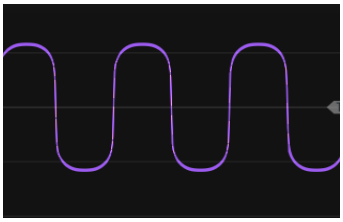
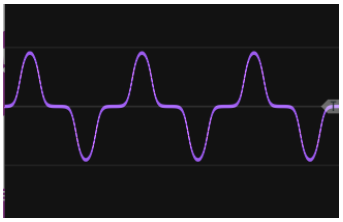
“KOAN” by Allieway Audio



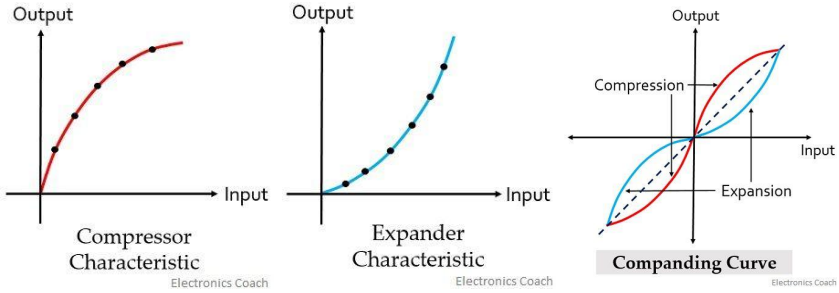
An Owner’s Guide



Concepts: WTF is “Companding”!?

I describe Koan as a *“Telecommunications Compander”.* Technically, Koan uses something called *“μ-law companding”* (μ is pronounced “MU”, homonym of the Japanese 無, hence the Zen Buddhist pun - try searching “mu koan” online for more info on that if you’re curious).

What is *companding*? Companding has two parts - *COMPression* and *exPANsion*, hence the name. However, this is *NOT* Compression/Expansion in the *“dynamics processor”* sense, though it can have a similar effect at times. Instead, this is really a form of *waveshaping*. These two parts are referred to as the *“Encoder” and “Decoder”:*



In the “compression” (encoding) stage, the signal is exaggerated, pushing positive samples *up* and negative samples *down* to act as a kind of “soft clipper”. Then, “expansion” (decoding) *UNDOES* this distortion, un-exaggerating, *pulling extreme values back down toward the center.* Theoretically, if you send the unaltered output of the encoder into the decoder through a perfect connection, you’ll get the same signal out that you put in - *the functions are perfect inverse versions of each other!*

The variable *μ (MU / 無)* is just a number that determines how much the signal will be pushed and pulled in each stage. *The international standard value of μ used by radio technicians is “255”, and usually stays constant.* However, Koan lets you smoothly explore (and even modulate!) μ values from 1 (no effect) through to the *MILLIONS!*

So, what’s the point? Back in the early 20th century, engineers working in fields like radio and broadcasting were faced with a big issue - *NOISE.* How can you send stuff like human speech, which can range wildly from quiet to loud sounds, over a long distance through a noisy connection, without making the quiet parts get drowned out by all the static and hum? *Companding was invented as a result* - they realized they could just *encode* the signal, send it through the noisy connection, and then when they *decoded* it, the speech came out much clearer at the other end (at the cost of a little distortion). Even stuff like whispering and soft music could be transmitted over long distances now! And this technique works in both the analog and digital realms! *Neato!*

You can replicate this technique yourself on Koan by *inserting things in-between the encoder output and the decoder input.* Try adding some noise (there are some pink/white noise generators built-in above each input for this), filtering, hum, bit-rate reduction, or even other effects like reverb or chorus if you’re feeling adventurous. Try this out with some speech and you’ll see why it’s such a useful technique! ^_^

Overview: What does each part do?

