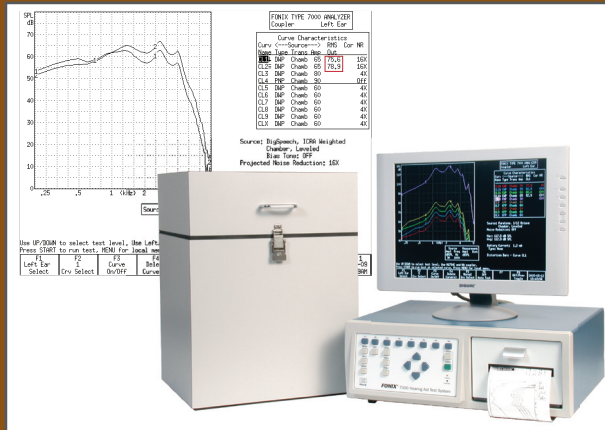


Testing FM Systems on the 7000 Hearing Aid Test System



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Introduction

This workbook describes how to test FM systems with the 7000 Hearing Aid Test System using coupler measurements. An FM system consists of two main parts: a transmitter and a receiver. The transmitter microphone can come in many different sizes and shapes, and it can be nondirectional or directional. The receiver can be a button earphone, or it can be attached to a BTE hearing aid either internally, via a boot receiver, via a silhouette coil, or via a neck loop. No matter the combination, all FM systems can be tested. These test procedures should be performed on an FM system at least once a year. For children under the age of 5, these procedures should be performed every six months.

As with most hearing aids, both the gain and the maximum output (OSPL) of an FM system should be adjusted to meet the listener's auditory requirements.

There are several issues to consider when comparing the hearing aid and FM performance.

- With FM systems, the pickup microphone is normally worn at the chest, 6-8 inches (15-20 cm) under the mouth of the talker, whereas with hearing aids, the pickup microphone is worn by the listener, typically at a minimum of 3 ft. (1 m) from the talker. This difference affects both the level and the frequency content of typical input signals. With FM systems, typical speech input levels range from 75 to 85 dB SPL, as compared with 60 to 70 dB SPL for hearing aids. With the chest-worn location of the pickup microphone, the high frequencies are relatively

lower in level (about 5 dB at 5 kHz) and the low frequencies are relatively higher in level (about 5 dB at 500 Hz) as compared with directly in front of the talker's mouth.

- The increased “vocal effort” by teachers in a classroom situation may create further changes to the speech spectrum at the input to an FM system, as compared with the speech spectrum at the input of a hearing aid (Cornelisse et al., 1991).
- FM systems often have an automatic gain control (AGC) or other nonlinear characteristic that could interact with that of the hearing aid being used to deliver the FM signal—if such a hearing aid is being used in this fashion.
- The frequency response of an FM system is often not as adjustable as that of a hearing aid, limiting the range of electroacoustic modifications available.

- It is recommended that the FM system provide a +10 dB advantage over the hearing aid microphone for best audibility.

The procedures recommended in this workbook are based upon the *FM Offset Procedure*, sometimes called the *Phonak FM Offset Procedure* or POP, which is available for download from www.phonak.com. Using this procedure, the output from the FM system is matched to the output from the hearing aid microphone. It is assumed that the actual FM output will have a +10 dB advantage over the hearing aid microphone when the adjustments made in this procedure are followed since the typical input to the FM system will be higher (75-85 dB SPL) than the typical input to the hearing aid microphone (60-70 dB SPL).

Basic FM Offset Procedure

This section describes the basic FM Offset Procedure. Step-by-step instructions on how to implement this procedure on the 7000 Hearing Aid Test System are described later in this workbook.

1. Program the hearing aid appropriately for the hearing loss of the patient.
2. Turn OFF any automatic feedback control and/or noise reduction on the hearing aid, if possible.
3. Attach the FM receiver to the hearing aid.
4. Program the FM receiver for a +10 dB FM advantage.
5. Set the FM system to the FM+Hearing Aid (or FM + Mic) position.

6. Place the hearing aid in the test box with the FM microphone outside the test box on mute or in a quiet environment.
7. Determine the RMS Out using this test setup with a 65 dB SPL broadband signal (HA-65).
8. Switch the positions of the hearing aid and the FM microphone so that the FM microphone is inside the test box and the hearing aid is outside the test box (but still attached to the coupler).
9. Determine the RMS Out using this test setup with a 65 dB SPL broadband signal (FM-65).
10. Calculate the FM Offset = $FM-65 - HA-65$. If the difference is ± 2 dB, adjust the output of the FM system. If the FM Offset is equal to or greater than +2 dB, then you will need to reduce the FM gain level in the receiver by the

offset value. If the FM Offset is equal to or less than -2 dB, then you will need to increase the FM internal gain setting by the offset value.

