

CZ77

Phase distortion synthesis in the spirit of the mid-80s digital keyboards: glassy bells, plucked strings, evolving pads and cutting leads from a cosine bent into eight waves - and into bends you draw yourself, morphing from one to another.

A Lab plug-in. The Lab is where new GFX plug-ins are built in the open: they may change sound or controls between versions. This is the Lab version of the Stable CZ77: it sounds the same until you use the new DRAWN wave.



Overview

CZ77 is an eight-voice phase distortion synthesiser. Each voice has two **lines**. A line reads a cosine wave through a bent phase: unbent, it is a pure sine; the more the phase is bent, the brighter it gets, until it becomes a full saw, square, pulse or one of

three resonant waves. How far it is bent is the **DCW** (the brightness), and it moves over time like a filter sweep - but without a filter. Each line has three envelopes of eight steps: **DCO** (pitch), **DCW** (brightness) and **DCA** (level).

The Lab copy adds a ninth wave, **DRAWN**. You draw the bend yourself - two of them, **A** and **B** - and **MORPH** between them, by hand or on its own: sweeping from A to B as each note goes on, following the DCW envelope, the LFO, velocity, the mod wheel or the key. As with every phase distortion wave, the DCW opens a drawn bend from a pure sine up to the full shape you drew.

The two lines can play alone, together (one detuned against the other), or as one line doubled and detuned. Line 2 can be ring-modulated by line 1 (bells and metal) or have its pitch scrambled by noise (breath and wind). An optional filter, a vibrato LFO and a strip of effects - phaser, a three-line stereo chorus in the style of the original, drive, compressor and ping-pong delay - follow, then the GFX THICK circuit and the output stage, which soft-clips anything above -0.3 dBFS.

The oscillators run at twice the sample rate, so even the sharpest bends stay clean up the keyboard. CZ77 reports 16 samples of latency, which REAPER compensates. There are no samples: every sound is synthesised.

Playing it

1. Insert CZ77 on a track as an instrument (it has no audio input; it plays from MIDI).
2. Arm the track with a MIDI input and record monitoring on, or draw notes in a MIDI item. It listens on every MIDI channel and passes the MIDI on. The voice lamps in the top bar light as notes sound.
3. Up to eight notes sound at once (each with both lines). When they run out, CZ77 takes over the quietest note that is fading out (or else the oldest), fading it over 3 ms so it never clicks. With MONO lit it plays one note at a time, legato.
4. Pitch bend covers ± 2 semitones. The mod wheel (CC1) adds up to 30 cents of vibrato. The sustain pedal (CC64) holds notes, CC120 / CC123 release them all, and every note is released when REAPER's transport stops.

DRIFT

DRIFT is the instrument's digital and analogue life. At 50 % (the standard amount) each voice's MORPH wanders a little (± 4 %, with its pitch), so a drawn wave never sits quite still, the oscillators' phase jitters very slightly, each voice's pitch wanders slowly by up to ± 20 cents, every note starts up to ± 6 cents off true, the waves' digital resolution wanders (about 13-bit at 50 %, 12-bit at 100 %, for a slightly

grainier edge), and the output level drifts slowly by about ± 0.25 dB, like a circuit warming up. 0 is perfectly steady and clean.

Reach for it for

- Waves of your own, drawn and morphed (DRAWN)
- Glassy, metallic bells and tubular bells (RING)
- Electric piano, clav, harpsichord and mallet sounds
- Slowly evolving pads, drawn step by step
- Resonant, vocal sweeps without a filter (the RESO waves)
- Cutting leads and gritty basses, with drive and compression
- Breath, wind and sci-fi effects (NOISE)

Controls

Drag a knob up or down (Shift for fine moves), or use the mouse wheel. Double-click (or Ctrl-click) returns a knob to its default. Values show while you hover. Changing a wave, the line mode, RING or NOISE dips the sound for 6 ms so it never clicks, and every effect setting glides.

The top bar

Pilot lamp	The amber lamp beside the name lights while the output is IN.
PRESETS	Opens the preset list.
◀ / ▶	Steps to the previous or next preset, wrapping round.
Preset display	Shows the preset's name. Click it for the preset list too.
Voice lamps	Eight lamps, one per voice, glowing with its level.
S / M / L	Panel size: small, medium or large.
?	Opens a pop-up with the design credit, the GFX website and the address of this manual. Click anywhere to close it.

