

# ChowTape User Manual

**ChowTape** is an analog tape machine physical model, originally based on the Sony TC-260. The current version can be used to emulate a wide variety of reel-to-reel tape machines, using physics-based emulation algorithms<sup>1</sup>. The plugin is currently available for Windows, Linux, Mac, and iOS in the following formats: VST/VST3, AU, CLAP, LV2, AAX, AUv3, and Standalone.

## Installation

To install ChowTape for desktop, download the plugin installer from the [ChowDSP website](#). If you would like to try the latest changes (unstable), you can download the latest [Nightly build](#). It is also possible to compile the plugin [from the source code](#). ChowTape for iOS can be downloaded from the [App Store](#).



Figure 1: A Sony TC 260 reel-to-reel tape machine

<sup>1</sup>The plugin is based off a 2019 DAFx paper “[Real-time Physical Modelling for Analog Tape Machines](#)”.



Figure 2: *ChowTape* User Interface

## Controls

ChowTape contains a wide range of controls allowing the user to design the the physical characteristics of the tape machine and magnetic tape being emulated. Several of the controls even allow the user to achieve more “extreme” results than would be possible with a physical tape machine.

### Main Controls

**Input Gain** controls the gain level going into the rest of the plugin. Note that abnormally large levels can cause the plugin to become unstable, so it is recommended that sound levels are at or below unity gain going into the plugin, and any extra gain should come from the input gain control.

**Dry/Wet** allows the user to choose how much of the signal they want to the plugin’s processing to affect.

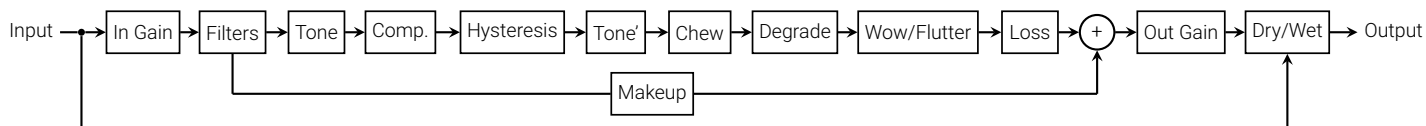


Figure 3: Signal flow for the ChowTape plugin. Note that the Tone block contains a set of pre-emphasis filters, while the Tone' block contains the corresponding post-emphasis filters.

**Output Gain** controls the level coming out of the plugin.

**Oversampling** controls the amount of oversampling being done internally within the plugin. More oversampling will result in a higher quality sound with fewer aliasing artifacts and better noise characteristics, but will also use more CPU. It is recommended to use as much oversampling as your CPU will allow.

**Mix Group:** When using ChowTape on multiple channels in a mix, you can synchronize parameters between plugin instances belonging to the same mix group. Essentially, all the plugin instances in the same mix group will share the same parameters.

## Input Filter Controls

The ChowTape input filters apply a low-cut and high-cut filter to the input signal before it is passed on to the rest of the plugin. The **Low Cut** and **High Cut** knobs control the cutoff frequencies of the two filters. The **Makeup** control allows the signal cut out by the input filters to be added back to the output of the plugin. Makeup be useful by allowing sub-bass frequencies to pass through the plugin unaffected.

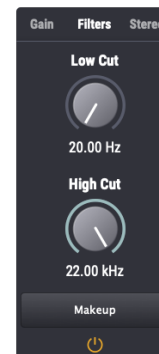


Figure 4: Input filter controls

## Stereo Controls

When using ChowTape in **Stereo** mode, the plugin will process the input signal as a left/right pair. In **Mid/Side** mode, the plugin will encode the input signal as a mid/side pair, process the mid/side signal, and then decode the signal back to a left/right stereo pair at the output.

The **Balance** control makes one of the channels louder than the

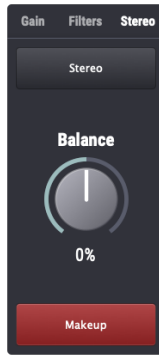


Figure 5: Stereo controls

other, either “panning” the signal, or emphasizing either the mid or side part of the signal. The **Makeup** control allows the signal which was attenuated by the Balance control to be amplified by the same amount at the output of the plugin. Makeup can be useful by allowing either the mid or side part of the signal to be distorted more heavily by the plugin. When using the plugin with a channel configuration other than stereo, these controls will have no effect.

## Hysteresis Controls

The hysteresis processing is the most important section of the plugin. **Hysteresis** is a complex nonlinear phenomenon that describes many natural processes in physics, biology, economics, and more. In particular, magnetic hysteresis describes the process by which tape becomes magnetised when subjected to a strong magnetic field. ChowTape emulates magnetic hys-



Figure 6: Tape hysteresis controls

teresis, using the Jiles-Atherton<sup>2</sup> model of magnetic hysteresis. Magnetic hysteresis is largely responsible for the “warm” sound often associated with analog tape distortion.

