ESS Technology, Inc.

Maestro/AC97
Audio System Test Methodologies

SECTION 1: INTRODUCTION

This document details the preferred method for performing analog performance measurements on a system that has the Maestro/ES1918 chipset and no voltage amplifier or attenuation circuitry on the input or output of the audio section.

There are 4 different test series to be performed:

1. A-A (TM001: Analog Signal Path Test)
2. A-D-D-A (CODEC Loop Test)
3. PC-D-A (TM002: Digital to Analog Path Test)
4. A-D-PC-D-A (TM004: Analog to Digital Record, Digital to Analog Playback Test)

Under each test series the hardware is tested for signal-to-noise ratio (SNR) or dynamic range, total harmonic distortion plus noise (THD+N), and frequency response.

SECTION 2: TEST UNIT PREPARATION

To insure that the test setup is adequate, check the test equipment.

1. Connect the input of the Audio Precision System II to the output (see Figure 1).
2. Perform the measurements as described in Section 4.

If the generator-out to analyzer-in measurements are well above the target range for the Microsoft® PC98 specification, then the system is ready to test the DUT (Device Under Test). Otherwise check the cables, connectors, external noise sources (such as monitors), etc., before continuing with DUT.

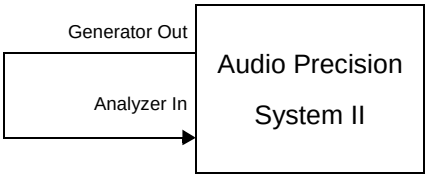


Figure 1 Setup Test Configuration

SECTION 3: SETUP

1. Connect Audio Precision System II to the DUT (Device Under Test) computer as shown in Figure 2.

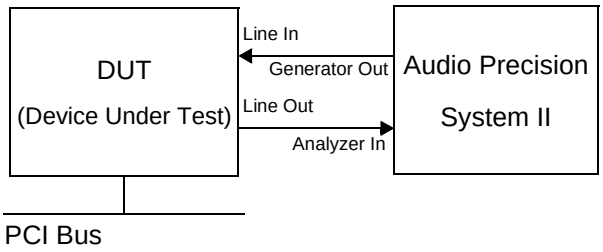


Figure 2 System Test Configuration

NOTE: These tests can be affected by system noise from sources such as computer monitors.

2. Copy the following files to a temporary directory on the DUT system:
   - legow.exe — sets up CODEC
   - aa.bat — sets A-A path to 0 dB gain
   - adda.bat — sets A-D-D-A path to 0 dB gain
   - pcda.bat — sets PC-D-A path to 0 dB gain
   - rc.bat — sets record path to 0 dB gain

   These files are available from ESS Technology, Inc. at the following ftp site:

   ftp.essservice.com/outgoing/util/Measurement_Util.zip

3. Copy the following files to the Audio Precision System II machine:
   - m2snr.at2 — AP System II test file for SNR
   - m2thd.at2 — AP System II test file for THD+N
   - m2fr.at2 — AP System II test file for A-A path frequency response
   - m2dpfr.at2 — AP System II test file for digital playback frequency response

   These files are available from ESS Technology, Inc. at the following ftp site:

   ftp.essservice.com/outgoing/util/Measurement_Util.zip

4. Create the audio test files shown in tables 1 and 2 and copy them to a temporary directory on the DUT system. See section 8 “Creating Audio Test Files” on page 16 for more details.

Table 1 48 kHz Test Files

File Name	Description
1khzfullscale.wav	PC-D-A reference
1khzhalfscale.wav	PC-D-A frequency response reference
1khz-60db.wav	PC-D-A SNR
1khz-3db.wav	PC-D-A THD+N
dpfr.wav	PC-D-A frequency response for sweep. This file has tones at the following frequencies: 17 Hz, 20 Hz, 24 Hz, 31 Hz, 61 Hz, 129 Hz, 270 Hz, 499 Hz, 1 kHz, 4 kHz, 8 kHz, 10 kHz, 12 kHz, 14 kHz, 16 kHz, 17 kHz, 18 kHz, 19 kHz, 20 kHz.

Table 2 44.1 kHz Test Files

File Name	Description
1khzfullscale.wav	PC-D-A reference
1khzhalfscale.wav	PC-D-A frequency response reference
1khz-60db.wav	PC-D-A SNR
1khz-3db.wav	PC-D-A THD+N
dpfr.wav	PC-D-A frequency response for sweep. This file has tones at the following frequencies: 17 Hz, 20 Hz, 24 Hz, 31 Hz, 61 Hz, 129 Hz, 270 Hz, 499 Hz, 1 kHz, 4 kHz, 8 kHz, 10 kHz, 12 kHz, 14 kHz, 16 kHz, 17 kHz, 18 kHz, 19 kHz, 20 kHz.

SECTION 4: A-A (ANALOG SIGNAL PATH) TEST

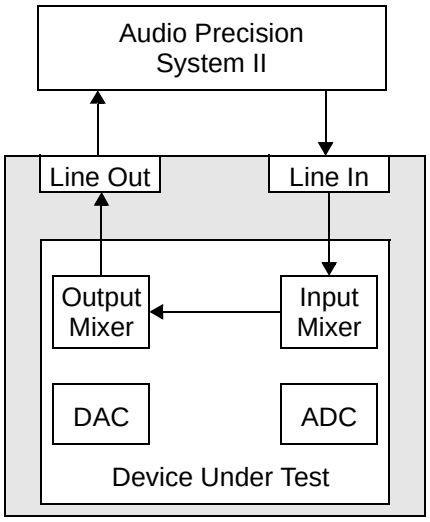
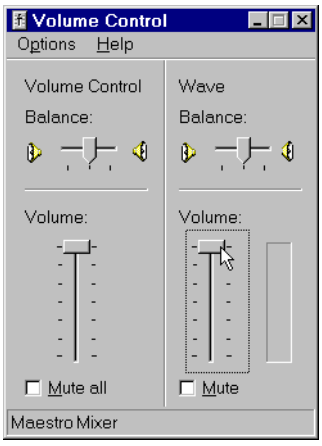


Figure 3 Analog Signal Path Test (A-A)

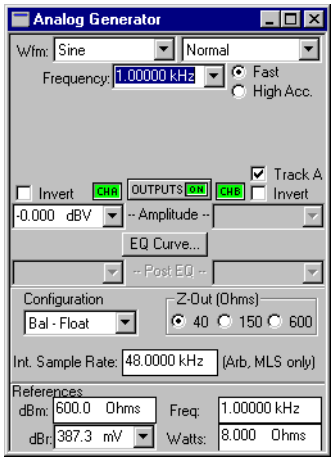
1. Connect the Audio Precision System II to the DUT computer as shown in Figure 2 on page 1.
2. Open the Volume Control panel (by double-clicking the icon on the task bar) and set the master volume and wave volume to maximum.



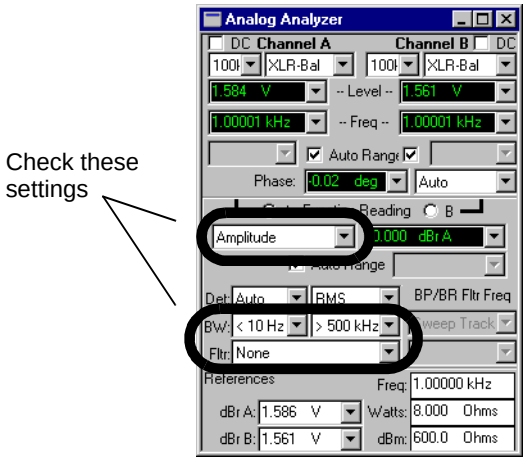
3. Run aa.bat in a DOS box on the DUT.
4. Proceed with the SNR, THD+N, and frequency response tests.

