DISTORTIONS

OVERDRIVE
FUZZ
BIT CRUSHING AND RESAMPLER
WAVESHAPING

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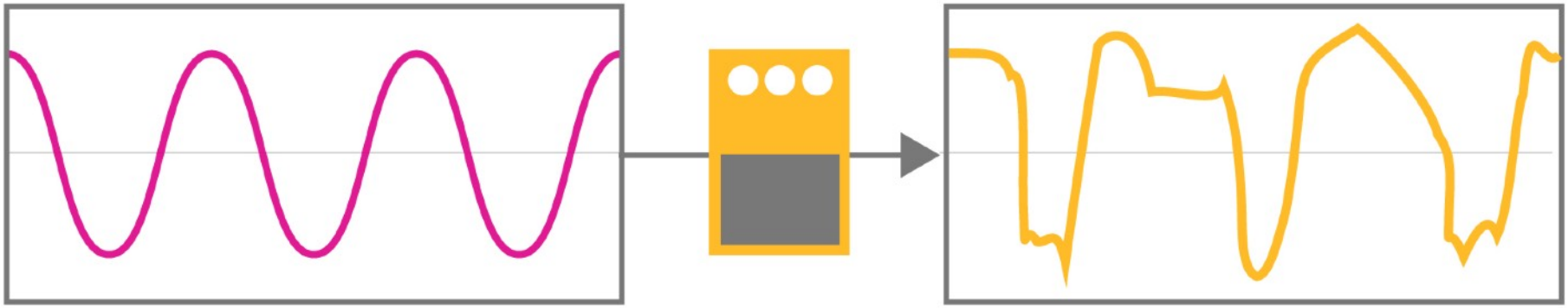
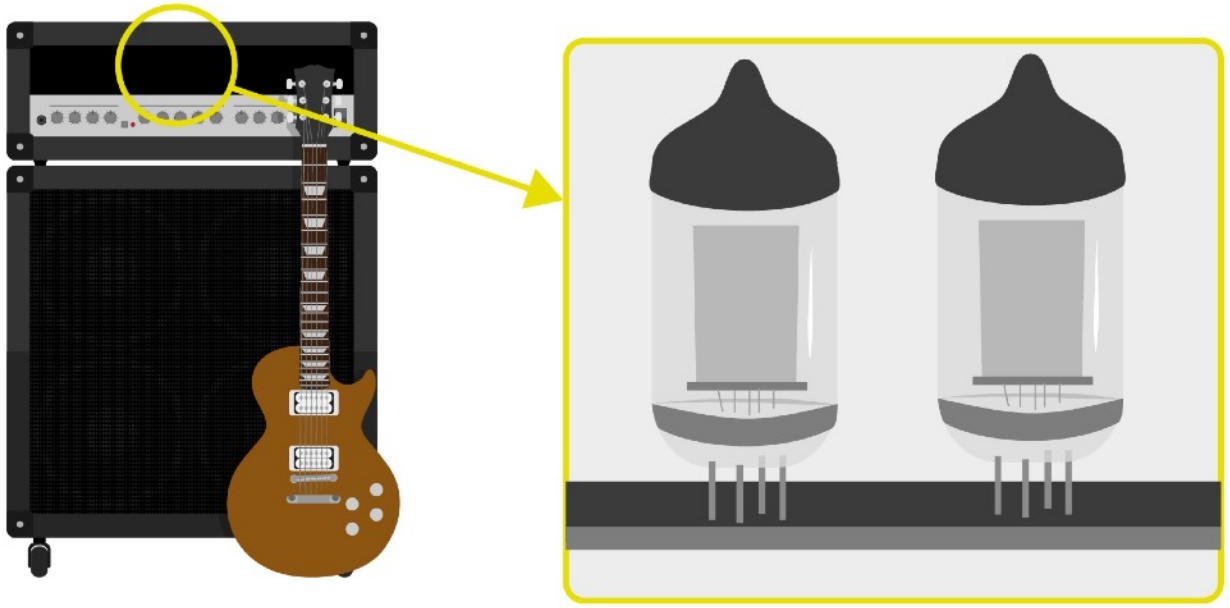
SOUND ART

Distortion is a **waveform warping** due to switching from analog circuits or special digital-type treatments. Compared to other types of treatment, it returns a “dirtier” and muddier sound but, at the same time, more complex and scratchy.

