3M™ E-A-RTONE™ 3A and 5A Audiometric Insert Earphones
INTRODUCTION

Congratulations on the purchase of your new E-A-RTONE™ 3A or 5A Insert Earphones. Whether you are performing comprehensive audiological diagnostic assessment, testing related to the fitting or evaluation of amplification, audiological research, or hearing screening in an educational or industrial setting, E-A-RTONE™ Insert Earphones provide many advantages that can enhance test reliability and minimize or eliminate problems typically encountered with supra-aural earphones. Because the test subject’s external canal is sealed with an E-A-RLINK™ foam ear tip, reliable threshold measurement can be accomplished in environments previously unsuitable for hearing testing. The E-A-RTONE™ Insert Earphone’s direct coupling to the ear canal also provides greater sound separation between ears across the test frequency range. That means more instances where the need for masking is eliminated, or the level necessary for effective masking is lower. Avoid testing time will decrease without sacrificing reliability. Your preferred method of clinical masking does not need to be altered; simply substitute the greater inter-aural attenuation values cited in the Obtained Inter-aural Attenuation table on page 2 of this booklet.

E-A-RLINK™ foam ear tips are available in three sizes, a standard (3A) size that will comfortably fit most adult ear canals, a pediatric (3B) size for small ear canals, and a large (3C) size for very large or surgically altered ear canals. Two additional sizes of ear tips are available as “Infant Eartips” in 3.5mm and 4.0mm versions to accommodate very small ear canals. Disposable ear tips eliminate the need for periodic cleaning of a headband and earphone cushions, and they facilitate infection control procedures.

The E-A-RTONE™ 3A and 5A Insert Earphones are available with two levels of impedance (100Ω and 500Ω) to match the output of most commercially available audiometers. Your distributor or a 3M Auditory Systems Customer Service Representative can help you determine which version is appropriate for your equipment.

Unless your audiometer was purchased with an E-A-RTONE™ 3A or 5A Insert Earphone pre-calibrated by the audiometric equipment manufacturer, the Reference Equivalent Threshold Sound Pressure Level (RETSPL) values and procedure cited in the ANSI S3.6-2004 Standard must be used to calibrate your equipment before initial use. Re-calibration should subsequently be performed as specified by the audiometer manufacturer, typically on an annual schedule. Measured correction factors can be applied where it is necessary to alternate between an insert earphone and a supra-aural earphone with audiometers that do not provide a dual calibration option.

E-A-RLINK™ foam ear tips are designed for single-use and should be replaced with new ear tips for each test session performed. Re-use of these disposable ear tips could result in inadvertent intra- and inter-subject cross-infection via contact transmission, or “biological reactivity” problems with the presence of residual chemicals when antimicrobial agents are used in an attempt to clean and disinfect previously used foam ear tips. Do not reuse E-A-RLINK™ foam ear tips.

This instruction booklet provides information that will allow you to perform hearing testing with your audiometer and E-A-RTONE™ Insert Earphones with the confidence that test results will be comparable to, or in certain instances more reliable than, measurements performed with supra-aural earphones. Uncertainty regarding the use and calibration of E-A-RTONE™ Insert Earphones can most often be resolved by reviewing this booklet and the American National Standards Specifications for Audiometers (currently, ANSI S3.6-2004). For information regarding replacement items, please contact your distributor or a 3M Auditory Systems Customer Service Representative.

WARNING:
- Reliable test results can be obtained with this equipment only when the audiometric equipment that will be used is calibrated to the device, before initial use, and periodically thereafter as specified by the audiometric equipment manufacturer, or in accordance with applicable national or international standards.
- The use of accessories and replacement parts, other than those supplied by the manufacturer of the E-A-RTONE™ Insert Earphone, or its authorized distributors, could result in invalid test results.
- E-A-RTONE™ 3A Insert Earphone front tubes must be replaced periodically, typically on an annual basis or whenever the tube(s) become brittle or perforated. Do not cut the sound tube to forestall replacement. A change of 10mm in the length of the sound tube will result in a change of the frequency response by as much as 0.5 dB at some frequencies.
- E-A-RTONE™ 3A and 5A Insert Earphones are available in two different impedance versions (10 ohm and 50 ohm) to accommodate most commercially available audiometric equipment. Full insertion depth, as described above, is necessary to achieve maximum ambient noise attenuation and inter-aural attenuation. Shallow insertion, as illustrated in Figure 4, may be the only option for certain ear canals, but more commonly reflects incomplete compression of the eartip before insertion. Table 1. below illustrates inter-aural attenuation as a function of the eartip insertion depth. The described inter-aural attenuation is obtained for each ear in which the E-A-RLINK™ eartip is fully inserted, regardless of whether it is the “sending” ear or “receiving” ear.

