KEMAR® Manikin Type 45BA

Product Data and Specifications

Features
- ANSI S3.36/ASA58-1985
- ANSI S3.25/ASA80-1989
- IEC 60959:1990
- IEC 60711 coupler
- KEMAR pinnae

Applications
- Hearing-aid testing
- Earphone testing
- Headset testing
- Handset testing
- Binaural recording

Description
The KEMAR® Manikin Type 45BA (Fig. 1), acquired from Knowles Electronics, is an acoustic research tool which permits reproducible measurements for establishing the performance of hearing aids and other electroacoustic devices, as well as the quality of binaural recordings. This head and torso simulator (HATS) is based on worldwide average human male and female head and torso dimensions and meets the requirements of ANSI S3.36/ASA58-1985 and IEC 60959:1990.

Background
Shortly after its introduction in 1972, hearing-aid manufacturers and research audiologists started using KEMAR for:
- Investigating the characteristics of hearing aids when mounted on the KEMAR Manikin.
- Seeking out new applications in which it was desired to simulate the actual use of acoustic devices on people, or the interaction of an average person with the acoustic environment.

This quickly led to a number of useful techniques which greatly simplified reporting the in-situ characteristics of hearing aids.

Applications
KEMAR has become a recognised industry-standard for in-situ anthropomorphic testing in the fields of:
- Hearing conservation
- Telecommunications
- Noise abatement

As well as for sound recording and sound-quality evaluation.

The manikin simulates the changes that occur to sound waves as they pass a human head and torso, such as the diffraction and reflection caused by each ear.

1 See also Manikin Measurements, Proceedings (KB0000). Can also be downloaded from www.gras.dk.
**External Connections**

The base plate is fitted with four anti-vibration mounts and includes sockets for all external connections at the base of the “spine” (Fig. 2). The torso also has a removable access panel on its back to facilitate setting up internal connections.

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**Pinnae description**

Twelve (six pairs) different types of pinnae are available from G.R.A.S. for the KEMAR Manikin. They come in two sizes (“Small” and “Large”) and in two shore hardnesses (Shore 00-55 and Shore 00-35). See Table 1. They all have matching holes for push-fitting them into the recesses on the sides of the KEMAR Head.

**Pinnae sizes**

- Small ears are typical of American and European females as well as Far-eastern males and females.
- Large ears have pinna sizes more typical of American and European males.
- VA-style (Veterans Administration) for use with tapered ear-extension canals.

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**Table 1 Available KEMAR pinnae**

<table>
<thead>
<tr>
<th>Ear No.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>KB0060</td>
<td>Small Right Ear Shore 00-55</td>
</tr>
<tr>
<td>KB0061</td>
<td>Small Left Ear Shore 00-55</td>
</tr>
<tr>
<td>KB0065</td>
<td>Large Right Ear Shore 00-55</td>
</tr>
<tr>
<td>KB0066</td>
<td>Large Left Ear Shore 00-55</td>
</tr>
<tr>
<td>KB0090</td>
<td>Large Right Ear (VA-style) Shore 00-55</td>
</tr>
<tr>
<td>KB0091</td>
<td>Large Left Ear (VA-style) Shore 00-55</td>
</tr>
<tr>
<td>KB1060</td>
<td>Small Right Ear Shore 00-35</td>
</tr>
<tr>
<td>KB1061</td>
<td>Small Left Ear Shore 00-35</td>
</tr>
<tr>
<td>KB1065</td>
<td>Large Right Ear Shore 00-35</td>
</tr>
<tr>
<td>KB1066</td>
<td>Large Left Ear Shore 00-35</td>
</tr>
<tr>
<td>KB1090</td>
<td>Large Right Ear (VA-style) Shore 00-35</td>
</tr>
<tr>
<td>KB1091</td>
<td>Large Left Ear (VA-style) Shore 00-35</td>
</tr>
</tbody>
</table>

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**Retrofitting earlier KEMAR Manikins for use with IEC 60711 Couplers**

A Retrofit (External-ear Simulator) Kit RA0143 (Fig. 2) is available for upgrading earlier KEMAR Manikins (with Zwislocki couplers) for use with G.R.A.S. IEC 60711 Couplers (RA0045).