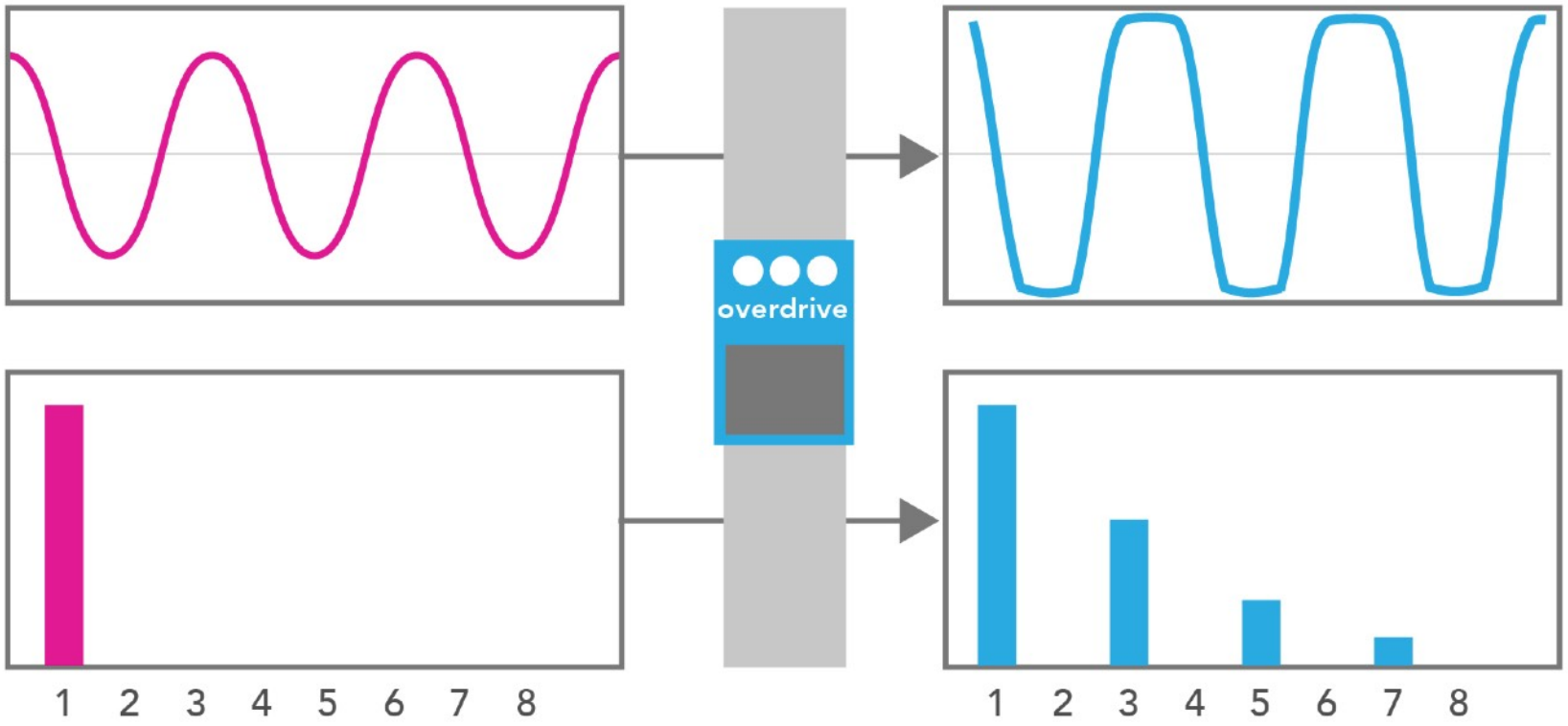


OVERDRIVE

In valve-based amplification systems, by turning up the amplification a lot, the circuit "colours" the sound by creating a type of distortion called **overdrive**. Under 'stress, the valve returns a more distorted waveform than the one it has at its input, and this effect can occur either in the pre-amplifier part, i.e., at the beginning of the circuit, or in the power amplifier circuits.



