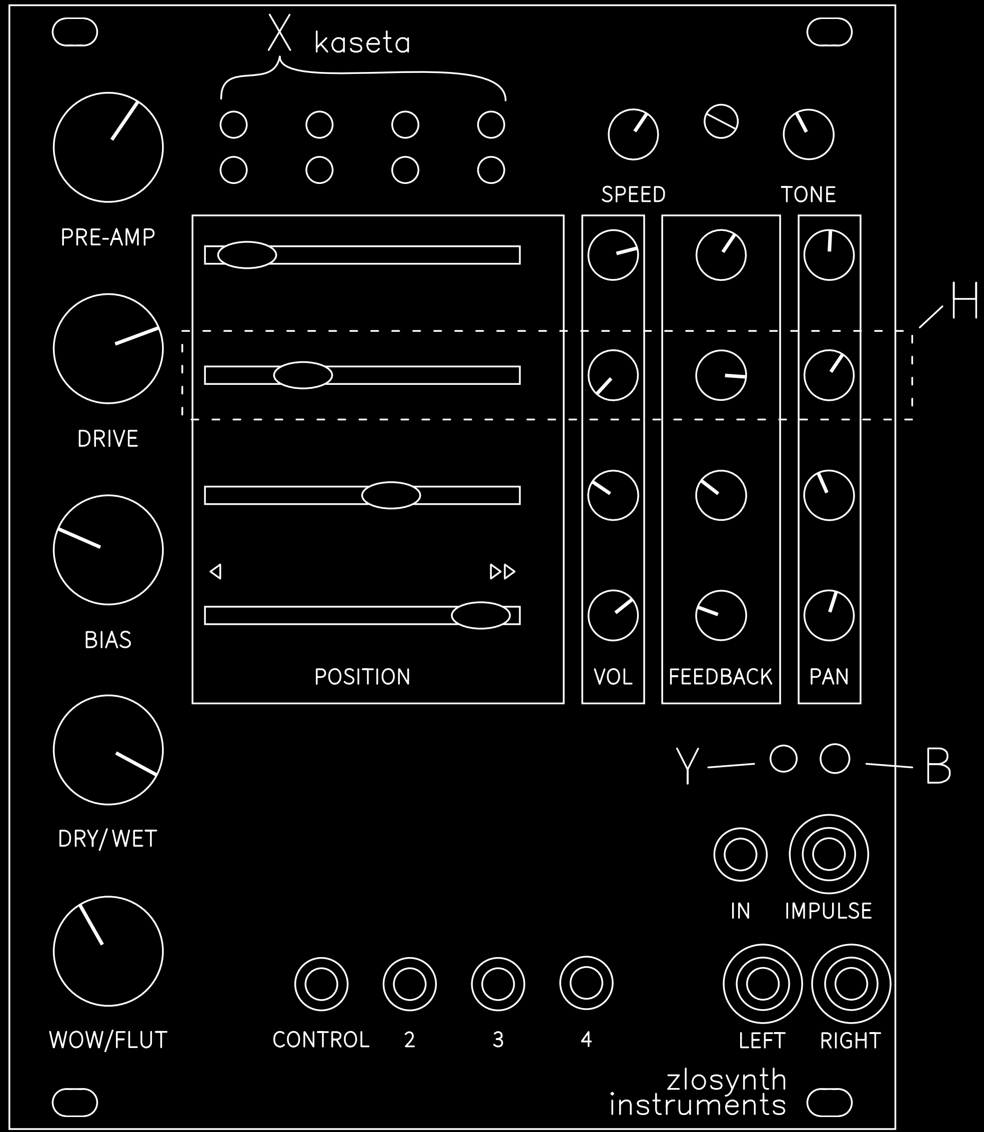
MANUAL

Kaseta is a multi-purpose module inspired by reel-to-reel tape machines. It simulates magnetic hysteresis to provide warm saturation, its four independent delay lines can be used to sculpt rhythms or feedback loops, and it offers wow and flutter control. The module also goes beyond typical tape machine features, with free-moving delays, trigger sequencing, and an internal oscillator.

Width	20 HP
Depth	28 mm
Power	+12 V (117 mA), −12 V (8 mA)
Input impedance	100 kΩ
CV inputs	−5 to +5 V, 16-bit, 1 kHz
Trigger output	0 to +5 V, 10 ms
Audio	24-bit, 48 kHz

- Delay with 4 reading heads
- Up to 5 minutes of audio recording
- Tape saturation simulation
- Wow and flutter effects
- Tone control
- Voltage-controlled oscillator
- Trigger sequencer
- Stereo output



1 Installation

Kaseta is 20 HP wide. It is powered by a +12V/−12V 2×5 connector. The red stripe (−12V) has to be connected on the side of the board marked with the white line. The module must be mounted in a eurorack case.

