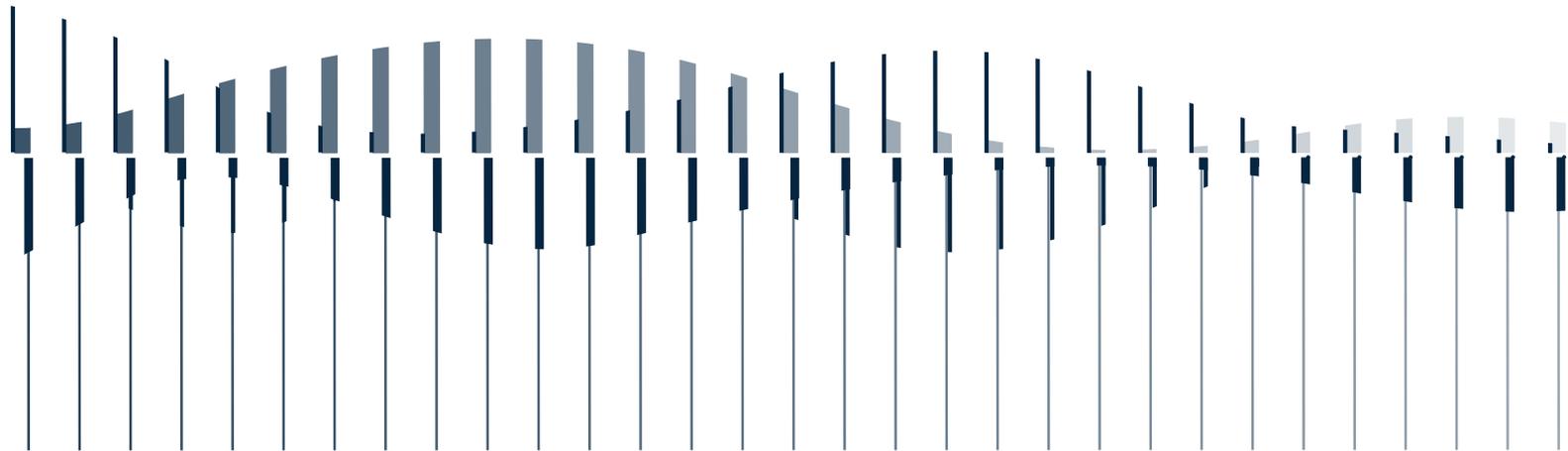


Instruction Manual

GRAS 60318-4 Ear Simulators

RA0045	Externally Polarized Ear Simulator
RA0045-S1	Prepolarized Ear Simulator
RA0045-S4	Externally Polarized Ear Simulator, High Sensitivity
RA0045-S5	Externally Polarized Ear Simulator, High Pressure
RA0045-S6	Prepolarized Ear Simulator, High Sensitivity
RA0401	Externally Polarized High-Frequency Ear Simulator
RA0402	Prepolarized High-Frequency Ear Simulator
RA0403	Externally Polarized Hi-Res Ear Simulator
RA0404	Prepolarized Hi-Res Ear Simulator



Revision History

Revision	Date	Description
1	30 September 2017	Extracted from Earbook as separate document. RA0045-S4, -S5 and -S6 added
2	17 September 2019	Correction to fig 5, page 7 (GR0409)
3	6 November 2019	High-Frequency and Hi-Res Ear Simulators added
4	11 August 2020	Paragraph about characteristics corrected.
5	2 September 2020	Information about level calibration at 1 kHz added

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Introduction

The 60318-4 Ear Simulators are for making acoustic measurements on earphones coupled to the human ear by ear inserts such as tubes, ear molds or ear tips. They are delivered with a built-in pressure microphone and an individual calibration chart for the coupler-microphone combination.

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

The ear simulators comply/are compatible with the following international requirements:

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

They come in a number of versions to meet specific connection and testing needs.

	Polarization	Microphone	Recommended Preamplifier
RA0045	External	40AG, 1/2"	26AK or 26AC-1
RA0045-S1	Prepolarized	40A0, 1/2"	26CA or 26CB
RA0045-S4	External	40AP, 1/2"	26AK or 26AC-1
RA0045-S5	External	40BP, 1/4"	26AC-1
RA0045-S6	Prepolarized	40AD, 1/2"	26CB

Apart from different microphones, the different versions are identical.

