

Pistonphones and Calibration Equipment

Calibration is an essential step in every precision sound measurement. It establishes the relationship between the sound pressure acting on a microphone and the resulting electrical output of the microphone. There are basically two properties of a measurement microphone requiring calibration, these are: Level calibration and frequency-response calibration.

Level calibration determines the absolute sensitivity of the measurement microphone. Various methods can be used, e.g. reciprocity, comparison, pistonphone or calibrator.

- a) Reciprocity is normally considered the most accurate method but is elaborate and expensive.
- b) Comparison is where the sensitivity of the microphone under test is compared with the known sensitivity of a reference microphone. It is simple and can be done with commonly-available equipment and requires minor investment.
- c) A pistonphone, with a precision barometer for applying static pressure corrections, is a robust and highly reliable method of level calibration at 250 Hz.
 - At 250 Hz, the frequency response of most microphones is flat and will give a more accurate result.
- d) A calibrator is a convenient way of calibrating a microphone at 1000 Hz but does not have the same precision as a pistonphone. Neither does it require static-pressure corrections.
 - At 1000 Hz, weighting filters have 0 dB attenuation and will therefore not affect the calibration. In these cases it might be an advantage to use a 1000 Hz calibration tone.

A frequency-response calibration describes the response of the microphone over a range of frequencies. Frequency-response measurements can be presented in various ways, i.e. pressure response, free-field response and diffuse-field response.

Generally, pressure response is determined by using an electrostatic actuator which simulates purely an oscillating pressure exerted on the microphone's diaphragm. Free-field and diffuse-field responses can then be arrived at by adding predetermined correction values to the measured actuator (pressure) response of the microphone.

Electrostatic actuators require no special acoustic laboratory facilities since background noise is not too critical a factor.

An electrostatic actuator consists of an electrically conductive rigid plate mounted close to, and parallel with, the microphone's diaphragm. When an oscillating voltage is applied between the microphone's housing and the electrostatic actuator, an oscillating force will be exerted on the diaphragm. This oscillating force simulates an oscillating sound pressure, thus making it possible to determine the response of the microphone to pressure alone. This means that the frequency response of microphones can be measured under normal circumstances, not requiring special sound insulated test chambers, as long as the background noise levels are reasonably low.

The pistonphone works on the principle of a pair of similar opposing, reciprocating pistons actuated by a precision-machined cam disc with a sinusoidal profile. The profile of the cam disc is such that the pistons follow a sinusoidal movement at a frequency equal to four times the speed of rotation. This results in a corresponding sinusoidal variation in the effective volume of the closed coupler and, consequently, an acoustic signal within it.

The mechanical structure of the pistonphone makes this generated acoustic pressure signal very reliable and stable. By careful control of the atmospheric pressure conditions and the calibration temperature, the calibration far exceeds the requirements for class LS calibrators. Absolute calibration accuracy has been determined to be within ± 0.05 dB at reference conditions for the pistonphone.



GRAS 42AA

Pistonphone



❖ 42AA is a precision sound source for calibrating microphones, sound level meters and other sound measuring equipment.

It is battery-operated and produces a constant nominal sound pressure level of 114 dB re. 20 μ Pa (equivalent to 10 Pa) at 250 Hz, or 105.4 dB(A) re. 20 μ Pa. Each 42AA is within 0.1dB of the nominal value and is delivered with an individual calibration chart and a barometer for Class 1 static pressure corrections. For Class 0 static pressure corrections, a precision barometer is required.

42AA can be used both for field checks of complete measurement systems as well as for laboratory calibrations of measurement microphones. It complies with the requirements of IEC 60942 (1988) Class 1 and is PTB approved.

GRAS 42AC

High Pressure Pistonphone



❖ 42AC is a precision sound source for calibrating microphones, sound level meters and other sound measuring equipment at high levels. It is battery-operated and produces a constant nominal sound pressure level of 134 dB re. 20 μ Pa (equivalent to 100 Pa) at 250 Hz, or 125.4 dB(A) re. 20 μ Pa. Each 42AC is within 0.1 dB of the nominal value and is delivered with an individual calibration chart and a barometer for Class 1 static pressure corrections. For Class 0 static pressure corrections, a precision barometer is required.

42AC can be used both for field checks of complete measurement systems as well as for laboratory calibrations of measurement microphones. It complies with the requirements of IEC 60942 (1988) Class 1. An adapter (GR0398) is included for use with hydrophone couplers.

