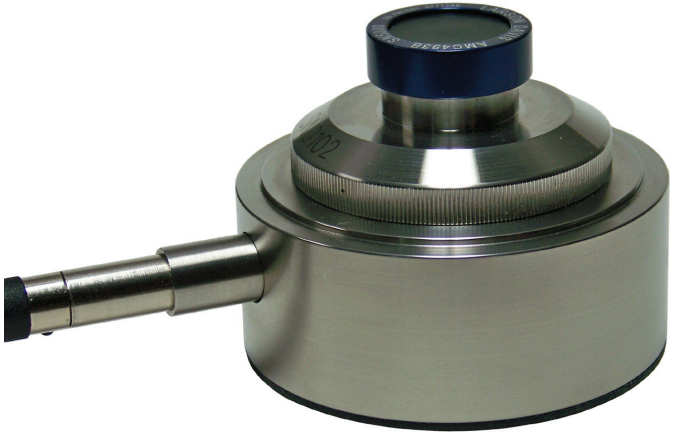
AMC493B

Artificial Mastoid
Technical Reference Manual



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AMC493B Artificial Mastoid

Technical Reference Manual

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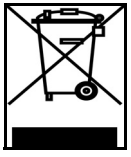

Warranty

Refer to our website, www.larsondavis.com, for a copy of our product warranty.

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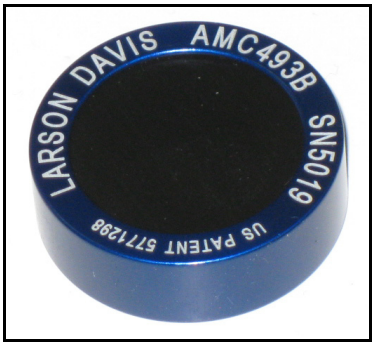
CHAPTER

1 Introduction



When testing a bone vibrator using a standard audiometer, the governing ANSI standard specifies that a device be used with impedance characteristics similar to a typical human mastoid. This testing device is the artificial mastoid. The impedance of the Larson Davis AMC493B artificial mastoid meets the impedance response limits specified in ANSI S3.13, ANSI S3.26 and IEC 60318-6. The Larson Davis AMC493B artificial mastoid is fully compliant with ANSI 3.26.

ANSI S3.13 and IEC 60318-6 also specify the physical construction of an artificial mastoid, which the Larson Davis AMC493B artificial mastoid does not meet. Specifically, the AMC493B does not meet the size or shape specifications in ANSI S3.13 or IEC 60318-6. However, because the Larson Davis AMC493B does meet the impedance requirements of ANSI S3.13 and IEC 60318-6, the Larson Davis AMC493B is a functional equivalent to the artificial mastoid that is described in ANSI S3.13 and IEC 60318-6.

The standards also require that the temperature of the artificial mastoid be stable in the testing environment. When changing environments, the Larson Davis AMC493B completes this thermal transition in less than one hour while other mastoids can take several hours to thermally stabilize. This problem can typically occur when taking test equipment from an automobile to an office when the auto is hotter or cooler than the office environment.

New to AMC493B

FIGURE 1-1 AMC493B

- Updated usage recommendations
- Improved long term stability
- Sealed case for humidity stabilization
- Temperature/humidity meter
- New humidity and correction curves
- Support in AUDit™ V2.1 for temperature and humidity correction and reading of mastoid response from file

Efficient Design

Previously, bone vibrators and headsets have required the use of two types of calibrators. Larson Davis has successfully integrated both calibrators into one cost-effective design; the AMC493B can be added to the AEC100 coupler or AEC201 artificial ear to convert them into an Artificial Mastoid.

Instead of using vibration detection methods as is done in other mastoid products, the microphone is used as the sensing element for both calibration tests. This for example permits accurate calibration of both with a Larson Davis CAL250 precision calibrator, with the CAL250 traceable to NIST. The microphone is mounted in the base of the AEC100 or AEC201 and connected to a preamplifier, threaded into the side opening. The AMC493B Artificial Mastoid is simply placed on the AEC100 or AEC201.

Recommended Equipment

- AUDit™ Software V2.1 or later

Required Equipment

- AEC100 or AEC201
  - **AEC100 coupler components**
    - Base with threaded preamplifier mounting hole
    - Coupler
    - Model 2575 microphone
    - Weight with handle
    - Headphone retaining ring
    - Case
    - CAL250 Precision Calibrator
  - **AEC201 artificial ear components**
    - Base with threaded preamplifier mounting hole
    - Coupler
    - Model 377A13 microphone
    - Weight with handle
    - Headphone retaining ring
    - CAL200 or CAL250 Precision Calibrator
- **AMC493B Artificial Mastoid components**
  - AMC493B Artificial Mastoid
  - Additional mass for weight
  - Case

    - Temperature/Humidity meter
- **Vibration isolation foam pad**
- **At least one Analysis system**
    - System 824 Real Time Analyzer/Sound Level Meter for either AEC100 or AEC201
        - Model PRM902 preamplifier
        - 824-AUD firmware option
        - AUDit™ Software (Optional)
        - EXAxxx microphone extension cable (xxx is length in feet)
    - Model 831 Sound Level Meter for AEC201 only
        - Model PRM831 Preamplifier
        - 831-OB3 Frequency analysis Firmware option
        - EXCxxx microphone extension cable (xxx is length in feet)

Use with AEC101

If you already own an AEC101, it can be used similarly to an AEC201 as documented in this manual.

CHAPTER

2 Using the AMC493B

Principles

To accomplish the integration of the AMC493B with an acoustic sensing solution, it is necessary to process the bone vibrator output in two stages. The vibrator exerts a force on the AMC493B and it responds by creating sound within the artificial ear cavity. In technical terms, the mastoid device is calibrated in Pa/N (Pascal per Newton). The microphone in the AEC100 or AEC201 then detects the sound and converts it into a voltage that is read by the analyzer. The analyzer is calibrated in mV/Pa (millivolts per Pascal). Thus there are two devices and two sets of calibration constants. The combination of the constants yields the more familiar mV/N calibration constant.