2 Controls, inputs and outputs

There is one AC coupled audio input IN, and two stereo outputs LEFT and RIGHT. They all operate in the range from −5 to +5 V.

There is a total of 23 knobs. With the four identical rows (H) controlling four independent delay reading heads.

The button (B) serves for tempo tap-in and access to secondary attributes of some knobs: Position of a filter set through TONE, unlimited hysteresis enabled through DRIVE, and internal oscillator enabled through PRE-AMP.

The four CONTROL inputs accept voltage from −5 to +5 V and can be mapped to any of the knobs. Values set by the knob and the control input are summed together.

For most attributes, summing the minimal value of the knob with +5 V control input would produce the maximum value of the attribute. 0 V on the control input would not affect the attribute, and −5 with maximum value on the knob would lead to the minimum value of the attribute.

For TONE and WOW/FLUT, the maximum control input would only offset the value to its middle point.

For the internal oscillator, the control input follows the 1V/oct standard, with the knob adding an offset of −2 to +2 octaves.

The display (X) visualizes dialed-in attributes, warnings and configuration.

The LED (Y) and IMPULSE output are triggered at intervals controlled by the delay heads.

3 Mapping

Each of the four multi-purpose control inputs can be mapped to any of the knobs:

1. Plug a cable into one of the control inputs.
2. Display will signalize mapping.
3. Turn the desired target knob.

The mapping is persisted between restarts. Disconnect a cable to unmap it.

4 Calibration

Some of the attributes follow the 1V/oct standard. Calibrate each of the control inputs to increase the accuracy.

1. While holding the button, connect a jack to an input.
2. The first and second LED should light up.
3. Play note C on the CV source and press the button.
4. Now, the third and fourth LED should light up.
5. Play C one octave higher and press the button again.

The calibration is persisted between restarts and disconnects.

5 Reset

Calibration, mapping and all secondary attributes are persisted between restarts of the module. To reset their values, hold the button pressed while powering on the module.