A retrofit will enable full use of all Application-specific Accessories listed on page 7 under “What to Order”.

The RA0143 can be configured three different ways according to set-up requirements.
Fig 4 shows an exploded view of the components of the RA0143. Only the underlined component is changed according to set-up requirements, namely:

- **GR0917** External-ear simulator has a straight ear-extension canal. Use with IEC 60711 Coupler RA0045. Ear-mould simulators (shown encircled - not included) are available for testing BTE hearing aids: i.e. KB0110 (for 2 mm tubes) and KB0111 (for 3 mm tubes).

- **GR0924** External-ear simulator has a VA-style tapered ear-extension canal. Use with IEC 60711 Coupler RA0045.

- **GR0958** Holder for a ½-inch microphone with ¼-inch preamplifier and adapter, for holding the microphone at the EEP. No Coupler required.

All three are included with the RA0143.

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**Pistonphone Calibration**

Enabled simply by removing the Pinna Simulator in order to gain access to the external-ear simulator.

This will permit a Pistonphone Type 42AA fitted with a dedicated Adapter (RA0157) to fit directly onto the exposed external-ear simulator (Fig. 4).

A minor correction (−0.62 dB) will need to be applied to the nominal sound pressure level of the Pistonphone to account for the RA0157 and IEC 60711 Coupler.

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**Fig. 4 Exploded view of RA0143. Note: GR1153 is an optional extra with the RA0143**

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**Fig. 5 Using a Pistonphone to verify directly the sensitivity of the IEC 60711 Coupler**

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**Typical Applications**

Typical KEMAR applications are:

1. Hearing-aid testing
2. Earphone testing
3. Evaluating sound quality

The first two use the IEC 60711 Coupler RA0045, are monaural and require single-channel set-ups.

The third doesn’t need a Coupler but is binaural and requires a dual-channel set-up.

A typical set-up for each of these applications is described in the following pages.

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Note: the plate GR0915 shown in Fig. 4 is already mounted on the new models of KEMAR. It is relevant only when upgrading earlier models, e.g. those fitted with Zwislocki couplers.
**Hearing-aid testing**

Depending on which ear-extension canal is used with the RA0143 (see Fig. 4) and the IEC 60711 Coupler RA0045, KEMAR can be set-up for testing hearing aids which fall into the following categories:

- for BTE or full concha ITE hearing aids use GR0917 which has a straight ear-extension canal for use with Ear-mould Adapters KB0110/KB0111.

- for ITE, ITC or CIC hearing aids use GR0924 which has a VA-style tapered ear-extension canal.

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Fig. 7 Monaural set-up for testing hearing aids, IEC 60711 Coupler RA0045 required

Fig. 7 shows a monaural set-up for testing a hearing aid. The test signal from the generator is sent to a loudspeaker (via a power amplifier). The signal from the loudspeaker is picked up by the hearing aid attached to KEMAR’s ear (Fig. 6).

The microphone of the IEC 60711 Coupler fitted to KEMAR picks up the hearing aid’s audio signal and sends it to the analyser via the Power Module Type 12AK.

Fig. 7 shows a set-up using an IEC 60711 Ear Coupler RA0045 incorporating an externally-polarized microphone.

Alternatively, a set-up using a Coupler incorporating a pre-polarized microphone can be used. In this case a CCP preamplifier must be used with a compatible Constant-Current Power supply.

Full details of “What to Order” with either externally-polarized or pre-polarized Couplers are given on pages 7 and 8, as well as what “Additional Accessories” are available.
**Earphone testing**

There is an ever-increasing use of personal and private listening devices.

These devices make use of small earphones attached to the ear (see Fig. 8) and are required to reproduce the audio signals as faithfully as possible for the greater listening pleasure of the user.

