

# **E520 Effects**

V1.3 – July 30, 2023

# Table of Contents

Introduction.....	4
Interfaces.....	4
Menu Organization.....	5
Main Page.....	5
Top Page.....	6
Prefs Page.....	6
LFOs Page.....	8
Patch Page.....	8
File Page.....	8
Color Page.....	9
Moses Page.....	9
About Page.....	9
About Overloads.....	10
Emergency Mute.....	10
Tap Tempo.....	10
Description of E520 Algorithms.....	12
Time Domain Delay Effects.....	12
Resampling Mini Delay.....	12
Clean Delay.....	14
Resampling Delay.....	16
Prime Delay.....	17
Reversible Delay.....	19
Diffusion Flanger.....	21
Chowder Delay.....	23
Pattern Delay.....	24
Resonators.....	26
Multitap Delay.....	28
SeqWah.....	30
Headspace.....	32
Time Domain Shift Effects.....	33
Deflector Shield.....	33
Frequency Shifter.....	35
Phaser.....	37
Granular Pitch.....	38
Shimmer Reverb.....	39
Resampling Reverb.....	41
Reflexions.....	43
Convolution.....	45
Multi-Chorus.....	46
Voder.....	48
Dual Mono.....	49
Looping and Sampling Effects.....	52
Looper.....	52
Sampler.....	54
Spectral Effects.....	55
Spectral Crusher.....	55

Spectral Time Machine.....	57
Spectral Delay + Pitch.....	59
Spectral Delay.....	61
Spectral Vocoder.....	62
Spectral Drone.....	63
Spectral Drone Hi-Res.....	65
Spectral Sweep.....	65
Miscellaneous Effects.....	66
Envelope-Wah.....	66
Dirt.....	68
Utility Effects.....	69
Scope.....	69
Revision History.....	71

## Introduction

The Synthesis Technology E520 Hyperion Processor is a stereo audio effects generator operating at 24-bit 48kSPS with a rich complement of algorithms that range from traditional to experimental, including delays, frequency shifts, phasing, flanging, filters, reverberation, looping, sampling and frequency domain manipulation. With responsive CV control of real-time parameters and an intuitive, shallow graphic user interface it is designed to easily integrate into Eurorack systems, but also has flexible audio I/O levels for use as an outboard effects unit.

## Interfaces

The E520 provides the following interfaces and controls:

- User Interface
  - Bright and readable 320 x 240 color graphic LCD
  - High-reliability rotary encoder with pushbutton for user-interface navigation
  - Four tactile pushbuttons for menu selection and mode control.
  - Micro SD card slot for firmware updates, audio file load / store operations and parameter backup.
  - Tap-tempo / sync pushbutton
- Control Voltages
  - Four Algorithm Parameters with offset and attenuator pots.
  - Left and Right Feedback controls, with offset and attenuator pots. Note that for most algorithms these controls provide inverting feedback when turned CCW from the center position and positive feedback when turned CW from center. Some algorithms which don't provide feedback use these controls for other parameters and will note this in their individual descriptions.
  - Left and Right Wet/Dry mix controls, with offset and attenuator pots. Usually these control basic Wet/Dry mix, but the function of the Right Wet/Dry can be overridden for voltage-controlled algorithm selection with a Preference page setting.
  - Tap / Sync input jack (in parallel with the Tap-tempo / sync button)
  - One auxiliary output voltage which can be used to output an internal LFO, or some algorithms provide additional outputs that can be sent here.
- Audio
  - Left and Right audio input – either Modular or Line level.
  - Left and Right audio output – either Modular or Line level.

# Menu Organization

## Main Page

At power-up the Main Page is active. All effects are accessed in this page which is divided in five separate areas:

1. Header area – contains the page title and several indicators, including the In/Out Filter status, patch name, Mute status (speaker-slash icon) and EEPROM status light (green means EEPROM is up-to-date, red means EEPROM will be updated with parameter changes within a few seconds).
2. Menu area – contains four items which can be selected via the rotary encoder:
  1. Exit – select this item and press the encoder button to leave the Main Page and enter the Top Page which allows access to other menus that control the E520.
  2. Algo – select this item and press the encoder button to select the active effect. Selection uses a pop-up scrolling menu.
  3. P2 – drops down into the algorithm-specific settings page where you can change parameter routing options, In/Out filter settings and additional per-algo settings (if any).
  4. P3 – drops down into the algorithm-specific patch page where you can load and save patches for the currently selected algorithm.
3. Effect area – where the active algorithm renders its status
4. VU meters – L/R input and output volume indicators which show real-time signal levels on input and output channels. When the VU meters show red then there is a strong likelihood of clipping distortion.
5. Indicators for Feedback and Mix settings – four small slider widgets that show the current state of the Feedback and Mix controls. When these controls are centered the ‘thumb’ of the widget is a filled circle, otherwise it is an outline. When Feedback controls are centered the amount of feedback is zero. When Mix controls are centered the output will be an equal proportion of wet and dry signal.
6. Buttons – legends and status of the four UI buttons appear in this area. The three left-most buttons are dedicated to effect parameters while the right-most button is usually a bypass function that disables the effect and passes audio thru the E520 without modification.  
NOTE: In the Looper algorithm the right-most button is repurposed so the bypass function is not available and any currently active bypass operation is disabled when the Looper is started.

## Pg2

Pg2 (Page Two) off the Main page provides a list of algorithm-specific settings including:

- Items 1-6 are internal routing matrix settings that allow assigning CV inputs and internal LFOs to the various parameters of the algorithm.

- HPF In – a high-pass filter applied to the audio inputs prior to the algorithm. Can be used to shape the way the E520 algorithm “sits in the mix”.
- LPF Out – a low-pass filter applied to the audio outputs after the algorithm. Also useful for sculpting the sound of the E520 for mixing.
- Some algorithms have additional parameters on Pg2 and these are described in more detail with each algorithm.

## Pg3

Pg3 (Page Three) off the Main page provides twelve “Algorithm Specific” patches which use just the current algorithm. These can be saved and loaded using either the four buttons, or the encoder. As shipped from the factory, at least one of these six will already be defined as a “factory preset”, created by our own Robert Rich to help demonstrate some of the unique capabilities of the E520.

## Top Page

The Top page is used to select other functional pages. It provides a short list of other pages that can be entered by scrolling with the encoder and pressing the button. At the bottom of the Top page the current firmware revision is displayed.

## Prefs Page

The Prefs page provides a list of editable parameters which are stored in system EEPROM and control various aspects of operation that are not directly related to algorithms and patching.

1. Time Display – select Seconds or BPM for display of some time values on the Main page.
2. Frequency Display – select Hz or BPM for display of some frequency values on the Main page.
3. Parameter style – select Pie, Arc or Bar for the visual widget indicator of CV parameters on the Main Page.
4. Input Level – select Modular (12Vpp) or Line (+4dBu typical, +9dBu max) for the max input level on the audio input jacks.
5. Output Level – select Modular (12Vpp) or Line (+4dBu typical, +9dBu max) for the max output level on the audio output jacks.
6. Aux Output – select “Algorithm” for auxiliary output from algorithms, or LFO1-4 to drive the Aux jack with the output of one of the 4 internal LFOs.
7. CV Patch Load – when “Patch+LRMix” the Right Mix CV input can be used to select the active patch from the 24 Global patches on the Patch page and both Left and Right mix settings are controlled by the Left mix input. When “LRMix” the Left and Right mix settings are controlled by the Left mix input but patches are still selected manually. When “Off” (default) the patches must be selected manually and the Left & Right mix controls are separate. Note – in either “Patch+LRMix” or “LRMix” settings, the Right Mix function is still active from this CV input but may be reassigned to another CV or a fixed value using the assignments on Pg 2.

8. Feedback Limiter – The feedback and filter resonance loops have an optional limiter to prevent runaway overloads (“explosions” or “screaming”). When the threshold loudness is exceeded the gain in the feedback loop is dialed down to prevent overload signals. There are four settings:
  1. Soft. (Default) Threshold of -6dBfs, 0.8s attack time, 1.6s release time.
  2. Medium. Threshold of -9dBfs, 0.5s attack time, 1.0s release time.
  3. Hard. Threshold of -12dBfs, 0.3s attack time, 0.6s release time.
  4. Off. Limiter is disabled. Allows direct control of feedback and can allow much longer tails. Be very cautious with this setting as extremely loud outputs may occur if feedback or resonance controls are dialed up to the extremes.
9. Tempo Hysteresis – Sets the hysteresis window below which tap tempo jitter is ignored in some delay-based algorithms. Values are 2, 5, 10 and 20ms. Use this setting if you’re driving the sync input with a source that has significant jitter and you want to prevent the delay from constantly readjusting. The “Tap” mode of the Scope algo can be used to estimate the amount of jitter present, then set the Tempo Hysteresis larger than that amount.
10. Wet/Dry mix type – selects the control curves for the Wet/Dry mix knobs:
  1. Linear – curves are simple 0-100% ramps that cross at 50/50 in the center.
  2. Const Pwr – curves are square-law that cross at 71/71 in the center.
  3. Center Full – curves are flat to the center at 100/100 then linear.
  4. Wet Only – Dry signal is ignored and linear gain is applied to the Wet signal.
11. Sync Rate – selects the sync input divider ratio:
  1. Quarter – quarter note sync. 1:1 clock ratio.
  2. Sixteenth – sixteenth note sync. 4:1 clock ratio.
  3. 24PPQ – 24 pulses per quarter note. 24:1 clock ratio.
12. Bypass – selects how Bypass button behaves
  1. SW (default) – audio bypass is implemented in DSP, normal latency is preserved and uses crossfade for minimal clicking.
  2. HW-Fast – audio bypass takes place outside of DSP and has reduced latency. Fast mode may generate noticeable “click” but happens instantly.
  3. HW-Slow – also done outside DSP and has reduced latency, but audio mutes / unmutes during changeover to reduce clicking. May result in “thumping”.

## LFOs Page

The LFOs page provides an overview of and access to four internal LFOs which can be used instead of CV inputs to drive any one of the eight algorithm inputs. Each LFO allows control over:

1. Frequency from 100 sec / cycle to 10Hz.
2. Waveform – Sine, Triangle, Saw Up, Saw Down, Square, Slow Noise, Fast Noise, Triangle Modulation, 5-cycle Sine, Full-Wave-Rectified Sine, 10% pulse, Stepped Random, Slew Random, L Env and R Env.
3. Offset
4. Depth
5. Sync Ena – allow rising edge of Sync input jack or press of Tap Tempo button to reset waveform to zero phase.
6. One Shot – Sync input triggers a single cycle of the LFO
7. Phase – selects 0, 90, 180, 270 degree phase offset.

A parameter widget and a waveform display are provided to help visualize the effects of the various settings.

Note – the two final waveforms “L Env” and “R Env” are envelope followers on the L and R inputs of the E520. The Offset and Depth controls can be used to adjust the envelope response.

## Patch Page

The Patch page provides access to twenty four user-defined patches which can use any one of the available algorithms. Quick access buttons provide instant loading of any one of the first four patches on the page. These patches can also be loaded via the CV Patch mode described above.

To load an existing patch, use the encoder to select it and then hit the “Load Sel” button.

To save a current configuration as a patch, use the encoder to select the desired patch number, then hit the encoder button to enter the patch naming process. Up to 8 characters may be used to name the patch using the encoder and buttons to navigate and select letters. When the name is complete, use the Save button to store the patch.

Once loaded a patch will “lock in” the state of all CV inputs and the UI elements will change color. The patch name will be displayed in the upper right corner of the UI and the patch name and settings will persist across power cycles until the algorithm is changed.

## File Page

The File page provides access to File Input / Output functions using the SD card slot. Several operations are possible:

1. Directory – shows a directory of all visible files on the SD card. If there are more files & directories than fit on the screen then scrolling is possible. Use the Top / Bottom buttons to



instantly jump to the beginning or end of the list. One level of directory depth is allowed, so clicking on a Directory in the top level (highlighted in a unique color) will drop down. While in a directory, one of the buttons becomes the “Dir Up” which leaves the directory. A “Delete” button is also available that will delete files and directories.

2. Sys Save – saves the contents of the system EEPROM to a file on the SD card. Up to 8 letter names are allowed. The file type is always “.EEP”.
3. Sys Load – loads the contents of a “.EEP” file into system EEPROM to restore previous state. This allows the user to keep an infinite number of unique patch arrangements in separate .EEP files. Note that only files for V1.2 are loaded directly. Files created with V1.1 firmware will be automatically converted to the V1.2 format and will only affect patches and settings that were previously present in V1.1 firmware.
4. WAV Save – Only visible if the current algorithm is Spectral Time Machine, Looper or Sampler and the algorithm is not currently playing. When these conditions are met then the contents of the audio buffer can be saved on SD card as a standard 16-bit 2 channel (stereo) PCM .WAV file. The file name can be user defined but the file type is always “.WAV”.
5. WAV Load – Only visible if the current algorithm is Spectral Time Machine, Looper, Sampler or Convolution. If the algorithm is Time Machine, Looper or Sampler then the algorithm must not be playing to allow loading the audio buffer with previously recorded material from the SD card. The Convolution algorithm can load IR WAV files. Audio files must be 16-bit PCM, single-channel (mono) for Convolution and two-channel (stereo) for Time Machine, Looper and Sampler.

Note that while in the File page the E520 audio processing will be muted and the “Speaker-Slash” icon will be displayed in the upper right.

## Color Page

The Color page allows users to customize the screen colors. There are 10 color types used throughout the GUI, and each one may be set to any one of 512 colors (eight brightness values for each of R, G and B components). There are also a number of color presets defined:

1. Default – A cool slate & cream colored scheme that is used on initial power-up.
2. Warm Mode – a tan scheme with warmer “desert” tones.
3. Dark Mode – a cool, dark scheme for use when the lights are low.
4. Bright Mode – the original color scheme, similar to that used in the E352 and E370 Uis.

## Moses Page

A picture of Paul Schreiber’s cat.