Specifications	42AA	42AC	42AP
Sound pressure level	114 dB (re. 20 μ Pa) \pm 0.08 dB	134 dB (re. 20 μ Pa) \pm 0.08 dB	114 dB (re. 20 μ Pa) \pm 0.05 dB
Frequency	250 Hz	250 Hz	250 Hz or 251.2 Hz
Accuracy	IEC 60942 (1988) Class 1	IEC 60942 (1988) Class 1	IEC 60942 (1988) Class 0, LS
Temperature range	-10 °C to +55 °C	-10 °C to +55 °C	-10 °C to +55 °C
Batteries	4 x AA alkaline (IEC LR 6)	4 x AA alkaline (IEC LR 6)	4 x AA alkaline (IEC LR 6)
External power	-	-	6V DC 125mA
Weight	325 g	325 g	437 g

GRAS 42AP

Intelligent Pistonphone



42AP is a battery-operated precision sound source for calibrating microphones, sound level meters and other sound measuring equipment. It has built-in precision barometer and thermometer. Via its display and RS-232 interface, the user can read the actual corrected sound pressure level, as well as the calibration temperature and ambient static pressure.

It produces a constant nominal sound pressure level of 114 dB re. 20 μ Pa (equivalent to 10 Pa) at either 250 Hz or 251.2 Hz (true centre frequency of a 250 Hz, 1/3-octave band filter).

The actual sound pressure level, corrected for static ambient pressure, is shown on its display, which can also show the A-weighted sound pressure level after correcting it for using an A-weighting filter.

The display can be switched to show any of the following:

- Actual corrected sound pressure level in decibels
- Actual corrected sound pressure level in decibels, if measured with an A-weighting filter
- Static air pressure in hPa
- Calibration temperature in $^{\circ}$ C
- Calibration temperature in $^{\circ}$ F
- The pistonphone frequency can be programmed, via its RS-232 interface, to be either 250 Hz or 251.2 Hz
- 42AP is an extremely stable laboratory standard sound source, which can also be used for field calibrations - it retains its high accuracy even under hostile environmental conditions. It complies with all the requirements of IEC Standard 60942 (2003) LS
- An individual calibration chart is part of the delivery.

GRAS 42AG

Multifunction Sound Calibrator



42AG Multifunction Sound Calibrator is a portable, battery-operated precision microphone calibrator. The calibrator can be used directly on 1" microphones. Adapters for calibrating 1/2" (factory mounted), 1/4" and 1/8" microphones are included. It can produce a sinusoidal signal of 250 Hz or 1 kHz at 94 dB or 114 dB.

The calibration level is virtually independent of ambient conditions like temperature, atmospheric pressure and humidity within the specified range of operation. For documentation purposes, 42AG provides display of the environmental conditions: ambient air pressure, and temperature.

42AG comes with adapters for all standard microphone sizes from 1" down to 1/8".

Specifications	42AG
Sound pressure level	94 dB (± 0.2 dB) or 114 dB (± 0.2 dB)
Frequency	250 (251.19 \pm 0.30 Hz) or 1 kHz (1000 \pm 1 Hz)
Accuracy	IEC 60942 (1988) Class 1
Temperature range	-10 $^{\circ}$ C to +50 $^{\circ}$ C
Batteries	LR03 (AAA)
Weight	125 g

GRAS 42AE

Low Frequency Calibrator



42AE permits microphone calibration at frequencies down to 0.01 Hz for both front- and rear-vented microphones.

The two-port configuration allows the actual sound pressure in the coupler to be monitored by a reference microphone simultaneously with the microphone under test. The sound pressure can alternatively be monitored using the voltage output proportional to the pressure in the coupler. The built-in, DC-coupled power amplifier enables the calibrator to be used for swept-sine, broadband and step function investigations.

42AE is delivered with various types of adapters for calibrating 1/8" to 1" microphones and preamplifiers. A power supply is included.

Specifications	42AE
Sound Pressure Level	140 dB (re. 20 μ Pa)
Frequency	< 0.1 - 150 Hz
Signal Input (max)	0.7 Vrms
Calibration Signal	1 mV/Pa (140 dB max)
Weight	1.6 kg

GRAS 14AA

Electrostatic Actuator Amplifier



High voltage, high gain amplifier and voltage supply for driving electrostatic actuators. The high voltage output can also be used to drive standard microphones as sound sources. The 14AA can drive an electrostatic actuator with a 300 V peak-to-peak signal superimposed on 800 V DC.

Its wide frequency range makes it possible to determine the pressure frequency response of condenser microphones from 1 Hz to 200 kHz (note: care should be taken below 200 Hz because of the influence of pressure equalization in the rear volume of the microphone).

14AA can be connected directly to an external signal generator or the generator output of any standard signal analyzer.

Specifications	14AA
Input Signal (max)	3 V peak-to-peak
Gain	+ 40 dB
Output Signal (max)	300 V peak-to-peak
Actuator Polarization Voltage	800 V
Frequency Response	1 Hz - 200 kHz
Output Impedance	1 k Ω
Power Supply	110/130 V AC or 220/240 V AC
Weight	1.4 kg

Calibration Stands



The GRAS Calibration Stands provide convenient platforms for holding the microphones and accessories used for calibration. They ensure that microphones and accessories are mounted in exactly the same way every time you calibrate.