How well it does this can be gauged using KEMAR fitted with an IEC 60711 Coupler RA0045 to simulate the way a listener experiences the audio signal from the earphone.

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*Fig. 9  Monaural set-up for testing an earphone, IEC 60711 Coupler RA0045 required*

Fig. 9 shows a monaural set-up for testing an earphone. The test signal is passed to the earphone (possibly via an adjustable amplifier) to the earphone attached to KEMAR’s ear (Fig. 8).

The microphone of the IEC 60711 Ear Coupler fitted to KEMAR picks up the earphone’s audio signal and sends it to the analyser via the Power Module Type 12AK.

Fig. 10 shows a set-up using an IEC 60711 Ear Coupler RA0045 incorporating an externally-polarized microphone.

Alternatively, a set-up using a Coupler incorporating a pre-polarized microphone can be used. In this case a CCP preamplifier must be used with a compatible Constant-Current Power supply.

Full details of “What to Order” with either externally-polarized or pre-polarized Couplers are given on pages 7 and 8, as well as what “Additional Accessories” are available.
Evaluating Sound Quality

Many products make some sort of sound when in use. And if they cannot be silenced altogether they should at least make a sound which signals quality.

A typical example is the sound of a car door closing, a soft “klunk” is preferable to a rattling slam.

Musical instruments must have the right “timbre”, a matter of harmonics, to lend quality to a recording session.

KEMAR, provided with binaural hearing with the aid of two ½-inch G.R.A.S. Pressure-field Microphones held in place by a GR0958 (see Fig. 4) comes close to the ideal set-up for evaluating the subjective quality of sounds. Note: Coupler not required.

Fig. 11 shows a binaural set-up for testing sound quality. The test object can be a product which must be “easy on the ear” such as a washing machine, a car door, or even an alarm clock.

The microphones fitted to KEMAR pick up the sound of the test object and send it to a recorder via the Dual Channel Power Module Type 12AA.

Fig. 11 shows a set-up which uses externally-polarized G.R.A.S. Microphones (Types 40AP)\(^3\).

Alternatively, a set-up using pre-polarized G.R.A.S. microphones (Types 40AD) could be used. In this case CCP preamplifiers must be used with compatible Constant-Current Power supplies.

Full details of “What to Order” with either externally-polarized or pre-polarized Microphones are given on pages 7 and 8, as well as what “Additional Accessories” are available.

\(^3\) For low-noise products, the lower limit of the dynamic range can be shifted down to 6.5 dBA by using a ½-inch Low-noise Level Microphone System Type 40HT with a special Power Module Type 12HF for each channel. In this case, the upper limit of the dynamic range will be 113 dB.
**What to Order**

KEMAR Manikin Type 45BA includes:
- 1x KEMAR Head assembly (excl. pinnae, couplers and microphones): Type 45DA
- 1x KEMAR Torso with Connector Assembly: RA0149
- 2x Collar Rings: GR0956
- 2x Coupler Holder with Standard Pinna-extension Tube: GR0917
- 2x Coupler Holder with VA-style Pinna-extension Tube: GR0924
- 2x ½-inch Microphone (50mV/Pa sensitivity) Holder for Binaural Recordings: GR0958
- 2x ¼-inch Microphone (12.5mV/Pa sensitivity) Holder for Binaural Recordings: GR1153
- 2x Retaining Rings for Coupler and the ½-inch Microphone Holder: GR0916
- 6x M3 Allen screw: SK1531
- 1x 2.5 mm Allen Key: YY0016

Application-specific Accessories
- Measurements of Hearing Instruments (ITE, ITC, CIC, BTE), headsets, earphones, ear-muffs and earplugs. Please note that the following configurations are for monaural measurements.

