Appendix F: Sound Field Calibration Instructions

The Hearing Evaluator sound field speakers are easy to calibrate. You will need a sound level meter traceable to the National Institute of Technology and Science (was National Bureau of Standards) or the appropriate national standards body. Table F-1 lists the speaker calibration. These values have changed from the previously listed values in order to comply with ANSI S3.6–1996. For comparison, Table F-2 lists the values used previous to ANSI S3.6–1996.

TABLE F-1

SPEAKER CALIBRATION (ANSI S3.6–1996)

Frequency	FONIX Speaker
125	+23.5 dB
250	+12.0 dB
500	+3.0 dB
750	+0.5 dB
1000	0.0 dB
1500	-1.0 dB
2000	-2.5 dB
3000	-9.0 dB
4000	-8.5 dB
6000	-3.0 dB
8000	+8.0 dB
Narrow Band Noise:	+6.0 dB
Speech Noise:	+12.5 dB
External:	+12.5 dB
White Noise:	0.0 dB

Entering the Calibration Mode

First turn the Hearing Evaluator off.

1. Set the left and right Input switches to Tone.
   Set the right Output switch to Left Channel.
   Set the left Output switch to Right Channel.
   Set the left and right Hearing Aid Simulator switches to Off.

2. Press and hold down the Pulse and Warble buttons while turning the audiometer on with the power switch on the rear panel. Hold the Pulse and Warble button down until the audiometer finishes warming up and all the LEDs go out except the left Hearing Aid Simulator LED. (The Frequency and both Hearing Level LEDs will also flash because both output dials are set to opposite channels, normally an invalid mode. Nothing is wrong with the instrument. Proceed with calibration.)

The audiometer will indicate that it is in the calibration mode by rapidly flashing the left Hearing Aid Simulator LED at 1/10 second rate

TABLE F-2

SPEAKER CALIBRATION (Prior to ANSI S3.6–1996)	
Frequency	FONIX Speaker
125	*
250	20.0dB
500	8.0dB
750	4.0dB
1000	4.0dB
1500	2.5dB
2000	4.0dB
3000	-3.0dB
4000	4.5dB
6000	3.5dB
8000	*
Narrow Band Noise:	7.0dB
Speech Noise:	13.0dB
External Microphone:	13.0dB
White Noise:	0.0dB

*Disabled

A. Calibrating Warble Tones (speakers)

1. Place the sound level meter three feet away from the tested speaker.
2. Make sure that Pulse is off.
3. Press the Warble button to turn on warble.
4. Set the Output switch to Speaker.
5. Set the Hearing Level switch to 70 dB.
6. Choose the first frequency to be calibrated
7. Press and hold the Stimulus switch down to present the sound.

8. Press either the -2.5 button to reduce the sound level or the Reverse button to increase the sound level. Holding the buttons down longer than one second will cause the sound level to step up or down repeatedly.

9. When you have reached the desired level based on your sound level meter, release the stimulus button and adjust the audiometer settings for the next frequency.

For calibration values refer to Table F-1 above.

NOTE: Speaker calibration is for speakers measured at three feet for 45 degree azimuth operation as specified in ANSI S3.6–1996, Section 9.5, Table 8.

If the calibration level exceeds the ability of the instrument to provide the sound, the Hearing Level LED will flash rapidly. If this happens you must calibrate the audiometer at a lower setting on the hearing level dial.

NOTE: If background noise level is higher than 50 dB you may want to calibrate at a higher level to reduce the error from the background noise.

B. Calibrating Speech Noise (speakers)

Speech Noise is calibrated for effective masking of speech.

1. Set Output switch to Speaker.

2. Select Speech Noise at the Input switch for the first speaker. Put Hearing Level dial at 70 dB. The SPL output on the source level meter should read 82.5 dB for an HL of 70 dB. The SPL to HL equivalent is 12.5 dB for speech noise.

3. Press and hold the Stimulus switch down to present the sound.

4. Press either the -2.5 button to reduce the sound level or the Reverse button to increase the sound level. Holding the buttons down longer than one second will cause the sound level to step up or down repeatedly.

5. When you have reached 82.5 dB based on your sound level meter, release the stimulus button.

Calibrate both speakers.

C. Calibrating White Noise (speakers)

White Noise is not calibrated in effective masking. The HL readings on the dial are converted to SPL without any corrections.

1. Set Output switch to Speaker

2. Select White Noise at the Input switch for the first speaker. Set the Hearing Level dial at 70 dB.

3. Press and hold the Stimulus switch down to present the sound.
4. Press either the -2.5 button to reduce the sound level or the Reverse button to increase the sound level. Holding the buttons down longer than one second will cause the sound level to step up or down repeatedly.
5. When you have reached 70 dB based on your sound level meter, release the stimulus button.

Calibrate both speakers.

NOTE: If background noise level is higher than 50 dB you may want to calibrate at a higher level to reduce the error from the background noise.

D. Calibrating Narrow Band Noise (speakers)

Narrow band noise is calibrated as effective masking. The value is determined by adding 6 dB to the SPL value determined in Puretone.

Note: The initial factory default setting for Narrow Band Noise is off. You must press the Reverse button to get an output for calibration.

1. Set Output switch to Speaker.
2. Select Narrow Band Noise at the Input Switch of the first speaker. Set the Hearing Level dial at 70 dB.
3. Set the Frequency dial to 1000 Hz.
4. Press and hold the Stimulus switch down to present the sound.
5. Press either the -2.5 button to reduce the sound level or the Reverse button to increase the sound level. Holding the buttons down longer than one second will cause the sound level to step up or down repeatedly.
6. When you have reached 76 dB based on your sound level meter, you may release the stimulus button.