By sending a sine wave into an overdrive circuit, we notice that as output, we obtain a waveform that is flattened at the peaks (resembling a square wave) and thus returns a sharper sound because it is richer in high harmonics which we commonly call distorted. The spectrum of the new sound has many new harmonics positioned precisely where we find them in a classical square wave.

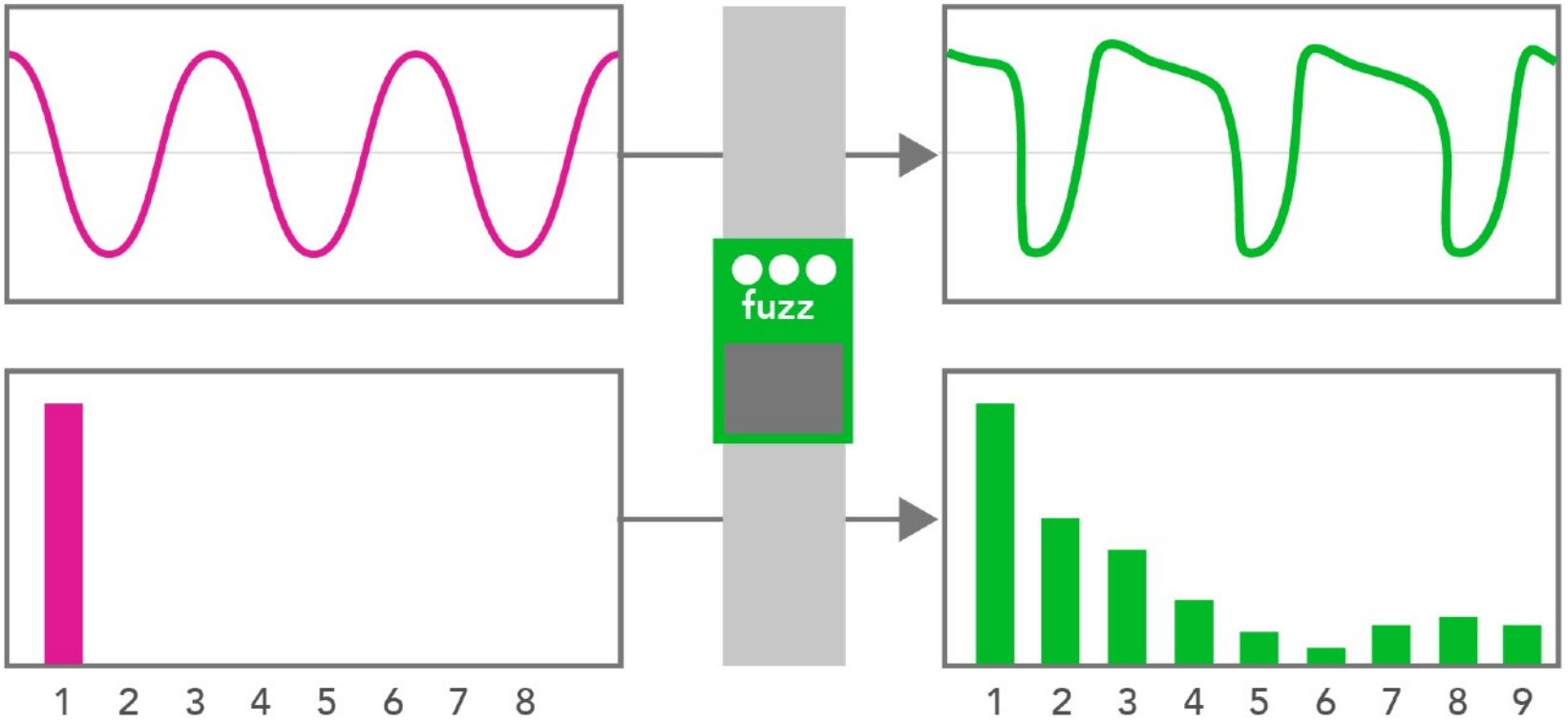


FUZZ

The Fuzz also derives from an accidental mistake in 1960 in a Nashville recording studio where Marty Robbins recorded the song 'Don't Worry.' During the recording session, the transformer of the guitar amplifier broke, and the amplifier started to produce a distorted sound that was immediately noticed. The artist and the sound engineer liked it so much that they decided to leave it. So, the piece came out and was a great success.

