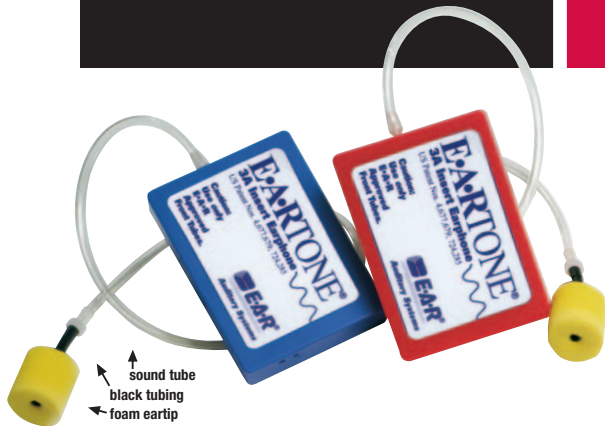


ER-3A INSERT EARPHONES for Audiometry

ETYMÖTIC RESEARCH^{INC.}



ER-3A Insert Earphones:

- approximate the TDH-39, -49, and -50 response at the eardrum
- are calibrated in a 2-cc coupler
- provide 30+ dB external noise exclusion
- provide noise exclusion equivalent to a single-wall booth
- provide 70+ dB isolation between ears, reducing the need for masking
- improve test/retest reliability compared to supra-aural earphone
- eliminate collapsed ear canal errors
- simplify RECD (Real-Ear-to-Coupler-Difference) measurements

EARTIP COUPLING

Foam eartips developed for ER-3A insert earphones are produced with constant dimensions to ensure proper calibration and test accuracy. To accommodate differences in ear canal size, there are three sizes of foam eartip (small, medium and large). To obtain accurate test results, the following dimensions must be maintained:

1. The length from the end of the eartip to the connection at the end of the earphone tube should be 22 mm (Figure 1). Do not cut the black tubing that connects the foam eartip to the sound tube.
2. The diameter from the end of the eartip to the connection at the end of the earphone tube should be 1.93 mm (Figure 1).
3. Insertion depth should be 14-15 mm into the ear canal, which is achieved when the edge of the foam eartip is 2-3 mm inside the entrance to the ear canal (Figure 2).

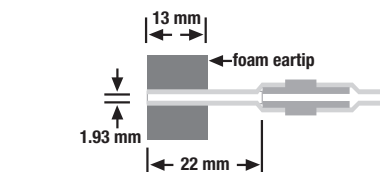


Figure 1

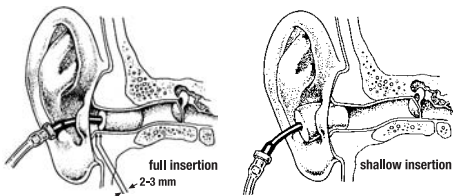


Figure 2

NOTE:

- Do not cut the sound tube itself. A change of 10 mm in the length of the sound tube will result in a change of the frequency response by 0.5 dB at some frequencies.
- Replace the sound tubes (ER3-04) if they crack or harden.
- Do not reuse foam eartips.

Foam eartips are recommended for most uses; however, immittance probe tip adapters (ER3-06) can be used with commonly used immittance eartips. When using immittance adapters, calibration will be maintained if the eartip is seated on the adapter so that the opening of the eartip is flush with the tip of the adapter (Figure 3). No data are available on the interaural attenuation or noise exclusion of immittance eartips.

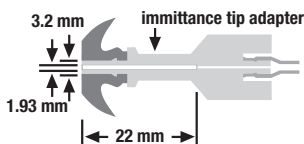


Figure 3

INSTRUCTIONS FOR USE

1. Examine the ear canal for obstruction or excessive cerumen.
2. Make sure the sound tube is not blocked.
3. Insert the black tubing of a fresh ER-3A foam eartip completely onto the nipple of the sound tube.
4. Roll the foam tip into the smallest diameter possible (Figure 4).
5. Insert the eartip well into the ear canal. Interaural attenuation is improved with deep insertion.
6. Allow foam to expand to acoustically seal ear canal.
7. Discard foam eartips after a single use.