A number of versions with an internal resonance damping system are available. They extend the useful frequency range to 20 kHz (RA0401 and RA0402) and 50 kHz (RA0403 and RA0404).

	Polarization	Microphone	Recommended Preamplifier
RA0401	External	40AG, 1/2"	26AK or 26AC-1
RA0402	Prepolarized	40A0, 1/2"	26CA or 26CB
RA0403	External	40BP, 1/4"	26AC-1
RA0404	Prepolarized	40BD 1/4"	26CB

Apart from different microphones, these four are identical.

Components

The ear simulators are delivered as shown in Fig. 1, to the left. An exploded view of the user-serviceable components is shown to the right.

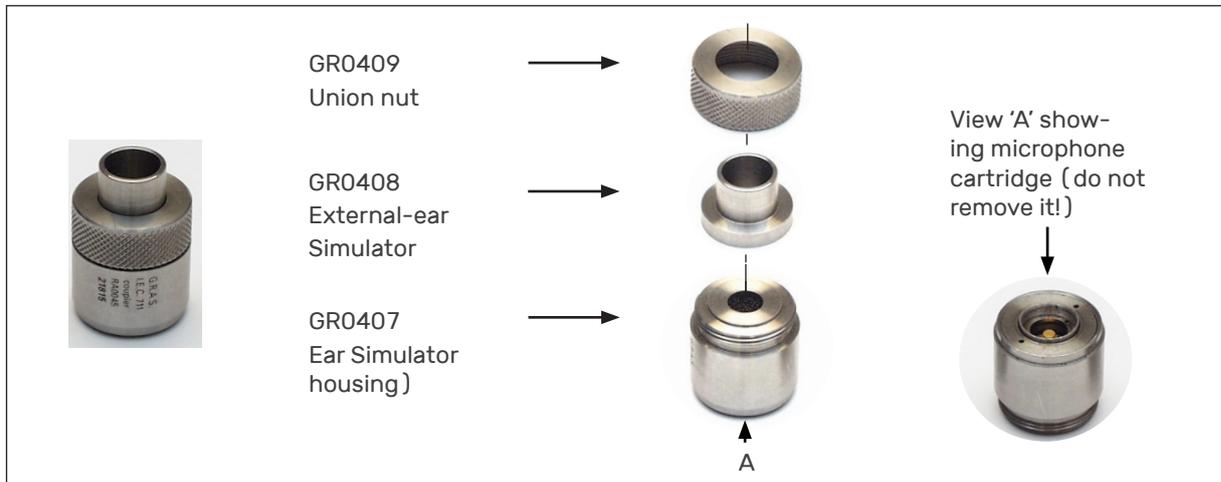


Fig. 1. The 60318-4 Ear Simulator as delivered (left) and its user serviceable parts (right)

The following user-serviceable components are included:

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

Characteristics

The acoustic input impedance of the IEC 60318-4 ear simulators closely resembles that of the human ear up to 10 kHz and, as a result, loads a sound source in very much the same way. They embody 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 air mass and airflow within the resistive grooves.

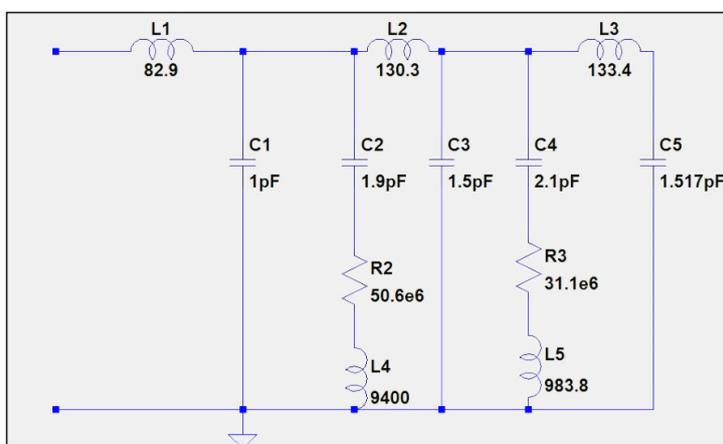


Fig. 2. Electrical equivalent diagram. The sound source is not shown in the model.