With externally polarized ear simulator
- 1x IEC 60 711 Coupler: RA0045
- 1x ¼-inch Preamplifier: Type 26AC
- 1x 90° Angle Adapter: RA0001

With pre-polarized ear simulator
- 1x IEC 60 711 Coupler: RA0045-S1
- 1x ¼-inch CCP Preamplifier: Type 26CB
- 1x 90° Angle Adapter: RA0001

Option for BTE Hearing Instruments
- 1x Pinna Mould Simulator for 2 mm Tube: KB0110
- 1x Pinna Mould Simulator for 3 mm Tube: KB0111

Optional KEMAR pinnae
- Hardness 55 Shore-00:
  - Small Right Pinna: KB0060
  - Small Left Pinna: KB0061
  - Large Right Pinna: KB0065
  - Large Left Pinna: KB0066
  - Large Right Pinna (VA-style): KB0090
  - Large Left Pinna (VA-style): KB0091
- Hardness 35 Shore-00:
  - Small Right Pinna: KB1060
  - Small Left Pinna: KB1061
  - Large Right Pinna: KB1065
  - Large Left Pinna: KB1066
  - Large Right Pinna (VA-style): KB1090
  - Large Left Pinna (VA-style): KB1091

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### What to Order (continued)

<table>
<thead>
<tr>
<th>Binaural recordings (left and right channels)</th>
<th>OR</th>
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<tbody>
<tr>
<td>With externally polarized microphones</td>
<td>2 x ½-inch Pressure-field Microphone, prepolarized (12.5mV/Pa, 3.15 Hz-20kHz): Type 40AO</td>
</tr>
<tr>
<td>2 x ½-inch Pressure-field Microphone (50mV/Pa, 3.15 Hz-10 kHz): Type 40AP</td>
<td></td>
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<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>2 x ½-inch Pressure-field Microphone (12.5mV/Pa, 3.15 Hz-20 kHz): Type 40AG</td>
<td></td>
</tr>
<tr>
<td>2 x ¼-inch Preamplifier (incl. Adaptor for ¼-inch preamplifier to ½-inch microphone GR0010): Type 26AC</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>With pre-polarized microphones</th>
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</thead>
<tbody>
<tr>
<td>2 x ½-inch Pressure-field Microphone, prepolarized (50mV/Pa, 6.3 Hz-10kHz): Type 40AD</td>
<td></td>
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</tbody>
</table>

### Additional Accessories (for all applications)

<table>
<thead>
<tr>
<th>Power module for ext. polarized Pinna simulators and microphones</th>
<th>Extension Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Module (Single-channel power supply with filter and gain): Type 12AK</td>
<td>For ext. polarized Pinna Simulators and microphones (LEMO - LEMO)</td>
</tr>
<tr>
<td>Power Module (Single-channel power supply, batt. operated): Type 12AD</td>
<td>3 m AA0008</td>
</tr>
<tr>
<td>Power Module (Dual-channel power supply with filter and gain): Type 12AA</td>
<td>10 m AA0009</td>
</tr>
<tr>
<td>Power Module (Dual-channel power supply, batt. operated): Type 12AR</td>
<td>xx m AA020-xx</td>
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<table>
<thead>
<tr>
<th>Power module for pre-polarized Pinna simulators and microphones</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>CCP(^4) Supply (Single-channel CCP supply, with A-weighting, batt. operated): Type 12AL</td>
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<table>
<thead>
<tr>
<th>Pistonphone Calibration</th>
<th>Litterature on KEMAR Manikin Type 45BA</th>
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</thead>
<tbody>
<tr>
<td>Pistonphone (250 Hz, 114 dB +/- 0,08 dB): Type 42AA</td>
<td>Manikin Measurements Book KB0000 (can be downloaded from <a href="http://www.gras.dk">www.gras.dk</a>)</td>
</tr>
<tr>
<td>Calibration Adaptor for KEMAR Pinna: RA0157</td>
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\(^{\text{a}}\) KEMAR is a registered trademark of G.R.A.S. Sound & Vibration

\(^{\text{4}}\) Constant Current Power

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G.R.A.S. Sound & Vibration reserves the right to change specifications and accessories without notice.