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Case Study:

Evaluating a Laptop's Audio Performance

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Abstract

The performance of a laptop computer's audio system is evaluated using the eightolives AudioAnalyzer.
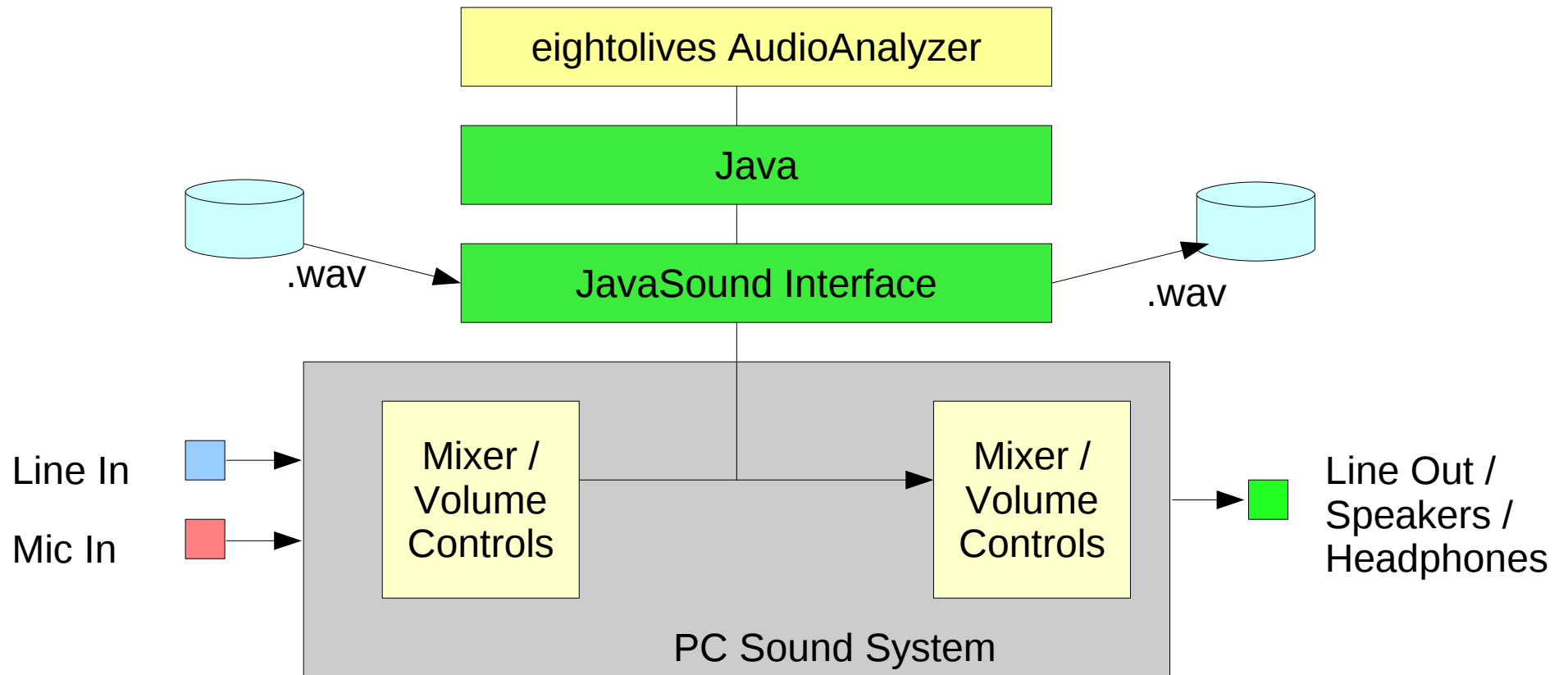
Background

- The eightolives AudioAnalyzer is a Java-based program that provides a set of audio tools that can interface to a PC's audio system (uses the Javasound interface)

  - 2 – Waveform Generators – sine, triangle, rectangle, white noise, AM, FM, phasing, harmonics

