G.R.A.S.
SOUND & VIBRATION

Instruction Manual

G.R.A.S. 43BB Low-noise Ear Simulator System

LI0179 – 21 July 2016

Revision History

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

Revision	Date	Description
1	1 November 2015	First Publication
2	21 July 2016	Frequency response corrected

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Trademarks

Contents

Introduction

The G.R.A.S. 43BB is a low-noise, high-sensitive ear simulator system intended for measurements of sound pressure levels close to or below the threshold of human hearing. Typical applications are within consumer electronics: R&D testing of headphones, especially in-ear headphones with Active Noise Cancellation.

It is based on the IEC 60318-4 ear simulator standard and basically consist of the well known standardized Ear Simulator and a low-noise microphone system.

The 43BB is for use in monaural setups. The length of the 26HG 1/4" Preamplifier prevents it from being used in a binaural setup inside any G.R.A.S. test fixture.

Delivered Items

43BB Low-noise Ear Simulator System

Description	G.R.A.S. number
Low-noise Ear Simulator	RA0234
1/2" Low-noise microphone system, comprising: 40AH 1/2" Ext. Polarized Pressure Microphone, high sensitivity 26HG 1/4" Preamplifier with 3m integrated cable GR0010 Straight Adapter	40HT
Filter and Gain Unit	26HT
1-Channel Power Module for Low-noise systems	12HF

Optional Accessories

Description	G.R.A.S. number
Pistonphone Class, 1	42AA
Intelligent Pistonphone, Class 0	42AP
94 dB Pistonphone Coupler	RA0090
Straight Ear-canal Extension Kit for KEMAR	RA0237
Pinna Holder Kit	RA0172
LEMO 7-pin to LEMO 7-pin 3 m Cable for Low-noise measuring system	AA0046
LEMO 7-pin to LEMO 7-pin 10 m Cable for Low-noise measuring system	AA0047
Customized length LEMO 7-pin - LEMO 7-pin Cable for Low-noise measuring system	AA0053-CL

Description

General Description

Basically 43BB consists of the well known standardized IEC 60318-4 (711) Ear Simulator and a the G.R.A.S. 40HT low-noise microphone system.

The noise floor is close to or below the threshold of human hearing. Where the traditional artificial ear has a noise floor of 24.2 dB(A), the 43BB has its noise floor below 10.5 dB(A). See Fig. 1 on page 6.

Its frequency response is very similar to that of a standard 60318-4 ear simulator. Below 10 kHz, the frequency response is identical to that of a standard IEC 60318-4 ear simulator.

Above 10 kHz, the differences in the microphone diaphragm impedance results in substantial differences. The standard ear simulator has a high-Q resonance around 13.5 kHz related to the length of the ear canal and the diaphragm impedance.

In the low noise version of the ear simulator the single high-Q resonance is replaced by two resonances. Part of the design of the low noise microphone is a filter unit that controls the mechanical resonance of the low noise microphone. The combination of the filter and the low damping of the diaphragm cancels out the high peak of the resonance in the simulator. The frequency response for the two ear simulators are compared in Fig. 2 on page 6.

43BB can be mounted in a monaural setup inside a KEMAR (45BB and 45BC) or a G.R.A.S. 45CA Hearing-Protector Test Fixture. Because of the length of the 26HG 1/4" Preamplifier, it is not possible to use 43BB in a binaural setup inside any G.R.A.S. test fixture.

See "Mounting in a Test Fixture" on page 12 for further information.

Typical Performance Data

Fig. 1 shows the noise floor of the 43BB compared to the threshold of human hearing as it is defined in "ISO 389-7:2005 Acoustics - Reference zero for the calibration of audiometric equipment - Part 7: Reference threshold of hearing under free-field and diffuse-field listening conditions". Fig. 2 shows the typical frequency response.

