

# GRAS RA0403

Externally Polarized Hi-Res Ear Simulator



100 Hz to 10 kHz: According to IEC 60318-4  
10 kHz to 20 kHz:  $\pm 2.2$  dB  
20 kHz to 50 kHz:  $\pm 3.2$  dB  
Volume: 1260 mm<sup>3</sup> @ 500 Hz  
Sensitivity: 1.6 mV/Pa  
Damped resonance, with peak @ 13.5 kHz

The GRAS RA0403 is a hi-res ear simulator with an acoustic input impedance closely resembling that of an average human ear. It includes a 40BP 1/4" pressure microphone and is individually calibrated with this specific microphone. It features a special damping system that extends its useful frequency range to 50 kHz. Its prepolarized equivalent is [RA0404](#).

## Introduction

The GRAS RA0403 is an ear simulator for hi-res audio testing. It is developed to meet the increasing demand for realistic and accurate high-frequency measurements with simulation of the acoustic load presented by the human ear. It is intended as a research and development tool for high-resolution capable headphones.

Using a ¼" microphone and a special damping system to attenuate the internal resonances, the RA0403 offers an unprecedented high-frequency capability for headphone testing.

The RA0403 is based on the standardized IEC60318-4 Ear Simulator but has been modified to improve its high-frequency response. It has the same internal design and its acoustic input impedance closely resembles that of the human ear and, as a result, loads a sound source in very much the same way. Below 10 kHz, the standardized ear simulator does a good job at simulating the human ear. However, above 10 kHz its performance starts rapidly to deteriorate. The primary reason for this is its high Q resonance at 13.5 kHz. This resonance makes the acoustic load that the ear simulator constitutes more complex and imposes an unlinearity on the output above 10 kHz where repeatability is poor and measurements of frequency response and distortion are unreliable.

The RA0403, however, uses a resonance damping system to attenuate the steep resonance at 13.5 kHz. This resonance is attenuated by more than 14 dB. This greatly improves the linearity above 10 kHz and makes it possible to use a ¼" microphone in the coupler and benefit from its extended frequency range. Therefore, the RA0403 is well suited for research and development of high-resolution capable headphones up to 50 kHz.

It is compatible with IEC60318-4 and its acoustic

transfer impedance is within the tolerance band specified by IEC60318-4 up to 10 kHz. From 10 to 20 kHz the transfer impedance is within  $\pm 2.2$  dB, from 20 kHz to 50 kHz it is within  $\pm 3.2$  dB. Therefore, it is now possible to make measurements up to 50 kHz with good repeatability.

It is measured and calibrated according to IEC60318-4 and delivered with a calibration chart specifying its sensitivity and frequency response.

When mounted in a KEMAR in combination with an anthropometric pinna you have the possibility of performing high-frequency tests including the effects from head diffractions.

Its prepolarized equivalent is [GRAS RA0404](#).

## Features

- Transfer impedance compatible with IEC60318-4
- 10 kHz to 20 kHz the response is within  $\pm 2.2$  dB
- 20 to 50 kHz the response is within  $\pm 3.2$  dB
- The 13.5 kHz resonance damped by more than 14 dB
- Calibrated to 100 kHz

## Benefits

- Measurements with a realistic acoustical load of the test object
- Measurements below and above 10 kHz in the same test sequence – results below and above 10 kHz can be compared/analyzed in the same process.
- Measurements below and above 10 kHz both at the ear-drum reference point, i. e. with the same acoustical load.
- Better distortion measurements, even from as low as 3–5 kHz and upwards.

## Design

The RA0403 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 airflow within the resistive grooves.

It is delivered with a built-in [GRAS 40BP 1/4"](#) externally polarized pressure microphone and an individual calibration chart for the ear simulator.

Where the standard ear simulator has a high Q resonance at about 13.5 kHz, the high-resolution version has a built-in dampening system that attenuates the volume related resonances by about 14 dB. Also, the shape of the resonances has been softened. The effects of the internal resonances are well controlled. At the same time, the slopes of the resonances are more rounded, making it possible to obtain reliable and reproducible measurement results.

