16 Bit vs. 24 Bit Audio

16 Bit vs. 24 Bit Audio (original article by The Tweak Contents)

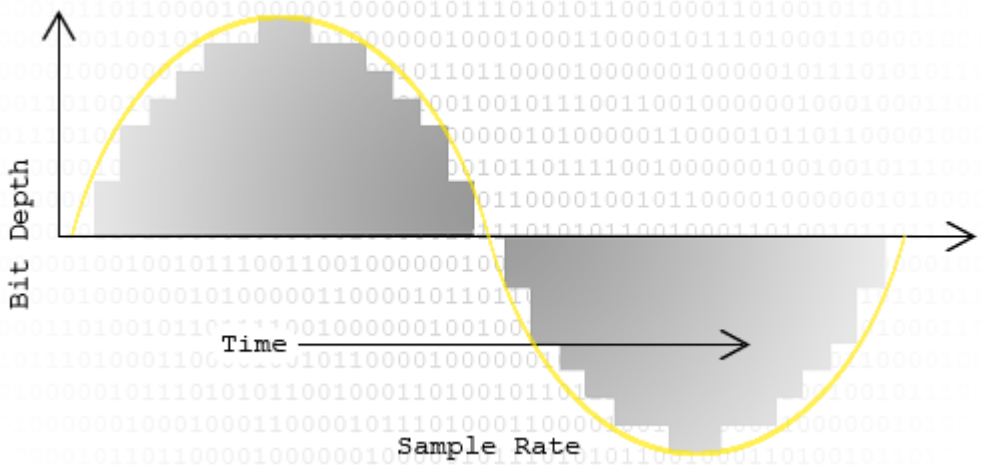
This article is going to be kept as simple as possible. It's just designed to get the new person up to speed on the issues and provide a strong sense of perspective on what really matters. We are going to talk about bit depth and sample rates, how these translate into storage requirements, and then talk about the subjective differences between the two methods of recording your music. In short, what is the relation of 24 bit recordings to the “sound quality” we all want.

When I first ventured into digital audio, it was a much simpler world. Products that recorded and generated digital audio were all 16 bit. Compact discs, the main method for music distribution, has digital audio that has a bit depth of 16 bits and a sample rate of 44.1 kHz. Tip: Never refer to 16-bit or 24 bit audio as the “bit rate”. Its properly called the bit depth and the pros will be so irked they'll have to correct you.

Gradually, products began to appear with a higher bit depth–an 18 bit drum machine, 20, then 24 bit effects processors. Then recorders made the leap to 24 bit. Today, your audio interface is probably 24 bit and allows you to select sample rate of your choice, 44.1, 48, 88.2, 96 and even 192khz. Multi track recorders vary between 16/44.1 and 24/96. When you buy one you have to decide which way to go and get it right the first time.

So what do all these number mean and how important are they? That's where we are going to go, but you have to have these definitions under control.

First of all, know that we are talking about data. Ones and zeros. That is what we are creating, folks! Its all a game of numbers. hat we are doing is putting the numbers into a format that sounds good.



Bit Depth refers to the number of bits you have to capture audio. The easiest way to envision this is as a series of levels, that audio energy can be sliced at any given moment in time. With 16 bit audio, there are 65,536 possible levels. With every bit of greater resolution, the number of levels double. By the time we get to 24 bit, we actually have 16,777,216 levels. Remember we are talking about a slice of audio frozen in a single moment of time.

Now lets add our friend Time into the picture. That's where we get into the Sample Rate. The sample rate is the number of times your audio is measured (sampled) per second. So at the red book

standard for CDs, the sample rate is 44.1 kHz or 44,100 slices every second. So what is the 96khz sample rate? You guessed it. It's 96,000 slices of audio sampled each second. Let's put it all together now.

This brings us to the Bit Rate, or how much data per second is required to transmit the file, which can then be translated into how big the file is. Your CD is 16bit, 44.1 so that is 44,100 slices, each having 65,536 levels. A new Audio interface may record 96,000 slices a second at nearly 17 million levels for every slice. If you think that is a lot of data, well, you are right, it certainly is. The Bit Rate is usually expressed in Mbit/sec. But you don't need to do all this math. I'm going to do it for you. This is not an important area in the recording process to get sidetracked on. What is important for you is how this translates to your hard drive storage.