Microphone Calibration

It is recommended that the microphone in the AEC100 or AEC201 be routinely calibrated using an appropriate acoustic calibrator, CAL250 or CAL200, prior to making measurements.

A calibration chart is supplied with the microphone which contains the frequency response of the microphone relative to 250 Hz. It is recommended that the microphone response data is put into AUDit ™ Software. Alternately it can be put into a spreadsheet as is done in column 5 of Table 3-1. When using a model 377A13 microphone, use the data labeled as ‘pressure response of microphone with grid cap.’ When using Model 2575 microphone, use the data labeled as 'pressure response as tested with electrostatic actuator'. Use of these values is given in the procedure below.

For accurate readings, the AMC493B needs to be at a stable temperature. If the AMC493B is moved from an environment where the temperature changes, such as from a cold automobile to a warm office, the AMC493B should be allowed to come to room temperature while remaining in the

case for at least 1 hour before making a measurement when the temperature differential is less than ± 10°C.

Manual Calibration Procedure

Calibrating the AEC100 or AEC201 and the analyzer (Larson Davis System 824 or Model 831)

Step 1 Remove the coupler from the top of the AEC100 or AEC201 to expose the microphone. The microphone grid cap should be installed for calibration.

Step 2 Set the analyzer to the value of the calibrator.

A CAL200 that emits a 1 kHz tone at 114 dB can also be used to calibrate an AEC201.

Step 3 Place the Model CAL250 precision calibrator over the microphone which should insert into the calibrator opening.

Step 4 Turn on the calibrator. This is the same procedure as used to calibrate the AEC100 or AEC201 for earphone tests.

The calibration of the microphone in the AEC100 or AEC201 to the analyzer is now complete. For additional details on calibrating the analyzer, please see the appropriate section in the analyzer manual.

Software Calibration Procedure

Please consult the AUDit™ Technical Reference Manual for instructions on calibrating the AEC100 or AEC201 using AUDit™ software and a System 824 Real Time Analyzer, or Model 831 Sound Level Meter.

AMC493B Artificial Mastoid Sensitivity

The AMC493B Artificial Mastoid is used on the AEC100 coupler or AEC201 Ear Simulator. Since these devices are used only for audiometric testing, a sensitivity table is provided that gives the response at each of the audiometric frequencies used for bone conduction hearing tests. These sensitivity values take into account the factors for conversion of force to sound pressure as well as the actual response of this device.

Note: The AEC100 and AEC201 couplers have different sensitivities when used with the AMC493B and thus need to be calibrated separately on the coupler it is used with. In order to meet accuracy requirements, an AMC493B must always be used on the coupler with which it was calibrated.

For accurate readings, the AMC493B needs to be at a stable temperature. If the AMC493B is moved from an environment where the temperature changes, such as from a cold automobile to a warm office, the AMC493B should be allowed to come to room temperature while remaining in the case for at least 1 hour before making a measurement when the temperature differential is less than ± 10°C.

CHAPTER

3 Manual Measurements

Setting up the System

The procedure described below is for either the AEC100 or AEC201.

Step 1 Make sure the AMC493B has been allowed to become thermally stable. If there has been a temperature change of the ± 10°C or less leave the AMC493B in the case for 1hour.

Step 2 Make sure the AMC493B has been factory calibrated within the last year.

Step 3 Connect the bone vibrator to the audiometer.

Note: Either the System 824 or Model 831 can be used for these measurements.

Step 4 Connect the preamplifier to the artificial ear and to the Sound Level Meter.

Step 5 Place the artificial ear base on the pad supplied. Carefully place the coupler on the base. Rotate it by hand to insure it is seated properly. When using an AEC201, don't use the black, conical ring and make sure the threaded top is fully seated.

Step 6 Open AMC493B case and immediately note temperature and humidity.

NOTE: If the coupler rim is burred or deformed, the system will not operate properly. If the burrs are small they can be carefully filed away, otherwise the coupler should be replaced

Step 7 Remove AMC493B from the case and place the AMC493B Artificial Mastoid over the rim of the coupler centered on the opening. Use the AEC100 or AEC201 with which the AMC493B was calibrated. The serial number of the mastoid should be up and visible. See FIGURE 3-1.

Note: The figures show the AEC201. These figures apply to the AEC100 as well.

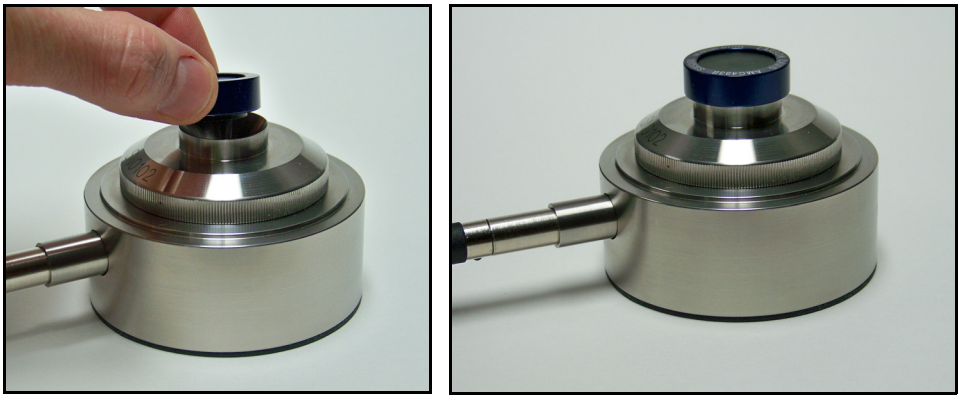


FIGURE 3-1 Placement of the AMC493B Artificial Mastoid on the coupler

Step 8 Place the bone vibrator at the center (visually) of the AMC493B as shown in FIGURE 3-2.