Fig. 3 shows the typical transfer impedance for the three main versions of the 60318-4 ear simulator, the standardized RA0045 and the newer versions with internal resonance damping, the RA0401/02 High-Frequency Ear Simulator, and the RA0403/04 Hi-Res Ear Simulator.

Where the RA0045 (and the S1 to S6 versions) has a steep resonance at 13.5 kHz, the RA0401/02 and RA0403/04 benefit from the internal resonance damping system which extends the useful frequency range to 20 kHz and 50 kHz respectively.

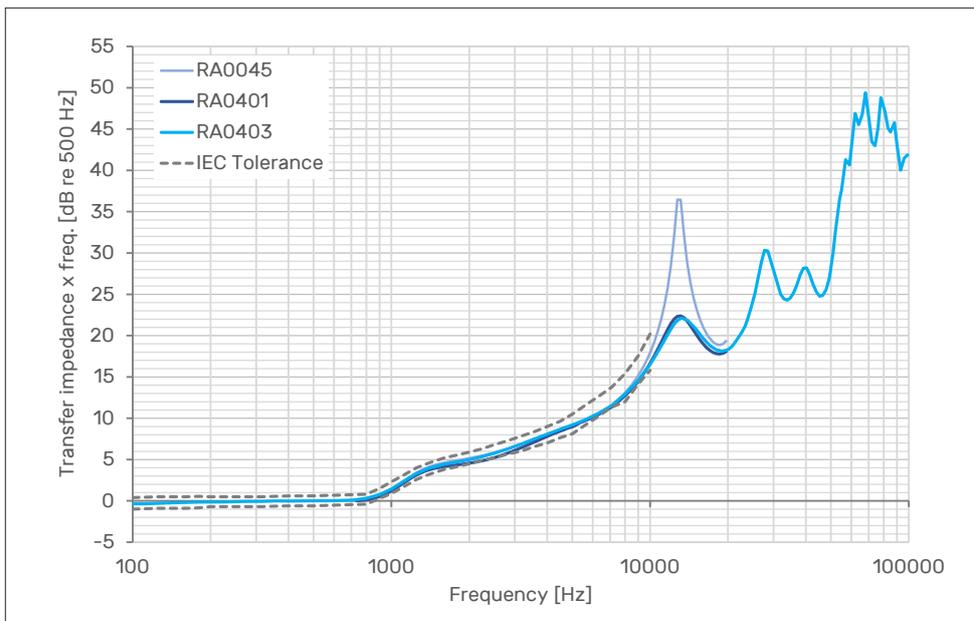


Fig. 3. Comparison of the typical transfer impedance re. 500 Hz for the three main versions of the IEC 60318-4 ear simulator.

Calibration

Level Calibration

This paragraph describes level calibration using a pistonphone, the procedure when using a sound calibrator is the same. However, do note that the corrections factors differ.

Correction Factors

The correction factors for calibration with a 42AP/42AA Pistonphone or a 42AG Multifunction Calibrator are listed below. These correction factors are needed to account for the effective volume resulting from using a pistonphone or the 42AG Multifunction Sound Calibrator.

Correction factors		
	External Ear Canal	Correction factor
42AP and 42AA	GR0408	-1.03 dB
42AG @250 Hz, 114 dB	GR0408	-0.09 dB
42AG @250 Hz, 94 dB	GR0408	-0.09 dB
42AG @1KHz, 114 dB	GR0408	-0.2 dB*
42AG @1KHz, 94 dB	GR0408	-0.2 dB*

Fig. 4. Correction factors for 42AA/AP Pistonphone and 42AG Multifunction Sound Calibrator

* See the following section **Calibration at 1 kHz**.

Calibration at 1 kHz

At 1 kHz, the frequency response changes from unit to unit. The actual value for the specific ear simulator is stated on the calibration chart and must be added to the correction. For example:

If the response of the specific ear simulator at 1 kHz is + 1.45 dB (re 500 Hz), the final correction value will be $-0.2 + 1.45 = 1.25$ dB. GRAS recommends calibrating at 250 Hz whenever possible.

