)
- Type RA0076 Thread Adapter
- Type 40EN 1" Microphone Type 40EN in Type L [1] (W.E. 640-AA) configuration
- Type 26AC ¼" Preamplifier (used with Adapter RA0001 instead of GR0010)
- Type RA0052 Test Jig

When assembled as shown in Fig. 6.1, it is ready for testing earphones such as telephone handsets and headphones (see example in Fig. 6.2). An exploded view of its user-serviceable components is shown in Fig. 6.5.

## 6.3 Additional Equipment

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

1) Power supply for the ¼" Preamplifier Type 26AC,
   e.g. the G.R.A.S. Power Module Type 12AK (see Fig. 1.3a)
2) Calibration source for the microphone,
   e.g. the G.R.A.S. Pistonphone Type 42AA which produces 114 dB *re.* 20 *μPa* (10 Pa) at 250 Hz (see Fig. 1.3b). Note: the pistonphone must be fitted with an RA0023 coupler for calibrating 1" microphones.
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.

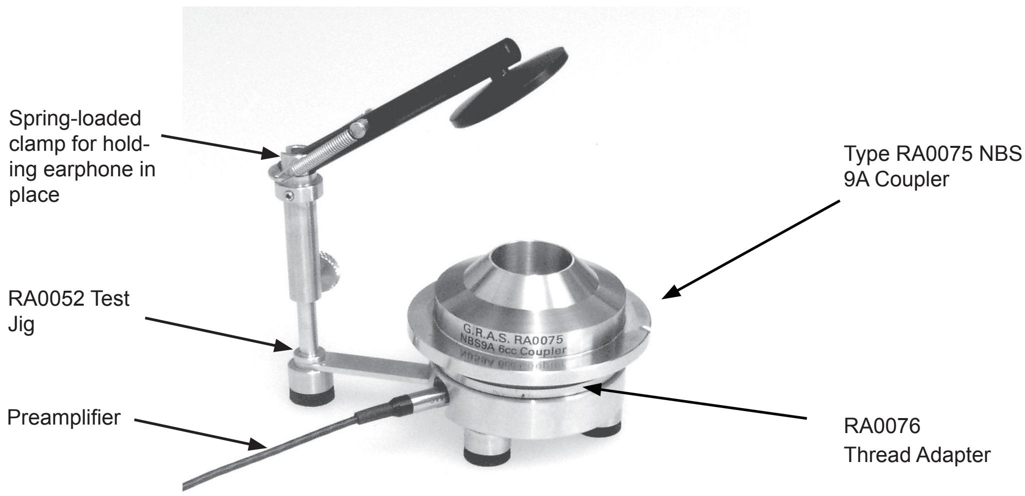



*Fig. 6.1 Assembled Artificial Ear Type 43AF*

[1] ASA Z 24.8-1949
[2] For example from 50 Hz to 10 kHz


*Fig. 6.2 Example of a supra-aural earphone mounted on the test jig*

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 Type 12AK (see Fig. 1.3a), the signal picked up by the Artificial Ear, 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. 6.3 shows a block diagram of a possible set-up for making tests.

## 6.4 Test Procedure

### 6.4.1 General

The basic stages in the test procedure are:

1) Setting up the test jig, e.g. as shown in Fig. 6.3
2) Calibration using the G.R.A.S. Pistonphone Type 42AA
3) Mounting the earphone on the test jig (see example shown in Fig. 6.2)
4) Applying a signal to the earphone and analysing the output from the Artificial Ear.
   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.

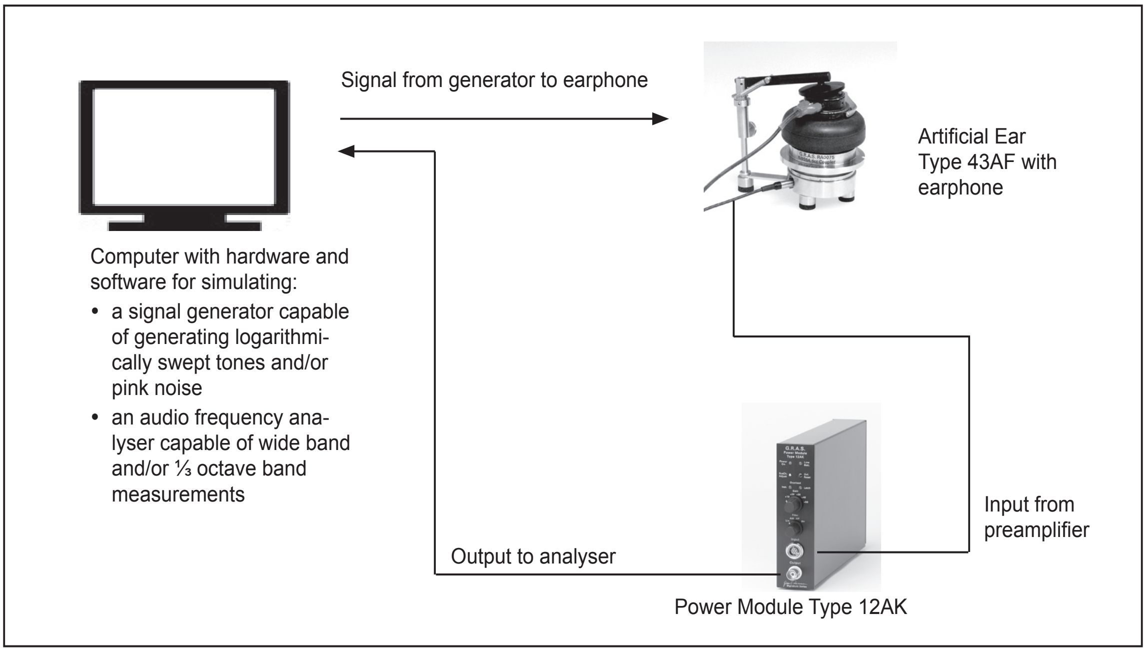



*Fig. 6.3 Block diagram of a complete set-up for making tests*

### 6.4.2 Setting up the Test Jig

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 Artificial Ear.

With the Artificial Ear assembled as shown in Fig. 6.1 and everything switched on, proceed as follows:

1) Power Module Type 12AK
   - 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) 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.

### 6.4.3 Calibration

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

1) Snap the spring-loaded clamp (see Fig. 6.1) to its upright position, or remove it.
2) Unscrew the RA0075 NBS 9A Coupler (but not the RA0076 Thread Adapter) and carefully remove it from the test jig. The microphone is now accessible.
3) Place the coupler of the Pistonphone over the microphone, push it gently down to the microphone stop and switch on (see Fig. 6.4).
4) Set the analyser to either wide band or to the ⅓ octave band whose centre frequency is 250 Hz.

*Fig. 6.4 Calibration using the Pistonphone*
*a) Place coupler over microphone, push gently down to microphone stop*
*b) Switch on*

5) When conditions are stable, adjust the analyser so that it correctly gauges the Pistonphone signal (nominally 114 dB *re.* 20 *μPa*). See Pistonphone manual for making barometric corrections.
6) Switch the Pistonphone off and remove it from the microphone.
7) Screw the RA0075 NBS 9A Coupler carefully back in place; do not use excessive pressure.

### 6.4.4 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 Artificial Ear so that it transmits directly into the NBS 9A Coupler.
2) If necessary, use the spring-loaded clamp to hold the earphone in place (see Fig. 6.2).

### 6.4.5 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

and shows 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 *β T* 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 Artificial Ear to the earphone throughout the

[3] For example from 50 Hz to 10 kHz

sweep and record and display the results accordingly (see example in Fig. 1.7).

**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 [4] and wait until conditions are stable.

c) start the analyser.

The analyser will record the response of the Artificial Ear to the earphone for each ⅓ octave band and record and display the results accordingly (see example in Fig.1.8).

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

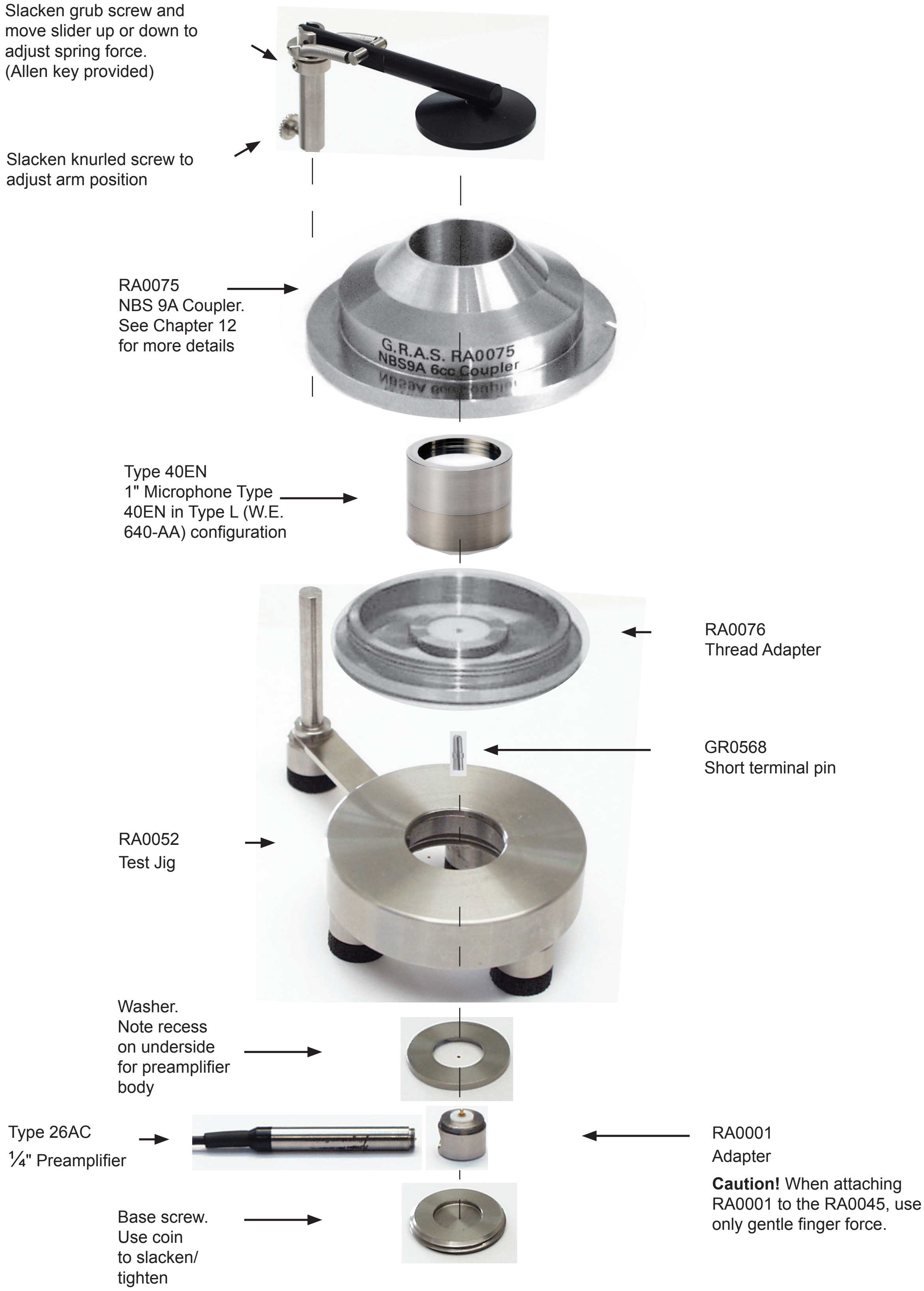



*Fig. 6.5  Exploded view of all the user-serviceable components of the Artificial Ear Type 43AF*

