Beverley

Bitcrusher · CLAP and VST3 plugin · free and open source



Beverley is a bitcrusher for guitars, drums, synths and anything else that could do with some dirt. Like an old sampler or a cheap converter, it cuts the sound into coarse steps. Unlike them, it lets you choose how many steps there are, where they fall and how sharp their edges are, so it goes from a faint grain to a square-wave fuzz.

Start with the Quick start on the next page. The chapters after it take each control in turn, with graphs that show what it does.

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Quick start

Put Beverley on a track and play. At its defaults you hear a 4-bit crush: gritty, buzzy, and clearly lo-fi, at about the same loudness as the dry sound. Then try three knobs:

- **BIT DEPTH** is the amount. Turn it down for more crunch (1 bit is a square-wave fuzz), up for less (8 bits and above is a faint grain).
- **SMOOTHING** takes the harsh, fizzy edge off without losing the crunch. Try 20 to 50%.
- **MIX** blends the crushed sound with the original. Around 50% keeps the punch of the dry sound under the grit.

If quiet parts sound different from loud ones (cleaner, or cutting out), press **AUTO**: Beverley then adjusts itself to the level, so quiet and loud passages are crushed alike.



Figure 1. The controls, at their defaults.

1 **GAIN**	How hard the sound is driven into the crush.	2 **AUTO**	Sets the drive for you, following the level.
3 **DETECT**	How AUTO listens: PEAK or RANGE.	4 **DECAY**	How quickly AUTO lets go after a loud moment.
5 **GAMMA**	Whether quiet or loud parts break up first.	6 **BIT DEPTH**	How coarse the steps are: the amount.
7 **SMOOTHING**	How sharp the steps' edges are.	8 **CRUSH**	Buzzing (ASYM) or gating (SYM) character.
9 **STEREO**	How left and right are treated.	10 **MIX**	Dry to crushed.

Reading the graphs

Each control's graphs put its settings side by side, and show each one with three test signals, one per row. The original is the grey dashed line, the result is in blue.

- **Ramp**: a straight line from the bottom to the top of the range. What comes out is Beverley's staircase: how each level going in is turned into a step.
- **Sine**: a pure tone, as one smooth wave.
- **Complex**: a richer wave that fades from loud to quiet, closer to an instrument. It shows what a setting does as a sound dies away.

The crush

BIT DEPTH sets how coarse the steps are, **CRUSH** where they sit, **SMOOTHING** how sharp their edges are, and **GAMMA** whether quiet or loud parts of the sound break up first.

Bit depth

BIT DEPTH is the main control: the lower it is, the fewer the steps and the rougher the sound. At 1 bit every wave becomes a square, at 4 bits (the default) the sound is clearly crushed, and from about 8 bits it is a fine grain; at 16 bits you will hear almost nothing. The knob's scale reads 1, 2, 4, 8 and 16 bits, so most of its travel is in the rough, low settings.