Calibrate both speakers.

E. Calibrating External

1. Set the output switch to Speaker. When you calibrate external (tape or CD) you calibrate the microphone also.
2. Set the Input switch to External and the Hearing Level dial to 70 dB.
3. Apply a 1000 Hz signal to the External input jack. (Use a signal generator or the calibration signal from tape or CD.)
4. Adjust the External gain control to set the VU meter to 0 dB.

5. Press and hold the Stimulus switch down to present the sound. The sound level meter should read 82.5 dB at 1 kHz when sound field speakers are properly calibrated.
6. Press either the -2.5 button to reduce the sound level or the Reverse button to increase the sound level. Holding the buttons down longer than one second will cause the sound level to step up or down repeatedly.

Calibrate both speakers.

Calibrating External automatically calibrates the microphone. Refer to Table F-1 for the required calibration values

F. Storing the Calibration and Leaving Calibration Mode

The calibrations you have just performed are stored into the internal EEROM (Electrically Erasable Read Only Memory) by leaving the calibration mode.

1. Set the left and right Source switches to Tone.
2. Set the right Output switch to Left Channel.
3. Set the left Output switch to Right Channel.
4. Set the left and right Hearing Aid Simulator switches to HFE.
5. Press and hold the Pulse and Warble buttons at the same time and hold them down until the left Hearing Aid Simulator LED goes out indicating that the calibration data has been stored and you are out of calibration mode.

Note that the Level error LEDs will be flashing rapidly because of the invalid output selection.

G. Error Indicator

If the calibration did not take, or an incorrect switch combination was selected to exit the calibration mode, the left Hearing Aid Simulator LED will remain flashing.

H. How to Cancel Calibration
(Discard the calibration values entered)

While still in the calibration mode, simply turn off the power switch and all calibration information modifications will be discarded.

I. Restoring the Factory Calibration

Should you make a mistake in calibrating the instrument and want to restore the original factory calibration tables, you can do so by pressing the Output reverse and Talk Forward buttons while turning the power on instead of pressing the Pulse and Warble buttons.

J. Calibration Errors

A calibration error is an attempt to exceed the capabilities of the instrument. If the Hearing Level LEDs on the front panel flash rapidly, you have exceeded the limits of that particular combination of input and output. You will have to calibrate at a lower level.

An inadvertent loss of calibration can normally be cured by recalibrating the instrument. The EEROM can be calibrated over 10,000 times so that should not be a cause of concern.

Appendix G: Bone Calibration Tables

Starting with serial #366 the parameters used in calibrating the bone vibrator conform to ANSI S3.43–1992. Some users will notice a difference in bone conduction thresholds, particularly at 250 Hz where there is a calibration difference of 6 dB. Here is the chart that is currently being used. The old chart is also included for comparison. ANSI S3.6–1996 did not change the bone calibration values.

It should also be noted that the RS232 Option has been available since December of 1992, starting with serial number #195.

TABLE G-1 Current Bone Vibrator Calibration

Radioear B-71 (100Ω) **BONE VIBRATOR 0 HL CALIBRATION (MASTOID dB = 1 μNEWTON)** Assuming artificial mastoid with flat frequency response			
Frequency	Mastoid output	Supporting Document	
125	OFF		
250	67.0 dB	ANSI S3.6-1996	TABLE 8
500	58.0 dB	ANSI S3.6-1996	TABLE 8
750	48.5 dB	ANSI S3.6-1996	TABLE 8
1000	42.5 dB	ANSI S3.6-1996	TABLE 8
1500	36.5 dB	ANSI S3.6-1996	TABLE 8
2000	31.0 dB	ANSI S3.6-1996	TABLE 8
3000	30.0 dB	ANSI S3.6-1996	TABLE 8
4000	35.5 dB	ANSI S3.6-1996	TABLE 8
6000	40.0 dB	ANSI S3.6-1996	TABLE 8
8000	40.0 dB	ANSI S3.6-1996	TABLE 8
1KHz NBN	48.5 dB	ANSI S3.6-1996 section 6.3.1	
Speech Noise	55.0 dB	Same as External Source	
Ext Source	55.0 dB	ANSI S3.6-1996 section 6.2.12	
White Noise	36.5 dB	1000 Hz Value - 6dB (Empirical)	

TABLE G-2 Previous Bone Vibrator Calibration
(Before serial # 366) ANSI S3.26-1981

Frequency	Hearing Level
250	61.0 dB
500	59.0 dB
750	47.0 dB
1000	39.0 dB
1500	35.0 dB
2000	32.5 dB
3000	28.0 dB
4000	31.0 dB
6000	35.0 dB
Narrow Band Noise	42.0 dB
Speech Noise	51.5 dB
White Noise	33.0 dB
Ext Source	51.5 dB

Appendix H: Earphone Calibration Tables

TABLE 1

Left Channel Earphone Calibration for TDH39 100Ω earphones

Left Input	Left Output	Frequency	Left Hearing Level	Sound Level Meter plus 6 cc coupler
Tone	Phone	125	70 dB	**115.0 dB SPL**
Tone	Phone	250	70 dB	**95.5 dB SPL**
Tone	Phone	500	70 dB	**81.5 dB SPL**
Tone	Phone	750	70 dB	**77.5 dB SPL**
Tone	Phone	1K	70 dB	**77.0 dB SPL**
Tone	Phone	1.5K	70 dB	**76.5 dB SPL**
Tone	Phone	2K	70 dB	**79.0 dB SPL**
Tone	Phone	3K	70 dB	**80.0 dB SPL**
Tone	Phone	4K	70 dB	**79.5 dB SPL**
Tone	Phone	6K	70 dB	**85.5 dB SPL**
Tone	Phone	8K	70 dB	**83.0 dB SPL**
Narrow Band Noise	Phone	1K	70 dB	**83.0 dB SPL**
Speech Noise	Phone	—	70 dB	**89.5 dB SPL**
White Noise	Phone	—	70 dB	**70.0 dB SPL**
L External Source (Ext 1 KHz; set OVU)	Phone	—	70 dB	**89.5 dB SPL**

