Introduction
The 45CB is an acoustic test fixture that can help manufacturers improve the quality of their products to meet the markets’ and the standards’ growing needs for design, quality assurance, and verified compliance to stricter regulations. The 45CB meets or exceeds the requirements as defined in ANSI/ASA S12.42 standard.

The 45CB’s robust design is ideally suited for binaural testing of active and passive earplugs, as well as circumaural hearing protectors. It is designed for portability, which gives you the flexibility you need to create testing setups from the lab to the field.

Features
- Compliance with ANSI/ASA S12.42 ("Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real Ear or Acoustic Test Fixture Procedures")
- Design that handles sound pressure levels up to 174 dB
- High self insertion loss that is better than 65 dB
- Extended frequency range from 80 Hz to 20 kHz
- Large base plate of the pinnae accommodates all types of circumaural ear muffs
- Control unit for heating the ear canal extension and pinnae to body temperature
- Long (14 mm) ear canal extension lined with silicone rubber for accommodating all types of ear plugs, including those designed for deep insertion
- Easy calibration

Applications
Tests at high sound levels with the 45CB include
- Measuring the insertion loss and sound pressure levels of
  - Active and passive earplugs
  - Circumaural earmuffs
  - Combined communication and hearing protection devices
- Testing with continuous or impulsive signals
- Testing in the laboratory or in the field
The Concept Behind the 45CB

At G.R.A.S., we have been working with high-quality measurement testing since the day we began. Our expertise is proven with the 45BA KEMAR manikin and the 45CA hearing-protector test fixture.

It was because of this expertise that ANSI's American National Standards on Acoustics S12 committee invited us to participate in the development of a new standard for measuring the insertion loss of hearing protection devices in continuous or impulsive noises.

Insertion loss requires testing and measuring both with and without hearing-protection devices and then calculating the difference between the two results. It is crucial for manufacturers to know the insertion loss of their hearing protector devices to achieve and ensure the required protection level and expected performance.

The new standard, ANSI S12.42, covers insertion loss testing procedures for both ATF (acoustic test fixtures) and MIRE (microphone-in-real-ear) in laboratory and field setups. At G.R.A.S., we set our focus on the development of the ATF manikin.

The standardized KEMAR design was a good starting point, but the new standard calls for extended ear canals and a higher self insertion loss required for the testing of high sound pressure levels that can be conducted without harm to a human subject. Additional elements were inspired by the 45CA, which conforms to the ISO 4869-3 standard that covers ear muffs, but not ear plugs as required by the new standard.

Based on the broad-reaching and respected acoustic expertise in G.R.A.S. and with the collaboration of the standards committee members, G.R.A.S. has developed a new acoustic test fixture that can meet the need for a commercially available ATF suitable for tests of hearing protectors at very high noise levels - the 45CB. In fact, it meets or exceeds the requirements as defined in ANSI/ASA S12.42.

The sturdy 45CB is built to handle a wide range of noise levels—continuous and impulsive—for testing

- Earplugs
- Active and passive ear muffs
- Ear muffs integrated in work and safety helmets or designed for use under helmets

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Fig. 2. Diagram of a typical setup with LEMO input to the analyzer for the 45CB and a blast probe for ear-muff testing.
Fig. 3. Position of ordinary earmuffs on the pinna.

Fig. 4. Earplug inserted in pinna.

Fig. 5. Typical mounting setup of the 45CB for field use.

Fig. 6. Position of safety helmet earmuffs on the pinna.

Fig. 7. A view of an aviator’s helmet earmuff’s placement on the pinna.

Applications
Because the 45CB is built to comply with, or exceed, the ANSI S12.42 standard, it can cope with demands such as testing in the field and withstanding high pressure levels like explosions.

The images on this page illustrate how the pinna is ideally suited for testing typical earmuff devices for different applications.
Technical Details

The pinnae for the 45CB are the same standardized KEMAR pinnae, but with a large base plate to comply with the requirements of the ANSI S12.42 for correct circumaural testing. This large base plate reduces or eliminates the risk of leakage.

The ear extension is also based on the original design for the 45BA KEMAR. It has been extended into a 14 mm long and 7.5 mm wide ear canal with a heatable silicone rubber lining. The ear extension can accommodate all sizes of ear plugs, especially the deep-insert type.

The removable ear simulator is based on the IEC 60318-4 standard (previously known as the 711 coupler) and modified with a ¼” pressure microphone, which makes it possible to test high sound levels and very fast impulse noises.

The control unit in the base of the 45CB is for setting and monitoring the temperature during tests. The control unit heats the silicone rubber lining of the ear canal extension to body temperature for realistic measurements of the properties and damping effects of ear plugs.

The 45CB includes two plugs for measuring self insertion loss in a closed ear.

Easy Calibration

We recommend calibration prior to each use to ensure the accuracy of your measurements. The design of the 45CB makes this task very easy. The Intelligent Pistonphone 42AP or Pistonphone 42AA are ideally suited for this task.