Procedure

Before calibration, mount the external ear canal as shown below.

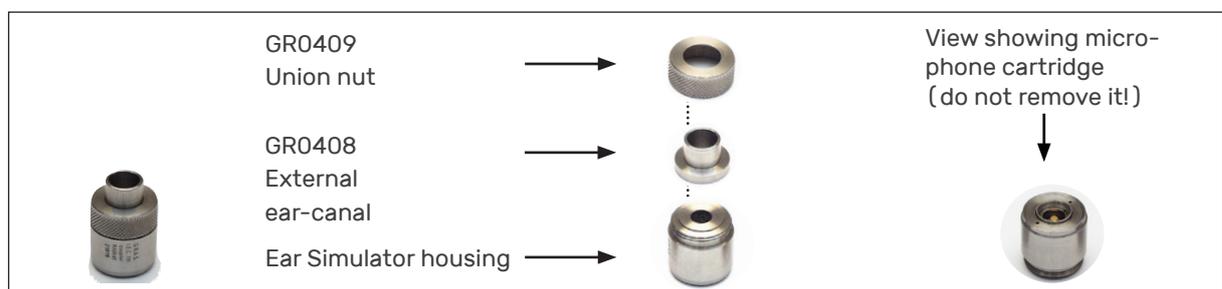


Fig. 5. Ear simulator ready for level calibration, with External Ear Canal and Union Nut.

Level calibration is the kind of calibration you would most often perform before measuring. How to perform a frequency calibration is described in "Frequency Calibration" on page 9.

Important! Do not extract the microphone housed in the ear simulator since this would invalidate the factory calibration. You will be calibrating the ear simulator as a whole with a pistonphone fitted with a ½" coupler. This, in effect, increases the coupler volume such that the signal from the pistonphone will be reduced by 1.03 dB .

- 1) Unscrew the collar of the pistonphone and remove the O-ring (see Fig. 6).

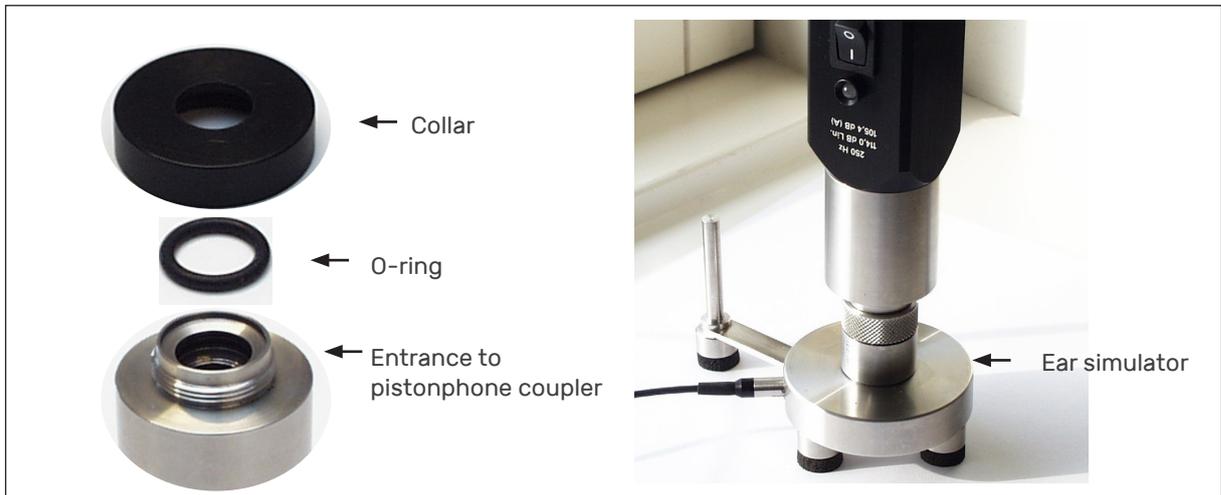


Fig. 6. Calibration using the pistonphone

- a) Unscrew pistonphone collar and remove O-ring.
 - b) Place coupler over the ear simulator, push gently down to the stop
 - c) Switch on
- 2) Place the coupler of the pistonphone over the ear simulator, push it gently down to the stop and switch on.
 - 3) Set the analyzer to either wide band or to the 1/3 octave band whose centre frequency is 250 Hz.
 - 4) When conditions are stable, adjust the analyzer so that it correctly gauges the pistonphone signal (nominally $114 - 1.03 = 112.97$ dB). See the pistonphone manual for making barometric corrections.
 - 5) Switch the pistonphone off and remove it from the ear simulator.
 - 6) Re-assemble the pistonphone.