SNR

1. Load the test file for SNR, m2snr.at2, on the Audio Precision System II.
2. Turn on the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.
3. Set amplitude to 0 dBV.
4. Set frequency to 1.0 kHz.

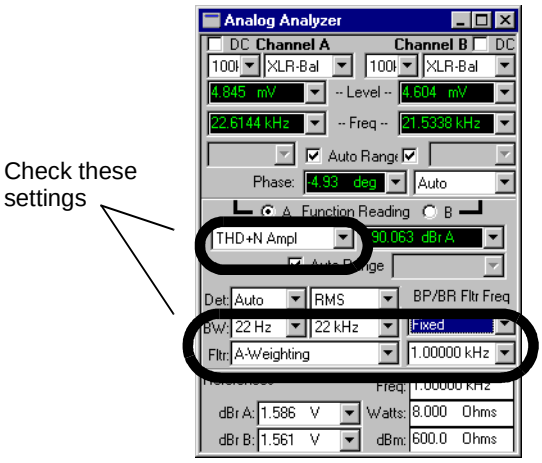


5. Press F4 to set the references on the Analog Analyzer.

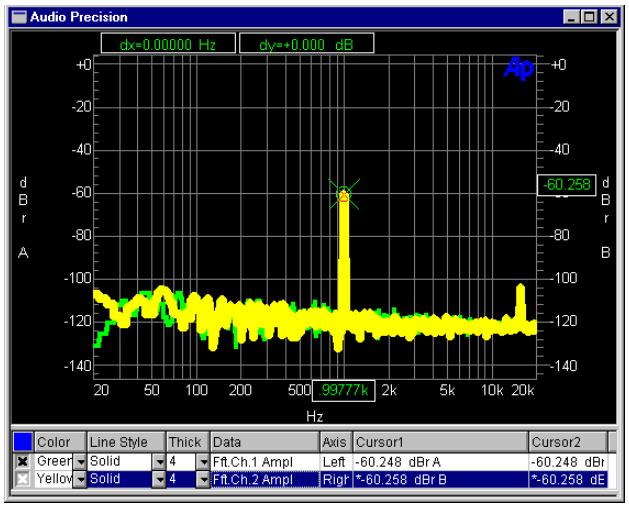


6. Change the Analog Generator output to -60 dBV.

7. Set the Analog Analyzer as follows:
   - Set the function to THD+N amplitude
   - A-weighted filter is ON
   - Selected bandwidth is 22 Hz – 22 kHz
   - Band pass/band reject filter frequency is fixed at 1 kHz

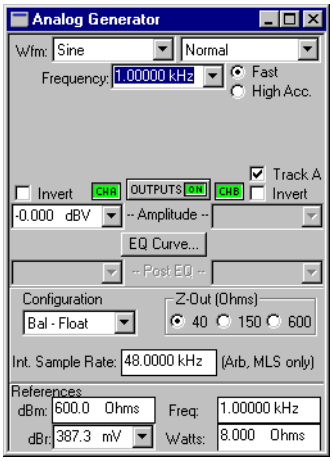


8. Read the THD+N amplitude on the Analog Analyzer panel for both channel A and B (in dBr A and dBr B respectively). This value is the SNR for the A-A path.
9. Press F9 to see an FFT.

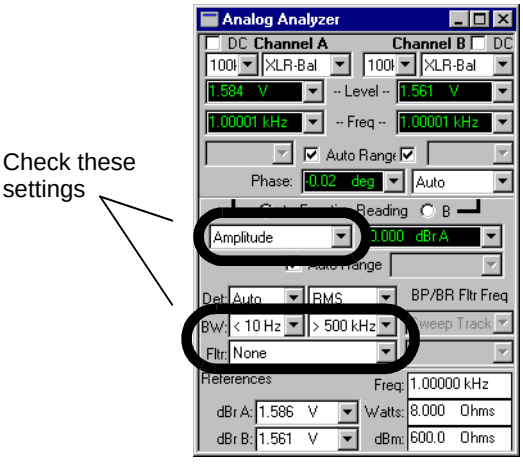


THD+N

1. Load the test file for THD+N, m2thd.at2, on Audio Precision System II.
2. Set the Analog Generator amplitude to 0 dBV.
3. Set frequency to 1.0 kHz.

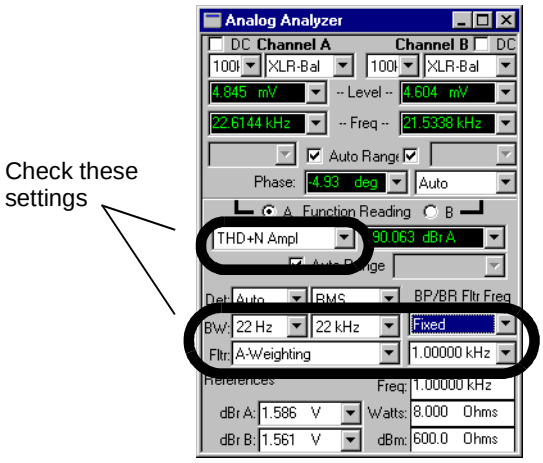


4. Press F4 to set the references on the Analog Analyzer.

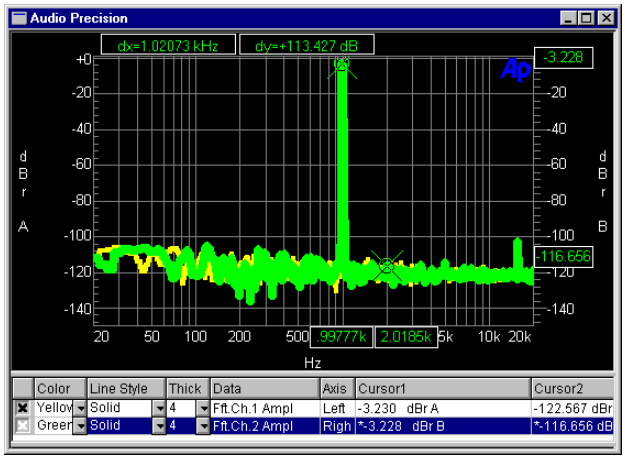


5. Set the Analog Generator amplitude to -3 dBV.

6. Set the Analog Analyzer as follows:
   - Set the function to THD+N amplitude
   - A-weighted filter is ON
   - Selected bandwidth is 22 Hz – 22 kHz
   - Band pass/band reject filter frequency is fixed at 1 kHz

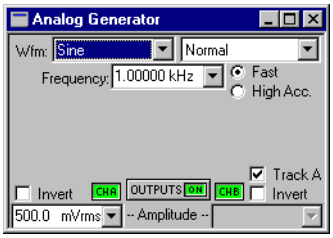


7. Read (measure) the THD+N amplitude on the Analog Analyzer panel for both channel A and B (in dBrA and dBrB respectively).
8. Press F9 to see an FFT.