  - Oscilloscope for viewing 2 channels

  - Spectrum Analyzer – FFT view of the audio spectrum

- Objective is to see how well it performs on a typical PC

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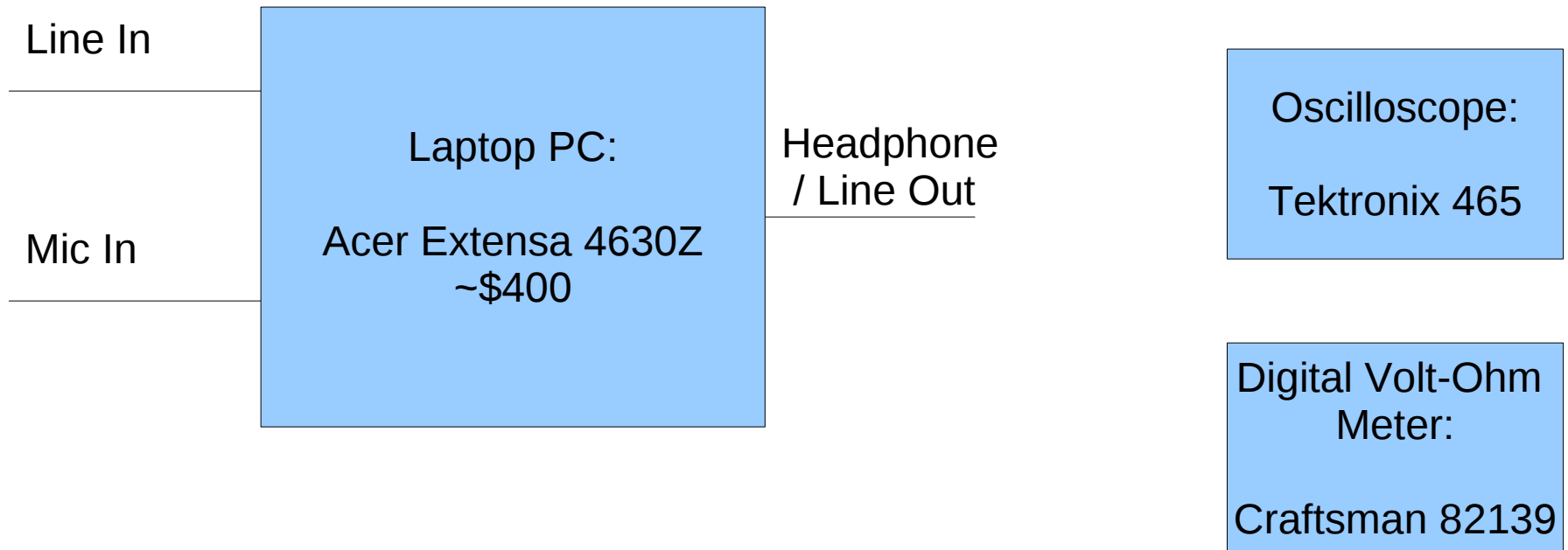AudioAnalyzer = Waveform Generator + Oscilloscope + Spectrum Analyzer + Recorder

The Sound System

eightolives AudioAnalyzer

Java

.wav → JavaSound Interface → .wav

Line In
Mic In

Mixer / Volume Controls → Mixer / Volume Controls

Line Out / Speakers / Headphones

PC Sound System

Test Setup

Line In

Mic In

Laptop PC:

Acer Extensa 4630Z
~$400

Headphone
/ Line Out

Oscilloscope:

Tektronix 465

Digital Volt-Ohm
Meter:

Craftsman 82139

Both Windows XP and Linux were used in the tests on the same hardware.

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Interface Basics

- Line In – 3.5 mm (1/8") Tip Ring Sleeve (TRS) connector (light blue)

  - Nominal level = .316 Vrms (.447 V peak, .894 Vpp)

  - Input impedance ~ 10 Kohms

- Line Out – 3.5 mm TRS (lime green)

  - Max output voltage ~ 2 V peak-peak

  - Output impedance ~ 100 ohms

  - Frequency Range = 20 Hz – 20,000 Hz

Source: Wikipedia

About Signal Levels

- Waveform Generator defines the maximum undistorted sine wave amplitude as +20 db

  - For 16 bit resolution, +20 db peak-to-peak is digitally expressed as +32767 to -32768

  - 0 db (nominal level) peak-to-peak is 10 times less

- Actual analog output levels on Line Out are determined by the PC mixer's volume controls

- Analog input signal levels are also determined by the PC mixer's volume controls

Javasound Interface

- Javasound supports reading and writing .wav files

- Supports sample rates of 8000, 11025, 16000, 22050, 44100 Hz

- Supports 2 channels (stereo)

- Supports 8 bit and 16 bit resolution

Observations on Same PC

- Using Windows XP

  - Max output on LINE OUT was 4.8 Vp-p

  - LINE IN had no attenuation

- Using Linux

  - Max output on LINE OUT was 2.8 Vp-p

  - LINE IN has a -20 db attenuation to the AudioAnalyzer

Observations (Linux)

