GRAS RA0402

Prepolarized High-Frequency Ear Simulator

100 Hz to 10 kHz according to IEC 60318-4
10 to 20 kHz: ± 2.2 dB test tolerance
Damped resonance, with peak @ 13.5 kHz
Volume 1260 mm³ @ 500 Hz according to IEC 60318-4
Sensitivity 12.5 mV/Pa
Based on ITU-T Rec P.57

The GRAS RA0402 is a high-frequency ear simulator with an acoustic input impedance closely resembling that of an average human ear. It includes a 40AO 1/2" pressure microphone and is individually calibrated with this specific microphone. It features a special dampening system that extends its useful frequency range to 20 kHz. Its externally equivalent is GRAS RA0401.

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Introduction

The GRAS RA0402 is a high-frequency version of the well-known standardized 60318-4 ear simulator which has gained wide acceptance as the preferred tool for measurements with simulation of the acoustic load presented by the human ear. Below 10 kHz, the standardized ear simulator does a good job at this. 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 un-linearity on the output above 10 kHz where repeatability is poor and measurements of frequency response and distortion are unreliable.

The new GRAS High-Frequency Ear Simulator mitigates this limitation. The steep resonance at 13.5 kHz has been replaced by a much-damped resonance and the useful frequency range is now extended to 20 kHz within a narrow tolerance band.

It complies with IEC60318-4 and its acoustic transfer impedance is within the tolerance band specified by IEC60318-4. From 10 to 20 kHz the transfer impedance is within ± 2.2 dB, resulting in much-improved repeatability. Also, realistic THD measurements are now possible. It is measured and calibrated according to the ITU-T Recommendation P.57 and delivered with a calibration chart specifying its sensitivity and frequency response.

Its externally polarized equivalent is GRAS RA0401 Externally Polarized High-Frequency Ear Simulator.

Features

- Transfer impedance in compliance with IEC60318-4
- 10 to 20 kHz the response is within ± 2.2 dB
- The 13.5 kHz resonance dampened by about 14 dB

Benefits

- 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 eardrum reference point, i. e. with the same acoustical load.
- Better distortion measurements, even from as low 3-5 kHz and upwards.

It complies 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 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

Design

The RA0402 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.

It is delivered with a built-in GRAS 40AO 1/2" prepolarized 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-frequency 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.

In this way, the useful frequency range of the coupler is extended to 20 kHz.

Comparison: The Standard 60318-4 Ear Simulator versus the RA0402 High-Frequency Ear Simulator

The advantages of the design with resonance dampening can easily be seen when comparing the standardized RA0045 Ear Simulator and the RA0402 Ear Simulator.

The curve below shows the transfer impedance of a standard RA0045 60318-4 Ear Simulator (Fig. 1)

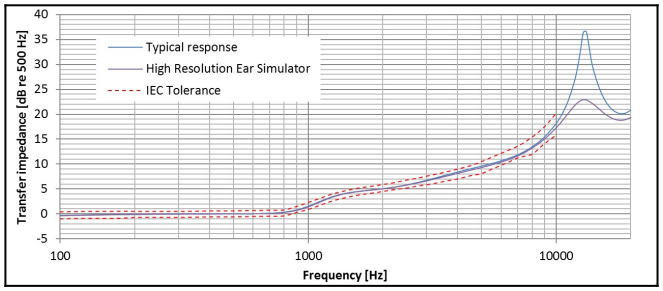


Fig 1. Comparison of the resonance of a typical standard 60318-4 Ear Simulator and a High-Frequency Ear Simulator

The transfer impedance of the High-Frequency Ear Simulator with the IEC tolerance and the GRAS tolerances from 10 to 20 kHz are shown in Fig. 2.

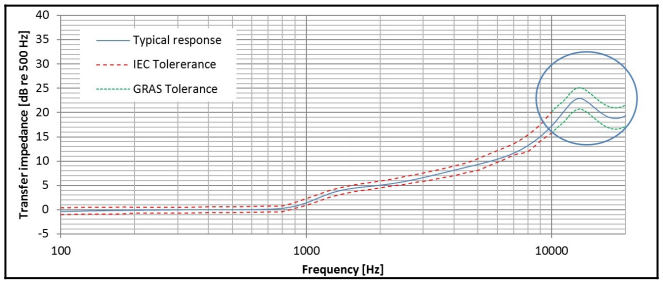


Fig 2. The half-wave resonance of a typical RA0402 High-Frequency Ear Simulator with IEC and GRAS tolerances

It can readily be seen that the amplitude and shape of the half-wave resonance are very different. Where the standardized ear simulator has a peak that tops above 36 dB, the RA0402 is 14 dB lower. At the same time, the slopes of this resonance are more rounded in the RA0402. The overall result is a much more useful response whose effects on measurements are much easier to identify.