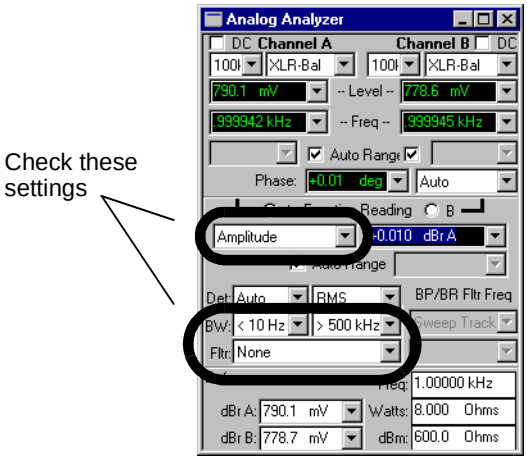


Frequency Response

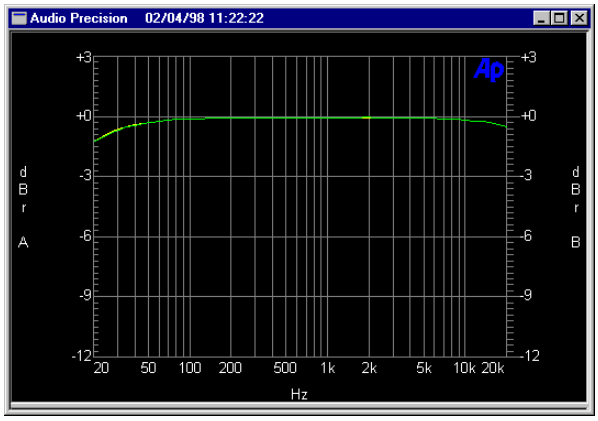
1. Load the test file for frequency response, m2fr.at2, on Audio Precision System II.
2. Generate a 1 kHz tone at 500 mVrms.



3. Press F4 to set the references.



4. Press F9 to run the test. Measure frequency response from -3 dBr corners.



SECTION 5: A-D-D-A (CODEC LOOP) TEST

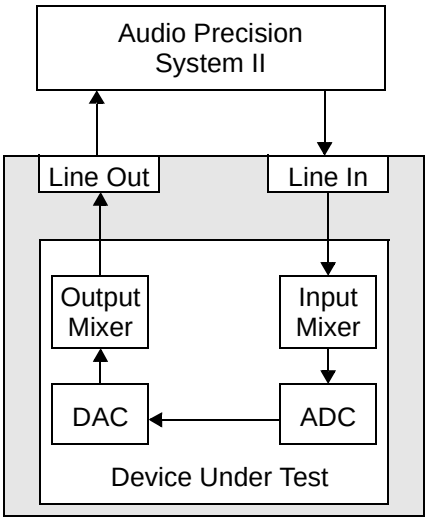
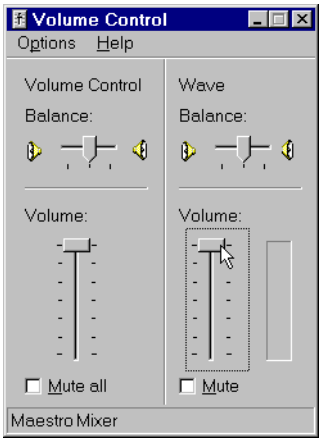


Figure 4 CODEC Loop Test (A-D-D-A)

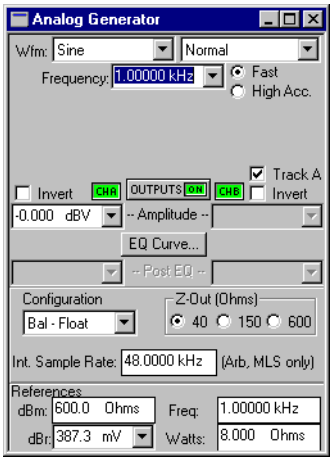
1. Connect the Audio Precision System II to the DUT computer as shown in Figure 2 on page 1.
2. Open the Volume Control panel (by double-clicking the icon on the task bar) and set the master volume and wave volume to maximum.



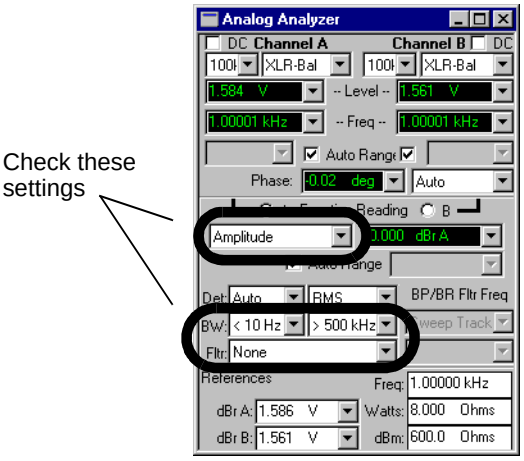
3. Run adda.bat in a DOS box on the DUT.
4. Proceed with the SNR, THD+N, and frequency response tests.

SNR (Dynamic Range)

1. Load the test file for SNR, m2snr.at2, on the Audio Precision System II.
2. Turn on the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.
3. Set amplitude to 0 dBV.
4. Set frequency to 1.0 kHz.

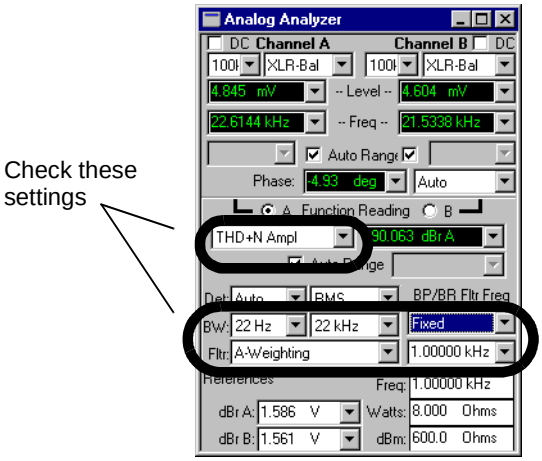


5. Press F4 to set the references on the Analog Analyzer.

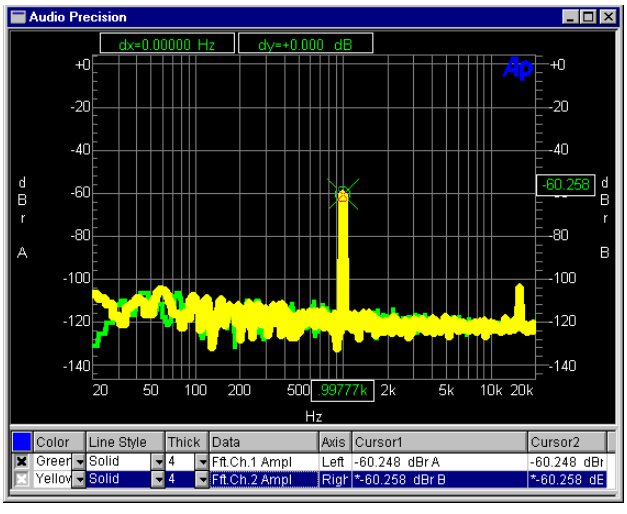


6. Change the Analog Generator output to -60 dBV.

7. Set the Analog Analyzer as follows:
   - Set the function to THD+N amplitude
   - A-weighted filter is ON
   - Selected bandwidth is 22 Hz – 22 kHz
   - Band pass/band reject filter frequency is fixed at 1 kHz

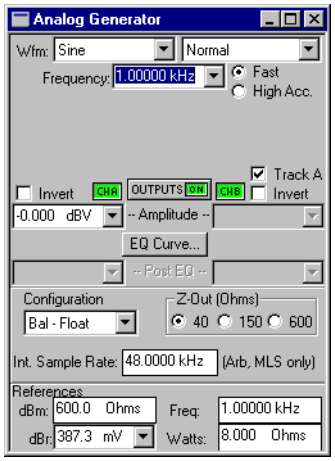


8. Read the THD+N amplitude on the Analog Analyzer panel for both channel A and B (in dBr A and dBr B respectively). This value is the SNR for the A-D-D-A path.
9. Press F9 to see an FFT.