- With audio system volume controls at max and AudioAnalyzer's volume control at 20 db (max)

  - Output sinewave was 2.8 Volts peak to peak (Vpp)

  - Response was the same 20 Hz to 20 Khz

  - At 1 Hz output was 1.4 Vpp

  - At 22050 Hz output was 1.2 Vpp

 - Channel 2 was about 0.1 V less than Channel 1

LINE OUT to LINE IN (Linux)

- Connecting LINE OUT to LINE IN

  - Observed amplitude from Mixer displayed on AudioAnalyzer's Oscilloscope was 0.134 Vpeak vs 1.4 V applied to the input or – 20db

  - At 20 Hz Vpeak = 0.187 V

  - At 10 Khz Vpeak = 0.134 V

  - The signal on LINE OUT was not affected by connecting it to LINE IN

LINE OUT to MIC IN (Linux)

- When LINE OUT was connected to MIC IN, the observed output from LINE OUT was oscillating a squarewave with an amplitude of 1.2 V peak to peak at 800 Hz
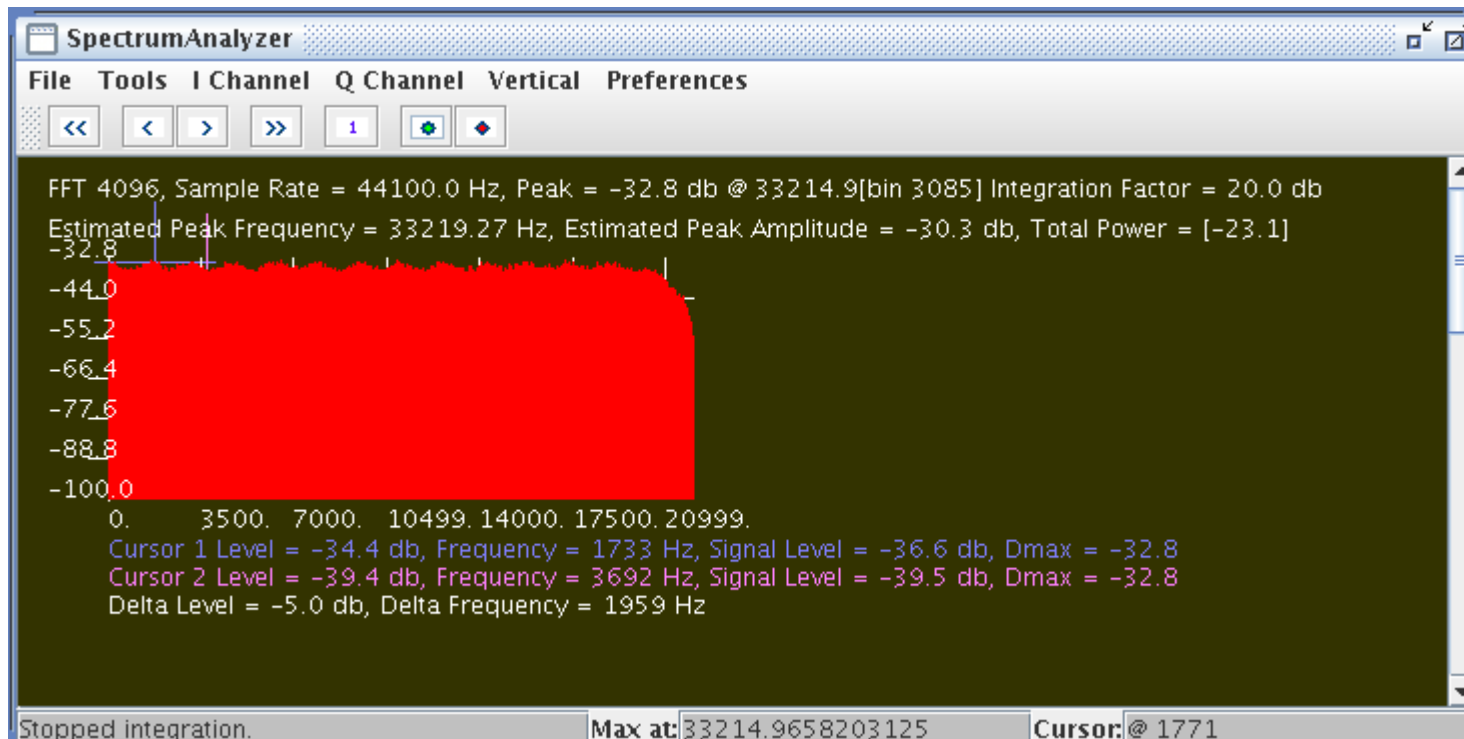