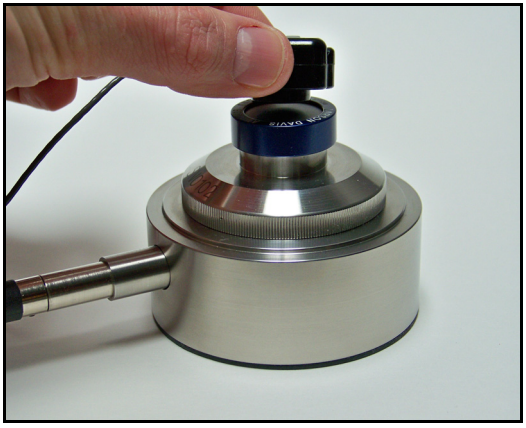


FIGURE 3-2 Placement of the bone vibrator on the AMC493B Artificial Mastoid

Step 9 Place the black retaining ring on the coupler with the bone vibrator wire coming out through the opening in the cover. Take care not to press down on the vibrator wire when you do this. If you bump it, remove the retaining ring and reposition the

bone vibrator at the center of the AMC493B Artificial Mastoid and replace the retaining ring, as shown in FIGURE 3-3.

FIGURE 3-3 Placing the retaining ring on the coupler

Step 10 Install the additional mass ring provided with the AMC493B onto the weight, as shown in FIGURE 3-4.

FIGURE 3-4 Additional mass on weight

Step 11 Gently lower the weight, with the additional mass, into the interior of the retaining ring until the foam vibration isolator on the mass is resting on top of the bone vibrator. No additional clamps or springs are needed.

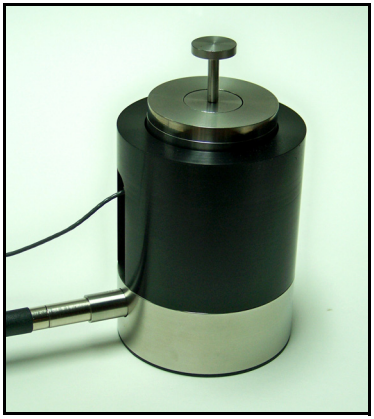


FIGURE 3-5 Weight in retaining ring

Note: A 1 °C temperature change can make a 1dB level change, as shown in Table 5-1

Step 12 If using the AUDit™, enter the temperature and humidity recorded in step 6 and the AMC493B and microphone sensitivities into AUDit for automatic correction. For manual corrections, enter these constants into a spreadsheet, as described below.

From the Temperature response table, Table 5-1, use the measured temperature to get the corrections for your measurement. Enter the correction values into a spreadsheet similar to column 6 of Table 3-1.

From the humidity response table, Table 5-2, use the measured humidity to get the corrections for your measurement. Enter the correction values into a spreadsheet similar to column 7 of Table 3-1.

The correction of the ear simulator used at static pressures much less than the reference static pressure (high altitudes) is derived from Table 5-3 or Table 5-4. For example using the mastoid at 86.6 kPa on an AEC201 at 6000 Hz has 0.092 dB/

kPa correction (see Table 5-4). 0.092 x (101.3-86.6) = 1.4 dB total correction.

Reading the Levels

Set the appropriate HL (Hearing Level) and frequency on the audiometer.

Read the measured level on the Sound Level Meter and enter the readings into a spreadsheet similar to column 10 of Table 3-1.

Repeat setting HL and frequency until all of the bone conduction frequencies are completed.

Return the AMC493B to the case. Close and latch the case.

AMC493B response used for this example is the AMC493B Sensitivity that can be found on the calibration sheet. For microphone response, the pressure response as found on the calibration sheet should be entered. See Appendix A "Sample Calibration Reports"

Enter the appropriate HL (Hearing Level) and RETFL (Reference Equivalent Threshold Force Level) in a spreadsheet similar to Table 3-1. Sum the HL, RETFL, mastoid response, microphone response, temperature response, humidity response and ear static pressure response to get the Target Level. (i.e. sum Columns 2, 3, 4, 5, 6, 7 and 8.)

Example:

For an AMC493B used on an AEC201 Ear Simulator, at 24 °C, 60% RH and 86.6 kPa, at 6000 Hz, the HL (Hearing Level) is 40 and the RETFL (Reference Equivalent Threshold Force Level) is 40; the AMC493B artificial mastoid response is -13.9, the microphone response is 0.0, the temperature response is -0.2, the humidity response is -0.3 and the ear static pressure response is -1.4.

Target Level = 40 + 40 - 13.9 + 0.0 - 0.2 -0.3 -1.4 = 64.2

1	2	3	4	5	6	7	8	9	10	11
Frequency	Input Level HL	Reference Force Level RETFL	AMC493B Sensitivity	Microphone Response	Temperature Response	Humidity Response	Ear Pressure Response	Target Level	Measured Level	Deviation
250	20	67.0	-7.6	0.0	0.8	1.1	-0.8	80.5	80.3	-0.2
500	40	58.0	-4.9	0.0	0.9	1.1	-1.4	93.7	95.0	1.3
750	40	48.5	-7.1	0.0	1.0	1.3	-1.1	82.6	84.5	1.9
1000	40	42.5	-8.3	0.0	1.1	1.3	-0.9	75.7	74.4	-1.3
1500	40	36.5	-8.3	0.0	1.1	1.4	-0.6	70.1	71.6	1.5
2000	40	31.0	-6.3	0.0	0.9	1.2	-0.9	65.9	67.7	1.8
3000	40	30.0	-5.9	0.0	0.2	0.2	-1.5	63.0	63.4	0.4
4000	40	35.5	-11.5	0.0	-0.4	-0.5	-1.4	61.7	62.5	0.8
6000	40	40.0	-13.9	0.0	-0.2	-0.3	-1.4	64.2	65.8	1.6
8000	40	40.0	-19.8	0.2	-0.3	0.0	-1.4	58.7	60.8	2.1

Table 3-1 Sample Manual Calculation of Deviation for 24° C and 60% RH

The deviation is the difference between the Measured Level and the Target Level. Subtract Column 9 from Column 10.