# Chapter 7

## IEC 126 Coupler Type RA0038


IEC 126 Coupler Type RA0038

## 7.1 Introduction

The IEC 126 Coupler Type RA0038 is a 2 $cm^3$ coupler which uses a ½" microphone, e.g. the G.R.A.S. Type 40AG. There is no need to remove the microphone’s protection grid and expose the microphone to accidental damage.

The coupler complies with the following international and national requirements for acoustically testing insert type hearing aids:

- IEC 60126 Ed. 2.OB IEC reference coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts (formerly IEC 126 )
- ANSI S3.7-1973 American National Standard for Coupler Calibration of Earphones

It is also part of the Artificial Ear Type 43AB described in Chapter 2.

## 7.2 Components

The Coupler Type RA0038 comprises the following user-serviceable components:

- GR0313K Coupling Housing
- GR0315 Gasket
- GR0316 Union nut
- GR0317 Ear-mould Adapter
- GR0318 Tube Adapter
- GR0319 Tube Adapter
- GR0320 Union nut
- GR0321 In-ear Adapter

The Type RA0038 is delivered assembled as shown in Fig. 7.1. An exploded view of its user-serviceable components is shown in Fig. 7.3.


*Fig. 7.1 IEC 126 Coupler Type RA0038 assembled as delivered*

You can assemble the coupler in various other ways depending on what type of hearing aid is to be tested. See the diagrams shown in Fig. 7.2.

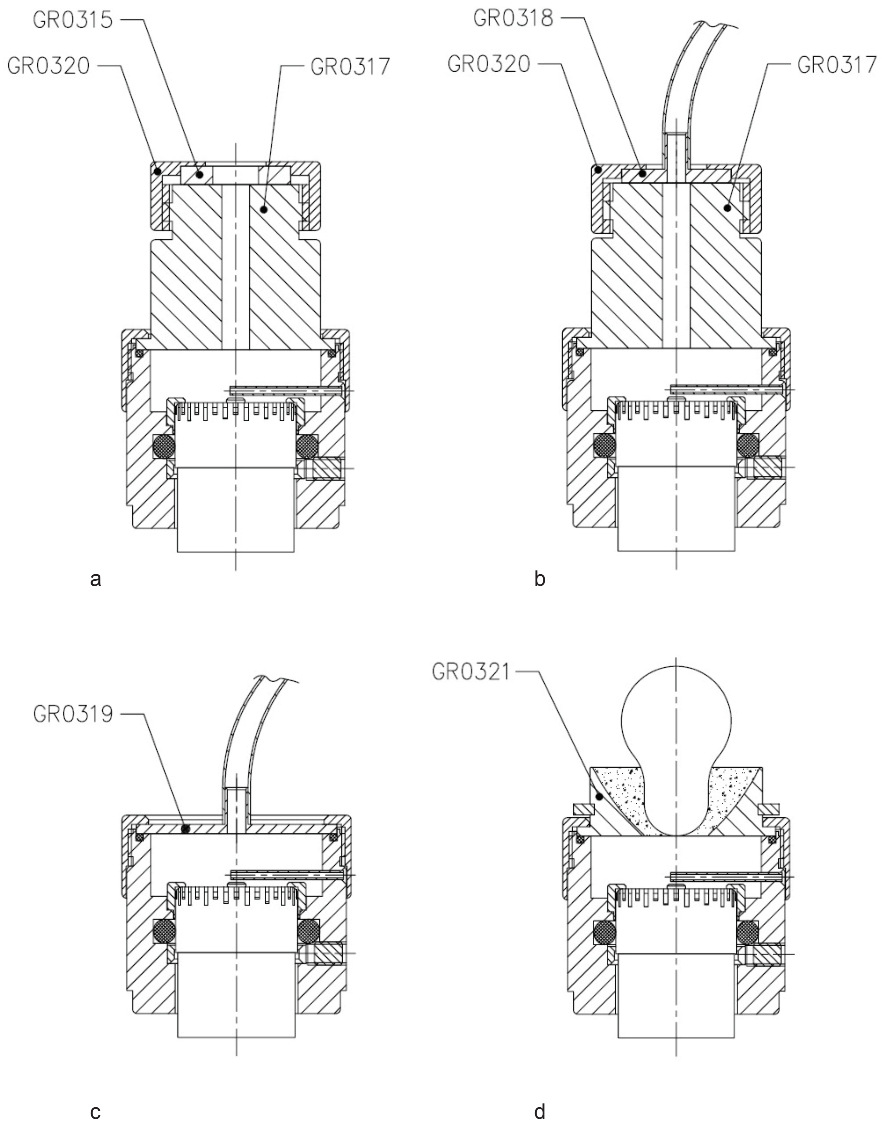



*Fig. 7.2 Various ways of assembling the Type RA0038*
*a) Coupler with ear-mould adapter*
*b) Coupler with ear-mould adapter and tube stud*
*c) Coupler with tube stud*
*d) Coupler with in-ear adapter*

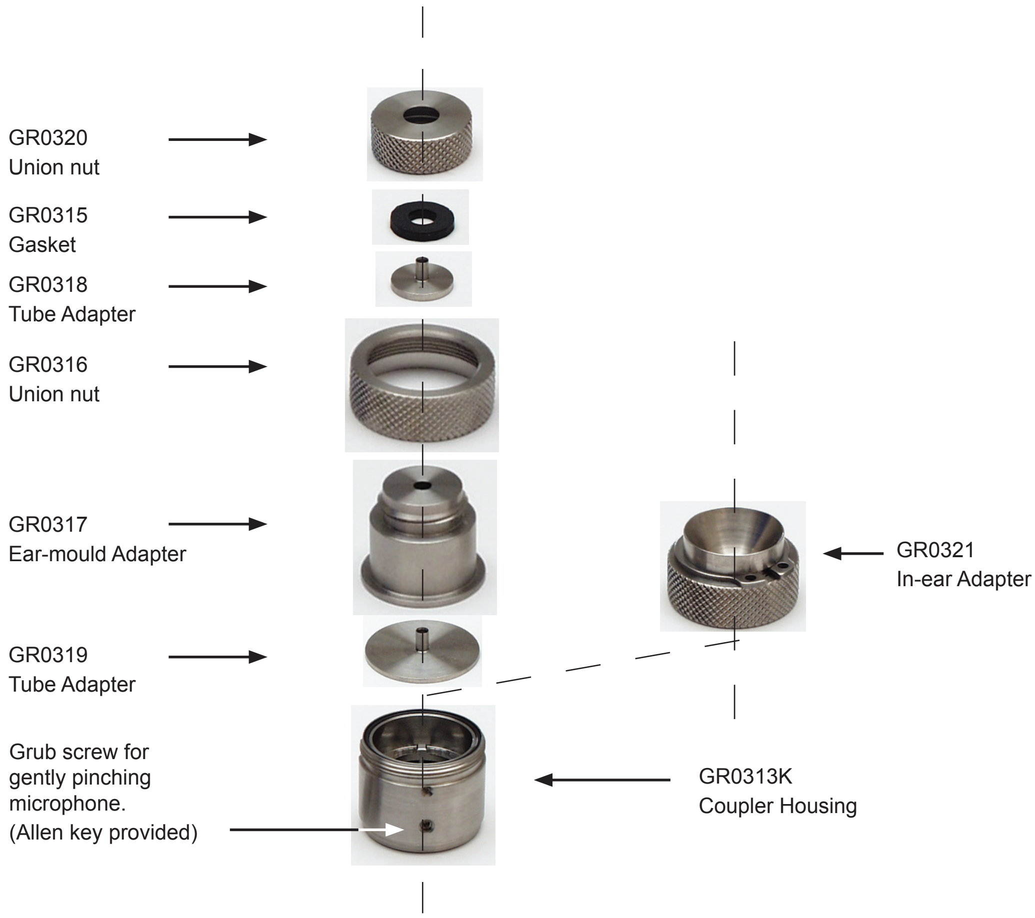



*Fig. 7.3 Exploded view of all the user-serviceable components of the Coupler Type RA0038*

# Chapter 8
# 2cc Coupler for 1" Microphone, RA0113


*2cc Coupler for 1" Microphone, RA0113*

## 8.1 Introduction

The RA0113 is a 2cm$^3$ IEC 126 coupler which uses a 1" microphone, e.g. the G.R.A.S. Type 40EN. The microphone (with its protection grid removed[1]) screws into the base of the RA0113. In all other respects, this Coupler is equivalent to the RA0038 described in Chapter 7.

The RA0113 complies with the following international and national requirements for acoustically testing insert type hearing aids:

- IEC 60126 Ed. 2.OB IEC reference coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts (formerly IEC 126 )
- ANSI S3.7-1973 American National Standard for Coupler Calibration of Earphones

## 8.2 Components

The Coupler Type RA0113 comprises the following user-serviceable components:

- GR0722K Coupling Housing
- GR0723 Tube Adapter
- GR0316 Union nut

The Type RA0113 is delivered assembled as shown in Fig. 8.1.