11. Repeat steps 6-10 until the FM Offset is within ± 2 dB.
12. Place the hearing aid in the test box with the FM microphone outside the the text box on mute or in a quiet environment.
13. Perform a frequency response measurement using a pure-tone sweep with a 90 dB SPL input. Make sure the response doesn't exceed maximum output targets.
14. Switch the positions of the hearing aid and the FM microphone so that the FM microphone is inside the test box and the hearing aid is outside the test box (but still attached to the coupler). Make sure the response doesn't exceed maximum output targets.

Attaching the FM Receiver to a Coupler

A variety of output devices can be used with FM systems. These include button earphones, behind-the-ear (BTE) units with an internal FM receiver, an external FM receiver boot, or options for coupling to the personal BTE hearing aid via direct audio inputs, silhouette coils, or neck loops. This section tells you how to arrange the 2-cc coupler with each type of output device.

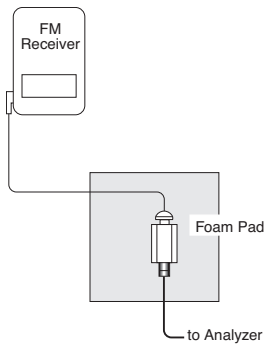


Figure 1A
Button Earphone

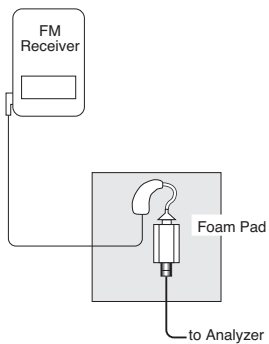


Figure 1B
*Internal FM Receiver,
External FM Boot Receiver
or Direct Audio Input*

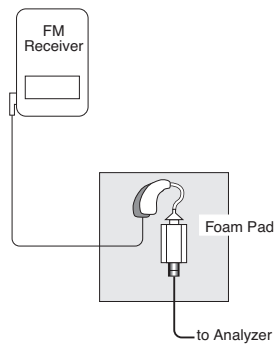


Figure 1C
Silhouette Coil

Button earphone (Figure 1A)

1. If necessary, remove the ear-level adapter from the HA-2 coupler.
2. Snap on the button earphone to the HA-2 coupler.
3. Place the coupler/hearing-aid assembly on a foam pad outside the test box, 2 ft. (60 cm) from the transmitter during testing.

BTE microphone/receiver or BTE aid with internal FM receiver, external FM boot receiver, or direct audio input (Figure 1B)

1. Attach the ear-level adapter to the HA-2 coupler, if necessary.
2. Attach the BTE hearing aid to the HA-2 coupler.
3. Set the switch on the position to receive the signal.

4. Place the coupler/hearing-aid assembly on a foam pad outside the test box, 2 ft. (60 cm) from the transmitter during testing.

BTE aid with silhouette coil (Figure 1C)

1. Attach the ear-level adapter to the HA-2 coupler, if necessary.
2. Attach the BTE hearing aid to the HA-2 coupler.
3. Place the coupler/hearing-aid assembly on a foam pad outside the test box on a nonmetallic surface during testing.
4. Choose a location free of stray magnetic fields (away from video monitors and other electrical devices), while also maintaining the required separation (2 ft./60 cm) from the transmitter.

5. Align the silhouette coil underneath the hearing aid, simulating the way it would be worn on the ear.
6. Set the hearing aid for “T.”

BTE aid with neck loop (Figure 1D)

1. Within the range of the coupler microphone cable, choose a location to seat the listener that is free of stray magnetic fields (away from video monitors and other electrical devices), while also maintaining the required separation (2 ft./60 cm) from the transmitter.
2. Place the neck loop around the listener’s neck or around the neck of a person of similar size.
3. Attach the listener’s hearing aid to the HA-2 coupler and set it to the “T” position with a normal use setting of the volume control.

4. While holding the coupler in hand, place the hearing aid at the listener's ear, as typically worn.
5. Take care not to move or touch the coupler microphone while testing.

