Everything you need to know about digital versus analog

Brought to you by

Tech Curiosity

2021

But first, a quiz

Question 1:

What does the acronym LASER stand for?

Answer

light amplification by stimulated emission of radiation

And now you're all wondering what the acronym LOSER stands for?

Answer

light amplification by stimulated emission of radiation

And now you're all wondering what the acronym LOSER stands for?

light oscillation by stimulated emission of radiation

A type of LASER that produces light by itself is technically an optical oscillator rather than an optical amplifier

But first, a quiz

Question 2:

How big is a ‘quantum leap’ (aka quantum jump)?

Answer

- A **quantum jump** is the abrupt transition of a quantum system (atom, molecule, atomic nucleus) from one quantum state to another, from one energy level to another. When the system absorbs energy, there is a transition to a higher energy level (excitation), when the system loses energy, there is a transition to a lower energy level. *(Niels Bohr, Werner Heisenberg – mid 1920s)*
- *Schrödinger*, 1952 "Are there quantum jumps?," "no," in his irritation he called them "quantum jerks."

So how big is a 'quantum leap'? Pretty darn small…

Sources

- Analog vs. Digital
- Digital vs Analog Audio: An Overview
- Analog vs Digital Audio: Which Is Better?
- Analog and digital technology - What's the difference?
- Video Explains Why Difference Between Analog
- Does digital sound better than analog?
- The Basic Facts of ANALOG vs DIGITAL
- Analog vs Digital - Difference and Comparison
- Which Sounds Better, Analog or Digital Music?
- Analog vs Digital: The Debate Rages On

Analog vs. Digital

- We live in an analog world. There are an infinite amount of colors to paint an object (even if the difference is indiscernible to our eye), there are an infinite number of tones we can hear, and there are an infinite number of smells we can smell. The common theme among all of these analog signals is their **infinite** possibilities.
- Digital signals and objects deal in the realm of the **discrete** or **finite**, meaning there is a limited set of values they can be.

DIGITAL VS ANALOG AUDIO: AN OVERVIEW

- No matter which recording process used, analog or digital, both are created by a microphone turning air pressure (sound) into an electrical analog signal.
- An analog recording is made by then imprinting that signal directly onto the master tape (via magnetization) or master record (via grooves) – from which copies can be made into cassette tapes and vinyl records.
- Digital recordings take that analog signal and convert it into a digital representation of the sound, which is essentially a series of numbers for digital software to interpret.
- After the analog signal is digitalized, the recording can be copied and placed onto a compact disc, hard drive or streamed online.
- Digital recordings can be played and copied endlessly without ever losing their original quality. Over time, vinyl records and tapes can lose their audible value when being played or copied.

Analog and digital

- When we say something is analog, we often simply mean that it's not digital: the job it does, or the information it handles, doesn't involve processing numbers electronically.
- Digital is entirely different. Instead of storing words, pictures, and sounds as representations on things like plastic film or magnetic tape, we first convert the information into numbers (digits) and display or store the numbers instead.
- Just because digital technology has advantages, that doesn't mean it's always better than analog. Though the future may be digital, analog technology will always have its place!

Analog vs Digital Audio: Which Is Better?

- Both analog and digital audio have drawbacks and advantages
- PCM, or Pulse Code Modulation, is the standard method for encoding audio signals into binary information. In analog audio recording, a model of the sound waves is created using magnetic charge. However, PCM creates a model of the sound waves by storing a sequence of numerical values that represent the amplitude at various points along a wave.
- These values are represented by groups of binary bits, called samples. Each sample represents a numerical value within a predetermined range of possible values. This process is called quantization, and is performed by an analog-to-digital converter (A-to-D converter).
- During playback of a digital recording, the samples are converted back to electrical signals and sent to speakers. This process is performed by a digital to analog converter (D-to-A converter or DAC).

An introduction to animagraffs...

Analog vs Digital Audio: Which Is Better?

- Each sample represents a value within a range of possible values. The range of possible values is determined by the bit depth. Bit depth is the term that describes how many bits are included in each sample.
- Each bit can represent two possible values. Samples which utilize more bits can represent a larger range of values, and therefore can store more precise information about the amplitude of a sound wave. Each time a bit is added, the number of possible values is doubled.
- The standard bit depth for CDs is 16-bit, allowing for 64,536 possible amplitude values. The professional standard is a bit depth of 24-bit, which allows 16,777,216 possible amplitude values! However, most studios record and mix using 32-bit

Analog vs Digital Audio: Which Is Better?

- The sample rate determines how many samples are taken of a sound wave per second. Sample rate is measured in Hertz (Hz). Recording at a higher sample rate allows higher frequencies to be recorded.
- The Nyquist Theorem states that digital sampling can only faithfully represent frequencies less than half of the sampling rate. This means that if you want to capture 20kHz, the highest frequency audible to humans, you must use a sample rate greater than 40kHz.
- For this reason, 44.1kHz is the standard sample rate for CDs. Professional audio for video utilizes a standard of 48kHz.

Analog vs Digital Audio: Which Is Better?