Example

At 6000 Hz, the Measured Level = 65.8 and the Target Level = 64.2.

Deviation = 65.8 - 64.2= 1.6

Setting the Audiometers Levels

After the deviation has been calculated in Table 3-1, use the Deviation column to make the necessary adjustments to the Audiometer.

Using the AMC493B Artificial Mastoid with Software

The AUDit™ software, designed to perform audiometric calibration with the System 824 or Model 831 as the measurement instrument, provides facilities for using the AMC493B as well. When using AUDit™ software, the AMC493B corrections can be entered once and measured data will be corrected for changes in AMC493B response due to temperature and humidity variations. In this scenario, all that needs to be entered is the temperature and relative humidity.

When using the 824 AUD option, corrections must be applied manually.

Please see the AUDit™ manual, included with the AUDit™ software, for instructions on performing measurements with the AMC493B and the AUDit™ software.

CHAPTER

4 Maintenance

Care of the AMC493B Artificial Mastoid

The AMC493B Artificial Mastoid component is a precision device and should be treated with care. Following are recommendations for use:

- Keep the AMC493B in its protective case with the lid closed and latched when not in use.
- Never leave the bone vibrator and weight on the AMC493B Artificial Mastoid when not in use.
- Keep the coupler rim smooth so the AMC493B Artificial Mastoid fits properly.

Yearly Certification

The ease of use and portability of the AMC493B compared to other artificial mastoids is due to its innovative use of elastomeric foam to simulate the response of the human mastoid. Elastomeric material properties will change over long periods of time due to the effects of aging, thus it is important to have the AMC493B calibrated at the factory, along with its associated coupler, on an annual basis. For annual factory calibration order:

- CER-AMC493 when ordering a calibration of the AMC493B with a single AEC100 or AEC201.
- CER-AMC493-2 when ordering a calibration of the AMC493B with both an AEC100 and AEC201.

The AMC493B is to be used on the artificial ear with which it was factory calibrated.

FIGURE 4-1 CCS043 Case with AMC439B and Digital Hygrometer/Temperature Meter

Because the AMC493B impedance and sensitivity is dependent on changes in temperature and relative humidity, for proper performance, the AMC493B should remain in the watertight case with the lid closed and latched when not being used. By storing the AMC493B in the closed case, the temperature and relative humidity reported inside the case will mirror the temperature and humidity of the AMC493B and can be used for correction.

Meter

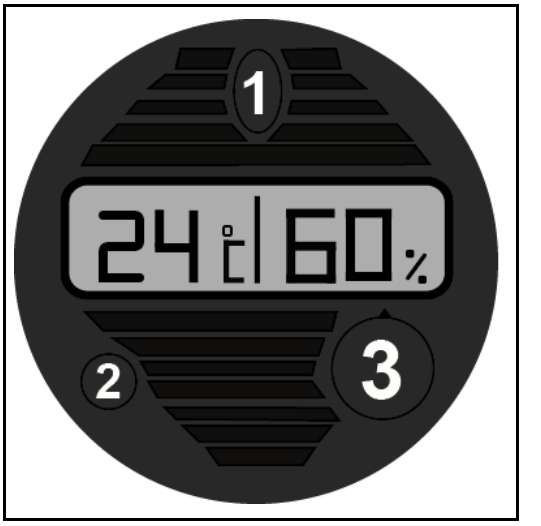


FIGURE 4-2 Digital Hygrometer/Temperature Meter

Note: The humidity adjustment setting is factory adjusted. DO NOT CHANGE.

#1 Button used to change the display of temperature between °C and °F.

#2 Button used to set the humidity adjustment.

#3 Control knob used to adjust the humidity reading.

Battery

The meter is a shipped with a battery installed. It will run continuously for over a year and if needed can be replaced with a 357A or A76 button cell battery.

CHAPTER

5 Specifications

AMC493B Specifications

Height	10.16 mm (0.40 in.)
Diameter	30 mm (1.2 in.)
Weight	11.8 g (0.026 lbs)
Reference Temperature	23 °C
Reference Humidity	50%
Thermal Stabilization Time ($\Delta t \leq \pm 10°C$)	1 hour
Humidity Stabilization Time	4 days
US Patent	5771298

Standards

Fulfills the requirements of:

- American National Standards Institute ANSI S3.26-1981 *Reference Equivalent Threshold Force Levels for Audiometric Bone Vibrators*

Meets the impedance response requirements of:

- American National Standards Institute ANSI S3.13-1987 (R2007) American National Standard Mechanical Coupler for the Measurement of Bone Vibrators
- International Standard IEC 60318-6:2007, *Electroacoustics - Simulators of human head and ear - Part 6: Mechanical coupler for the measurement of bone vibrators*