AL0010 provides a platform for testing condenser microphones. It has a fixture for holding a 1/2" preamplifier securely in place as well as recesses and a column for safely parking electrostatic actuators and microphone protection grids when not in use. It can be set up for both 1/2" and 1" microphones.

AL0011 provides a convenient platform for calibrating IEC 60318-1 Ear Simulators, e.g. RA0039. The stand and the adapters are designed for standardized frequency calibration using a transmitter setup with a microphone as sound source (not included) and the 14AA Electrostatic Actuator Amplifier for driving the setup.

- AL0010** Calibration Stand
- AL0011** Calibration Stand for IEC 60318-1 Ear Simulator
- AL0017** Pistonphone Calibration Stand (not shown)
- AL0021** Microphone Set Calibration Stand (not shown)



GRAS RA0014

1/2" Electrostatic Actuator



An electrostatic actuator for testing the frequency response of standard 1/2", 1/4" and 1/8" microphones. Adapters are included for testing 1/4" and 1/8" microphones. The RA0014 can be connected directly to the 14AA Electrostatic Actuator Amplifier.

GRAS RA0014-S1

1/2" Electrostatic Actuator for 40AU-1



As RA0014, but with dimensions fitting 40AU-1.

GRAS RA0015

1" Electrostatic Actuator



An electrostatic actuator for testing the frequency response of standard 1" microphones. The RA0015 can be connected directly to the 14AA Electrostatic Actuator Amplifier.

GRAS 51AB

Intensity Calibrator



For calibrating the phase response of a pair of microphones used for measuring sound intensity, e.g. GRAS 40AI and GRAS 40BI. It includes a calibrated acoustic resistance to enable the computation of particle velocity and intensity levels.

Complies with IEC International Standard 61043.

Accessories included:

2 x 1/4" microphone adapters

Specifications	51AB
Input Connector	BNC socket
Maximum input signal	1 V RMS
Frequency Range	50 Hz - 6.3 kHz
Frequency-intensity index	>27 dB (nomin. mic. spacing 25 mm)
SPL difference between channels	<0.1 dB
Operating temperature range	+ 5 °C to + 40 °C
Dimensions	Height: 42.2 mm Width: 50.3 mm Depth: 60.0 mm
Weight	515 g

GRAS Audiometer Calibration Systems



The GRAS Audiometer Calibration Systems are configured to meet the requirements of modern audio-meter calibration. They are easy and fast to set up and control, and can be upgraded as your calibration needs change. Two standard packages are available and several options can be added depending on the type and features of the audiometer and connected earphones.



The GRAS 42AG Multifunction Sound Calibrator is also part of the delivery (not shown in the photo)

GRAS 90AA

Audiometer Calibration System



This system has been configured for the calibration technician on the move. It is portable and includes everything you need for calibrating supra- and circum-aural audiometric earphones like TDH-39 and HDA-200. The system includes a GRAS Audiometer Calibration Analyzer, two complete sets of standardized ear simulators on two coupler platforms, and a sound level calibrator and force gauge for verification of the system. All instrumentation is packed into a rugged suitcase that also allows space for options like free-field and insert-earphone calibration.

GRAS 90AB

Basic Audiometer Calibration System



This system is configured for the stationary calibration lab and will also calibrate supra- and circum-aural audiometric earphones like TDH-39 and HDA-200. This configuration includes a GRAS Audiometer Calibration Analyzer, two complete sets of standardized ear simulators and a coupler platform.

Specifications	GRAS 90AA & 90AB
Ear Simulators conform to:	ANSI 3.6 IEC 60318-1 & -2 & -3 & -4
Measured parameters:	Level, frequency and distortion (in one display)

GRAS 90CA -S2

Microphone Calibration System based on NI-PXI



Computer for system control and monitor are part of the delivery (not shown in the photo)



The GRAS 90CA-S2 Microphone Calibration System is a complete computer-controlled system for calibration of microphones and microphone sets. It provides you with a computer-controlled level and frequency-response calibration of measurement microphones and microphone sets. This highly automated process is convenient with its ready-to-use software and hardware, and auto-generated customizable documentation.

90CA-S2 provides accurate calibration hardware, easily changeable test conditions and a highly reproducible calibration method.

Calibration with the 90CA-S2 is in compliance with

- ANSI S1.10 – 1966 (R1976)
- IEC 61094-1
- IEC 61094-6

Additional software can be purchased for the calibration of preamplifiers.

Specifications	GRAS 90CA-S2
Level Calibration:	250 Hz, 114 dB
Frequency Calibration:	200 Hz to 92 kHz*

*Up to 200 kHz with additional hardware option