Frequency Calibration

This section describes how to perform a frequency calibration using a 40BP ¼" Microphone as a sound source. For this, the RA0334 Calibration Kit is needed (must be ordered separately).

- 40BP ¼" Microphone
- RA0086 Transmitter Adapter for ¼" Microphones
- GR0433 Calibration Adapter
- GR0434 Stop Washer
- GR2099 Nut



Fig. 7. Assembled and exploded views of the ear simulator itemising user-serviceable accessories for individual calibration

The ¼" microphone is used as a high-impedance sound source. The complete set-up is shown in Fig. 9. The computer in Fig. 7 is capable of concurrently generating and measuring audio frequency signals. The 14AA Actuator Supply receives a swept tone generated by the computer and sends this, superimposed on a polarisation voltage of 200VDC, to the ear simulator mounted in the jig, also shown in Fig. 9. The ear simulator picks up the resulting audio signal and sends this back to the computer which traces out and displays the response. An example of a displayed response is shown in Fig. 10.

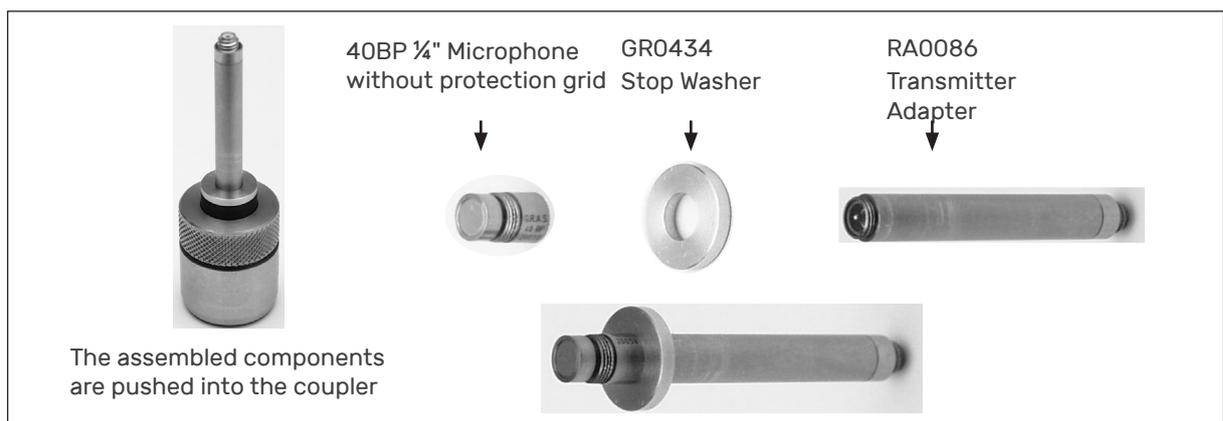


Fig. 8. Assembled and exploded views showing how the GR0434 is used when calibrating the Ear Simulator.

