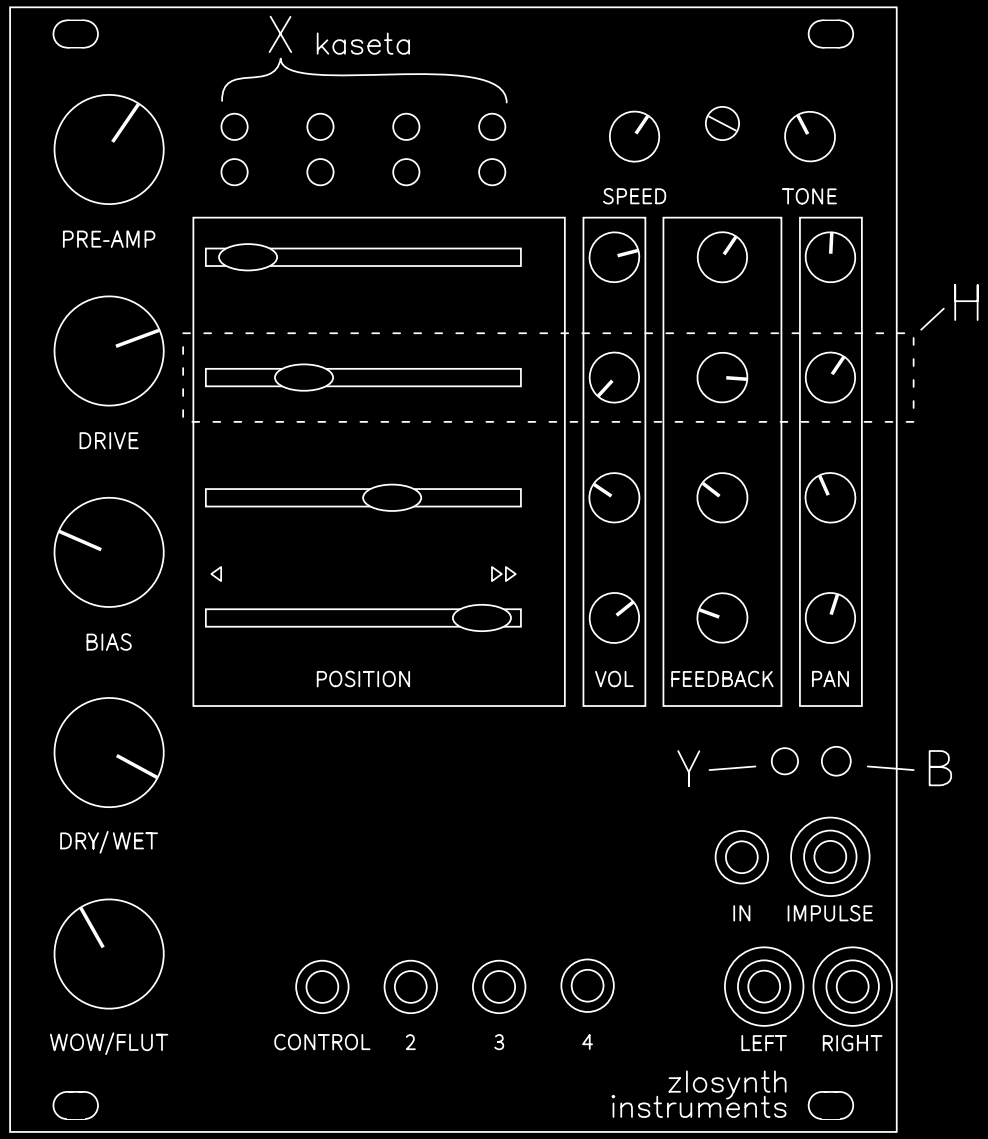
MANUAL

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, placement of wow and flutter effects set through WOW/FLUT, 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 V 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 +1 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 module then enters mapping mode of the given control input.

