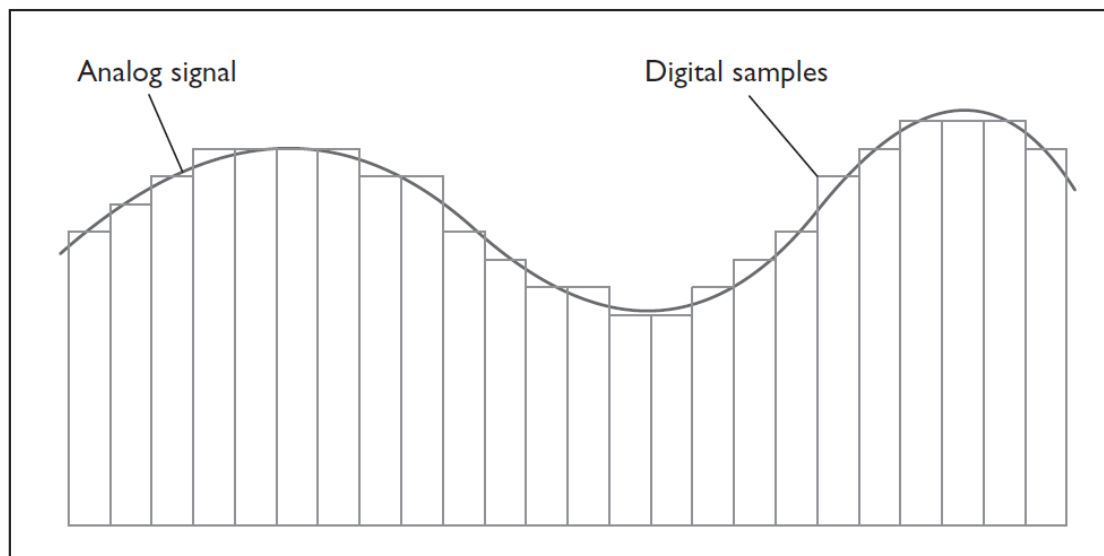


## Sampling Rates – Basics

Sampling is the most important step in the Analog to Digital conversion process. Sampling basically makes a “Digital” copy of an “Analog” signal. The samples are taken at specific time intervals, and the sampling rate is how often the samples are taken. The most common example would be the sampling rate of 44.1kHz (which is the sampling rate of a CD (Compact Disc). 44.1kHz is actually 44,100Hz. So, for a sampling rate of 44.1kHz – every second 44,100 samples are taken.



Here is a diagram from my CTS training manual showing an Analog Signal and Digital Samples.

### What is the Nyquist Rate all about?

A basic definition would be that the Nyquist rate is the minimal rate that a signal needs to be sampled at in order to retain all of the signal's frequencies and information. This allows for the appropriate reconstruction of the samples during the conversion process.

### How does the Nyquist rate relate to Human Hearing?

It all has to do with the range of human hearing which is 20Hz to 20,000Hz and the sampling rate. Let's say we want to sample an Analog signal (a piece of music), in order to reproduce this Analog signal and stay “True” to the 20Hz to 20kHz human hearing frequency range - we would need to (in the very least) use the 44.1kHz sampling rate. This is the lowest sampling rate you can use in order to reproduce the 20kHz signal (the highest frequency in the range). Think of the process this way – 44.1kHz (44,100Hz) is a little more than “Double” the highest frequency of human hearing, which is 20kHz (20,000Hz). This “doubling” is what provides for the accurate reproduction of the sampled audio. To sum up the Nyquist rate – If the highest frequency of the signal is lower than the Nyquist frequency being used - the result is a “distortion free” sample. If the signal is sampled at a rate that is too low and does not accurately capture the original signal it can result in distortion (this is referred to as “Aliasing” in the sampling world). When the music is sampled at 44.1kHz (44,100 samples) and you have a clean “Digital” copy of the music – you can now edit, modify, and mix the music without losing any sound quality.

## What is Bit Rate?

Along with the sample rate you need to pay attention to the Bit Rate as well. Bit Rate can be defined as the number of “Bits” per one second of Audio.” Bit Rates can get really complicated fast so here are a few basic notes. CD Quality is usually sampled at the 44.1kHz / 16-bit rate. High resolution sampling commonly uses the 96kHz / 24-bit rate. The more “bits” used, the faster the samples, the wider the range of frequencies, and the cleaner the music will sound.

## What are the Different Sampling Rates?

44.1kHz / 48kHz. – The 48kHz sampling rate could also be considered another “standard” since it is used just as much as 44.1kHz. Just don’t use both sampling rates (mixed and matched) in the same track (they do not playback at the same speeds).

88.2kHz. / 96kHz – Used for high resolution studio recordings. Both these rates are used for mixing / mastering tracks.

192kHz. – This sampling rate is commonly used for mastering and archiving audio tracks.

## Common Issues with Sampling Rates:

You should use a consistent sampling rate when working on a project. If you record one track of music at the 48kHz sampling rate, and another at the 44.1kHz sampling rate – During playback, one of the tracks will either be slower or faster than the other. Best Practice is to keep track of the sampling rates of your music tracks or better yet, select a sampling rate and use it consistently in your recordings.

The higher the sampling rate, the higher the affect will be on your computers disk space and performance. For example: The 96kHz sampling rate will take up more CPU power than the 44.1kHz sampling rate. This can impact the quality of your recordings. Make sure that your computer can handle the higher sampling rates during recordings and playback!

There is way more to Sampling Rates and Bit Rates than what is presented in this handout. We barely touched the surface of the Sampling World. If you need additional and / or “more in-depth” information we recommend that you do further research on the subject of Sampling / Bit Rates. The subject can get really intense fast.