- The audio files produced by recording studios are very large, due to the amount of information they contain. If a 3-minute song is recorded with a bit depth of 24-bit and a sample rate of 96kHz, the file size will be approximately 52MB. This file is too large for consumer applications, such as streaming. For this reason, data compression formats are used.
- Data compression is a method of reducing the size of a file. There are two main categories of data compression formats, lossy and lossless.
- If information is lost through the process of compressing data, the compression format being used is lossy (e.g. mp3, AAC…). Unfortunately, the most widely used data compression formats in consumer audio are lossy. This means that, although special algorithms are used to reduce negative effects, data is lost during the process of compressing the file. Once data is lost, it can never be restored.

Analog vs Digital Audio: Which Is Better?

- If no information is lost through the process of compressing data, the compression format being used is lossless (e.g. FLAC, AIFF…). Some streaming services, such as Tidal, utilize lossless compression. Using these formats, information can be encoded into a smaller file and later decoded, ultimately restoring the original PCM information as a WAV file. Although these formats do save some space compared to uncompressed files, they are nowhere close to the efficiency of lossy formats.

Analog vs Digital Audio: Which Is Better?

- SO, which is better?
  - analog and digital audio recording technologies share a common goal – to create a model of acoustic waveforms that can be played back as accurately as possible. Each technology accomplishes this goal quite well. The audio quality achieved using one method is not necessarily better than the other, just different.
- Frequency Range - not a practical difference
- Noise Floor - major drawback for analog audio
- Vulnerability & Longevity - digital media is more resilient
- Portability and Reproducibility – better for digital audio media

Analog vs Digital Audio: Which Is Better?

The Debate Continues

- The truth is that both analog and digital audio systems have value in the modern world. The debate over which is better and which is worse will never end, because there is not a clear answer.

My .02 – digital audio is totally acceptable for my ears, and the portability and convenience of digital audio is what sells it for me, but for best results, don't skimp on your audio output devices:

- SONOS One – audio throughout the house
- VIZIO Soundbar - for 5.1 TV audio
- SONY MDR7506 - headphones
- Klipsch ProMedia 2.1 THX – desktop speakers

Video Explains Why Difference Between Analog versus Digital

Great Video

- "Analog versus digital" – the discussion, it seems, is everywhere. The problem is, many people simply don't understand what these terms mean.
- In short:
  1. 16-bit, 44.1 kHz really is okay for many tasks. (You're saving that data for the computer and processing rather than your own ears. Hope to talk about this question in more detail soon.)
  2. Digital audio doesn't involve stair-stepping.
  3. Digital signals can store and be used to reproduce sound that's identical to what's stored in analog form.
- "Choosing" between analog and digital, as categories, therefore doesn't make any sense at all. Now, choosing between individual filters, for instance, or caring about the physical design of electronic instruments, or recognizing that you can screw up a digital or an analog recording – all those things do matter. In fact, they matter so much that obscuring them with misinformation is a very bad thing.
- Instead of getting stuck in meaningless debates like whether analog or digital is "better," in other words, we need to have very meaningful debates about design, sound, music, and art.

Does digital sound better than analog?

- There's a sizeable population of audiophiles -- people who want the highest quality in sound systems possible -- who insist that analog systems provide a better sound.
- Analog vs. Digital: The Verdict
  - After much research and subjecting ourselves to hours of listening to music, we've come up with an answer. We're going to have to call this one a tie.
  - Skeptics suggest that if an audiophile expects to hear better sound out of an analog recording, he or she will be convinced that the analog version was better even if the two recordings are identical.

Which Sounds Better, Analog or Digital Music?

- The answer is subjective, but the underlying math is not
  - Because mathematics describes an idealized version of reality, the reconstruction of a sound wave from a digital file may not perfectly match the vibrations of the sound itself. On the other hand, analog recording is purely physical.
  - Does this mean analog is more accurate? No, it just means it's different. The sound wave produced by analog playback could be further from the original than a good quality digital file would be.

Analog vs Digital: The Debate Rages On

- There will probably never be an end to the analog vs. digital argument. Each side has its proponents and critics. In truth, there are advantages and disadvantages to both.
- In reality, there is a place for both recording methods in the collections of music lovers. Remember, there are analog recordings that haven't made it to CD yet.
- The best way to choose is to listen to both media and then make a decision. Should you choose vinyl, look no further than Electrohome's Signature Retro HiFi Stereo System to enjoy the warm crackle of your favorite records!

It’s all about Cables – not!

- Amazon Basics 100ft 16-Gauge Audio Stereo Speaker Wire Cable, 100 Feet ($14.22)
- 16 AWG CL2 OFC in Wall Speaker Wire, GearIT Pro Series 16 AWG Gauge ($29.99)
- Amazon Basics 12-Gauge Audio Speaker Wire Cable - 99.9% Oxygen-Free Copper, 100 Feet ($50.74)
- DH Labs Q-10 SIGNATURE ($810 for 15’)
- DH Labs Deity ($10,400 for 15’)

- Or just use an old metal coat hangar (free, and it works fine!)
  - Cable myths: reviving the coat hanger test