6 Signal flow

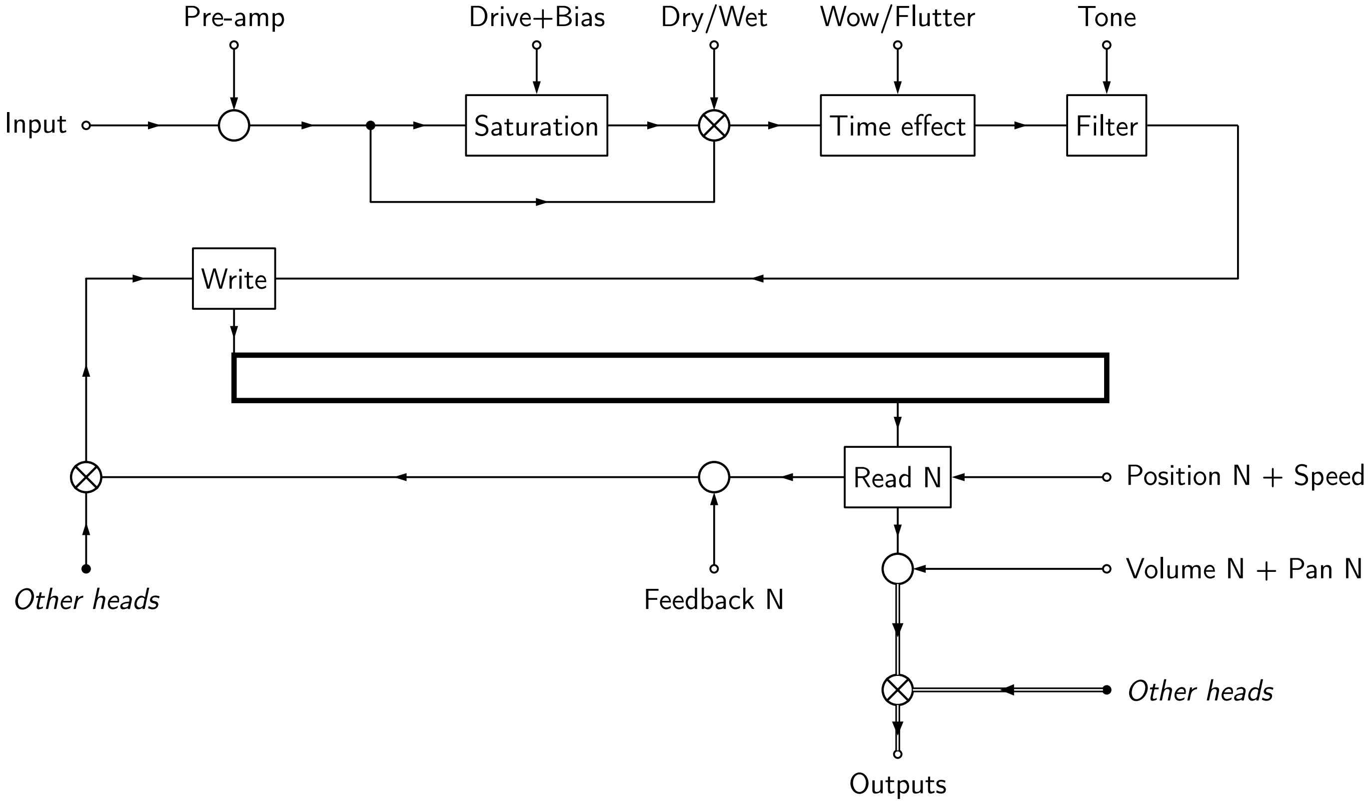


Figure 1: *Signal flow within the module. Only a single reading head is shown for clarity.*

7 Pre-amp

The PRE-AMP attribute attenuates or amplifies the signal received via INPUT between silence and +28 dB. If the input signal is boosted too hard and starts clipping, the display will start blinking.

8 Internal oscillator

The INPUT signal can be replaced with an internal oscillator. This oscillator consists of two sine waves, one of which is a slightly detuned sub-octave.

To enable this feature, turn the PRE-AMP knob to the max while holding the button. The PRE-AMP knob controls the pitch. If a control input is mapped to the pitch, it will follow the 1V/oct standard.

9 Hysteresis

To replicate the warm tape saturation, the modules leverages Jiles-Atherton magnetization model[1]. DRIVE and BIAS are affecting the character of the saturation. DRY/WET blends between clear and saturated signals.

The range of drive and bias is limitted to keep the simulation stable. This limitation can be disabled to reach far harsher distortions, clicks and pops. Disable it by turning the DRIVE knob to the max while holding the button.

10 Tone

TONE applies a filter on the saturated signal. When the pot is at its 12 hours, the filter is disabled. Turning it to the left or right enables a low-pass or high-pass filter, respectively.

Turning this knob to the max while holding the button makes it so the filter gets applied on the feedback of each of the delay heads.

[1] Implementation of this algorithm is based on Jatin Chowdhury's paper `https://ccrma.stanford.edu/~jatin/420/tape/TapeModel_DAFx.pdf`

11 Wow and flutter

The module simulates two phenomena known from the physical medium: Wow, a slow fluctuation of the playback speed, causing the pitch to move up or down. And flutter, abrupt changes of the playback speed, resulting in faster momentary increases of pitch.

WOW/FLUT is controlling these time effects. When the pot is at its 12 hours, the effect is disabled. Turning it to the left or right enables wow or flutter, respectively.

12 Delay

The input signal gets recorded on an imaginary tape by a writing head, to be then, after a set interval, played back by a reading head. See the figure 1.

There are four such reading heads, each controlled by four knobs (H). POSITION sets the relative position in the delay. VOL controls how much of the signal will be sent into the output, with PAN controlling the balance between LEFT and RIGHT. FEEDBACK controls how much of the signal is fed back to the beginning of the delay.

SPEED controls the velocity in which the imaginary tape loops around, or in other words, the length of the delay. By default, this length is between 5 minutes and 10 ms. Turning this knob to the middle while holding the button switches to a shorter range between 8 seconds and 10 ms, turning it to the maximum switches to audio range between 14 Hz and 1.8 kHz.

Alternatively, tap the button four times to set the desired tempo. Similarly, if a clock signal is detected in control input, it would set the tempo, with the SPEED knob acting as a multiplier.

The IMPULSE trigger output will fire in the pattern set through head positions. It is synchronized with the tap-in or clock-in.