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

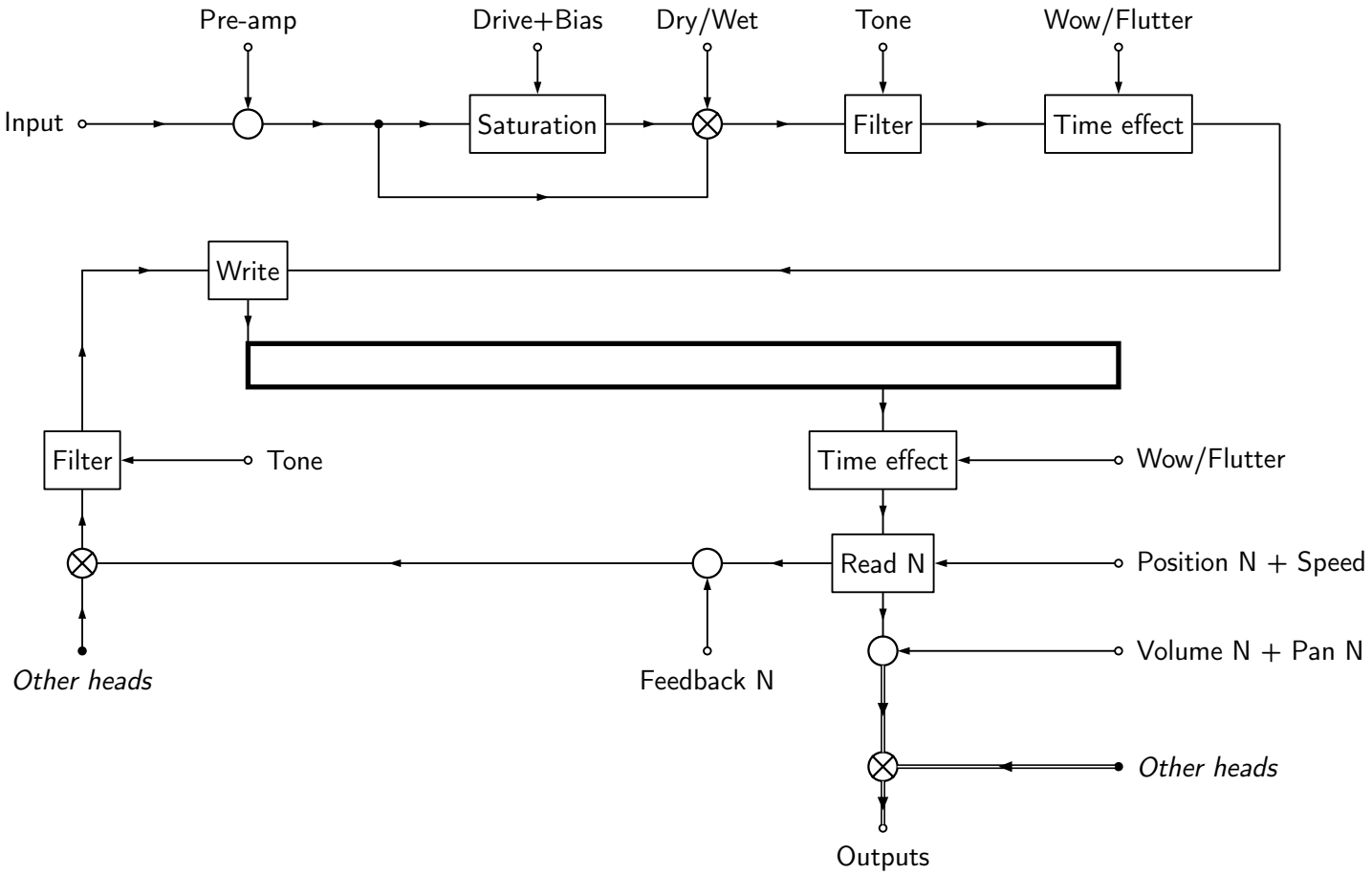


Figure 1: *The default signal flow within the module. Only a single reading head is shown for clarity.*

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.

9.1 Limitting

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.

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

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.

10.1 Placement

There are three placement options for the filter.

On the input – the filter gets applied on the signal after it leaves the saturation stage. This is useful to shave off some unwanted frequencies and can act as a VCF when mapped to a CV input.