The overall result is a much more useful response, whose effects on measurements are much easier to identify and the useful frequency range of the coupler is extended to 50 kHz.

## Typical applications and use

The RA0403 is for measurements on earphones where the influence of the pinna and the head and torso are part of the investigation.

GRAS has a large portfolio of test devices for such measurements, ranging from fairly simple tabletop test setups to comprehensive configurations based on the KEMAR manikin, with or without mouth simulation.

## 45CA Headphone Test Fixture

The RA0403 is a drop-in replacement for 45CA already configured with an externally polarized ear simulator.

A preconfigured version is available, the 45CA-11 Headphone Test Fixture - Hi-Res Ear Simulator & Anthro. Pin LEMO.

The prepolarized equivalent is the 45CA-12 Headphone Test Fixture - Hi-Res Ear Simulator & Anthro. Pin CCP.

## KEMAR

RA0403 is a drop-in replacement for KEMAR already configured with an RA0045 or a RA0401.

Four configurations are available:

45BB-15 KEMAR for Test of Ear & Headphones with Hi-Res Ear Simulator, 2-Ch LEMO

45BC-15 KEMAR for Test of Headset with Hi-Res Ear Simulator, 2-Ch LEMO

The prepolarized equivalents are:

45BB-16 KEMAR for Test of Ear & Headphones with Hi-Res Ear Simulator, 2-Ch CCP

45BC-16 KEMAR for Test of Headset with Hi-Res Ear Simulator, 2-Ch CCP

## GRAS 43-series tabletop Ear Simulator Kits

If you already own one of our tabletop testbeds, the RA0403 is a drop-in replacement for a 43AG already configured with RA0045.

A preconfigured version is available, the 43AG-8 Anthro. Ear and Cheek Simulator with Hi-Res Ear Simulator, LEMO

The prepolarized equivalent is 43AG-9 Anthro. Ear and Cheek Simulator with Hi-Res Ear Simulator, CCP.

Two versions of the 43AC Ear Simulator Kit configured for hires testing are available:

43AC-S6 with Hi-Res Ear Simulator, LEMO and  
43AC-S7 with Hi-Res Ear Simulator, CCP

## Headphone testing

Realistic test of headphones and earphones requires that they are presented with an acoustic load that simulates the human ear. The traditional 60318-4 coupler does exactly that, but testing above 10 kHz does not produce reliable and reproducible results because of the sharp and very dominant resonance at 13.5 kHz. In practice, this limitation has made it necessary to measure the high-frequency behavior of the transducer under test with other means, such as mounting it on a baffle and measure in the near-field with a ¼" microphone.

With the RA0403 ear simulator, it is now possible to measure below and above 10 kHz in the same measurement setup, at the drum reference point and with the same acoustical loading of the transducer under test. This makes tests of headphones much easier, with improved repeatability.

RA0403 can be used as a development tool for the development of insert type headphones as well as supra- and circumaural types.

For R&D of headphones, the RA0403 can be mounted in a KEMAR. When furnished with the anthropometric pinna, tests of supra-aural and circum-aural headphones can be done to a much higher degree of realism than previously possible. When a headphone is mounted, the anthropometric pinna collapses against the head much like the real ear, and sealing and leakage related effects can

better be investigated. For insert type of headphones, the better shape of the ear canal improves seal and fit, vastly improving the repeatability of measurements.

The combined advantage of the anthropometric pinna and the RA0403 is better test results at low frequencies and improved resolution at high frequencies and much-improved repeatability.