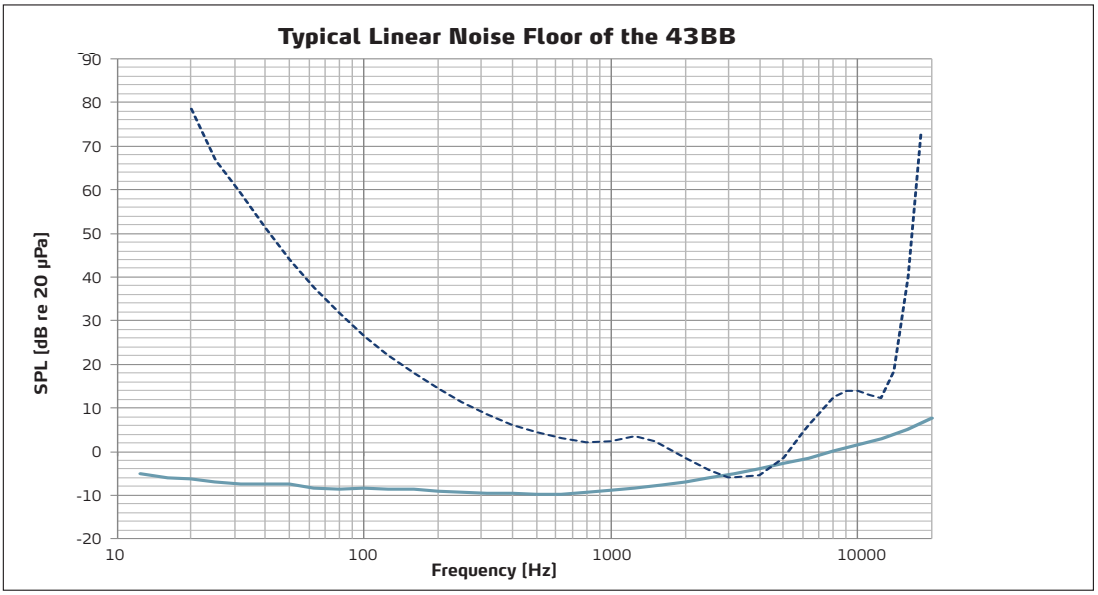

Fig. 1. *The noise floor (solid curve) is typically below the threshold of human hearing (dashed curve)*

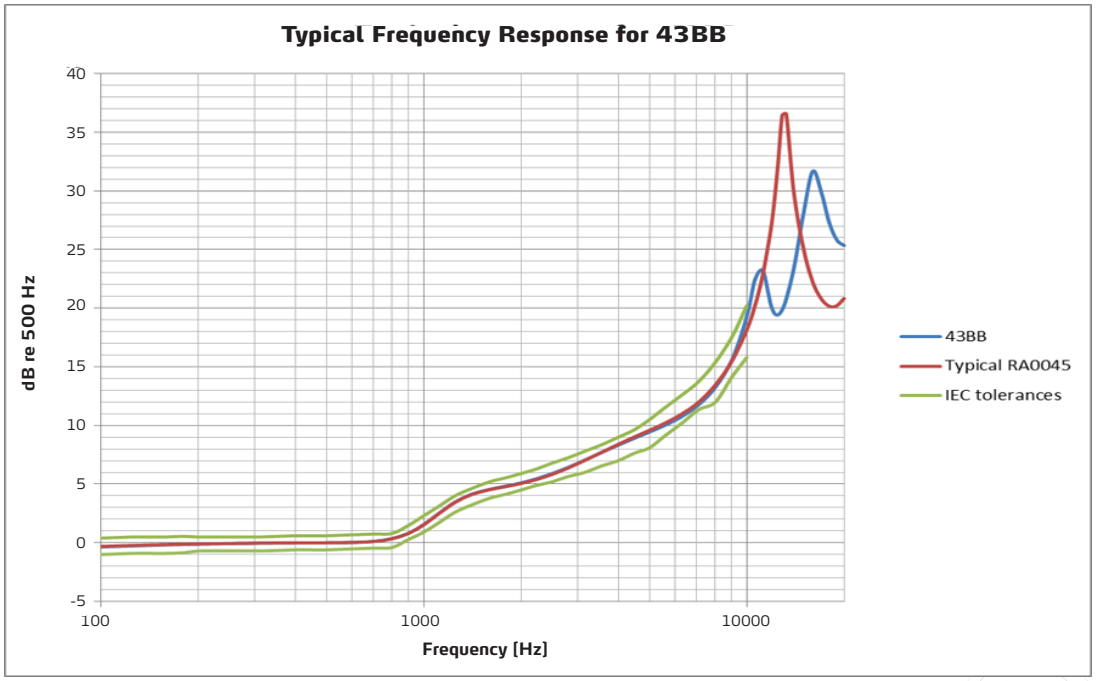

Fig. 2. *Typical frequency response (solid blue) versus the IEC tolerances (dashed black) and the ideal IEC 60318-4 frequency response (red curve)*

System Components

RA0234 Low-noise Ear Simulator

The RA0234 comes as a complete unit with preamplifier and adapter glued in place to safeguard it against dust and dirt. Dust inside the coupler or on connections will compromise its low-noise properties, and you should therefore never remove any of its components. It is calibrated as a complete unit.