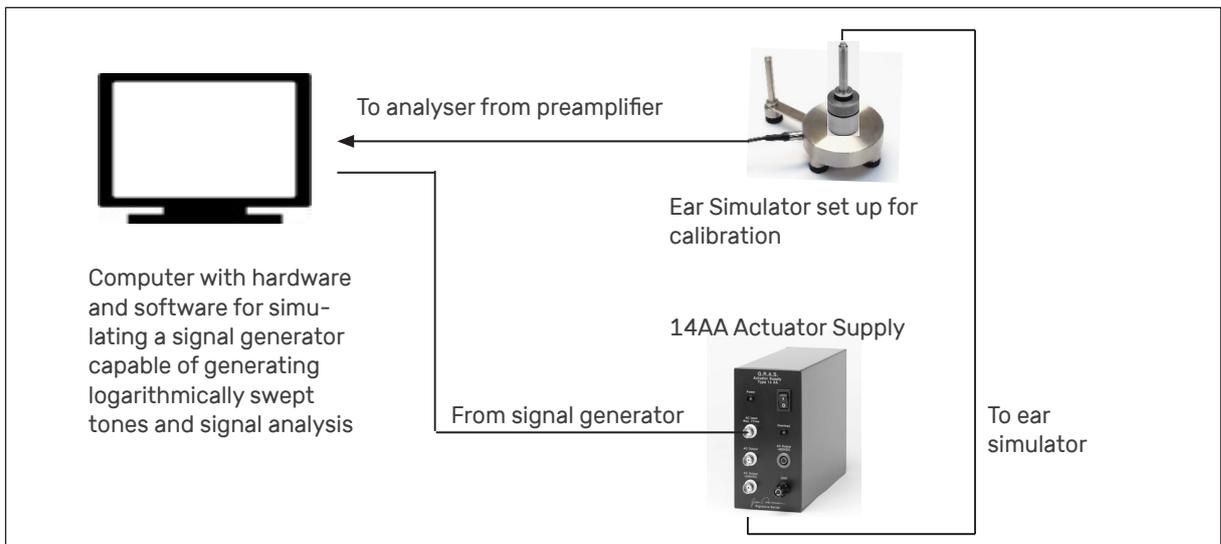


Fig. 9. Block diagram of a complete set-up for calibration.

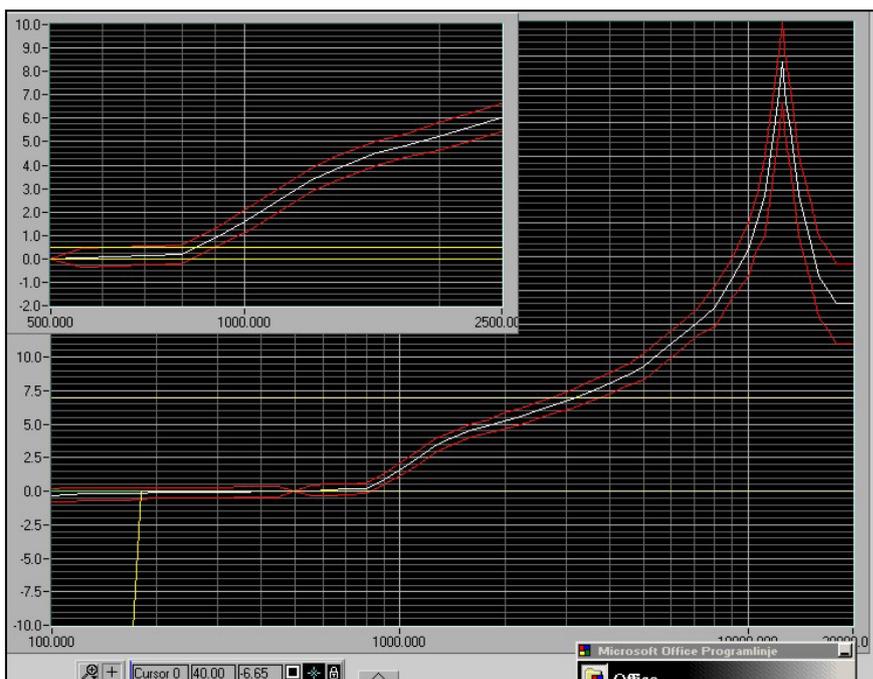


Fig. 10. Example of a calibration result using a swept tone.

Warranty, Service and Repair

Calibration

Before leaving the factory, all GRAS products are calibrated in a controlled laboratory environment using traceable calibration equipment.

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

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

Warranty

GRAS products are made of components from our proven standard portfolio and are all manufactured of high-quality material and branded parts that were chosen and processed to ensure life-long stability and robustness.

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

The warranty period for the ear simulators covered by this manual is 5 years.

Service and Repairs

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

Manufactured to conform with:

CE marking directive:
93/68/EEC



WEEE directive:
2002/96/EC



RoHS directive:
2002/95/EC



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