

Digital audio sample resolutions are defined with 8-bit, 12-bit, 16-bit, 24-bit, or 32-bit data. In digital imaging and digital video, data resolution is quantified by the number of 8-bit color channels; in digital audio, the resolution is quantified by the number of bytes of data used to define each of the audio samples being taken. Audacity samples at 32-bit data resolution, because you want to start high and then optimize digital audio to one of the mainstream lower resolutions (as you'll see in Chapter 12, where digital audio data footprint optimization is discussed).

Except for the 12-bit resolution for digital audio, which is actually rarely used, the 8-bit, 16-bit, 24-bit, and 32-bit data packet resolutions match up identically between digital imagery editing and digital audio editing. The most commonly used audio data resolutions are 8 bits in low-quality sound effects or voice tracks, 16 bits in music, and 24 bits in HD audio (again, music).

As with digital images, where more color yields a better image quality, in digital audio, a higher sample resolution always yields a better sound wave reproduction.

Thus, higher sampling resolutions, or using more data to reproduce a given sound wave sample, yields a higher audio playback quality at the expense of a larger data footprint.

This is the reason why 16-bit audio, termed “CD quality” audio, sounds better than 8-bit audio; just like true color JPEG or PNG24 imagery should always look better than 8-bit GIF indexed color images. Having a 12-bit digital audio resolution is a valuable option for getting higher quality vocal tracks or sound effects without having to use 16-bit or 24-bit data, because these audio data resolutions are more appropriate for high-quality music experiences or for the audio track in a film or digital video production.

In digital audio broadcasting, there's a trend in using a 24-bit digital audio sampling resolution, known as “HD audio” in the consumer electronics industry.

HD digital audio broadcast radio and satellite radio now use a 24-bit data sampling resolution, so each audio sample, or slice of a sound wave, contains 16,777,216 (this is 24 bits in decimal) potential sample-resolution numeric accuracy.

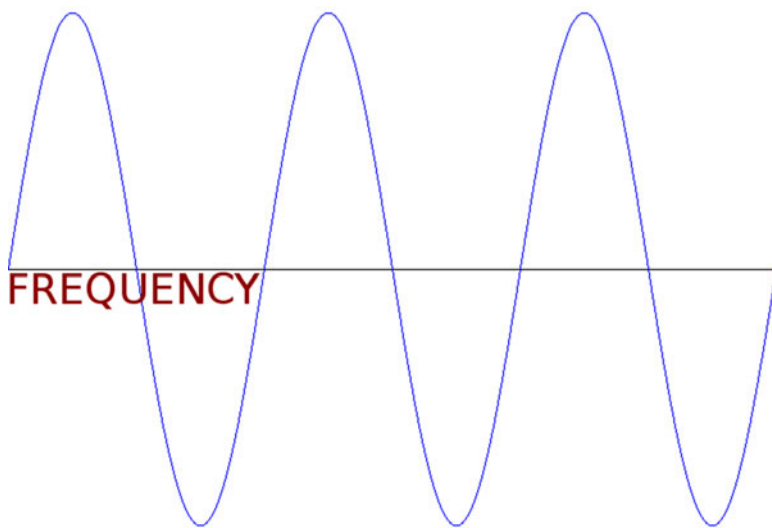
Some of the newer iOS, Android, and Blackberry devices now support HD audio, starting with the smartphone products that are advertised as featuring HD-quality digital audio playback hardware (a 24-bit capable audio data decoding hardware chip). In order for a hardware device to play the HD audio format, you must have 24-bit audio hardware. I recommend using the 16-bit audio for the widest playback compatibility.

## Data Sample Frequency: Data Samples per Second

Besides a digital audio sample resolution, you also have a digital audio **sampling frequency**. This defines the number of data samples, at any given sample resolution, which are taken during one second of sample time. In digital imagery, sampling frequency is analogous to the number of pixels that are contained in a digital image. Sampling frequency is sometimes termed a **sampling rate**. You are familiar with the term CD quality audio, which is defined as using a 16-bit sample resolution and a 44.1 kHz sampling rate. This is taking 44,100 samples, each of which contains 16 bits of sample resolution, or the potential maximum 65,536 data values, for digital audio data held in each sample.

