<u>Analog vs Digital Signals</u>

Overview

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. That could mean just two total possible values, 255, 4,294,967,296, or anything as long as it's not ∞ (infinity).

Real-world objects can display data, gather inputs by either analog or digital means. (From left to right): Clocks,multimeters, and joysticks can all take either form (analog above, digital below).

Working with electronics means dealing with both analog and digital signals, inputs and outputs. Our electronics projects have to interact with the real, analog world in some way, but most of our microprocessors, computers, and logic units are purely digital components. These two types of signals are like different electronic languages; some electronics components are bi-lingual, others can only understand and speak one of the two.

In this tutorial, we'll cover the basics of both digital and analog signals, including examples of each. We'll also talk about analog and digital circuits, and components.

Adapted from https://learn.sparkfun.com/tutorials/analog-vs-digital

Analog Signals

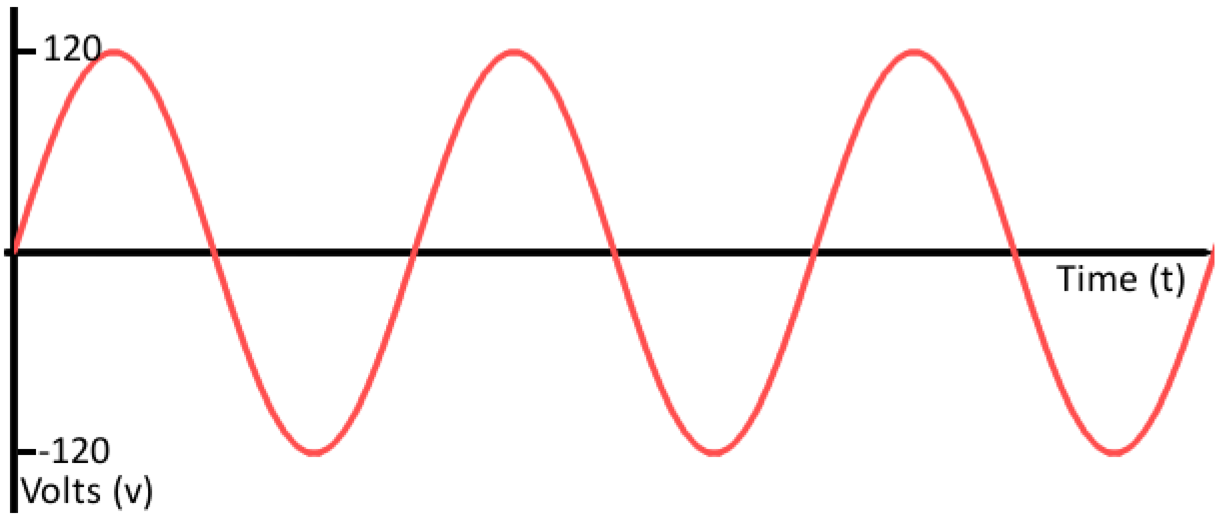
Define: Signals

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).

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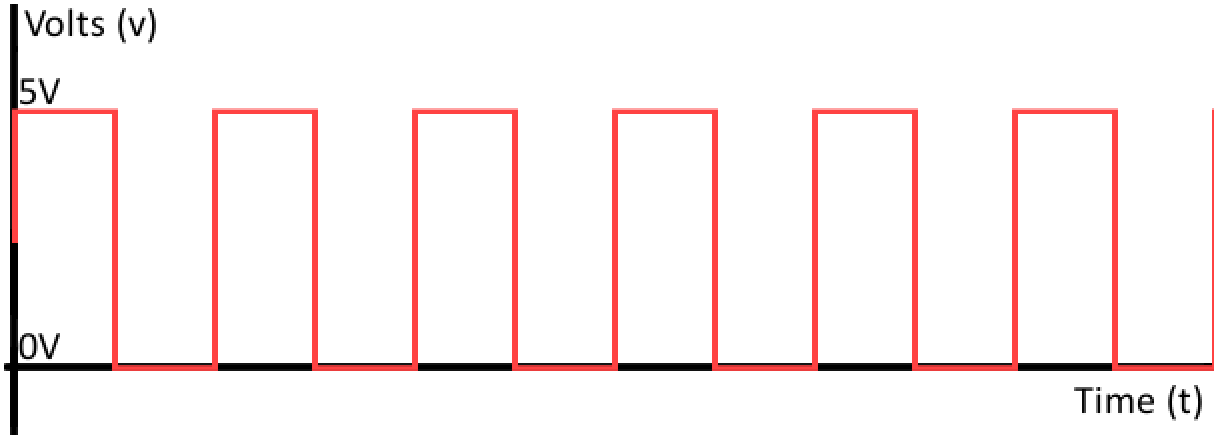
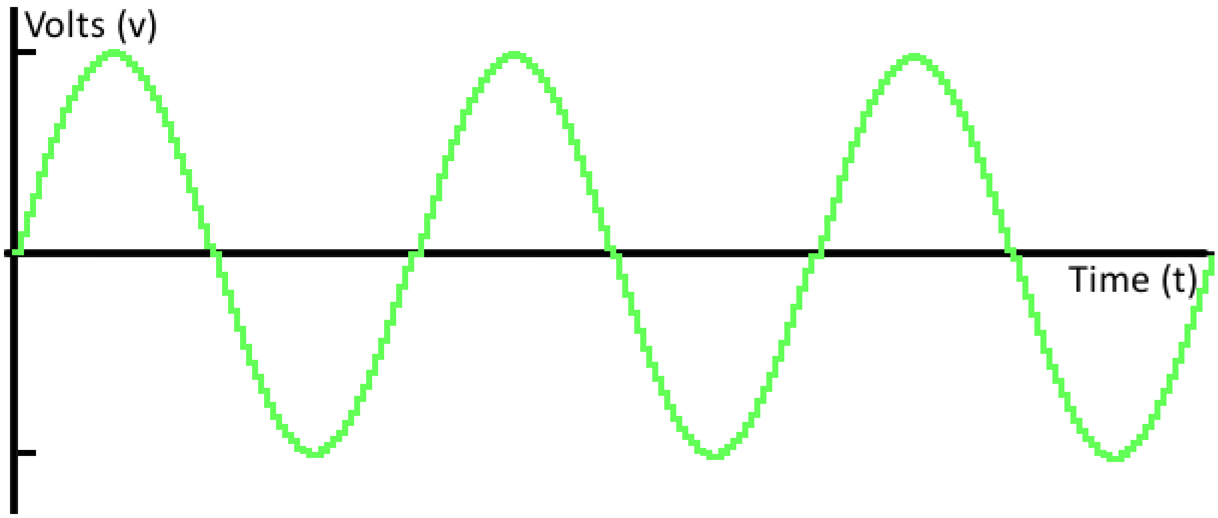
Digital Signals

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.

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