Slowly roll and squeeze the eartip into as small a diameter as possible

Figure 4

ANSI S3.6 AND ISO 389.2 REFERENCE THRESHOLDS

Sound Pressure Levels in dB re. 20µPa

| Frequency (Hz) | Occluded Ear | HA-2 with | |
|----------------|--------------|-------------|-------------|
| | Simulator | Rigid Tube | HA-1 |
| 125 | 28.0 (98.0) | 26.0 (96.0) | 26.5 (86.5) |
| 250 | 17.5 (87.5) | 14.0 (84.0) | 14.5 (84.5) |
| 500 | 9.5 (79.5) | 5.5 (75.5) | 6.0 (76.0) |
| 750 | 6.0 (76.0) | 2.0 (72.0) | 2.0 (72.0) |
| 1000 | 5.5 (75.5) | 0.0 (70.0) | 0.0 (70.0) |
| 1500 | 9.5 (79.5) | 2.0 (72.0) | 0.0 (70.0) |
| 2000 | 11.5 (81.5) | 3.0 (73.0) | 2.5 (72.5) |
| 3000 | 13.0 (83.0) | 3.5 (73.5) | 2.5 (72.5) |
| 4000 | 15.0 (85.0) | 5.5 (75.5) | 0.0 (70.0) |
| 6000 | 16.0 (86.0) | 2.0 (72.0) | -2.5 (67.5) |
| 8000 | 15.5 (85.5) | 0.0 (70.0) | -3.5 (66.5) |

Table 1

CALIBRATION IN A 2CC COUPLER

Table 1 shows the Reference Equivalent Threshold Sound Pressure Levels (RETSPLs) measured in three couplers. The couplers are:

1. An occluded ear simulator as described in ANSI S3.7 and IEC 711 that closely replicates the acoustic properties of the average ear canal and eardrum. ANSI standard 3.6-1996 calls for the HA-2 sound channel to be substituted for the sound channel in the eartip.
2. An HA-1 2cc coupler with the ER-3 eartip sealed to the top surface of the coupler.
3. An HA-2 2cc coupler with rigid tube. In this case the sound channel of the coupler is substituted for the sound channel in the eartip.

Audiometer calibration is normally performed at a dial setting of 70 dB HL. The calibration targets shown in parentheses next to the RETSPL numbers in Table 1 were obtained by adding 70 dB to each RETSPL number.

ER-3A RESPONSE IN THREE COUPLERS

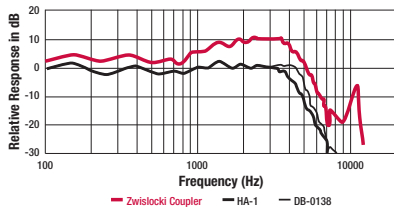


Figure 5

ER-3A RESPONSE IN THREE COUPLERS

The numbers in Table 1 were chosen to produce the same calibration regardless of coupler. In other words, an earphone calibrated to 70 dB SPL at 1 kHz in either of the 2cc couplers should produce 75.5 dB SPL at the average eardrum or in an occluded ear simulator.

Figure 5 shows the frequency response of an ER-3 earphone measured in each of three couplers. For the Zwislocki coupler (ear simulator) curve, the ER-3A eartip was sealed directly into the coupler rather than through an HA-2 sound channel as specified in ANSI S3.6-1996. The response measured with the eartip sealed into the coupler is nearly identical to the average eardrum pressure produced by an insert earphone such as the ER-3A (Sachs and Burkhard, 1972). The HA-2 sound channel introduces an extraneous high-frequency boost in the coupler measurement.

COMPARISON OF ANSI-1989 AND ANSI-1996

Measured in HA-1 2cc Coupler

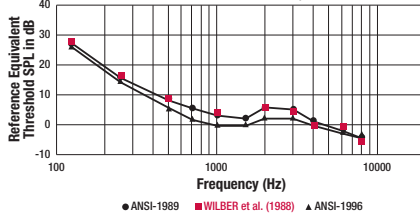


Figure 6

COMPARISON OF ANSI-1989 AND ANSI-1996

Measured in DB-0138 2cc Coupler

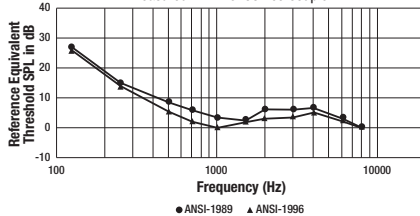


Figure 7

COMPARISON OF ANSI-1989 AND ANSI-1996

Measured in Occluded Ear Simulator

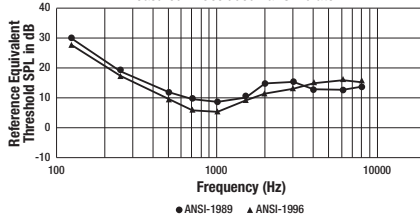


Figure 8

COMPARISON OF ANSI S3.6 1989 AND ANSI S3.6 1996

Figures 6 through 8 show the RETSPLs from ANSI S3.6-1989 and ANSI S3.6-1996. The 1996 values were based on only three studies (two European and one US), but were adopted in the U.S. in the interest of international harmony. The 1996 values are, nonetheless, the ones to be used for normal audiometer calibration in order to comply with legal requirements for proper calibration.

For purposes of hearing research, the ANSI S3.6-1989 values should be considered: They were originally based on a compilation of 35 studies from 1928 to 1977 (Killion, 1978), and validated by five threshold studies using the ER-3A insert earphone and summarized by Wilber et al. (1988). The ANSI 1989 ear simulator RETSPL numbers in Figure 8 are the same as the Minimum Audible Pressure at the Eardrum (MAPD) numbers described by Killion (1978).