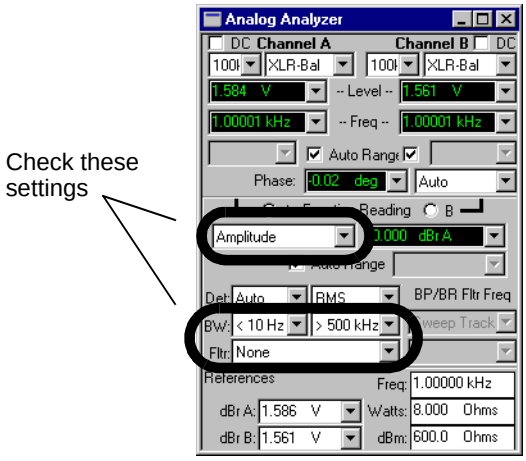


THD+N

1. Load the test file for THD+N, m2thd.at2, on Audio Precision System II.
2. Set amplitude to 0 dBV.
3. Set frequency to 1.0 kHz.

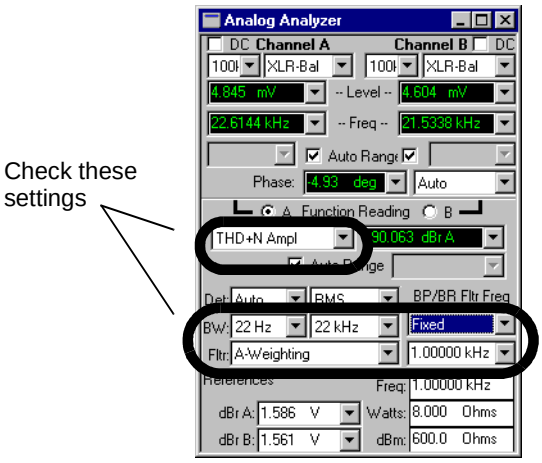


4. Press F4 to set the references on the Analog Analyzer.

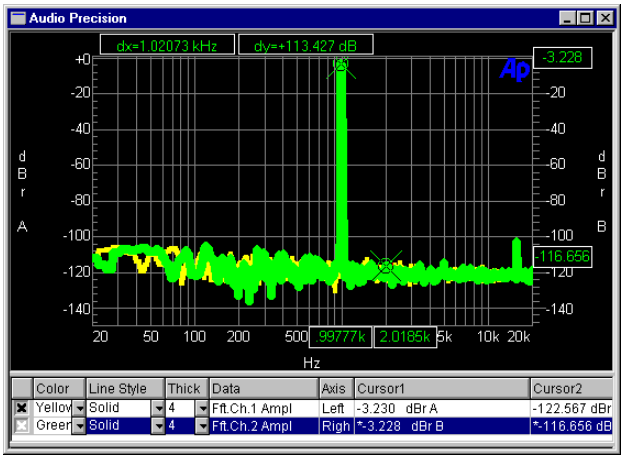


5. Set the Analog Generator amplitude to -3 dBV.

6. Set the Analog Analyzer as follows:
   - Set the function to THD+N amplitude
   - A-weighted filter is ON
   - Selected bandwidth is 22 Hz – 22 kHz
   - Band pass/band reject filter frequency is fixed at 1 kHz

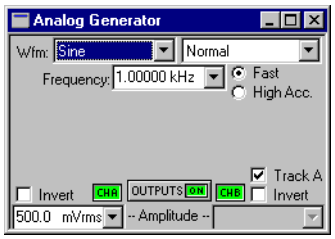


7. Read (measure) the THD+N ratio on the Analog Analyzer panel for both channel A and B.
8. Press F9 to see an FFT.

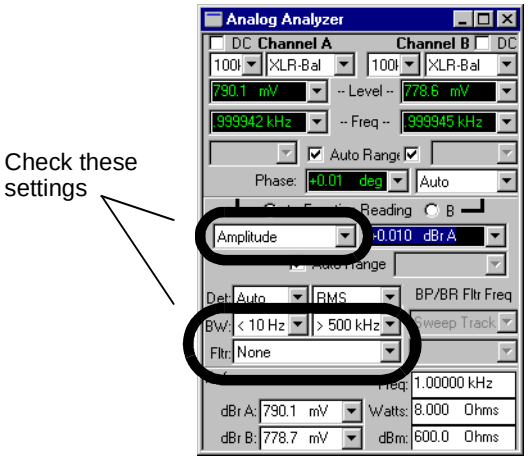


Frequency Response

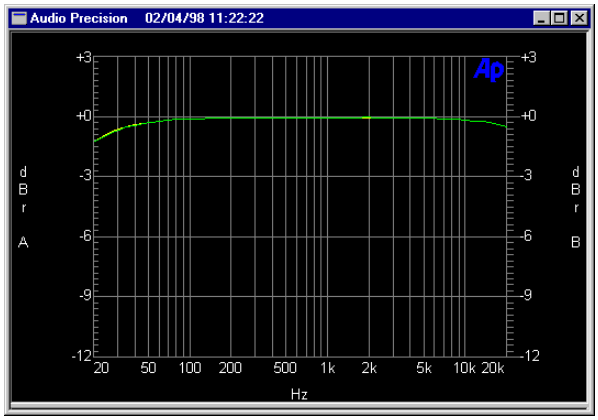
1. Load the test file for frequency response, m2fr.at2, on Audio Precision System II.
2. Generate a 1 kHz tone at 500 mVrms.



3. Press F4 to set the references.



4. Press F9 to run the test. Measure frequency response from -3 dBr corners.



SECTION 6: PC-D-A (DIGITAL TO ANALOG PATH) TEST

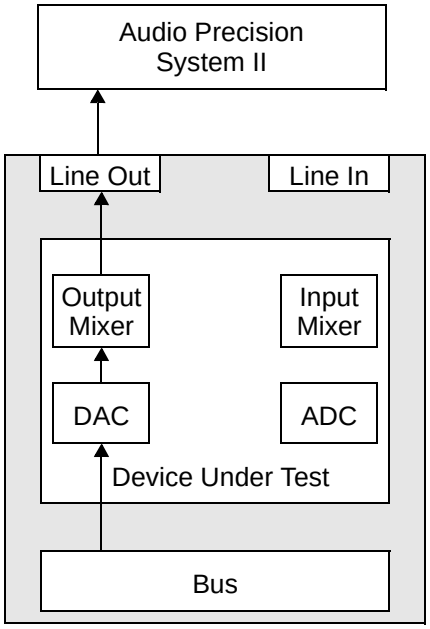
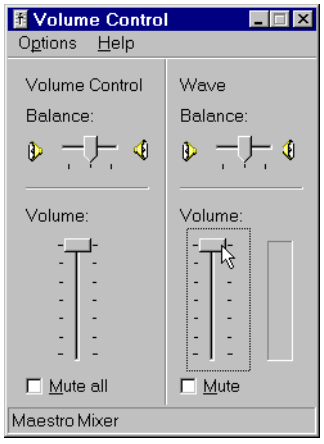


Figure 5 Digital to Analog Path Test (PC-D-A)

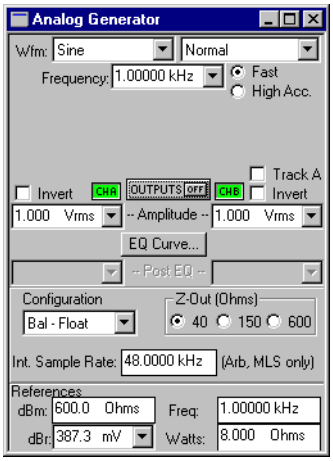
1. Connect the Audio Precision System II to the DUT computer as shown in Figure 2 on page 1.
2. Open the Volume Control panel (by double-clicking the icon on the task bar) and set the master volume and wave volume to maximum.