TABLE 2

Left Channel Earphone Calibration for Eartone 3A 50Ω Earphones

Left Input	Left Output	Frequency	Left Hearing Level	Sound Level Meter plus DB0138 coupler
Tone	Phone	125	70 dB	**96.0 dB SPL**
Tone	Phone	250	70 dB	**84.0 dB SPL**
Tone	Phone	500	70 dB	**75.5 dB SPL**
Tone	Phone	750	70 dB	**72.0 dB SPL**
Tone	Phone	1K	70 dB	**70.0 dB SPL**
Tone	Phone	1.5K	70 dB	**72.0 dB SPL**
Tone	Phone	2K	70 dB	**73.0 dB SPL**
Tone	Phone	3K	70 dB	**73.5 dB SPL**
Tone	Phone	4K	70 dB	**75.5 dB SPL**
Tone	Phone	6K	70 dB	**72.0 dB SPL**
Tone	Phone	8K	70 dB	**70.0 dB SPL**
Narrow Band Noise	Phone	1K	70 dB	**76.0 dB SPL**
Speech Noise	Phone	—	70 dB	**82.5 dB SPL**
White Noise	Phone	—	70 dB	**70.0 dB SPL**
L External Source (Ext 1 KHz; set OVU)	Phone	—	70 dB	**82.5 dB SPL**

TABLE 3

Right Channel Earphone Calibration for TDH39 100Ω earphones

Right Input	Right Output	Frequency	Right Hearing Level	Sound Level Meter plus 6 cc coupler
Tone	Phone	125	70 dB	**115.0 dB SPL**
Tone	Phone	250	70 dB	**95.5 dB SPL**
Tone	Phone	500	70 dB	**81.5 dB SPL**
Tone	Phone	750	70 dB	**77.5 dB SPL**
Tone	Phone	1K	70 dB	**77.0 dB SPL**
Tone	Phone	1.5K	70 dB	**76.5 dB SPL**
Tone	Phone	2K	70 dB	**79.0 dB SPL**
Tone	Phone	3K	70 dB	**80.0 dB SPL**
Tone	Phone	4K	70 dB	**79.5 dB SPL**
Tone	Phone	6K	70 dB	**85.5 dB SPL**
Tone	Phone	8K	70 dB	**83.0 dB SPL**
Narrow Band Noise	Phone	1K	70 dB	**83.0 dB SPL**
Speech Noise	Phone	—	70 dB	**89.5 dB SPL**
White Noise	Phone	—	70 dB	**70.0 dB SPL**
R External Source (Ext 1 KHz; set OVU)	Phone	—	70 dB	**89.5 dB SPL**

TABLE 4

Right Channel Earphone Calibration for Eartone 3A 50Ω Earphones

Right Input	Right Output	Frequency	Right Hearing Level	Sound Level Meter plus DB0138 coupler
Tone	Phone	125	70 dB	**96.0 dB SPL**
Tone	Phone	250	70 dB	**84.0 dB SPL**
Tone	Phone	500	70 dB	**75.5 dB SPL**
Tone	Phone	750	70 dB	**72.0 dB SPL**
Tone	Phone	1K	70 dB	**70.0 dB SPL**
Tone	Phone	1.5K	70 dB	**72.0 dB SPL**
Tone	Phone	2K	70 dB	**73.0 dB SPL**
Tone	Phone	3K	70 dB	**73.5 dB SPL**
Tone	Phone	4K	70 dB	**75.5 dB SPL**
Tone	Phone	6K	70 dB	**72.0 dB SPL**
Tone	Phone	8K	70 dB	**70.0 dB SPL**
Narrow Band Noise	Phone	1K	70 dB	**76.0 dB SPL**
Speech Noise	Phone	—	70 dB	**82.5 dB SPL**
White Noise	Phone	—	70 dB	**70.0 dB SPL**
R External Source (Ext 1 KHz; set OVU)	Phone	—	70 dB	**82.5 dB SPL**

Appendix I: Calibrating the FA-10

I-1 Equipment Required

1. A 1000 Hz sine wave generator (calibration not critical).
2. A sound level meter*.
3. An artificial mastoid with calibration table. If you are following this procedure for the first time and/or you have only a curve for your artificial mastoid, see Section I-7.
4. A scientific or engineering calculator for establishing the artificial mastoid calibration table in Section I-7.
5. An AC-millivoltmeter* RMS responding, NOT average responding for measuring the output of the artificial mastoid.
6. Type 9A (6cc) earphone coupler with earphone weight or spring.

* The sound level meter and the millivoltmeter must be traceable to a government standards laboratory such as, in the U.S., the National Institute of Technology and Science (used to be called the National Bureau of Standards). There should be a sticker from a calibration laboratory on the sound level meter and on the voltmeter showing: the name of the calibration laboratory and the date that next calibration is due.

I-2 Introduction

The FA-10 can be calibrated without opening the enclosure. Calibration is enabled by setting the controls to a "secret" code, holding down two keys, then turning power on. The **-2.5 dB** and **Reverse** keys then function as "adjust .5 dB downward" and "adjust .5 dB upward" keys respectively. One simply sets the FA- 10 controls for a particular function. That function can then be calibrated. There are a total of 75 steps to be completed in a full calibration. Calibration values are stored and calibation mode exited by another "secret" setting of controls plus pressing two keys.