## About Page

The About page displays various bits of information about the E520 firmware, including:

- The current CPU loading (in the upper left of the display)
- The time / date & version of the firmware.
- A scrolling marquee of the names of the usual suspects.
- The measured Vref voltage. 2.5V is normal
- The measured CPU temperature. 30-50C is normal.
- A status listing of all the CV and button inputs for diagnosing hookup problems.

## About Overloads

In a multi-effects processor like the E520 there are an infinite number of ways to generate overloads – situations where the output signal “blows up” and generates maximum loudness sounds that can potentially damage equipment and cause discomfort to the listener. To help avoid this, feedback limiting is included (see the description in the Preferences section) which defaults to providing some protection against this and supports even stronger levels of protection. Despite this it’s still possible to create loud and unexpected sounds, but this can be minimized with some simple steps:

1. Be careful when switching between algorithms – make sure that the Feedback and Filter Resonance controls (if any) are not set to extremes.
2. Use the limiter feature provided on the Preferences page – this applies to almost all algorithms that support feedback, as well as all algorithms that allow resonant filters. Use extra caution if the limiter has been disabled (“Off” setting).
3. Some algorithms are especially prone to overloading:
  1. Clean Delay – with both taps active and 100/100 mixing the output signal can naturally be quite loud. With resonant filtering and strong feedback it will overload very easily even when limiting is enabled.
  2. Dual Mono – in Chain mode it is very easy to overload when using feedback.
4. When designing new patches or just experimenting, be wary of setting feedback and resonance controls beyond 75%.

## Emergency Mute

If the E520 (or an upstream source) happens to generate undesired sounds, an “Emergency Mute” feature is provided that will quickly mute the output. Simply press any 3 of the LCD buttons simultaneously and output audio will cease and a small “Speaker-Slash” icon will appear in the upper right of the display to indicate muting is enabled. Pressing 3 buttons again will unmute.

## Tap Tempo

Many of the algorithms in the E520 support Tap Tempo for setting either the delay timing, or LFO period. In general when Tap Tempo is active a small “TT” symbol will appear in the upper left corner

of the Main page. Acquiring the accurate tempo takes two or three taps during which a “...” symbol will be displayed. After about 5 seconds of no taps or sync pulses the system enters a wait state and new taps / syncs will start the timing process over from scratch. While the “TT” symbol is displayed the CV parameter that normally controls delay or LFO period will be overridden, but varying it will kick the system out of Tap Tempo mode.

Most algorithms which support Tap Tempo also have a Pg2 setting for Tap Ratio which can be used to multiply/divide the tap period. If the algorithm has a parameter for delay or LFO period that is overridden by Tap Tempo then there will also be a “Live Tap” entry in this setting which will turn that parameter into a Tap Ratio control. When “Live Tap” is selected then the control will always vary the ratio and will not disable Tap Tempo mode. If no taps / syncs are present then Live Tap defaults to 120BPM until the user taps in something different.

# Description of E520 Algorithms

The following are individual descriptions of each algorithm in the E520. The algorithms are grouped into several types:

- Time Domain Delay effects
- Time Domain Shift effects
- Looping effects
- Spectral effects
- Miscellaneous effects

## Time Domain Delay Effects

Time domain effects in the E520 are processed without the use of time/frequency transforms and use a buffer rate that provides a good compromise between overhead and latency.

## Resampling Mini Delay

### Overview

This effect is based on the E580 Resampling Mini Delay and encompasses or extends all of its functions. Stereo inputs are mixed down to a single channel, resampled (ie – the sampling rate may be reduced by a variable amount through a band-limited interpolation process), pass through a delay line with a fixed and variable tap, and are then resampled to two separate outputs. Separate L/R feedback controls allow fine adjustment of recirculation on both the fixed and variable delay. Three mode settings emulate various classical delay characteristics.

### CV Inputs

Four CV input parameters are supported:

1. Tap Offset – controls the position of the variable delay tap. Range is from 0% to 200% of the fixed tap position. Varying this control in real-time will cause granular cross-fading effects as the delay amount changes. The parameter readout shows offset as a percentage of the fixed tap.
2. Delay Time – this controls sampling rate over a 1:8 (48kHz-6kHz) range, smoothly varying delay without granular artifacts but introducing considerable FM. The parameter readout shows the time multiplication factor.
3. InMix – The original E580 is a monophonic effect, so on the E520 which is stereo the two inputs are mixed according to this. Full CCW is 100% Left channel, full CW is 100% Right channel and 12:00 position is 50/50 mix. The parameter readout shows percent L & R.
4. Multifunction – varies depending on mode selection:
  1. Clean mode – no functions

2. BBD mode – reduces SNR by addition of noise.
3. Tape mode – controls random delay time variation. Similar to unstable tape speed warble.

## Buttons

Three button functions are supported:

1. Range – Four delay settings for the fixed tap: 1x, 16x, 256x, 4096x allow delays from 0.196s to ~10min.
2. Mode – Similar to the E580, there are three operating modes:
  1. Clean mode – Basic delay function with no distortion or filtering aside from the normal resampling process.
  2. BBD mode – Emulates old-style bucket-brigade circuit with rolloff starting around 4kHz. The fourth parameter controls a variable noise floor.
  3. Tape mode – Emulates old-style tape loop, including saturation distortion, slight peaking and rolloff around 2kHz. The fourth parameter controls tape warble.
3. Freeze – Audio in the delay line is “frozen” and no new audio overwrites it. Feedback controls don’t have any effect and the contents repeats at the delay rate.

## Readouts

In addition to the parameter readouts there are four indicators:

1. Range – the range button selection
2. Mode – the mode button selection
3. Fixed Delay – the time delay on the fixed tap
4. Tap Offset – the time delay on the variable tap

## Page 2 Settings

There are two Page 2 settings:

- Tape NL - controls the type of nonlinearity applied in Tape mode. Settings are None, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> – the exponential order of the nonlinearity.
- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16
- Delay Quant – When enabled selects a variety of musical intervals for quantization of the Delay parameter.
- 1V/Oct Rsmpl – Scales the Delay input parameter to approximately 1V per octave.
- Delay Tm Lag – When enabled introduces various lag speeds on the Delay parameter.

## Feedback

Both feedback knobs are active in this effect.

## Tap Tempo

Tap Tempo is active and controls the amount of fixed delay. Use the range button to return to the fixed ranges. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the Range setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

This effect has no auxiliary output.

## Clean Delay

### Overview

The Clean Delay is a non-resampling delay (ie – the sampling rate is constant throughout the processing) which always runs at the full 48kHz rate and introduces no interpolation artifacts into the signal while the delay length is stable. This is a true stereo effect in that there are separate delay lines for Left and Right channels but they are processed identically (same delay length, same filtering, etc.). A switchable resonant 4th-order lowpass filter is available in the feedback path if desired. Ping-pong feedback between the two channels may be enabled.

### CV Inputs

Three CV input parameters are supported:

1. Dly Len – this controls the length of the delay line. Varying this control in real-time will cause granular cross-fades as the length changes. The parameter readout is in percentage of the full range from 0-99%.
  1. This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.
2. Tap Offset – controls the position of the variable delay tap which is mixed with the main delay according to the proportions selected on a Pg2 setting. Range is from 0% to 200% of the Delay Length from parameter #1. Varying this control in real-time will cause granular cross-fading effects as the delay amount changes. The parameter readout shows offset as a percentage of the Delay Length. When set to 0% this tap is disabled.
3. Filter Cutoff Frequency (when filter enabled) – controls the lowpass filter cutoff frequency. The parameter readout is in kHz from 0-24kHz. When the filter is disabled this parameter is grayed out.
4. Filter Resonance (when filter enabled) – controls the lowpass filter resonance. The parameter readout is in percentage from 0-99% where 0% is no resonance. When the filter is disabled this parameter is grayed out. Be careful – the filter may self-oscillate when this parameter is near 99% and can cause overloads in some situations.

## Buttons

Three button functions are supported:

1. Range – Four delay ranges: 1x, 16x, 256x, 4096x allow delays from 0s to ~6min.
2. Swap – swaps the feedback paths of the L & R channels so that audio “ping-pongs” between the two channels.
3. Filt – enables the filters.

## Feedback

Feedback is active for this effect.

## Readouts

There are five readouts for this effect:

1. Range – 1x thru 4096x
2. Swap – on/off
3. Filter – on/off
4. Time – main delay time in seconds
5. Offset – delay time of the tap in seconds

## Page 2 Settings

There two additional Page 2 settings:

- Tap Mix - provides several options for mixing the main and aux taps – either 100/100, 90/10, 50/50 or 10/90. Use caution with the 100/100 setting as this, coupled with extreme feedback or resonance settings can easily result in overloads.
- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap
  - Live setting causes the Delay Time CV input to become a live ratio control.
- Filter Type – selects LPF, HPF, BPF filter topologies.

## Tap Tempo

Tap Tempo is active and controls the Delay Length. Use the range button or Delay Length parameter to resume knob/button control. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the Range setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

This effect has no auxiliary output.

# Resampling Delay

## Overview

The Resampling Delay is a variable-rate interpolating delay which allows control of both the delay line length (for granular cross-fade effects) as well as sample rate (for smooth delay changes and FM effects). This is a true stereo effect in that there are separate resamplers and delay lines for Left and Right channels but they are processed identically (same delay length, same filtering, etc.). A switchable resonant 4th-order lowpass filter is available in the feedback path if desired. Ping-pong feedback between the two channels may be enabled.

## CV Inputs

Four CV input parameters are supported:

1. Dly Len – this controls the length of the delay line. Varying this control in real-time will cause granular cross-fades as the length changes. The parameter readout is in percentage of the full range.
2. Delay Time - this controls sampling rate over a 1:8 (48kHz-6kHz) range, smoothly varying delay without granular artifacts but introducing considerable FM. The parameter readout shows the time multiplication factor.
  1. This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.
3. Filter Cutoff Frequency (when filter enabled) – controls the lowpass filter cutoff frequency. The parameter readout is in kHz from 0-24kHz. When the filter is disabled this parameter is grayed out.
4. Filter Resonance (when filter enabled) – controls the lowpass filter resonance. The parameter readout is in percentage from 0-99% where 0% is no resonance. When the filter is disabled this parameter is grayed out. Be careful – the filter may self-oscillate when this parameter is near 99% and can cause overloads in some situations.

## Buttons

Three button functions are supported:

1. Range – Four delay ranges: 1x, 16x, 256x, 4096x allow delays from 0s to ~6min.
2. Swap – swaps the feedback paths of the L & R channels so that audio “ping-pongs” between the two channels.
3. Filt – enables the filters.

## Page 2

There are several additional Pg2 settings:

- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap
  - Live setting causes the Delay Time CV input to become a live ratio control.



- Delay Quant – When enabled selects a variety of musical intervals for quantization of the Delay parameter.
- Filter Type – selects LPF, HPF, BPF filter topologies.
- 1V/Oct Rsmpl – Scales the Delay input parameter to approximately 1V per octave.
- Delay Time Lag – When enabled introduces various lag speeds on the Delay parameter.

## Feedback

Feedback is active for this effect.

## Readouts

There are four readouts for this effect:

1. Range – 1x thru 4096x
2. Swap – on/off
3. Filter – on/off
4. Time – time delay in seconds

## Tap Tempo

Tap Tempo is active and controls the Delay Length. Use the range button or Delay Length parameter to resume knob/button control. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the Range setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

This effect has no auxiliary output.

## Prime Delay

### Overview

The Prime Delay is an emulation of the Lexicon Prime Time rack-mount delay. It is a resampling delay which allows control of both the delay line length (for granular cross-fade effects) as well as sample rate (for smooth delay changes and FM effects). As the original, this is a mono effect in that there is one delay line whose input is an equal mix of Left and Right channels and separate output taps for Left and Right channels with independent delay lengths that are selectable from a pre-determined set which includes delays that have relatively prime ratios. Controllable 4th-order lowpass filters are available in the feedback path if desired. Buffer lengths well beyond that of the original Prime Time effect are available and the two outputs may be mixed down to mono if desired.

### CV Inputs

Four CV input parameters are supported:

1. Delay Set A – this controls the length of the A delay line. Varying this control in real-time will cause granular cross-fades as the length changes. The parameter readout is in milliseconds assuming the VCO is in “Cal” mode. There is a limited list of delay values, some of which are “prime” which is indicated above the control.
2. Delay Set B – this controls the length of the B delay line. Varying this control in real-time will cause granular cross-fades as the length changes. The parameter readout is in milliseconds assuming the VCO is in “Cal” mode. There is a limited list of delay values, some of which are “prime” which is indicated above the control.
3. VCO Adj – this varies the sample rate over a 1:2 range. Fully CCW is considered “Calibrated” and an indicator above the control will reflect this. As the control is rotated CW the sample rate is increased by up to 2x and the indicator will show “Uncal” to reflect that the sample rate is not locked down at a precisely known rate. The parameter readout is in percent from 0-99%. Note – the E520 hardware does not support the full VCO range of the original Prime Time unit, so in the 1x and 8x Mult ranges the VCO Adj control doesn’t cover the full range. In these cases the indicator will show “Out of Range”.
4. Rolloff – controls the lowpass filter cutoff frequency. The parameter readout is in kHz from 0.8kHz to 15.0kHz (the full range of the original Prime Time).

## Buttons

Three button functions are supported:

1. Delay Mult – Four delay multiplier ranges as in the original Prime Time: 1x, 2x, 4x, 8x. These settings reduce the effective sample rate by the selected amount.
2. Buf Len – three buffer length controls which enable delay settings beyond those of the original Prime Time. The 8k setting is equivalent to the original, while the 64k and 256k setting allow much longer delays.
3. Mix – Allows combining the Left & Right output channels.

## Page 2

There are two additional Pg2 settings:

- Sync Fnctn – selects function of Sync / Tap input. Either it toggles the Repeat function or it synchronizes the Tap Tempo.
- Tempo Ratio – selects the tempo ratio for the Tap Tempo feature.