Up to 10 kHz, the acoustic input impedance of the RA0234 closely resembles that of the G.R.A.S. RA0045 Ear Simulator according to IEC 60318-4 and, as a result, loads a sound source in very much the same way as the human ear.

It 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. 3 shows the typical acoustical input impedance of the RA0234.

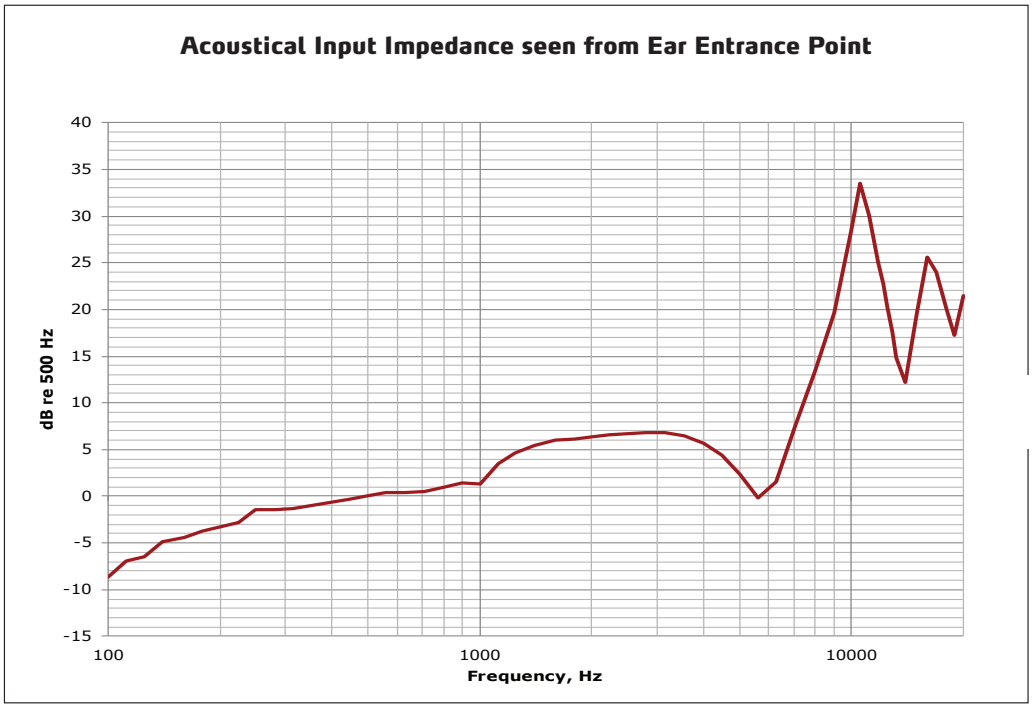

Fig. 3. *Typical acoustical input impedance for the RA0234 Low-noise Ear Simulator*

The input impedance is defined as the ratio of the sound pressure at the Ear Entrance Point 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.

40HT Low-noise Microphone System

The 40HT comprises

- G.R.A.S. 40AH ½" Ext. Polarized Pressure Microphone, High sensitivity
- G.R.A.S. 26HG ¼" Preamplifier with 3 m Integrated Cable, Low Frequency
- GR0010 ¼" to ½" Adapter (included with the 26HG)
- 26HT Gain and Filter Unit with two built-in compensation filters and an overload-warning LED.

To complete the system, a special power module is part of the delivery, i.e.

- G.R.A.S. 12HF 1-Channel Power Module for 40HF/40HH/40HT Low-noise Systems

The power module provides all necessary voltages for powering the preamplifier and polarizing the microphone.

40AH ½" Ext. Polarized Pressure Microphone, high sensitivity

The 40AH is a special high-sensitive ½" microphone. It is externally polarized with a specially reduced inherent noise floor.

26HG ¼" Preamplifier

The 26HG ¼" Preamplifier with 3 m integrated cable, low-frequency is similar to the 26AC ¼" Standard Preamplifier with 3 m integrated cable, but with a 40 GΩ input impedance to enable low-level noise measurements. It has an integrated lightweight cable terminated in a 7-pin LEMO connector that plugs into the G.R.A.S. 26HT Gain and Filter Unit.

26HT Gain and Filter Unit

The signal of the microphone is amplified by 20 dB in the 26HT Gain and Filter Unit. The body of the Unit has an overload-warning LED, (Fig. 4), which is repeated on the front panel of the power module.