1. **µ (MU/ 無) Knob.** Determines how much compression the encoder does, and how much expansion the decoder does in turn. When this is it's lowest value, the encoder and decoder are just passing the signal through without any companding.
On *initialization/double-click,* the MU knob is set to the international standard value of 255 - useful if you plan to send important messages overseas with Koan! ***PS: If you're curious, the Kanji is pronounced "Mu", and means something like "Without / Nothing-ness".***
2. **µ (MU) CV Input.** Expects Bipolar 5v signals, though you can get crazy high MU values by sending it even higher voltages! Offsets knob value.
3. **Drive Knob.** Applies a signal boost to the signal entering the Decoder section. The reason for this boost is that the Decoder is expecting a very "smooshed" signal at its input, so it can sometimes use a little extra juice. If the knob is all the way to the left, there is no boost.
4. **Drive CV Input.** Expects bipolar 5v, offsets knob value.
5. **Range Toggle.** Selects from one of 3 different voltage ranges for Koan to expect at the Encoder and Decoder inputs. Generally, use +-5v for audio inputs, +10v for unipolar envelopes and LFO processing, and +-10v for when you need some extra headroom or are experimenting (with caution).
6. **Clipping Toggle.** Selects from 3 different choices of clipping, to be applied whenever the signal tries to push past the Range you have set (for example, using the "Drive" knob). ***Soft clipping*** applies a smooth analog-style distortion, though it also introduces a slight nonlinearity, so the signal won't be perfectly encoded/decoded. ***Hard clipping*** is traditional digital clipping, and is the "cleanest" method of encoding your signals, though be careful to avoid overdriving. ***!?!?!? clipping*** is *CURSED waveshaping* - try it on a sine wave and play with MU and Drive! >:D

After this point, all parameters are identical for both Encoder and Decoder sections - the only difference is that the Encoder output is normalled to the Decoder Input, though you can break this by patching something else in :)

7. **Noise Select / Mixer Attenuverters.** When SOMETHING is patched to (8), this knob will mix in a normal or inverted version of that signal into the section's main input. The amount goes from 0 in the middle, to a x2 boost at the extremes. ***When NOTHING is patched to (8), this knob will instead select between two different noises to mix in instead!*** Pink is on the left, white is on the right. Both are useful for simulating a bad connection or for adding grit or vinyl noise!
8. **Mixer Input.** Adds a signal (audio or CV) to be mixed in the section's main input (9).
9. **Section's Main Input.** Patch the signal you want to encode/decode into here. When nothing is patched to the decoder input, it will take its signal from the encoder's output as God intended.
10. **Section Output.** Outputs the mixed and processed signal, with an amplitude determined by (11).
11. **VCA/Ringmod Input.** Multiplies with the signal coming out of the section output (10). By default this acts as a bipolar ringmod on the output, though it can also behave as a linear VCA instead (*right-click* to change this setting). If nothing is patched here, the entire signal is passed through the output unaffected.

As a final note, since Koan can create a ton of new harmonics, it has built-in Oversampling Anti-Aliasing. Right-click to choose between anywhere from x0 (none) to x16 (a ton, CPU hog!). The default is x2, a good balance between performance and nice sound quality, but play around with this (especially when driving Koan hard!)

Tips, Tricks, and Patch Ideas

▶▶▶ To get started with Koan, *try patching a sine wave into Koan's Encoder Input.* First, listen to the output of the *Encoder (upper) section,* and play with the *MU* (top) knob to observe its compression of the signal - at the highest values, it should become almost square shaped! Next, *switch to listening to the decoder's output of that encoded signal (no need to patch the encoder into the decoder input - it is normalled there automatically!).* Without any drive, with "soft" clipping you should get something close to a sine wave from the output *(and identical to one if you use the "hard" clipping option. The "!?!?!" clipping option will totally rip up the sine wave like a crazy wavefolder of sorts - use with caution!).* Then, try sprinkling in some noise with the sine wave by turning the knobs above the Encoder/Decoder inputs. Nice!