## Feedback

Feedback is active for this effect.

## Readouts

There are four readouts for this effect:

1. Delay Mult – 1x thru 8x

2. Buf Len – 8k thru 256k
3. Mix – L+R (mixed) or L/R (separate)
4. A: – blank or Prime
5. B: - blank or Prime
6. VCO – Cal, Uncal or Out of Range
7. Repeat – Highlighted when in repeat mode (buffer freeze)

## Tap Tempo

Tap Tempo has two possible functions:

1. (Default) Pg2 “Sync Fnctn” set to “Repeat” - Repurposed to enable/disable the Repeat mode. In Repeat mode the audio input is disabled and the buffer recirculates with the previous contents until Repeat is disabled.
2. Pg 2 “Sync Fnctn” set to “Tap Tempo” – operates as normal tap tempo, in which case the current actual delay / BPM of the A channel will be displayed across the top of the main page. Note that this is the true BPM and may not match the reading on the A channel display, depending on the setting of the “Mult” button and VCO CV.

## Auxiliary Output

This effect has no auxiliary output.

## Reversible Delay

### Overview

The Reversible Delay is a reversing and resampling delay which allows control of both the delay line length (for granular cross-fade effects) as well as sample rate (for smooth delay changes and FM effects). This is a true stereo effect in that there are separate resamplers and delay lines for Left and Right channels but they are processed identically (same delay length, same filtering, etc.). A switchable resonant 4th-order lowpass filter is available in the feedback path if desired. The unique features are that this delay can be run forward or backwards and it can be “frozen” to keep playing the current delay contents without changing.

### CV Inputs

Four CV input parameters are supported:

1. Dly Len – this controls the length of the delay line. Varying this control in real-time will cause granular cross-fades as the length changes. The parameter readout is in percentage of the full range which is fixed at 5.4 seconds.
  1. This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.

2. Delay Time - this controls sampling rate over a 1:8 (48kHz-6kHz) range, smoothly varying delay without granular artifacts but introducing considerable FM. The parameter readout shows the time multiplication factor.
3. Filter Cutoff Frequency (when filter enabled) – controls the lowpass filter cutoff frequency. The parameter readout is in kHz from 0-24kHz. When the filter is disabled this parameter is grayed out.
4. Filter Resonance (when filter enabled) – controls the lowpass filter resonance. The parameter readout is in percentage from 0-99% where 0% is no resonance. When the filter is disabled this parameter is grayed out. Be careful – the filter may self-oscillate when this parameter is near 99% and can cause overloads in some situations.

## Buttons

Three button functions are supported:

1. Reverse – pressing this button switches the direction of recording in the buffer memory. Sounds already in the buffer will play in the opposite direction and new sounds recorded into memory will go in reverse.
2. Freeze – pressing this button enables/disables Freeze mode, wherein no new sounds are recorded into the memory and the contents of the memory will continue to play out unchanged.
3. Filt – enables the filters.

## Page 2 Settings

There are four additional Page 2 settings for this algorithm:

1. Glitchy (On/Off) – “On” (default) disables the controlled transitions but may introduce clicks and pops. When in “Off” mode changes to the length of the delay line use crossfades to smooth the transition, but introduces some lag in responsiveness, especially if the Dly Len parameter is changing frequently.
2. Rev Src – allows selection of the source for the Reverse command. By default this is controlled by Button 1, but may be controlled by any CV input crossing a threshold.
3. Frz Src – allows selection of the source for the Freeze command. By default this is controlled by Button 2, but may be controlled by any CV input crossing a threshold.
4. Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap
  1. Live setting causes the Delay Time CV input to become a live ratio control.
5. Filter Type – selects LPF, HPF, BPF filter topologies.

## Feedback

Feedback is active for this effect.

## Readouts

There are four readouts for this effect:

1. Reverse – highlighted when in reverse mode.
2. Freeze – highlighted when in freeze mode.
3. Filter – on/off
4. Time – time delay in seconds

## Tap Tempo

Tap Tempo is active and controls the delay length. Adjust the Delay Length parameter to switch control back to that parameter. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the Range setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

This effect has no auxiliary output.

## Diffusion Flanger

### Overview

The Diffusion Flanger is short delay which allows smooth control of the delay line length over intervals of 0-5ms which makes it particularly useful for Flanging and Karplus-Strong effects. This is a true stereo effect in that there are separate delay lines for Left and Right channels but they can be processed identically. The unique feature of this algorithm is the inclusion of an 8-stage allpass diffuser at the input with control over mix and length which can be used to “thicken” up the sound prior to flanging. Additional features are that the delay control can be done either in linear time or exponential frequency, and that the output can be set into “flanger mode” which makes comb-filter sounds easier to achieve.

### CV Inputs

Four CV input parameters are supported:

1. Diffuse – this is a two-mode control which varies the mix and length of the diffuser. Use button 1 on the right of the display to select control of either the mix or the length – the uncontrolled parameter will be held at its last value (the value is saved during reset / power-cycle). Mix ranges from 0-99% and operates like a wet/dry control. Length readout is displayed as percentage with a maximum of more than 1 second. Current values of both parameters are displayed in a readout near the top of the screen.
2. Delay Time - this controls the delay over a 0-5ms range when in Time mode and a 20Hz-20kHz range when in Frequency mode, smoothly varying delay without granular artifacts but introducing considerable FM. The parameter readout is in percent of maximum but the actual Time or Frequency value is displayed in a readout near the top of the screen.

3. LFO Freq – this controls the frequency of the integrated low-frequency oscillator. The parameter readout varies from 100 sec-1sec/1-11Hz in an exponential curve that provides greater sensitivity in the low frequency range.
  1. This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.
4. LFO Depth – this controls the amplitude of the LFO waveform as it is summed with the Delay Time parameter. The parameter readout varies from 0-99%.

## Buttons

Three button functions are supported:

1. Diff Sel – toggles between CV1 controlling either the mix or length of the diffuser.
2. T/F Mode – toggles between CV2 controlling delay time in either Time or Frequency mode.
3. Out Mode – toggles between pure delay output and “Flange” output which performs a 100/100 mix of the delay line input and output. Flange mode provides for the deepest comb notches which enhances the sound of the classic effect.

## Page 2 Settings

There is one additional Page 2 setting for this effect:

- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap
  - Live setting causes the LFO Freq CV input to become a live ratio control.

## Feedback

Feedback is active for this effect.

## Readouts

There are three readouts for this effect:

Time / Freq – displays the delay length as either time or frequency.

DMix – the current value of the Diffuse Mix parameter.

DLen – the current value of the Diffuse Length parameter.

## Tap Tempo

Tap Tempo is active and controls the LFO rate. Adjust the LFO rate parameter to switch control back to that parameter. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the LFO rate setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

The delay time value (with offset and LFO) is available on the auxiliary output.

# Chowder Delay

## Overview

The Chowder Delay is used to chop/slice incoming audio into “chunks” which are randomly reordered in time with optional reversing and pitch shifting. Various parameters provide control over the chunk size, probability of chopping, reversing and shifting, as well as the time span of reordering. Clean 5ms splices are created between chunks to avoid unpleasant clicking transitions. Tap Tempo is used to set the base time rate.

## CV Inputs

Four CV input parameters are supported:

1. Chop Div – Chop Division controls the size of the chunks. Tap Tempo establishes the duration of a quarter note and the Chop Div parameter scales that from whole notes to 1/64th notes.
2. Sttr Prb – Stutter Probability controls the probability that a chop/slice operation will occur. At full CCW rotation chopping will never happen. At full CW rotation every chunk will be chopped.
3. Chop Ord – Chop Order controls how far back in time to go when fetching alternate chunks to insert into the output stream. From full CCW (0%) the range increases up to the limit determined by the Buf Mult button setting. Beyond 50% to full CW the probability that the chunk will be reversed increases from 0 to 100%.
4. Ptch Prb – Pitch Probability controls the probability that a pitch shift will be applied to any chunk.

## Buttons

Three button functions are supported:

1. Buf Mult – selects one of four possible maximum delays over which the Chop Ord control operates. Range is 4 chunks to 32 chunks.
2. Stutter – manually forces a repeat of the most recent chunk. Overrides all random operations.
3. Freeze – toggles Freeze mode where no new audio is recorded in the delay buffer. Chopping still takes place but only on material already in the buffer.

## Feedback

There is no feedback and the controls are repurposed in this effect.

Left Feedback – Repeats. Controls the maximum number of repeats randomly applied to any stutter operation. CW from center varies from 1-15 while CCW from center varies from 1-15 and also forces reverse play.

Right Feedback – Pitch Shift. Controls the amount of pitch shift applied to any stutter operation. CW from center is upward shifts while CCW from center is downward shift. Repeated stutters will compound shifts up to one octave and then wrap back to no shift.

## Readouts

There are three readouts for this effect:

1. repeats – displays the number of repeats selected by the Left Feedback.
2. pitch – displays the pitch shift selected by the Right Feedback.
3. Flashing Chunk Indicator – a dot in the upper center flashes at the chunk timing rate.

## Page 2 Settings

There are 3 additional settings on Pg2

1. Chl Diverge – Channel Divergence. When set to “Off” the right and left channels will have identical chopping operations applied. When “On” the channels are independently processed and will behave differently depending on the random probability settings.
2. Ptch Quant – Pitch Quantization. When “Off” the pitch selection on the Right Feedback is unconstrained and can select any pitch shift amount between +/- 800 cents. When “On”, only multiples of 100 cents are allowed.
3. Sync Phase – Controls the timing phase of the chopping process relative to the Tap Tempo input. Values of -10ms, 0ms and +10ms are allowed and control alignment of the chopping point. Default is -10ms but a value of 0ms will most often ensure that notes are not chopped during their attack.

## Tap Tempo

Tap Tempo is active and controls the basic quarter note timing. Adjust the LFO rate parameter to switch control back to that parameter. Tap Tempo status is shown in the upper left of the effect area: Current tempo is always displayed, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active. Tap intervals longer than ~5 seconds cause the tempo calculation to reset. Tempo rate is saved when switching algorithms or powering down. Apply a continuous quarter-note clock (as from a sequencer) to keep the chopping process in sync with the external source.

## Auxiliary Output

A 5ms 0-8V trigger signal is output on the Aux jack when a new chunk is started.

## Pattern Delay

### Overview

The Pattern Delay is a stereo tapped delay line with CV-controlled tap patterns. Each channel (left / right) has its own separate delay line with two sets of taps – Primary and Secondary. The patterns are chosen from a set of 64 and the length of the patterns can be adjusted via buttons. Mixing between Primary and Secondary, filtering and feedback all allow control over the complexity and dynamics of the output. Tap Tempo is used to set the base time rate and a selectable multiply/divide ratio can scale the rate.



## CV Inputs

Four CV input parameters are supported:

LPri Dnsty – Left Primary Density. This selects a pattern for the left primary taps. Density of the active taps increases with increasing voltage.

RPri Dnsty – Right Primary Density. This selects a pattern for the right primary taps. Density of the active taps increases with increasing voltage.

2<sup>nd</sup> Dnsty – Secondary Density. This selects a pattern for the left and right secondary taps. Density of the active taps increases with increasing voltage.

P/S Mix – Primary / Secondary mix. This allows proportional mixing of the Primary and Secondary taps into the final output for both left and right channels.

## Buttons

Three button functions are supported:

- Len Sel – selects one of six possible length parameters to adjust:
  - L Pri – Left Primary pattern length
  - L Sec – Left Secondary pattern length
  - R Pri – Right Primary pattern length
  - R Sec – Right Secondary pattern length
  - L FB – Left Feedback tap position
  - R FB – Right Feedback tap position
- Len Adj – Cycles through 1-16 for length parameter selected by Button 1.
- Tap Mult – Cycles through Mult/Div ratios for tap tempo. Possible values are: 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16

## Feedback

Feedback knobs are active and control both feedback and filter cutoff frequency. Top center position is disabled as usual. Turning CCW enables feedback **AND** filtering. Turning CW enables only feedback.

## Readouts

The pattern settings are displayed above the CV widgets in two groups. Left channel patterns in the left group, Right channel patterns in the right group. Each group consists of three lines:

- Top line – Primary pattern
- Middle line – Secondary pattern
- Bottom line – position of feedback tap

Within each line are three types of symbols:

- Filled circle – active tap
- Empty circle – inactive tap
- Dot – beyond length of pattern, or feedback position.

## Page 2 Settings

There are 4 additional settings on Pg2

- Pri Filt – enables / inverts / disables lowpass filter on primary taps.
- Sec Filt – enables / inverts / disables lowpass filter on secondary taps.
- L FB – enables / disables Left channel feedback.
- R FB – enables / disables Right channel feedback.
- Tap BPM – sets the default Tap Tempo rate.

## Tap Tempo

Tap Tempo is active and controls the basic timing interval. Tap Tempo status is shown in the upper left of the effect area: Current tempo is always displayed, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

This effect does not drive the auxiliary output.

## Resonators

### Overview

Resonators is an array of four tunable delay line resonators with several different ways to assign pitch. Tap Tempo and Sync inputs can be used to stimulate the system for Karplus-Stong effects. This is a stereo effect with separate resonators for left and right channels which are tuned to follow each other.

### CV Inputs

Four CV input parameters are supported and their functions change with the selected pitch mode. Pitch sensitivity is approximately 1V/Oct – as close as is possible with the uncalibrated CV input paths on the E520 when the attenuator knobs are turned fully CW.

### Buttons

Three button functions are supported:

- Quant : Selects the type of pitch quantization used for assigning pitch to the resonators
  - Off – no quantization.
  - Chrom – chromatic 12-tone equally tempered scale

- Various major / minor / pentatonic scales
- Whole tone, Minor 3<sup>rd</sup>, Major 3r, Octave scales
- Key : Selects the key of the scale
- Mode : Selects the pitch assignment mode
  - Indep – independent control of each resonator from the Cvs
  - Offset – CV 1 controls root note and resonator 1 pitch, while CV2-CV4 are offsets from the root for resonators 2-4.
  - Cloud – CV1 controls root note, CV2 is “spread” about the root, CV3 is chaos amount (random modulation of each pitch), and CV4 is chaos bandwidth (speed of random modulation).