The engineer, *Glenn Snoddy*, did some reverse engineering, building a circuit that recreated it. Thus 1962, the first fuzz pedal effect in history was born: the Maestro Fuzz Tone.

Compared to overdrive, the waveform distortion is more 'important': not only are the peaks squashed, but asymmetrical treatment is achieved as the peaks shift, generating small ramps. This, at the frequency level, means the addition of even harmonics; as seen from the spectrogram, these harmonics are many. This explains why the fuzz sounds so invasive, scratchy, and sour.



BIT CRUSHING and RESAMPLER

There are, however, distortions that are possible due to digital sound processing.

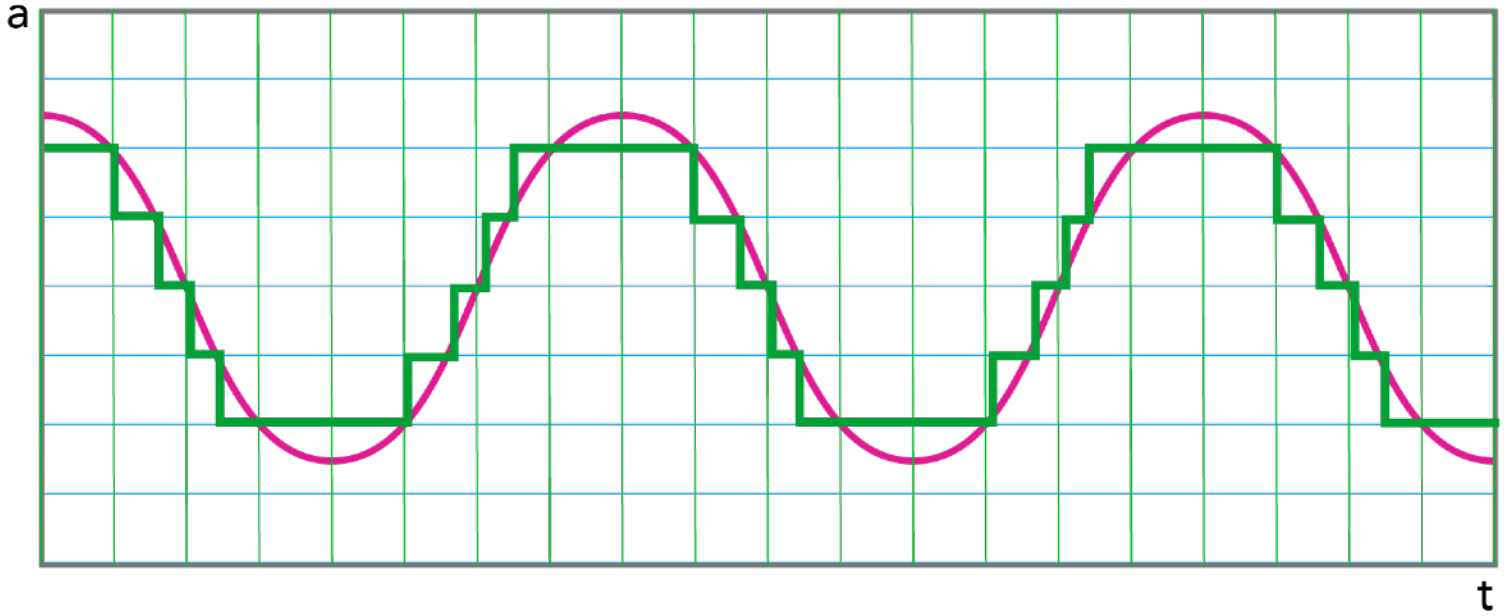
To understand them, it is helpful to understand the process of digital sound sampling. As we go from analog to digital, we pass from a continuous signal (without steps) to a discrete one (with steps), when we digitize an analog sound, the ADC (analog-digital converter) inevitably creates an approximation of the input wave sampling the value of the wave itself, a certain number of times per second.

BIT CRUSHING and RESAMPLER

It is all about how many times per second I take a new sample (sample rate) and how many values each sample can have (bit depth). These two parameters are what these effects play upon to create distortions.