Temperature Response

	AMC493B Sensitivity Change as Temperature is Varied Relative to Levels at 23 °C (dB)										
Frequency	18 °C	19 °C	20 °C	21 °C	22 °C	23 °C	24 °C	25 °C	26 °C	27 °C	28 °C
(Hz)	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
250	-5.6	-4.5	-3.3	-2.2	-1.1	0.0	0.8	1.6	2.4	3.2	4.0
315	-5.5	-4.4	-3.3	-2.2	-1.1	0.0	0.8	1.6	2.5	3.3	4.1
400	-5.6	-4.5	-3.4	-2.2	-1.1	0.0	0.8	1.7	2.5	3.4	4.2
500	-5.8	-4.7	-3.5	-2.3	-1.2	0.0	0.9	1.8	2.7	3.6	4.5
630	-5.9	-4.7	-3.6	-2.4	-1.2	0.0	0.9	1.9	2.8	3.8	4.7
750	-6.0	-4.8	-3.6	-2.4	-1.2	0.0	1.0	2.0	3.0	4.0	5.0
800	-6.0	-4.8	-3.6	-2.4	-1.2	0.0	1.0	2.0	3.0	4.0	5.0
1000	-6.1	-4.9	-3.7	-2.5	-1.2	0.0	1.1	2.1	3.2	4.2	5.3
1250	-6.3	-5.0	-3.8	-2.5	-1.3	0.0	1.1	2.2	3.3	4.4	5.5
1500	-6.3	-5.0	-3.8	-2.5	-1.3	0.0	1.1	2.2	3.3	4.4	5.5
1600	-6.3	-5.0	-3.8	-2.5	-1.3	0.0	1.1	2.2	3.3	4.4	5.5
2000	-6.0	-4.8	-3.6	-2.4	-1.2	0.0	0.9	1.9	2.8	3.8	4.7
2500	-5.2	-4.2	-3.1	-2.1	-1.0	0.0	0.6	1.1	1.7	2.2	2.8
3000	-3.6	-2.9	-2.1	-1.4	-0.7	0.0	0.2	0.3	0.5	0.6	0.8
3150	-3.1	-2.5	-1.9	-1.2	-0.6	0.0	0.0	0.1	0.1	0.2	0.2
4000	0.2	0.2	0.1	0.1	0.0	0.0	-0.4	-0.7	-1.1	-1.5	-1.9
5000	2.7	2.2	1.6	1.1	0.5	0.0	-0.2	-0.5	-0.7	-1.0	-1.2
6000	3.3	2.6	2.0	1.3	0.7	0.0	-0.2	-0.3	-0.5	-0.6	-0.8
6300	3.3	2.7	2.0	1.3	0.7	0.0	-0.1	-0.3	-0.4	-0.6	-0.7
8000	2.7	2.2	1.6	1.1	0.5	0.0	-0.3	-0.5	-0.8	-1.1	-1.4

Table 5-1 Temperature Response relative to response at 23 °C

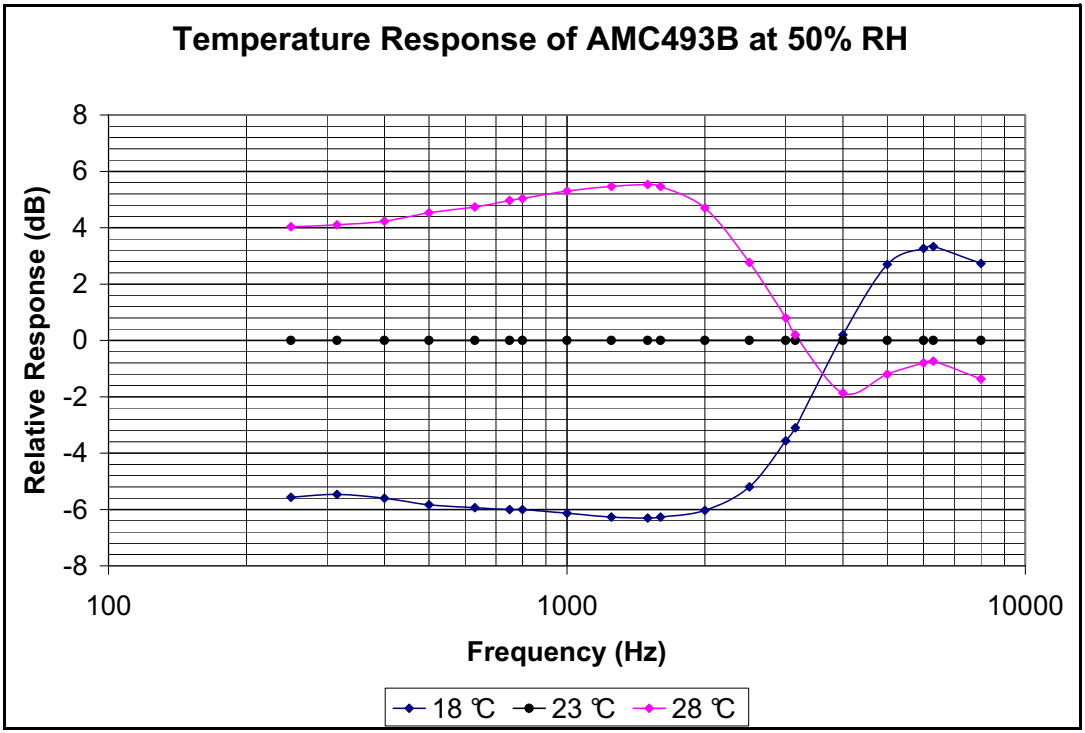


FIGURE 5-1 Temperature Response Relative to Response at 23 °C

Humidity Response

The correction for humidity is more complex since it depends on frequency, temperature and relative humidity. Since the humidity is not normally measured, the humidity has been put into broad groups that the average user can use to identify and make the appropriate correction.

To find the appropriate correction, please select the RH (Relative Humidity) that most closely matches the measured RH and the temperature that most closely matches the measured temperature. The AMC493B is not specified for use in temperatures colder than 18 °C or warmer than 28 °C