## Feedback

Feedback knobs are active and control feedback for the left and right channels. In this context the feedback affects decay time of the resonances with more feedback resulting in slower decay.

## Page 2 Settings

There are 3 additional settings on Pg2

- Qnt Tune : Shifts the quantizer offset 0-100 cents. A value of 50 cents will ensure the pitch of A is 440Hz.
- Split : (On/Off) When Off works as 4 tracking stereo resonators. When On the algorithm divides into to two independent mono resonators in the left and right channels.
- Stimulus: Determines the type of Karplus-Strong stimulus signal applied when the Tap Tempo and/or Sync inputs are triggered
  - Uni Short – all four resonators receive a common short noise burst
  - Uni Med – all four resonators receive a common medium noise burst
  - Uni Long – all four resonators receive a common long noise burst
  - Str Fast – each resonator receives a separate short noise burst in fast sequence (strumming)
  - Str Med – each resonator receives a separate short noise burst in medium sequence
  - Str Slow – each resonator receives a separate short noise burst in slow sequence
  - Bowed - each resonator receives a separate long noise burst in slow sequence.
- Pitch Lag – When enabled introduces various lag speeds on the Pitch parameters.

## Tap Tempo

Tap Tempo is active and triggers Karplus-Strong stimulus.

## Auxiliary Output

This effect does not drive the auxiliary output.

## Multitap Delay

### Overview

The Multitap Delay provides up to 16 taps with many options for tap spacing, tap amplitudes, feedback and resampling. Effects ranging from simple echos to chaotic reflections and even synthetic reverbs are possible.

### CV Inputs

Four CV input parameters are supported:

- Dly Len – this controls the tap spacing interval. Varying this control in real-time will cause granular cross-fades as the length changes. The parameter readout is in percentage of the full range.
- Delay Time - this controls sampling rate over a 1:8 (48kHz-6kHz) range, smoothly varying delay without granular artifacts but introducing considerable FM. The parameter readout shows the time multiplication factor.
  - This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.
- Taps – controls the number of taps that are summed together for the final output. Ranges from 1 to 16.
- Gain Mod – Controls the slope applied to the tap amplitudes. Turning CCW from noon position yields amplitudes rising from 0 to maximum, while CW from noon position results in amplitudes that fall off from maximum to zero.

### Buttons

Three button functions are supported:

- Range – Four delay ranges: 1x, 16x, 256x, 4096x allow delays from 0s to ~6min.
- Tap Loc – controls how tap locations are computed. There are four options:
  - Uniform – interval between taps is equal to the delay length multiplied by delay time.
  - Increase – tap spacing increases with every tap.
  - Decrease – tap spacing decreases with every tap.
  - Rand – tap spacing is randomized with every tap.
- Tap Amp – controls how tap amplitudes are computed. There are four options:
  - Linear – tap amplitudes are a linear function of tap number and Gain Mod control.
  - Exp – tap amplitudes are an exponential function of tap number and Gain Mod control.

- Sin – tap amplitudes follow a complete cycle of a sinusoid. Gain Mod controls phase of the wave.
- Rand – tap amplitudes are pseudorandom. Gain Mod chooses the random seed for repeatability.

## Page 2

There are five additional Pg2 settings:

- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap
  - Live setting causes the LFO Freq CV input to become a live ratio control.
- Delay Quant – resampling is quantized to musical intervals:
  - Off
  - Octave
  - 5<sup>th</sup>
  - Maj 3<sup>rd</sup>
  - Semitone
- Gain Adj – Controls a limiter in the output path that can help to avoid overloads when many taps are summed. Options are:
  - Normalize – the gain is scaled by the number of taps.
  - Limit – an adaptive limiter attempts to reduce signal level when it exceeds -6dBFS
  - 100% - no gain adjust – taps are all summed at full strength.
- Out Swap – swaps the Left & Right channels for ping-pong effects.
- FB Tap – chooses where the feedback originates. Options are:
  - First – first tap only
  - All Norm – output normalized by number of taps
  - All 100% - full output level.
- 1V/Oct Rsmpl – Scales the Delay input parameter to approximately 1V per octave.

## Feedback

Feedback is active for this effect.

## Readouts

There are two readouts for this effect:

- Gain – a bar-graph of the gain applied to the output signal. Especially useful when the limiter is active so you can see how it's adjusting the level.
- Graph – a graph of tap spacing vs amplitude. Helps to visualize how the tap settings affect the response.

## Tap Tempo

Tap Tempo is active and controls the Delay Length. Use the range button or Delay Length parameter to resume knob/button control. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the Range setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

This effect has no auxiliary output.

## SeqWah

### Overview

SeqWah is a combination of controllable delays feeding into 4th-order filters whose cutoff frequencies are controlled by a pair of sequencers with options for fixed or generative / random patterns. Various timing relations are allowed and amplitude/offset of frequency changes can be adjusted in realtime.

### CV Inputs

Four CV input parameters are supported:

1. Delay Ratio - controls the ratio between the base tap rate and each of three delays (Left/Right/Center). Knob at "noon" will give all delays 1:1, turning CW will select shorter ratios, CCW longer ratios.
2. Filter Cutoff Sequence selection for the Left channel. There are five types of sequences:
  1. Cos - a cosine shape with two octaves range. You control the length of the sequence from 2 to 16 steps.
  2. 5th - a progression of circle-of-fifths over a two octave range. You control the length of the sequence from 2 to 16 steps.
  3. Rrp - Random Replacement Generative - starts with a random sequence with controlled length from 2 to 16 steps. One of the steps will be replaced with a new value every time through the sequence.
  4. Rwk - Random Walk Generative - Always 16-steps long and regenerates at the end of every pass. The generative rule is determined by two parameters that vary as the knob is turned. The control the step size and number of steps taken.
  5. Rnd - purely random, constrained to 4 octaves.

3. Filter Cutoff Sequence selection for the Right channel. Same sequences as described above.
4. Cutoff - controls the Amplitude and Offset of the the filter cutoff sequences within the overall range. Use Button 2 to select which parameter is currently controlled. The other parameter will be held constant.

## Buttons

Three button functions are supported:

1. Center channel control - chooses if the center channel is active and how the frequency is computed from the Left and Right channels.
2. Cutoff - selects Amp or Offset as the live parameter on CV4
3. Tap Mult - selects 1-4x multiplication of the base tap rate for the overall timing of the system.

## Page 2

There are four additional Pg2 settings:

1. Tap (BPM) - selects the default tap tempo for the algorithm when it first powers up. Applying tap/sync will override this, and altering this setting will override any tap/sync tempo previously applied.
2. Filt Typ - selects Bandpass (BP), Lowpass (LP) or Highpass (HP) for the channel filters.
3. Filt Res (%) - selects the resonance for the filters from 0 (flat) to 100 (lots of self-oscillation and screaming).
4. Filt Lag - sets the amount of lag (portamento) on the filter cutoff frequency control.

## Feedback

Left and Right feedback controls are active. At 12:00 it's zero as usual and increases as turned either CW or CCW. One major difference is that turning CCW results in cross-channel feedback - in other words turning Left feedback CCW will insert the Left channel output into the Right channel input and vice-versa.

## Readouts

There are two types of readouts for this effect:

Sequence Indicators – two 16-step sequencers, one each for Left and Right channels. Active steps are shown in the Wave Foreground color, inactive steps are shown in the Grid color. Current step is shown in Yes color.

Cutoff – a bar on the right that shows how the cutoff amp / offset values affect the overall range of the controls to the filter.

## Tap Tempo

Tap Tempo is active and controls the base tempo for delay length and sequencer step rate. The Pg2 Tempo (BPM) setting can override any current tap tempo. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the Pg2 Tempo setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

This effect has no auxiliary output.

## Headspace

### Overview

Headspace is a stereo image synthesizer which treats the Left and Right input signals as separate mono sources that can be placed in arbitrary positions about the listener’s location. It provides a toolkit of four different techniques:

- Swap – the left and right signals can be blended and swapped before being passed on to subsequent processes.
- Haas Panner – the left and right signals are delayed and attenuated relative to each other to provide location cues.
- Ambience – provides long cross-channel delays to simulate room reflections.
- Mid / Side – collapse and expand the stereo field through matrix operations.
- Comb – alternating left/right comb filter effects for stereo enhancement.

## CV Inputs

Four CV input parameters control each of the different processes:

- CV1 controls the Swap effect. Full CCW disables swap, Center position mixes both left and right inputs together into mono signals and full CW swaps left and right channels.
- CV2 controls the Ambience effect. Full CCW is disabled, Full CW is maximum gain of the cross-channel echos.
- CV3 controls Mid/Side effects. Full CCW collapses the stereo field to mono. Center position is no effect. Full CW provides maximum separation of Left & Right signals (all common information is removed).
- CV4 control Comb effect. Full CCW is maximum negative comb effect. Center position disables. Full CW is maximum positive effect.

## Buttons

Three button functions are supported:



- Enables : cycles through 16 possible combinations of Swap, Haas, Mid/Side and Comb processes. When a process is active its initial (SHMC) will appear in the button value and the control will be active. When a process is disabled its initial will be replaced with a ‘-’ and its control will gray-out.
- R in : enables the right channel input.
- Amb-Wide : changes the Ambience process for a somewhat wider sound.

## Feedback

Feedback knobs are active and control position of the Left and Right channels in the Haas panner process. A small “head” icon in the upper left of the UI is surrounded by colored dots to help visualize the placement of each channel with respect to the listener.

## Page 2 Settings

There are no extra pg2 settings.

## Tap Tempo

Tap Tempo is is not active.

## Auxiliary Output

This effect does not drive the auxiliary output.

## Time Domain Shift Effects

### Deflector Shield

#### Overview

The Deflector Shield is a recreation of the original E560 Deflector Shield module. It is a monophonic effect similar to the original Bode frequency shift which applies a variable frequency offset to any input signal. As the original, there are three distinct operating modes, as well as a unique carrier morphing feature that provides unusual output harmonics. Although the input is mono, there are two outputs which allows simultaneous up/down shift as well as true quadrature outputs. Variable feedback is available as well as linear or exponential frequency CV response.

#### CV Inputs

Three CV input parameters are supported:

1. InMix – The original E560 is a monophonic effect, so on the E520 which is stereo the two inputs are mixed according to this control. Full CCW is 100% Left channel, full CW is 100% Right channel and 12:00 position is 50/50 mix. The parameter readout shows percent L & R.
2. Carrier – this controls the frequency of the internal carrier oscillator which may be varied by +/-5kHz about 0Hz. The parameter readout is in Hz.
  1. This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.

3. Morph – the controls morphing of the carrier waveshape. There are 8 different wavetables in the morphing sequence, ranging from a pure sine, triangle, saw, square, random, etc. There is a small waveform display on the UI which shows the current waveshape.

## Buttons

Three button functions are supported:

1. Mode – Selects one of three possible operating modes as in the original E560:
  1. Shift – Bode frequency shift. Input signal is shifted in frequency by the carrier amount.
  2. Ring Mod – Ring modulation. Input signal is multiplied by the carrier waveform which results in a more harmonically complex signal than Bode shifting.
  3. Phase – Phase shifting. The internal carrier is disabled and instead the input signal is phase shifted by an amount ranging from 0-360deg as determined by the carrier control parameter.
2. Frq Mode – Selects Exponential or linear response of the carrier frequency to the carrier control parameter.
3. Out Mode – Selects Up/Down or Quadrature output modes.
  1. In Up/Down the two output channels are shifted by opposite amounts as determined by the carrier frequency.
  2. In Quadrature the two outputs shifted by the same amount but are 90deg out of phase with each other

## Feedback

Feedback is active for this effect.

## Readouts

There are four readouts for this effect:

1. Mode – Shift, Ring Mod, or Phase
2. Frq Mode – Lin or Expo
3. Out Mode – Up/Down or Quadrature
4. LFO BPM – the the Carrier frequency in Beats per Minute.

## Page 2 Settings

There are three additional settings available on Page 2:

- BPM Quant - enable or disable quantization of the carrier frequency in integer beats-per-minute.
- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap

- Live setting causes the Carrier Freq CV input to become a live ratio control.
- Phase Morph – in Phase mode this provides a choice of either all 8 carrier waveforms, or just the Sin and Sin5 as was used in the E560.

## Tap Tempo

Tap Tempo is active and controls the Carrier rate. Adjust the Carrier parameter to switch control back to that parameter. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the Carrier setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

The carrier oscillator is available on the auxiliary output.

## Frequency Shifter

### Overview

The Frequency Shifter is similar to the Deflector Shield but is a true stereo effect – the Left and Right channels are completely independent but can be processed with identical parameters. Similar frequency shifts, carrier morphing and modes are available but the output modes are limited to variations of Up and Down shifting. Variable feedback is available as well as linear or exponential frequency CV response.

### CV Inputs

Three CV input parameters are supported:

1. L/R Phs – controls the carrier phase offset between the Left and Right channels. Allows creation of stereo effects.
2. Carrier – this controls the frequency of the internal carrier oscillator which ranges from +/- 5kHz. The parameter readout is in kHz.
  1. This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.
3. Morph – the controls morphing of the carrier waveshape. There are 8 different wavetables in the morphing sequence, ranging from a pure sine, triangle, saw, square, random, etc. There is a small waveform display on the UI which shows the current waveshape.

### Buttons

Three button functions are supported:

1. Mode – Selects one of three possible operating modes as in the original E560:
  1. Shift – Bode frequency shift. Input signal is shifted in frequency by the carrier amount.
  2. Ring Mod – Ring modulation. Input signal is multiplied by the carrier waveform which results in a more harmonically complex signal than Bode shifting.

3. Phase – Phase shifting. The internal carrier is disabled and instead the input signal is phase shifted by an amount ranging from 0-360deg as determined by the carrier control parameter.
2. Frq Mode – Selects Exponential or linear response of the carrier frequency to the carrier control parameter.
3. Out Mode – Selects Up/Down shift for the Left and Right channels.