Typical applications and use

The RA0402 is for measurements on earphones and hearing aids coupled to the human ear by ear inserts such as tubes, ear molds, or ear tips and for measurements 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.

KEMAR

A drop in-replacement for KEMAR already configured with RA0045 for testing

- Hearing aids, monaural or binaural
- Headphones, in-ear, supra- and circumaural
- Headsets

GRAS 43-series tabletop Ear Simulator Kits

If you already own one of our tabletop testbeds, the RA0402 is a drop-in replacement for 43AC, 43EA, and 43AG already configured with RA0045.

GRAS 43AC, GRAS 43AE, GRAS 43AG

Low and High Leak Pinna Simulators

In accordance with ITU-T Recommendation P.57, it can be used with the following GRAS pinna simulators for testing telephones:

- GRAS RA0056 Low-leak Pinna Simulator
- GRAS RA0057 High-leak Pinna Simulator

A comprehensive range of accessories for making measurements in accordance with IEC 60318-4 is available.

For upgrade information, contact GRAS for further information.

Audiology

Advances in hearing-aid design have made it possible to increase the frequency range of hearing aids. This is the basis for a need for a method for measuring above 10 kHz, in ways that are precise, consistent and offer good repeatability. A traditional 60318-4 ear simulator has poor repeatability above 10 kHz and is ill-suited for measurements on wide-band hearing aids.

The High-Frequency Ear Simulator meets the demand for an accurate broadband measurement method where the measurements at high frequencies can be trusted. It is within the IEC limits, so the link to historical data can be maintained and existing test procedures can still be used - full backward compatibility is ensured.

It is therefore well suited as a high-frequency supplement to the standardized 60318-4 (former 60711) ear simulator – or as a new reference tool for hearing aids manufacturers R&D testing and design verification.

Consumer electronics: 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 RA0402, 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.

RA0402 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 RA0402 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 RA0402 is better test results at low frequencies and improved resolution at high frequencies and much-improved repeatability.

For QC purposes, the RA0402 can be mounted in a 45CA Headphone/Hearing-protector Test Fixture.

Compatibility

The RA0402 can be used with a standard CCP preamplifier, e.g. the GRAS 26CA 1/2" Preamplifier or the GRAS 26CB 1/4" Preamplifier fitted with an

adapter. For the 1/4" preamplifier, use either the straight RA0003 Adapter or the right-angled RA0001 Adapter.

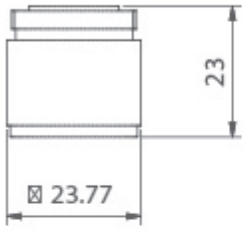
Like the RA0045 the RA0402 has a dust protection filter to prevent dust and dirt from entering the internal volume. This filter should be kept clean and replaced when needed as dust build-up will influence the performance of the coupler.

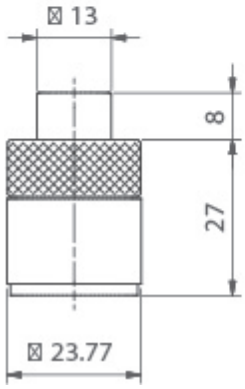
Specifications

Polarization/Connection		0 V / CCP
Theoretical dynamic range lower limit with GRAS preamplifier	dB(A)	25
Theoretical dynamic range upper limit with GRAS preamplifier @ +28 V / ±14 V power supply	dB	153
Theoretical dynamic range upper limit with GRAS preamplifier @ +120 V / ±60 V power supply	dB	164
Set sensitivity @ 250 Hz (±3 dB)	dB re 1V/Pa	-38
Resonance frequency	kHz	13.5
Coupler volume	mm^3	1260 @ 500 Hz
Temperature range, operation	°C / °F	-30 to 60 / -22 to 140
Temperature coefficient @250 Hz	dB/°C / dB/°F	0.05
Humidity range non condensing	% RH	0 to 90
ANSI standard		S3.7
IEC standard		60318-4 (former 60711)
ITU-T recommondations		P.57
CE/RoHS compliant/WEEE registered		Yes/Yes, Yes
Weight	g / oz	52 / 1.8

Dimensions

Dimensions in mm





Optional items

GRAS RA0088	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
GRAS RA0056	Low-leak Pinna Simulator
GRAS RA0057	High-leak Pinna Simulator
GRAS 26CA	26CA 1/2" CCP Standard Preamplifier with BNC Connector
GRAS 26CB	26CB 1/4" CCP Standard Preamplifier with Microdot Connector
GRAS RA0001	Right-angled Adapter for 1/2" microphone and 1/4" preamplifier
GRAS RA0003	Adapter for 1/2" microphone and 1/4" preamplifier

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

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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

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