File Sizes For Stereo Digital Audio Bit Depth Sample Rate Bit Rate 1 Stereo Minute 3 Minute Song 16 44,100 1.35 Mbit/sec 10.1 MB 30.3 MB 16 48,000 1.46 Mbit/sec 11.0 MB 33 MB 24 96,000 4.39 Mbit/sec 33.0 MB 99 MB mp3 128 k/bit rate 0.13 Mbit/sec 0.94 MB 2.82 MB

So you see how recording at 24/96 more than triples your file size. Lets take a 3 minute multi-track song and add up the numbers. Just to put the above into greater relief, I included the standard MP3 file's spec.

Hard Disk Requirements For 3 Minute Multi-track Song Bit Depth / Sample Rate # of Mono Tracks File Size per Mono Track File Size per Song Songs per 20 GB Hard Disk Songs per 200 GB Hard Disk 16/44.1 8 15.1 MB 121 MB 164 1640 16/48 8 16.5 MB 132 MB 150 1500 24/96 8 49.5 MB 396 MB 50 500 16/44.1 16 15.1 MB 242MB 82 820 16/48 16 16.5 MB 264 MB 74 740 24/96 16 49.5 MB 792 MB 24 240

Note that these size do not count any out takes you may have recorded but didn't delete and they assume a linear recording method from beginning to end of the song for every track. They also don't account for hard disk sector size which will leave a lot of space on the drive empty. Real world mileage may vary.

So, you should be noting two things:

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  Recording at 24/96 yields greatly increased audio resolution-over 250
times that at 16/44.1
  Recording at 24/96 takes up roughly 3 1/4 times the space than recording
at 16/44.1
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End of technical discussion. Are you still with me? Lets get into the thick of it. Should you record at a high Bit Depth and Sample Rate?

Now lets get to the subjective side of how music sounds at these different bit depths and sample rates. No one can really quantify how much better a song is going to sound recorded at 24/96. Just because a 24/96 file has 250 times the audio resolution does not mean it will sound 250 times better; it won't even sound twice the quality. In truth, your non-musically inclined friends may not even notice the difference. You probably will, but don't expect anything dramatic. Can you hear the difference between an MP3 and a wave file? If so, you will probably hear the difference between different sample rates. For example, the difference between 22.05 kHz and 44.1 kHz is very clear to most music lovers. A trained ear can tell the difference between 32khz and 44.1. But when 44.1 and 96kHz are compared it gets real subjective. But lets try to be a little objective here. Tip: Use 24 bit If you've got it !!! (or 32 bit float if available) Nyquist Theory and Sample Rate

This theory is that the actual upper threshold of a piece of digital audio will top out at half the sample rate. So if you are recording at 44.1, the highest frequencies generated will be around 22kHz. That is 2khz higher than the typical human with excellent hearing can hear. Now we get into the real voodoo. Audiophiles have claimed since the beginning of digital audio that vinyl records on an analog system sound better than digital audio. Indeed, you can find evidence that analog recording and playback equipment can be measured up to 50khz, over twice our threshold of hearing. Here's the great mystery. The theory is that audio energy, even though we don't hear it, exists as has an effect on the lower frequencies we do hear. Back to the Nyquist theory, a 96khz sample rate will translate into potential audio output at 48khz, not too far from the finest analog sound reproduction. This leads one to surmise that the same principle is at work. The audio is improved in a threshold we cannot perceive and it makes what we can hear “better”. Like I said, it's voodoo.

Advanced class: What is 32 bit float point processing? Most major sequencers and many of the better multi track recorders will render audio temporarily in a 32 bit floating point format. This should not be confused with 32 bit recording. Basically, the extra bits are added onto the file after recording to allow generous headroom for audio mathematics in the digital domain. Before the file is output it will go through the 24 bit converters on your interface. I think of the “floating point” as a scalable decimal point in a calculation. Having 32 rather than 24 registers for calculations is going to render a more accurate result. Its also allows for some calculations that would be theoretically impossible with strings of 24 numbers.

Think of a 16 channel audio mixer summing i.e., “adding” and matrixing 16 sets of 32 numbers 44,100 times every second. That's a lot of math! Now add in all those nifty plugins doing their math on top of each channel and that super hard brick wall limiter at the end of your chain. Yo! We be kickin da numbers dude!

Yet when the data hits the 24 bit converter 8 bits are “truncated” or cut off. But still, the mathematical result is more accurate. This is all happening behind your back and you don't need to think about it.

