

ANALOG SIGNALS AND DIGITAL SIGNALS

Analog Signals

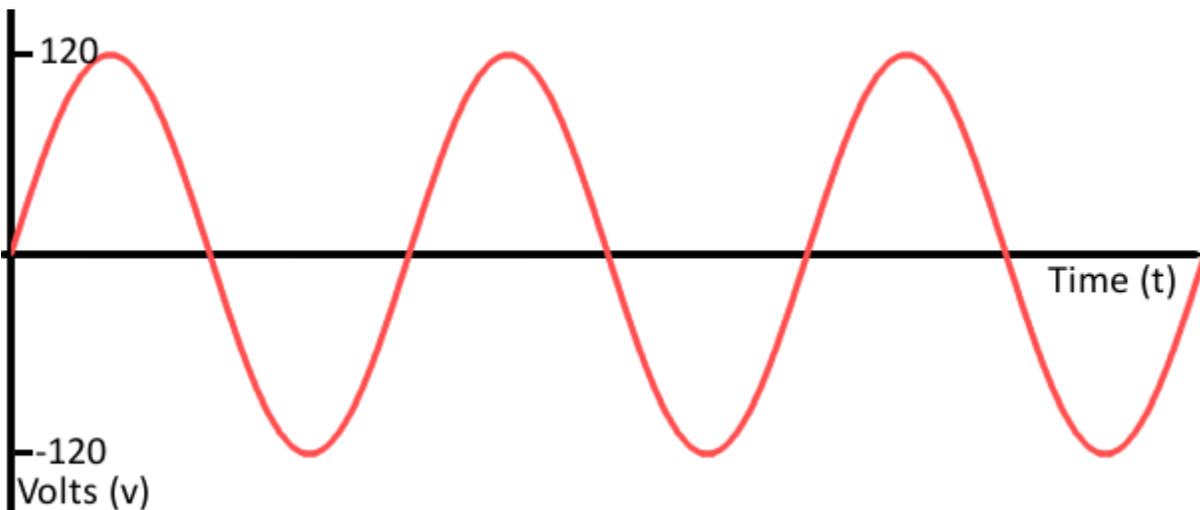
Define: Signals

Before going too much further, we should talk a bit about what a *signal* actually is, electronic signals specifically (as opposed to traffic signals, albums by the ultimate power-trio, or a general means for communication). The signals we're talking about are **time-varying** "quantities" which convey some sort of information. In electrical engineering the *quantity* that's time-varying is usually **voltage** (if not that, then usually current). So when we talk about signals, just think of them as a voltage that's changing over time.

Signals are passed between devices in order to send and receive information, which might be video, audio, or some sort of encoded data. Usually the signals are transmitted through wires, but they could also pass through the air via radio frequency (RF) waves. Audio signals, for example might be transferred between your computer's audio card and speakers, while data signals might be passed through the air between a tablet and a WiFi router.

Analog Signal Graphs

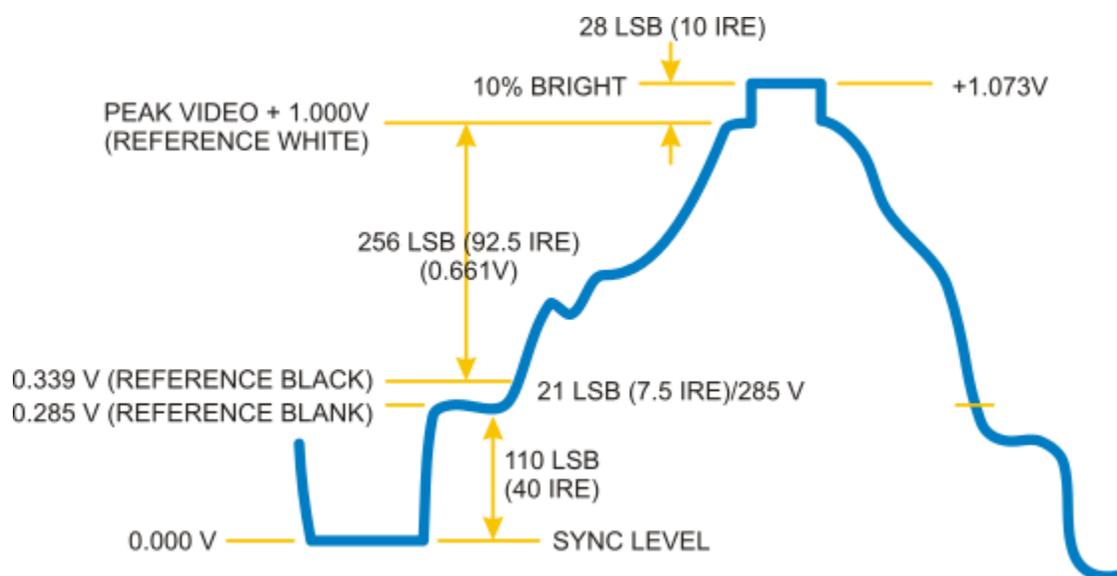
Because a signal varies over time, it's helpful to plot it on a graph where time is plotted on the horizontal, x -axis, and voltage on the vertical, y -axis. Looking at a graph of a signal is usually the easiest way to identify if it's analog or digital; a time-versus-voltage graph of an analog signal should be **smooth** and **continuous**.