## Feedback

Feedback is active for this effect.

## Readouts

There are three readouts for this effect:

1. Mode – Shift, Ring Mod, or Phase
2. Frq Mode – Lin or Expo
3. Out Mode – Up/Up, Up/Dn, Dn/Up, Dn/Dn
4. LFO BPM – the the Carrier frequency in Beats per Minute.

## Page 2 Settings

There are three additional settings available on Page 2:

- BPM Quant - enable or disable quantization of the carrier frequency in integer beats-per-minute.
- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap
  - Live setting causes the Carrier Freq CV input to become a live ratio control.
- Phase Morph – in Phase mode this provides a choice of either all 8 carrier waveforms, or just the Sin and Sin5 as was used in the E560.

## Tap Tempo

Tap Tempo is active and controls the Carrier rate. Adjust the Carrier parameter to switch control back to that parameter. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the Carrier setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

The carrier oscillator is available on the auxiliary output.

# Phaser

## Overview

The Phaser is an all-pass phaser with selectable number of all-pass stages and an integrated LFO with variable frequency and depth. It is a true stereo effect – the Left and Right channels are completely independent but are processed with identical parameters. Variable feedback is available as well as selectable LFO waveform and optional phase offset between the Left and Right channels.

## CV Inputs

Four CV input parameters are supported:

1. Phase – this adjusts static phase into the all-pass filter stages. The parameter varies from 0-99%.
2. LFO Freq – this controls the frequency of the integrated low-frequency oscillator. The parameter readout varies from 0-11Hz in an exponential curve that provides greater sensitivity in the low frequency range.
  1. This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.
3. LFO Depth – this controls the amplitude of the LFO waveform as it is summed with the Phase parameter. The parameter readout varies from 0-99%.
4. LFO Phase – this controls the phase offset between the Left and Right channel LFO values, allowing subtly different sweeps and greater stereo imaging. The parameter readout varies from 0-360deg.

## Buttons

Two button functions are supported:

1. Stages – Selects 1, 2, 4, 6, 8, 12, 18 or 24 stages of all-pass processing. Lower numbers of stages are gentle with 6 being similar to most analog phaser effects. 24 stages results in many more cycles of phase shift and produces a very resonant sound.
2. LFO Wave – Selects Sine or Rectified Sine waveshape for the LFO output.
3. Mode – Selects either “Phaser” or “Allpass” operating modes. In Phaser mode the dry input signal is mixed with the output of the phaser’s allpass filter network to generate the output signal, resulting in a comb filter response at the allpass delay timing. In Allpass mode the raw allpass filter signal is output.

## Feedback

Feedback is active for this effect. Use with caution as high values of feedback can cause wild oscillation depending on the settings of other controls.

## Readouts

There are two readouts for this effect:

1. Stages – 1, 2, 4, 6, 8, 12, 18, 24
2. LFO Wave – Sine, FWR Sine

## Page 2 Settings

There is one additional setting on Pg2:

- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap
  - Live setting causes the LFO Freq CV input to become a live ratio control.

## Tap Tempo

Tap Tempo is active and controls the LFO rate. Adjust the LFO rate parameter to switch control back to that parameter. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the LFO rate setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

The dedicated LFO signal for the Left channel is routed to the Auxiliary output.

## Granular Pitch

### Overview

Granular Pitch is a granular pitch shifter with +/-2 octave range, variable grain size and chaos offset. It is a true stereo effect – the Left and Right channels are completely independent but are processed with identical parameters. Variable feedback is available as well as selectable shift quantization to an equally tempered scale.

### CV Inputs

Three CV input parameters are supported:

1. Shift – this controls the amount of pitch shift. Parameter readout range is up to +/-2400 cents, depending on the Range selection.
2. Grain Size – this control varies the size of the cross-fade grains in the shift algorithm. Smaller grains result in a faster modulation rate and introduces a somewhat ring-mod sound. The parameter readout is in percent from 0-99%.
3. Chaos – this control allows a variable amount of random offset in the time position of the cross-fade grains. The effect is subtle but can sometimes reduce the amplitude modulation inherent in the granular pitch shift process.
4. Delay – this control provides a variable amount of delay inserted between the shifting effect and the feedback pick-off. The result is greater control over the feedback repeat rate.
  1. This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.

## Buttons

Two button functions are supported:

1. Range – selects one of four different shift ranges for the Shift parameter:
  1. 25 cent – very subtle shifts for fine control of detuning
  2. 100 cent – up to a half-tone shift for more radical detuning
  3. 1200 cent – up to +/-1 octave
  4. 2400 cent – up to +/-2 octaves.
2. Quant – Enables Equal Tempered quantization (100 cent) of the shift parameter.

## Feedback

Feedback is active for this effect.

## Readouts

There are two readouts for this effect:

1. Range – 25, 100, 1200, 2400
2. Quant – on/off

## Page 2 Settings

There are two additional settings on Pg2:

- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap
  - Live setting causes the Delay CV input to become a live ratio control.
- 1V/Oct Rsmpt – Scales the shift input parameter to approximately 1V per octave.

## Tap Tempo

Tap Tempo can be used to override the CV setting of the Delay parameter. The value in BPM and Time is displayed, as well as the tap tempo status.

## Auxiliary Output

This effect has no auxiliary output.

## Shimmer Reverb

### Overview

The Shimmer Reverb is a reverberator combined with a granular pitch shifter in the feedback path that can be used to introduce a variety of ambient textures. It is a true stereo effect – the Left and Right channels are processed independently but share the same reverb loop so that sounds in one channel will reverberate in the other, but from a different part of the process so that stereo imaging does not

collapse. Variable feedback is available as well as selectable shift amounts to allow for a wide range of moods, dark, chaotic and ethereal. Infinite mode is controlled via the Tap Tempo input and preserves the sound in the reverb by disabling inputs, filters and internal attenuation, extending its duration for hours.

## CV Inputs

Four CV input parameters are supported:

1. Rvb Time – this controls the decay time (RT) of the reverb from 0.1 seconds to 10 seconds.
2. Low Cut – depends on Filt Type selection on Button 3
  1. Shelf – this control varies the amount of high-pass cut in the reverb and will reduce the duration of the low frequencies while preserving the high frequencies. The cutoff frequency is ~400Hz and the shelving parameter ranges from 1dB to 14dB.
  2. Cutoff – this control varies the corner frequency of a 6dB/oct highpass in the reverb. Cutoff frequency varies from 0Hz - 1200Hz.
3. High cut – depends on the Filt Type selection on Button 3
  1. Shelf – this control varies the amount of low-pass cut in the reverb and will reduce the duration of the high frequencies while preserving the low frequencies. The cutoff frequency is ~5kHz and the shelving parameter ranges from dB to 14dB.
  2. Cutoff – this control varies the corner frequency of a 6dB/oct lowpass in the reverb. Cutoff frequency varies from 3kHz – 18kHz.
4. Attack – this control varies the amount of initial diffusion applied to the Left and Right channel inputs to the reverb. At low settings the attack is spread out and at high settings it is more sharply defined. The parameter varies from 0 to 99%.

## Buttons

Two button functions are supported:

1. Shift L – selects one of 6 different shift amounts for the shimmer feedback in the Left channel:
  1. Oct Up – shifts up an octave. Useful to create an ethereal feel.
  2. 5<sup>th</sup> up – shifts up a musical 5<sup>th</sup> interval. Can sound like a chord playing.
  3. Tweak + – shifts up by amount specified on Pg2.
  4. Tweak - - shifts down amount specified on Pg2.
  5. 5<sup>th</sup> dn – shifts down a musical 5<sup>th</sup>. Orchestral.
  6. Oct dn – shifts down an octave. Dark, imposing.
2. Shift R – selects one of 6 different shift amounts for the shimmer feedback in the Right channel. Uses the same selections as Shift L. Combine different shifts on the two channels for broader textures.



3. Filt Type – selects either “Shelf” filtering or “Cutoff” filtering inside the reverb model.

## Feedback

Feedback is active for this effect and controls the amount of shift that is re-introduced to the reverb for each channel.

## Readouts

There are two readouts for this effect:

1. Shift L – (see list above)
2. Shift R – (see list above)

## Page 2 Settings

There is one setting on Page 2

- Tweak – controls the amount of shift applied by the “Tweak” setting of the shift amounts.

## Tap Tempo

Tap Tempo is repurposed to enable / disable the Infinite mode wherein sounds in the reverb cycle continuously without decaying.

## Auxiliary Output

This effect has no auxiliary output.

## Resampling Reverb

### Overview

The Resampling Reverb is a collection of different reverberators combined with a sample rate converter. The different types of reverbs provide a wide range of different sounds to choose from, and the variable sampling rate helps to control the timing and bandwidth of the reflections heard.

### CV Inputs

Four CV input parameters are supported:

- Resample – controls the sampling rate. Variable from 48kHz (1x) down to 6kHz (8x)
- Three more which depend on the reverb type – see below.

### Buttons

Two button functions are supported:

- Type – selects the reverb algorithm in use:
  - Basic – a full-featured reverb similar to that used in the Shimmer Reverb algorithm. Controls are:
    - RT – reverb time, from 0.1 to 10 seconds

- Low Cut – controls the low corner or lowpass shelf attenuation
  - High Cut – controls the high corner or highpass shelf attenuation
- Subterranean – a unique sparse space with distinct echos. Controls are:
  - RT – reverb time.
  - Damp – filtering & attenuation of tails.
  - Diff – diffusion applied to the input.
- Crystal – a brilliant reverb with less diffusion, more clarity and overdrive capability.
  - RT – reverb time.
  - InGain – input gain and distortion. Higher gains will cause some soft saturation which can add pleasing harmonics to the signal.
  - Filter – Controls brightness of the effect.
- MV I – All 63 of the original reverb programs from the classic Alesis Midiverb I.
  - Prog – selects the program number from 1 to 63
- Mfx – All 63 of the original delays, reverbs and other effects from the Alesis MidiFex.
  - Prog – selects the program number from 1 to 63
- MV II – Ten of the reverb programs from the Alesis Midiverb II, the reverse reverb programs 40-49 which includes the two unique “Bloom” programs.
- Eigenverb – a unique “Bloom” reverb
  - Attack – controls the initial delay and attack time.
  - Decay – controls the length of the tail and overall reverb time.
  - LPF – controls a low-pass filter in the reverb which can roll off the high end more quickly.
- Rsmpt Qnt – selects the type of quantization applied to the resample parameter. Options are:
  - Off
  - Octave
  - 5<sup>th</sup>
  - Maj 3<sup>rd</sup>
  - Semitone

## Feedback

Feedback is active for this effect.

## Readouts

There are no readouts for this effect

## Page 2 Settings

There are two additional settings on Pg2.

- 1V/Oct Rsmpl – Scales the Resample input parameter to approximately 1V per octave.
- Rsmpl Lag – When enabled introduces various lag speeds on the Resample parameter.

## Tap Tempo

Tap Tempo is repurposed to enable / disable the Infinite mode for the Basic and Subterranean types.

## Auxiliary Output

This effect has no auxiliary output.

## Reflexions

### Overview

Reflexions is a time-domain reverb that provides control over a number of detailed operation parameters and provides early reflections, diffusion, variable room sizes, long decay times and modulation. Parameters can be pushed to extremes that allow wild deviation from realistic spaces, but can also operate with very clean, subtle and realistic spaces.

### CV Inputs

Four CV inputs are available:

- ErlyRflc – controls amplitude and density of early reflections that occur prior to the main reverberant effect.
- Decay – controls the feedback in the reverb network which directly affects the length of the tails.
- Size – controls the length of the delay lines in the reverb network which affects the complexity of the tails.
- Mod Amp – controls the amplitude of the delay modulation applied within the reverb network which adds thickness and chorusing to sounds.

### Buttons

Three buttons are supported:

- Output – selects either the Reverb output, or the Diffuser that's upstream of the Reverb.
- Diff Stg – selects 0 thru 4 diffuser stages to control attack times of the reverb.

- Mod Per – selects various rates of modulation.

## Feedback

The feedback inputs have been repurposed to control filtering within the loop.

- Left Feedback - Lowpass filtering - controls a 1st-order LPF inside the network that will damp down high frequencies faster than low frequencies. Center is off, turning right applies increasing shelving filter with a corner around 400Hz. Turning left applies a cutoff filter whose corner drops the further CW the control is turned.
- Right Feedback - Highpass filtering - controls a 1st-order HPF inside the network that will damp down low frequencies faster than high frequencies. Center is off, turning right applies increasing shelving filter with a corner around 5kHz. Turning left applies a cutoff filter whose corner drops the further CW the control is turned.

## Readouts

There are two custom readouts:

1. A spinning dial in the upper center of the Main page which indicates LFO speed.
2. A small dot illuminates next to the Size control when the the delay lengths are readjusting to a new setting.

## Page 2 Settings

There are four Pg 2 settings:

1. Delay Type
  1. Auto (Pre) – this is the default setting in which the “Delay” setting below controls predelay which is automatically computed as other settings vary. Note that these automatic adjustments may cause some crossfading modulation in the dry signal.
  2. User Set – this allows direct control of the dry signal delay with no automatic adjustments.
2. Delay (ms) – this is the amount of desired delay for the delay type setting above.
3. Size Jitter – this enables varying amounts of random wiggle in the Size control which can provides an additional degree of modulation in the overall reverb effect.
4. Stereo – provides varying degrees of stereo width (channel separation).

## Tap Tempo

Tap Tempo is repurposed to toggle Infinite mode. When this is active the reverb network input is disabled, the filters are removed and decay time is set to maximum to allow any sound in the network to circulate forever with minimal changes.

## Auxiliary Output

This effect has no auxiliary output.

# Convolution

## Overview

Convolution is a classic impulse response (IR) reverberation processor. It is limited to approximately 550ms of “tail”, but is fully stereo, processing each channel separately with the same IR. By default it creates synthetic impulse responses based on parameter settings, but it is able to load externally created impulse responses from WAV files.