### 8.2.1 Available Accessories

In addition, the following accessories are available:

- RA0114 Adapter for ¼" button type hearing aids
- RA0115 Moulding adapter for ITE (In The Ear) hearing aids
- RA0116 Adapter for using a ½" microphone, e.g. G.R.A.S. Type 40AG

Fig. 8.2. shows the various ways of assembling the coupler depending on what type of hearing aid is to be tested, using both included and available accessories.

Note the O-ring (OR5003) in the Coupler housing to ensure snap fitting for each of the hear-ing-aid Adapters. This will save time in situations where the Union nut GR0136 is unecessary between numerous Adapter changes.


*Fig. 8.1 2cc Coupler Type RA0113 assembled as delivered*

[1] A microphone without its protection grid should be handled with the utmost care!

## 8.3 Additional Equipment

The following equipment is required for connection to external systems:

### 8.3.1 When using a 1" Microphone

- Type 40EN 1" Pressure Microphone (protection grid removed[2])
- RA0017 ½" to 1" Adapter (alternatively, RA0073)
- Type 26AK ½" Preamplifier

### 8.3.2 When using a ½" Microphone

- Type 40AG ½" Pressure Microphone (protection grid removed[2])
- RA0116 1" to ½" Adapter
- Type 26AK ½" Preamplifier

Fig. 8.3 shows an exploded view of the user-serviceable components of the RA0113 as well as available accessories and additional equipment.

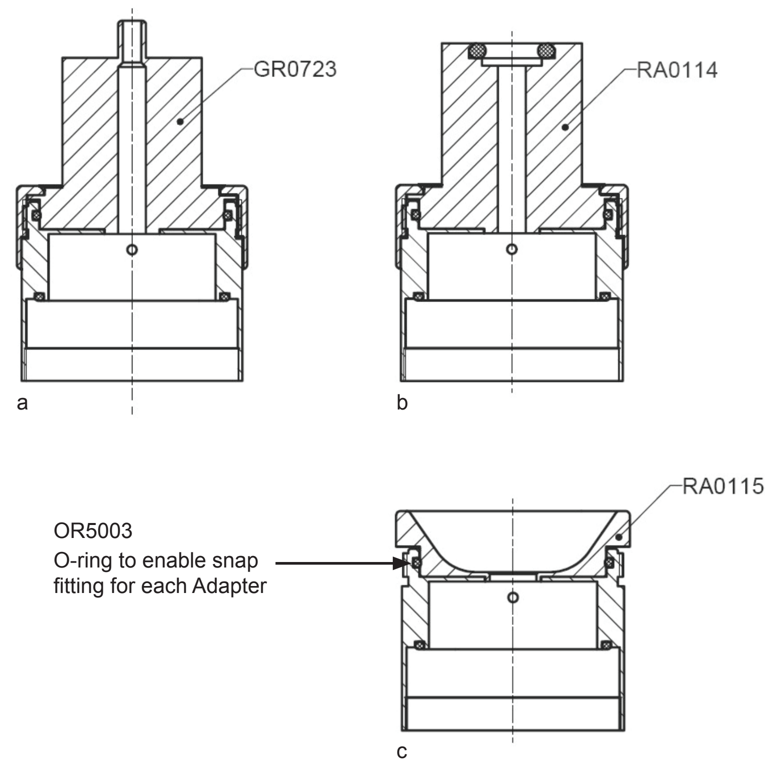



*Fig. 8.2 Various ways of assembling the Type RA0113*
*a) Coupler with Tube Adapter (GR0723, included)*
*b) Coupler with ¼" Button Adapter (RA0114, available)*
*c) Coupler with in-ear adapter (RA0115, available)*

[2] A microphone without its protection grid should be handled with the utmost care!

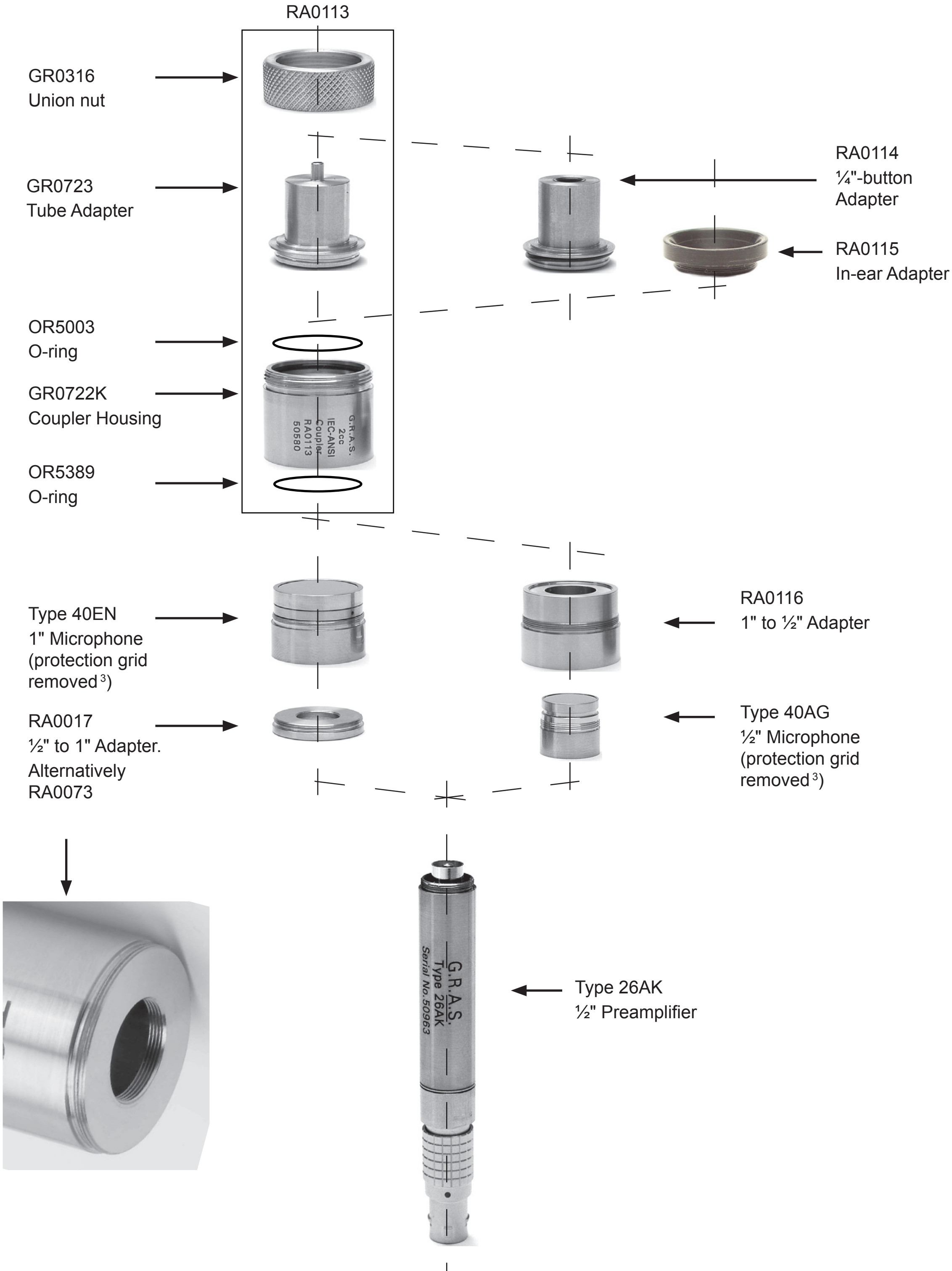



*Fig. 8.3 Exploded view of all the user-serviceable components (boxed) of the Coupler Type RA0113 and available accessories*

[3] A microphone without its protection grid should be handled with the utmost care!

# Chapter 9
## IEC 318 Ear Simulator RA0039


*IEC 318 Ear Simulator Type RA0039*

## 9.1 Introduction

The IEC 318 Ear Simulator Type RA0039 which uses a ½" microphone, e.g. the G.R.A.S. Type 40AG. There is no need to remove the microphone's protection grid and expose the microphone to accidental damage.

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, 1998-07.
- ITU-T Recommendations P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

It is also part of the Artificial Ears Types 43AA and 43AD described in Chapters 1 and 4.

## 9.2 Components

The Artificial Ear Type RA0039 comprises the following user-serviceable components:

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

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

The Type RA0039 is delivered as shown in Fig. 9.1. An exploded view of its user-serviceable components is shown in Fig. 9.6.

It uses a ½" pressure microphone such as the G.R.A.S. Type 40AG with either a ½" Preamplifier Type 26AK or ¼" Preamplifier Type 26AC fitted with Adapter RA0001. If ordered with a microphone, the RA0039 will be calibrated with the specific microphone and be delivered with the resulting calibration chart.