This calibration procedue is the minimum required to fully calibrate an FA-10. This procedure assumes that the FA-10 is fully functional. This procedure is not intended as an instrument performance check.

The FA-10 is intended to be used with 100Ω patient earphones, 100Ω bone vibrator, and 8Ω speakers. Use of other impedance devices will reduce available output and may slightly degrade FA-10 accuracy.

Since the frequencies are crystal controlled, there is no frequency drift and no need to calibrate the frequencies on the Hearing Evaluator.

Only one channel needs to be calibrated for the Bone Vibrator. Both channels use the same calibration table values.

If you intend to skip steps, be aware of the following. These effects are limited to channel calibrated (left or right) and limited to the output calibrated (earphone, bone vibrator, or speaker):

- **Tone** must be calibrated before **Narrow Band Noise**.
- If 1 **KHz Tone** is changed, **1 KHz Narrow Band Noise** must be recalibrated.

You may exit calibration at any time and resume later where you left off. If you have unreliable mains power, exiting calibration several times through the calibration procedure may be of benefit.

I-3 Hints

Especially low frequencies, with **Stimulus** pressed, wiggle the earphone against the 9A coupler to check that there are no acoustic leaks.

With **Stimulus** pressed,wiggle the bone vibrator against the artificial mastoid to be certain that it is seated properly.

You may increase the sound levels as needed (within FA-10 capabilities) to reduce the effects of ambient noise. Increase the calibration point at the sound level meter or millivolt meter by the same amount that you increase the Hearing Level control. It is desirable that background noise be 20 dB less than measured signal. Check background noise frequently.

If the **red LEDs flash**, one or more of four conditions exists:

- ALL THREE RED LEDs FLASH: The left **Output** switch set to **Right Channel** plus right **Output** switch set to **Left Channel** (part of switch combination used to enter and exit calibration).
- ONE Hearing Level LED FLASHES plus FREQUENCY LED FLASHES: The Frequency setting for the output selected has been disabled by holding -2.5 dB until the calibration has reached zero output.
- ONE Hearing Level LED flashes rapidly: You have exceeded the maximum output capabilities of the FA-10. Decrease the Hearing Level control setting.
- One Hearing Level LED flashes slowly **(POTENTIAL OPERATOR TRAP!)**: You have adjusted the calibration level above a software safety limit. The Hearing Level LED will flash slowly at all Hearing Level control settings. To clear this condition, (in calibration mode) hold **Stimulus** and simultanously press **-2.5 dB** once.
- Compensate for any frequency response error in your sound level meter. If the frequency response of the meter is low at a frequency, your expected measurements at that frequency will be low by the same amount.

I-4 Procedure: Start

I-4.1 Enter Calibration Mode

Turn the Hearing Evaluator power off.

1. Set the left and right **Input** switches to **Tone**.
   Set the right **Output** switch to **Left Channel**.
   Set the left **Output** switch to **Right Channel**.
   Set the left and right **Hearing Aid Simulator** switches to **Off**.

2. Press and hold down the **Pulse** and **Warble** buttons.
   Turn the audiometer rear panel **POWER** switch **ON**.

   The audiometer will indicate that it is in the calibration mode by rapidly flashing the left **Hearing Aid Simulator LED** at a 1/10 second rate.

3. Set the left **Output** switch to **Phone**.
   Set the right **Output** switch to **Phone**.

I-4.2 Calibration

To calibrate the external source in the Cal steps 15, 30, 45, 60, and 75 below:

- Connect the 1000 Hz sine wave generator to the External Source Input being calibrated.
- Set the sine wave generator for about 1 volt output (not critical!)
- Set the FA-10 **Input** to **External**.
- Press FA-10 Stimulus and adjust the FA-10 front panel **External** control so that the VU meter reads “0 VU”. Perfect adjustment occurs with the “-1 VU” and “0 VU” LEDs both lit.

For complete FA-10 calibration, make all **adjustments** listed in tables 1 through 5 below. Calibrate to the values shown in **bold**.

For each step:

- Set up the FA-10 for the calibration step.
- Press and hold down the channel **Stimulus** button to present sound and simultaneously press the **-2.5** dB key to decrease amplitude or press the **Reverse** key to increase amplitude.
- Release the **Stimulus** key and go to the next step.
- Disable the channel at calibration steps 16, 26, 31, 41, 61, and 71. Press and hold the **Stimulus** key and the **-2.5** dB key until the Hearing Level LED flashes plus the Frequency LED flashes. This indicates that the channel is off.

TABLE 1
Left Channel Earphone Calibration for TDH39 100Ω Earphones

CAL step	Left Input	Left Output	Frequency	Left Hearing Level	Sound Level Meter plus 6 cc coupler
1	TONE	Phone	125	70 dB	**115.0 dB SPL**
2	TONE	Phone	250	70 dB	**95.5 dB SPL**
3	TONE	Phone	500	70 dB	**81.5 dB SPL**
4	TONE	Phone	750	70 dB	**77.5 dB SPL**
5	TONE	Phone	1K	70 dB	**77.0 dB SPL**
6	TONE	Phone	1.5K	70 dB	**76.5 dB SPL**
7	TONE	Phone	2K	70 dB	**79.0 dB SPL**
8	TONE	Phone	3K	70 dB	**80.0 dB SPL**
9	TONE	Phone	4K	70 dB	**79.5 dB SPL**
10	TONE	Phone	6K	70 dB	**85.5 dB SPL**
11	TONE	Phone	8K	70 dB	**83.0 dB SPL**
12	Narrow Band Noise	Phone	1K	70 dB	**83.0 dB SPL**
13	Speech Noise	Phone	—	70 dB	**89.5 dB SPL**
14	White Noise	Phone	—	70 dB	**70.0 dB SPL**
15	L External Source (Ext 1 KHz; set OVU)	Phone	—	70 dB	**89.5 dB SPL**

For Eartone 3A Earphones (formerly ER3A), calibrate the same as for TDH39 Earphones, but use the following table.