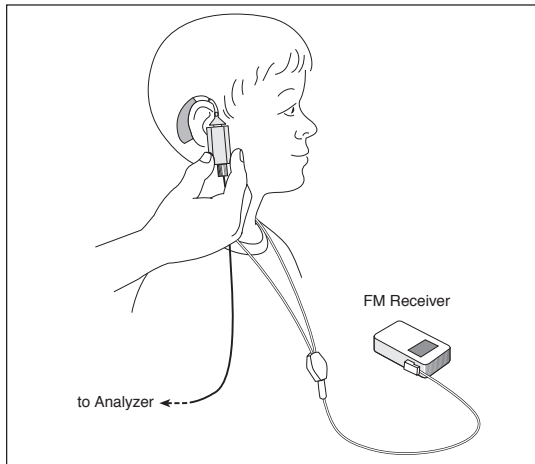


Figure 1D
Neck loop

Occluding the Second Microphone

The FM Offset procedure described in this workbook performs sequential measurements of the hearing aid microphone and FM microphone. In most cases, the second microphone not being tested (that is, if the hearing aid is in the test box, the FM microphone or vice versa) is still active although it won't receive the test signal directly. Therefore, this test procedure must be performed in a quiet environment with low ambient noise. It is recommended to further isolate the second active microphone by placing it inside a spare sound chamber (if one is available) or even a shoebox lined with foam. This will help improve test accuracy.

Step-by-Step FM Offset Test Procedure

1. Press [F1] from the Opening Screen (with the Frye logo) to enter the Coupler Multicurve screen.
2. Level the sound chamber following the standard leveling procedure found in the Operator's Manual.
3. Make sure the test graph is labeled "dB SPL" in the upper left corner of the screen. If it is labeled "dB GAIN," press [MENU] and use the arrow keys to change the Display from Gain to SPL. Press [MENU] again to close the local menu.
4. Program the hearing aid appropriately for the hearing loss of the patient.
5. Turn OFF any automatic feedback control and/or noise reduction on the hearing aid, if possible.

6. Attach the FM receiver to the hearing aid.
7. Program the FM receiver for a +10 dB FM advantage.
8. Set the FM system to the FM+Hearing Aid (or FM + Mic) position.
9. Attach the hearing aid to the coupler, as described in the previous section and insert the coupler microphone.
10. Place the hearing aid in the sound chamber with the hearing aid microphone at the reference point of the chamber. Close and latch the lid. See Figure 2.
11. Place the FM microphone outside the sound chamber. If possible, mute the FM microphone. Otherwise, it is recommended to place it within a sound occluding box. See Figure 2.
12. Use [F2] to select CRV 1.

13. Use [F5] to select the Digital Speech signal.
14. Use the [▲, ▼] keys to set the Source to 65 dB SPL.
15. Press [START/STOP]. After the measurement has stabilized, press [START/STOP] again to stop the test.
16. Switch the positions of the hearing aid and the FM microphone. That is, place the FM microphone at the reference point of the sound chamber and place the hearing aid outside the sound chamber while it is still attached to the coupler and analyzer microphone. Close and latch the lid of the sound chamber. See Figure 3.
17. Use [F2] to select CRV 2.
18. Use [F5] to select the Digital Speech signal.
19. Use the [▲, ▼] keys to set the Source to 65 dB SPL.