On feedback – the filter gets applied on the signal every time it passes through the feedback. This is useful to keep the loop from getting out of hand and also to introduce dampening.

Both simultaneously – both of the placements are active. Default.

Hold the button while turning the TONE knob to switch between the input, feedback, and both placements.

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.

11.1 Placement

There are three placement options for this effect, each with its distinct behavior.

On the input – the effect will be applied to the signal before it enters the delay. This is useful when using multiple heads placed in different positions since the modulation at the time of their reading will vary.

On reading from tape – the effect will be applied when reading the signal back from the tape. This is useful when using feedback, since each time the signal passes through the tape it will get further modulated.

Both simultaneously – both of the placements are active. Default.

Hold the button while turning the WOW/FLUT knob to switch between the input, read, and both placements.

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.

Hold the button for 5 seconds to clear the entire tape.

12.1 Heads

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.

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, or use the tone filter.

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.

12.2 Speed

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 mapped to SPEED, it would set the tempo, with the SPEED knob acting as a multiplier.

12.3 Impulse

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

13 Configuration

Some aspects of the module can be further customized through its configuration menu. To enter the menu, hold the button for 30 seconds. Tap the button again to exit the menu.

13.1 Default display page

Select what should be visualized on the display when pots are inactive.

1. Position within the loop – the LEDs blink in round-robin fashion, representing the current position within the delay loop. Note that this mode is not active when using delay in the audio range. This is the default.

2. Active heads – the top and bottom row of LEDs represent heads with active playback and feedback respectively.

While in the configuration menu, turn the SPEED knob to select the page.

13.2 Position reset trigger

Assign one of the control inputs to the delay position reset. When triggered, the tape loop and the impulse output sequence are brought to their beginning.

Note that this does not rewind the delayed audio, but merely sets a new virtual beginning of the loop.

While in the configuration menu, turn the TONE knob to select a dedicated control input for this mapping. Turning it all the way to the left will disable this mapping.

13.3 Pause/resume trigger

Assign one of the control inputs for pause/resume of the delay line. When paused, delay retains its current position, and it won't record or play back any signal. The delay can be also resumed by tapping-in a tempo.

While in the configuration menu, turn the first PAN knob to select a dedicated control input for this mapping. Turning it all the way to the left will disable this mapping.

13.4 Tap-in interval

Configure the length of the tap-in interval. Using a shorter interval makes dialing in longer delay lengths easier. Setting the right interval may also provide more intuitive control of tempo for cases where you count beats and bars.

1. 1/16 of the delay length – the delay is four times as long as the the time it takes to tap-in. This is as if you counted-in 4 bars long sequence.

2. 1/8 of the delay length – the delay is twice as long as the time it takes to tap-in. This is as if you counted-in 2 bars long sequence.

3. 1/4 of the delay length – the length of the delay is the same as the total time it takes to tap-in.

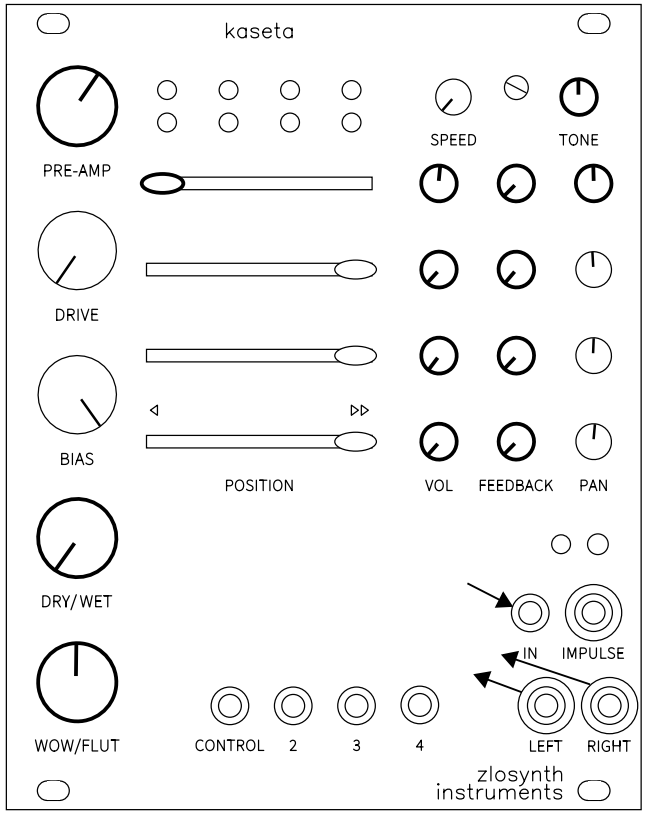
4. Full delay length – the length of the delay is equal to the interval between each of the taps.