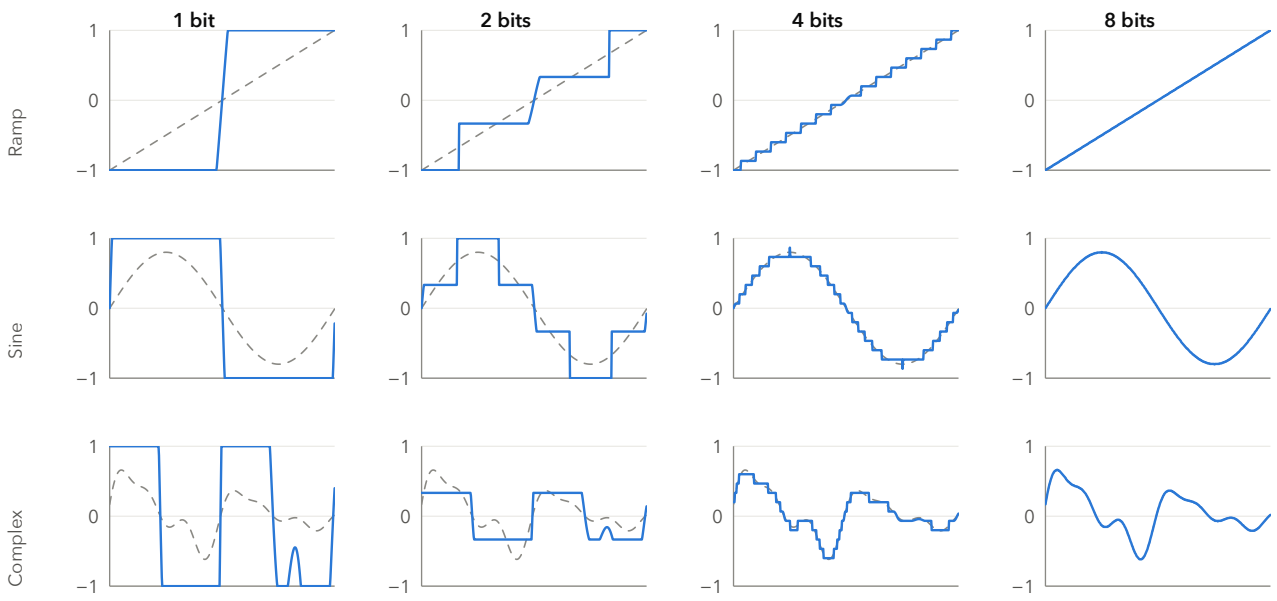


Figure 2. Fewer bits, fewer and bigger steps. At 1 bit every wave is a square; at 8 the steps are too small to see here. **CRUSH** on ASYM, which eases off the steps close to zero (see Crush mode): the bumps in the complex wave's quiet end.

The knob moves smoothly, not in jumps from one whole number of bits to the next: 2.5 bits sits halfway between 2 and 3. Sweeping it, by hand or with automation, morphs gradually from one roughness to another.

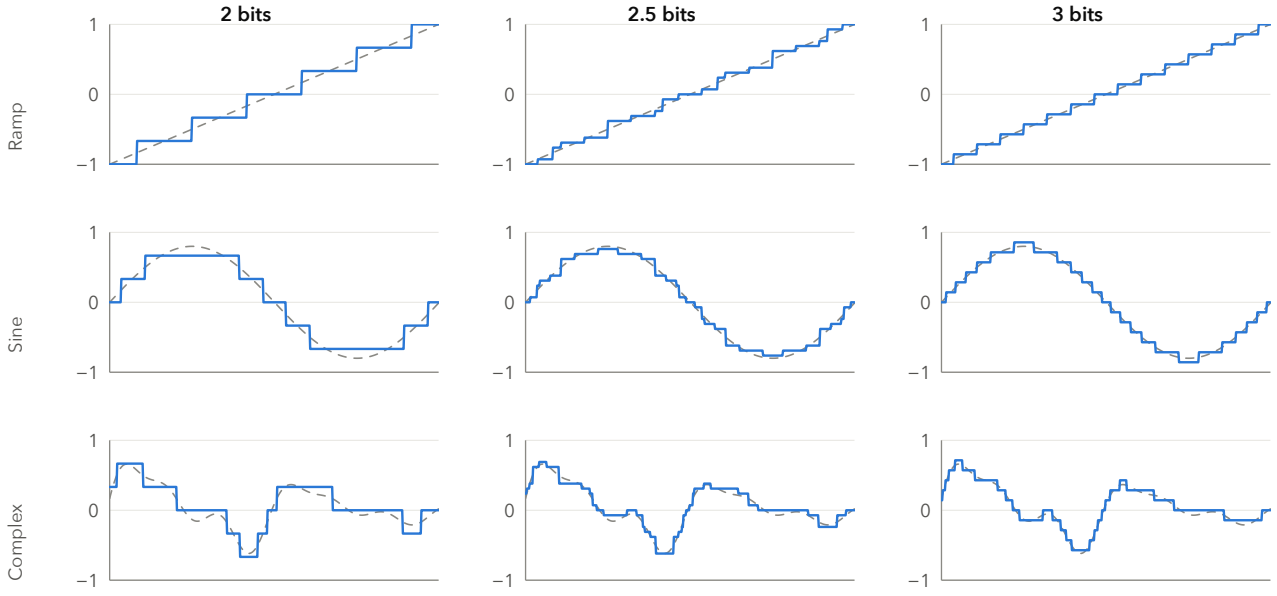


Figure 3. Between whole numbers of bits the steps change gradually. **CRUSH** on SYM.

Crush mode

CRUSH changes the character of the crush, most of all on quiet sounds.

- **ASYM** (switch down, the default) has no step at silence, so the sound never quite goes quiet: as a note fades it keeps buzzing on the steps either side of zero, like an old sampler. In the last stretch before silence (below about a twentieth of full level, or −26 dB) it eases off the steps and lets the sound through as it is, so a dying note slides smoothly to nothing instead of ending on a buzz. On the graphs this shows as a bump: where the complex wave swings close to zero, the blue line leaves its step and dips towards the original.
- **SYM** (switch up) has a step at silence, so quiet sounds drop out altogether, which works like a rough gate. It also has twice as many steps across the wave, so at the same **BIT DEPTH** it sounds a little finer.

