About Digital Audio

Background

In the early days of recording, sound was captured by a microphone, which converted the sound waves to an electrical signal, which was then mapped onto a medium such as magnetic tape or vinyl records. Digital technology took this process one step further by converting the analog electrical signal to digital information using an analog-to-digital converter. The most common process for doing this is called pulse code modulation, or PCM for short. Digital audio is the general term for the technology that is used to record, process, store, and transmit sound signals using digital information. The technology matured during the 1970's and rapidly replaced analog technology.

Audio Formats

Digital audio information – any digital information - can be stored on either tape, disc or any other medium capable of rendering bit and bytes. The Compact Disc, or CD, became the dominant media for digital audio in the 1980's. The compact disc is a digital optical disc data storage format that was originally developed to store and play audio recordings but was later adapted for data storage in the CD-ROM format. As the use of compact discs expanded, the engineering community developed a set of compact disc format specifications and standards called the Rainbow Books. There are nine color-coded standards in all. The key standards for digital audio are the following.

- The Red Book was established in 1982 for digital audio. When you see a CD with the file extension .CDA or .WAV, the disc was encoded according to the Red Book specs.
- The Yellow Book was established in 1988 for digital data storage in the CD-ROM format. This format can accommodate many file types. When you buy a software program on a CD it is produced using the Yellow Book CD-ROM standards. Most MP3 and WMA audio formats are conveyed on Yellow Book CD-ROMs.

Sample Rate

When analog audio is recorded the machinery takes continuous samples or tiny snapshots of the signal data. The rate at which it does this is called the sample rate. The original rate established for PCM recording was 44,100 bits over second, and this rate is still the norm for conventional audio CDs. More samples taken in a given instant will render a richer and more accurate representation of the original, while fewer samples will render a less accurate result. This is similar to the dots-per-inch, or "DPI" concept in visual images, where a higher density of pixels per inch will produce a more detailed result.

Many systems now record at rates of 48,000 bit, 96,000 bits, or 192,000 bits, generating a richer result, but then convert them back down to 44,100 rate to conform to CD audio specifications. As you might imagine, using a higher sample rate per second uses more more storage memory, so a rate of 48,000 will require 8.8% more storage than a rate of 44,100, and a rate of 96,000 will require twice as much as 48,000, and so on.

Compact Disc Capacities

The capacity of a compact disc to store conventional audio material is directly related to the sample rate and the density of the disc. Most CDs, which have a sample rate of 44. kHz, have a stated capacity of 700 MB and can hold about 80 minutes of recorded material.

MP3 Audio

MP3 is the shorthand term used to refer to digital audio that has been compressed and encoded in the MPEG-1 or MPEG-2 Audio Layer III format. It is the format that is used in most audio streaming applications and for the transfer and playback of audio on digital audio players such as an iPod. Since the format uses much less data than conventional audio, it can be used to stream audio in real time and to store recordings of far greater length than

The MP3 format was designed by the Moving Pictures Experts Group (hence MPEG) in the early 1990's and makes use of lossy compress to greatly reduce the amount of data required to faithfully reproduce an uncompressed audio recording. The lossy compression process entails a loss of detail as the parts of the recording that are inaudible or redundant are discarded. It is important to note that MP3 is a format used to encode, store and decode audio data known as a "codec" (for code/decode). IT is not an audio recording or audio processing medium.

Bit Rate

The bit rate is a measurement that applies to the process of encoding conventional WAV audio to the MP3 specifies how many kilobits are used per second in the process of converting an audio file to the compressed MP3 format.

- *Constant Bit Rate* (CBR) refers to an encoding method that codes all parts of the audio file at the same rate, whatever the complexity of the source material.
- *Variable Bit Rate* (VBR) refers to a more complex method of encoding that varies the bit rate according to the changing complexity of the material being encoded. More complex material is coded with a higher rate, less complex material with a lower rate.
- *Compression Ratio* refers to the degree that the data has been reduced by the data compression algorithm. The sample rate of 44.1kHz is almost always used as the reference point, since it is the standard for CD audio. The following table shows the compression ratios for the most common bit rates.

Typical Bit Rates and Times are shown in the table below.

Bit rate	Usage	Compression Ratio	Minutes on 700 MB CD	Total time 700 MB CD
1411 kbps	Compact Disc	1:01	80	1 hour 20 minutes
256 kbps	High quality MP3	5:01	440	7 hours 20 minutes
192 kbps	MP3 download	7:01	522	8 hours 42 minutes
160 kbps	MP3 download	9:01	705	11 hours 45 minutes
128 kbps	Internet stream	11:01	882	14 hours and 42 minutes
64 kbps	FM Radio voice	22:01	1764	29 hours and 24 minutes