Fig. 4. *The 26HT Gain and Filter Unit*

The 26HT has two compensation filters, giving the system two parallel outputs, one with a linear pressure-frequency response and another with free-field correction.

Important. The free-field option should not be used. The microphone in the coupler is used as a pressure microphone.

12HF 1-Channel Power Module for Low-noise Systems

The G.R.A.S. 12HF 1-Channel Power Module for 40HF/40HH/40HT Low-noise Systems is especially designed for low-noise measurements. The microphone signal is amplified in the 26HT Gain and Filter Unit by 20 dB. The nominal system sensitivity at the output of the Power Module corresponds to 0.8 V/Pa. When the measured output voltage from the Power Supply is 0.8 V RMS, the microphone is being subjected to 94 dB re. 20 µPa. The actual sensitivity is quoted on the individual calibration chart.

Front Panel

The front panel (see Fig. 5) has the following features:

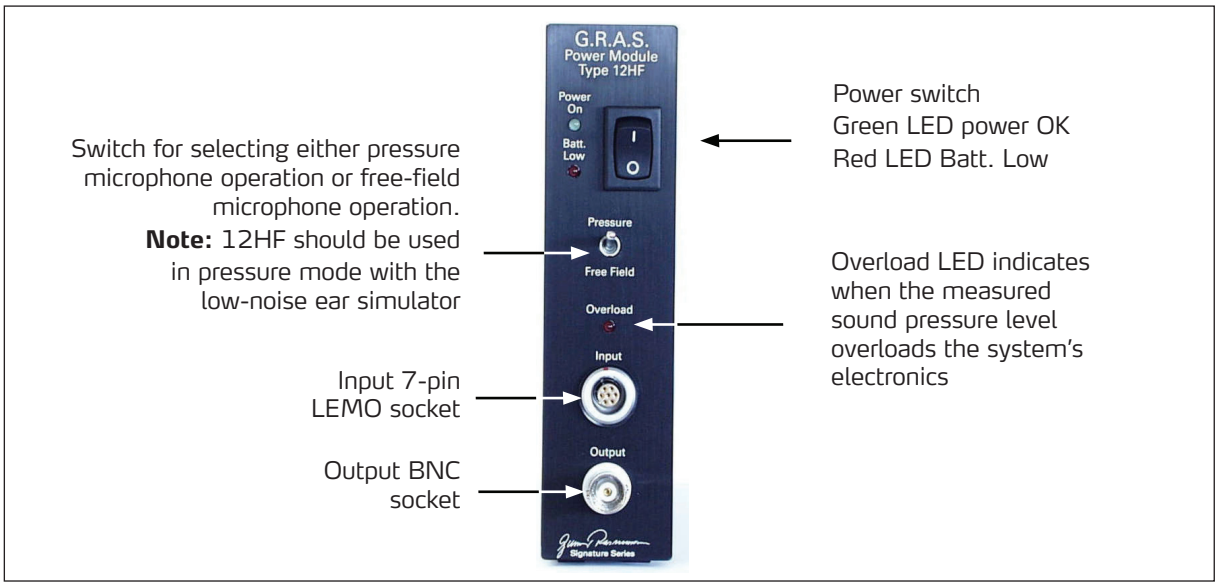

Fig. 5. *Front panel of the Power Module Type 12HF*

- Power switch with two LEDs: green "OK", red "Batt. Low".
  If the power supply is correct, the green LED lights up. If the red LED lights up, either the batteries are low and should be changed or the external DC supply voltage is too low.

- Two-position switch for selecting frequency response, Pressure microphone operation or Free-Field microphone operation.

Important. Do not use the free-field position when the 12HF is used as part of the 43BB Low-noise Ear Simulator System.

- Overload-warning LED synchronised with the one on the 26HT Gain and Filter Unit (see Fig. 4).

- 7-pin LEMO EGA 307 1B input socket for the LEMO plug on the cable of the 26HT Gain and Filter Unit. The wiring diagram is shown in Fig. 6.

- BNC output socket for the output signal.