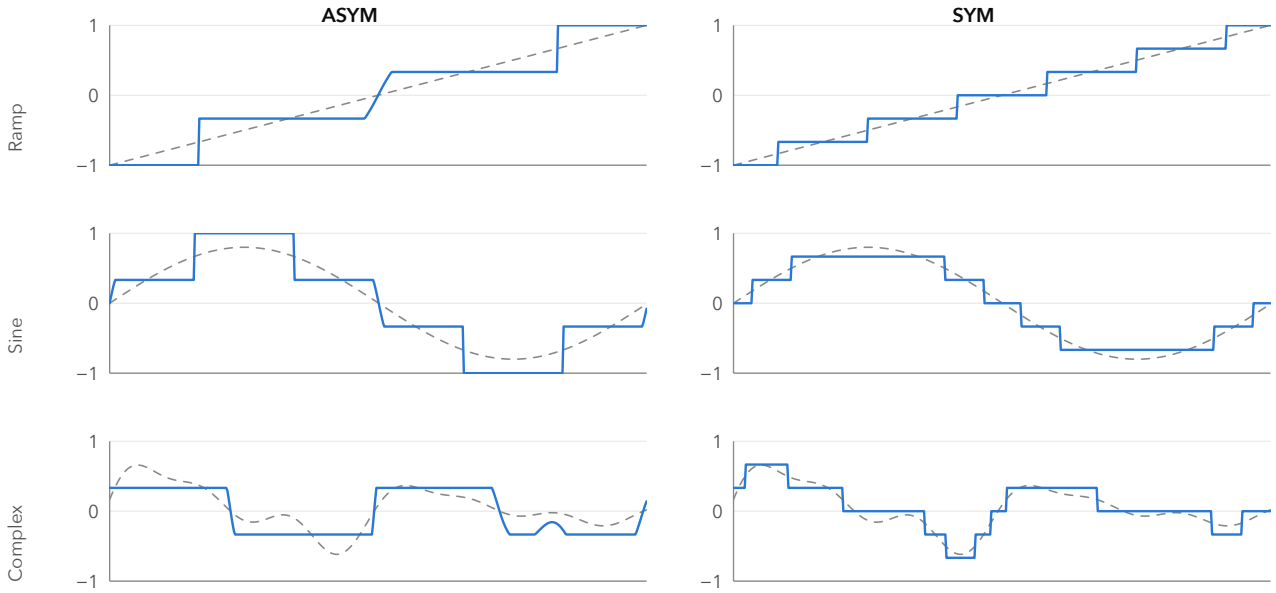


Figure 4. At 2 bits. ASYM keeps buzzing on the steps either side of zero as the complex wave fades, crossing between them on a short slope; where the wave comes close to zero it leaves the step and dips towards the original. SYM has a step at zero, where quiet sound becomes silence.

Smoothing

SMOOTHING rounds off the edges of the steps. At 0% they are sharp, which gives the brightest, fizziest crush. Around 20 to 50% the edges become curves and the sound turns warmer and less harsh while keeping its crunch. At 100% the steps disappear and the sound passes unchanged. Most of the knob's character is in its first half: its centre reads 20%.