	AMC493B Sensitivity Change as Humidity is varied Relative to Levels at 50% (dB)											
Frequency	18 °C				23 °C				28 °C			
(Hz)	30%	50%	70%	90%	30%	50%	70%	90%	30%	50%	70%	90%
250	-0.1	0.0	4.0	6.9	-2.8	0.0	2.2	5.0	-1.7	0.0	2.1	4.4
315	0.0	0.0	4.0	6.7	-2.7	0.0	2.2	4.9	-1.7	0.0	1.9	4.3
400	0.0	0.0	4.0	6.9	-2.7	0.0	2.2	5.1	-1.7	0.0	2.0	4.5
500	0.0	0.0	4.1	7.0	-2.8	0.0	2.3	5.3	-1.9	0.0	2.0	4.8
630	0.0	0.0	4.1	7.1	-2.9	0.0	2.4	5.6	-1.9	0.0	2.2	5.3
750	0.0	0.0	4.1	7.2	-2.9	0.0	2.5	5.8	-2.1	0.0	2.4	5.6
800	0.0	0.0	4.0	7.2	-2.9	0.0	2.5	5.8	-2.1	0.0	2.4	5.7
1000	0.0	0.0	4.1	7.2	-2.9	0.0	2.6	6.1	-2.2	0.0	2.5	6.0
1250	0.0	0.0	4.1	7.4	-3.0	0.0	2.7	6.2	-2.2	0.0	2.6	6.0
1500	0.1	0.0	4.0	7.5	-2.9	0.0	2.8	6.2	-2.1	0.0	2.5	5.3
1600	0.1	0.0	4.0	7.4	-3.0	0.0	2.8	6.2	-2.1	0.0	2.4	4.9
2000	0.0	0.0	3.9	7.1	-2.8	0.0	2.5	5.2	-1.7	0.0	1.6	2.8
2500	0.1	0.0	3.6	6.1	-2.4	0.0	1.7	3.3	-0.9	0.0	0.5	1.3
3000	0.1	0.0	2.7	4.0	-1.4	0.0	0.7	1.4	-0.1	0.0	-0.5	-0.8
3150	0.2	0.0	2.5	3.5	-1.3	0.0	0.4	0.6	0.1	0.0	-1.0	-1.5
4000	0.0	0.0	0.7	-0.1	0.1	0.0	-0.8	-1.8	0.5	0.0	-1.7	-2.1
5000	-0.1	0.0	-1.2	-2.5	1.1	0.0	-0.8	-1.3	0.5	0.0	-0.2	-0.2
6000	-0.3	0.0	-2.2	-3.3	1.2	0.0	-0.7	-0.9	0.6	0.0	0.0	0.1
6300	-0.2	0.0	-2.2	-3.2	1.2	0.0	-0.8	-0.7	0.5	0.0	-0.1	-0.1
8000	-0.4	0.0	-0.5	-1.5	0.6	0.0	0.0	0.0	-0.2	0.0	0.1	0.3

Table 5-2 Humidity Response relative to 50% RH

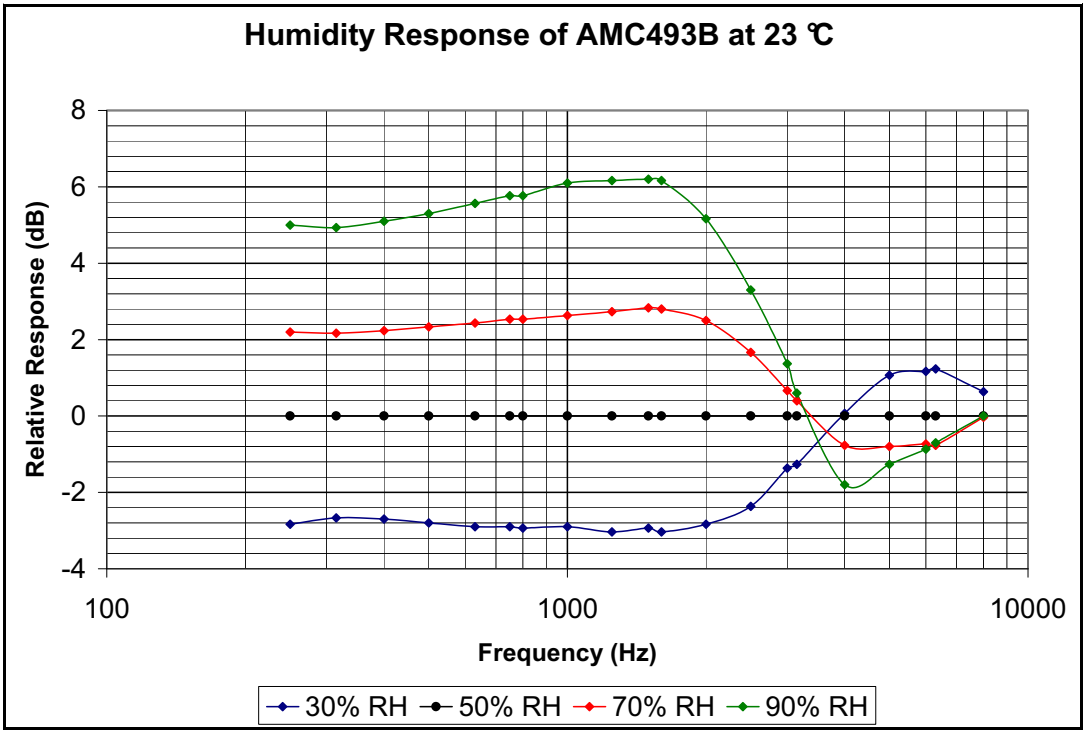


FIGURE 5-2 Humidity response relative to 50% RH

AEC100 Specifications

Height	64 mm (2.5 in.)
Diameter	82 mm (3.2 in.)
Weight[1]	1.86 kg (4.10 lbs)
Force provided by weight including additional mass	5.5 Newton (1.24 pound - force)
Frequency Range	250 Hz to 8 kHz
Microphone	Model 2575 (1 in.)
Reference Static Pressure	101.3 kPa
[1] *Base and coupler only, not including weight and retainer*	

frequency (Hz)	static pressure coefficent (dB/kPa)
100	0.085
126	0.076
158	0.073
200	0.071
251	0.071
316	0.072
398	0.066
501	0.072
631	0.069
750	0.071
794	0.073
1000	0.074
1259	0.069
1500	0.077
1585	0.076
1995	0.074
2512	0.080
3000	0.078
3162	0.076
3981	0.078
5012	0.081
6000	0.090
6310	0.090
7943	0.090
9000	0.079
10000	0.065