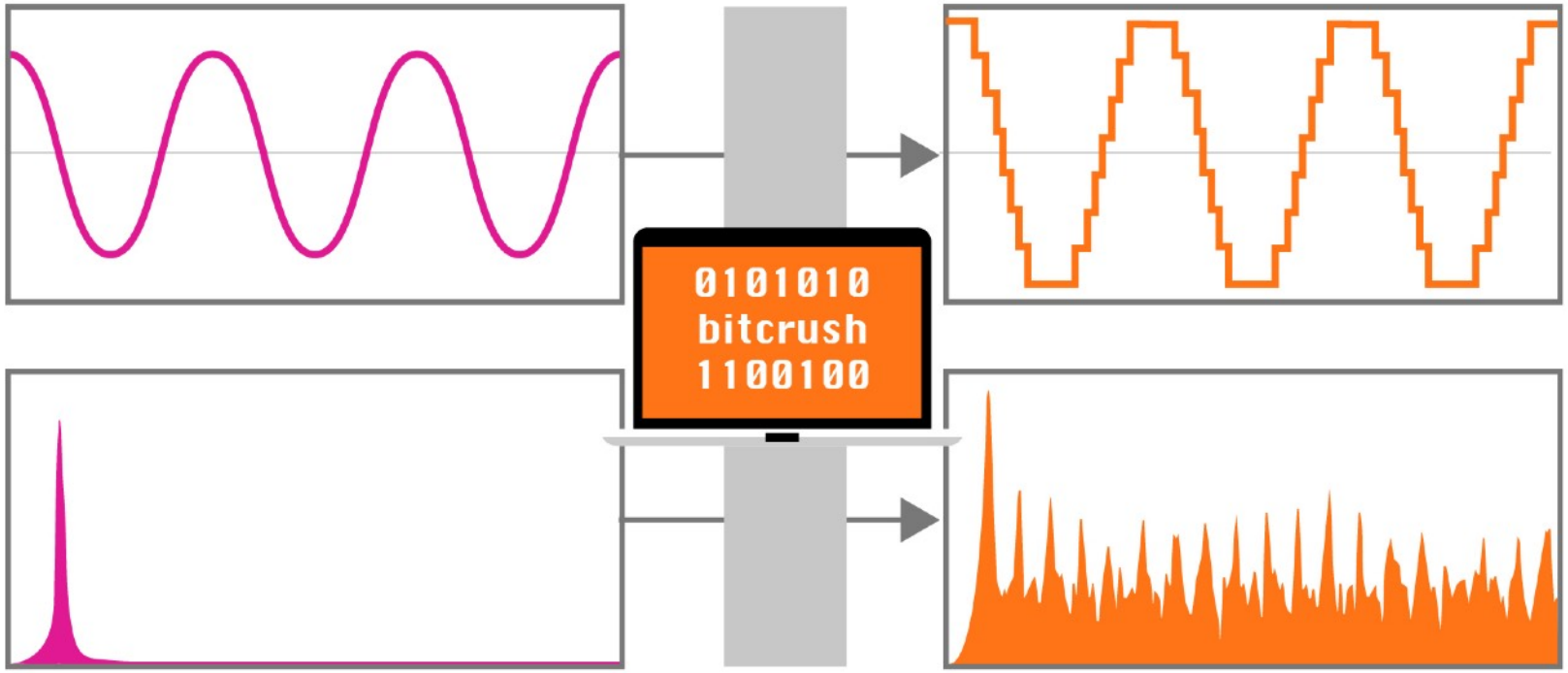
The standard values of the sampling parameters needed to get a waveform true to the original are at least 44100 samples per second with at least 16 bits of resolution (bit depth). If I reduce one or both of these parameters, I gradually get more and more distortion of my input sound.