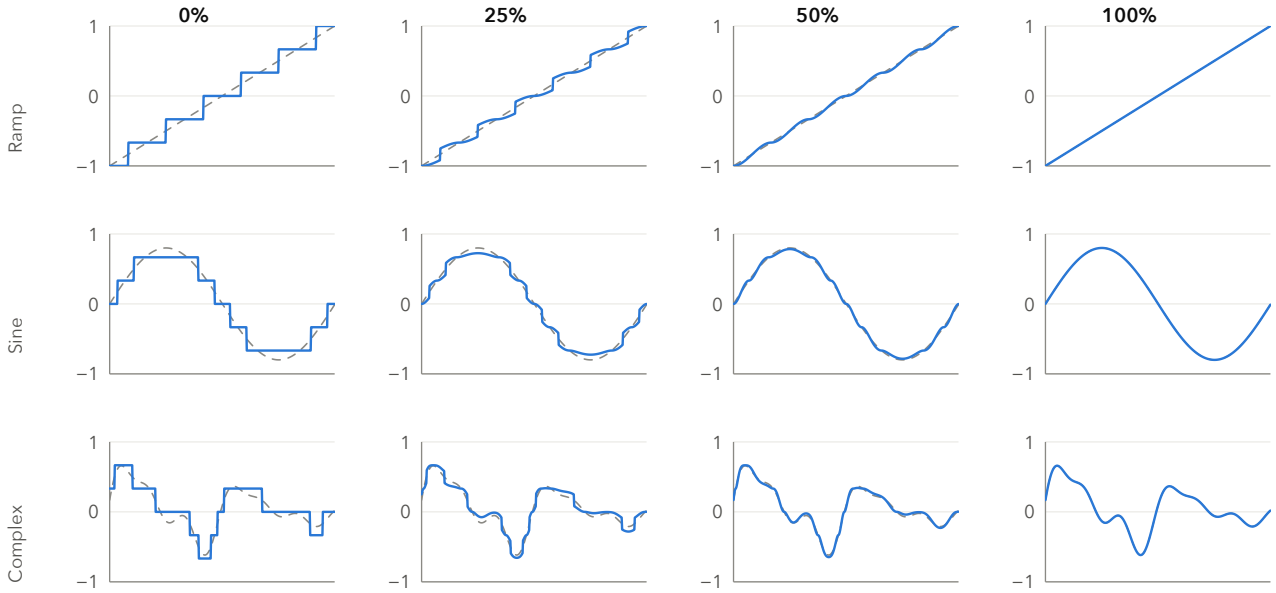


Figure 5. From sharp steps (0%) to none (100%), at 2 bits, **CRUSH** on SYM.

Smoothing turns down the overtones the crush adds, all of them together, so the sound keeps its character but loses its edge. At 50% the lowest overtones are about 14 dB quieter, the higher ones about 10 dB; at 100% none are left.

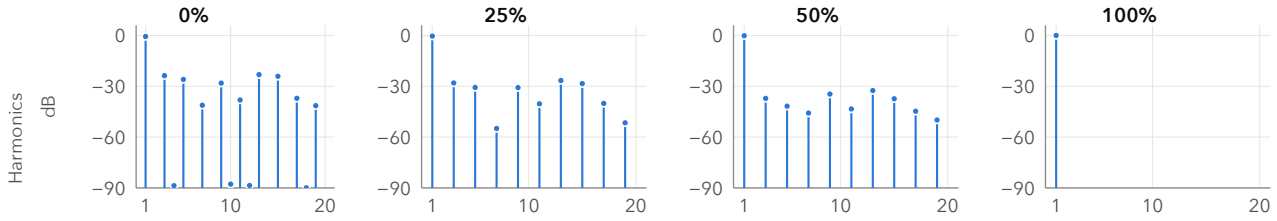


Figure 6. The overtones of a pure tone at the settings above (2 bits, **CRUSH** on SYM). The first bar is the tone itself, the rest its overtones, all against the tone going in. A symmetric crush adds only odd overtones (3rd, 5th, 7th…).

Sharp steps also make a high, out-of-tune whine on top of the note, called aliasing (see Fizz and whine, below). Smoothing is the cure.

Gamma

GAMMA chooses which parts of the sound break up first. At 1 (the knob's centre) the steps are evenly spaced.

- Turned down (towards 0.1), the steps are coarse where the sound is quiet and fine where it is loud. Fades, tails and soft notes grit up or drop away, while loud peaks stay comparatively clean.
- Turned up (towards 10), the steps are fine where the sound is quiet and coarse where it is loud. Attacks and peaks break up, while quieter material keeps its detail.