CALIBRATION FOR SPEECH AUDIOMETRY

Calibration of ER-3A insert earphones for speech is performed by the following method:

1. Set a 1 kHz signal at 0 VU through the speech circuit.
2. Set the attenuator dial to 60 dB HL.
3. Adjust the speech circuit on the audiometer to measure 72.5 dB in a 2-cc coupler.

The ANSI standard specifies that a 1 kHz reference tone level for the speech circuit should be 12.5 dB above a 1 kHz reference test threshold for any earphone. The 1 kHz RETSPL for ER-3A is 0 dB SPL. ($60 + 0 + 12.5 = 72.5$). A range of 69.5 to 75.5 dB meets the ± 3 dB tolerance allowed in the ANSI standard.

TEST RELIABILITY

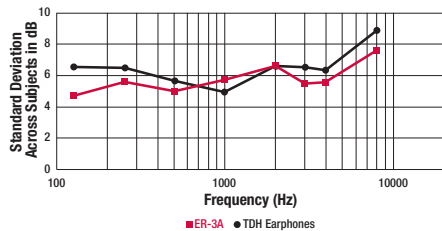


Figure 9

RELIABILITY

Traditional supra-aural earphones have several limitations. Among them are:

1. Poor noise exclusion at low frequencies, which invalidates tests done outside a sound booth.
2. Low interaural attenuation.
3. Erroneous high-frequency thresholds resulting from collapsed ear canals when using the traditional MX-41AR earphone cushions.

Insert earphones eliminate all three of these problems. Wilber et al. (1988) also found less variability across subjects using insert earphones (Figure 9).

EARTIP INSERTION

The purpose of deeply inserted eartips is to maximize interaural attenuation and noise exclusion, but there is usually less than a 3 dB difference in eardrum pressure (i.e., threshold) between shallow and deeply placed eartips.

EXTERNAL NOISE EXCLUSION OF 3 EARPHONES

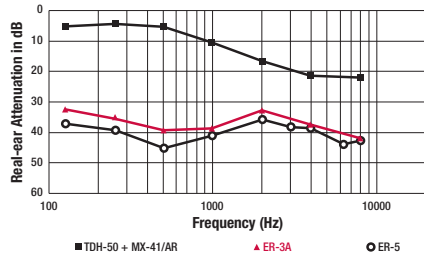


Figure 10

EXTERNAL NOISE EXCLUSION

ER-3A insert earphones provide greater than 30 dB exclusion of background noise. As insertion depth increases the amount of attenuation increases. Deeply inserted ER-3A foam eartips can provide noise exclusion equivalent to a single-wall booth. Testing to audiometric zero can be done reliably whenever the SPL of the background noise is less than 45 dBA. Figure 10 shows the attenuation of four audiometric earphones. The ER-3A and ER-5A have significantly greater attenuation than traditional supra-aural earphones and circumaural earphones.

INTERAURAL ATTENUATION OF TDH AND ER-3A EARPHONES

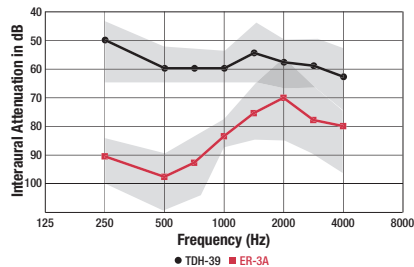


Figure 11

INTERAURAL ATTENUATION

A comparison of the interaural attenuation of a TDH-39 and ER-3A insert earphone is shown in Figure 11. High interaural attenuation values reduce the need for masking air conduction thresholds when using insert earphones. In cases of severe bilateral conductive hearing loss, a masking dilemma (overmasking) occurs when a high level of masking in the non-test ear reaches the opposite (test ear) cochlea via bone conduction and elevates threshold in the test ear. Interaural attenuation is significantly higher with insert earphones, making it possible to use lower masking levels in the non-test ear.

The interaural attenuation of the ER-3A insert earphone increases with insertion depth. Figure 12 illustrates the importance of deep eartip insertion when maximum interaural attenuation is desired.

