SOUND DESIGN WORKSHOP
SFX Machine Pro

The glitchless pitch shifter presets work by changing the delay time of a delay processor over the period of a low-frequency sawtooth waveform. The sawtooth frequency (F) is usually in the range of -5 to 5 Hz, with negative frequencies indicating a ramp-down sawtooth and positive frequencies indicating a ramp-up. The delay time (D) is typically between a few milliseconds and one second, and is indicated in milliseconds. The modulation amount (A) is given as a percent and is generally in the -200 percent to 200 percent range. Here a setting of 100 percent causes the delay time to range from 0 to 2D and negative values reverse the direction.

For example, if F = 1 Hz, D = 100 ms, and A = 100, then over the course of the sawtooth's ramp-up phase the delay time will go from 0 to 200 ms. That stretches time over the period of the ramp up, thereby stretching the incoming audio and causing a downward pitch shift. With F = -1, the sawtooth is a ramp-down and the delay time will go from 200 to 0 ms, compressing time and causing an upward pitch shift. The same applies if A = -100, whereas if both A and F are negative, time is again stretched.

The amount of pitch shift depends on how much and how fast the delay time changes. How fast is determined by F. How much is determined by both D and A. For musical purposes, the important measure is the ratio (R) of the before and after pitches. Here are some typical ratios.

Musical Interval	**Pitch Ratio**	**F=-2, A=100, D=?**
Octave	2	250
Perfect Fifth	3/2 (1.500)	125
Perfect Fourth	4/3 (1.333)	83.333
Harmonic Major Third	5/4 (1.250)	62.500
Harmonic Minor Third	32/27 (1.185)	46.25
Harmonic Major Second	9/8 (1.125)	31.250
Equal Tempered Semitone	$2^{1/12}$ (1.059)	14.866
Equal Tempered Fifth	$2^{7/12}$ (1.498)	124.577
Equal Tempered Fourth	$2^{5/12}$ (1.335)	83.710
Equal Tempered Major Third	$2^{4/12}$ (1.260)	64.980
Equal Tempered Minor Third	$2^{3/12}$ (1.189)	47.25
Equal Tempered Major Second	$2^{2/12}$ (1.122)	30.616

The equation for calculating R from F, D, and A using their indicated units is:

$$R = 1 - F \times D/1000 \times 2A/100$$

That is equivalent to the slightly simpler equation from the article:

$$R = 1 + (F \times D \times A)/-50{,}000$$

Often you'll want to calculate one of the parameters F, D, or A from R and the other two. Here are the equations to do that:

$$F = (1-R) / ((D/1000) \times (2A/100)) = 50{,}000 \times (1-R) / (D \times A)$$

$$D = 1{,}000 \times (1-R) / (F \times (2A/100)) = 50{,}000 \times (1-R) / (F \times A)$$

$$A = 50 \times (1-R) / ((D/1000) \times F) = 50{,}000 \times (1-R) / (D \times F)$$