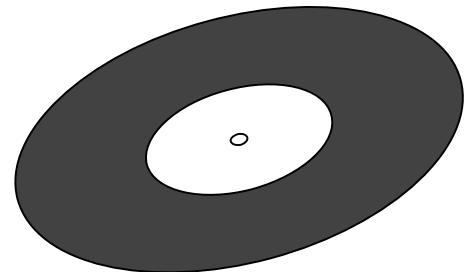


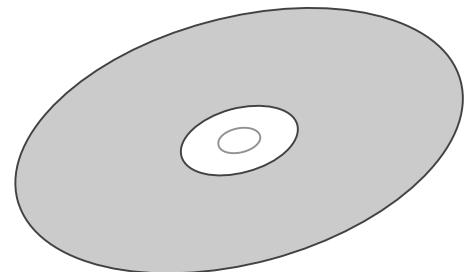
## Analog vs. Digital

An "Analog" transmission or recording medium is one in which the sound information is carried as an exact **copy**. In the case of an LP Phonograph record, for example, the sound that enters the recording microphone is used to form a groove in the record surface that wiggles back and forth exactly as the microphone diaphragm does. The groove traces out an exact **copy** of the sound waves. On playback, the stylus tracks the groove, wiggling along, moving exactly as the microphone did. This motion is amplified and used to move a loudspeaker.

All along the chain from the microphone to the speaker, the sound was represented exactly as the original wave. Any noise added by each amplifier stage becomes part of the recording. If the record gets scratched, then every time the stylus crosses the scratch a "pop" or "click" will be heard. The scratch is now part of the "copy" and the playback equipment has no alternative but to reproduce exactly what is on the record.



In a "Digital" transmission or recording, the original sound is "sampled" and carried as a **numerical description**. For example, in recording a Compact Disc, the sound is converted to an electrical signal and sampled at 44,000 times a second. At each of these instants, the instantaneous voltage of the signal is measured, and represented numerically. These numbers are converted into Binary (base-2), a numerical scheme in which all values are represented with 'ones' and 'zeros'. When the CD is made, microscopic pits are made in the bottom of the disc. A pit is used to represent a 'zero' and the absence of a pit means 'one'. The plastic surface is then coated with aluminum to make it reflective, and clear plastic is formed over the bottom to protect the microscopic pits, which are now inside the disc. When the disc is played, a tiny laser shines up at the bottom of the spinning disc, and reflects back down to a sensor. Where the beam hits a pit, the sensor sees a dark spot, and where there is no pit, a bright spot. As the reflected light flickers on and off, the player sees a stream of ones and zeros, which it puts back together into the sampled signal. From this, the player can reconstruct the original sound, or at least a good facsimile. Once the original conversion from an analog sound signal to a digital numerical stream has taken place, no additional noise will be added at any intermediate step along the way.



If the CD gets a scratch, the microprocessor in the player can decide to ignore it, based on error correcting data imbedded in the number stream. Data compression and error correction are two big advantages of digital techniques.

Digital techniques allow us to send voice or text data over a radio channel. Packet radio, Pactor, RTTY are all digital data transmissions. IRLP, Echolink and D-STAR are all digital forms of voice transmissions. FM and SSB voice are analog transmissions. These work over the air similarly to the above recording systems.

Because a digital signal is a **description** of the original signal, instead of a **copy**, it arrives perfectly (or not at all). The noise and distortion that can be a problem with analog signals doesn't affect digital transmissions.