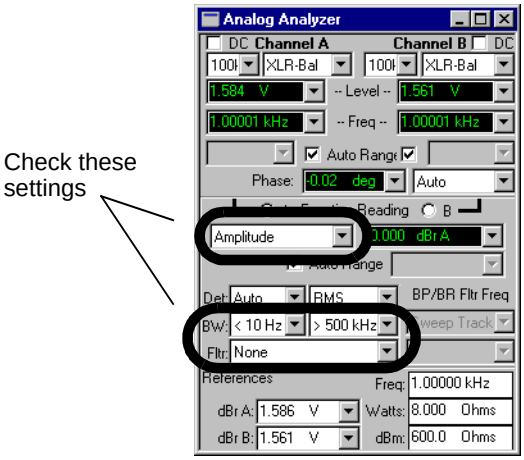
3. Run pcda.bat in a DOS box on the DUT.
4. Proceed with the SNR, THD+N, and frequency response tests.

SNR (Dynamic Range)

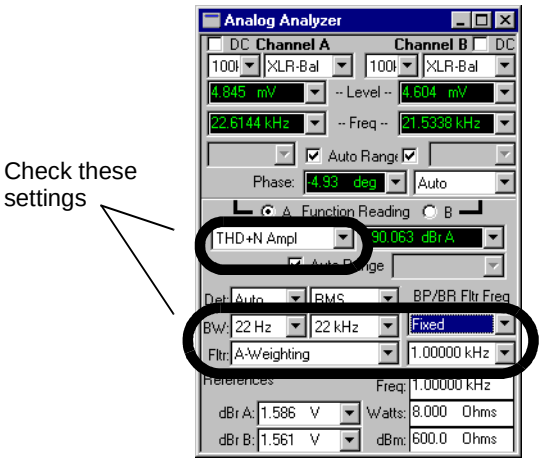
1. Load the test file for SNR, m2snr.at2, on the Audio Precision System II.
2. Turn off the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.



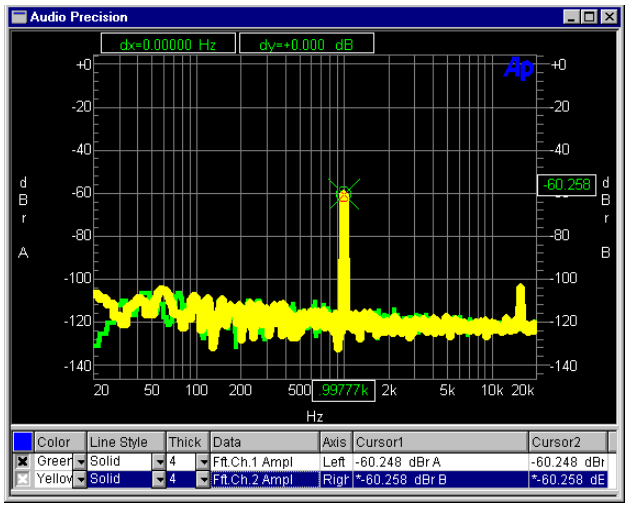
3. Play 1khzfullscale.wav on the DUT (either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform).
4. Press F4 to set the references on the Analog Analyzer.



5. Play 1khz-60db.wav on the DUT (either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform).
6. Set the Analog Analyzer as follows:
   - Set the function to THD+N amplitude
   - A-weighted filter is ON
   - Selected bandwidth is 22 Hz – 22 kHz
   - Band pass/band reject filter frequency is fixed at 1 kHz

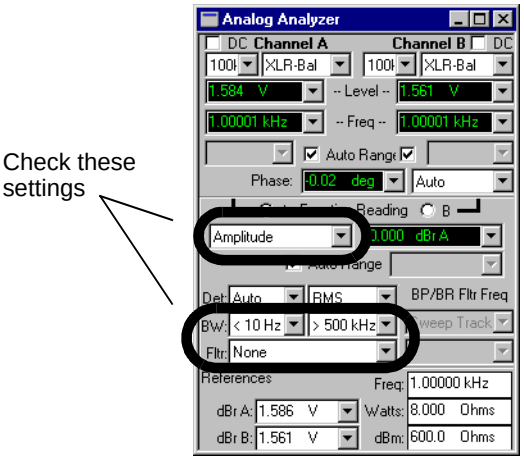


7. Read the THD+N amplitude on the Analog Analyzer panel for both channel A and B (in dBr A and dBr B respectively). This value is the SNR for the D-A path.
8. Press F9 to see an FFT.

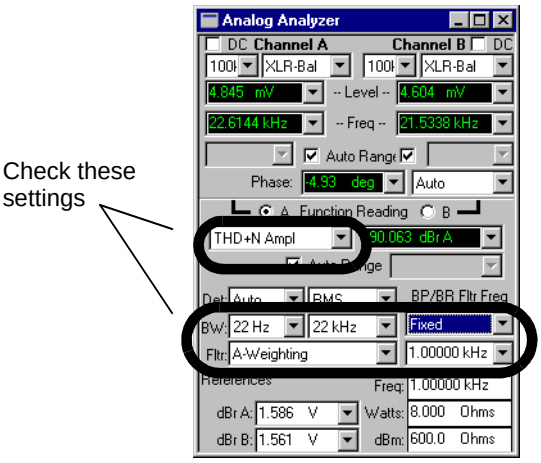


THD+N

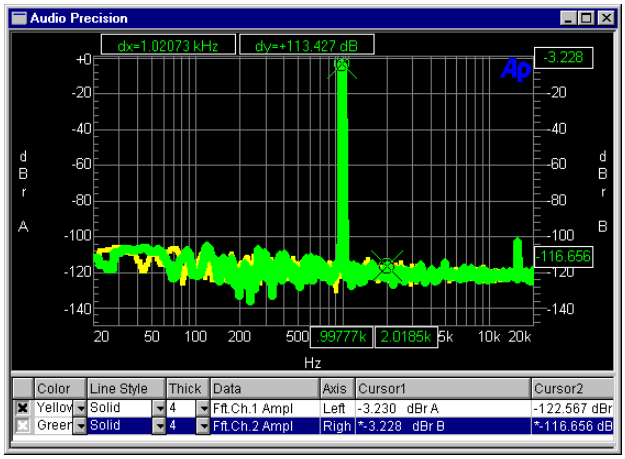
1. Load the test file for THD+N, m2thd.at2, on Audio Precision System II.
2. Turn off the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.
3. Play 1khzfullscale.wav on the DUT (either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform).
4. Press F4 to set the references on the Analog Analyzer.