TABLE 1A
Left Channel Earphone Calibration for Eartone 3A 50Ω Earphones

CAL step	Left Input	Left Output	Frequency	Left Hearing Level	Sound Level Meter plus 6 cc coupler
1a	TONE	Phone	125	70 dB	**96.0 dB SPL**
2a	TONE	Phone	250	70 dB	**84.0 dB SPL**
3a	TONE	Phone	500	70 dB	**75.5 dB SPL**
4a	TONE	Phone	750	70 dB	**72.0 dB SPL**
5a	TONE	Phone	1K	70 dB	**70.0 dB SPL**
6a	TONE	Phone	1.5K	70 dB	**72.0 dB SPL**
7a	TONE	Phone	2K	70 dB	**73.0 dB SPL**
8a	TONE	Phone	3K	70 dB	**73.5 dB SPL**
9a	TONE	Phone	4K	70 dB	**75.5 dB SPL**
10a	TONE	Phone	6K	70 dB	**72.0 dB SPL**
11a	TONE	Phone	8K	70 dB	**70.0 dB SPL**
12a	Narrow Band Noise	Phone	1K	70 dB	**76.0 dB SPL**
13a	Speech Noise	Phone	—	70 dB	**82.5 dB SPL**
14a	White Noise	Phone	—	70 dB	**70.0 dB SPL**
15a	L External Source (Ext 1 KHz; set OVU)	Phone	—	70 dB	**82.5 dB SPL**

TABLE 2
Bone Vibrator Calibration
WATCH OUT FOR NOISE

CAL step	Left Input	Left Output	Frequency	Left Hearing Level	Mastoid + Millivoltmeter from Table 6 See Appendix A
16	TONE	Bone	125		**Cal to minimum (disable)**
17	TONE	Bone	250	20 dB	———(Table 6)
18	TONE	Bone	500	40 dB	———(Table 6)
19	TONE	Bone	750	40 dB	———(Table 6)
20	TONE	Bone	1K	40 dB	———(Table 6)
21	TONE	Bone	1.5K	40 dB	———(Table 6)
22	TONE	Bone	2K	40 dB	———(Table 6)
23	TONE	Bone	3K	40 dB	———(Table 6)
24	TONE	Bone	4K	40 dB	———(Table 6)
25	TONE	Bone	6K	40 dB	———(Table 6)
26	TONE	Bone	8K	40 dB	———(Table 6)
27	Narrow Band Noise	Bone	1K	40 dB	———(Table 6)
28	Speech Noise	Bone	—	40 dB	———(Table 6)
29	White Noise	Bone	—	40 dB	———(Table 6)
30	L External Source (Ext 1 KHz; set OVU)	Bone	—	40 dB	———(Table 6)

TABLE 3
Left Channel Speaker Calibration

CAL step	Left Input	Left Output	Frequency	Left Hearing Level	Sound Level Meter at 3 feet
31	TONE (warble on)	Speaker	125	50 dB	**73.5 dB SPL**
32	TONE (warble on)	Speaker	250	70 dB	**82.0 dB SPL**
33	TONE (warble on)	Speaker	500	70 dB	**73.0 dB SPL**
34	TONE (warble on)	Speaker	750	70 dB	**70.5 dB SPL**
35	TONE (warble on)	Speaker	1K	70 dB	**70.0 dB SPL**
36	TONE (warble on)	Speaker	1.5K	70 dB	**69.0 dB SPL**
37	TONE (warble on)	Speaker	2K	70 dB	**67.5 dB SPL**
38	TONE (warble on)	Speaker	3K	70 dB	**61.0 dB SPL**
39	TONE (warble on)	Speaker	4K	70 dB	**61.5 dB SPL**
40	TONE (warble on)	Speaker	6K	70 dB	**67.0 dB SPL**
41	TONE (warble on)	Speaker	8K	70 dB	**78.0 dB SPL**
42	Narrow Band Noise	Speaker	1K	70 dB	**76.0 dB SPL**
43	Speech Noise	Speaker	—	70 dB	**82.5 dB SPL**
44	White Noise	Speaker	—	70 dB	**70.0 dB SPL**
45	L External Source (Ext 1 KHz; set OVU)	Speaker	—	70 dB	**82.5 dB SPL**

TABLE 4
Right Channel Earphone Calibration for TDH39 100Ω Earphones

CAL step	Right Input	Right	Frequency	Right Hearing Level	Sound Level Meter plus 6 cc coupler
46	TONE	Phone	125	70 dB	**115.0 dB SPL**
47	TONE	Phone	250	70 dB	**95.5 dB SPL**
48	TONE	Phone	500	70 dB	**81.5 dB SPL**
49	TONE	Phone	750	70 dB	**77.5 dB SPL**
50	TONE	Phone	1K	70 dB	**77.0 dB SPL**
51	TONE	Phone	1.5K	70 dB	**76.5 dB SPL**
52	TONE	Phone	2K	70 dB	**79.0 dB SPL**
53	TONE	Phone	3K	70 dB	**80.0 dB SPL**
54	TONE	Phone	4K	70 dB	**79.5 dB SPL**
55	TONE	Phone	6K	70 dB	**85.5 dB SPL**
56	TONE	Phone	8K	70 dB	**83.0 dB SPL**
57	Narrow Band Noise	Phone	1K	70 dB	**83.0 dB SPL**
58	Speech Noise	Phone	—	70 dB	**89.5 dB SPL**
59	White Noise	Phone	—	70 dB	**70.0 dB SPL**
60	R External Source (Ext 1 KHz; set OVU)	Phone	—	70 dB	**89.5 dB SPL**

For Eartone 3A Earphones, calibrate the same as for TDH39 Earphones, but use the following table.