Using White Noise
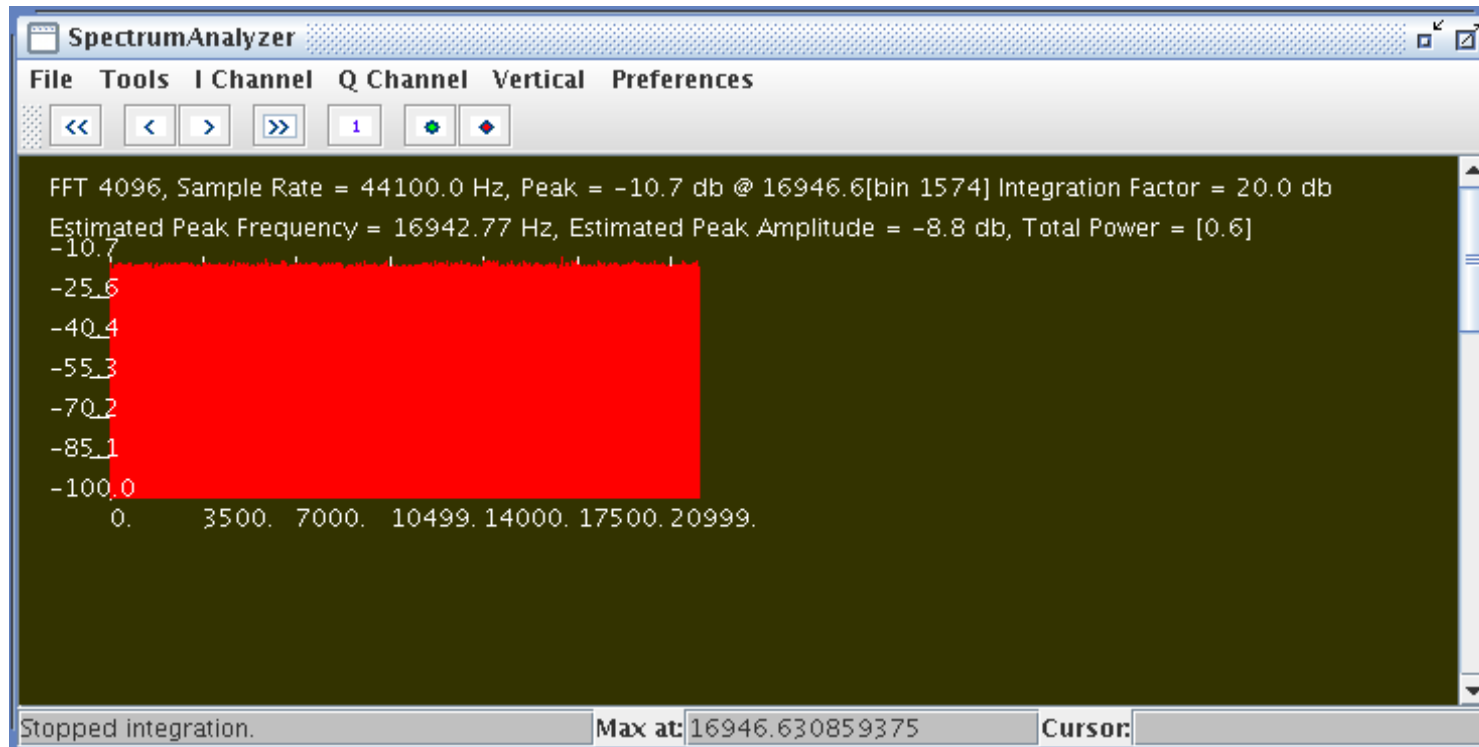
The White Noise from the Waveform Generators produce a flat spectrum.

The display shows 10 passes integrated.

Connecting LINE OUT to LINE IN

Looking at the Mixer input with LINE OUT connected to LINE IN shows the filtering of PC's output and input stages.

The 10 integrated passes show +/- 2.5 db ripple in the bandpass, a roll-off at 19 Khz with response being -30 db lower at 22050 Hz, and a -20 db overall loop gain.

Other Observations

- The polarity of the output signals was inverted from that displayed on the AudioAnalyzer's Oscilloscope.

- An external speaker system connected to the Headphone jack had no output below 200 Hz or above 7 Khz

  - Same observer using headphones:

    - 20 to 8700 Hz

For more information

- Check the tutorials at:
  http://www.eightolives.com/tutorials.htm