**Drive** controls the level of amplification done by the hysteresis process. This differs from the input gain in that it affects the nonlinear characteristic of the hysteresis process.

**Saturation** controls the level at which the hysteresis function saturates. Higher values correspond to a lower saturation point, resulting in a more distorted sound.

<sup>2</sup>Jiles, D.C.; Atherton, D.L. (1984) “Theory of ferromagnetic hysteresis” *Journal of Applied Physics*.

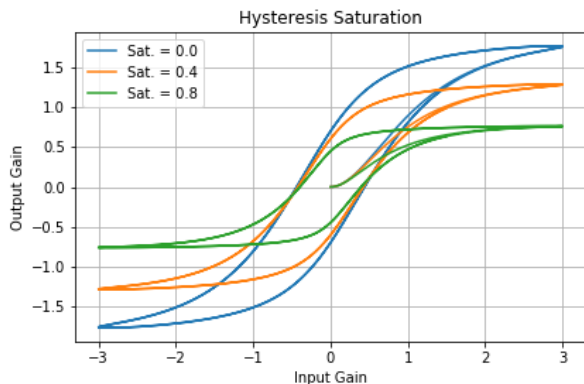


Figure 7: Hysteresis curves with varying saturation

**Bias** controls the amount of bias used by the tape recorder. Tape bias is the addition of an inaudible high-frequency signal to the audio signal<sup>3</sup>. At lower bias levels, the hysteresis curve becomes “wider”, thus creating the “deadzone” effect often associated with underbiased tape.

**Hysteresis Mode** selects the equation solver used to solve the Jiles-Atherton equation in real time. ChowTape currently supports the following hysteresis modes:

- 2nd-order Runge Kutta (RK2)
- 4th-order Runge Kutta (RK4)
- 4-iteration Newton Raphson (NR4)
- 8-iteration Newton Raphson (NR8)

<sup>3</sup>More information on tape biasing

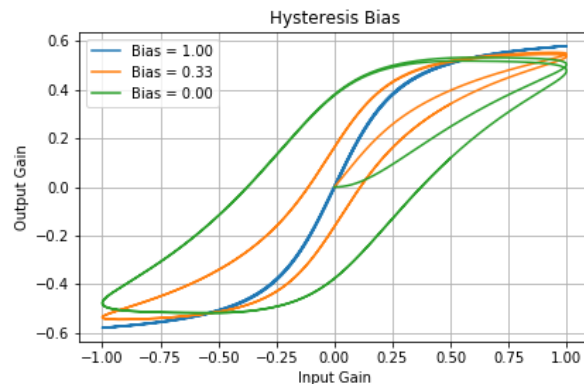


Figure 8: Hysteresis curves with varying bias

- State Transition Network<sup>4</sup> (STN)
- Version 1.0 processing (V1)

The Runge-Kutta solvers are computationally cheaper, but somewhat less accurate than the Newton-Raphson solvers. Similarly, the higher-order solvers will be more accurate, but will also consume more compute resources. The State Transition Network is designed to be a computationally cheaper approximation of the NR8 solver; although it distorts more harshly at extreme settings. The V1 mode reverts to a different parameterization of the hysteresis equation that was used in earlier versions of the plugin. It is recommended to use higher-order solvers for mix busses and key tracks in a mix, while using lower-order solvers for less important tracks.

<sup>4</sup>Parker, J.D. et. al. (2019) “Modelling of Nonlinear State-Space Systems using a

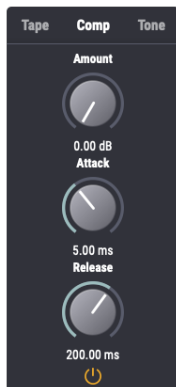


Figure 9: *Tape compression controls*

## Compression Controls

The compression section applies a characteristic compression curve to the signal, which can be useful for reducing the dynamic range of the signal before going into the hysteresis processing.

**Amount** controls the level at which the compression curve starts to take effect. At 0 dB, the compression has no effect on the signal. At 9 dB, any signal above -9 dB will start to be compressed.

The **Attack** parameter controls how quickly the compression will start to take effect once the signal enters the range where it is being compressed.

Deep Neural Network" Proc. 22<sup>nd</sup> Int. Conference on Digital Audio Effects.

Similarly, the **Release** parameter controls how quickly the compression backs off once the signal is no longer in the compression region.