TABLE 4A
Right Channel Earphone Calibration for Eartone 3A 50Ω Earphones

CAL step	Right Input	Right Output	Frequency	Right Hearing Level	Sound Level Meter plus DB0138 coupler
46a	TONE	Phone	125	70 dB	**96.0 dB SPL**
47a	TONE	Phone	250	70 dB	**84.0 dB SPL**
48a	TONE	Phone	500	70 dB	**75.5 dB SPL**
49a	TONE	Phone	750	70 dB	**72.0 dB SPL**
50a	TONE	Phone	1K	70 dB	**70.0 dB SPL**
51a	TONE	Phone	1.5K	70 dB	**72.0 dB SPL**
52a	TONE	Phone	2K	70 dB	**73.0 dB SPL**
53a	TONE	Phone	3K	70 dB	**73.5 dB SPL**
54a	TONE	Phone	4K	70 dB	**75.5 dB SPL**
55a	TONE	Phone	6K	70 dB	**72.0 dB SPL**
56a	TONE	Phone	8K	70 dB	**70.0 dB SPL**
57a	Narrow Band Noise	Phone	1K	70 dB	**76.0 dB SPL**
58a	Speech Noise	Phone	—	70 dB	**82.5 dB SPL**
59a	White Noise	Phone	—	70 dB	**70.0 dB SPL**
60a	R External Source (Ext 1 KHz; set OVU)	Phone	—	70 dB	**82.5 dB SPL**

TABLE 5
Right Channel Speaker Calibration

CAL step	Right Input	Right Output	Frequency	Right Hearing Level	Sound Level Meter at 3 feet
61	TONE (warble on)	Speaker	125	50 dB	**73.5 dB SPL**
62	TONE (warble on)	Speaker	250	70 dB	**82.0 dB SPL**
63	TONE (warble on)	Speaker	500	70 dB	**73.0 dB SPL**
64	TONE (warble on)	Speaker	750	70 dB	**70.5 dB SPL**
65	TONE (warble on)	Speaker	1K	70 dB	**70.0 dB SPL**
66	TONE (warble on)	Speaker	1.5K	70 dB	**69.0 dB SPL**
67	TONE (warble on)	Speaker	2K	70 dB	**67.5 dB SPL**
68	TONE (warble on)	Speaker	3K	70 dB	**61.0 dB SPL**
69	TONE (warble on)	Speaker	4K	70 dB	**61.5 dB SPL**
70	TONE (warble on)	Speaker	6K	70 dB	**67.0 dB SPL**
71	TONE (warble on)	Speaker	8K	70 dB	**78.0 dB SPL**
72	Narrow Band Noise	Speaker	1K	70 dB	**76.0 dB SPL**
73	Speech Noise	Speaker	—	70 dB	**82.5 dB SPL**
74	White Noise	Speaker	—	70 dB	**70.0 dB SPL**
75	R External Source (Ext 1 KHz; set OVU)	Speaker	—	70 dB	**82.5 dB SPL**

I-4.3 Alternate Earphone Calibration

If the alternate earphone option is installed, the audiometer may be calibrated for two separate earphone types.

To select the alternate earphone, place the left Hearing Aid Simulator switch in the Option A position. If the alternate earphone calibration is available, the Hearing Aid Simulator LED will flash rapidly, indicating that the alternate earphone calibration is being used.

You may now repeat the normal earphone calibration procedure to calibrate the alternate earphones.

Remember to clearly mark on the audiometer which earphones are the primary earphones and which ones are the alternate earphones. Mismatching of the earphone calibration will result in incorrect thresholds being measured.

I-4.4 Exit Calibration Mode (and Store Calibration Data)

The calibration you have just performed will be automatically stored into the internal EE-ROM (electrically Erasable Read Only Memory) when leaving the calibration mode. Two copies of the data are stored in "field calibration tables". This step may be performed at any point you choose during the calibration procedure. You may later resume where you left off.

1. Set the left **Input** switch to **Tone**.

2. Set the right **Input** switch to **Tone**.

3. Set the right **Output** switch to **Left Channel**.

4. Set the left **Output** switch to **Right Channel**.

5. Set the left **Hearing Aid Simulator** switch to **HFE**.

6. Set the right **Hearing Aid Simulator** switch to **HFE**.

7. Press and hold the **Pulse** and **Warble** buttons at the same time and hold them down until the Hearing Aid Simulator LEDs go out. This indicates that the calibration data has been stored and you are out of calibration mode. This process will take about 5 seconds.

***** FLASHING RED OK *****

Note that the red Level error LEDs will be flashing rapidly because the Output switches are set to an invalid output selection. This is normal. Change the Output switch settings to stop the flashing.

**** ERROR ** WARNING ** FLASHING GREEN ****

If the calibration did not take because you did not properly set the switch combination to exit the calibration mode or because of FA-10 circuit problems: then the left GREEN Hearing Aid Simulator LED will remain flashing. Recheck the switch combination items 1) through 7) above. If the switch combination is correct, then: sorry! You must repeat the calibration. First replace U9, the 93C66 on the CPU/KEYBOARD.

End of procedure. Your FA-10 is now calibrated.