LINES

LINE 1 / LINE 2	Play one line only.
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1 + 2	Both lines, each with its own waves and envelopes; line 2 is shifted by the DETUNE settings.
1 + 1'	Line 1 doubled: the copy plays line 1's waves and envelopes, detuned by DETUNE - a thick chorused version of one line.
RING	Line 2 is multiplied by line 1 (ring modulation): metallic, bell-like and clangorous. Only with both lines playing.
NOISE	Line 2's pitch is scrambled by noise: breath, wind and effects. Works whenever line 2 plays.
MONO	One note at a time, legato: a key played while another is held slides there over GLIDE without restarting the envelopes; letting go slides back to the newest key still held. Switching it releases every note.
OCTAVE	Line 2's (or the copy's) detune in octaves, -2 to +2. Click for a menu.
NOTE	Detune in semitones, +0 to +11. Click for a menu.
FINE	Fine detune, 0 to 60 cents.
GLIDE	1 to 2000 ms: how long MONO takes to slide between notes.

The DETUNE controls grey out unless two lines are playing, RING and NOISE likewise, and GLIDE unless MONO is lit.

WAVES

LINE 1 / LINE 2	Choose which line the WAVES keys, the follow knobs and the ENVELOPES page edit. In 1 + 1' line 2 simply plays line 1, so its page says so.
WAVE	The line's wave, each with its own colour and LED: SAW, SQUARE, PULSE, DOUBLE (a double sine, hollow and vocal), SAW-PULSE, and RESO I, RESO II and RESO III - a resonant peak that sweeps up the harmonics as the DCW rises, in a saw, triangle or trapezoid shape, like a filter sweep with resonance. And DRAWN (paper-coloured): the

	bends you draw on the DRAWN WAVES page, A and B, blended by MORPH A - B.
SECOND WAVE	An optional second wave that alternates with the first, cycle by cycle, for richer and more complex tones. Click the lit key again to turn it off.
DCW DEPTH	0 to 100 %: scales both lines' DCW envelopes. Lower is softer and more sine-like overall.
DCW FOLLOW	0 to 100 %: the higher the key, the less DCW (brightness evens out up the keyboard).
DCA FOLLOW	0 to 100 %: the higher the key, the faster the level envelope runs (up to four times as fast at the top), as on struck instruments.
LINE 2 LEVEL	-24 to +6 dB: line 2 against line 1.
VELOCITY	0 to 100 %: how much playing harder makes notes louder and brighter.
MORPH A - B	0 to 100 %: where a DRAWN wave sits between bend A (0 %) and bend B (100 %); MORPH BY moves it from there. It glides, so turning it never steps. Greyed while no line plays DRAWN.

ENVELOPES

Each line has three eight-step envelopes. Every step has a RATE (how fast it moves, 0 to 99: 99 is near-instant, 0 takes about four seconds across the full range) and a LEVEL to move to (0 to 99). The envelope holds at the SUSTAIN step while the key is down; letting go moves it on to the next step, and it stops at the END step.

DCO / DCW / DCA	Which envelope the display shows. DCO moves the pitch (up to +24 semitones at level 99), DCW the brightness, DCA the level.
Display	The envelope drawn as a line, with S on the sustain step and E on the end step (steps after END are dimmed). Drag a point up or down for its level and left or right for its rate (right is slower); hold Shift for fine moves. The mouse

wheel changes the chosen step's level, Shift + wheel its rate. A light dot rides the envelope of the newest note.

STEP

The arrows choose the step being edited (also chosen by clicking a point).

RATE / LEVEL

The chosen step's values.

SUSTAIN

OFF or STEP 1 to 8. Click for a menu.

END

STEP 1 to 8: the last step. Click for a menu.

The envelopes are saved with the project.

The DRAWN WAVES page

The **DRAW** key in the ENVELOPES title band swaps the middle row for this page (and back: it sits in the same place on both). Choose DRAWN on a line's WAVE keys to hear what you draw. Both lines share bends A and B, but each line morphs with its own DCW envelope.