1. PRELIMINARY PROCEDURES

Examine each ear canal for obstruction(s), and visually determine the appropriate size of E-A-RLINK™ foam ear tip needed to fit the test subject’s ear canals. An airtight seal is necessary, and some test subjects may require different size ear tips for the right and left ear. The standard size E-A-RLINK™ 3A ear tip fits most adult ear canals, and the smaller diameter, beige color foam E-A-RLINK™ 3B ear tips are available if the standard size ear tip is too large for full insertion into small ear canals. Larger diameter E-A-RLINK™ 3C ear tips are also available to obtain a good seal for test subjects with wide or surgically altered ear canals. A good seal and the proper insertion depth will provide the greatest ambient and inter-aural attenuation. Deep insertion may be difficult to achieve in extremely small ear canals. In these cases, a shallow E-A-RLINK™ 3B ear tip placement, or the use of the smaller 3.5 mm or 4.0 mm “Infant Eartips” should be employed. Once the appropriate ear tip size has been selected:

- Secure the section of black tubing extending from the ear tip onto the plastic sound tube nipple of the E-A-RTONE™ 3A Insert Earphone’s front tube (Figure 1.) or, directly onto the E-A-RTONE™ 5A Insert Earphone’s stainless steel case nipple (Figure 2.).

2. BACKGROUND NOISE REDUCTION

A major benefit of the E-A-RTONE™ Insert Earphone is the reduction of background noise that might otherwise mask air or bone conduction test signals and influence threshold determinations. Ambient noise attenuation with an E-A-RTONE™ Insert Earphone typically exceeds 30 dB in the frequency region of 125-8000Hz. Audiometric air conduction threshold testing threshold testing down to 0 dB Hearing Level (HL) can be reliably performed in the presence of a background noise level not exceeding 45 dB(A). The current ANSI Standard “Maximum Permissible Ambient Noise Levels” (MPANLs) For Audiometric Test Rooms” (ANSI S3.1-1999 Table 1 and Table 2.) includes octave band and one-third octave band permissible noise levels for both supra-aural and E-A-RTONE™ Insert Earphones. The ANSI octave band MPANLs are presented here in Table 2. below for standard earphones and for E-A-RTONE™ Insert Earphones with fully inserted E-A-RLINK™ eartips. ANSI S3.1-1999 - Ears covered: octave band MPANLs using a supra-aural or insert earphone for three test frequency ranges re 20µPa to nearest 0.5 dB.
3. POSITIONING OF THE E-A-RTONE™ INSERT EARPHONE

When positioning the E-A-RTONE™ 3A insert Earphone on a test subject, avoid sound tube contact with the subject’s clothing. The supplied Vetro-backed clips (Figure 7) can be used to attach each of the E-A-RTONE™ 3A insert Earphone transducer cases directly to the test subject’s clothing, or they can be used in conjunction with the supplied neck loop as illustrated in Figure 5. The threaded hole on the E-A-RTONE™ 5A insert Earphone cable assembly can be supported at or near the patient’s mid chest level by attaching a single Vetro-backed clip to the pod portion of the cable and then either directly clipping it to the subject’s clothing or to the metal ring on the lanyard that is worn around the neck. The spring-loaded bead on the lanyard will allow its length to be adjusted as necessary. Although the shape of the E-A-RTONE™ 5A insert Earphone case is similar to that of a small BTE instrument, correct insertion of the connected E-A-RLINK™ foam earplug will suspend the red and black foam earplugs just below the ear. This is particularly important when using the case nipple and coupler (Figure 4) because the red foam earplug will not fit into the HA-1 coupler if the white foam earplug is still in the channel. For ears covered testing, this reduction would cover approximately 84% of all subjects. The standard deviations for Insert Earphones for 125 to 8000 Hz are between three (3) and six (6) decibels. Please refer to ANSI S3.1 – 1999, Table A.2, for specific standard deviation values by frequency.

