WAHIDA AUDIO

RESEARCH DOCUMENT

Filter Types, Morph Spaces & Z-Plane Lineage

A research-led explanation of why WA ONE8 uses multiple filter families, why the system has 2, 4, and 8-filter workflows, and how the historic Z-Plane idea became a point of inspiration rather than a boundary.

Filter language

Low-pass, high-pass, band-pass, notch, peak, comb, phaser, formant, hybrid, and custom shapes.

Morph architecture

2 filters for focused pair movement, 4 for XY planes, 8 for full XYZ cube design.

Z-Plane influence

An affection for structure-aware morphing led to a broader, ONE8-specific motion system.

Build date: 2026-05-05. External references include E-mu Morpheus material, Rossum Electro-Music Morpheus documentation, Apple Logic Pro filter documentation, Cycling '74 filtergraph documentation, Sound On Sound formant synthesis notes, and MATLAB z-plane documentation.

1 Executive Summary

ONE8 was not built around the idea that one filter type is enough. It was built around the idea that filter identity, movement, routing, saturation, stereo behavior, and safety all become part of the same instrument once the filter is allowed to move.

Fact-check note: it is fair to say that the project can reach a Z-Plane-style mode, because the current build includes a constrained, structure-aware 2-filter interpolation path for compatible models. It is also fair to say that the wider product goes beyond that inspiration in a different direction through 4-filter XY and 8-filter XYZ morph spaces, modulation, Matrix routing, macros, Sonic Control, and output-safety tools. It should not be described as the original E-mu/Rossum Z-Plane algorithm.

Research Question	Finding	How ONE8 Responds
Why so many filter types?	Basic filter categories solve different frequency-shaping problems: passing, rejecting, emphasizing, phase-shifting, resonating, and vocalizing parts of the spectrum.	ONE8 groups 93 selectable voicings into 10 practical families so users can choose by musical purpose instead of only by technical name.
Why 2, 4, and 8 filters?	One axis, two axes, and three axes invite different kinds of movement. A pair is focused; a plane is expressive; a cube is a performance space.	ONE8 uses 2 filters for A/B and Z-Plane-compatible work, 4 filters for XY movement, and 8 filters for XYZ morph-cube design.
What did Z-Plane inspire?	The historic appeal is that one musical control can move through a complex changing filter response rather than simply turning one static EQ knob.	ONE8 keeps a Z-Plane-style 2-filter path, while expanding into a broader morphing, modulation, and mix-aware environment.

2 What Filters Do In Musical Terms

A filter is often described technically, but producers experience it emotionally: darker, thinner, focused, hollow, vocal, metallic, wider, warmer, sharper, or more alive.

Apple's Logic Pro documentation gives the basic subtractive-synthesis explanation: filters remove or shape parts of a signal's frequency spectrum, with cutoff, resonance, drive, slope, envelopes, LFOs, and performance controls all playing important roles. That is the practical foundation behind ONE8: the filter is not only a tone control, it is a movement destination.

Family	Core Behavior	Why It Matters Musically
Low-pass	Passes low frequencies and attenuates high frequencies.	Warmth, darker sweeps, bass movement, classic synth filtering.
High-pass	Passes high frequencies and attenuates low frequencies.	Cleanup, lightness, air, space for kick and bass.
Band-pass	Lets a chosen frequency band pass while attenuating material outside it.	Wah movement, vocal focus, obvious midrange animation.
Notch / band reject	Attenuates a chosen band and leaves the surrounding spectrum intact.	Hollow motion, de-essing ideas, phase-like movement without only boosting peaks.
All-pass / phaser family	Preserves amplitude more than tone, but changes phase relationships.	Swirling cancellations, animated width, classic phaser texture.

Resonance changes the personality.

The same cutoff frequency can feel polite or dangerous depending on resonance. This is why ONE8 keeps resonance close to morphing and modulation instead of treating it as a static afterthought.

Drive changes the filter's response.

A driven filter does not only get louder. It may thicken, flatten, bite, or compress the movement. That is why drive variants matter in a filter-centered product.

3 Beyond The Basic Families

The more characterful families exist because music often needs movement that is not merely brighter or darker. Some filters create identity rather than correction.

