Playback Quality of 16-bit Audio on Macintosh Hardware (1/96)

Article Created: 21 July 1993
Article Reviewed/Updated: 31 January 1996

TOPIC -----

I mounted an audio compact disc and converted one of the tracks to a QuickTime movie sound file using 44.1KHz, 16-bit, Stereo settings in MoviePlayer's Open…/Convert…/ Options… dialog. When I listened over headphones connected to the computer, the playback of the file through MoviePlayer had a hiss or background noise. When I played the track from MoviePlayer before it was converted (the option screen has a play selection) the sound file had the same background noise. However, when I played the same CD track through CD Remote with headphones connected directly to the CD player the sound was great and there was no background noise.

Why is there noise when playing back from MoviePlayer? Shouldn't the playback be equal to the original?

DISCUSSION -----

The reason for the apparent noise in the playback is due to the lack of 16-bit 44.1KHz audio playback hardware on some Macintosh computers. Using the file settings you indicated, the file will be an identical copy of what is on the audio CD. The QuickTime movie file on disk is a full CD-quality 16-bit, 44.1KHz, stereo sound file. However, to enjoy the full clarity of this file, your Macintosh computer must be capable of 16-bit, 44.1KHz sound output. Starting with the original AV computers released in July 1993, most subsequently released Macintosh computers have 16-bit sound capability. The Power Macintosh 5200, 5300, 6200, and 6300 series computers have 16-bit sound out capability but only at 22.05KHz. You can use this procedure below to determine if your computer supports 16-bit sound:

Step 1

Choose Control Panels from your Apple menu.

Step 2

Open the Sound control panel.

Step 3

Choose "Sound Out" from the "Alert Sounds" pull down menu. If the 16-bit sound radio button is grayed out, you only have 8-bit sound capabilities.

If 16-bit is not grayed out, make sure there is a dot in the radio button next to it.

Step 4

Use the close box in the upper left corner to close the Sound control panel.

Older Macintosh computers that do not support 16-bit sound can be made 16-bit capable by adding an audio card like Digidesign's AudioMedia II card. To use a 16-bit audio card like this will require Sound Manager 3.x and a Sound Manager component (driver) for the card. The driver component will be supplied by the card manufacturer.

Creating a sound file from the audio disc using the method described is actually a file transfer from the audio disc to the Macintosh hard disk. Thus, there is no conversion of the digital audio to analog audio when transferring the track from the audio disc to the hard disk. By keeping the audio track in the digital domain, it is possible to make an identical copy. Using the 44.1KHz, 16-bit, Stereo options provides that identical copy. The reason noise is introduced when playing back the sound through your computer is the limit of the of 8-bit sound only Macintosh audio hardware.

What happens to the recorded sound on 8-bit only sound capable computers
---
When playing back the sound without 16-bit hardware, the Sound Manager must throw away half of the bits in the audio samples and playback only half of the samples that exist. Thus, the actual data being used is only 25% of the original file.

The reason only 25% of the original data is used is because 8-bit sound Macintosh computers only sample at 22.05KHz. Therefore, the 16-bits must be reduced to 8-bits; and the 44.1KHz must be reduced to 22.05KHz. The Sound Manager accomplishes this "dithering" (known as "downsampling") of the sound - much like QuickDraw dithers a 24-bit color image into an 8-bit color image.

As a side note: Sound Manager 3.x uses a more sophisticated method of downsampling than Sound Manager 2.0. This improves the playback quality of the 16-bit, 44.1KHz sound file on an 8-bit, 22.05KHz system; although, it does not come close to playing back the full 16-bit, 44.1KHz recording.

Digital audio engineers would not usually use "noise" to describe what is happening to the sound. It is more correctly called quantization distortion. Unless you are discussing this issue with a digital audio engineer, "noise" is an acceptable phrase - that is, after all, what it sounds like to the your ear.

In digital audio the main measurement of maximum expressible amplitude to error ratio is called Signal-to-Error (S/E) ratio. This expressible amplitude is also referred to as the "maximum signal" of the recorded sound. The error is what is perceived as noise. The S/E ratio specification of a digital system is closely

related to the Signal-to-Noise (S/N) ratio of an analog system, although it is not identical in nature due to differences between digital and analog methods.

The S/E ratio can be expressed specifically by calculating first a maximum signal value, second an error value, and finally creating their ratio. Although there are intervening steps in the math, the final formula to use when calculating the strength of the audio signal above the noise (distortion or error) level looks like this:

```
      6.02 * n + 1.76 dB
```

Where n is equal to the number of bits in the sample. The following results are approximate signal above noise ratios for a various number of bits in a sample. Generally, the calculated results will be slightly higher than the measured results. Also, specific implementations of hardware will affect the actual measured ratios in a downward fashion.

```
      16-bit samples (number in CD audio)  = 98 dB
      12-bit samples                       = 86 dB
       8-bit samples (Macintosh sound)     = 48 dB
```

To relate the quality of these digital recordings to analog recordings, think of the 8-bit recordings as inexpensive cassette recorders with inexpensive tape. The 12-bit recordings correlate to high quality cassette recorders with noise reduction and metal tape. The 16-bit recordings equate to professional studio reel-to-reel tape recorders with noise reduction and professional tape at high tape speeds.

The Tech Info Library article titled "Locating Vendor Information" can help you search for a particular vendor's address and phone number.

Article Change History:
31 Jan 1996 - Added 8-bit and 16-bit computer information.
26 Jan 1996 - Made minor technical and formatting changes.

Support Information Services

Keywords: <None>

==========

This information is from the Apple Technical Information Library.

19960215 11:05:19.00