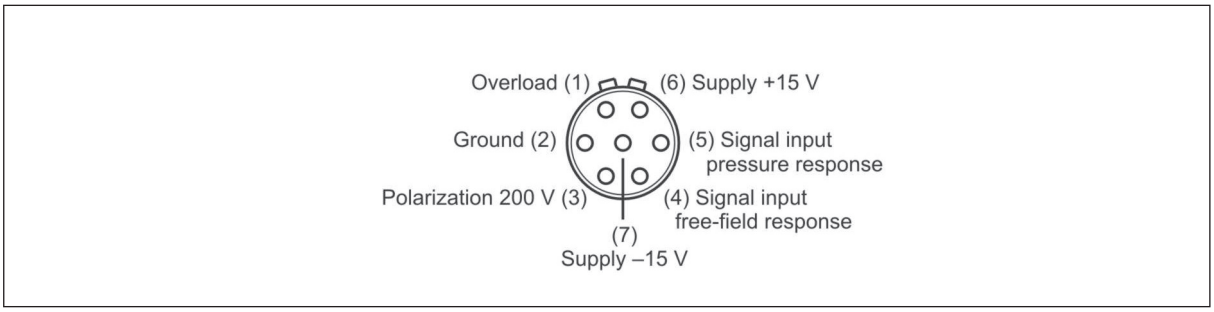

Fig. 6. *7-pin LEMO EGA 307 1B input socket (external view)*

Rear Panel

The rear panel has the following features (see Fig. 7)

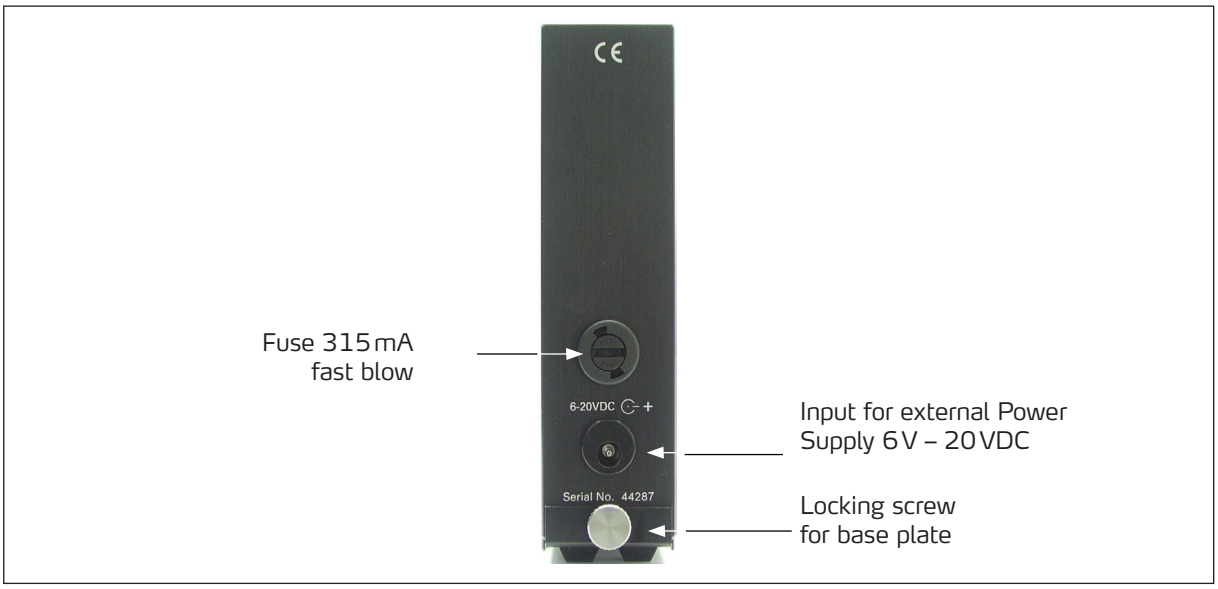

Fig. 7. *Rear panel of the Power Module Type 12HF*

- Twist/release holder for 315 mA fast-blow fuse.
- Input socket for an external voltage supply of 6 V - 20 V DC; centre pin +terminal. Use the Mains/line Adapter AB0010 supplied with the 12HF.
- Locking screw for base plate.

Battery Pack

To gain access to the battery pack, unscrew the locking screw on the rear panel (Fig. 7) and slide the base plate off towards the rear. Pull out the battery pack, see Fig. 8.

Fig. 8. *The battery pack of the 12HF Power Module*

The battery pack consist of a battery holder and 4 x LR14 (C) standard alkaline cells. When replacing the batteries, replace all of them making sure that the polarity is as indicated on the battery holder.

Mounting in a Test Fixture

43BB can be mounted in a test fixture, i.e. a KEMAR Manikin (45BB or 45BC) or a 45CA Hearing-protector Test Fixture.