Family	Research Context	ONE8 Use Case
Peak / shelf	Cycling '74's filtergraph documentation treats peak/notch and shelf responses as core filter/EQ shapes alongside low-pass, high-pass, band-pass, band-stop, and all-pass models.	Presence, air, bite, low/high tonal tilt, and finishing-style shaping inside a morphable patch.
Comb	Comb filters are delay-based structures that create regularly spaced spectral peaks and notches. They are the sound-design bridge to flanging, metallic resonance, and tuned hollowness.	Metallic motion, resonant rhythmic texture, synthetic movement that does not sound like a normal EQ sweep.
Formant	Formant synthesis literature connects vowel-like sound to spectral peaks shaped by resonant filtering; Sound On Sound discusses how a few formant frequencies can suggest vowel identity.	Vocalized movement, talking bass, vowel sweeps, growl, and synthetic speech-like filtering.
Hybrid	Hybrid filters combine response ideas rather than obeying one classic category.	Complex travel, multi-attitude movement, morph paths that feel more designed than utilitarian.
Custom	Custom curves let the user define the response directly instead of choosing only from named models.	Signature spectral shapes and special-purpose contours that can still be morphed, modulated, and performed.

Custom response shaping: once the stock families are understood, drawing a curve becomes a deliberate design act rather than random experimentation.

4 Why The System Uses 2, 4, And 8 Filters

The 2/4/8 design is not there for quantity alone. Each count changes the geometry of the musical decision.

Mode	Geometry	Best For	Why It Exists
`2 Filters`	One axis: A to B.	Focused comparison, classic sweeps, pairwise morphing, Z-Plane-compatible mode.	It keeps movement legible. The listener can hear one filter state become another.
`4 Filters`	Two axes: XY plane.	Performance pads, macro gestures, blends between four related tonal corners.	It turns filter selection into a surface. The user can travel between bright/dark and narrow/wide at the same time.
`8 Filters`	Three axes: XYZ cube.	Large evolving patches, scene design, cinematic motion, advanced sound design.	It lets each corner of the cube become a different tonal state, which makes the filter space feel like an instrument.

> Important distinction: in this build, 8 filters are not how Z-Plane is unlocked. Z-Plane-style interpolation is constrained to the focused 2-filter workflow. The 8-filter mode is a separate expansion: a larger XYZ morph cube for broader creative movement.

Slot geometry: 2 filters give a line, 4 filters give a plane, and 8 filters give a cube.

5

Z-Plane: The Historical Spark

The phrase Z-Plane has two related meanings in this story: a mathematical DSP space used to understand digital filters, and a beloved musical idea associated with E-mu and Dave Rossum's morphing filter work.

In DSP, the z-plane is where the poles and zeros of a discrete-time system are plotted. MATLAB's documentation describes zplane-style plots as zero-pole plots for discrete-time systems, using circles for zeros and crosses for poles. That mathematical language matters because changing a filter's structure is deeper than only fading one output against another.

The musical Z-Plane story is most strongly associated with E-mu's Morpheus. The Morpheus operation manual describes the Z-Plane filter as changing function over time by interpolating between two complex filter responses with a single Morph parameter. Rossum Electro-Music's current Morpheus module page connects that lineage directly to Dave Rossum and describes modern cube-based interpolation between up to 8 complex filters.

The original magic.

One control could move through many filter parameters at once. That made the filter feel less like a static EQ and more like a living response shape.

The enduring appeal.

Producers love the idea because it compresses complexity into a performable gesture: a sweep can become a transformation rather than a simple cutoff move.