WAVE A / WAVE B	The two bends. The light line is the bend: how far through its cycle the sine has got at each moment, from 0 at the left to one whole cycle at the right. The dotted diagonal is no bend at all (a pure sine). Above it the wave rushes ahead, below it lags behind; a bend that climbs above the middle line (up to two cycles) adds extra cycles - the resonant, vocal sounds. The amber line underneath is the wave it makes at full DCW.
Drawing	Press in a display and drag across it: each of the 11 points in between follows the pointer (the two ends stay put, so the cycle always joins up). A smooth curve runs through the points. Double-click a point to put it back on the straight line. Every change glides over about 20 ms, so you can draw while a note plays.
SHAPE	A starting shape for that bend: Sine (no bend), Saw, Square, Pulse, Double, Hump, Twin, Steps, Random, or a copy of the other bend.
MORPH display	The blend of A and B as the newest note plays it now (the knob's setting while nothing plays), with the morph position on the A - B line above it.
MORPH BY	What moves the morph, click for the list: OFF, SWEEP (from where MORPH A - B sits towards B over TIME after each note starts), DCW ENVELOPE (the line's own brightness envelope), LFO (the vibrato's, its RATE and wave; it runs even with the vibrato DEPTH at 0), VELOCITY, MOD WHEEL or KEY (low to high across the keyboard).
AMOUNT	-100 to +100 %: how far MORPH BY moves the morph, and which way (negative moves it back towards A).
TIME	0.05 to 10 s: how long SWEEP takes. Greyed unless MORPH BY is SWEEP.

The drawings are saved with the project and with each preset. A steep bend is held back a little at the very top of the keyboard, so it stays clean rather than turning harsh and digital.

FILTER

Mode	Click for a menu: OFF (the default - phase distortion needs no filter), LOW-PASS, BAND-PASS or HIGH-PASS. The knobs grey out while it is off.
CUTOFF	40 Hz to 20 kHz.
RESO	Resonance, 0 to 100 %.
KEY TRACK	0 to 100 %: the cutoff follows the keyboard (centred on middle C).
ENV	-100 to +100 %: line 1's DCW envelope moves the cutoff (up to six octaves).

VIBRATO

Wave	Click for a menu: TRIANGLE, SAW UP, SAW DOWN or SQUARE.
DELAY	0 to 3 s: the vibrato fades in after each note starts, as a player would add it.
RATE	0.1 to 12 Hz.
DEPTH	0 to 100 cents. The mod wheel adds up to 30 cents more.
DCW MOD	0 to 100 %: the same LFO, faded in over the same delay, breathes both lines' brightness - a slow, shimmering formant movement.

The FX strip

Each effect has a round lamp beside its title: click it to switch the effect in or out (crossfaded). An effect that is out is greyed.

PHASER: RATE	0.05 to 8 Hz. Left and right sweep a quarter-cycle apart, for width.
PHASER: DEPTH	0 to 100 %: how wide the sweep is (up to 200 Hz - 4 kHz).
PHASER: FEEDBACK	0 to 90 %: a sharper, more resonant phaser.

CHORUS: RATE	0.25 to 4 times the original's speeds (a slow sweep and a faster shimmer, mixed together).
CHORUS: DEPTH	0 to 100 %.
CHORUS: MIX	0 to 100 %: three delay lines, spread left, centre and right, with a slightly darker top, like the bucket-brigade chips it is modelled on.
DRIVE: AMOUNT	0 to 100 % (up to +30 dB) into a smooth, anti-aliased soft clipper; the level is matched, so it changes the colour more than the volume.
DRIVE: TONE	A low-pass after the drive, darker to the left.
COMP: THRESHOLD	-40 to 0 dB. The LED row in the title shows the gain reduction.
COMP: RATIO	1:1 to 20:1, with a soft knee and automatic make-up gain.
COMP: ATTACK / RELEASE	0.1 to 100 ms / 10 to 1000 ms.
DELAY: SYNC	Lit: the time is a note value at the project tempo. Off: milliseconds.
DELAY: TIME	With SYNC: 1/32, 1/16 T, 1/16, 1/8 T, 1/16 D, 1/8, 1/4 T, 1/8 D, 1/4, 1/2 T, 1/4 D, 1/2 or 1 bar (T = triplet, D = dotted). Without: 10 to 2000 ms.
DELAY: FEEDBACK	0 to 95 %. The delay is ping-pong: the repeats cross from side to side.
DELAY: DAMPING	1 to 18 kHz: a low-pass in the loop, so each repeat is a little darker.
DELAY: MIX	0 to 100 %: the level of the repeats.

OUTPUT

IN	Switches the instrument's output in or out (faded). The amber LED and the pilot lamp light while it is in.
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LEVEL	-18 to +6 dB.
DRIFT	0 to 100 %, 50 % by default (see above).
THICK	The GFX THICK circuit: lifts the low-mid body of decaying notes, adds a gentle iron-like saturation below 500 Hz and rounds off the sharpest edge of each attack. The red LED lights when it is on.
OUT	The output meter.

Presets

Every preset is level-matched and sets the whole sound, envelopes and effects included (not the IN key).