ANSI Blast Probe

According to the ANSI S12.42 standard, you must monitor the noise source in tests. The 67SB Blast Probe is designed to comply with ANSI S12.42. The 67SB measures the quality of the noise source, which means evaluating whether it is long enough and high enough for testing purposes. The measurements of the 67SB guarantee that your measurements are valid because the focus of the blast probe is on the length of time of the noise source.

The 67SB contains a ¼” microphone that is ideally suited for capturing impulsive noises with a very short time resolution. The microphone has an upper limit of 174 dB in the dynamic range and its frequency response exceeds that of the 45CB.
The Self Insertion Loss of the 45CB

In Fig. 11, the self insertion loss shown in the upper curve clearly indicates how the 45CB exceeds the ANSI S12.42 standard, which is indicated by the lower curve and the blocked-out area. This shows the difference between measurements with a closed and an open ear. (For verification of the self insertion loss, two plugs are included with the 45CB to use for closed ear measurements.)

Fig. 11. Self insertion loss of the 45CB at 170 dB continuous noise signal (top line) compared to ANSI S12.42 Standard (bottom line); the y axis shows damping re open ear (dB) and the x axis shows frequency (Hz).
The Time Domain of Impulse

Figure 12 shows an example of a signal suitable for impulse testing.

The dotted line represents the sound picked up by the 67SB. Its peak measurement of 6000 Pa is approximately 170 dB.

The solid line is the perception inside the open ear of the 45CB. Its peak measurement of 20,000 Pa corresponds to 180 dB.

The A-duration is 1 ms.

System Requirements

The 45CB is designed to handle high impulsive noises, which is why an externally polarized microphone with a 200 V polarization voltage was chosen. Your analyzer must be compatible with LEMO inputs to supply the voltage and the power supply to the preamplifiers. Otherwise, you can use a two-channel power module that will provide the conditioned line-out signal, using cables with BNC connectors.
Technical Specifications and Ordering Information

Technical Specifications

Head Dimensions
Width, from EEP to EEP (Ear Entrance Point) .................. 138 mm
Height from center axis .................................. 137 mm

45CB Dimensions
Width (from handle to handle) ............... 364 mm
Height, total ........................................ 400 mm
Depth .................................................. 240 mm
Weight ............................................. 14.75 kg
Mounting thread in base ....................... 5/8"

Self Insertion Loss
Measured with closed ear simulators
100 Hz – 8 kHz ................................ >74 dB
80 Hz – 12.5 kHz ................................ >65 dB

Ear Simulator Specifications

Dynamic range
Maximum level, open ear ..................... 174 dB
Nominal sensitivity at 250 Hz .......... 1.6 mV/Pa
Resonant frequency ........... 13.5 kHz (±1 kHz)
Effective volume .................. 1.26 cm³ (± 0.04 cm
Sensor output .................. Two 7-pin female Lemo

Data was collected in a temperature of 23 °C
(±3 °C) and in a relative humidity of 60 % ±20 %.

Power Supply
Mains ........................................ 110–230 V
Power Requirements ............... 24 V DC / 2.5 A

Power Requirements for Heating Unit
Socket .................................................. 2 pin
Voltage ............................................... 24 V DC
Power consumption .................. 2.5 A

Ambient Operating Conditions
Temperature................................. 0 °C – 39 °C
Relative humidity (non-condensing) 0 % – 100 %

System Integration
The 45CB is assembled and tested by G.R.A.S. before leaving the factory. An individual test certificate is included with each 45CB.

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.

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

Warranty
All G.R.A.S. products are made of high-quality materials that will ensure life-long stability and robustness. The 45CB is delivered with a 2-year warranty.

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.

For more information, contact your G.R.A.S. representative.

Service and Repair
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.

Fig. 13. Measurements on 45CB.
Ordering Information
The 45CB acoustic test fixture is delivered as a preassembled package. The contents of the package include

- The head assembly (two Ear Simulators, each with an Ear Canal Extension and ¼” pressure microphone; two plugs for self insertion loss verification; two preamplifiers, each with cable and 7-pin Lemo connector; and heating control panel, including connectors for the ear simulators and heating elements)
- Left and right pinnae
- Power supply for the heating system
- Hex key, 2.5 mm
- Flight case with removable wheels
- Manual

Fig. 14. The 45CB in the flight case

Accessories
These accessories must be ordered separately.

67SB Blast Probe according to ANSI S12.42

Dual channel power module for 45CB:
12AA 2-Channel LEMO Power Module with gain, filters, and SysCheck generator
or
12AQ 2-Channel CCP/LEMO Power Module with Signal Conditioning and Computer Interface

Single channel power module for 67SB:
12AK 1-Channel LEMO Power Module with gain, filters, and SysCheck generator
42AP Intelligent pistonphone

Cables
AA0008 3-m LEMO extension cable
AA0009 10-m LEMO extension cable
AA0012 30-m LEMO extension cable
AA0014 100-m LEMO extension cable
AA0034 2-m BNC-to-BNC
AA0035 3-m BNC-to-BNC
AA0036 5-m BNC-to-BNC

KB0075 Left pinna for 45CB, Shore 00-55
KB0076 Right pinna for 45CB, Shore 00-55
RA0157 ½” Calibration adapter for KEMAR pinnae

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.