

# The C15 Synthesis Engine

The C15's first synthesis engine is named "Phase 22". The design goal for Phase 22 was to take advantage of digital synthesis algorithms in order to build an expressively playable instrument that has a strong individual character. At the same time the set of parameters should be small enough to be easily accessible.

The core structure is a phase modulation synth that is based on two sine oscillators and two sine shapers only. Their signals can be passed through a comb filter, a state-variable filter, and a chain of five effects.

The Comb Filter is a tool for complex spectral shaping and also works as a resonator. The State Variable Filter can be applied flexibly for subtractive filtering.

The signal routing is determined by the settings of the Output Mixer and the Feedback Mixer. The feedback bus can be used to create feedback loops between different function blocks.

The filters and effects have an important influence on the feedback behavior: their amplitude and phase responses determine the frequencies where the feedback can result in self oscillation.

## The Components in Detail

**Oscillator A & B:** The two sine wave oscillators are the only signal sources. With a random frequency fluctuation they can also produce tunable noise. They are equipped with three phase modulation inputs for:

- self modulation
- modulation from the other oscillator
- modulation from the feedback (FB) signal

**Shaper A & B:** The signal of each oscillator is processed by a wave shaper. The shaping curve is a sine function with adjustable foldback and asymmetry. The mix amounts of the shaper signal can be adjusted individually for each phase modulation branch and for the output.

The Shaper block also contains mixing points for the feedback signal and the result of a ring modulation between the output signals of the branches A and B.

**Envelope A & B:** These two ADBDSR envelopes are the control sources for:

- the output amplitude of the Oscillator-Shaper branch
- the Oscillators' phase modulation depths
- the Drive (input gain) of the referring Shaper

There is detailed control of how the velocities and the key position influence levels and times.

**Envelope C:** The third ADBDSR envelope has bipolar Breakpoint and Sustain levels. It can modulate:

- the pitches and fluctuations of Oscillator A and B
- the feedback signal
- parameters of the Comb Filter and the State Variable Filter

**Comb Filter:** The Comb Filter contains:

- a precisely tunable delay (Pitch)
- a control for the Decay time of the impulse response
- a second-order Allpass (AP) filter
- a lowpass (Hi Cut) in the feedback loop
- a delay modulation by the Oscillator signals, similar to phase modulation (PM)

**State Variable Filter:** The State Variable Filter has a variable 4-pole structure with:

- two internal 2-pole filters with splittable cutoff frequencies (Spread)
- crossfade between serial and parallel modes
- crossfade between lowpass, bandpass, and highpass mode
- cutoff frequency modulation (FM) by the Oscillator signals

**Output Mixer:** The Output Mixer creates a stereo sum of the signals from Oscillator/Shaper A and B, the Comb Filter and the State Variable Filter. It includes a sine shaper for the sum signal of each voice.

**Feedback Mixer:** This mixer combines the following signals for the feedback bus: the outputs of the Comb Filter and the State Variable Filter and the output of the Effects chain, with a separately adjustable amount of Reverb. It includes a sine shaper for the sum signal.

The feedback bus signal (FB) can be used for the phase modulation of the Oscillators and it can be injected into the signal path behind the Shapers for direct audio feedback.

In Layer Sounds the Feedback Mixer can route signals between the layered voices. It provides an additional input for the Oscillator signals (A/B) of the other Part, and the Comb, SV Filter and Effects channels can also receive signals of the other Part.

**Flanger:** An LFO-modulated stereo delay plus a 4-pole allpass filter creating a wide range of chorus, flanger and phaser effects. The LFO can also modulate the amplitudes of the output signals for a tremolo effect.

**Cabinet:** A stereo distortion unit (sine shaper) with pre and post filtering that can sound similar to a guitar amp driving a speaker.

**Gap Filter:** A 4-pole lowpass and a 4-pole highpass in a parallel or serial structure, creating a flexible band-rejection or band-pass filter. The offset between the center frequencies of the left and the right channel can be controlled.

**Echo:** A stereo delay effect with adjustable cross-feedback.

**Reverb:** A flexible simulation of rooms and halls. The Size can be varied without artefacts.

**Macro Controls:** Six Macro Controls (A, B, C, D, E, F) are available as modulation sources. 106 parameters can be assigned as modulation targets with individual amounts. For each Macro Control a Smoothing time can be set.

**Hardware Sources:** Eight physical control elements are available, that can be mapped to the six Macro Controls:

- four Pedals
- two Ribbons
- the Bender
- Aftertouch

**Voices:** The parameters in this group control the monophonic mode and the use of the voices for Unison.

**Part and Master:** Master Volume and Master Tune are always available, while the Part groups are used to control aspects of the two Parts of a Split Sound or a Layer Sound.

**Scale:** The Scale group offers twelve Offsets to tune the keys of an octave. The Base parameter can be used to shift the base key of the scale.