The 43BB is for use in a monaural setup. Because of the length of the 26HG 1/4" Preamplifier, it is not possible to mount the 43BB in a binaural setup inside any G.R.A.S. test fixture.

The KEMAR Manikin (45BB or 45BC)

How to mount an ear simulator in a KEMAR is described in the KEMAR manual. It can be downloaded from http://www.gras.dk/media/docs/files/items/m/a/man_45BB_45BC.pdf.

Mechanical Mounting

An ear canal extension is needed, the RA0237 Straight Ear Canal Extension Kit for KEMAR is recommended. Ear Canal Extensions for KEMAR come with O-rings mounted on the flange. If you already have an ear canal extension, but without O-ring, you must order the RA0244 O-ring Kit for KEMAR Ear Canal Extensions.

Electrical Connection

Route the LEMO cable down through the head and connect it to one of the LEMO sockets in the top of the KEMAR neck. This cable is longer than needed – therefore, ensure that the surplus length is placed inside the KEMAR head without any sharp bends to it.

Connect the 26HT Filter and Gain Unit to the corresponding LEMO socket at the bottom of the KEMAR, and connect the gain unit to the power module with a low noise cable. (AA0046, 3 m, AA0047, 10 m, or AA0053-CL (customized length).

The 45CA Hearing-protector Test fixture

How to mount an ear simulator in a 45CA is described in the 45CA manual. It can be downloaded from http://www.gras.dk/media/docs/files/items/m/a/man_45CA.pdf.

Mechanical Mounting

G.R.A.S. RA0172 Pinna Holder Kit is needed for mounting a pinna.

Electrical Connection

Route the cable through the test fixture. Connect the cable to the 26HT Filter and Gain Unit, and then connect the filter unit to the power module with a low noise cable. (AA0046, 3 m, AA0047, 10 m, or AA0053-CL, customized length).

Calibrating the RA0234 Ear Simulator

Dismount before Calibration

To avoid overload, the output from the pistonphone must be attenuated with the RA0090 94 dB Pistonphone Coupler. To use this, the ear simulator must be dismounted from test fixture.

System Sensitivity

Since the microphone signal is amplified by 20 dB by the 26HT Gain and Filter Unit, the nominal system sensitivity corresponds to 0.8 V/Pa. When the output voltage from the Power Module is 0.8 V RMS, the microphone is subjected to 94 dB re. 20 µPa. The actual system sensitivity is quoted on the calibration chart supplied with the system.

Pistonphone Calibration

A pistonphone fitted with a normal ½-inch coupler cannot be used as this will overload the system with a level of 114 dB re. 20 µPa. To reduce the output from the pistonphone, the RA0090 94 dB Pistonphone Coupler must be substituted for the standard pistonphone coupler.

Fig. 9. *Pistonphone without its normal coupler and ready to accept the Coupler RA0090*

A 42AA Pistonphone or 42AP Intelligent Pistonphone fitted with an RA0090 Coupler (both available from G.R.A.S.) can be used to produce 94 dB re. 20 µPa.

1. Connect the 26HT via its LEMO connector to the LEMO input socket of the 12HF.
2. Connect the BNC output of the 12HF (see Fig. 5) to the analyzer and switch both power module and analyzer on.
3. Unscrew and remove the normal coupler of the Pistonphone.
4. Screw the RA0090 Coupler onto the Pistonphone, see Fig. 9.
5. Push fit the ½-inch adapter GR0619 shown in Fig. 9 onto the entrance of the RA0090 Coupler.
6. Mount the RA0234 Ear Simulator, including ear-canal extension, and switch on the Pistonphone.
7. Adjust the analyzer to indicate 94 dB re. 20 µPa (the standard value for 42AP with GR0619 Adapter). Adjust this value by a further –0.7 dB to account for the additional ear simulator volume.

Refer to your Pistonphone's manual for further information, including how to correct for barometric pressure.

Technical Specifications

Connector type		7-pin LEMO
Theoretical dynamic range lower limit with G.R.A.S. preamplifier	dB(A)	10.5
Theoretical dynamic range upper limit	dB	113
Coupler volume		1260@500 Hz
CE/RoHS compliant/WEEE registered		Yes/yes/yes

Typical performance data are shown on page 6, typical input impedance is shown on page 7.

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.

Warranty

All G.R.A.S. products are made of high-quality materials that will ensure life-long stability and robustness. Damaged diaphragms in microphones can be replaced. 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.