The sampling frequency is taken along the other (x) axis of the sound wave, or waveform, than the resolution is, so that each sample can also have a resolution.

The sampling rate is the number of resolution data samples in a full second of audio data along the frequency dimension of a digital audio waveform, as illustrated in Figure 3-2.



**Figure 3-2.** *The number of data samples are taken over the frequency*

Common audio sample rates for the digital audio industry include 8 kHz, 11.25 kHz, 22.5 kHz, 32 kHz, 44.1 kHz, 48 kHz, 96 kHz, 192 kHz, and recently, 384 kHz. As you may have noticed, I like to use the ones that are evenly divisible by a power of two (8-bit), and so I gravitate toward 8 kHz (low quality), 32 kHz (medium quality), and 48 kHz (high quality).

Lower sampling rates, such as 8 kHz or 11.25 kHz, should be optimal for sampling “voice-based” digital audio, as well as sound effects, such as game sound effects, dialog tracks, or an audio e-book narration track, for example.

Medium-quality audio sample rates, such as 22.5 kHz or 32 kHz, are more appropriate in background music loops in games and some sound effects, such as rumbling thunder, which absolutely needs to have a high dynamic range to ensure higher fidelity digital audio reproduction. The same goes for using 22.5 kHz on vocal tracks in high-quality vocals.

Higher audio sample rates, such as 44 kHz or 48 kHz, are more appropriate for music, which usually requires your highest fidelity reproduction.

Some sound effects, or even music, can get away with using lower 22.5 kHz or 32 kHz sampling rates, as long as the sampling resolution used is 16-bit quality or higher.

Ultimately, you have to use your ears as your guide during the digital audio optimization process, which you’ll do in Chapter 12 after you create and edit a data sample and need to ascertain what your “aural quality-to-digital audio asset file size” trade-off is going to be.

## Data Sample Mathematics: Amount of Binary Data

Let's do some math to find out the number of bits of data that might be held in one second of **raw** (uncompressed) digital audio data. This is calculated by multiplying the sample resolution by the sampling frequency. A 16-bit sample resolution contains 65,536 potential data samples, and the sampling frequency is 44,100 samples per second. Multiplying these yields 2,890,137,600 data values available to represent one second of CD quality audio.

Digital audio data codecs compress this down to an amazingly small file size. The initial raw data footprint size is the starting point for digital audio data footprint optimization. So if you can get adequate quality using a lower sample resolution and (or) a lower sampling rate, the digital audio compression algorithm (codec) is able to do a much better job of exporting a more compact data file; that is, a smaller digital audio file size.

The same trade-off you have with a digital imaging asset exists with digital audio. If you include more data, you get a high-quality result at the cost of a larger file size. Audio codecs do a great encoding job. Fortunately, digital audio has better quality-to-file size results than digital imagery.

## Sample Products: Sampler Hardware and Libraries

Although this book includes the work process for creating your own digital audio data samples, you can also obtain third-party, professional digital audio data samples in a number of different formats, including sampler keyboards and rack-mount hardware, sampler software, and sample libraries, which come on CD-ROM, DVD-ROM, or EPROM chips that install in the keyboard or rack-mount sampler hardware. If you want to be a composer, this is the best option because the instrument samples are done for you, so you can focus on creating musical compositions.

The most expensive sampling hardware is keyboard samplers, because they have a MIDI controller and a sample playback hardware architecture in one completely integrated instrument. Rack-mount sampler hardware is significantly less expensive, because it only has the sampler playback hardware and few moving parts other than some knobs, dials, sliders, and LCD readouts.

The next step down in expense is sample playback software. You need a MIDI controller to use it. This is the next most expensive option because it uses the computer processor as sample processing hardware to play the samples. With this solution, sample data comes on a CD-ROM or DVD-ROM, and is loaded onto the hard disk and played back by the sampler software using a MIDI controller after the instrument samples are loaded into the system memory.

## Recording Digital Audio: Using Audacity

Since this is the third chapter, let's start the process of using Audacity to record a data sample and to see how Audacity works. As you can see in Figure 3-3, Audacity's audio recording levels are located at the top center of the screen, exactly where they should be. Click **Click to Start Monitoring** to learn the ambient sound levels that your microphone is recording in your room. Audio levels show you the amplitude of the sound waves that you are recording.