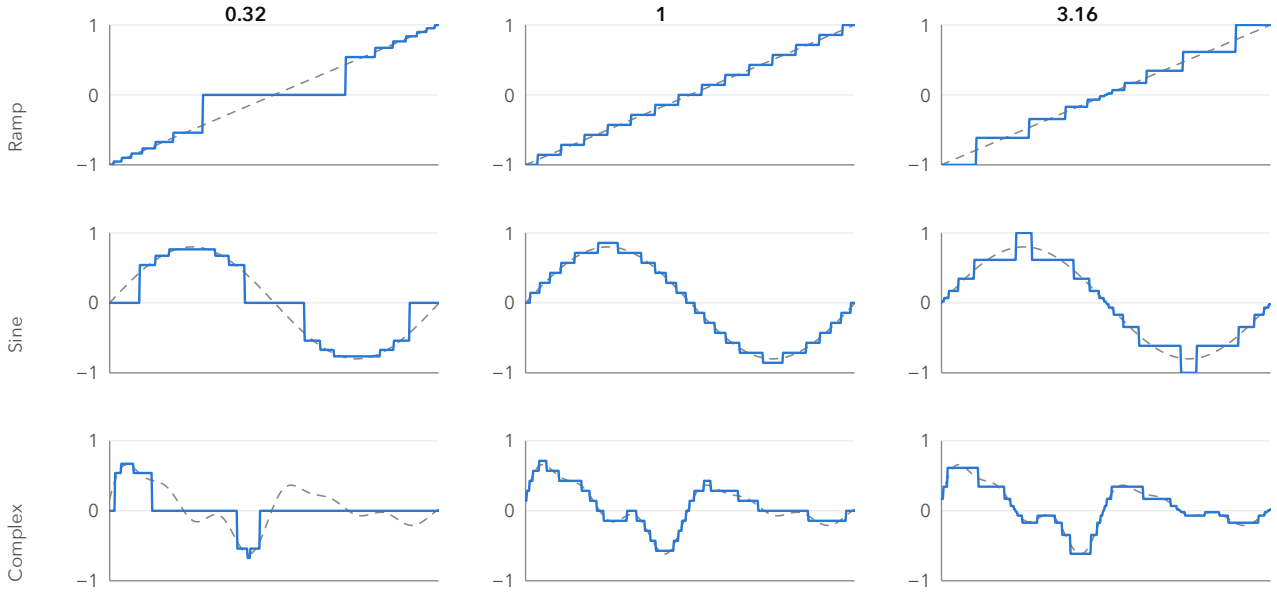


Figure 7. GAMMA at 3 bits, **CRUSH** on SYM: the same number of steps, placed differently. At 0.32 the steps are coarse near silence, so the fading tail drops away; at 3.16 they are fine near silence and coarse near full level.

GAMMA also changes which overtones you hear, and how much depends on how loud the sound is. On a loud note, turning it down brings up the low overtones (the 3rd and 5th), a thick, fuzzy grit; turning it up brings up higher ones (the 7th and 9th), a thinner, buzzier edge. At 1 a loud note is crushed least. On a quiet note the picture changes: at 1 it is crushed hard, close to a square wave; turned down it drops to silence; turned up it comes through much cleaner.

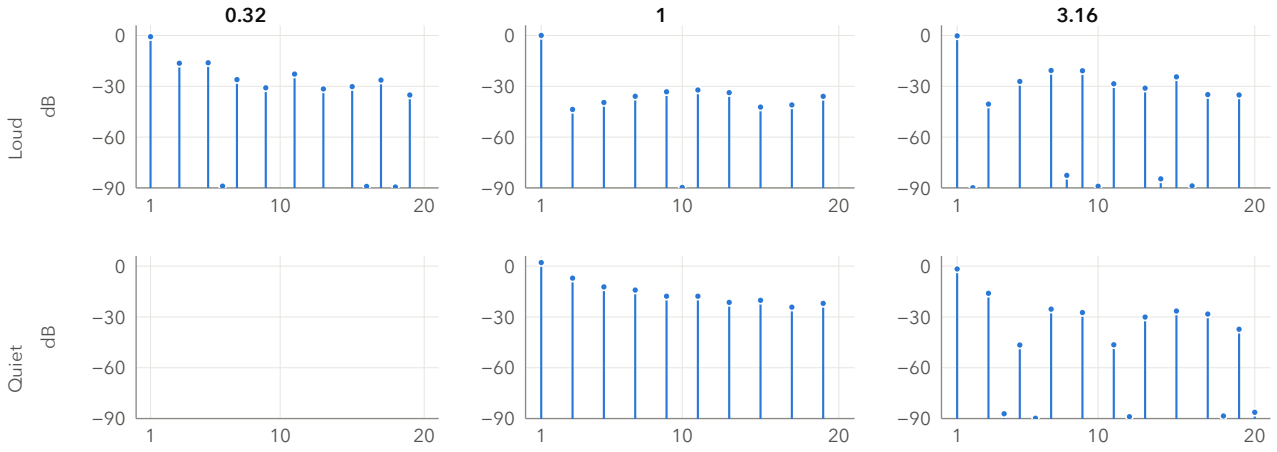


Figure 8. The overtones of a pure tone at the settings above (3 bits, **CRUSH** on SYM), loud (top) and 18 dB quieter (bottom). The first bar is the tone itself, all against the tone going in. At 0.32 the quiet tone is silenced, so there is nothing to show.

What it adds to the sound

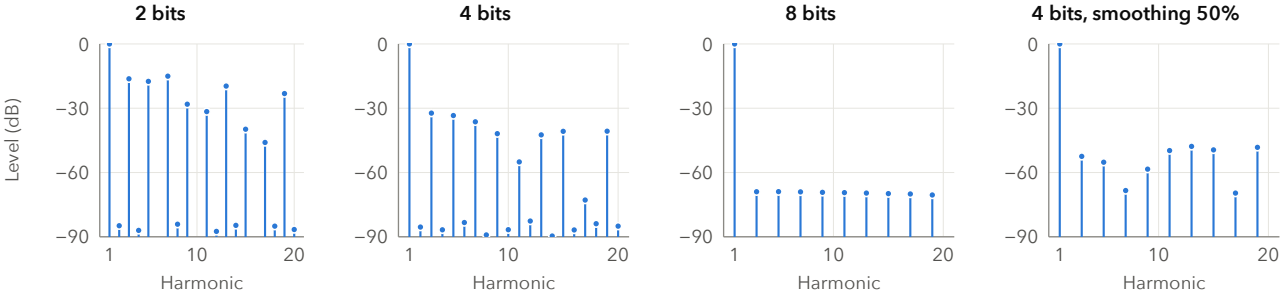


Figure 9. The overtones crushing adds to a pure tone (the first bar is the tone itself). Fewer bits add louder overtones, which is the grit; smoothing at 50% turns most of them down, the lowest by about 20 dB.