5. Play 1khz-3db.wav on the DUT (either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform).
6. Set the Analog Analyzer as follows:
   - Set the function to THD+N amplitude
   - A-weighted filter is ON
   - Selected bandwidth is 22 Hz – 22 kHz
   - Band pass/band reject filter frequency is fixed at 1 kHz

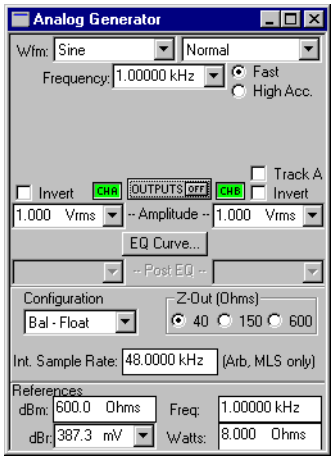


7. Read (measure) the THD+N amplitude from the Analog Analyzer panel for both channels A and B.
8. Press F9 to see an FFT.



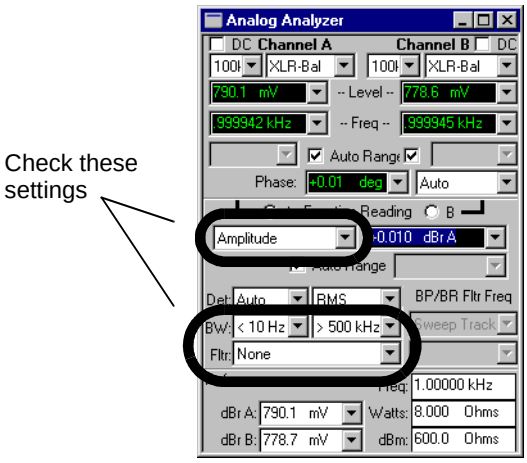
Frequency Response

1. Load the test file for frequency response, m2dpfr.at2, on Audio Precision System II.
2. Turn off the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.

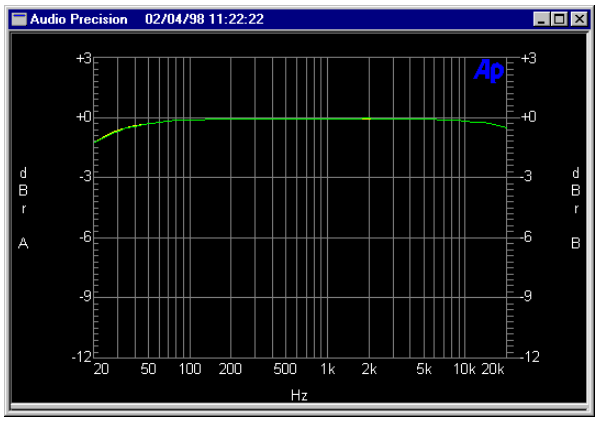


3. Play 1khzhalfscale.wav on the DUT (either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform).

4. Press F4 to set the references.



5. Press F9 on the Audio Precision System II. The Audio Precision II will automatically start the frequency response measurement when dpfr.wav is played in Step 6.
6. Play dpfr.wav on the DUT either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform.
7. Measure frequency response from the -3 dBr corners of the plot.



SECTION 7: A-D-PC-D-A (ANALOG TO DIGITAL RECORD, DIGITAL TO ANALOG PLAYBACK) TEST

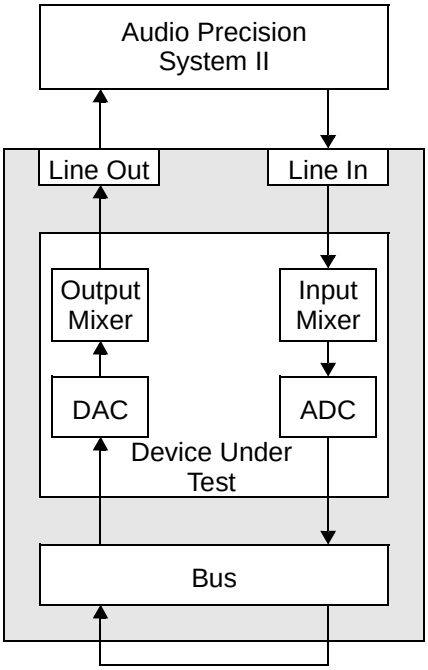
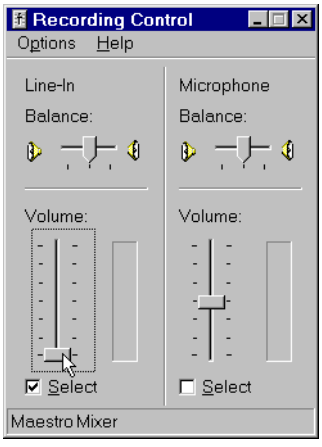


Figure 6 Analog to Digital Record, Digital to Analog Playback Test (A-D-PC-D-A)

1. Connect the Audio Precision System II to the DUT computer as shown in Figure 2 on page 1.
2. Open the Recording Control panel, select line-in and set the line-in volume to minimum.

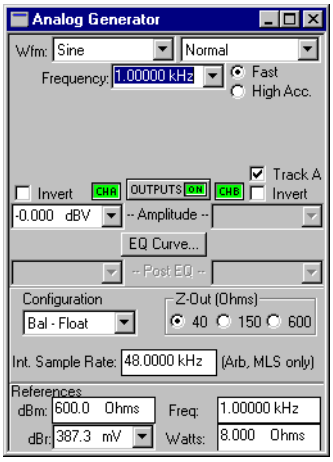


To open the Recording control panel, double-click the icon on the task bar and select Properties from the Options menu. Select Adjust Volume for Recording and click OK.

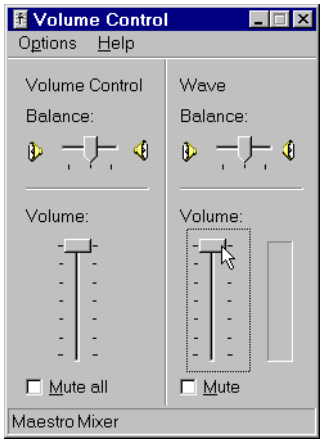
3. Run rc.bat in a DOS box on the DUT.
4. Proceed with the SNR, THD+N, and frequency response tests.

SNR (Dynamic Range)

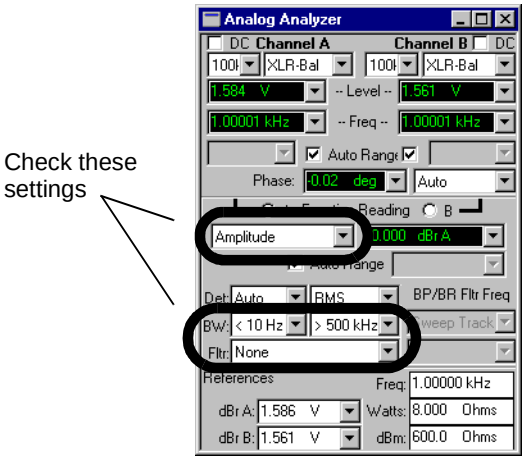
1. Load the test file for SNR, m2snr.at2, on the Audio Precision System II.
2. Turn on the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.
3. Generate 1kHz at 0 dBV (1 Vrms) with the Analog Generator.



