

DIGITAL AUDIO

One of the most exciting developments in desktop music in recent years is the ability to work with digital audio on a home PC. Previously only available to research institutions and recording studios, digital audio editing software has become commonplace on computers and is now among the most accessible and powerful types of computer software available. Recording, editing, and playing digital audio on a home computer gives the user considerable power to design and produce new sounds, and to edit and craft one's own music with great precision.

What is Digital Audio

Digital audio is a numeric representation of sound; it is sound stored as numbers. In order to understand what the numbers mean, we need to review some of the basic principles of acoustics, the study of sound.

How is Sound Produced?

Sound is produced when molecules in the air are disturbed by a vibration of some kind, such as when a guitar string, human vocal cord or garbage can vibrates. The rate and amount of vibration is important to what we hear. If it is not fast enough or strong enough, we won't hear it. But if the vibration occurs at least twenty times a second and the molecules in the air are moved enough (a more difficult phenomena to measure), then we will hear sound. To understand the process better, let's take a closer look at a guitar string.

<i>Put these five stages in the correct order by writing the numbers 1-5 in the left hand column...</i>	
	As the string moves back and forth, the air molecules around it also move back and forth.
	At the end of the chain, these molecules move our eardrum in the same way as the original string movement, and we hear the sound.
	The entire string moves back and forth a certain number of times a second, called the frequency, which is measured in Hertz (Hz)
	The guitarist plucks a string
	These air molecules bump their neighbours until the molecules next to our ears are set in motion.

One string will vibrate at many different frequencies at once, forming a very complex waveform. This is what gives the string its unique sound. Another major factor in determining the quality of the tone we hear is the resonator, for example the guitar body.

Recording a Sound

When a microphone records a guitar playing, a small membrane in the mic (called the diaphragm) moves in a pattern identical to the guitar wave's pattern and creates an electrical current that is sent through a cable to a measuring device, called an analog to digital (A/D) converter. This device measures how strong the signal is at every instant and sends a numeric value to a storage device – for example, the hard drive in your computer. A digital to analog (D/A) converter turns the numbers back into electrical currents which are sent to speakers, which in turn vibrate air molecules and create sound. The A/D and D/A form part of your sound card.

There are several important aspects of this measuring process. First is the rate at which we choose to examine the signal coming into the converter. It is a fact of physics that we must measure or sample the signal at a rate twice as fast as the highest frequency we wish to capture. Humans can hear tones that occur at rates well up into the tens of thousands of times per second, and so, we use a rate of 44,100 measurements or "snapshots" of a sound per second in our professional equipment. This sampling rate, 44.1 kHz is the rate used in commercial CD's, ie, CD quality. Other common sampling rates are 11kHz, 22kHz, and for some professional equipment, 48kHz.

The other important issue is how accurate our measuring system will be. What number should we measure up to each time? The music industry has decided on the number 65,536, which means that each measurement of the strength of a sound can have a value from 0 to 65, 536 at any given instant. "Why in the world did they choose 65,536?" The answer is simply because it is 2^{16} , which is the largest number we can express in the binary numbering system if we use 16 bits, or 16 places.

If you've followed the discussion up until now, you should have a pretty good idea of what is on a compact disc. It's a massive amount of numbers, each two bytes (16 bits) long, which represent the strength or amplitude of the pressure wave in front of the microphone that made the recording. No matter if the sound was an orchestra, a guitar or a car horn, the CD simply contains measurements for the pattern of motion produced by that sound. We can use our hard drives to record the information in the same form as that on a CD. Changing the bit rate (resolution) and sampling rate (kHz) of a sample will reduce the accuracy of the measurements stored, which means poorer sound quality, but less disk space. The decision regarding how accurate we need to be will be determined by the material we are recording and the amount of storage space we have available to hold the recording.

Digital Audio Software

There are several common varieties of software used to manipulate digital audio data on a computer. The most popular is wave editing software, which allows you to work with a graphic representation of sound, the waveform, and cut, copy and paste it with the ease of a word processor. The software also allows additional processing of the material such as special effects, reversing, stretching and changing the pitch of sounds. Features of this type fall into the category of signal processing, or digital signal processing (DSP) functions. On the IBM-compatible platform, digital audio files are typically called Wave files and carry the extension, .WAV. On the Macintosh, the standard audio file type is the AIFF file.

Sound Cards

Sound cards have a number of important functions.

1. They are an audio output device, capable of recording and playing digital audio.
2. They contain a synthesizer that uses either frequency modulation (FM) synthesis to produce sound, or that stores actual recorded audio data in wavetables for use in playback. Wavetable synthesizers are more preferable because it provides far more realistic sounds. Most wavetable cards, regardless of their manufacturer, offer a General MIDI sound set, which makes them compatible with many popular multimedia programs.
3. A MIDI interface for MIDI input and output, plus the digital to analog (D/A) and analog to digital (A/D) converters described above.

DIGITAL AUDIO – QUESTIONS

1. What is Digital Audio?	
2. Give an example of TWO things that must vibrate in order to create sound.	
3. How fast does something have to vibrate in order to make a sound?	
4. What TWO factors would contribute to the unique sound of, say, a piano?	
5. what is the name of the only moving part in a microphone?	
6. How many times a second is information recorded to a CD?	
7. What bit rate resolution will give you CD-quality sound?	
8. Name one advantage and disadvantage of recording sound with a HIGH bit rate.	
9. What are some special effects that can be applied to digital audio?	
10. What data is recorded in a wavetable?	