## 9.3 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. 9.4), capacitors would

*Fig. 9.1 IEC 318 Ear Simulator Type RA0039 as delivered*


Fig. 9.2      Type RA0039 acoustic input impedance

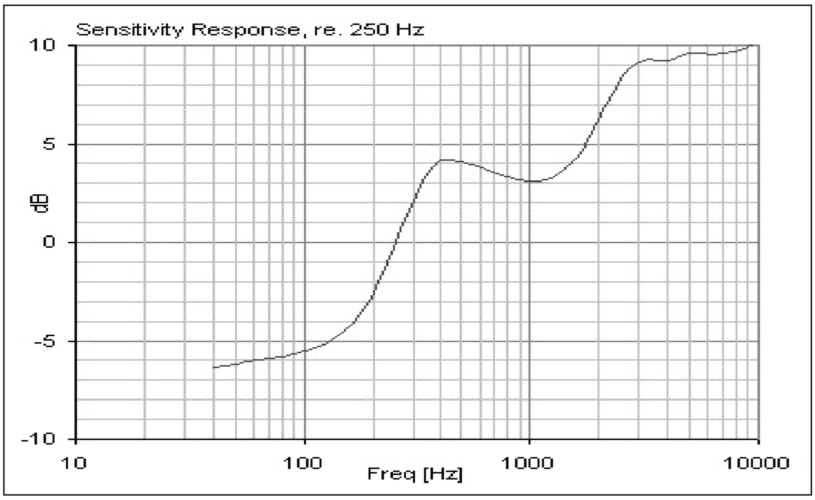



Fig. 9.3      Type RA0039 closed-coupler frequency response

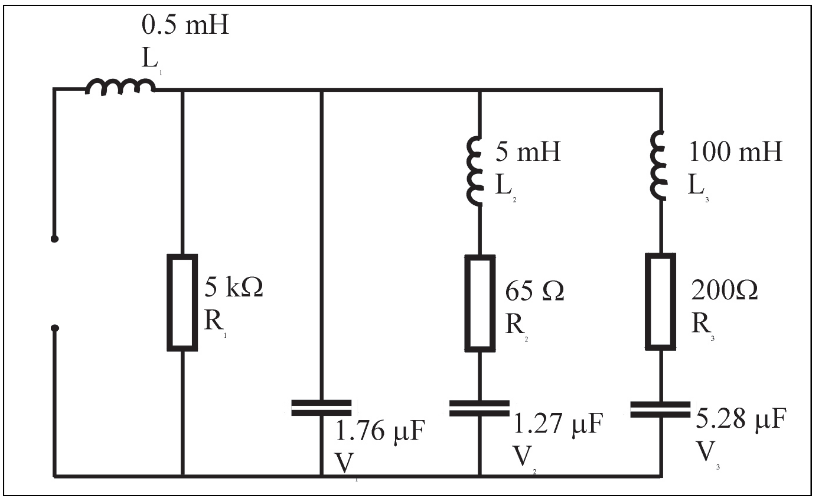



Fig. 9.4      Type RA0039 lumped parameter model

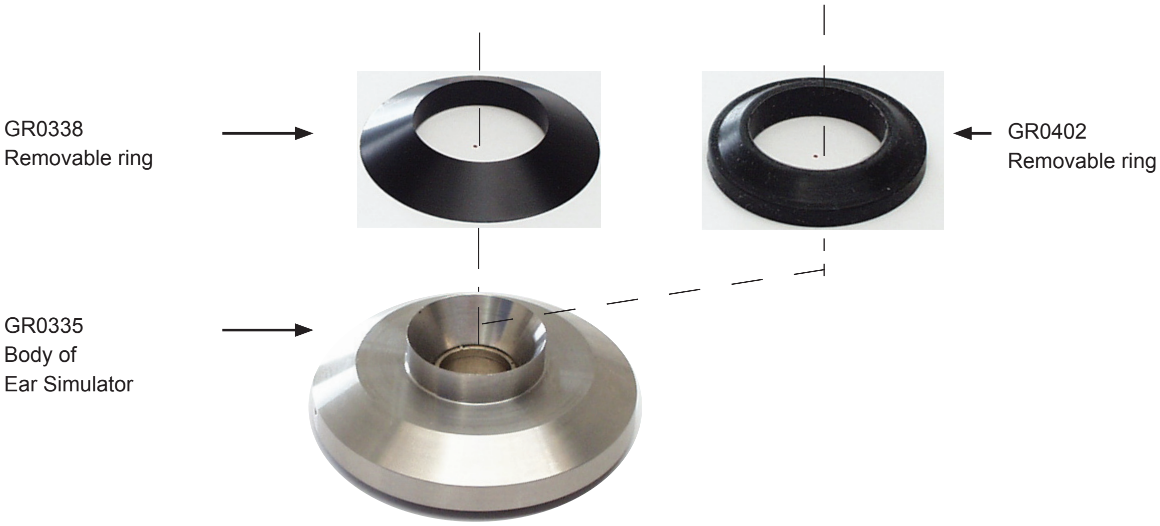



*Fig. 9.5 Exploded view of all the user-serviceable components of the Ear Simulator Type RA0039*

represent the volumes, and inductance and resistance would represent respectively air mass and air flow within the capillary tubes. The input impedance (see Fig. 9.2) 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.

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.

# Chapter 10
## IEC 60711 Ear Simulator Type RA0045


*IEC 60711 Ear Simulator Type RA0045*

## 10.1 Introduction

The IEC 60711 Ear Simulator Type RA0045 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 G.R.A.S. ½" pressure microphone Type 40AG and an individual calibration chart for the coupler-microphone combination.

**Important!** do not extract the microphone housed in the RA0045 Coupler since this could invalidate the factory calibration of the Coupler. See also section 5.4.3.

The ear simulator complies with the following international requirements:

- IEC 60711 Ed. 1.OB Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts
- ITU-T Recommendations P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

It is also part of the Artificial Ear Type 43AC described in Chapter 3.

## 10.2 Components

The Ear Simulator Type RA0045 comprises the following user-serviceable components:

- GR0407 Ear Simulator Housing (with Type 40AG Pressure Microphone)
- GR0408 External-ear Simulator
- GR0409 Union Nut

The Type RA0045 is delivered as shown in Fig. 10.1. An exploded view of its user-serviceable components is shown in Fig. 10.3.

### 10.2.1 Preamplifiers

It can be used with a standard preamplifier, e.g. a ½" Preamplifier Type 26AK or a ¼" Preamplifier Type 26AC fitted with an adapter. For a ¼" preamplifier, use either the straight Adapter RA0003 or the right-angled Adapter RA0001 (as in the case of the Artificial Ear Type 43AC).


*Fig. 10.1 IEC 60711 Ear Simulator Type RA0045 as delivered*

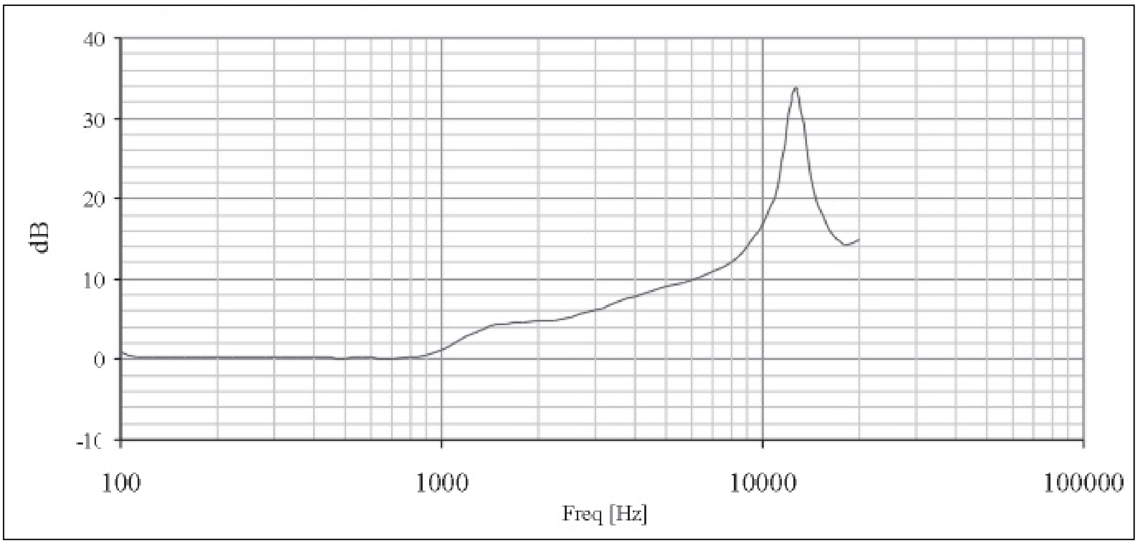



*Fig. 10.2 Type RA0045 - typical coupler frequency response re. 500 Hz*

## 10.3 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 (see Chapter 11)
- High-leak Pinna Simulator Type RA0057 (see Chapter 11)

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. 10.2 shows a typical coupler frequency response of the RA0045.

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.

## 10.4 Calibration

Section 3.4.3 describes how to calibrate the RA0045 using a G.R.A.S. Pistophone fitted with a ½" coupler. You can also use a Pistonphone fitted with a 1" coupler if you first remove the Union nut and External-ear simulator (see Fig. 10.3) and place the Pistonphone’s coupler directly onto the housing of the RA0045.

It may be necessary to apply a thin layer of petroleum jelly on the contact surface (see Fig. 10.4) of the RA0045 to improve sealing within the coupler.

The corresponding correction for using a G.R.A.S. Pistonphone fitted with a 1" coupler is –0.07 dB [1]

[1] For a B&K pistonphone with a 1" coupler, the correction is +0.14 dB.

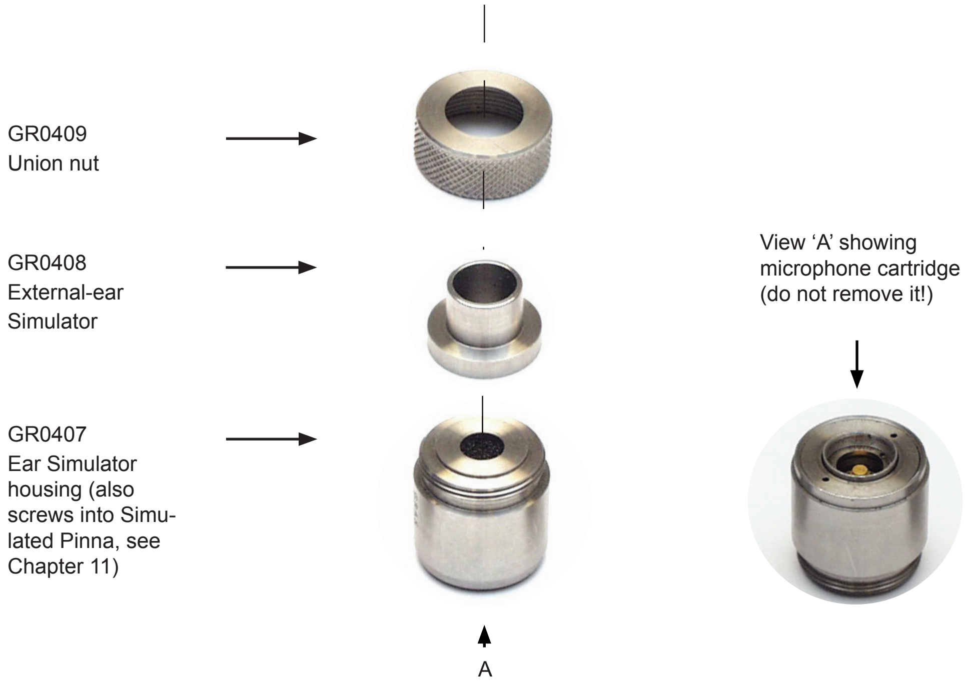
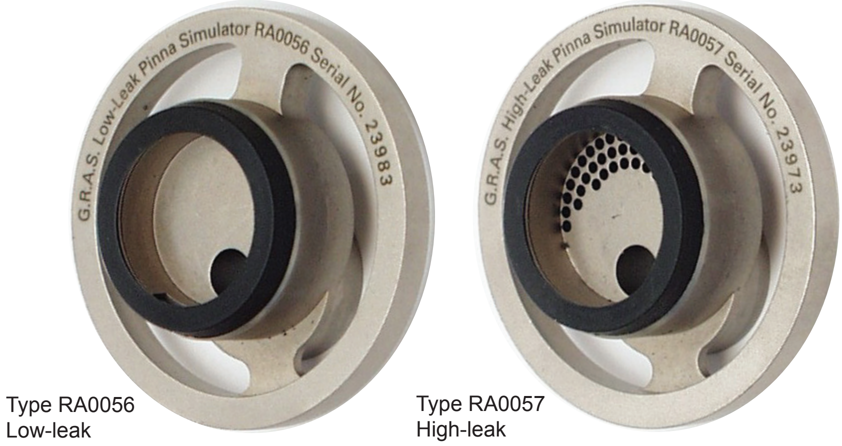