5. CORRECTION FACTORS

Measured correction factors may be used where it is necessary to switch between insert and supra-aural earphones. If the audiometer is calibrated for either type of transducer as the primary earphone, measured correction factors for a secondary earphone can be obtained without adjusting the audiometer calibration by measuring the output of the secondary earphone on the appropriate coupler and calculating the difference from the appropriate target value at each frequency. Audiogram correction factors can then be confidently applied for testing with the secondary earphone. The outlined procedure below is followed by an example worksheet (Table 4.) for the calculation of correction factors by frequency where, in this example, the audiometer is calibrated for a supra-aural earphone, and an insert earphone will be used as the secondary transducer. The measured SPLs are the 2cc coupler values obtained with an insert earphone connected to an audiometer calibrated for a supra-aural earphone, and the Target SPLs are the audiometer HL setting plus the insert earphone RETSPLs for the particular 2cc coupler used. The process will work as well in reverse; i.e. with an audiometer calibrated for an E-A-RTONE™ Insert Earphone with a supra-aural earphone desired as the secondary transducer, as long as the appropriate Target SPLs (TDH supra-aural earphone values) are employed.

- If necessary, calibrate the audiometer to the appropriate standard with/for the primary transducer. (TDH-39, 49 or 50 in this example)
- Connect the E-A-RTONE™ Insert Earphone to the audiometer.
- Measure the output by frequency in a 2cc coupler and enter (substitute) the obtained values for the Measured SPLs in the example worksheet below.
- Tabulate at each test frequency the difference between actual and target sound pressure levels.
- Apply the rounded correction factors obtained to the audiometer dial readings. Record and post for convenience.
- Repeat the procedure whenever the audiometer is calibrated with the primary transducer.

Worksheet example for calculation of individual E-A-RTONE™ Insert Earphone correction factors for an audiometer calibrated with a TDH type (supra-aural) earphone.

**Measured SPLs** are hypothetical.

<table>
<thead>
<tr>
<th>Frequency in Hz</th>
<th>Coupler 2cc DB-0138 (HA-1)</th>
<th>Coupler IEC 711 Occluded Ear Simulator</th>
<th>Coupler 2cc HA-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>84.0</td>
<td>87.5</td>
<td>84.5</td>
</tr>
<tr>
<td>500</td>
<td>75.5</td>
<td>79.5</td>
<td>76.0</td>
</tr>
<tr>
<td>1000</td>
<td>72.0</td>
<td>76.0</td>
<td>72.0</td>
</tr>
<tr>
<td>1500</td>
<td>70.0</td>
<td>75.5</td>
<td>70.0</td>
</tr>
<tr>
<td>2000</td>
<td>72.0</td>
<td>79.5</td>
<td>70.0</td>
</tr>
<tr>
<td>2500</td>
<td>73.0</td>
<td>81.5</td>
<td>72.5</td>
</tr>
<tr>
<td>3000</td>
<td>73.5</td>
<td>83.0</td>
<td>72.5</td>
</tr>
<tr>
<td>4000</td>
<td>75.5</td>
<td>85.0</td>
<td>70.0</td>
</tr>
<tr>
<td>6000</td>
<td>72.0</td>
<td>86.0</td>
<td>67.5</td>
</tr>
<tr>
<td>8000</td>
<td>70.0</td>
<td>85.5</td>
<td>66.5</td>
</tr>
</tbody>
</table>