3 bit = 2^3 = 8 possible amplitude values



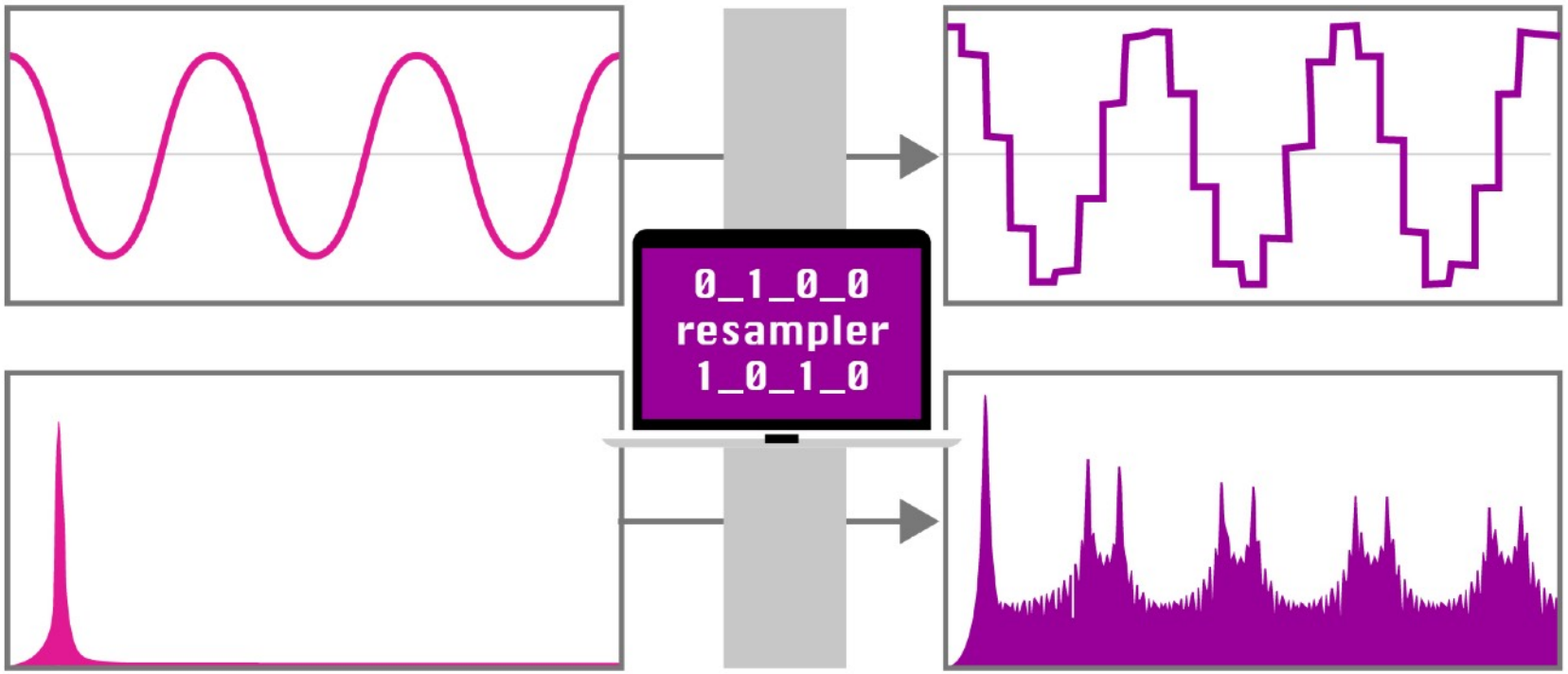
BIT CRUSHING

Bit crushing is the decrease in the number of steps sampling has available to describe the wave. This leads to sound waves that are more angular and, therefore, rich in high frequencies, which generate a sharp, acidic sound that goes all the way to a digital square wave when there are only 2 steps.