*Fig. 10.3 Exploded view of all the user-serviceable components of the IEC 60711 Ear Simulator Type RA0045. Do not to remove the microphone cartridge from the housing.*


*Fig. 10.4 Showing where to apply a thin film of petroleum jelly to improve sealing within a 1" Pistonphone coupler*

# Chapter 11

## Pinna Simulators Types RA0056/RA0057




*Low-leak and High-leak Pinna Simulators*

## 11.1 Introduction

These Pinna Simulators (Fig. 11.1) are for use with the IEC 60711 Ear Simulator Type RA0045 (described in Chapter 10). In both cases, they screw directly onto the RA0045 as shown in Fig. 11.2 to simulate a complete ear for testing supra-aural earphones, telephone handsets and loudspeakers. Section 5.4.3 describes a calibration check for a set-up similar to Fig. 11.2.

They differ only in the amount of simulated leakage designed into each, otherwise they are geometrically similar. An ear-canal extension is simulated by the hole which directs the sound to the microphone of the RA0045.

Both comply with the specifications given in:

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

## 11.2 Low-leak Pinna Simulator RA0056

Use this for tests which simulate a telephone handset or earphone held comfortably against the listener’s ear.

## 11.3 High-leak Pinna Simulator RA0057

Use this for tests which simulate a telephone handset or earphone held slightly away from the listener’s ear.

## 11.4 Test Situation

In a test situation, the Pinna Simulator (irrespective of which) should be placed centrally over the telephone handset or earphone as shown in Fig. 11.3; making light contact with the soft rubber seal.

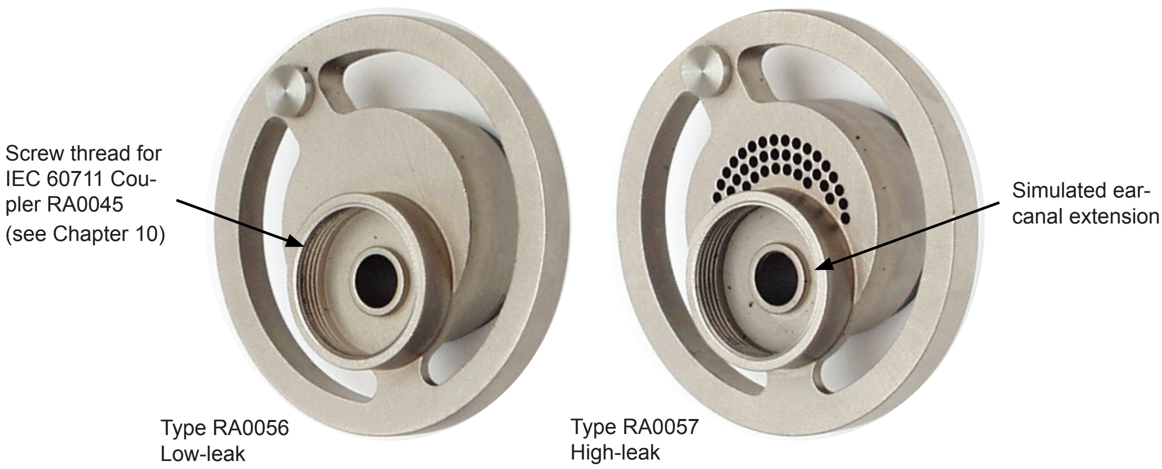



*Fig. 11.1 Showing the reverse sides of the Pinna Simulators*


*Fig. 11.2 Pinna Simulator with IEC coupler RA0045 and ½" Preamplifier Type 26AK*

*Fig. 11.3 Place the Pinna Simulator centrally over the earpiece of the telephone handset*

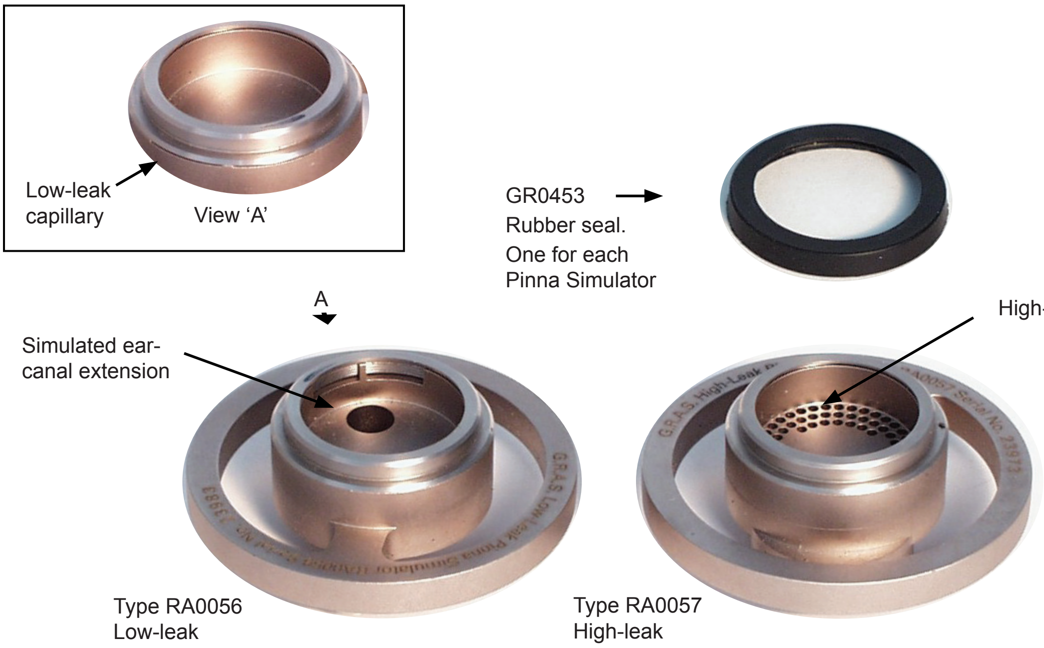



*Fig. 11.4 Exploded view of all the user-serviceable components of the Pinna Simulators*

# Chapter 12
## NBS 9A Coupler Type RA0075


*NBS 9A Coupler Type RA0075*

## 12.1 Introduction

The G.R.A.S. Type RA0075 is a coupler for testing earphones. It uses a 1" condenser microphone with preamplifier.

The Type RA0075 complies with the requirements of:

- ANSI S 3.7 – 1995 – American National Standard for Testing Earphones.

It is also part of the Artificial Ear Type 43AF described in Chapter 6.

## 12.2 Components

The Type RA0075 comprises the following components:

- RA0075 NBS 9-A Coupler
- GR0572 Stop Collar (to maintain consistent coupler-volume)

The Type RA0075 is delivered as shown in Fig. 12.1. It uses a 1" pressure condenser microphone with preamplifier. An exploded view of its user-serviceable components together with a suitable preamplifier and adapter, and microphone is shown in Fig. 12.2.

### 12.2.1 Preamplifiers

It can use either a 1" preamplifier or ½" preamplifier with an adapter. The example in Fig. 12.2 shows:

- Type 26AK G.R.A.S. ½" Preamplifier
- RA0073 G.R.A.S. ½" - to 1" Adapter

### 12.2.2 Microphones

It uses primarily a 1" pressure condenser microphone (of the type WS1P) with the normal protection grid replaced by a special coupler-adapter ring. The example in Fig. 12.2 shows the 64 AA configuration of:

- Type 40EN G.R.A.S. 1" Pressure Condenser Microphone
  fitted with
- RA0074 Coupler-adapter ring


*Fig. 12.1 NBS 9A Coupler Type RA0075 as delivered*

**Use with ½" Microphone**

The RA0075 can also be used with the G.R.A.S. ½" Microphone Type 40AG. In this case, the optional Adapter RA0077 should replace the protection grid of the Type 40AG. This combination will allow measurements to frequencies higher than those with a 1" microphone.

## 12.3 Characteristics

### 12.3.1 Main Purpose

ANSI specifies the NBS 9A Coupler for calibrating the earphones of audiometers. It has been chosen because of it's simple construction and because the threshold transfer data [1] of so many different earphones have already been determined.

### 12.3.2 Volume

It has a volume of about 5.6 $cm^3$ which approximates the volume enclosed by a supra-aural earphone on a human ear.

### 12.3.3 Frequency

The output level of an earphone on a real ear measured below 500 Hz is lower because of leakage and flesh compliance. From 500 Hz to 1500 Hz, it is about the same for both ear and coupler.

Between 1500 Hz and 8000 Hz, the response of the coupler is a fair indication of the earphone's performance. However this cannot necessarily be used as a precise indication of the relationship between coupler and ear because of complex interactions between the earphone and its acoustic load.

[1] Earphone coupler sound pressure level produced when earphone is excited by a voltage corresponding to hearing threshold. See also ANSI S3.6-1989 and ISO R 389-1985, Standard Reference Zero for the Calibration of Pure Tone Air Conduction Audiometers, and Addendum 1-1983 to ISO R389-1975.