Default	One saw line with a bright start that settles, a simple level envelope, no effects.
Glass Bell	Saw and square ring-modulated, line 2 an octave and a fifth up, long decays with no sustain, chorus and a quarter-note delay.
Phase Strings	A doubled saw (1 + 1') detuned 12 cents, slow brightness and level swells, delayed vibrato and a deep chorus.
Electric Piano	A near-sine body with a pulse tine an octave up that fades faster; velocity-sensitive, with chorus.
Brass Lead	A saw whose brightness swells in, with a quick fall in pitch into each note, vibrato, drive and a dotted-eighth delay.
Resonant Sweep	RESO I swept slowly up and back down by the DCW, with a dotted-eighth delay.
Ambient Pad	DOUBLE alternating with RESO II, doubled and detuned, slow envelopes, phaser, chorus and a long dotted-quarter delay.
Metallic Pluck	Pulse and saw ring-modulated, line 2 an octave and a third up, short and bright, with an eighth-note delay.

Dirty Sync Bass	RESO III with a square an octave down, drive and compression.
Chorus Organ	Two squares an octave apart (8' and 4'), instant on and off, through a rich chorus.
Sci-Fi FX	Two RESO I lines an octave apart with noise modulation and falling pitch sweeps, a fast deep phaser and a long ping-pong delay.
Soft Evolution	DOUBLE alternating with SAW, doubled and detuned; its brightness rises, falls and rises again over several seconds. Chorus and delay.
Synth Bass	A saw with a square an octave down and light compression.
Breathy Flute	DOUBLE with a quiet noise-modulated saw for the breath, delayed vibrato and a short delay.
Funky Clav	A bright pulse that closes quickly, very velocity-sensitive, with a little drive.
Vibes	DOUBLE with a quiet saw two octaves up, decaying, with a slow chorus for movement.
Reso Lead	RESO II doubled and detuned, with vibrato, a touch of drive and a delay.
Sync Lead	RESO I alternating with SQUARE, doubled, with vibrato, drive and an eighth-note delay.
Digital Choir	RESO III and DOUBLE slightly detuned, slow attack, gentle vibrato, deep chorus and delay.
Tubular Bells	Two saws ring-modulated, line 2 two octaves up and a little sharp, long decays, with delay.
Marimba	DOUBLE with a quiet saw two octaves up, short decays, very velocity-sensitive.
Harpsichord	SAW-PULSE doubled and detuned, bright and quickly

	decaying, faster up the keyboard, with a light chorus.
Reso Bass	RESO I with a square an octave down, drive and compression.
Night Wind	DOUBLE with a noise-modulated RESO I an octave up whose brightness breathes, a slow phaser, chorus and a long half-note delay.
Space Choir	Saw and pulse slightly detuned, a slow multi-step brightness swell, slow vibrato with DCW MOD, deep chorus and a long delay.
Synth Strings	A saw with a RESO II line an octave up that settles lower, delayed vibrato, chorus, a short delay and more DRIFT (70 %).
Space Flute	MONO with a 140 ms glide: a soft saw with a breathy noise chiff on the attack, delayed vibrato and a dark dotted-eighth delay.
Ink Bell	Both lines DRAWN, line 2 an octave and a fifth up: a jagged drawn bend that SWEEPs to a rounded one over 2.5 s as the bell dies away, with chorus and delay.
Sketch Pad	1 + 1': a saw bend rocking slowly into a double bend on the LFO, with chorus and a long delay.
Morph Bass	A hump bend that turns into a pulse as the DCW envelope closes, with a square an octave below and the compressor.
Pen Lead	MONO with glide: the mod wheel morphs a soft drawn bend into a hard, resonant one; drive and delay.

Tips

- To start a drawn wave, pick a SHAPE close to what you want and drag a few points from there.
- Draw B as a variation of A (SHAPE, then copy A here, then move a few points): the morph then changes the colour without losing the character.

- MORPH BY DCW ENVELOPE with a negative AMOUNT makes the wave change shape as the brightness falls, as in Morph Bass.
- Start with the DCW envelope: it is the "filter" of phase distortion. A fast rise and slow fall gives plucks and pianos; a slow rise gives brass and pads.
- For bells, use 1 + 2 with RING and detune line 2 by a non-octave interval (NOTE +7, or an odd FINE amount): the further from an octave, the more clangorous.
- 1 + 1' with 5 - 12 cents of FINE is the quickest way to make any single line wide and lush.
- The RESO waves sound like a resonant filter sweep; give them a slow DCW envelope and they talk.
- Raise DCW FOLLOW when high notes get too shrill, and DCA FOLLOW for struck sounds whose high notes should die away sooner.
- THICK adds weight to basses and pads; try it with Synth Bass or Dirty Sync Bass.

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