While these signals may be limited to a **range** of maximum and minimum values, there are still an infinite number of possible values within that range. For example, the analog voltage coming out of your wall socket might be clamped between -120V and +120V, but, as you increase the resolution more and more, you discover an infinite number of values that the signal can actually be (like 64.4V, 64.42V, 64.424V, and infinite, increasingly precise values).

Example Analog Signals

Video and audio transmissions are often transferred or recorded using analog signals. The composite video coming out of an old RCA jack, for example, is a coded analog signal usually ranging between 0 and 1.073V. Tiny changes in the signal have a huge effect on the color or location of the video.

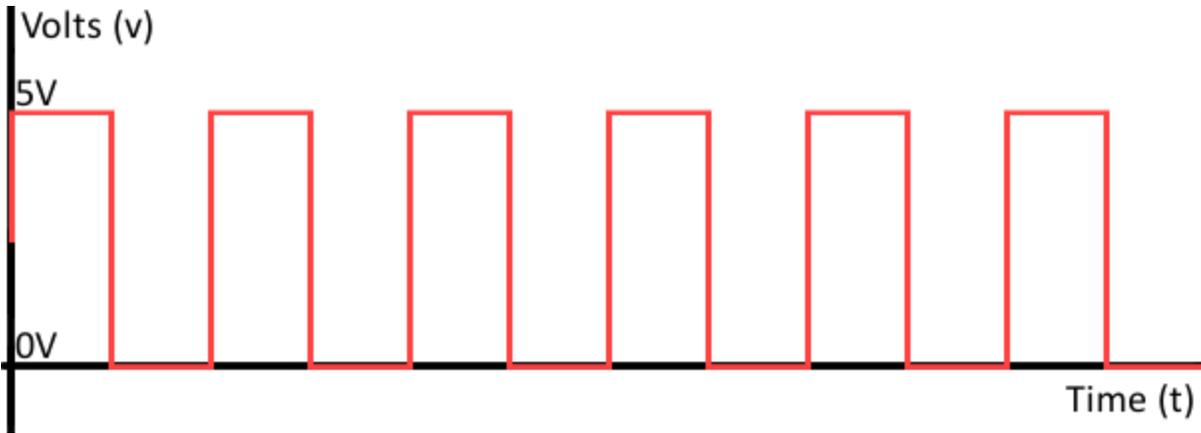


An analog signal representing one line of composite video data.