I-5 Other Calibration Options

I-5.1 How to Discard Calibration Values

While still in the calibration mode, simply turn off the power switch and all calibration information modifications will be discarded.

I-5.2 To Enter Calibration Mode with Original Factory Calibration

Should you make a mistake in calibration and want to restore the original factory calibration tables for your FA-10:

1. Turn FA-10 Power switch off.

2. Set the left and right **Input** switches to **Tone**.
   Set the right **Output** switch to **Left Channel**.
   Set the left **Output** switch to **Right Channel**.
   Set the left and right **Hearing Aid Simulator** switches to **Off**.

3. Press and hold down the **Output Reverse** and **Talk Forward** buttons.

4. Turn the audiometer rear panel **POWER** switch **ON**.

At this point, the FA-10 is in calibration mode. Make any calibration changes necessary, then go to step I-4.3 to save the calibration data and exit calibration.

I-5.3 To Enter Calibration Mode with an Average of Factory Calibrations

This is an average of the calibration tables for the first few FA-10smanufactured. These steps will be useful if all ofthe EEROM tables are defective. Possible uses might include:

- ERROM has been replaced.
- Troubleshooting an FA-10 which has multiple electrical problems including a replaced EEROM (not yet calibrated).
- Establishing a "calibration deviation report" for an FA-10 with totally damaged EEROM calibration tables. This FA-10 might have been used to collect patient data. (The user operated the FA-10 while the Hearing Aid Simulator green LEDs were flashing in groups of 6 or 7 flashes.)

Unless you know for certain that the data in the EEROM were destroyed by technician's calibration errors, the EEROM should be replaced. The cost of the EEROM is small compared to the cost of recalibration.

START:

1. Turn FA-10 Power switch off.

2. Set the left and right **Input** switches to **Tone**.
   Set the right **Output** switch to **Left Channel**.
   Set the left **Output** switch to **Right Channel**.
   Set the left and right **Hearing Aid Simulator** switches to **Off**.

3. Press and hold down all 4 of the following buttons:
   Output Reverse, Pulsed, Warble, Talk Forward. (Use a ruler or pencil.)

4. Turn the FA-10 rear panel **POWER** switch **ON**.

At this point, the FA-10 is in calibration mode.

Continue with all the calibration steps and then go to item 3.9 (following) to save the calibration data and exit calibration.

I-5.4 Exit Calibration Mode (Store Calibration Data and Store New Factory Calibration Data)

Don't do this unless:

- you have replaced the EEROM, or
- FA-10 transducer(s) have been changed, or else
- you know that the factory calibration tables were destroyed by technician error.

The calibration you have just performed will be automatically stored into the internal EEROM (electrically Erasable Read Only Memory) when leaving the calibration mode. This step may be performed at any point you choose during the calibration procedure. You may later resume where you left off.

1. Set the left **Input** switch to **Tone**.
2. Set the right **Input** switch to **Tone**.
3. Set the right **Output** switch to **Left Channel.**
4. Set the left **Output** switch to **Right Channel.**
5. Set the left **Hearing Aid Simulator** switch to **HFE**.
6. Set the right **Hearing Aid Simulator** switch to **HFE**.
7. Press and hold the left **Stimulus**, right **Stimulus**, **Pulse**, and **Warble** buttons at the same time; and hold them down until the Hearing Aid Simulator LEDs go out. This indicates that the calibration data has been stored and you have exited calibration mode. This process will take about 10 seconds.

FLASHING RED OK

Note that the red Level error LEDs will be flashing rapidly because the **Output** switches are set to an invalid output selection. This is normal. Change the **Output** switch settings to stop the flashing.

** ERROR ** WARNING ** FLASHING GREEN **

If the calibration did not take because you did not properly set the switch combination to exit the calibration mode or because of FA-10 circuit problems: then the left GREEN Hearing Aid Simulator LED will remain flashing. Recheck the switch combination items 1 through 7 above. If the switch combination is correct, then: sorry! You must repeat the calibration. First replacing U9, the 93C66 EEROM located on the FA-10 CPU/KEYBOARD.

I-6 EEROM Failures

Duplicate calibration information is stored in the EEROM to insure that the EEROM data is valid. In fact, there are actually five sets of calibration tables in the audiometer. Two are duplicate factory calibration tables, done by computer through the RS232 port. Another two are duplicate field calibration tables created using the procedures described in this booklet. The fifth set of calibration tables is in the EPROM. It is based on average data of the transducers used, and cannot be considered more than approximately correct.

The EEROM, where the calibration information is stored, uses a CRC (cyclical redundancy check) that will detect a failure of the data stored in the EEROM. Three levels of calibration failure are identified by the pattern of the flashing of the Hearing Simulator LEDs.

Should an EEROM failure occur when you turn the audiometer on, turn FA-10 power off, then on again to see if the error will correct itself. If an EEROM error occurs while trying to save the new calibration values just entered, try to exit calibration again. If the error does not go away or is intermittant, replace the EEROM.

Note: See Section 3.5.4 if you repalce the EEROM.

I-6.1 Field Calibration Table Bit Error Warning

, ** OR **

The Hearing Aid Simulator LEDs flash in a pattern of one, two, or three times in succession, with pauses between the grouping of flashes.

One of the two field calibration tables contains an error. The other Table is good. The FA-10 is still calibrated but should be serviced. The EEROM is less than perfect.

This type of error can often be corrected by recalibrating the audiometer as described above, BUT DO NOT. Order a new EEROM from Frye Electronics, because the cost of this part is small compared to the usual cost of calibration.

I-6.2 Both Field Calibration Table Bit Error Warning

****** OR *******

The Hearing Aid Simulator LEDS flash in groups of 4 or 5 flashes. In addition, Hearing Level and Frequency LEDS will flash every three seconds.