▶▶▶ To spice up the previous patch, *we insert a filter in between the encoding and decoding sections! Feed the filter with the Encoder Output, and then send the filter's output to the Decoder input.* It will apply filtering to the encoded signal, and then the decoder will try to interpret what the original wave might have looked like, resulting in some dramatic and interesting results! Play with the filter's parameters, and *if you're brave, even try feeding the decoder output back to the encoder section's mixer input (try both positive and inverted polarities!).* This can be a great way to get new responses out of your favorite filters!

▶▶▶ *Experiment with inserting other effects between the encoder and decoder sections* - try bitcrushers, wavefolders, frequency shifters, reverbs, choruses, delays, and more! The sky's the limit!

▶▶▶ *The "!?!?!?" clipping mode is EXTREMELY nonlinear in it's waveshaping - a little input will go a long way!* For this reason, *I recommend feeding it heavily attenuated signals* - try patching your input into one of the mixer inputs instead of the main input so you can control how much you feed it! This technique can be handy with the other clipping modes as well if you want more subtle effects.

▶▶▶ *Play around with the Drive and Mu parameters* - they can have a *dramatic* effect on the type of sounds Koan creates, and *oftentimes adding some Drive can actually paradoxically make sounds come out SMOOTHER.* The reason for this is that *THE DECODER EXPECTS HARSH SOUNDS* - the decoder wants *something close to a square wave,* which it will then "expand" back to its original shape, so the saturation can really help with this.

▶▶▶ Modulate MU/Drive with envelopes, audio-rate signals, or LFOs for more movement - *you can create an entire west-coast style voice* with just an oscillator (or two!) and Koan this way.

▶▶▶ Koan excels at processing sounds with a *wide dynamic range* - Koan loves stuff like speech, drum loops with lots of ghost notes, and classical music. But really, just experiment to find what sounds you like best.

▶▶▶ While Koan is capable of some intense and transformative distortion effects, *it can also be used for more subtle "analog" warming.* Keep MU close to its lowest value, and apply subtle drive to taste - maybe sprinkling in a bit of noise to add character.

▶▶▶ *Koan can also be used to process CV signals!* Try adding interference or noise to your LFOs and envelopes!

▶▶▶ Because the encoding and decoding functions are *inverses* of each other, *there is no rule saying you have to use the encoder before and the decoder after!* Try swapping their order around and observe the differences!

▶▶▶ If you have any questions or comments, reach out to me! *My email is alliewayaudio@gmail.com,* and you can also find the link to my discord at the github page linked from the module's "info" right-click - Have fun :)

Appendix: Use Cases

I like to design open-ended modules which can be used for many different kinds of tasks.
Why would you ever choose to use Koan?
Here is an non exhaustive list of things Koan can be used for:

- Analog-style signal warming / processing, great as a mastering/post processing effect
- Intense waveshaper / standalone distortion
- Unique shortwave/vinyl noise generator/sprinkler
- Weird organic form of sidechainer (by mixing into the decoder section)
- A flexible tool to transform your favorite filters/fx
- West-coasty ring modulator / wavefolder / shaper (best for sine/triangle waves)
- Audio/CV Mixer
- CV Processor/Shaper
- 2 VCAs - you can never have too many VCAs!
- No-input feedback component
- Dynamics Shaper
- Tanh style soft clipper/peak limiter
- Speech processor
- Encoder/Decoder pair for long-distance telecommunication needs

Appendix: Design Inspirations + Special Thanks

- The brave, crafty, and somewhat cuckoo electrical engineers of the early 20th century
- Airwindows, for his VST “u-law” plugins and other awesome works
- @hemmer for their tips implementing oversampling AA (and Squinky Labs for encouraging it!)
- My Zen teachers and Sangha
- Meng Qi, a huge inspiration for me - 非常感谢!
- Instruo, especially for their tanh module
- The VCVrack team and community, with a special thanks to Andrew for his dedicated work and passion
- My lovely beta testers and supportive synthfriends :)
- You for reading this far and for supporting my dream ^^

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