5.5. PURE TONE CALIBRATION

When the E-A-RTONE™ Insert Earphone is to be used as the primary transducer, the audiometer should be re-calibrated using the reference thresholds specified in ANSI S3.6-2004, or its revisions. The Standard provides reference thresholds for the HA-2 coupler (Figure 6. and Figure 10. for the E-A-RTONE™ 3A and E-A-RTONE™ 5A models, respectively), the HA-1 coupler (Figure 9, and Figure 11. for the E-A-RTONE™ 3A and E-A-RTONE™ 5A models, respectively), and for the “Occluded Ear Simulator” coupler (not illustrated). The Bruel & Kjaer 2cc DB-0138 (HA-2) coupler will simplify the calibration procedure for both insert earphone models, and is recommended. Calibration values for the three acoustic couplers are provided below in Table 3. (from ANSI S3.6-2004). Should calibration be performed for an audiometer currently calibrated towards ISO-389, the reference thresholds in a 2cc DB-0138 coupler should be used.

In order to calibrate the audiometer for direct readings of the hearing thresholds in dBHL using the reference thresholds, the following procedure is recommended. The instrumentation required includes a Sound Level Meter with octave-band filter capability and an appropriate condenser microphone, calibrated according to the manufacturer’s specification, and a 2cc coupler, e.g., Bruel & Kjaer DB-0138 is attached to the microphone. The white nylon tube nipple of the E-A-RTONE™ 3A Insert Earphone, or the stainless steel case nipple of the E-A-RTONE™ 5A Insert Earphone, is connected directly to the coupler (see illustrations) via a small section of #13 hearing aid tubing. Set the intensity dial on the audiometer to 70 dBHL and adjust the output from the audiometer to the Sound Pressure Level (SPL) values given for each of the test frequencies in Table 3. below. Repeat the procedure for all available test frequencies, and in case of a dual channel audiometer, for both channels.
6. CALIBRATION FOR SPEECH AUDIOMETRY
ANSI S3.6-2004 specifies, with an earphone connected to an HA-1 or HA-2 coupler, the 1 kHz reference-tone level for the speech circuit as 12.5 dB above the 1 kHz pure-tone reference test threshold for the earphone in question. Calibration of the E-A-RTONE™ Insert Earphone for a speech signal is thus performed by setting a 1,000 Hz pure tone signal at 0 Volume Units (VU) through the speech (microphone) circuit, with the audiometer attenuator dial set at 60 dBdL, and adjusting for 72.5 (60.0 + 12.5) dB SPL in the 2cc coupler. A range of 69.5 to 73.5 dB meets the ±3.0 dB tolerance allowed in the Standard.

7. CABLE REPLACEMENT
Replacement cables are available for both the E-A-RTONE™ 3A Insert Earphone and E-A-RTONE™ 5A Insert Earphone models. Cable replacement does not require concomitant recalibration of your equipment. For the E-A-RTONE™ 5A Insert Earphone, regardless of the impedance, there is only one (dual, mono plug) cable replacement part. E-A-RTONE™ 5A Insert Earphone replacement cables, however, are impedance specific (10 ohm or 50 ohm), and cannot be used interchangeably with a different (E-A-RTONE™ 5A Insert Earphone) impedance model, nor should they be connected to an E-A-RTONE™ 5A Insert Earphone. For all models, the cable’s dual pin connector and its respective transducer case receptacle (large-pin-to-large-hole; small-pin-to-small-hole) orientation must be followed (see Figure 12). Improper or incorrect cable installation will result in performance failure as well as damage to the cable and transducer case that may not be covered by the product’s Limited Warranty.