Both field calibration tables have failed. The FA-10 is now using one of the two factory calibration tables. If the factory calibration were still valid, then the FA-10 is still calibrated, but servicing is recommended. If the factory calibration is not valid because of a transducer change, or because sound field was calibrated in the field, then the FA-10 should be considered out of calibration.

A serious multiple failure has occurred inside the EEROM. You might succeed in doing a field calibration, BUT DO NOT. Replace the EEROM.

I-6.3 Total EEROM Failure Warning

****** **OR** *******

The third level of failure is complete EEROM failure signaled by a flashing pattern of six or seven on the Hearing Simulator LEDs. Hearing Level and Frequency LEDs will flash faster (once per second) than for an EEROM error. In this case, the audiometer will default to the backup calibration burned into the EPROM. This calibration is based on average values and is not precise.

If the user insists on taking data with this warning present, data can be salvaged by providing a table of calibration data from before calibration and from after calibration.

I-6.4 Calibration Failure / Fail-Safe Shutdown

******* + *****

Should all five sets of calibration tables fail, the audiometer will go into fail-safe mode and shut down all operation. If you see the Hearing Simulator LEDs flash a count of seven followed by a flash count of five, you know that the back-up calibration in the EPROM has failed.

I-6.5 Recovery from a Fail-Safe Error

A shutdown is a very rare occurance. It is possible that a shutdown will be due to a transient failure such as a static discharge or power surge. In such cases, the problem can normally be cured by turning the instrument off and then back on again. A problem caused by hardware failure will require the instrument to be repaired.

An inadvertent loss of calibration due to technician error can normally be cured by recalibrating the instrument. The EEROM can be calibrated over 10,000 times so that should not be a cause of concern.

I-7 Procedure to Establish Artificial Mastoid Calibration Table

This procedure is to be done each time the artificial mastoid is sent to a certification laboratory. It is NOT done for each audiometer. Keep completed TABLE 6 in a safe place for reference.

Information Required

1. Artificial mastoid sensitivity at 1000 Hz measured in nanovolts per micronewton (nV/μN). If you have sensitivity in nanovolts per dyne, divide by 10 to get nanovolts per micronewton. 1 microvolt = 1000 nanovolts.

2. A graph or table showing the artificial mastoid output at frequencies from 250 Hz to 6000 Hz; in dB relative to 1000 Hz.

Start:

1. Make a copy of TABLE 2 . Do not mark up the original in this manual.
2. Make a copy of TABLE 6. Do not mark up the original in this manual.
3. Fill out the top portion of TABLE 6 from documentation provided with your artificial mastoid.

TABLE 6

FRYE ELECTRONICS INC. **ARTIFICIAL MASTOID CALIBRATION TABLE**

DATE: _____

ARTIFICIAL MASTOID MANUFACTURER:_____

MODEL NUMBER:_____

SERIAL NUMBER:_____

SENSITIVITY AT 1000 Hz:_____ nanovolts per microNewton = S

COLUMN A	COLUMN B	COLUMN C	COLUMN D	COLUMN E	COLUMN F	COLUMN G
SOURCE	MASTOID RELATIVE SENSITIVITY	ISO 7566 1987 (E) THRESHOLD	RELATIVE OUTPUT AT 0 dB HL	OUTPUT VOLTAGE AT 0 dB HL	OUTPUT VOLTAGE AT 20 dB HL	OUTPUT VOLTAGE AT 40 dB HL
250 Hz TONE	dB	67.0 dB	dB			
500 Hz TONE	dB	58.0 dB	dB			
750 Hz TONE	dB	48.5 dB	dB			
1 kHz TONE	0.0 dB	42.5 dB	42.5 dB			
1.5 kHz TONE	dB	36.5 dB	dB			
2 kHz TONE	dB	31.0 dB	dB			
3 kHz TONE	dB	30.0 dB	dB			
4 kHz TONE	dB	35.5 dB	dB			
6 kHz TONE	dB	40.0 dB	dB			
8 kHz TONE	dB	40.0 dB	dB			
1 kHz NBN	0.0 dB	48.5 dB	48.5dB			
SPEECH NOISE	0.0 dB	55.0 dB	55.0dB			
EXT SOURCE	0.0 dB	55.0 dB	55.0dB			
WHITE NOISE	0.0 dB	36.5 dB	36.5dB			
			D=B+C	$E=Sx10^{(D/20)}$	F=10 x E	G=100 x E

4. From the table or graph provided with your artificial mastoid, enter the relative sensitivity of your artificial mastoid at 8 frequencies. 1 KHz must be 0 dB. The numbers must be in dB. If the frequency has less output than 1 KHz, then the relative output has a minus (-) sign.

5. Add the numbers in COLUMN B plus the numbers in COLUMN C and write the totals in COLUMN D

6. Using a scientific calculator, for each number in COLUMN D:

- Divide number by 20
- Press 10^x key (raise 10 to the above result)
- Multiply by S the sensitivity of your artificial mastoid at 1000 Hz)
- Write the result in COLUMN E including voltage label (nV, μV, mV, V).

  Note: The result must have at least 3 significant digits. Change to microvolts or millivolts when required.

7. Multiply each number in COLUMN E by 10 and write the result in COLUMN F including voltage label (nV, μV, mV, V).

8. Multiply each number in COLUMN E by 100 and write the result in COLUMN G including voltage label (nV, μV, mV, V).

9. Enter the appropriate values in TABLE 2.

End of procedure

Note: If you wish to calculate voltages 10 dB higher, multiply by the square root of 10. $\sqrt[2]{10} = 3.1623$.