While in the configuration menu, turn the second PAN knob to select the desired interval.

14 Examples

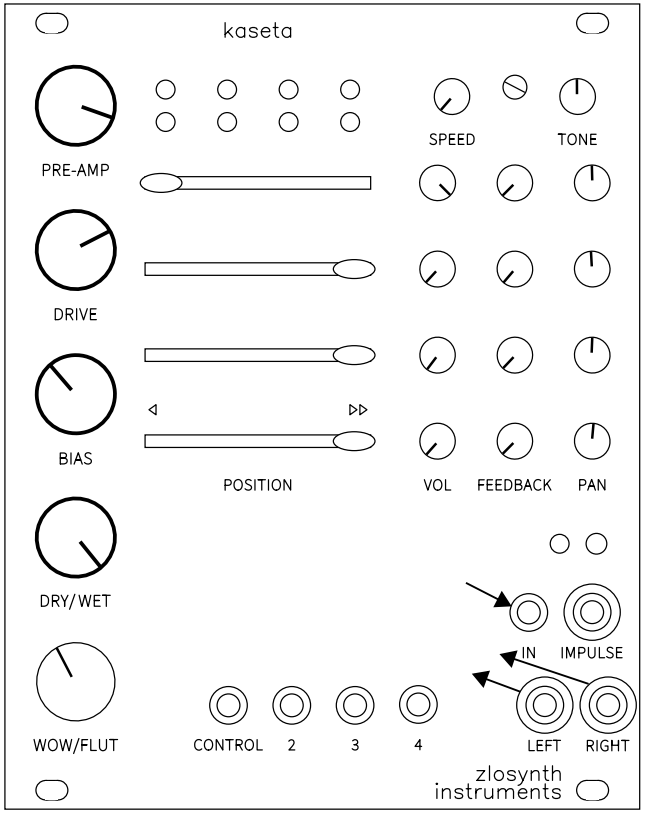
Some basic combinations to get you started.

14.1 Clean slate



Pass through clean unaffected signal.

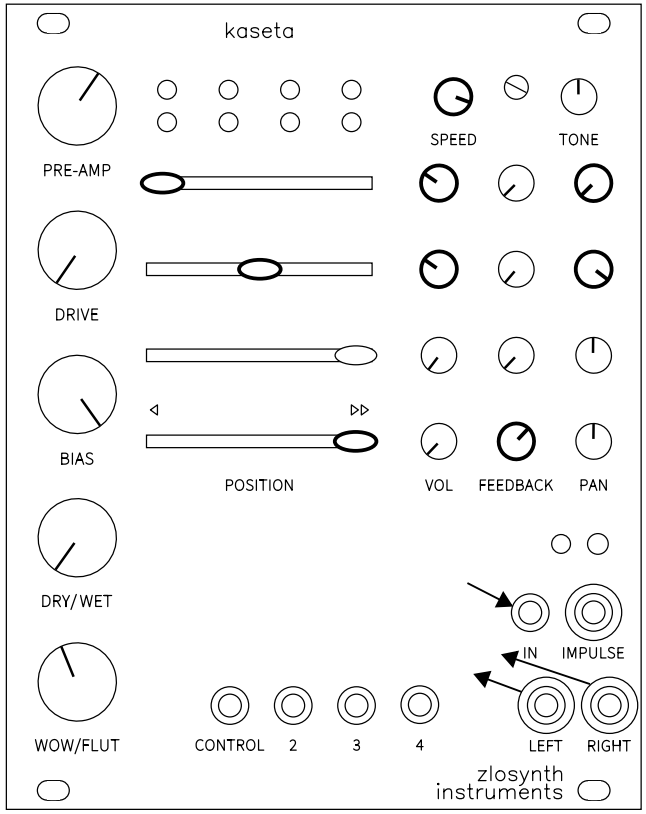
14.2 Saturation



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.