8. TECHNICAL SPECIFICATIONS AND LIMITS FOR E-A-RTONE™ 3A AND 5A INSERT EARPHONE
Available Impedance:
- 10 Ø (10 Ohm) or 50 Ø (50 Ohm)

1 kHz Sensitivity:
- 102.5 dB SPL (± 3.0 dB) in HA-2 (DB-0138) coupler
  @ 0.1 Volt rms. (10 Ø)
  @ 0.2 Volt rms. (50 Ø)

Distortion:
- < 3.0% measured @ 500 Hz, 118.5 dB SPL

Maximum output:
- Meets or exceeds 110 dBdL at standard audiometric frequencies between 500 and 4000 Hz

Recommended Safe Operating Limits: Maximum continuous sine wave drive:
- 2.5 Volt rms. (for 10 Ø models)
- 5.0 Volt rms. (for 50 Ø models)

Recommended Maximum Peak voltage for 1% duty cycle:
- 10 Volts (for 10 Ø models)
- 20 Volts (for 50 Ø models)

Accessories supplied:
- 50 disposable E-A-RLINK™ 3A eartips, 10 disposable E-A-RLINK™ 3B eartips, 4 disposable E-A-RLINK™ 3C eartips, Vekro Clip(s), Lanayrd (5A), Neck Loop (3A) and 213cm (7‘) cord with dual (left and right) 1/4" mono color-coded phono plugs.

Data supplied:
- User Instruction Booklet
- 2cc-coupler frequency response chart on individual units.

10. LIMITED WARRANTY
3M Company warrants E-A-RTONE™ 3A and E-A-RTONE™ 5A insert earphones to be free from defects in material and workmanship under normal use for a period of twelve (12) months from the date of sale to the original end user, but in no event shall any warranty be extended more than eighteen (18) months from the date of manufacture. During this warranty period, 3M will repair or replace, at its sole discretion, any defective part returned to 3M with shipping charges prepaid to the address listed below. This shall be the sole and exclusive remedy available for any product defect or failure under this warranty and for any and all claims arising out of the purchase and use of the product, and the sole obligation of 3M Company under this warranty shall be limited to repair or replacement of any defective part.

For each product returned during the warranty period, the serial number(s) of the product, the original date of purchase, and the nature of the problem must be included. Merchandise not returned with shipping charges prepaid will be refused. Timelines for completing warranty work vary depending on the availability of parts and the workload. If any product is returned which does not qualify for warranty repair, the product will be repaired and flat rate repair charges will be applied and billed. All repair charges must be paid in full prior to return of any product.

3M’s warranty for E-A-RTONE™ 3A and E-A-RTONE™ 5A insert earphones does not cover damage or failure caused by abuse, misuse, abnormal usage, faulty installation, improper maintenance, failure to follow the operation and other instructions found in the written manuals provided with the product, or repairs other than those made by 3M. 3M shall not be liable for any special, incidental or consequential damages arising out of, or in the connection with, the operation, use or performance of any E-A-RTONE™ 3A and E-A-RTONE™ 5A insert earphones including, without limitation, any losses of revenues or profits.

This Warranty is in lieu of all other oral or written, express or implied warranties including, without limitation, warranties of fitness for a particular purpose or merchantability, and there are no warranties that extend beyond the description or duration of this warranty. No representative, agent, dealer or employee of 3M is authorized to give any other warranty or to assume for 3M any other liability in connection with sale or service of the products covered by this limited warranty.

3M Company
Auditory Systems Repair
8001 Woodward Drive
Indianapolis, IN 46278

Toll Free Customer Service: (from the US) 888/733-4512 x 2, Fax: 800/488-8007
International Ph: 317/655-5880, Fax: 317/658-5760
Technical Support Ph: 317/652-6550, Fax: 960/425-3982

© 3M 2010
3M, E-A-RTONE™, and E-A-RLINK™ are trademarks of 3M Company

3M United Kingdom PLC
3M Centre, Cain Road Bracknell,
Berkshire RG12 8HT
0870 60 800 90

3M Ireland
The Iveagh Building, The Park
Cartricknines, Dublin 18
1 800 320 500

3M South Africa
146a Kelvin Drive, Woodmead
Sandton 2128, Johannesburg
+27 11 806 2230

3M Gulf Ltd.
P.O. Box 20191
Building 11, Third Floor, Dubai Internet City,
Deira
+971 4 367 0777

3M Egypt Trading Ltd.
Softel Tower, 19th Floor, Comiche el-Nil St.,
Maadi, Cairo
+202 529 9007

3M Auditory Systems
5457 W. 79th Street,
Indianapolis, IN 46268,
888 733-4512