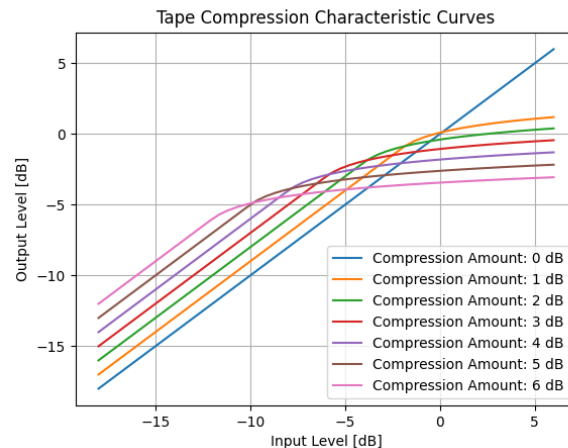


Figure 10: *Tape compression characteristic curves*

## Tone Controls

The tone section applies a set of pre-/post-emphasis filters to the signal before and after the hysteresis processing is applied. The filters work similar to [RIAA filters](#), in that the pre- and post-filters have exact opposite frequency responses.

The **Bass** and **Treble** knobs control the frequency response of

the pre-emphasis filter, and the post-emphasis filter will automatically adjust. The **Frequency** knob controls the transition frequency between the bass and treble sections of the filter.

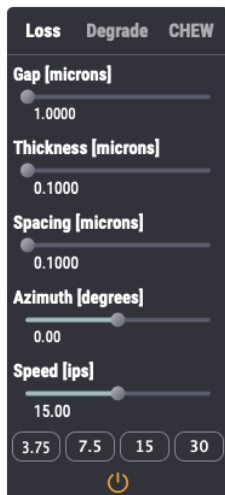


Figure 11: Loss filter controls

## Playhead Controls

Physical tape machines also have a frequency response that is affected by the amount of space between the playhead and the tape, the width of the playhead gap, and the thickness of tape used. The frequency responses of each of these “loss effects” is also dependent on the tape speed.

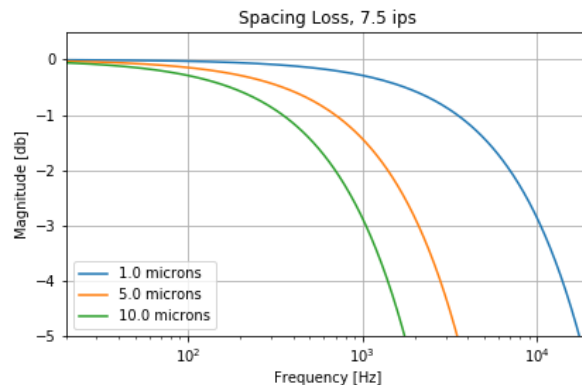


Figure 12: Spacing loss at 7.5 ips

**Spacing** controls the amount of space between the playhead and the tape, measured in centimeters.

**Thickness** controls the thickness of the tape, measured in centimeters.

**Gap** controls the width of the playhead gap, measured in millimeters.

**Azimuth** controls the playhead alignment angle<sup>5</sup>. A misalignment between the playhead and the tape causes a corresponding time misalignment between the two stereo tracks on the tape, resulting in a stereo “widening” effect.

<sup>5</sup>[More information on playhead azimuth.](#)

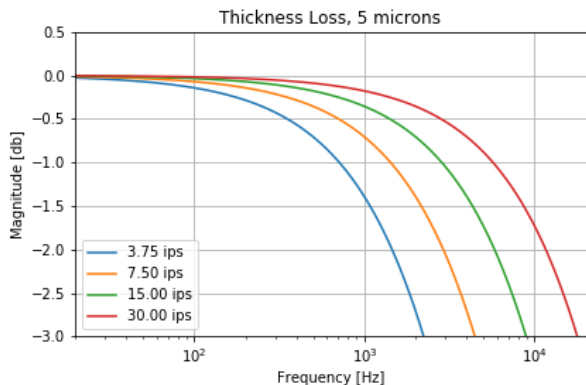


Figure 13: *Thickness loss for 5 micron tape*

**Speed** controls the tape speed as it effects the above loss effects, measured in inches per second (ips). While this control is continuous, the parameter can be quantized to the standard speeds for reel-to-reel tape machines: 3.75, 7.5, 15, and 30 ips.

## Tape Degradation Controls

The degradatation parameters control a simulation of old tape that has been used over and over, and has started to degrade.