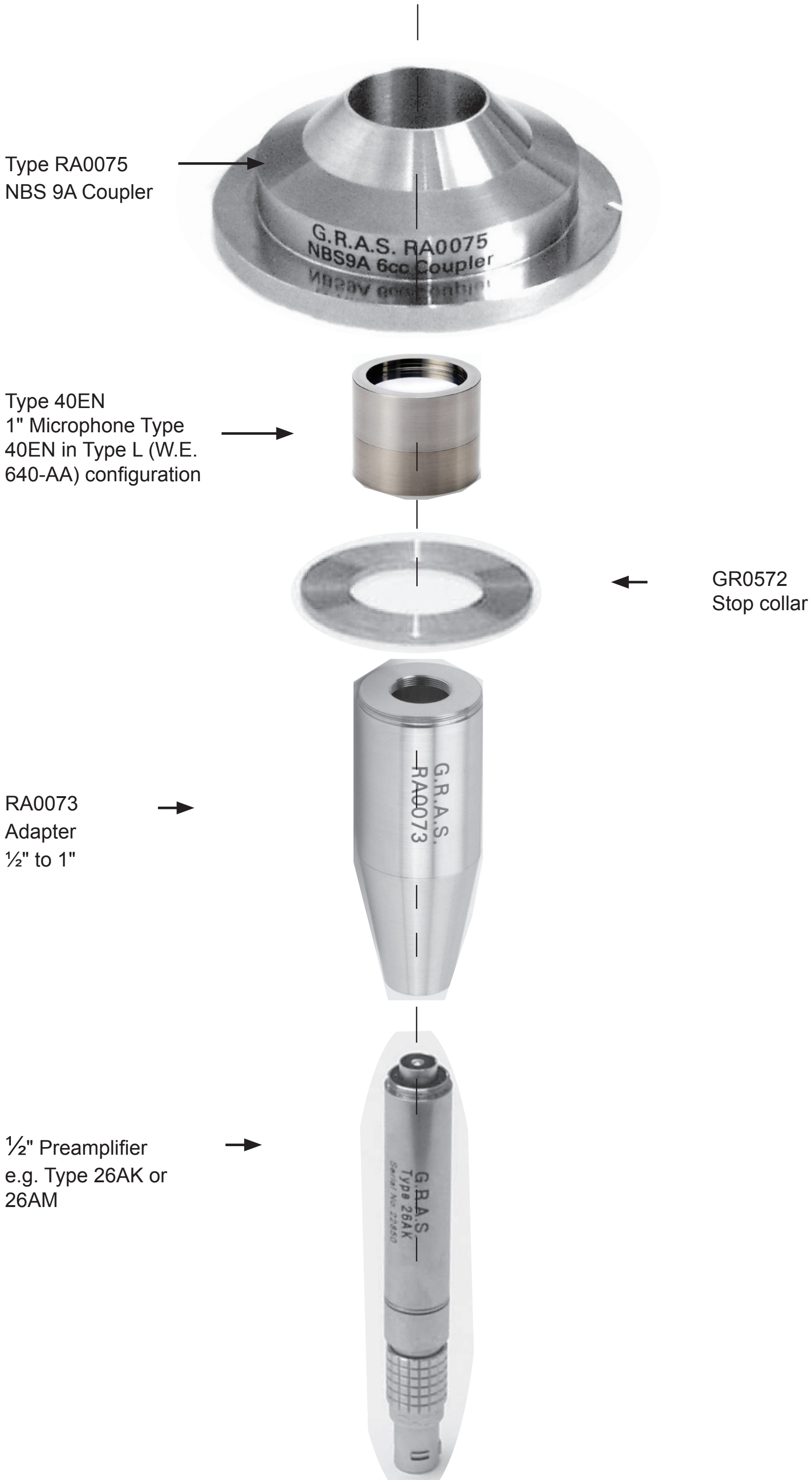



*Fig. 12.2    Exploded view of user-servicable parts with a 1" microphone and a ½" preamplifier*

# Chapter 13
# Mouth Simulators Types 44AA/44AB


*Mouth Simulators Type 44AA and Type 44AB (right)*

## 13.1 Introduction

The G.R.A.S. Mouth Simulator Type 44AA (and Type 44AB) is sound a source which simulates the sound field around the human mouth at close quarters.

The Mouth Simulator is for testing telephone mouthpieces as well as other microphones similarly used in vocal-communication networks and complies with the requirements of:

- IEEE 269, 661.
- ITU-T Rec. P51.

At the mouth reference point (MRP), which is 25mm from the detachable lip ring (35mm from the simulator's mouth), the maximum continuous equalised signal it can produce in ⅓-octave bands is 100 dB re. 20 µPa in the frequency range 100 Hz to 16 kHz.

### 13.1.1 Difference between Type 44AA and Type 44AB

**Type 44AA**

The 8 Ω loudspeaker of the Type 44AA accepts an external signal (applied via the BNC socket shown in Fig. 13.1) either:

a) directly.

Or

b) via a built-in power amplifier (10 dB gain).

The built-in power amplifier switches on automatically when energised by an external 24 V DC supply, e.g. via the Mains/line Power Supply AB0012 (included with the Type 44AA).

**Type 44AB**

The 8 Ω loudspeaker of the Type 44AB accepts an external signal directly (applied via the BNC socket shown in Fig. 13.1) . It has no built-in power amplifier.

## 13.2 Components

The Mouth Simulator comprises the following main-components:

- GR0591K Housing (for Type 44AA)
- GR0717K Housing (for Type 44AB)
- GR0700 Mouth Piece

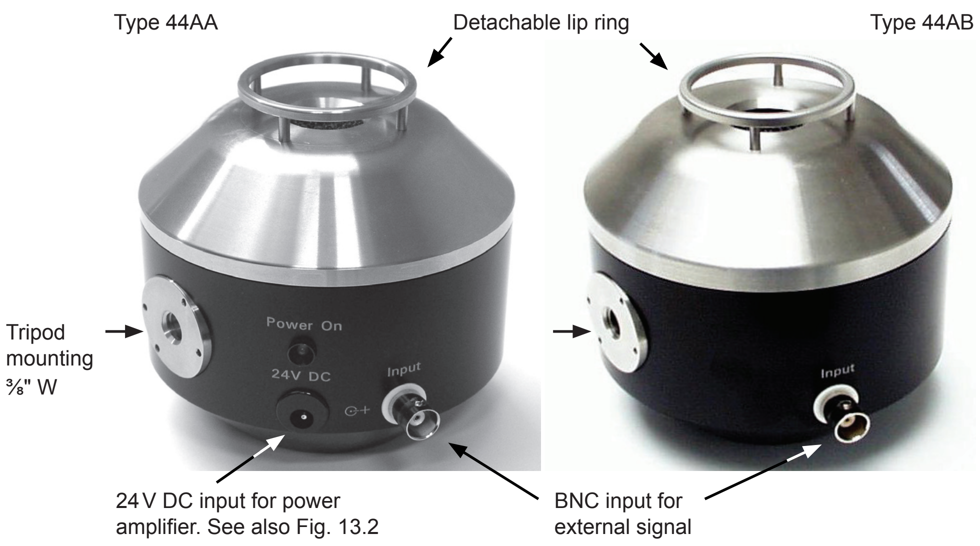



*Fig. 13.1 Mouth Simulators Types 44AA and 44AB*

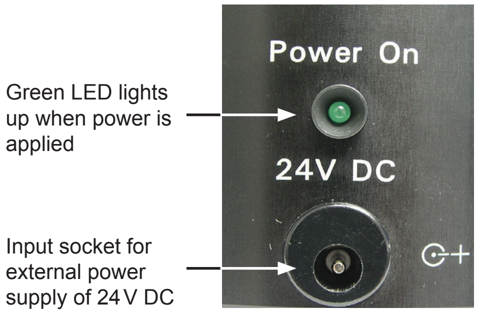



*Fig. 13.2 Power input for the power amplifier of the Type 44AA*

- RA0106 Lip ring
- RA0104 Jig for CCITT P51 Calibration
- RA0105 Jig for IEEE 269 Calibration
- AB0012 Mains/line Power supply (for Type 44AA)

The Mouth Simulator is delivered as shown in Fig. 13.1. An exploded view of its user-serviceable components is shown in Fig. 13.11.

### 13.2.1 Earlier Mouthpiece

An earlier conical mouth piece RA0110 (Fig. 13.3) is available and can be delivered with the Mouth Simulator for users who require it, e.g. for historical reasons. It comes without the four holes for mounting the lip ring.

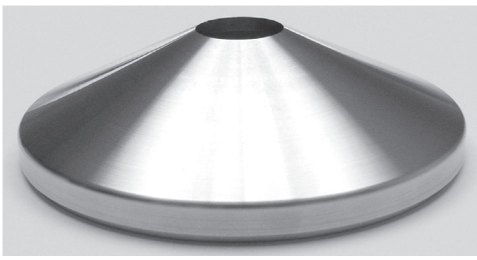


*Fig. 13.3 RA0110 earlier conical mouth piece available from G.R.A.S.*

## 13.3 Additional Equipment

### 13.3.1 Common to Calibration and Testing

1) Suitable power amplifier
2) Audio signal generator capable of:
   - generating logarithmically swept tones within the audio frequency range[3]
   - equalising in real time for the fluctuations of the true response of the Mouth Simulator

   This audio signal is fed (directly or indirectly) to the Mouth Simulator.
3) Audio frequency analyser

   The audio analyser receives the signal picked up either by the telephone handset

[3] For example from 50 Hz to 10 kHz

(Fig. 13.6) under test or the microphone in a calibration set-up (Fig. 13.9) and measures its response to the Mouth Simulator.

Items 2 and 3 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.

### 13.3.2 Telephone Testing

4) A suitable fixture (see section 13.5) for holding the Mouth Simulator and telephone as shown in Fig. 13.4. The correct relative postions of these two are shown in Fig. 13.5.

Fig. 13.6 shows a block diagram of a possible set-up for testing the microphone of a telephone handset.

### 13.3.3 Calibration

5) Preamplifier and microphone as shown in:
   - Fig. 13.7 for calibrating according to IEEE 269
   - Fig. 13.8 for calibrating according to according to CCITT P51
6) Power supply for a ¼" Preamplifier Type 26AC,
   e.g. the G.R.A.S. Power Module Type 12AK (see Fig. 1.3a)

Fig. 13.9 shows a block diagram of a possible set-up for making calibrations according to IEEE 269. A set up such as this is used for each individual calibration chart of a G.R.A.S. Mouth Simulator.