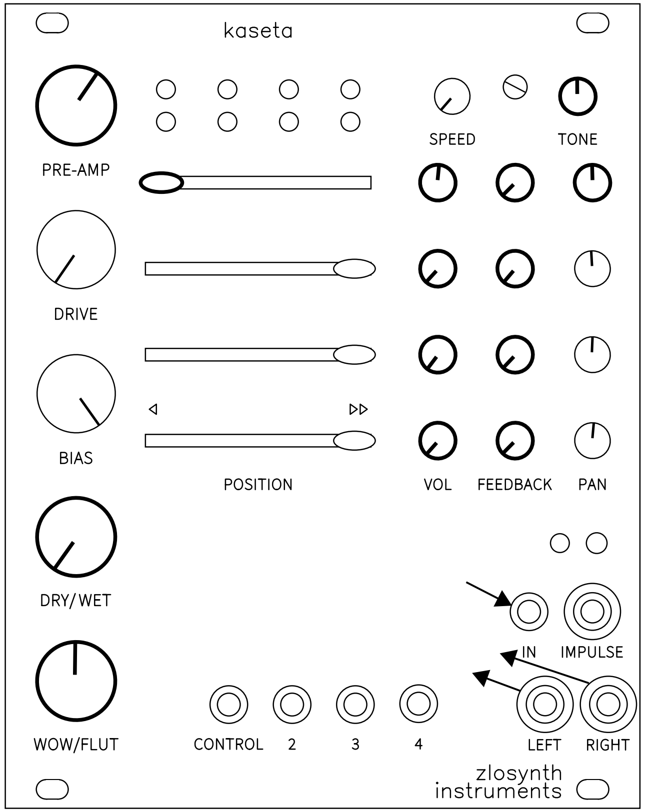
When the signal written to the tape is too loud, it will not allow any feedback to fit in. To allow stronger feedback, reduce the pre-amp or drive.

When the combined strength of all feedback gets too strong, the module may enter into a feedback loop. To get out of this loop, reduce the feedback.

13 Examples

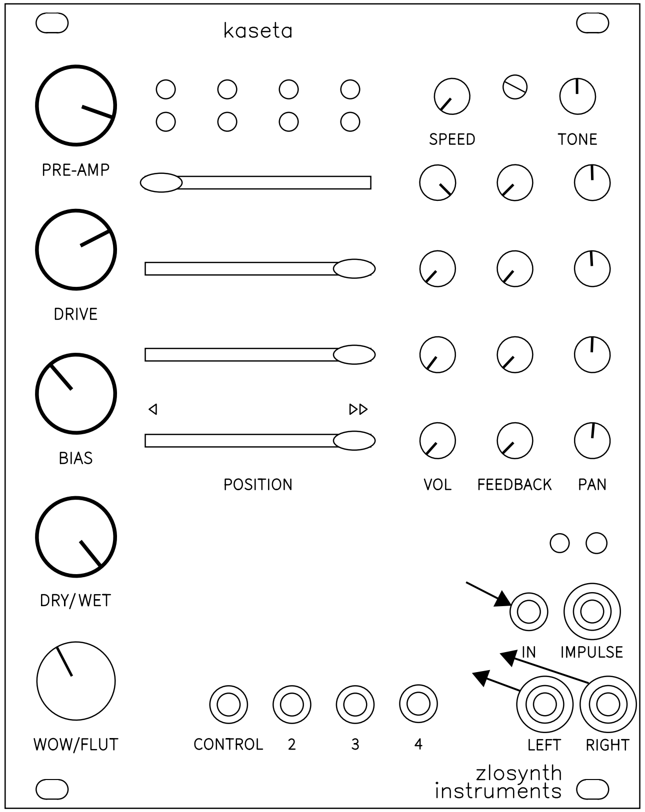
Some basic combinations to get you started.

13.1 Clean slate



Pass through clean unaffected signal.

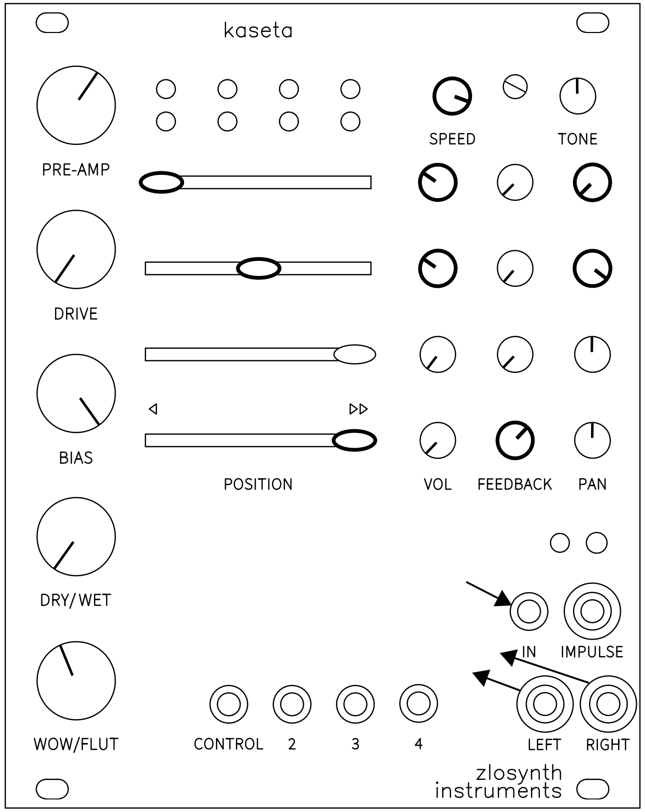
13.2 Saturation



Saturated signal without any delay or effects. Play with the PRE-AMP, DRIVE, BIAS and DRY/WET controls to achieve the desired sound. Try different input sources.