INTERAURAL ATTENUATION

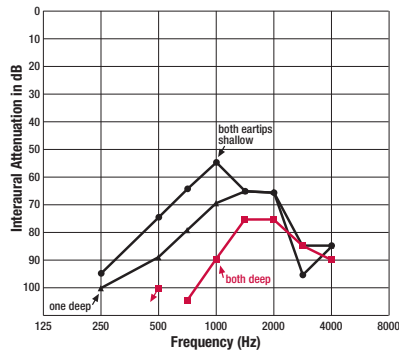


Figure 12

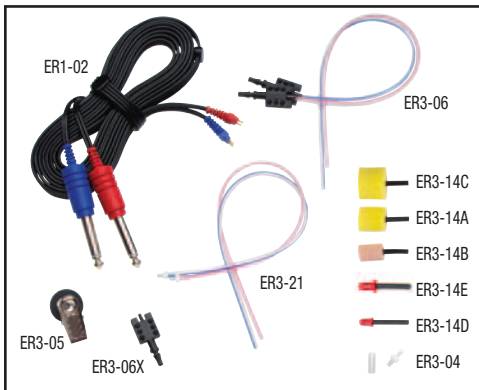
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ER-3A INSERT EARPHONE

SYSTEM INCLUDES

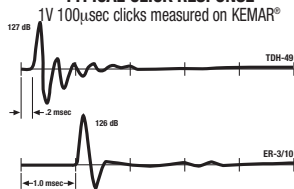
- Earphones (10 Ohm, 50 Ohm or 300 Ohm)—specify when ordering
- Dual-mono 7' cable assembly
- 50 foam eartips (regular, 13 mm)
- 50 foam eartips (baby, 10 mm)
- 2 foam eartips (jumbo, 18 mm)
- Velcro clips



ER-3A ACCESSORIES

| | | |
|---------|--|--------|
| ER1-02 | Dual-mono replacement 7' cable assembly | 1/pkg |
| ER3-04 | Sound tube adapters | 10/pkg |
| ER3-05 | Velcro clips | 6/pkg |
| ER3-06 | Immittance probe tip adapters with front tubing | 2/pkg |
| ER3-06X | Immittance probe tip adapters without front tubing | 10/pkg |
| ER3-14A | Foam eartips (regular, 13 mm) | 50/pkg |
| ER3-14B | Foam eartips (baby, 10 mm) | 50/pkg |
| ER3-14C | Foam eartips (jumbo, 18 mm) | 24/pkg |
| ER3-14D | 3.5 mm infant eartips | 20/pkg |
| ER3-14E | 4 mm infant eartips | 20/pkg |
| ER3-21 | Replacement sound tubes with adapters | 4/pkg |

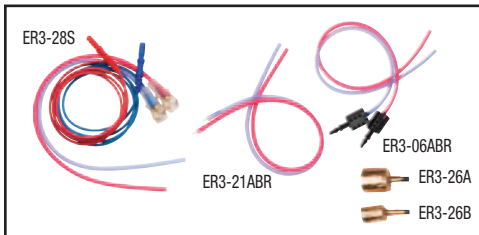
TYPICAL CLICK RESPONSE



ABR VERSION

Etymotic's ABR-version insert earphones are available only from ABR equipment manufacturers. ER3ABR earphones require special connectors and other proprietary modifications. Ask your evoked potential equipment manufacturer for specifications and prices.

ER-3A ABR ACCESSORIES



| | | |
|-----------|--|--------|
| ER3-06ABR | For ABR: Immittance probe tip adapters with tubing | 2/pkg |
| ER3-21ABR | For ABR: Replacement front tubes with adapters | 4/pkg |
| ER3-26A | For ABR: Electrode eartips (regular, 13 mm) gold | 20/pkg |
| ER3-26B | For ABR: Electrode eartips (baby, 10 mm) gold | 20/pkg |
| ER3-28S | For ABR: Electrode eartip cable (gold) | 2/pkg |

SPECIFICATIONS

Impedance: 10 Ohms, 50 Ohms or 300 Ohms

Sensitivity: 102.5 dB SPL in HA-2 coupler at 0.1 Vrms (10 Ohms)
 102.5 dB SPL in HA-2 coupler at 0.2 Vrms (50 Ohms)
 103.5 dB SPL in HA-2 coupler at 0.49 Vrms (300 Ohms)
 Limits ± 3 dB

Maximum output: Meets or exceeds 110 dB HL at standard audiometric frequencies between 0.5 and 4 kHz

Safe operating limits:

Maximum continuous sine wave drive: 2.5 Vrms (10 Ohms), 5 Vrms (50 Ohms), 13.75 Vrms (300 Ohms)

Maximum peak voltage for 1% duty cycle: 10 V (10 Ohms), 20 V (50 Ohms), 55 V (300 Ohms)

WARRANTY

Etymotic Research, Inc. warrants each insert earphone it manufactures to be free of defects in material and workmanship for a period of one year from the date of sale to the original purchaser. Etymotic Research's obligation under this warranty is fulfilled, at ER's option, by replacing the product in kind without charge to the original purchaser, repairing the part, or crediting the original purchaser with the purchase price of the returned defective part. For a part to be covered by the warranty it must be returned to Etymotic Research, postage prepaid, within the warranty period, and the part must not show evidence of misuse, neglect, incorrect wiring by others, or improper installation.

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