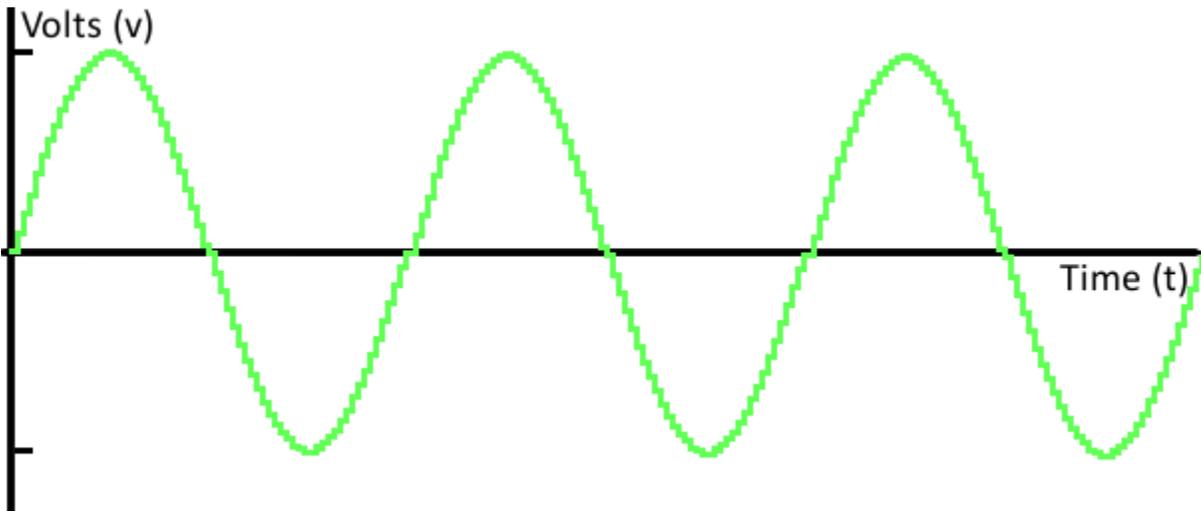
Pure audio signals are also analog. The signal that comes out of a microphone is full of analog frequencies and harmonics, which combine to make beautiful music.

Digital Signals

Digital signals must have a finite set of possible values. The number of values in the set can be anywhere between two and a-very-large-number-that's-not-infinity. Most commonly digital signals will be one of **two values** – like either 0V or 5V. Timing graphs of these signals look like **square waves**.



Or a digital signal might be a discrete representation of an analog waveform. Viewed from afar, the wave function below may seem smooth and analog, but when you look closely there are tiny discrete **steps** as the signal tries to approximate values:

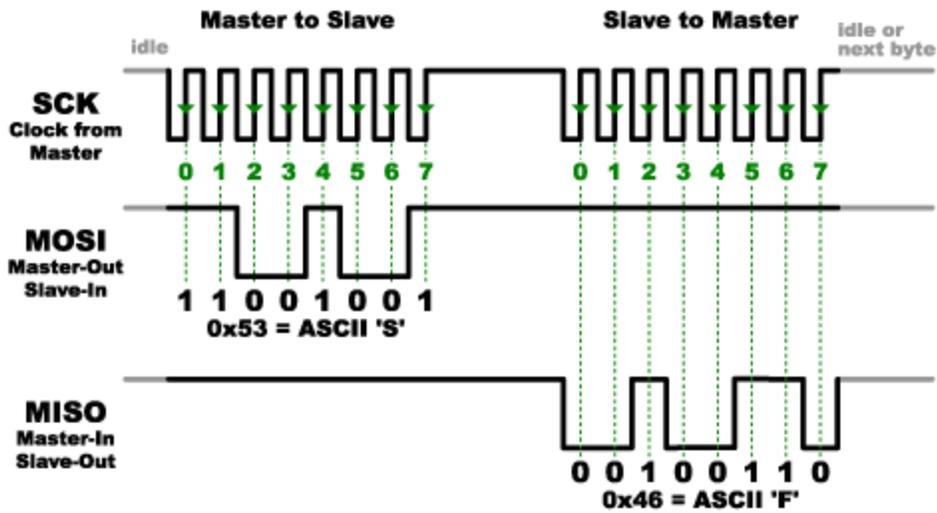


That's the big difference between analog and digital waves. Analog waves are smooth and continuous, digital waves are stepping, square, and discrete.

Example Digital Signals

Not all audio and video signals are analog. Standardized signals like HDMI for video (and audio) and MIDI, I²S, or AC'97 for audio are all digitally transmitted.

Most communication between integrated circuits is digital. Interfaces like serial, I²C, and SPI all transmit data via a coded sequence of square waves.



Serial peripheral interface (SPI) uses many digital signals to transmit data between devices.

Source : <https://learn.sparkfun.com/tutorials/analog-vs-digital#analog-signals>