**Depth** controls the intensity of the wear on the tape. Enable the **0.1x** option to make this control more subtle.

**Amount** controls the amount of wear, typically corresponding to the age of the tape.

**Variance** adds a time-varying randomness to the degradatation.

**Envelope** applies an amplitude envelope to the tape noise.

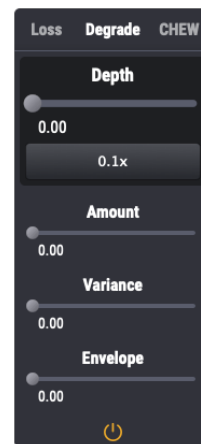


Figure 14: *Degradation controls.*

## Chew Controls

The chew parameters simulate tape that has been chewed up by a broken tape machine. **Depth** controls how deep the tape is chewed, **Frequency** controls how much space there is between bits of tape that have been chewed up, and **Variance**

determines how much randomness there is in determining the amount of space between chewed up sections.

## Wow and Flutter Controls

---

Tape machines also exhibit timing irregularities, often due to small imperfections in the mechanics of the machine causing the tape to subtly speed up and slow down while being played back. The flutter characteristic in this plugin was captured from an original Sony TC-260 tape machine.

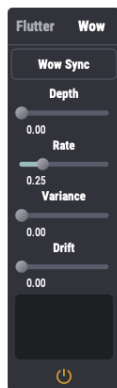


Figure 15: Wow controls.

**Depth** controls the depth of the flutter and **Rate** controls the rate of flutter, with higher values causing the flutter to occur faster. Note that the flutter rate can be synchronized to the tape speed, or to the tempo of the song.

**Wow** is similar to flutter but on a much longer time scale, and

contains similar controls, as well as **Variance** and **Drift** which control the random irregularities that cause the wow characteristic.

## Presets

---

Presets provide a quick way to achieve a specific sound with the plugin. ChowTape comes with a set of built-in factory presets. To contribute your presets to be added to the factory presets list for future releases, see the [Presets GitHub issue](#).

## User Presets

---

To save the current plugin state as a user preset, open the presets menu, and select “Save”. The first time a preset is saved, you will be asked to choose a preset folder. All future presets will be saved to this folder, and when the plugin opens, it will search this folder, as well as any subfolders, to load new user presets. Presets located in subfolders will be placed in their own groups in the preset menu.

## Accessibility

---

ChowTape includes accessibility for screen readers on Windows and Mac OS. All the controls in the user interface may be navigated using either the screen reader’s navigation keys, or using the “Tab” key. Users may interact with buttons and menus using the “Enter” key. For continuous slider controls, the following keyboard shortcuts are supported:



- Up/Down Arrow Key: Nudge the slider value.
- Page-Up/Page-Down Key: “Big” nudge the slider value.
- Delete Key: Move the slider to its default value.
- Home Key: Move the slider to its minimum value.
- End Key: Move the slider to its maximum value.

Note that Windows users will want to ensure that OpenGL is turned off when using the plugin with a screen reader, otherwise the screen reader software may not be able to navigate into the plugin window.

## **Troubleshooting**

---

If you run into issues when using ChowTape, you may submit bug reports using GitHub Issues. However, it is recommended to read the following troubleshooting suggestions first.

### **Resetting Global Settings**

---

If you run into any issues that require the global settings to be changed or reset, the global settings file can be found in the users “AppData” directory (Windows), “Library” directory (Mac OS), or “.config” directory (Linux). To reset the global settings, you may delete this file, and it will automatically be regenerated the next time the plugin is used.

### **OpenGL Rendering**

---

On Windows and Linux, ChowTape will have the option to use OpenGL for rendering the UI, unless the host system does not

support OpenGL version 2.0 or greater. If OpenGL is available, it is possible to turn rendering with OpenGL on or off in the global settings menu. If you need to override your chosen OpenGL setting, please visit the global settings file.

### **Copying Plugin Diagnostics**

---

If you need to submit a bug report, it is very useful to include the plugin’s diagnostic information in your bug report. The diagnostic info can be copied from the global settings menu.

## **Open Source**

---

ChowTape is open-source software that is free (as in “free beer”), and free (as in “free speech”), under the [General Public License](#). As a research project, the goal of developing this plugin is to help advance the body of knowledge of real-time audio signal processing. Therefore, keeping any part of this project behind a paywall, or licensing this software under a proprietary license would be antithetical to that goal. As an open-source project, ChowTape is open to outside contributors. For more information, see our [Contributing](#) page.

## **Feedback**

---

If you notice any bugs, or have any questions, feel free to [email me directly](#), or [create an issue ticket](#) on GitHub. GitHub issues are preferred, since they are publicly visible.

# Acknowledgements

---

Thanks to Yann from SINK Music for helping to create this user manual, as well as all the users of ChowTape who have made efforts to help improve the plugin.

Enjoy!

Jatin Chowdhury

<https://github.com/jatinchowdhury18/AnalogTapeModel>