Table 5-3 AEC100 Sensitivity to static pressure

AEC201 Specifications

Height	53 mm (2.1 in.)
Diameter	82 mm (3.2 in.)
Weight[1]	1.43 kg (3.15 lbs)
Force provided by weight including additional mass	5.5 Newton (1.24 pound - force)
Frequency Range	100 Hz to 10 kHz
Microphone	Model 377A13 (1/2 in.)
Reference Static Pressure	101.3 KPa
[1]*Base and coupler only, not including weight and retainer*	

frequency (Hz)	static pressure coefficient (dB/kPa)
100	0.056
126	0.045
158	0.033
200	0.031
251	0.053
316	0.090
398	0.108
501	0.098
631	0.084
750	0.077
794	0.074
1000	0.064
1259	0.052
1500	0.044
1585	0.043
1995	0.062
2512	0.099
3000	0.105
3162	0.103
3981	0.094
5012	0.091
6000	0.092
6310	0.093
7943	0.096
9000	0.099
10000	0.101

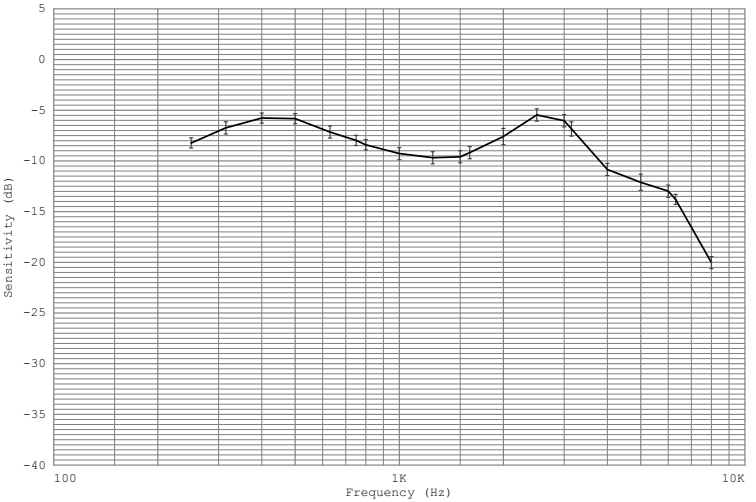
Table 5-4 AEC201 Sensitivity to static pressure

APPENDIX

A Sample Calibration Reports

Artificial Mastoid Test Report: Sensitivity when used on an AEC201
Model: AMC493B Serial Number: 5016
AEC201 Serial Number: 0102

Tested without Black Conical Ring



Mastoid Sensitivity (reference: 20 µPa/µN)

Frequency (Hz)	Sensitivity (dB)	Uncertainty (dB)	Frequency (Hz)	Sensitivity (dB)	Uncertainty (dB)
250	-8.2	0.5	1600	-9.2	0.6
315	-6.7	0.6	2000	-7.6	0.8
400	-5.8	0.5	2500	-5.5	0.6
500	-5.8	0.5	3000	-6.0	0.6
630	-7.1	0.6	3150	-6.8	0.7
750	-8.0	0.5	4000	-10.8	0.6
800	-8.4	0.5	5000	-12.1	0.8
1000	-9.3	0.6	6000	-13.0	0.6
1250	-9.7	0.6	6300	-13.8	0.5
1500	-9.6	0.6	8000	-20.0	0.6

Temperature (°C): 23 ± 1
Relative Humdity (%): 50 ± 5
Static Pressure (kPa): 85.4 ± 2.0 (data corrected to 101.3 ± 3.0)

Uncertainty at ~95% confidence level (k=2)

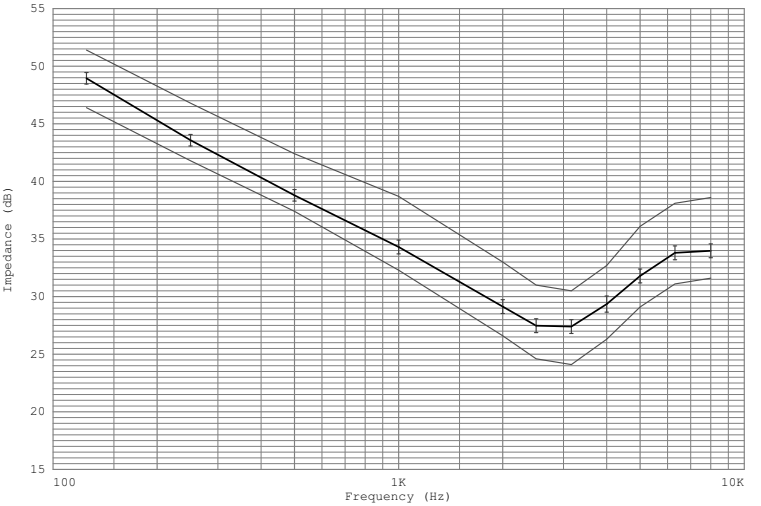
Tested by Scott Montgomery on 2JUN2011 Page 1 of 2

Test performed at: Larson Davis, a division of PCB Piezotronics, Inc.
1681 West 820 North, Provo, Utah 84601
Tel: 716 684-0001 www.LarsonDavis.com

FIGURE A-3 AEC201 Mastoid Test Report

Artificial Mastoid Test Report: Impedance when used on an AEC201
Model: AMC493B Serial Number: 5016
AEC201 Serial Number: 0102

Tested without Black Conical Ring



Mastoid Impedance (reference: 1 N·s/m)

Frequency (Hz)	Impedance (dB)	Lower Limit (dB)	Upper Limit (dB)	Uncertainty (dB)
125	49.0	46.4	51.4	0.5
250	43.6	41.8	46.8	0.5
500	38.8	37.4	42.4	0.5
1000	34.3	32.3	38.7	0.6
2000	29.1	26.6	33.0	0.6
2500	27.5	24.6	31.0	0.6
3160	27.4	24.1	30.5	0.6
4000	29.4	26.3	32.7	0.7
5000	31.8	29.1	36.1	0.6
6300	33.8	31.1	38.1	0.6
8000	34.0	31.6	38.6	0.6

