

Vulpus Labs

Curvature

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Introduction

Curvature is a voltage-to-voltage converter which maps an inbound voltage to an outbound voltage along a user-definable and audio rate-modulatable curve, displayed in a helpful oscilloscope.



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It can be used as an oscillator (when driven by a pure sawtooth wave input signal), a wave folder or a general-purpose control signal mangling tool.

Theory of Operation

Curvature's controls define *points* on a curve, and *segment curves* for the values between those points. Each point has an "x" and a "y" value.

There is a start point, whose "x" value is fixed at $-5v$, and an end point, whose "x" value is fixed at $+5v$. The "y" values for these points define the start and end of the curve.

Up to six intermediate points can be added. Each intermediate point must have an "x" value greater than that of the point before it (otherwise it is simply ignored). The "y" value ranges between $-5v$ and $+5v$.

For input "x" values between these points, intermediate "y" values are generated, based on the shape of the segment curve defined for each point.

It is helpful to be able to visualise this, which is why **Curvature** incorporates a handy oscilloscope showing the values of "y" as "x" sweeps from $-5v$ to $+5v$.

The available segment curve shapes are:

- "Step" - the segment is a flat line at its start point's "y" value, jumping instantaneously to the next point's start "y" value at the end.
- "Linear" - the segment is a straight line from its start point's "y" value to its end point's "y" value.
- "Quarter sine" - the segment is shaped like the first quarter of a sine wave, i.e. the rising curve from $y=0$ to $y=1$ between $x=0$ and $x=\pi/2$ for $y=\sin(x)$. The rate of change is faster at the beginning of the segment and slower at the end.
- "Inverse quarter cosine" - the segment is shaped like the first quarter of a cosine curve, turned upside down. The rate of change is slower at the beginning of the segment and faster at the end.
- "Sinusoid" - the rate of change is slower at the beginning and end of the segment, and faster in the middle.

Wave shaping with Curvature

Used as a wave shaper, Curvature can do saturation, rectification, and many other things besides. To start with, here's the "identity" curve $y = x$:



As you can see, there is a single curve segment, with a curve type of Linear, from -5v at **START** to 5v at **END**. Now here's the same segment, using a curve type of Sinusoid:



This has a gently saturating effect, flattening the peaks of the sine wave and adding some extra harmonics.

We can get an almost identical curve by introducing a midpoint at (0v, 0v) (see the second row of controls) and using Quarter Sine and Inverse Quarter Cosine curve types:



We can apply linear rectification to the signal by inverting the voltages between -5v and 0v:



The “DC” button can be used to “centre” the resulting waveform around 0v:



Notice that this slightly distorts the waveform. The DC-blocking circuit pulls anything that looks like a constant voltage towards 0v, which means that it quite radically alters square waves:



Non-linear rectification can sound slightly more pleasing:



If we move the midpoint to (0v, -5v) and switch the DC circuit off, we effectively double the frequency of the sine wave without losing amplitude:



Much more complex shaping is possible. Here is a curve with four points:



Crossfading between inputs

We can also use Curvature to crossfade between inputs, by connecting them to the “Y” inputs and sweeping “X” back and forth. Try this, and observe the output waveform “morphing” between different shapes:



Using Curvature as an Oscillator

Define a curve shape that works as an oscillator, and run a very pure sawtooth wave through it. The sawtooth emitted by an LFO is likely to be better for this purpose than the sawtooth emitted by an oscillator intended for audio-rate tone generation, as these are often smoothed out in some way to give a more pleasing sound.



Controls



Pass an input signal into the “x” input, and take the voltage-converted signal from the “y” output.

The “DC” button switches the DC bias correction circuit off and on.

Controls for the curve are arranged in rows, with one row for each point in the curve. Each point has a knob and CV input jack controlling its “y” value, a knob and CV input jack controlling its “x” value if it is not the start or end point, and a “curve” knob controlling the shape of the curve between that point and the next.

If the CV input is connected, the value sent to the jack entirely overrides the value set by the knob.

Credits and Acknowledgements

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