

# Read About Digital vs. Analog Signals

## WHAT ARE DIGITAL SIGNALS?

Electronic signals allow computers and other electronic devices to take in, send out, and process the information they need to function. Computers and other digital devices send and store information as a series of digits like 1s and 0s. We call signals made of only two digits, digital signals.

*To better understand digital vs. analog signals...*

## LET'S BREAK IT DOWN!

### A sound wave is an analog signal.

Sound waves are created by vibrations, and sound can be recorded on vinyl records with grooves that cause the needle on a record player to vibrate. Those vibrations are then amplified to play back the sound that was originally recorded. The pitch, or frequency, of that sound can take on a wide range of values. In other words, the frequency of that sound is a continuous variable. The

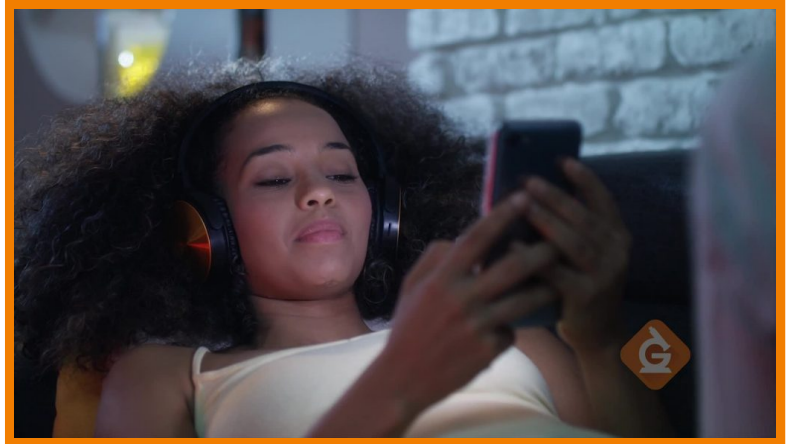
signal produced by playing a record can be represented as a smooth sound wave that describes exactly how the sound changes over time. This is known as an analog signal. The sound wave produced by the record player is analogous, or similar, to the original sound wave that was recorded.



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## Analog signals can be converted to digital signals.

Modern computers are controlled by digital, not analog signals. Digital signals are made up of values, or digits, that can have only certain values. The most basic instructions controlling a computer are made up of a series of 1s and 0s. Because computers often need to handle analog signals, like a digital thermometer reading your body temperature, we need to be able to



convert analog signals to digital signals. This happens through a process called sampling. To convert the sound wave produced by a record player into a digital signal, we would take the value for the wave height at evenly spaced time intervals and convert those values into a digital code of 1s and 0s. Once the sound wave is converted to a digital signal, it can be stored and transmitted by a computer. This is what allows us to download, play, and stream music from our smartphones.

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## Sending digital signals

Analog and digital signals can both be transmitted through the air using electromagnetic waves, like radio waves. AM and FM radio stations broadcast analog waves, and these signals deteriorate as they travel over long distances. That's why you start to hear static as you get too far away from a certain station. Digital signals are transmitted as short pulses that represent different digits. Because these signals can contain only certain values, like 1s and 0s, they can easily be corrected to remove static. Satellite TV, satellite radio, WiFi, and cell phones all rely on digital signal transmission.



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## Storing digital information

Along with transmitting and receiving digital signals, computers also store information in digital form. As examples, hard drives encode 1s and 0s as tiny areas that are magnetized or demagnetized, and flash drives encode data based on electrical charges. In the same way that digital signal transmissions can be corrected to remove static, digitally stored data can



be corrected when it degrades over time. Devices that send data to your computer (like your keyboard or mouse) send these instructions as digital code. And devices like your monitor that provide output from your computer convert digital code into a form that makes sense to you as the user.

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## Career Spotlight: Computer Programming

Everything that happens in a computer is controlled by binary code—the series of 1s and 0s that tells the computer what to do and when to do it. This binary code provides the foundation for websites, apps, computer games, and all other computer programs. These programs help us do almost everything in our everyday lives, so there are countless career opportunities for software



programmers. Most of these professionals don't work directly with binary code, though. Instead, they use programming languages that make it much easier for the programmers to code instructions for the computer. And the software programs these coders create make it easy for people and computers to communicate with each other to help us get things done.

## DIGITAL VS. ANALOG SIGNALS VOCABULARY

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**Signal**

Anything that is used to convey information.

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**Analog signal**

A signal conveyed by continuous data, often in the form of a wave.

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**Digital signal**

A signal in which continuous data has been translated to a series of noncontinuous digits, like 1 and 0.

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**Sampling**

The process of converting an analog signal to digital by taking values at points along the wave.

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**Amplitude**

The distance from the midpoint of a wave to its crest or trough.

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**Continuous**

Data in which each point can have a slightly different value, like reading temperature from a glass thermometer.

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## **DIGITAL VS. ANALOG SIGNALS DISCUSSION QUESTIONS**

### **What is the main difference between analog and digital signals?**

Analog signals are composed of a continuous range of values, where each point can have a slightly different value. Digital signals are made up of a series of digits that are either 0 or 1.

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### **How can an analog signal be converted into a digital signal?**

During the process of sampling, measurements are taken along the analog signal, and those measurements are converted to binary code (0s and 1s). The closer together the samples are, the more similar the digital signal is to the analog signal.

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### **How does binary code control the processes in a computer?**

Ones tell the computer to turn on certain circuits, and zeroes tell the computer to turn off certain circuits. Through a string of millions of 1s and 0s, a computer program can carry out very complex tasks like running a video game.

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## **What is the main advantage that digital signals have over analog signals?**

Because the values in a digital signal must be either 0 or 1, the signal can easily be corrected to eliminate noise.

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## **Which type of signal would be best for NASA to use to send signals into space to be received by extraterrestrial life? Why?**

Because digital signals can be corrected to remove noise, the signals can be received clearly even after travelling a very long distance.

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## **If you were a singer recording a song, what factors would you need to consider when deciding to record with analog or digital equipment?**

Analog would capture the full sound of the singer's voice and might sound more like a live performance. Digital would provide cleaner sound with less interference, would be easier to store and share, and can even allow for the singer's voice to be adjusted or improved.

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