## 13.4 Testing a Telephone or Calibrating the Mouth Simulator

The following applies to the set-ups described in section 13.3 and shown in Figs. 13.6 and 13.9.

In both cases a swept signal (equalised for the fluctuations of the true response of the Mouth Simulator, see Fig. 13.10.) is fed to the Mouth Simulator and the resulting sound is picked either by:

a) the microphone of a telephone handset (Fig. 13.6)

   Or

b) the microphone used for calibrating the Mouth Simulator (Fig. 13.9)

It is assumed that the generator and analyser work to produce constant-confidence results (i.e. maintaining a constant $\beta T$ product) in real time throughout the frequency range of interest and make the measurement data available graphically and numerically.

### 13.4.1 Procedure

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 logarithmic sweep[4] on the generator

The analyser will follow the response of the microphone to the Mouth Simulator throughout the sweep and record and display the results accordingly.

In case of telephone tests, 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. 13.4 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. 13.5 for geometrical details*

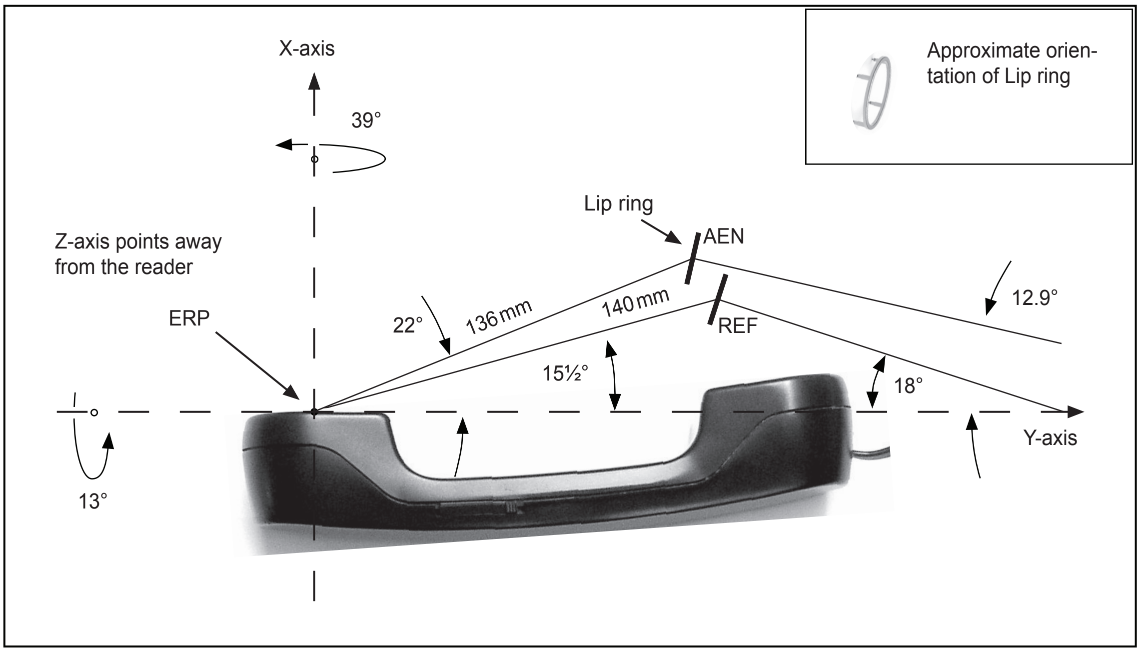



*Fig. 13.5 Showing where the Lip-ring should be for both AEN and REF positions. The angular distances of 39° and 13° (in that order) will move the handset from the AEN postion to the LRGP*

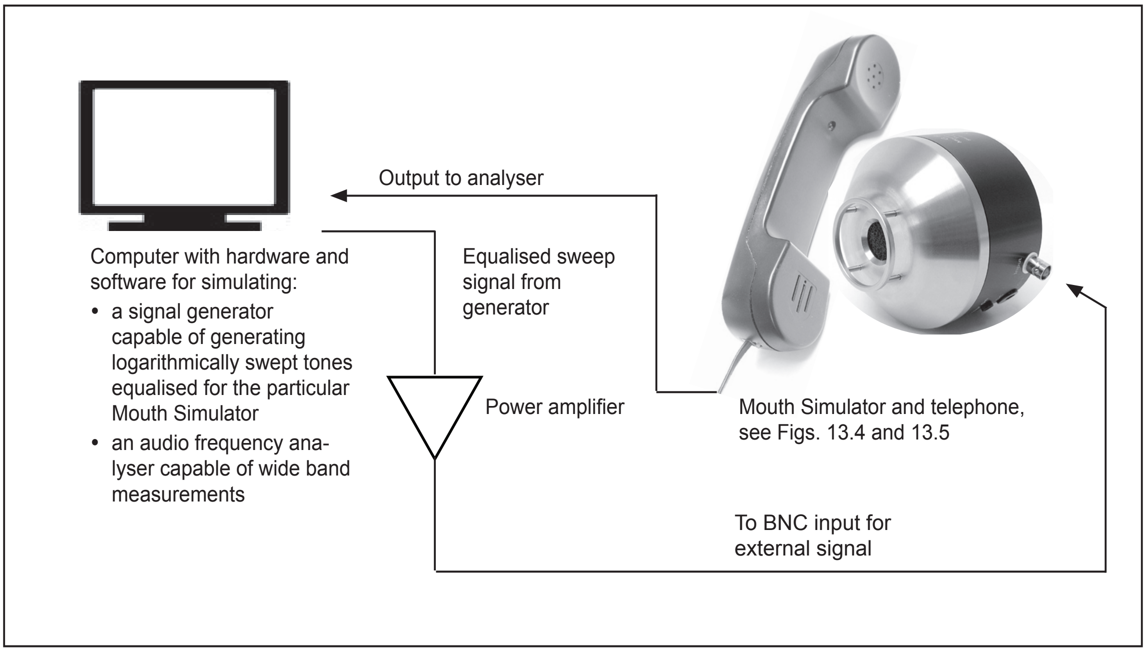



*Fig. 13.6 Block diagram of a set-up for testing the microphone of a telephone handset. See also Fig. 13.12 for a complete set-up using the G.R.A.S. Telephone Test Head Type 45AA*

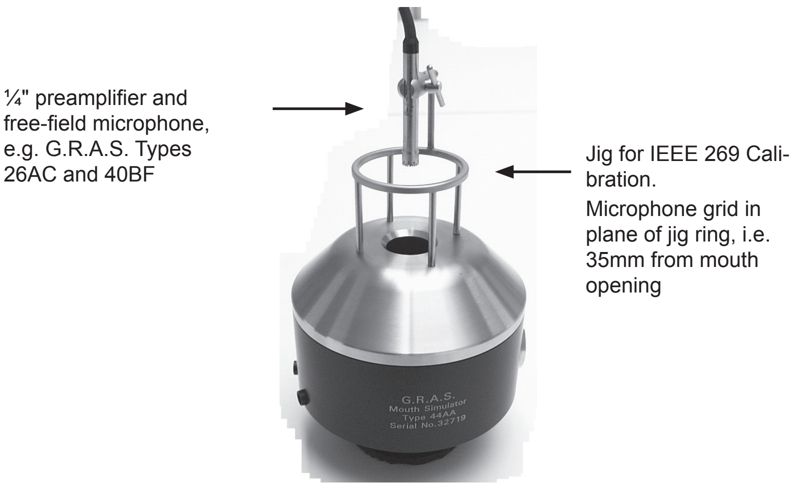



*Fig. 13.7 Set up for calibrating the Mouth Simulator according to IEEE 269*


*Fig. 13.8 Set up for calibrating the Mouth Simulator according to CCITT P51*

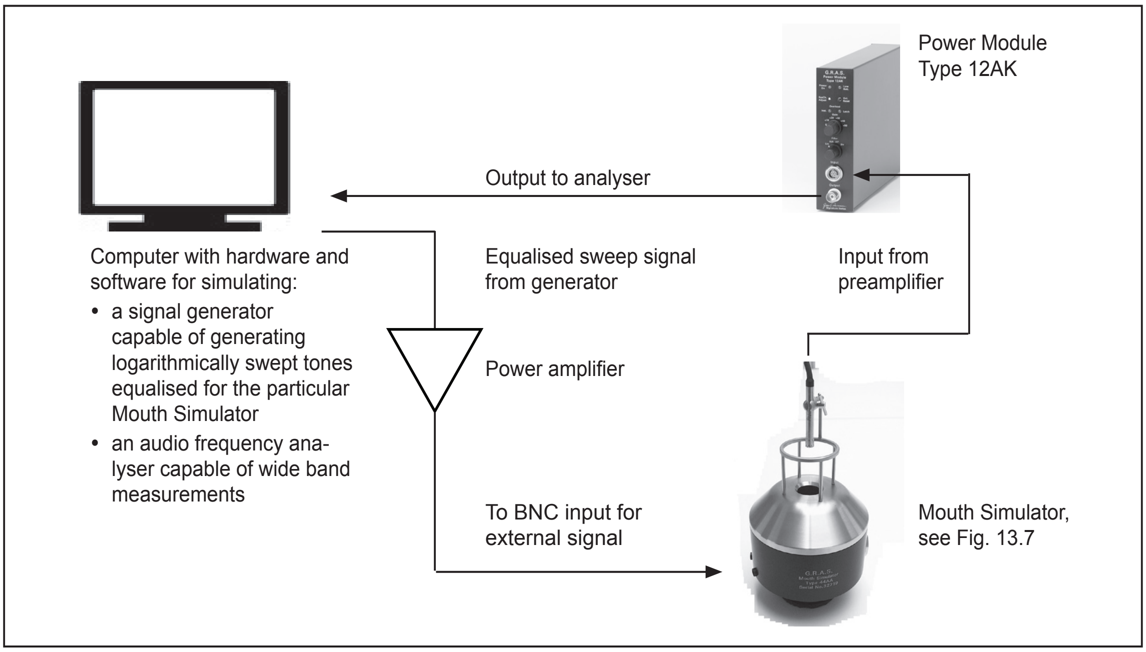



*Fig. 13.9 Block diagram of a set-up for calibrating the Mouth Simulator according to IEEE 269*