RME Fireface 800 FireWire Audio Interface RME $1799.00

But should you record at a high sample rate? Alright! Remember now that the sample rate in hugely different than the bit depth. Its going to depend on who you ask. Some people say “It's all going to end up as 44.1 any way” when the cd is burned. Others will tell you that when an audio interface processes and mixes sounds at 96 kHz the result is better and remains better even after the final conversion to 44.1. And just about every other position is taken too. Some say 16/44.1 is good enough for CD its good enough for me. Others say do 24/44.1 because it's not that much more space and it increases the signal to noise ratio. There is one argument that says 24/88.2 is superior to 24/96 because it is an even number conversion going back to 44.1. Bit Depth

Ok, this is the gospel according to Tweak! Use 24 bit for every recording if you have this feature. I was a believer for the past decade that 16 bit was the way to go and I have absolutely changed my mind. No matter of what you are recording this is true. If you have a nice mic, a very good preamp and a clean audio system and are recording highly dynamic instruments such as acoustic guitars, classical orchestras, acapella vocals, the difference will be there. But! Its not that 24 bits of data makes the sound better. It actually does not. What is does is give your audio more room to breathe in the numeric realm of digital audio. Remember, we are talking about numbers, calculations, not analog waveforms. With 24 bits of data demarcing your recording medium, its is possible to record extremely dynamic music, with very quiet soft passages and extraordinary loud passages. Quiet passages will be less likely struggling to stay above the noise floor on your system. One can record with no compression. You can record at lower levels, with more headroom. This ensures that the occasional

peak is not truncated at the top and it will give converters some room the breathe. Because you are not pushing the limits of your bandwidth, your instruments will sound clearer, and the vocals may sound “cleaner”, the song will mix better and there will be less noise. So its not that 24 bit recordings sound better. In fact they may sound just as bad or worse than 16 bit. But 24 bits gives the recordist a noise floor and headroom to create an excellent recording. Its a tool, and in the right hand, it can blow you away, audio wise. Sample Rate

Regarding the sample rate, unless you have a good reason not to, use a sample rate of 44.1. If you are doing audio for video you might want to use 48 khz as many editors only use that rate. Some kinds of music seem to benefit slightly from the high resolution of 88.2 or 96 khz. Acoustic instruments, like guitars, percussion, and of course vocals, i.e., things with delicate high frequencies seem to benefit but its subtle. Lets say you had a $399 audio interface with onboard preamps. Replacing your preamp and converters with better ones will give you more of a sonic difference at 44.1 that recording at 96khz will.

Once inside the sequencer, audio files may be converted to 32 bit for processing and converted back to 24 or 16 on the way out. So, my advice is to record at 24 bits/44.1 at minimum and go up to a sample rate of 88.2 or 96 if you think your material warrants it (and you have the disk space.)

What about the 192khz rate? Ok, let me get you to think of how audio interface manufacturers plan to get you to buy their products. One company comes out with 192 then they all feel they have to or they will lose sales. Its hype in my opinion. If you want to fill up hard drives faster, go ahead and use it. We have debated this long an hard on the forums. In the end, no one can tell the difference. So how do we achieve Sound Quality?

People ask me all the time, and I wince every time they do: “What gear (fill in the blank…soundcard, preamp, cable, recorder, sequencer) will give me the “best” sound quality?” I wince because I imagine the person going out, buying a $500 preamp and the stick it in their studio and connect the Mic and crestfallenly realize it “sounds the same” “maybe a little better” um, “hard to tell”. Why the heck is that? The main reason is that it is all a big system and it is only as pure as its dirtiest pan pot. One humming cable can obliterate the gains made by otherwise great sounding gear. A pristine Mic preamp connected digitally to a soundcard with the jitters will be defeated. Your whole chain has to pro quality, from preamps, in and out of the converters, into top quality monitors. But if you do have a great signal chain, even your 16 bit recordings will sound better than 24/96 with average preamps and typical converters and monitors.

But lets be real clear: it is not just gear. It's technique. Someone with a $2,700 Neumann U87 and a top of the line Great River preamp will still have an awful recording if the Mic is not placed well, or if the room brings out undesirable characteristics. If you apply to much compression on a vocal while recording its going to sound bad no matter what gear you have. This is all to say, positively, that when you know how to apply eq, processors and plugins you will be on your way to achieving a mix of high sound quality. This brings me to the point. A person who really knows and works with their gear can deliver greater sound quality at 16 bit with lesser gear than a person who just plugs in and goes on top of the line 24/96 recorders. Technique is as important as gear which is more important than bits and rates. And there is only one thing more important that technique and gear.

cassette deck The most important point is saved for last, and I've said it before, and will again. Great music recorded on a crappy cassette deck will win more hearts than a turd polished at 24/192. Your talent is more important than anything else, and you can't buy that. So remember to practice, work on your technique, when you can afford to, upgrade your signal path, and then when the pearly gates of Sound Quality open, then consider 24/96 as you would a nice finish on a well-crafted piece of art.

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