## CV Inputs

Four CV input parameters are supported:

- PreDly – a “live” parameter that responds in real-time to changes, this controls the amount of delay that occurs prior to the IR processing, essentially pushing the earliest time of response out. Varies from 0 to 85ms.
- Atten – a “live” parameter that responds in real-time to changes, this controls the amount of attenuation applied to the output of the IR processing before it’s output. This is important because the gain of impulse response files can vary widely.
- Decay – a “batch” parameter that controls the decay rate of synthetic impulse responses and only affects output when the “Recalc” button is pressed. Short decays result in “small” spaces. Long decays make the spaces seem larger. It’s possible to have little or no decay which results in an unnatural, truncated response.
- Bright – a “batch” parameter that controls the bandwidth of synthetic impulse responses and only affects output when the “Recalc” button is pressed. Fully CCW is maximum lowpass filtering which creates dark-sounding responses. Fully CW is no filtering which yields a bright-sounding response.

## Buttons

Three button functions are supported:

- Recalc – uses the Decay, Bright and Direction settings to recompute a synthetic IR. This takes a few milliseconds to complete.
- File Load – Jumps to the File → Wav Load menu page to allow loading an external IR WAV file from SD card.
  - IR files should be 48kHz, 1 channel, 16-bit WAV formatted. Any wave content beyond 26624 samples will be truncated.
  - An IR loaded from a WAV file is **not** preserved in patches and automatically recalled on power-up or patch reload. Only synthetic IR parameters are saved and recomputed when the patch is loaded or power is restored. If a file IR is desired it must always be loaded manually.
- Direction – controls the decay direction of synthetic impulse responses.

## Feedback

Feedback is active for this effect.

## Readouts

There are two readouts for this effect:

- Top Left – an indicator of the IR file name, or an indication that the current IR is synthetic.
- Graph – an amplitude vs time plot of the IR. Updates every time the “Recalc” or “File Load” buttons are pressed.

## Page 2 Settings

There no additional settings on Pg2.

## Tap Tempo

Tap Tempo is not active.

## Auxiliary Output

This effect has no auxiliary output.

## Multi-Chorus

### Overview

The Multi-Chorus is a multi-tap chorus with selectable number of phases and an integrated LFO with variable frequency and depth. It is a true stereo effect – the Left and Right channels are completely independent but can be processed with identical parameters. Variable feedback is available as well as selectable LFO waveform and optional phase offset between the Left and Right channels.

### CV Inputs

Four CV input parameters are supported:

- Mode Var – depending on the Mode selected via button 1, this controls one of two variables. The parameter varies from 0-99%.
  - Offset Mode – a common delay offset for all phases is varied. This can be useful for adding tremolo by modulating the parameter in the 5-10Hz range with an external LFO (or an internal routable LFO). Tap phases are evenly spaced at intervals of  $360/N$  where N is the number of phases selected by button 2.
  - Phase Mode – the common offset delay is fixed at 35ms and tap phases are spaced at intervals which vary by this parameter.
- LFO Freq – this controls the frequency of the integrated low-frequency oscillator. The parameter readout varies from 0-11Hz in an exponential curve that provides greater sensitivity in the low frequency range.
  - This control also becomes a live tempo ratio setting – see Pg2 Tempo Ratio below.

- LFO Depth – this controls the amplitude of the LFO waveform as it is summed with the Phase parameter. The parameter readout varies from 0-99%.
- LFO Phase – this controls the phase offset between the Left and Right channel LFO values, allowing subtly different sweeps and greater stereo imaging. The parameter readout varies from 0-360deg.

## Buttons

Three button functions are supported:

Mode – selects either Offset or Phase mode as described above.

Phases – Selects 1-4 taps/phases on the delay. 1 phase is a low-complexity chorus similar to early low-cost units. 3 phases is typical for modern chorus effects.

LFO Wave – Selects Sine, Rectified Sine or Triangle waveshape for the LFO output.

## Feedback

Feedback is active for this effect. Use with caution as high values of feedback can cause wild oscillation depending on the settings of other controls.

## Page 2 Settings

There are two additional settings on Pg2:

- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16, Live Tap
  - Live setting causes the Delay CV input to become a live ratio control.
- Fdbk Swap – swaps the Left and Right channels in the feedback path to allow signals to bounce between channels.

## Readouts

There are three readouts for this effect:

Mode – Phase, Offset

Phases – 1, 2, 3, 4

LFO Wave – Sine, FWR Sine

## Tap Tempo

Tap Tempo is active and controls the LFO rate. Adjust the LFO rate parameter to switch control back to that parameter. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the LFO rate setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

The dedicated LFO signal for the Left channel is routed to the Auxiliary output.

## Voder

### Overview

The Voder is a filter that shapes sound into vowels which are chosen from a set of 15 that were determined by research. It is a true stereo effect – the Left and Right channels are completely independent but can be processed with identical parameters. In addition to selecting the specific vowel sound there is also control over pitch, width and resonance of the formant frequencies, and the lag and morphing applied as the vowels change. A random sample/hold allows stepping through the vowels at a rate determined by the tap tempo input.

### CV Inputs

Four CV input parameters are supported:

1. Vowel – selects one of 15 vowel sounds to shape the spectrum of the input signal. This can morph smoothly between the distinct vowels, or it can be quantized to the exact settings.
2. VwlLag – a variable lag filter that will smoothly interpolate in time between the vowels selected.
3. Pitch – skews the pitch of the vowel by +/-300Hz from the ideal values.
4. Width – spreads the frequency spacing of the resonances within the vowel by +/-50% from the ideal values.
5. Resonance – (on Left Feedback input) adjusts the bandwidth of the filters. Center position is “standard” and full CW will result in self-oscillation.
6. Limiter – (on Right Feedback input) adjusts some settings of the built-in limiter.

### Buttons

Three button functions are supported:

1. Quantization – enables vowel quantization to nearest canonical setting.
2. Rnd S/H – Turns on randomized sample/hold on vowel.
3. Limiter – Selects limiter output type:
  1. Off – no limiter or distortion. Raw output from formant filter may occasionally hard clip unless input is backed off.
  2. Set – Adaptive gain limiter enabled with output level target set by the Right FB control. This helps to prevent hard clipping when input signal pitch aligns with the formant peaks.
  3. Auto – Adaptive gain limiter enabled with output level target determined by input signal level. Note that this may introduce a noticeable gating.



4. Soft – Soft clipping on output of formant filter which sounds less harsh than hard clipping.
5. Dist – Variable distortion on output of formant filter with distortion order determined by Right FB control.

## Feedback

Feedback is not enabled for this effect.

## Page 2 Settings

There is one additional setting on Pg2:

- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16

## Readouts

There is one readout for this effect:

- Limiter – shows current gain value of limiter when active.

## Tap Tempo

Tap Tempo is active and controls the Rnd S/H rate. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the LFO rate setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

There is no Auxiliary output for this algorithm.

## Dual Mono

### Overview

The Dual Mono algorithm is a collection of single-channel (mono) sub-algorithms that can be individually assigned to the Left and Right channels. This allows running two different algorithms simultaneously. A “Chain” mode is available that internally patches the Left channel output into the Right channel and allows feedback from the Right channel to the Left channel input.

### Sub Algorithms

1. RsDly – Resampling Delay line.
  1. Dly Len: Controls the length of delay at the resampled rate
  2. Delay Time: Controls the resampling rate
  3. Pg2 – Range: Selects the maximum delay length allowed
2. LPF – Lowpass Filter
  1. Cutoff: Controls the cutoff frequency of the filter

2. Resonance: Controls the amount of resonance (peaking) at the cutoff frequency.
3. HPF – Highpass Filter
  1. Cutoff: Controls the cutoff frequency of the filter
  2. Resonance: Controls the amount of resonance (peaking) at the cutoff frequency.
4. BPF – Bandpass Filter
  1. Cutoff: Controls the center frequency of the filter
  2. Resonance: Controls the amount of resonance (peaking) at the center frequency.
5. Fshf – Frequency Shifter
  1. Freq – controls the frequency of the carrier. Varies +/-5kHz
  2. Wave – Morphs between 8 different carrier waveforms.
6. Rngmod – Ring Modulation
  1. Freq – controls the frequency of the carrier. Varies +/-5kHz
  2. Wave – Morphs between 8 different carrier waveforms.
7. PhsShf – Phase shift
  1. Phase – controls the angle of phase shift. Varies 0-360 degrees.
  2. Wave – Morphs between 8 different carrier waveforms.
8. Pshf – Pitch shifter
  1. Shift – controls amount of pitch shift. Varies +/-2400 cents (+/-2 octaves)
  2. Grain Size – controls the rate at which buffered grains cross-fade.
  3. Pg2 Pquant – enables 100cent quantization of shift.
9. Phaser – Phaser
  1. Phase – amount of phase shifting
  2. LFO Depth / Frequency – sets LFO parameters
  3. Pg2 LFO – selects if 2<sup>nd</sup> CV controls LFO Depth or Frequency
10. Flanger
  1. Delay time – sets flanger delay which controls spacing of comb notches.
  2. LFO Depth / Frequency – sets LFO parameters
  3. Pg2 LFO – selects if 2<sup>nd</sup> CV controls LFO Depth or Frequency
11. Diffuser
  1. Length – the time duration of the diffusion cloud

2. LP cut – enables a lowpass shelf to keep diffusion from oscillation when feedback is applied.

#### 12. Shimmer

1. RT – reverberation time. Varies 0.1 – 10s
2. Shift – amount of pitch shift applied in feedback loop. Varies +/-2400 cents.
3. Pg2 Pquant – enables 100cent pitch quantization.

#### 13. Distort

1. Order – controls the shape of the distortion curve.
2. Drive – controls gain into the distortion operator.

#### 14. Voder

1. Vowel – morphs between 15 vowel sounds
2. Lag – time filtering of vowel control.
3. Pg2 Pquant – enables quantization of vowel to “canonical” parameters.

## CV Inputs

Four CV input parameters are supported – CV1 and CV2 are dedicated to the Left channel sub-algorithm, while CV3 and CV4 are for the Right channel sub-algorithm.

## Buttons

Three button functions are supported:

L Sel – Selects sub-algorithm for the left channel

R Sel – Selects sub-algorithm for the right channel.

Chain – when “On” internally patches Left channel output to Right channel input. Right channel feedback controls amount of Right channel output mixed into Left channel input.

## Feedback

Feedback is enabled for this effect. With Chain mode off each channel has its own feedback control. With Chain mode on the Left channel feedback wraps around the Left channel only, while the Right channel feedback wraps around the Left → Right chain.

## Page 2 Settings

Six additional settings are available on Page 2

- 1, 2 – Left and Right delay range for the RsDly sub-algo.
- 3, 4 – Left and Right quantization for the Pitch Shift, Shimmer and Voder sub-algos.
- 5, 6 – Left and Right LFO parameter select for the Phaser and Flanger sub-algos.
- 7, 8 – Left and Right Tap Tempo enables. Default is “On”.

## Readouts

There are no additional readouts for this effect.

## Tap Tempo

Tap Tempo is active and controls delay range for the RsDly sub-algo. A Page 2 setting can disable tap control for each channel.

## Auxiliary Output

There is no Auxiliary output for this algorithm.

# Looping and Sampling Effects

## Looper

### Overview

The Looper is a time-domain looper with resampling that provides up to 5.8 minutes of looping duration at the full sample rate and approx 45min at the lowest rate. It provides the usual feature set of recording, overdubbing and playback. It is also possible to save and load the looper audio to the SD card via the File page while the looper is in Pause mode.

### CV Inputs

Four CV input parameters are supported:

1. Resample – this controls the resampling rate and varies from 1.0x (full 48kHz sample rate) to 8.0x (6kHz sample rate). Changing this parameter in real time will vary the playback/record speed and affect the pitch of recorded sounds. Lower sample rates allow longer record times but also have reduced bandwidth and may sound dark/dull. Resampling can be quantized to various intervals as determined by a button setting below.
2. Warble – controls random variation of the resample rate to simulate tape warble.
3. Sat/Drive – over first ½ rotation adds gradually more soft saturation. Over second ½ rotation increases drive gain into saturation. Note that drive gain is normalized after the saturation operation to prevent runaway feedback.
4. EQ – over the first ½ rotation gradually reduces lowpass cutoff from 24kHz to ~2kHz. Over second ½ rotation gradually increases highpass cutoff from DC to ~200Hz.

## Buttons

Four button functions are supported:

1. Quantize – enables various interval quantization of the resample rate.
  1. Off
  2. Octave

3. 5<sup>th</sup>
  4. Maj 3<sup>rd</sup>
  5. Semitone.
2. Reverse – reverse direction of overdub or play.
  3. Reset – Clears memory and returns the looper mode to Wait.
  4. Pause – this temporarily halts the record and/or play process. Pressing again will resume record/play at the same point in the memory. While in Pause mode you can load and save the contents of the loop to the SD card. NOTE: This button is normally used for the BYPASS function, but for the Looper algorithm it is used as “Pause” so BYPASS mode is always disabled on entry to the Looper algorithm.

## Feedback

Feedback controls the amount of original signal from the loop is mixed back in during overdub. Set to full CW for perfect preservation of the original. Lower values will cause the loop to fade away with each pass.

## Page 2 Settings

One additional setting is available on Page 2.

- 1V/Oct Rsmpl – Scales the Resample input parameter to approximately 1V per octave.

## Readouts

There are four readouts for this effect:

1. Mode – the current operating mode is displayed in the upper left of the screen.
2. Length / Loop – shows the current record length or loop duration in seconds. Note that this is scaled by the selected Resample rate.
3. A graphic display of loop length and record/play position as a bar graph.