Temperature (°C): 23 ± 1
Relative Humdity (%): 50 ± 5
Static Pressure (kPa): 85.4 ± 2.0 (data corrected to 101.3 ± 3.0)

Uncertainty at ~95% confidence level (k=2)

Tested by Scott Montgomery on 2JUN2011

Page 2 of 2

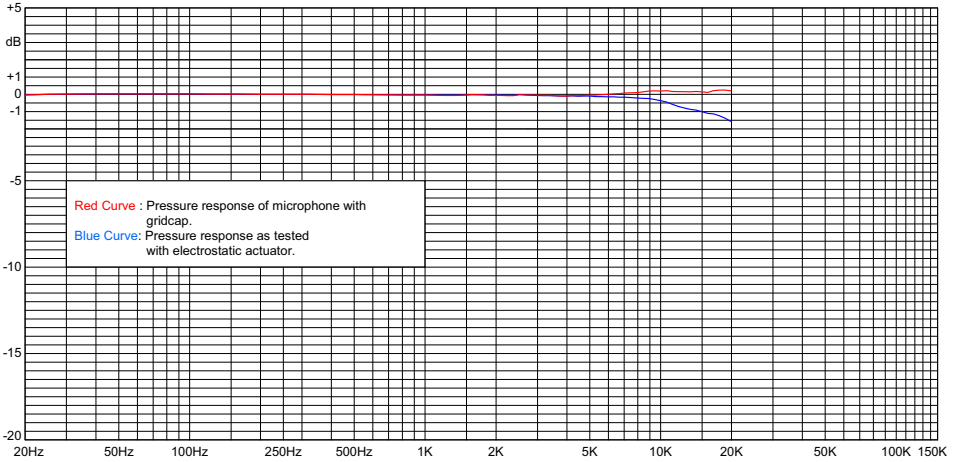
Test performed at: Larson Davis, a division of PCB Piezotronics, Inc.
1681 West 820 North, Provo, Utah 84601
Tel: 716 684-0001 www.LarsonDavis.com

FIGURE A-4 AEC201 Mastoid Rest Report

PCB 1/2" Microphone Calibration Chart
Model: 377A13 Serial Number: 112500

Open Circuit Sensitivity @ 1015.0 mbar & 251.19 Hz
-37.61 dB re 1V/Pascal
13.16 mV/Pascal
+11.59 K_0(-dB re 50 mV/Pascal)
Expanded Uncertainty @ ~95% confidence level
0.18 dB
Sensitivity Change
-0.01 dB since 23APR2010

Capacitance @ 251.2 Hz
14.2 pF
Lower Limiting Frequency
-3 dB @ **2.59** Hz
Test Conditions:
Polarization Voltage **0** V
Ambient Pressure **1015.0** mbar
Temperature **23.3** °C
Relative Humidity **30.3** %



Frequency Response (0 dB @ 251.19 Hz)
Pressure and actuator response with reference to level at 251.19 Hz

Freq (Hz)	Red (dB)	Blue (dB)	Freq (Hz)	Red (dB)	Blue (dB)	Freq (Hz)	Red (dB)	Blue (dB)	Freq (Hz)	Red (dB)	Blue (dB)	Freq (Hz)	Red (dB)	Blue (dB)
19.95	-0.03	-0.03	501.19	-0.02	-0.02	1883.65	-0.06	-0.04	4216.97	-0.08	-0.09	9440.61	0.20	-0.30
25.12	0.00	-0.00	630.96	-0.02	-0.02	1995.26	-0.06	-0.04	4466.84	-0.08	-0.11	10000.00	0.19	-0.37
31.62	0.01	0.01	794.33	-0.03	-0.03	2113.49	-0.07	-0.05	4731.51	-0.06	-0.10	10592.54	0.22	-0.44
39.81	0.02	0.02	1000.00	-0.04	-0.04	2238.72	-0.07	-0.05	5011.87	-0.04	-0.10	11220.19	0.17	-0.58
50.12	0.03	0.03	1059.25	-0.05	-0.04	2371.37	-0.07	-0.05	5308.84	-0.04	-0.13	11885.02	0.15	-0.70
63.10	0.03	0.03	1122.02	-0.05	-0.04	2511.89	-0.02	-0.01	5623.41	-0.02	-0.13	12589.25	0.15	-0.79
79.43	0.02	0.02	1188.50	-0.07	-0.05	2660.73	-0.03	-0.03	5956.62	0.00	-0.14	13335.21	0.15	-0.86
100.00	0.02	0.02	1258.93	-0.06	-0.04	2818.38	-0.05	-0.06	6309.57	0.02	-0.15	14125.38	0.16	-0.91
125.89	0.01	0.01	1333.52	-0.07	-0.05	2985.38	-0.05	-0.07	6683.44	0.04	-0.17	14962.36	0.14	-1.00
158.49	0.01	0.01	1412.54	-0.06	-0.05	3162.28	-0.06	-0.08	7079.46	0.08	-0.16	15848.93	0.11	-1.10
199.53	0.01	0.01	1496.24	-0.03	-0.03	3349.65	-0.06	-0.08	7498.94	0.09	-0.19	16788.04	0.21	-1.14
251.19	0.00	0.00	1584.89	-0.02	-0.03	3548.13	-0.08	-0.09	7943.28	0.09	-0.22	17782.80	0.24	-1.25
316.23	-0.01	-0.01	1678.80	-0.02	-0.02	3758.37	-0.09	-0.09	8413.95	0.14	-0.23	18836.49	0.24	-1.39
398.11	-0.01	-0.01	1778.28	-0.04	-0.03	3981.07	-0.11	-0.10	8912.51	0.19	-0.25	19952.62	0.20	-1.58

FIGURE A-5 377A13 Microphone Calibration Chart

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