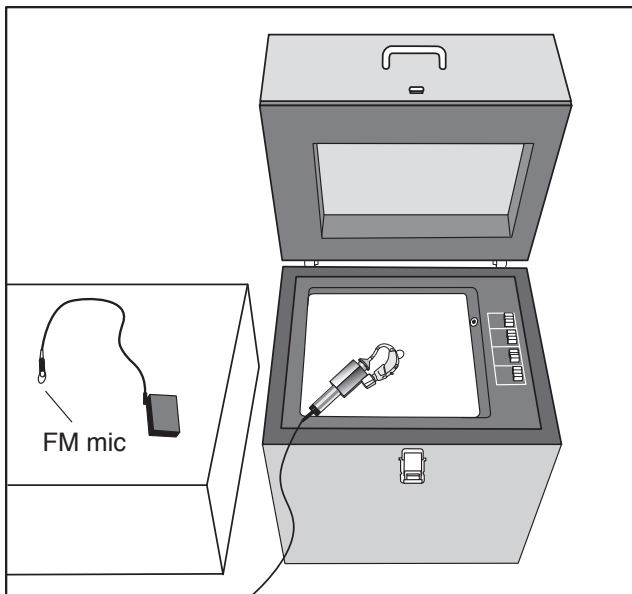


Figure 2: Hearing aid set up

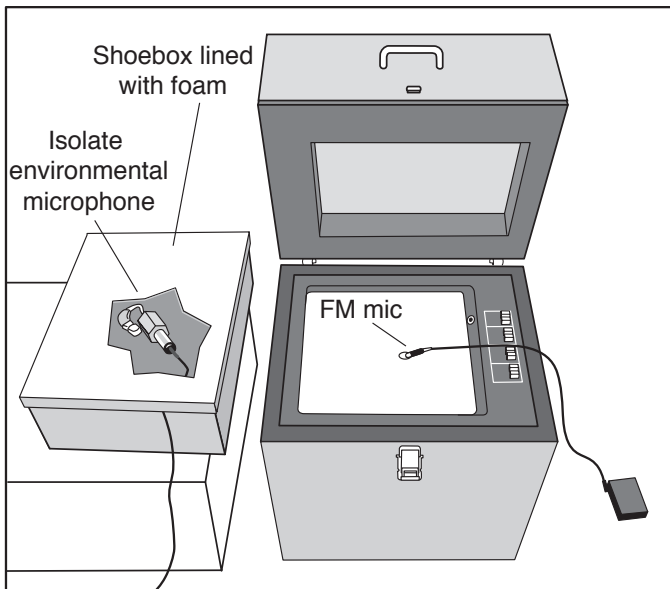


Figure 3: FM microphone set up

20. Press [START/STOP]. After the measurement has stabilized, press [START/STOP] again to stop the test.
21. Look at the Curve Characteristics box and mentally subtract the RMS OUT of Crv 1 from the RMS OUT of Crv 2. This calculated number is the FM Offset. See Figure 4.
 - If the difference is less than ± 2 dB, the FM receiver has been adjusted accurately and you may skip to the next section.
 - If the FM Offset is equal to or greater than +2 dB, then you will need to reduce the FM gain level in the receiver by the offset value.
 - If the FM Offset is equal to or less than -2 dB, then you will need to increase the FM internal gain setting by the offset value.

22. Adjust the gain of the FM receiver as determined in the previous step and repeat steps 10-21 until the FM Offset is less than ± 2 dB.

Step-by-Step Maximum Output Test Procedure

This section describes make sure the FM system does not exceed the maximum output target. Obtaining the maximum target itself is outside the scope of this workbook.

1. Follow the steps in the previous section to adjust the FM Offset of the FM system.
2. Use [F2] to select CRV 3.
3. Use [F5] to select TONE NORMAL.
4. Use the [▲, ▼] keys to set the Source to 90 dB SPL.

5. Place the hearing aid in the sound chamber, and place the FM microphone outside the sound chamber. Close and latch the lid. See Figure 2.
6. Press [START/STOP] to run the pure-tone sweep. The test will stop automatically.
7. Compare the test result to the maximum output target. Adjust the FM system if the measured response exceeds the target.
8. Switch the positions of the hearing aid and the FM microphone; place the FM microphone at the reference point inside the sound chamber and place the hearing aid outside the sound chamber. Close and latch the sound chamber lid. See Figure 3.
9. Use [F2] to select CRV 4.

10. Use [F5] to select TONE NORMAL.
11. Use the [▲, ▼] keys to set the Source to 90 dB SPL.
12. Press [START/STOP] to run the pure-tone sweep. The test will stop automatically.
13. Compare the test result to the maximum output target. Adjust the FM system if the measured response exceeds the target.
14. If you have made any adjustments to the FM system, you may want to repeat the FM Offset test procedure to make sure that your changes didn't affect the normal speech-level gain of the system.
15. Print the test results or use one of the FONIX software programs to save them to a computer database for future reference.

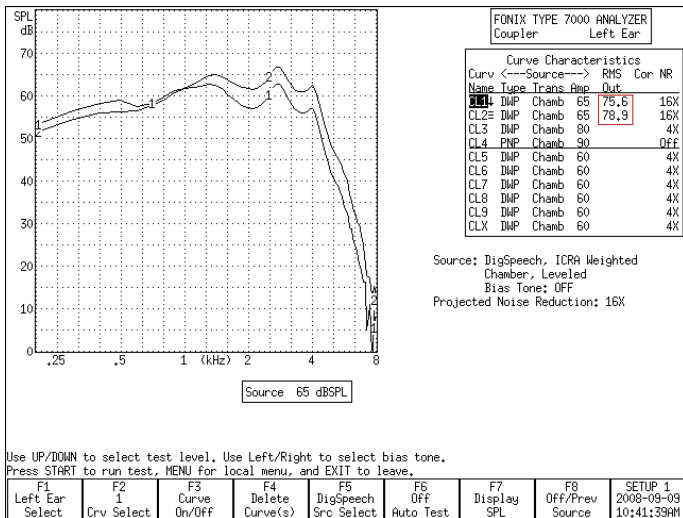


Figure 4: The FM offset for this test is $78.9 - 75.6 = +3.3$. The FM gain level needs to be reduced by about 3 dB.



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