Fact-checked design statement

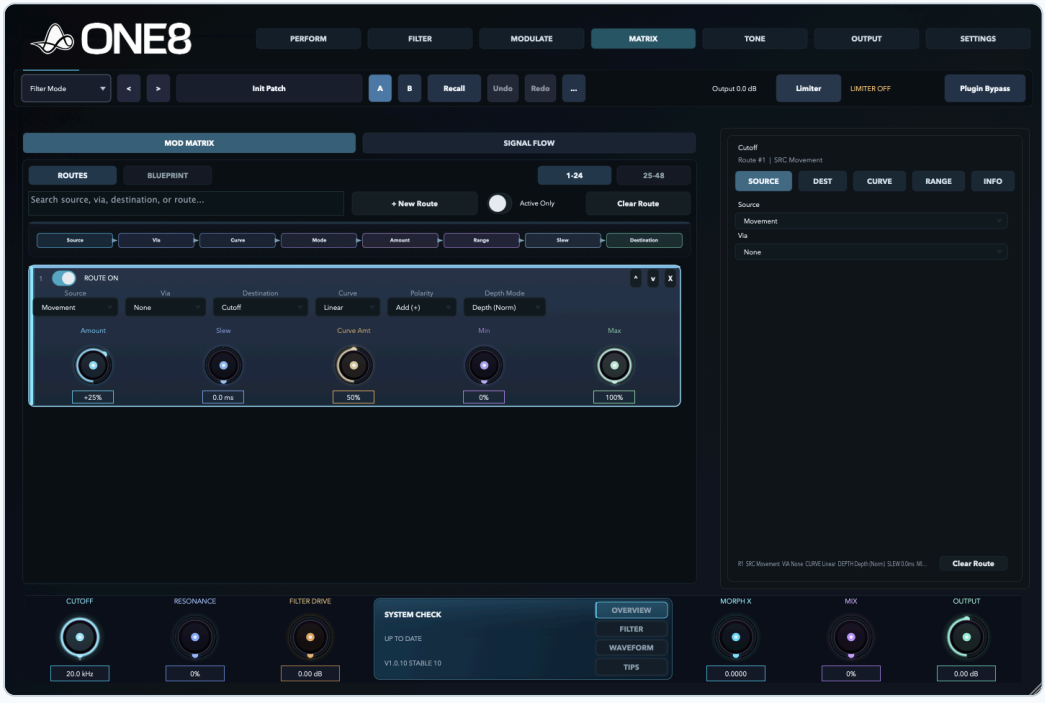
ONE8 can be described as Z-Plane-inspired. It includes a constrained Z-Plane-style mode for compatible two-filter interpolation, and it extends beyond that inspiration with its own 4-filter XY and 8-filter XYZ morph architectures. It should be presented as inspired by the Z-Plane idea, not as a clone of the E-mu or Rossum implementation.

6 From Inspiration To ONE8

The emotional through-line is simple: a fascination with Z-Plane movement opened the door, but the project did not stop at recreating a historical behavior.

> Design note: the starting desire was to explore the feeling of a filter that turns into another filter rather than merely switching or crossfading. That affection for Z-Plane-style motion became the first spark. The deeper the exploration went, the more the product moved toward its own identity: a wider morph space, more filter families, modulation sources, Matrix routing, macros, Sonic Control, gain staging, and safety tools.

Design Pull	What It Suggested	Where ONE8 Took It
Z-Plane-style smoothness	Move through the structure of compatible filters, not only their wet outputs.	A dedicated 2-filter structure-aware path when the patch qualifies.
Morph-space performance	Let the user travel through a field of tone states.	2, 4, and 8-filter workflows with X, Y, and Z movement.
Filter diversity	Include practical and character families, not one model family.	10 families with 93 selectable voicings across clean, resonant, hybrid, comb, phaser, formant, and custom groups.
Modern production needs	Movement must survive the mix.	Sonic Control, stereo handling, low-end focus, sidechain behavior, loudness match, and SAFE output protection.



Where the rabbit hole led: the filter became a movement system, and the movement system needed readable routing.

7

The Current ONE8 Architecture

The product's internal documentation describes a deliberately split architecture: a focused Z-Plane path for compatible pairs, and a broader Legacy morph path for the full catalogue and larger morph spaces.

Path	Behavior	Strength	Constraint
`Z-Plane`	Structure-aware pair interpolation in 2-filter mode.	Smoother pairwise spectral motion and more continuous resonance behavior.	Requires 2-filter mode and compatible model categories.
`Legacy`	Weighted output blending across active slots.	Works across the full model catalogue and supports 2, 4, and 8-filter layouts.	Can feel less structurally continuous than true pair interpolation.
`Retro`	Immediate, punchier 2-filter legacy movement.	Aggressive A/B moves, rhythmic flips, sharper performance behavior.	2-filter only.

Compatible families

Low-pass, high-pass, band-pass, notch, and peak models form the current Z-Plane-compatible set.

Character families

Hybrid, comb, phaser, formant, and custom models stay on the Legacy weighted-morph path.

Design consequence

The user can choose continuity, breadth, or punch depending on the patch instead of forcing every sound through one engine.