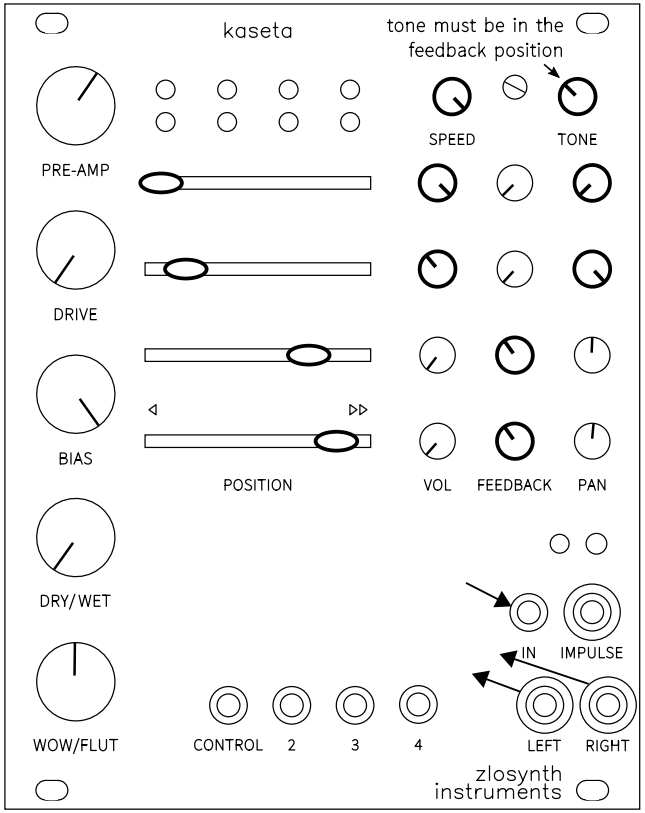
14.3 Ping pong delay



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.

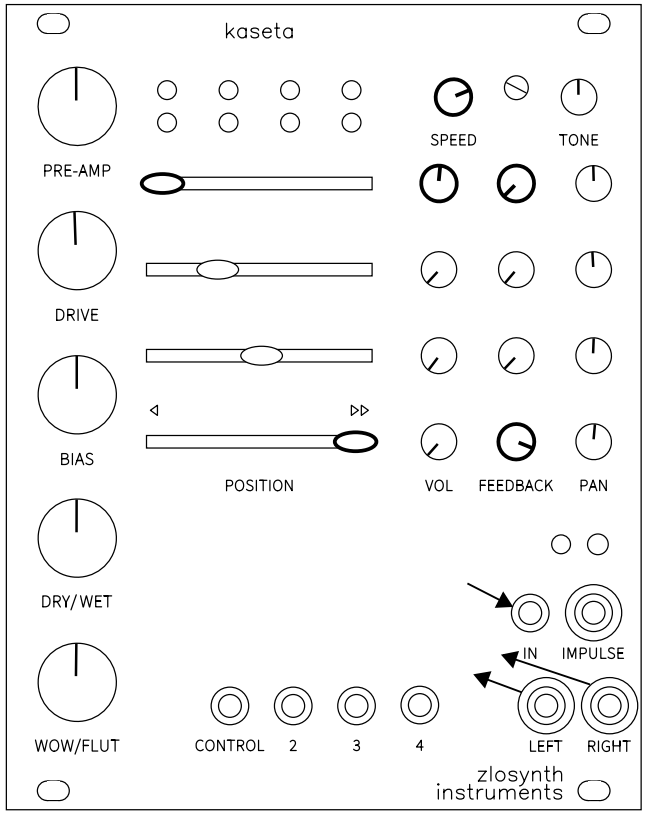
14.4 Haas effect and reverb



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.