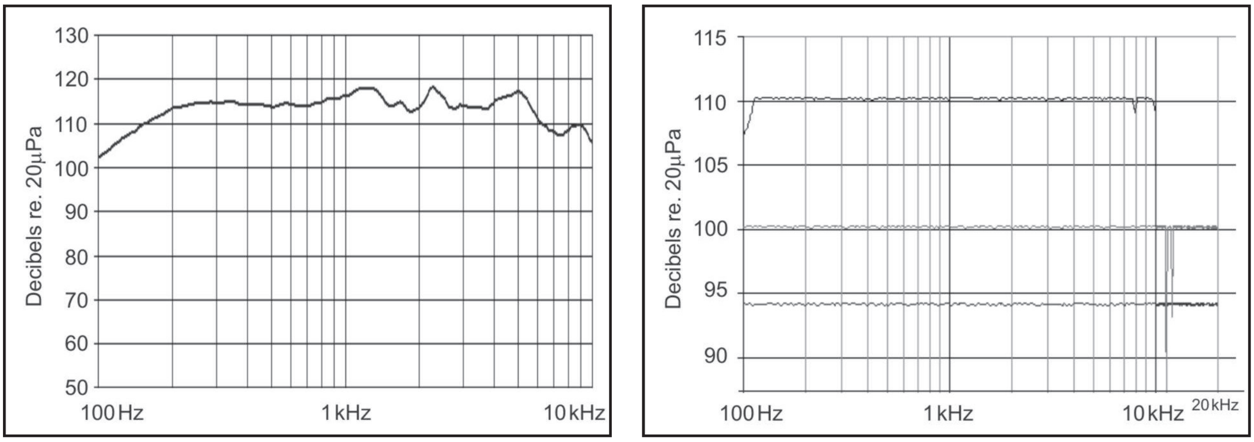



*Fig. 13.10 Typical frequency-response measurements of a Type 44AA using the IEEE 269 set up shown in Fig. 13.7.*

*Left: true response for a 1 V RMS input to the built-in power amplifier. Note: an input of 3.16 V RMS would be required for the Type 44AB (and Type 44AA without using its built-in power amplifier), to give an equivalent result.*

*Right: equalised response at the Mouth Reference Point for 94dB, 100dB, and 110dB SPLs*

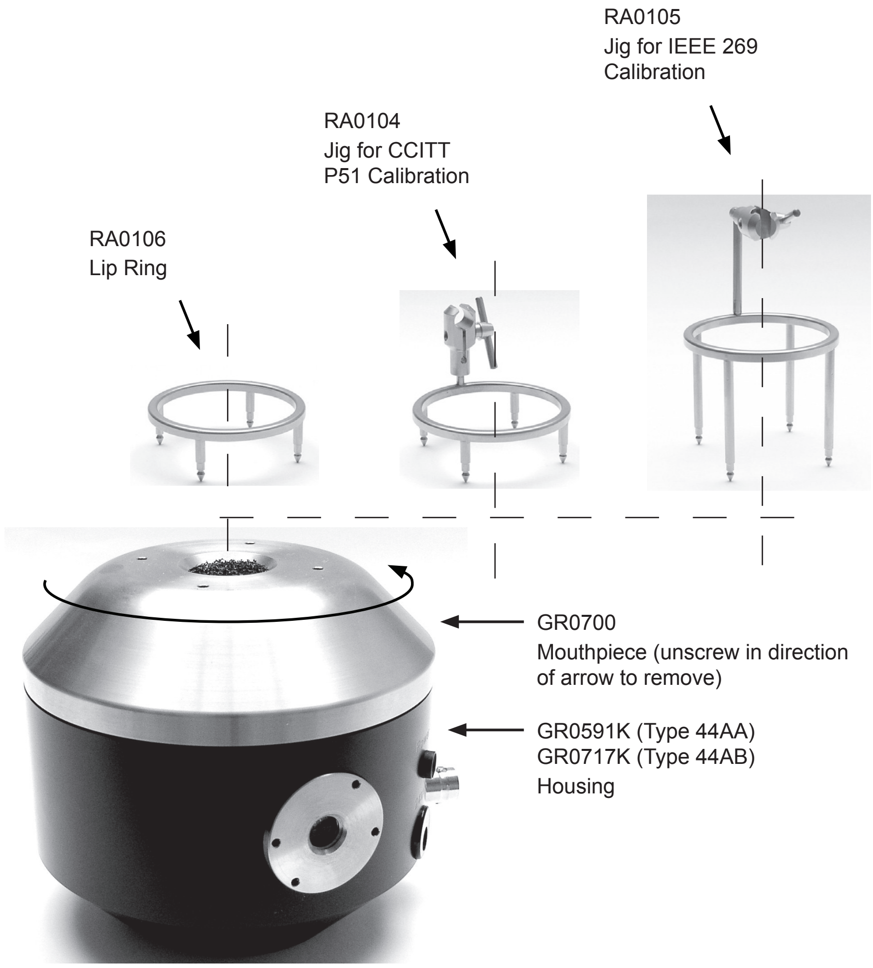



*Fig. 13.11 Exploded view of all the user-serviceable components of the Mouth Simulator (if required the mouth piece GR0700 can be replaced by the earlier conical version RA0110 available from G.R.A.S., see section 13.2.1)*

## 13.5 Telephone Test Head Type 45AA

The G.R.A.S. Telephone Test Head Type 45AA (Fig. 13.12) is a tailor-made fixture for testing the acoustic performance of telephone handsets in accordance with international standards and recommendations.

Its design combines precision with a robust construction to ensure stability and reproducible test results with a minimum of acoustic interference.

When used with an Artificial Ear Type 43AD or an Ear Simulator Type 43AE, and a Mouth Simulator Type 44AA or 44AB, it can be set up for testing telephone handsets in accordance with ITU-T recommendations.

Contact G.R.A.S. for full details.

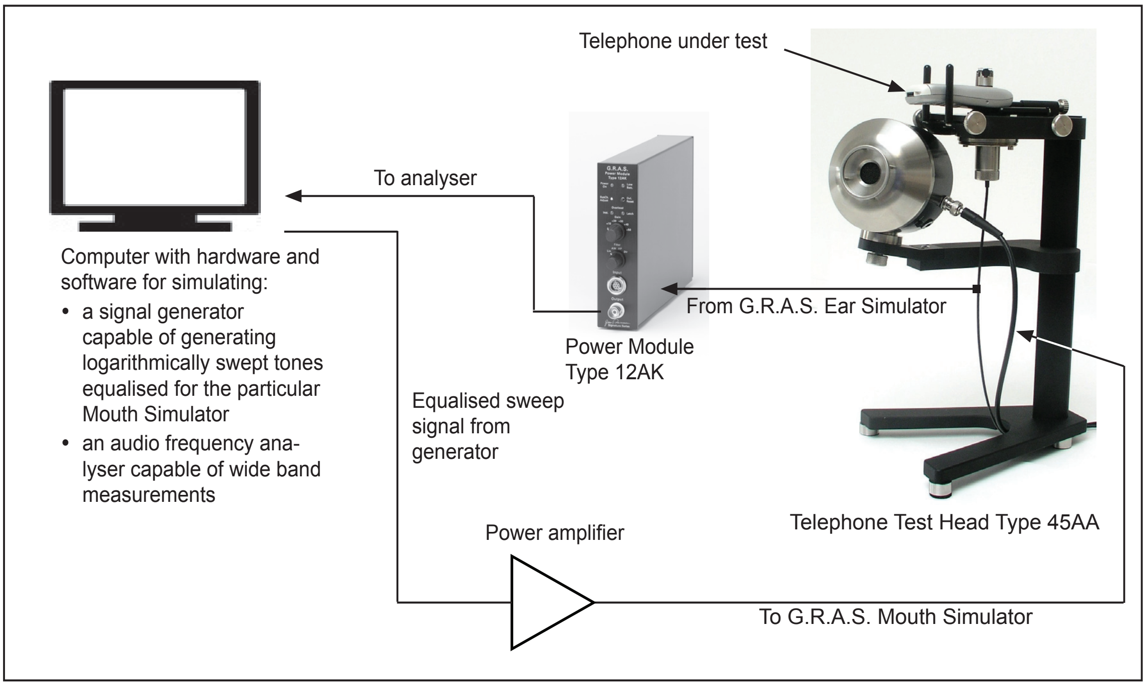



*Fig. 13.12 Block diagram of a set-up using the G.R.A.S. Telephone Test Head Type 45AA for testing a complete telephone handset. Both Mouth and Ear Simulators can be mouted on the Telephone Test Head in accordance with all current standards.*

## 13.6 Specifications

**Max. continuous output level at MRP:**

| | |
|---|---|
| 200 Hz - 6 kHz: | 110 dB re. 20 µPa |
| 100 Hz - 10 kHz: | 100 dB re. 20 µPa |
| Distortion (94 dB re. 20 µPa at MRP): | |
| 200 Hz - 5 kHz: | typically 1 %, max. 1.5 % |

**Loudspeaker:**

| | |
|---|---|
| Impedance: | 8 Ω |
| Maximum power: | |
| continuous: | 10 W |
| pulsed: | 50 W (for 2 sec) |

**Amplifier*:**

Automatically enabled when external power is applied and is fully protected against overload.

| | |
|---|---|
| gain: | 10 dB |
| input impedance: | 20 kΩ |
| max. input voltage: | 2 V RMS |
| max. consumption: | 24 V DC, 1000 mA |

**Mouth opening:**

| | |
|---|---|
| Diameter: | 20 mm |

**Lip ring:**

| | |
|---|---|
| External diameter: | 48 mm |
| Distance from mouth | 10 mm |

**Dimensions:**

| | |
|---|---|
| Diameter: | 104 mm |
| Height (with lip ring): | 104 mm |

**Weight:**

| | |
|---|---|
| Type 44AA | 1.3 kg |
| Type 44AB | 0.93 kg |

**Accessories included:**

| | |
|---|---|
| Jig (CCITT P51) | RA0104 |
| Jig (IEEE 269) | RA0105 |
| Power supply* | AB0012 |

**Accessories available:**

| | |
|---|---|
| Conical mouthpiece | RA0110 |

* Not applicable to Type 44AB

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.