Fizz and whine

Sharp steps add overtones far higher than a digital system can hold, and they come back down as a thin, metallic whine that isn't in tune with the note: this is aliasing. A little of it is part of a bitcrusher's sound. If it bothers you, turn up **SMOOTHING**; turning up **BIT DEPTH** helps too. The table shows how loud the whine is compared with the note (lower is quieter; every 20 dB is ten times quieter). Your project's sample rate makes little difference.

BIT DEPTH	SMOOTHING	44.1 kHz	48 kHz
2 bits	0%	−20 dB	−20 dB
2 bits	25%	−25 dB	−25 dB
2 bits	50%	−54 dB	−54 dB
2 bits	100%	none	none
4 bits	0%	−25 dB	−25 dB
4 bits	25%	−30 dB	−30 dB
4 bits	50%	−38 dB	−38 dB
4 bits	100%	none	none
8 bits	0%	−48 dB	−48 dB
8 bits	25%	−53 dB	−53 dB
8 bits	50%	−61 dB	−61 dB
8 bits	100%	none	none

Table 1. The whine against the note, for a pure tone of about 1 kHz.

Gain

GAIN decides how hard the sound is crushed without making it louder. **AUTO** sets it for you from the sound's level, so quiet and loud passages are crushed alike.



1	**GAIN**	0 to 20 dB. Greyed out while **AUTO** is on.
2	**AUTO**	Lit while on.
3	**DETECT**	PEAK (down) or RANGE (up). Greyed out while **AUTO** is off.
4	**DECAY**	1 ms to 5 s. Greyed out while **AUTO** is off.

Gain

GAIN drives the sound harder into the crush and turns it back down afterwards, so a sound that doesn't clip comes out at about its own level. Use it when your sound is quiet: a quiet sound only touches the first few steps and comes out very coarse, or (with **CRUSH** on SYM) not at all. Turning **GAIN** up spreads it over more steps. At its maximum, 20 dB, a sound at a tenth of full level uses the whole range.

Anything pushed past full level is clipped flat, for a harder, fuzzier edge, and since the gain is taken off again afterwards, the clipped parts come out quieter than they went in: at 20 dB, a full-level peak comes out at a tenth of full level. With a loud source, keep **GAIN** low or use **AUTO**.