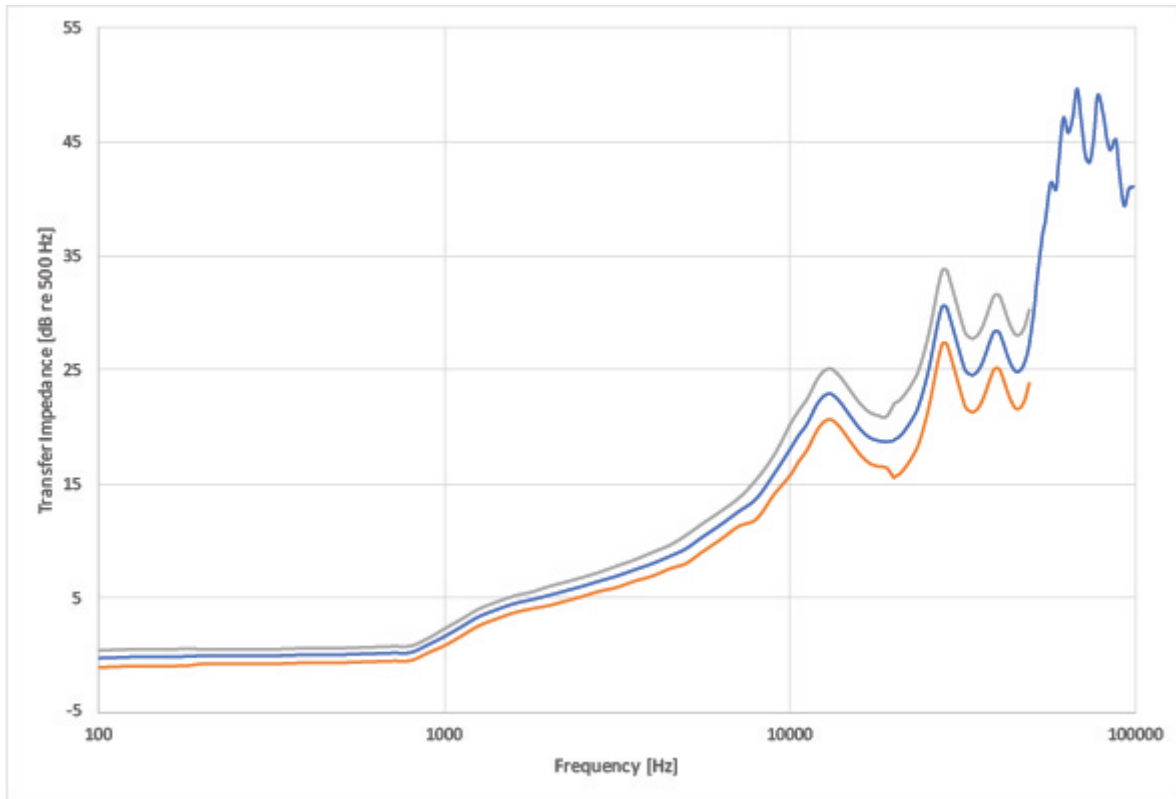
For QC purposes, the RA0403 can be mounted in a 45CA Headphone/Hearing-protector Test Fixture.

## Compatibility

The RA0403 can be used with a standard LEMO preamplifier, e.g. the [GRAS 26AC-1](#) 1/4" Preamplifier. For dual-channel applications with size constraints, use the [GRAS 26AS](#) 1/4" Preamplifier, very short.

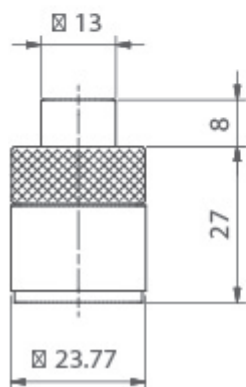
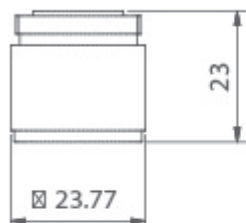
Like the RA0045 the RA0403 has a dust protection filter to prevent dust and dirt from entering the internal volume. This filter should be kept clean and replaced when needed as dust build-up will influence the performance of the ear simulator.