## Tap Tempo

Tap Tempo controls the operating mode:

1. Wait – the looper is reset and waiting to start recording with the next press of the Tap button. No audio is passed thru in this mode (wet output is silent).
2. Record – the looper is recording audio into its memory and will continue until it reaches the end of memory, or the next press of the Mode button which will define the loop point, insert a Splice and start the Overdub mode. No audio is passed thru in this mode (wet output is silent).
3. Overdub – all input audio is mixed with the existing contents of the memory according to the Feedback setting. The previous memory contents is simultaneously played thru the wet output with saturation and EQ as selected. Overdub continues recording through the loop point defined

by the previous press of the Mode button until the next press of the Tap button at which time it advances to Play mode.

4. Play – memory contents is played but input audio is not recorded. Play continues through the previously defined loop point until the next press of the Mode button at which time it will return to Overdub mode.

## Auxiliary Output

A 5ms 0-8V trigger signal is output on the Aux jack when the loop restarts.

## Sampler

### Overview

This is a basic sample recorder / player with variable sample rate, variable start/loop/end positions and a number of filtering and distortion options. Samples can be loaded & saved via SD card.

### CV Inputs

Four CV input parameter is supported:

- Pitch (actually sample rate from 1x to 8x slower). Record at lower rates and playback at higher rates to raise pitch.
- Playback Start Point (can range of full length of sample)
- Loop Start Point (ranges from start to end points)
- End Point (ranges from start to full length of sample)

### Buttons

Four button functions are supported:

- Mode - Record / Play Once / Play Loop / Continuous (Cycle)
- Dir - Forward / Bidirectional (Cycle) / Reverse
- Fade - Off/ Fast / Medium / Slow. (Cycle) (only applies to start/stop, not looping crossfade which is always medium)
- Button 4 - Bypass

### Feedback

Feedback inputs have been repurposed as Distortion or Filter controls (selected on Pg2)

- Distortion mode:
  - Left FB - Center off, CW is warble, CCW is aliasing (very subtle)
  - Right FB - Center off, CW is distortion, CCW is bit reduction
- Filter mode:

- Left FB - Center off, CW is LPF cutoff, CCW is HPF cutoff
- Right FB - Center off, CW or CCW is more resonance

## Page 2 Settings

- Pitch Quantization selection
- Pitch 1V/Oct enable
- Pitch lag enable
- FB mode selection
- Bitcrush Lowpass corner
- Crossfade length

## Readouts

Sample Envelope Indicator - Shows full length of sound in rough log<sub>2</sub> amplitude response. Colored indicators for start/loop/stop positions, plus a moving indicator for playback position.

## Tap Tempo

Tap Tempo has been repurposed as the Start/Stop/Trigger control for the sampler. In Record mode the Tap signal will start and stop recording. Recording always restarts at the beginning of the sample memory. In Play Once mode the Tap signal triggers playing the sample which continues from the start point to the end point with no looping. In Play Loop mode the Tap signal is a gate and while Tap is active (pressed or Sync high) the sample will play with looping.

## Auxiliary Output

A 5ms 0-8V trigger signal is output on the Aux jack when the loop restarts.

## Spectral Effects

Spectral effects are processed in the frequency domain using the Fast Fourier Transform. All spectral effects in the E520 use a 1024 point complex FFT to provide two 512 point real transforms at a rate of 2.7ms which provides a good compromise between time and frequency resolution, while allowing full stereo processing for most effects. Frequency resolution is 512 bins of 48Hz each.

## Spectral Crusher

### Overview

The Spectral Crusher is a multi-effect which provides a number of unique ways to manipulate sound in the frequency domain. Six different algorithms are available, each of which “crushes” audio in a different way.

### CV Inputs

Four CV input parameters are supported:

1. Pitch – This controls a frequency-domain pitch shift by up to +/- 2 octaves. The parameter reads out in cents over the selected range (see below). Quantization to equally tempered half-tone intervals (100 cent steps) is available.
2. Phase Blur – This adds varying amounts of random phase noise to every frequency bin which can decorrelate some of the metallic sounding artifacts that are characteristic of spectral processing.
3. Depends on mode – see description below
4. Depends on mode – see description below.

## Buttons

Three button functions are supported:

1. Range – selects one of four different shift ranges for the Shift parameter:
  1. 25 cent – very subtle shifts for fine control of detuning
  2. 100 cent – up to a half-tone shift for more radical detuning
  3. 1200 cent – up to +/-1 octave
  4. 2400 cent – up to +/-2 octaves.
2. Quant – Enables Equal Tempered quantization (100 cent) of the shift parameter.
3. Mode – cycles through operating modes
  1. Pass-thru – Only pitch shifting and phase blur are applied, no additional processing takes place.
  2. Threshold – filters out all bins with loudness that don't fall between the Low and High threshold settings. CV #3 is the low threshold – all bins quieter than this will be dropped. CV #4 is the high threshold – all bins louder than this will be dropped.
  3. Compress – Similar to Threshold mode, except only a low threshold is set and all bins louder than the low threshold will be forced to the target loudness. CV #3 is the low threshold and CV #4 is the target loudness.
  4. Peak-Hold – This algorithm detects the peak loudness in every bin and holds it with exponential decay that's controlled by CV #3. The frequency of the bin will track the actual frequency until the actual loudness falls below the threshold set by CV #4, at which point it will be held.
  5. FrqCrush – The full spectrum is divided into groups and the loudest bin in every group is preserved while all others are dropped. The loudness of the preserved bin is binary quantized. CV #3 controls the size of the groups (powers of 2 from 1 up to 512) while CV #4 controls the loudness quantization (bits from 1-15).



6. Scintll8 – Random noise modulation is applied to the loudness of every bin. CV #3 controls the amplitude of the noise from 0-99%. CV #4 controls the bandwidth of the noise from 0-99%.
7. LPF/HPF – CV3 controls the highpass cutoff frequency, CV4 controls the lowpass cutoff frequency. If  $CV3 > CV4$  then no audio will pass.

## Feedback

Feedback is active for this mode.

## Page 2 Settings

There are two additional settings on Pg2:

- Blur Start – the starting offset for the Blur parameter
- Blur Range – the range of the blur parameter. Combined with (2) above this allows extremely fine control over the amount and bandwidth of phase blur applied to the Drone audio and may help reduce some of the harmonic buzzyness of the sound.
- 1V/Oct Pitch – Scales the pitch input parameter to approximately 1V per octave.

## Readouts

There are four readouts for this effect:

1. Range – 25, 100, 1200, 2400 cents
1. Quant – on/off
2. Mode – see list above.
3. Freeze – Highlighted when Freeze mode is enabled.

## Tap Tempo

Tap Tempo is repurposed to enable/disable Freeze mode. During Freeze the spectrum of the playing sound is held static until Freeze is disabled.

## Auxiliary Output

This effect has no auxiliary output.

## Spectral Time Machine

### Overview

The Spectral Time Machine is a combination of a looper, pitch shifter and time stretcher. A large (5.8 minute) memory records and loops sounds which can be played back continuously or looped with variable speed and pitch. Due to the processing overhead this is a mono effect – Left and Right channels are mixed 50/50 prior to input. Output has pseudo-stereo at some settings of the Phase Blur control. It is also possible to load and save the contents of the looping memory to SD card while recording is in Pause mode.

## CV Inputs

Four CV input parameters are supported:

1. Time Factor – This controls the playback speed over a range of +/- 2 x the record speed. Changing speed (or even stopping) does not change pitch. During “Record” mode, the play head may pass up the record head, either forward or backward. When passing forward it will continue playing the previous contents of the memory which may have either silence, or sound from earlier cycles. When passing in reverse it will suddenly shift from old sound to newly recorded sound. During “Overdub” or “Pause” mode, playback is constrained to the loop that was defined when moving from “Record” to “Overdub”.
2. Pitch – This controls a frequency-domain pitch shift by up to +/- 2 octaves. The parameter reads out in cents over the full range of +/-2400 cents. Quantization to equally tempered half-tone intervals (100 cent steps) is available.
3. Phase Blur – This adds varying amounts of random phase noise to every frequency bin which can decorrelate some of the metallic sounding artifacts that are characteristic of spectral processing. Phase blur is applied independently to the Left and Right output channels which results in a wider stereo image at some settings.
4. Spect Fdbk – this allows the spectral output from the play process to be mixed back into the Record buffer.

## Buttons

Four button functions are supported:

1. Tap Tempo – Controls the Record process. There are four modes:
  1. Wait – the record process is waiting to be started. Press Tap to advance to Record mode.
  2. Record – the buffer is being overwritten with new audio data. Feedback is not enabled at this point and the entire 5.8min buffer can be used for recording. Press Tap to define a loop point, enable feedback and advance to Overdub mode.
  3. Overdub – continues to record, but mixes new input with the current contents of the record buffer and also the spectrally processed output according to the Feedback and Spect Fdbk settings. Press Tap to stop recording and enter Pause mode.
  4. Pause – recording is stopped. Press Tap to return to Overdub mode. In this mode you can use the File page to load and save the contents of the looping memory to SD card.
2. Quant – Enables Equal Tempered quantization (100 cent) of the Pitch Shift parameter.
3. Play – Controls the Play process. There are two Play modes:
  1. Wait – No playback audio. Press the Play button to advance to “Play” mode.
  2. Play – the play process reads out of the buffer at a rate set by the Time Factor parameter. During “Record” mode the entire buffer is available to play so the play head may pass the

record head. During “Overdub” or “Pause” modes the play head will be restricted to the loop point established when the record process advanced from “Record” to “Overdub” mode. Press the Play button to stop playback and return the “Wait” mode.

4. Reset – Resets both the Record and Play modes back to “Wait” without clearing the memory. The play process may still access previously recorded audio in the buffer but the loop point encompasses the entire 5.8min buffer.

## Feedback

Feedback parameters for Left and Right control the mixing of input audio with the existing contents of the buffer during “Overdub” mode.

## Page 2 Settings

There are four additional settings on Pg2:

- TF Quant – Enables quantization of the Time Factor (CV1) to steps of 25%.
- Blur Start – the starting offset for the Blur parameter
- Blur Range – the range of the blur parameter. Combined with (2) above this allows extremely fine control over the amount and bandwidth of phase blur applied to the Drone audio and may help reduce some of the harmonic buzzyness of the sound.
- 1V/Oct Pitch – Scales the pitch input parameter to approximately 1V per octave.

## Readouts

A graphic display of loop length and record/play position as a bar graph. The location of the record head is shown above the line and the play head is shown below the line.

## Tap Tempo

Tap Tempo controls the record mode.

## Auxiliary Output

A 5ms 0-8V trigger signal is output on the Aux jack when the loop restarts.

## Spectral Delay + Pitch

### Overview

The Spectral Delay + Pitch is a stereo effect with independent delay and pitch shift applied to the Left and Right channels. Pitch shift quantization to equal tempered half tone intervals is available independently on each channel and a fixed value phase blur may be applied to both channels simultaneously.

### CV Inputs

Four CV input parameters are supported:

1. Delay L – This controls the amount of delay applied to the Left channel. The range is 0 to 1.96 seconds.

2. Pitch L – This controls frequency-domain pitch shift by up to +/- 2 octaves for the Left channel. The parameter reads out in cents over the full range of +/-2400 cents. Quantization to equally tempered half-tone intervals (100 cent steps) is available.
3. Delay R – This controls the amount of delay applied to the Right channel. The range is 0 to 1.96 seconds.
4. Pitch R – This controls frequency-domain pitch shift by up to +/- 2 octaves for the Right channel. The parameter reads out in cents over the full range of +/-2400 cents. Quantization to equally tempered half-tone intervals (100 cent steps) is available.

## Buttons

Three button functions are supported:

1. Quant L – Enables Equal Tempered quantization (100 cent) of the Left channel shift parameter.
2. Quant R – Enables Equal Tempered quantization (100 cent) of the Right channel shift parameter.
3. Cross – Enables feedback from opposite channel. Useful for creating ping-pong effects.

## Feedback

Feedback is active for this mode.

## Page 2 Settings

There are three additional settings available on Page 2:

- Phase Blur – Adds various fixed values of phase blur for both channels.
  - 1%, 2%, 5%, 10%, 20%, 50%, 100%
- Tempo Ratio – controls an additional ratio between the Tap Tempo and timing. Values are 1/1, 3/2, 2/1, 3/1, 4/1, 8/1, 16/1, 2/3, 1/2, 1/3, 1/4, 1/8, 1/16
- 1V/Oct Pitch – Scales the pitch input parameter to approximately 1V per octave.

## Readouts

There are three readouts for this effect:

1. Quant L – on/off
2. Quant R – on/off
3. Blur - on/off.

## Tap Tempo

Tap Tempo is active and controls delay for both Left and Right channels.

## Auxiliary Output

This effect has no auxiliary output.

# Spectral Delay

## Overview

The Spectral Delay is a stereo effect which delays each spectral bin by different amounts. Several modes are provided to vary the bin delays in different ways. Left and Right channels have independently controlled delay parameters.

## CV Inputs

Four CV input parameters are supported but their function varies depending on the operating mode so see below for details:

1. Left channel mode-dependent parameter 1.
2. Left channel mode-dependent parameter 2.
1. Right channel mode-dependent parameter 1.
2. Right channel mode-dependent parameter 2.

## Buttons

Three button functions are supported:

1. Range L – Selects maximum delay range for the Left channel. Ranges vary between 0.17 sec up to 5.46 sec.
1. Range R – Selects maximum delay range for the Right channel. Ranges vary between 0.17 sec up to 5.46 sec.
2. Mode – selects one of three possible algorithms for varying the bin delays:
  1. Pivot / Tilt – This creates a piecewise-linear response curve with control of the slope and center frequency. Parameter #1 “Pivot” controls the the center frequency and ranges from 0 - 24kHz, while parameter #2 controls the slope of the response and ranges from [fixme].
  2. Sinusoid – The creates a sinusoidal response curve with control of period and gain. Parameter #1 controls the period of the sinusoid from 375 Hz to 24kHz, while parameter #2 controls the amplitude of the sine wave and ranges from -1.0 to +1.0
  3. Random – This creates a pseudo-random delay across all bins with varying seed and gain. Parameter #1 selects the seed from among 128 possible to keep the per-bin random delays stable while the parameter is not changed. Parameter #2 controls the amplitude of the random values and ranges from -1.0 to +1.0.