4. Record the tone generated in Step 3 as a full-scale wave file. (Use either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform.) Save the file as 48rc_ref.wav or 44rc_ref.wav.
5. Set the Analog Generator amplitude to -60 dB.
6. Record and save the tone generated in Step 5 as a -60 dB wave file. (Use either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform.)
7. Turn off the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.
8. Open the Volume Control panel (by double-clicking the icon on the task bar) and set the master volume and wave volume to maximum.

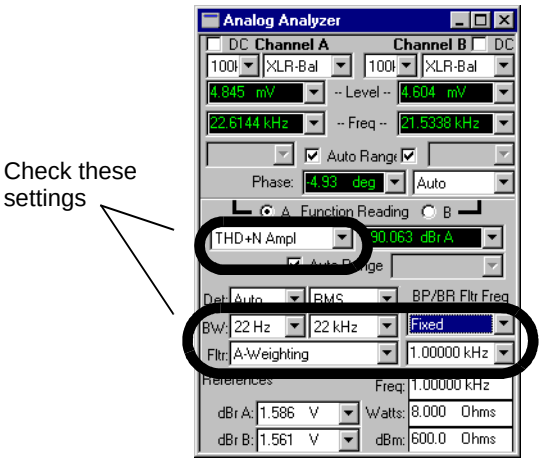


9. Run pcda.bat in a DOS box on the DUT.
10. Play either 48rc_ref.wav or 44rc_ref.wav on the DUT.
11. Press F4 to set the references on the Analog Analyzer.

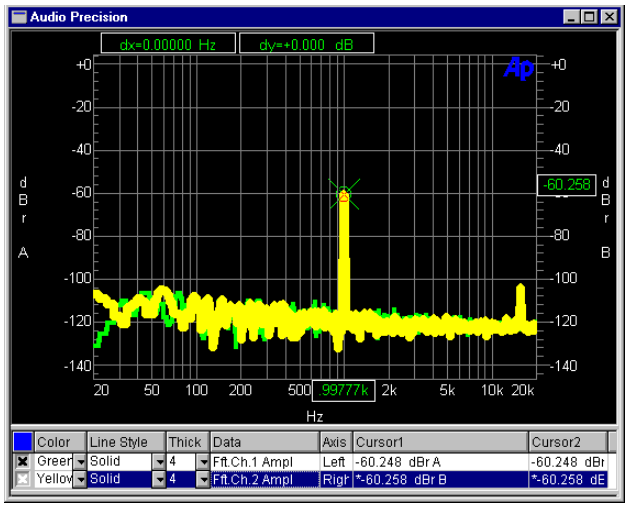


12. Play the file you recorded in Step 6 on the DUT.

13. Set the Analog Analyzer as follows:
    - Set the function to THD+N amplitude
    - A-weighted filter is ON
    - Selected bandwidth is 22 Hz – 22 kHz
    - Band pass/band reject filter frequency is fixed at 1 kHz

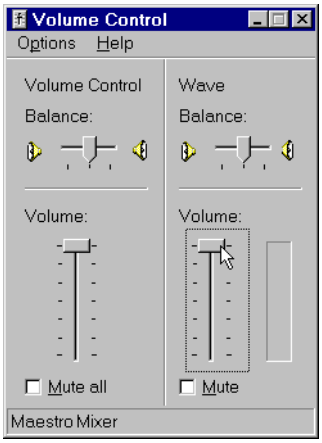


14. Read the THD+N amplitude on the Analog Analyzer panel for both channel A and B (in dBr A and dBr B respectively). This value is the SNR for the A-D-PC-D-A path.
15. Press F9 to see an FFT.



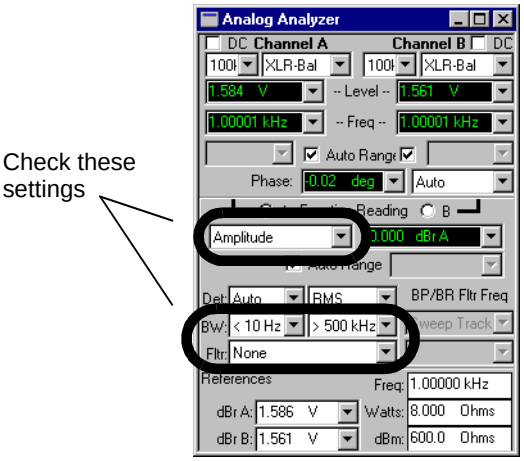
THD+N

1. Load the test file for THD+N, m2thd.at2, on Audio Precision System II.
2. Turn on the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.
3. Run rc.bat in a DOS box on the DUT.
4. Generate 1kHz at -3 dBV with the Analog Generator.
5. Record and save the tone generated in Step 4 as a - 3 dBv wave file. (Use either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform.)
6. Turn off the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.
7. Open the Volume Control panel (by double-clicking the icon on the task bar) and set the master volume and wave volume to maximum.

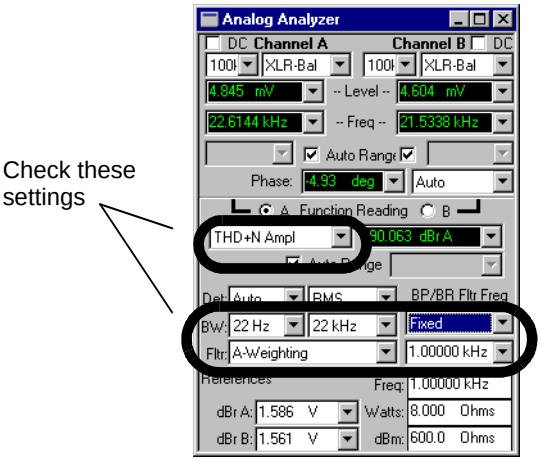


8. Run pcda.bat in a DOS box on the DUT.
9. Play either 48rc_ref.wav or 44rc_ref.wav on the DUT.

10. Press F4 to set the references on the Analog Analyzer.

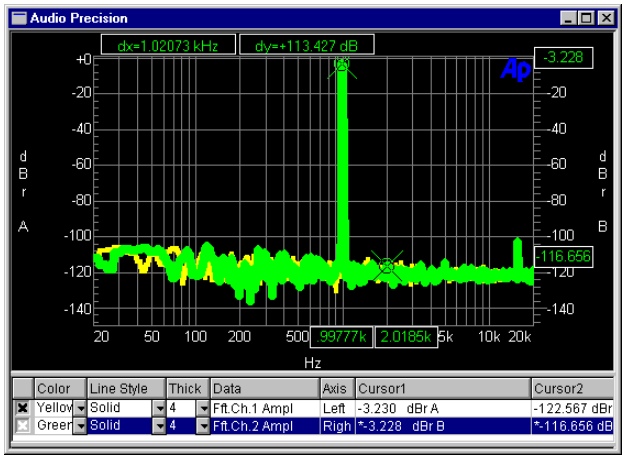


11. Play the file you recorded in Step 5 on the DUT.
12. Set the Analog Analyzer as follows:
    - Set the function to THD+N amplitude
    - A-weighted filter is ON
    - Selected bandwidth is 22 Hz – 22 kHz
    - Band pass/band reject filter frequency is fixed at 1 kHz



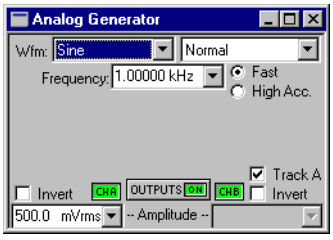
13. Read (measure) the THD+N amplitude from the Analog Analyzer panel for both channels A and B.