Polarization/Connection		200 V / Traditional
Theoretical dynamic range lower limit with GRAS preamplifier	dB(A)	44
Theoretical dynamic range upper limit with GRAS preamplifier @ +28 V / ±14 V power supply	dB	169
Theoretical dynamic range upper limit with GRAS preamplifier @ +120 V / ±60 V power supply	dB	172
Set sensitivity @ 250 Hz (±3 dB)	mV/Pa	1,5 mV
Set sensitivity @ 250 Hz (±3 dB)	dB re 1V/Pa	-56,5
Resonance frequency	kHz	13.5
Coupler volume	mm <sup>3</sup>	1260 @ 500 Hz
Temperature range, operation	°C / °F	-30 to 60 / -22 to 140
Temperature coefficient @250 Hz	dB/°C / dB/°F	-0.01 / -0.006
Humidity range non condensing	% RH	0 to 90
ANSI standard		S3.7
IEC standard		Based on 60318-4
ITU-T recommendations		P.57
CE/RoHS compliant/WEEE registered		Yes/Yes, Yes
Weight	g / oz	44
Frequency Response	IEC60318-4 ± 2,2 dB ± 3,2 dB	100 Hz -13,5 kHz 10 kHz - 20 kHz 20 kHz - 50 kHz



*Fig 1. The transfer impedance of a typical RA0403 Hi-Res Ear Simulator with tolerances. Up to 10 kHz, the response is within the limits defined by IEC 60318-4. Above 10 kHz, the response is within a fairly tight tolerance band up to 50 kHz*

Dimensions in mm



## Optional items

<a href="#">GRAS RA0088</a>	In Ear Adapter
GRAS GR0433	Calibration Adapter
GRAS GR0434	Stop Washer
GRAS GR0436	Tube Adapter
GRAS GR0437	Ear-mould Simulator
GRAS GR0438	Retention Ring
GRAS GR0440	Tube Adapter
<a href="#">GRAS 26AC-1</a>	1/4" Standard Preamplifier with Integrated Miniconnector
<a href="#">GRAS 26AS</a>	1/4" Preamplifier, Very Short

GRAS Sound & Vibration reserves the right to change specifications and accessories without notice.



# GRAS Worldwide

Subsidiaries and distributors in more  
than 40 countries

**HEAD OFFICE, DENMARK**  
**GRAS SOUND & VIBRATION**  
Skovlytoften 33  
2840 Holte  
Denmark  
Tel: +45 4566 4046  
[www.GRASacoustics.com](http://www.GRASacoustics.com)  
[gras@grasacoustics.com](mailto:gras@grasacoustics.com)

**USA**  
**GRAS SOUND & VIBRATION**  
9290 SW Nimbus Avenue  
Beaverton, OR 97008  
Tel: 503-627-0832  
Toll Free: 800-231-7350  
[www.GRASacoustics.com](http://www.GRASacoustics.com)  
[sales-usa@grasacoustics.com](mailto:sales-usa@grasacoustics.com)

**UK**  
**GRAS SOUND & VIBRATION**  
Unit 115, Gibson House,  
Ermine Business Park, Huntingdon,  
Cambridgeshire, PE29 6XU  
Tel: +44 (0) 7762 584 202  
[www.GRASacoustics.com](http://www.GRASacoustics.com)  
[sales-uk@grasacoustics.com](mailto:sales-uk@grasacoustics.com)

**CHINA**  
**GRAS SOUND & VIBRATION**  
Room 315, RuiBo Center(T1)  
Lane683, Shenhong Rd,  
Minhang District,  
Shanghai, China, 201107  
Tel: +86 21 64203370  
[www.GRASacoustics.cn](http://www.GRASacoustics.cn)  
[cnsales@grasacoustics.com](mailto:cnsales@grasacoustics.com)



## About GRAS Sound & Vibration

GRAS is a worldwide leader in the sound and vibration industry. We develop and manufacture state-of-the-art measurement microphones and related equipment for industries where acoustic measuring accuracy and repeatability are of the utmost importance. This includes applications and solutions for customers within the fields of aerospace, automotive, audiology, consumer electronics and other highly demanding industries. GRAS microphones are designed to live up to the high quality, durability and accuracy that our customers have come to expect, trust and require.

GRAS Sound & Vibration is represented through subsidiaries and distributors in more than 40 countries and is part of Axiometrix Solutions, a leading test solutions provider comprised of globally recognized measurement brands. Read more at [www.grasacoustics.com](http://www.grasacoustics.com)

[grasacoustics.com](http://grasacoustics.com)

**GRAS**  
An Axiometrix Solutions Brand