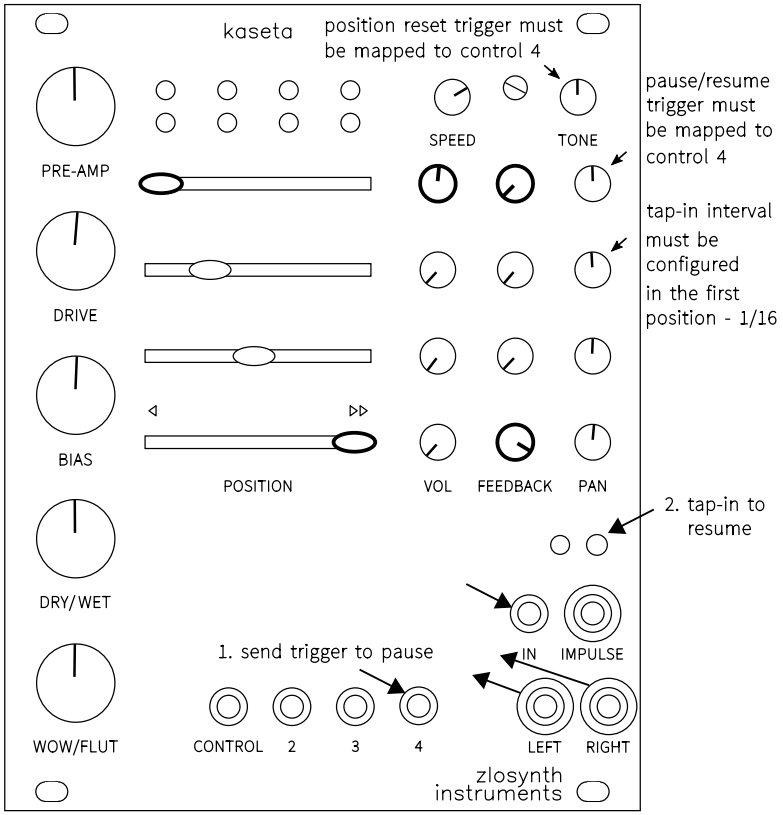
14.5 Frippertronics looper



The first head plays the incoming sound and sound that's fed back by the last head. The feedback gain of the last head is set around unity, so it retains the previously recorded sound indefinitely. The length of the loop depends on the SPEED knob.

Play with the tone or WOW/FLUT controls, so the looped sound changes over time. Bring in other heads to introduce layers from different parts of the loop. You can optionally map clock input to SPEED, so your loop will be synchronized.

14.6 Improved Frippertronics looper



This builds on the previous example, adding some configuration tweaks to provide better user experience, closer to using a dedicated looper.

Using pause/resume and reset position trigger inputs allows you to reset the buffer and start recording the loop when you are ready. Read sections 13.2 and 13.3 to learn how to map these triggers.

To dial in the desired loop length accurately, configure a shorter tap-in interval. This will allow you to effectively count in the loop sequence. Tapping-in unpauses delay if it is paused. Read section 13.4 to learn how to customize the tap-in interval.

15 Acknowledgments

Kudos to all the eurorack, DSP, and embedded programming communities online. Here are some of the people and 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.

Hainbach[7] and his contaigious enthusiasm about tape machines. Which sparked my initial ideas to create this module.

Ale Moglia, aka Bartola Valves[8], for suggesting to extend this module's looping capabilities and introducing me to Frippertronics.

[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`
[8] `https://www.bartola.co.uk/valves/`

16 Changelog

v1.0 The status LED blinks once
v1.2 The status LED blinks twice
Holding button clears the tape
New wow and flutter placements
New filter placements
v1.3 The status LED blinks three times
Default display can be customized
Configure the tap/delay length ratio
Delay position can be reset
Delay playback can be paused
Optimizations for use as a looper

17 Questions?

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

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