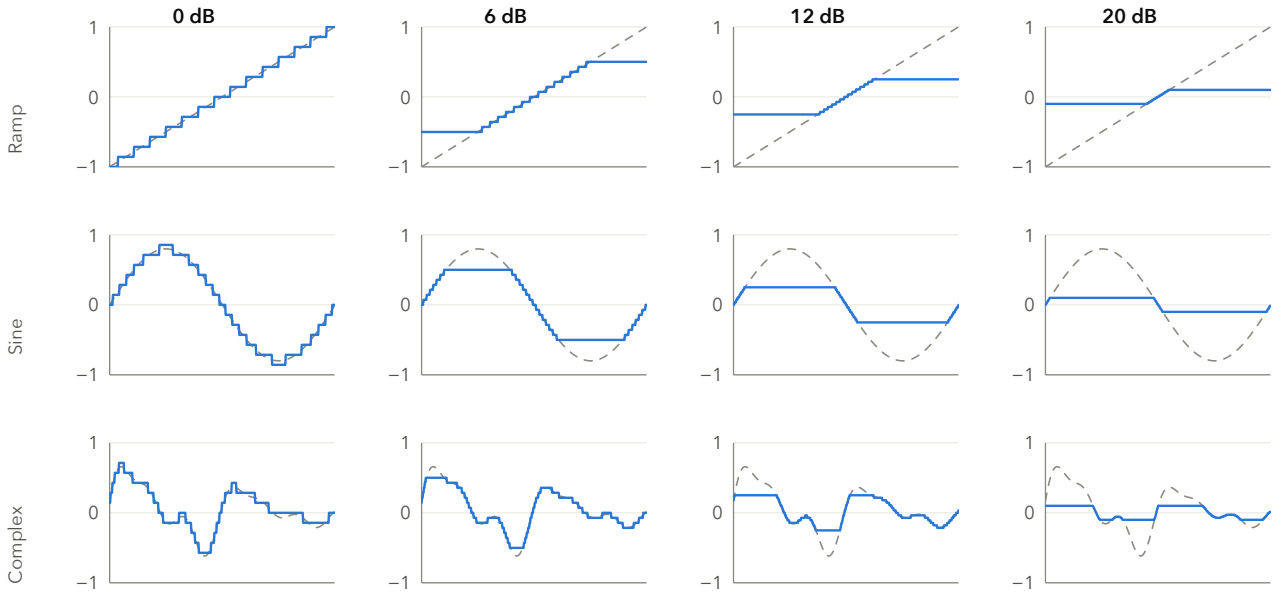


Figure 10. More **GAIN**: finer steps for quiet sound, and the loudest parts clipped flat and quieter. At 3 bits, **CRUSH** on SYM.

Auto gain

With **AUTO** on, Beverley follows the sound's level and adjusts the gain itself, so that every passage, loud or quiet, is crushed by the same amount. A fading note stays crushed to the end instead of thinning out. The output still follows the level of what goes in. Near silence the gain stops at a limit (46 dB) rather than rising without end, so faint hiss is crushed only so far.

DETECT chooses how it listens:

- **RANGE** (switch up, the default) follows the highest and lowest points of the wave. It reacts instantly to anything louder, so peaks never clip. It also copes with sound that isn't centred on zero (a DC offset), crushing it around its own centre.
- **PEAK** (switch down) follows the loudest points. It reacts within about half a millisecond, so the very start of a sharp attack can clip slightly, which can add bite.

DECAY sets how quickly auto gain lets go after something loud, from 1 ms to 5 s (default 115 ms). Short settings follow every swell and dip, keeping the crush even right through a fade. Long settings hold back after a loud moment, so the quiet that follows is crushed more gently for a while, a little like a compressor's release. Its centre reads about 70 ms.

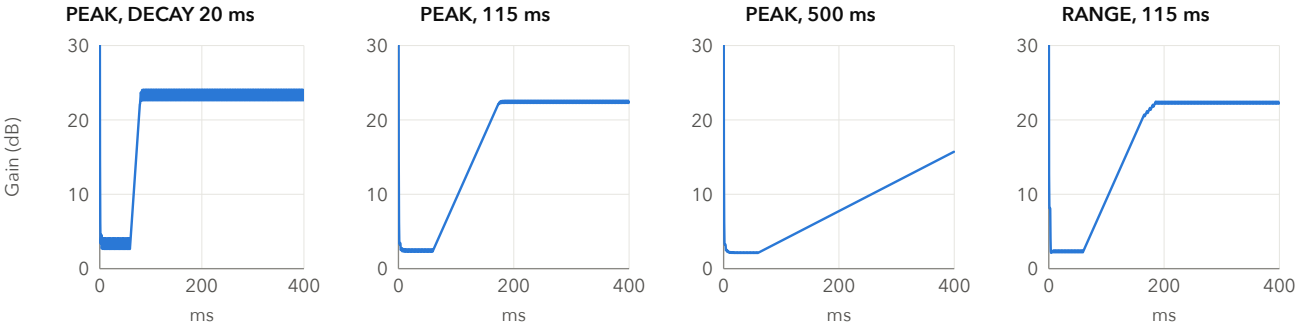


Figure 11. How auto gain responds when a loud passage (the first 60 ms) gives way to one 20 dB quieter. The longer **DECAY**, the more slowly the gain rises to suit the quiet part. At very short settings PEAK wobbles with the wave itself, which you hear as extra roughness.

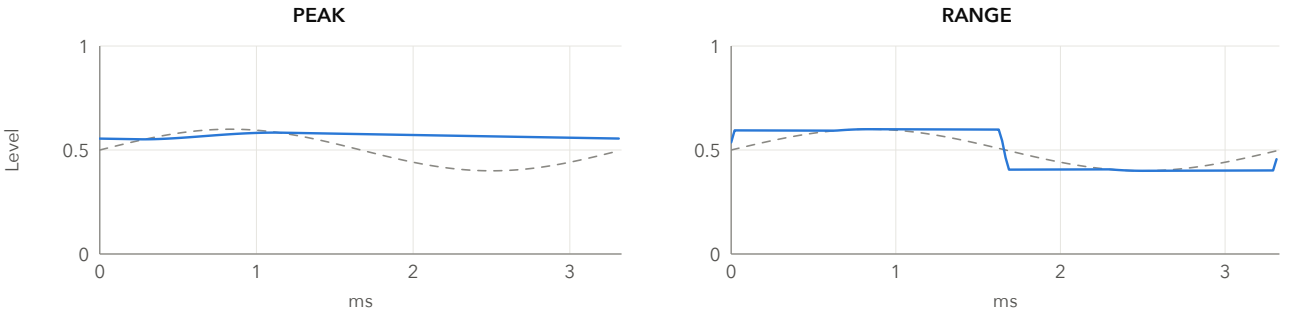


Figure 12. A wave that isn't centred on zero, at 1 bit with auto gain. PEAK squashes it almost flat; RANGE crushes it around its own centre and keeps it moving.