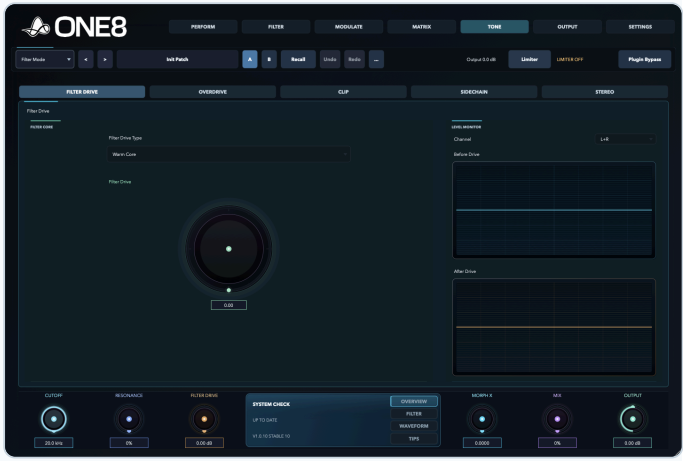
8

Why This Became More Than A Filter Clone

A direct clone would have made the story smaller. The more interesting path was to keep the fascination with structural movement while building a broader modern instrument around it.

Historical Inspiration	ONE8 Expansion
Move between complex filter states with a small number of musical controls.	Add macros, Matrix routing, buses, processors, and scene movement so the user can perform that motion.
Think of the filter as a changing spectral object.	Allow not only pairwise movement, but also XY and XYZ travel across multiple tonal states.
Make complex filter movement manageable.	Wrap the motion in gain safety, loudness matching, stereo control, and sidechain-aware mix behavior.

Performance layer: macros make the complex routing playable.



Tone layer: drive and Sonic Control keep the moving filter tied to mix reality.

> This is the breath of the story: the love was for the feeling of filters transforming. The research path led through Z-Plane, into morph geometry, then into a larger question: what if the filter was not a single effect, but a playable space?

9 Positioning Language

The safest language is specific, inspired, and technically honest. It gives the Z-Plane lineage its respect without overstating ownership of the original technology.

Use This	Avoid This	Reason
Z-Plane-inspired morphing.	Original E-mu Z-Plane filter recreated.	ONE8 has its own implementation and constraints.
Structure-aware 2-filter interpolation when compatible models qualify.	All 8 filters are Z-Plane.	In the current build, Z-Plane-style behavior is 2-filter only.
2-filter, 4-filter, and 8-filter morph spaces for different design jobs.	More filters automatically means better filtering.	The counts represent different movement geometries, not a simple quality ladder.
Inspired by the love of morphing filter movement, expanded into a modern performance environment.	Basically a Z-Plane clone.	The product's identity is broader: modulation, Matrix, macros, Sonic Control, gain, stereo, and safety.

Suggested final wording

WA ONE8 began from a fascination with the musical idea behind Z-Plane filtering: the feeling that one filter shape can transform into another rather than simply switching or crossfading. That exploration became a wider instrument. ONE8 keeps a constrained Z-Plane-style path for compatible two-filter morphing, then expands outward into XY and XYZ morph spaces, a broad filter catalogue, modulation, Matrix routing, macro performance, Sonic Control, and output safety.

10

References

These sources were used to fact-check the filter-family descriptions, the DSP meaning of the z-plane, and the E-mu/Rossum Z-Plane lineage.

1. Apple Support, Logic Pro: Filters overview. Used for the basic filter-type definitions and the subtractive-synthesis role of cutoff, resonance, drive, slope, envelopes, and LFOs.
2. Cycling '74 Documentation, filtergraph~ reference. Used for filter response concepts, frequency response, center/cutoff frequency, Q/resonance, and common filter modes including low-pass, high-pass, band-pass, band-stop, peak/notch, shelves, resonant, and all-pass.
3. MathWorks, zplane: Zero-pole plot for discrete-time systems. Used for the DSP meaning of z-plane as a pole-zero representation for discrete-time systems.
4. E-mu Systems, Morpheus Operation Manual, The Z-Plane Filter. Used for the historical description of interpolating between two complex filters with a Morph parameter.
5. Rossum Electro-Music, Morpheus: Stereo Morphing Z-Plane Filter. Used for Dave Rossum lineage, 14-pole Z-Plane reference, and modern cube language with up to 8 complex filters.
6. Sound On Sound, Gordon Reid, Formant Synthesis. Used for the relationship between filters, formants, and vowel-like synthesis.
7. Internal source: `Source/docs/ONE8_Manual.md`. Used for the product's current 10-family, 93-voicing catalogue, 2/4/8 mode behavior, compatible Z-Plane categories, Legacy/Z-Plane/Retro definitions, and current architectural constraints.
8. Internal source: `Source/Source/DSP/FilterModels.cpp` and `Source/Source/DSP/MorphFilter.cpp`. Used to verify that ONE8's implementation includes the documented model families and a dedicated two-filter Z-Plane morph path.

> Citation note: external sources support the history and general filter theory. The origin-story language is presented as an internal design note, not as an externally verifiable historical claim.