14. Press F9 to see an FFT.



Frequency Response

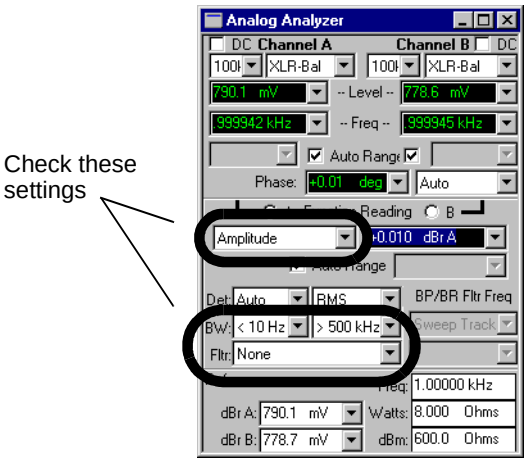
1. Load the test file for frequency response, m2fr.at2, on Audio Precision System II.
2. Turn on the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.
3. Run rc.bat in a DOS box on the DUT.
4. Generate 1kHz at 500 mVrms with the Analog Generator.



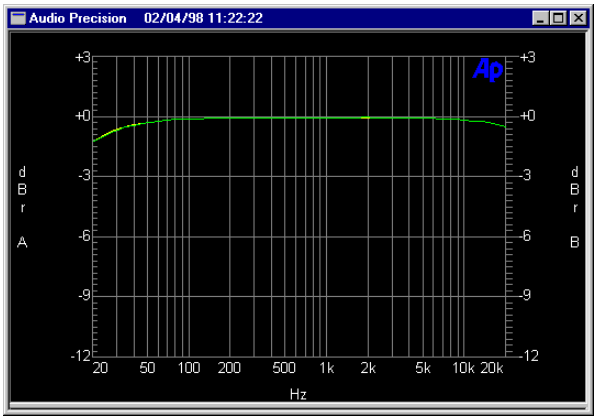
5. Record the tone generated in Step 4 as a half-scale wave file. (Use either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform.) Save the wave file as 48rchalf.wav or 44rchalf.wav.
6. Record a frequency sweep file.

   To record a frequency sweep file, generate a 17 Hz tone on the Audio Precision System II at half-scale and record about 1.5 seconds of it on the DUT system. (Use either 48 kHz sample rate or 44.1 kHz sample rate depending on the test you want to perform.) Do the same for a 20 Hz tone and append it to the 17Hz tone files. Continue appending recordings of the following frequencies: 24 Hz, 31 Hz, 61 Hz, 129 Hz, 270 Hz, 499 Hz, 1 kHz, 4 kHz, 8 kHz, 10 kHz, 12 kHz, 14 kHz, 16 kHz, 17 kHz, 18 kHz, 19 kHz, 20 kHz.

   Save this recorded frequency sweep file as m2rcfr44.wav or m2rc48.wav.
7. Load the test file for frequency response, m2dpfr.at2, on Audio Precision System II.
8. Turn off the Audio Precision System II Analog Generator output by selecting the field labeled Outputs.
9. Open the Volume Control panel (by double-clicking the icon on the task bar) and set the master volume and wave volume to maximum.
10. Run pcda.bat in a DOS box on the DUT.
11. Play the file you recorded in Step 5 on the DUT.
12. Press F4 to set the references.



13. Press F9 on the Audio Precision System II. The Audio Precision System II will automatically start the frequency response measurement when m2rcfr44.wav or m2rcfr48.wav is played in Step 14.
14. Play m2rcfr44.wav or m2rc48.wav (recorded in Step 5) on the DUT.
15. Measure frequency response from the -3 dBr corners of the plot.

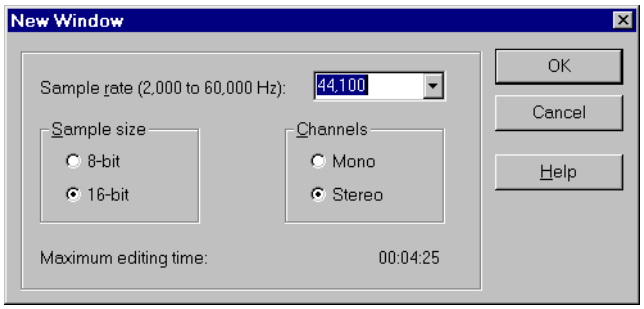


SECTION 8: CREATING AUDIO TEST FILES

You can use any appropriate sound recording software to create test files. Here at ESS Technology, Inc., we use Sound Forge 4.0 from Sonic Foundry, Inc.

1. Start Sound Forge 4.0.
2. Select New… from the File menu.

   This opens the New Window dialog box.

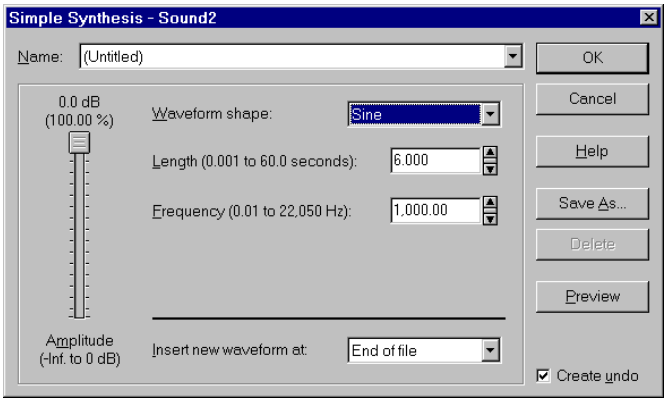


3. Select the sample rate you want to record at, 44.1 kHz or 48 kHz.
4. Select 16-bit sample size.
5. Select Stereo Channels.
6. Click OK.

   This closes the New Window dialog box and opens a new sound file window.

7. Select Synthesis from the Tools menu and select Simple… from the continuation menu.

   This opens the Simple Synthesis dialog box.



8. Select the options based on the test file you want to generate.

Table 3 Test File Properties

Name of File	Waveform Shape	Amplitude (dB)	Length (sec)	Freq. (Hz)
1khzfullscale.wav	Sine	0	6	1000
1khzhalfscale.wav	Sine	-6	6	1000
1khz-60db.wav	Sine	-60	6	1000
1khz-3db.wav	Sine	-3	6	1000
dpfr.wav	Sine	-6	6	see below

For the file dpfr.wav you need to generate a series of segments at different frequencies. To generate the different frequencies, you will need to return to the Simple Synthesis window once for each frequency. Generate the following frequencies: 17 Hz, 20 Hz, 24 Hz, 31 Hz, 61 Hz, 129 Hz, 270 Hz, 499 Hz, 1 kHz, 4 kHz, 8 kHz, 10 kHz, 12 kHz, 14 kHz, 16 kHz, 17 kHz, 18 kHz, 19 kHz, 20 kHz.

9. Click OK.

   This closes the Simple Synthesis window and generates the wave file. If you are creating the frequency response file, return to the Simple Synthesis window, select the next frequency, and generate the next part of the wave file. Sound Forge automatically appends the new data to the end of the previous data. Otherwise go on to step 10.

10. Select Save from the File menu.

    This opens the Save As dialog box.

11. Enter the name you want to save the file under and click OK.

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