Stereo and mix



1. **CRUSH** ASYM (down) or SYM (up); see The crush.
2. **STEREO** MONO (down), SEP (middle) or LINK (up).
3. **MIX** DRY to WET.

STEREO matters mostly with **AUTO** on.

- **LINK** (switch up, the default) crushes left and right separately but with one auto gain for both, so the stereo picture stays put. Use it on most stereo material.
- **SEP** (middle) gives each side its own auto gain. A quiet side is pushed as hard as a loud one, which makes the crush even across the stereo field but can make the image move around.

- **MONO** (switch down) mixes left and right together and crushes the result once, sending the same sound to both sides. Use it for a deliberately narrow, old-school sound, or on a mono source.

With **AUTO** off, LINK and SEP sound the same.

MIX blends the crushed sound with the original, from DRY (0%) to WET (100%, the default). Blending in some of the original keeps the clarity and punch of the source under the grit, without any phasing.

The knobs respond smoothly as you turn or automate them, without clicks; the switches change at once. Beverley adds no delay, so it can be used while recording or playing live.

Starting points

Each of these changes only the controls it names; leave the rest at their defaults.

Lo-fi drums **BIT DEPTH** 6 bits, **CRUSH** SYM, **AUTO** on, **DETECT** PEAK, **DECAY** 20 ms, **MIX** 50%. Every hit is crushed by the same amount, tails grit up as they fade, and the dry signal keeps the punch.

Square fuzz **BIT DEPTH** 1 bit, **CRUSH** ASYM, **AUTO** on. Every note becomes a square wave at its own level, like a fuzz pedal that never runs out of gain.

Soft grain **BIT DEPTH** 8 bits, **SMOOTHING** 50%. A faint, warm graininess without the fizz.

Gated crunch **BIT DEPTH** 3 bits, **CRUSH** SYM. Loud notes crunch, and the gaps between them fall to silence.

Fragile tails **BIT DEPTH** 4 bits, **GAMMA** 0.3, **CRUSH** SYM. Sustains and reverb tails break up while attacks stay clean.

Spitting attacks **BIT DEPTH** 4 bits, **GAMMA** 3, **GAIN** 12 dB. The start of each note spits and clips while the body stays smoother.

Tips

Too harsh or fizzy turn up **SMOOTHING** (start at 25%), or raise **BIT DEPTH** a little.

Quiet parts drop out **CRUSH** is on SYM, which silences quiet sound. Switch to ASYM, turn up **GAIN**, or press **AUTO**.

Quiet parts sound cleaner than loud ones press **AUTO**, or turn up **GAIN**.

The level pumps with AUTO on lengthen **DECAY**.

The stereo image wanders set **STEREO** to LINK.

The effect is too much bring **MIX** down rather than **BIT DEPTH** up; you keep the character and get the clarity back.

Reference

Controls

Control	From	To	Default
Gain	0.0 dB	20.0 dB	0.0 dB
Auto Gain	Off	On	Off
Gamma	0.10	10.00	1.00
Bit Depth	1.0 bits	16.0 bits	4.0 bits
Smoothing	0 %	100 %	0 %
Crush Mode	Asymmetric	Symmetric	Asymmetric
Mix	0 %	100 %	100 %
Stereo	Mono	Linked	Linked
Decay	1 ms	5000 ms	115 ms
Detect	Peak	Range	Range

Table 2. Every control's range and default. Your host shows the controls under these names for automation.

Knob at	GAIN (dB)	GAMMA	BIT DEPTH	SMOOTHING (%)	DECAY (ms)	MIX (%)
0	0	0.1	1	0	1	0
¼	5	0.32	2	6.7	8	25
½	10	1	4	20	71	50
¾	15	3.16	8	46.7	595	75
1	20	10	16	100	5000	100

Table 3. What each knob reads at points along its travel.

The plugin

- Formats: CLAP and VST3, for macOS (Apple silicon and Intel), Windows and Linux. On a Mac it installs and opens without security warnings.
- Audio: stereo in and out. A mono track works too.
- Delay: none.
- Licence: free, under the MIT or Apache-2.0 licence. The source code is at https://github.com/Vulpus-Labs/vxn-free.
- VST is a registered trademark of Steinberg Media Technologies GmbH.