Stronger PRE-AMP usually produces more pronounced saturation, but be careful not to let it clip.

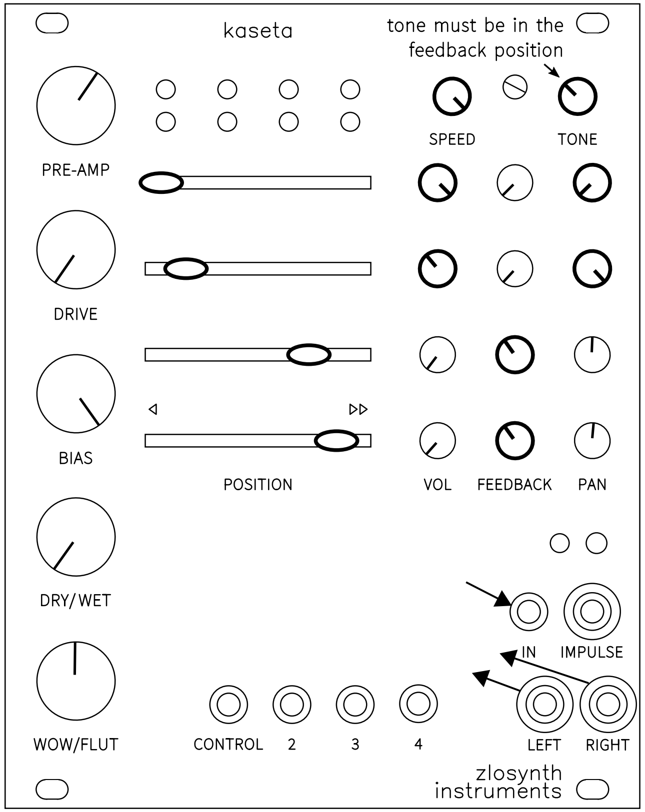
13.3 Ping pong delay



The two top-most heads play the incoming signal with a delay set via POSITION. They are placed left and right using PAN. Note that VOL of both of these heads is reduced to avoid compression or clipping.

The last head is enabled with FEEDBACK, feeding the signal back to the beginning to sustain the echo.

13.4 Haas effect and reverb



The first two heads, playing left and right with a short delay in between, model a Haas effect. This effect makes the mono input sound wide in the stereo output.

The two other heads are enabled with FEEDBACK. The feedback signal is filtered with a low-pass filter configured using TONE. This produces a very simple reverb. If the output sound grows into a loud feedback loop, set TONE or FEEDBACK a little lower.

14 Acknowledgments

Kudos to all the eurorack, DSP, and embedded programming communities online. Here are some of the valuable resources that helped shape this module:

Jatin Chowdhury's white papers *Real-time physical modelling for analog tape machines*[1] and *Complex nonlinearities for audio signal processing*[2], and his open-source plugin *ChowTape*[3]. These materials served as the base for Kaseta's hysteresis model.

Nigel Redmon's blog *EarLevel Engineering*[4] and specifically his series about oversampling[5].

mhampton's implementation[6] of the Ornstein-Uhlenbeck algorithm, which was used as part of the wow effect.

And last but not least, Hainbach[7] and his contagious enthusiasm about tape machines. Which sparked my initial ideas to create this module.

[1] `https://ccrma.stanford.edu/~jatin/420/tape/TapeModel_DAFx.pdf`

[2] `https://ccrma.stanford.edu/~jatin/papers/Complex_NLs.pdf`

[3] `https://github.com/jatinchowdhury18/AnalogTapeModel/`

[4] `https://www.earlevel.com/`

[5] `https://www.earlevel.com/main/category/digital-audio/sample-rate-conversion/`

[6] `https://github.com/mhampton/ZetaCarinaeModules`

[7] `https://www.youtube.com/@Hainbach`

15 Changelog

v1.0 The status LED blinks once

16 Questions?

You can find more information about the module on `https://zlosynth.com/kaseta`.

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