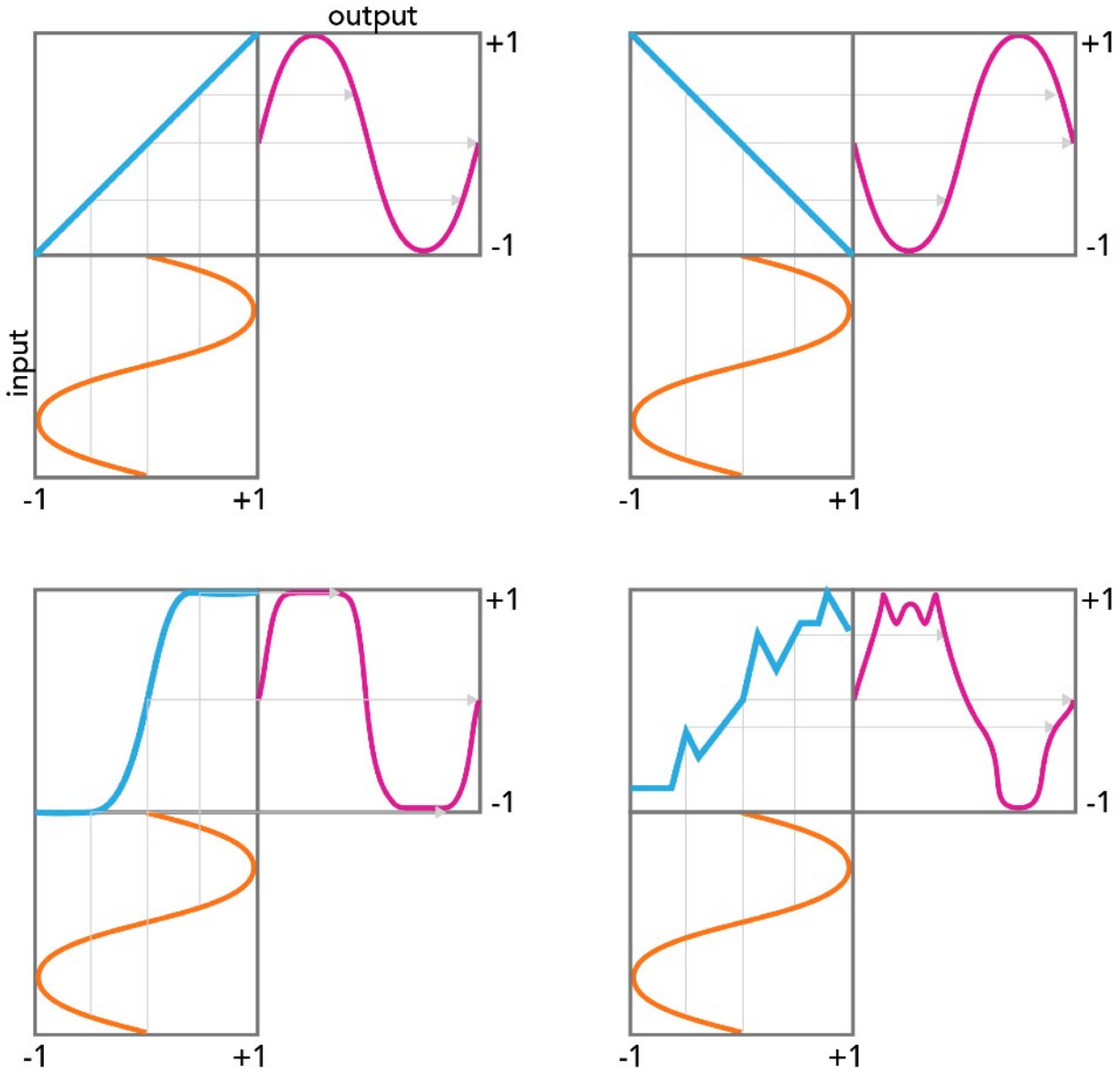
RESAMPLING

In **resampling**, we reduce the sample rate. This has an effect of waveform degradation due to aliasing. This side effect of sampling creates copies of the sound itself above the chosen sample rate and multiple of it. If the sampling frequency is high, I don't have this problem because the copies are so high in frequency that they are inaudible. Still, when sampling frequency is low, these copies enter the audible range and disrupt the original waveform. Unlike bit crushing, where harmonics appear at regular intervals, in the resampler, I do not have this regularity, and the effect is to have a kind of 'random' harmonization of the input sound.



WAVESHAPING

Waveshaping is primarily considered a sound synthesis technique, but if we put our sound to distort in place of a sine wave, we can exploit it as an efficient distortion tool. This algorithm is based on passing an audio signal through a 'transfer function' that distorts its shape.



Resources

VIDEO: A Brief History of Electric Guitar Distortion - Polyphonic LINK

WEB: IT Breve storia della chitarra distorta - Noisey by Vice - LINK

WEB: IT Come funzionano gli effetti: la distorsione - SM Strumenti Musicali - LINK

BOOK: Curtis Roads - The Computer Music Tutorial - ed. Mit Press, 1995

BOOK: IT Leonello Tarabella – Musica Informatica – ed. Maggioli, 2014

www.tommasorosati.it