## Feedback

Feedback is active for this mode.

## Page 2 Settings

Three additional settings are available on Page 2:

1. Left Pitch – introduces a slight pitch shift into the left channel for slippery sounding feedback.
2. Right Pitch – introduces a slight pitch shift into the right channel for slippery sounding feedback.
3. Phase Blur – Adds various fixed values of phase blur for both channels.
  1. 1%, 2%, 5%, 10%, 20%, 50%, 100%

## Readouts

There are five readouts for this effect:

1. Range L – 0.17s thru 5.46s
2. Range R – 0.17s thru 5.46s
3. Mode – see list above.
4. Delay vs Frequency plot for Left channel
5. Delay vs Frequency plot for Right channel

## Tap Tempo

Tap Tempo is active and controls the maximum delay range of both channels. Use the range buttons to return to the fixed ranges. Tap Tempo status is shown in the upper left of the effect area: No indicator means tap tempo is inactive, “...” means that some taps are detected and the algorithm is acquiring the tempo, while “TT” signifies that tempo is active and overrides the Range setting. Tap intervals longer than ~5 seconds cause the tempo calculation to reset.

## Auxiliary Output

This effect has no auxiliary output.

## Spectral Vocoder

### Overview

The Spectral Vocoder is a mono effect which superimposes the amplitude response of one signal (the Modulator, in the Left channel) upon another signal (the Carrier, in the Right channel) which can (among other things) be used to create “talking instruments” when speech is used as the Modulator signal. Various amplitude and frequency manipulations are provided to improve or distort the intelligibility of the resulting sounds, including gain adjustments, compression, enhanced sibilance (“S” sounds) and frequency resolution reduction.

### CV Inputs

Four CV input parameters are supported:

1. Gain – this adjusts the sensitivity of the detector on the Modulator signal. The parameter ranges from 0 – 100 with higher values indicating greater sensitivity.

2. Tilt – this parameter provides a coarse equalization and ranges from 0.99 to -0.99. Fully CCW (0.99) the low frequency response is emphasized and at fully CW (-0.99) the high frequency response is emphasized. In the center the overall response is flat with frequency.
1. Sibilance – this controls the amount of high-frequency noise injected into the Carrier signal. The parameter ranges from 0-99% and increasing it adds more noise which can enhance overall intelligibility by emphasizing “S” sounds in speech.
2. Bands – this controls the frequency resolution of the algorithm. The parameter ranges from 8 to 512 and at lower settings will muddle the intelligibility of the resulting sound.

## Buttons

Two button functions are supported:

1. Compress – this applies a nonlinear response to the Modulator gain calculation and can be used to improve intelligibility of vocoded speech.
2. Invert – this does a spectral inversion of the Modulator signal, pivoting around 6kHz. It makes speech completely unintelligible.
3. AltLR – splits the odd/even channels of the vocoder into the Left & Right output channels for enhanced stereo effects.

## Feedback

Feedback is active for this mode.

## Page 2 Settings

No additional settings are available on Page 2.

## Readouts

There are Two readouts for this effect:

1. Compress - on/off
2. Invert - on/off

## Tap Tempo

Tap Tempo is disabled in this effect.

## Auxiliary Output

This effect has no auxiliary output.

## Spectral Drone

### Overview

The Spectral Drone is a stereo effect which is patterned on the Michael Norris Spectral Dronemaker plugin. It takes any audio as input, samples the frequency response at controllable intervals and interpolates between these samples.

## CV Inputs

Four CV input parameters are supported but their function varies depending on the operating mode so see below for details:

1. Length – This varies from 0.01 second to 10 seconds and controls the nominal length of the sampling interval. Shorter lengths track the incoming sound more accurately, longer lengths lead to slowly changing sounds.
2. Phase Blur – This controls the amount of phase blur added to the output. At full CCW no blur is added, while at full CW the maximum is added. Increasing blur will change from wavy to bubbly to glassy sounding output.
3. Left Pitch – A variable amount of pitch shift can be added to the left channel audio prior to the sampling process. Range is -1200 cents to +1200 cents and is nonlinear to provide more fine tuning for small shifts.

Right Pitch – same as Left Pitch but for the right channel.

## Buttons

Three button functions are supported:

1. Peak – When On, instead of taking the amplitude of the audio at the sampling instant, the peak value over the previous interval is used. This can make the output louder but also results in less dynamic sounds.
2. Variance – controls the amount of variation in the sampling length between the FFT bins. Off means no variation and all frequencies are sampled at the same rate. 40% and 100% settings allow increasing randomness.
3. Grid – When on, all frequencies are quantized to the center of the nearest FFT bin. Can make the sounds more mechanical and buzzy.

## Feedback

Feedback is active for this mode. When either feedback is in the negative (left of center) range then Ping mode is on for that channel. Ping mode changes the way frequencies are sampled and can result in interesting discontinuities in the tones.

## Page 2 Settings

Five additional settings are available on Page 2:

1. Pitch Quant - quantizes the pitch shifts to 100 cent intervals.
2. Blur Start – the starting offset for the Blur parameter
3. Blur Range – the range of the blur parameter. Combined with (2) above this allows extremely fine control over the amount and bandwidth of phase blur applied to the Drone audio and may help reduce some of the harmonic buzzyness of the sound.
4. Sync – chooses interpolation sync or freeze option for Tap/Sync inputs



5. 1V/Oct Pitch – Scales the pitch input parameter to approximately 1V per octave.

## Readouts

There are two readouts for this effect:

Left and Right Ping mode status is shown above the parameter widgets.

## Tap Tempo

Tap Tempo is active and can perform one of two functions:

- Sync Interp - synchronizes the sampling interval. Each tap will force an immediate sample operation and can be used to keep the drone time aligned with an external source.
- Freeze – holds the current sample state until released.

## Auxiliary Output

This effect has no auxiliary output.

## Spectral Drone Hi-Res

### Overview

The Hi-Res Spectral Drone is identical to the Spectral Drone, with the exception that it operates with 2048 frequency bands instead of 512. This results in a much smoother sound with less noticeable modulation.

## Spectral Sweep

### Overview

The Spectral Drone is a stereo effect which is patterned on the Michael Norris Gliding Filters plugin. It creates a shifting cloud of filters with controllable start frequency, sweep rate and duration that move about the signal spectrum.

### CV Inputs

Four CV input parameters are supported :

1. Start Freq - sets the start frequency in Hz at which new filters enter the system. Range is 10Hz - 10kHz with expo response.
2. Rate - sets the sweeping rate of the filters in cents per second. Range is +/-1200 cents/s (+/- 1 octave/sec)
3. Duration - sets the length of time in seconds that a filter will be active in the system before shutting off and restarting with new parameters. Range is 0 to 100 sec with fine control in the 0-9 second range.
4. Blur - Typical spectral phase blur control that gives subtle motion and stereo enhancement.

## Buttons

Three button functions are supported:

1. Num Filt - cycles through [2, 4, 8, 16, 32] active filters at a time.
2. Width - Bandwidth of the filters in bins (roughly 12Hz/bin). Options are [4, 8, 16, 32, 64, 128] - about 50Hz to 1.5kHz.
3. Variance - controls the amount of random deviation applied to the filter start frequency, rate and duration. Four steps [None, Small, Med, Large].

## Feedback

Feedback is active for this mode. Use caution at high settings because “explosions” of overload can occur.

## Page 2 Settings

Five additional settings are available on Page 2:

1. Blur Start - starting offset of the Blur CV.
2. Blur Range - controls the maximum amount of blur possible with the CV.
3. Filter Type - selects either Bandpass or Notch filters.
4. Duty cycle - controls the "off" time between active periods of all filters.

## Readouts

There a single custom readout for this effect that displays a spectrum plot of the filters. Filters are shown as blobs of color that move around the spectrum. When Filter type is set to “BP” (Bandpass) the background color of the spectrum is Wave Background and when Filter type is set to “Notch” the background color is set to Wave Foreground.

## Tap Tempo

Tap Tempo / Sync is used to retrigger all filters to start.

## Auxiliary Output

This effect has no auxiliary output.

## Miscellaneous Effects

Miscellaneous Effects are neither Time or Spectral in nature but still modify audio.

## Envelope-Wah

This is a classic Auto-Wah effect consisting of an envelope follower combined with resonant lowpass filters.

## CV Inputs

Four CV input parameters are supported:

1. Gain – this adjusts the sensitivity of the detector on the Left channel signal. The parameter ranges from 0 – 5.5x with higher values indicating greater sensitivity.
2. Offset – this is a voltage offset added to the detected signal after gain is applied. Use it to adjust the baseline value when no signal is present such that the desired “off” filtering is applied.
3. Lag – this adjusts the response of a lag filter that smooths the detected envelope. 0% (full CCW) applies no filtering while 99% (full CW) freezes the signal.
4. Resonance – this controls the resonance peak of the audio lowpass filter. Use it to enhance the formant of the ‘wah-wah’ effect to make the baby cry harder.

## Buttons

Three button functions are supported:

1. Detector – selects one of five different detection algorithms:
  - I. Precision – closely follows the envelope without much ripple but has some lag on the attack. Probably the best choice for ‘wah-wah’ effects.
  - II. Crunchy – similar to Precision, but has a very fast attack.
  - III. Sinusoid – tracks signals with sinusoidal waveforms very accurately, but not so accurate for more complex waveforms.
  - IV. Average – tracks the average power of signals but requires a lot of lag filtering to smooth out ripple.
  - V. Peak – very accurate peak tracking but also requires a lot of lag filtering to remove ripple.
2. Sensitivity – Low or High. Low is normal and High applies 20dB of signal boost on the detected envelope. Useful when dealing with weak signals.
3. Invert – Changes the sense of the final detected output. “Wah-Wah” is normal positive sense. “Yo-Yo” inverts and makes the filter sweep in the opposite direction.

## Feedback

Feedback is active for this mode.

## Page 2 Settings

No additional settings are available on Page 2.

## Readouts

There are no readouts for this effect.

## Tap Tempo

Tap Tempo is disabled in this effect.

## Auxiliary Output

The detected / scaled / offset / inverted envelope as applied to the filter is available on the Auxillary output.

## Dirt

This is destroyer of sounds that allows you to apply various kinds of grit / grime / grunge and instability to emulate the feel of vintage electronics.

## CV Inputs

Four CV input parameters are supported:

- Bits – does bit crushing from 24 bits down to just 1. Optional dither noise may be added with button 1.
- Sample – does sample rate reduction from 48kHz down to 48Hz to introduce aliasing. Two different alias styles are available on button 2.
- Warble – adds random pitch wiggle similar to unsteady motors and alignment in tape and LP players. Two different types of randomness are available on pg2.
- Grunge – adds variable distortion. The type of distortion is selectable on button 3.

## Buttons

Three button functions are supported:

- Dither – adds dither noise during the bit crushing operation. The amount of noise is scaled to the number of bits crushed.
- Alias – provides two different types of aliasing in the Sample Rate Reduction operation.
  - Gentle – linear ramps between samples. A somewhat smoother/quieter aliasing.
  - Harsh – zero-order hold steps between samples. Crunchy!
- Dist – controls the type of distortion:
  - Off – no distortion
  - Odd – Odd harmonic distortion. Transistor amps.
  - Even – Even harmonic distortion. Tube amps.

## Feedback

Feedback knobs are active for this mode and controls filters applied at the end of the chain:

- Left Channel : Lowpass filter. Center position is disabled. Moving towards the ends reduces the filter corner. Moving CCW applies some resonance. Moving CW is a flat response.

- Right Channel : Highpass filter. Center position is disabled. Moving towards the ends increases the filter corner. Moving CCW applies some resonance. Moving CW is a flat response.

## Page 2 Settings

There is one setting on Pg2 which controls the type of warble noise used.

## Readouts

There are readouts for the LPF and HPF corner frequencies, as well as an indicator for the current warble value.

## Tap Tempo

Tap Tempo is a “Drag” effect which is akin to touching the edge of a tape reel. While the Drag effect is applied the sound will pitch down momentarily and speed up when the effect is released.

## Auxiliary Output

The effect has no Auxiliary output.

## Utility Effects

Utility effects are those which don't modify audio signals - instead they analyze inputs and present the results to the user via the display, or as signals on the audio and auxiliary outputs.

## Scope

### Overview

The Scope utility effect is a multi-purpose signal analyzer which comprises a number of different analysis modes:

1. Time mode – essentially an oscilloscope with control over triggering, vertical gain and horizontal timebase.
2. X-Y mode – a 2D plotting utility that can be used to generate Lissajous graphs of the Left vs Right channels.
3. Freq mode – a spectrum analyzer with variable frequency span.
4. VU mode – a level meter which functions similarly to industry-standard VU meters.
5. Tune mode – a frequency meter accurate to 0.1Hz which includes quantization and tuning error readouts for standard Equal Tempered tuning.
6. Tap mode – measures Period (ms), Rate (BPM) and Jitter (ms) of the tap tempo button and sync inputs. Note that there is about +/-1.3ms of inherent jitter in the measurement so only values in excess of this are meaningful.

Left and Right input channels are processed separately and modes may be selected independently on each.

## CV Inputs

Four CV input parameters are supported. Parameters 1 & 2 are assigned to the Left channel readout and parameters 3 & 4 are assigned to the Right channel readout. The functions vary depending on mode:

1. Time mode – Two parameters are used: a Vertical parameter controls the amplitude of the displayed signal in and a Horizontal parameter controls the time base. The maximum amplitude is 7V/division which covers the full input range of the audio signal and the minimum amplitude is 0.05V/division. Horizontal resolution varies from 170.7ms/division down to 1.3ms/division which is one pixel per sample at the native 48kHz rate.
2. X-Y mode – the same two parameters as Time mode. Note that the time base control now affects the duration of the Lissajous trace. Longer time base means the trace captures a longer duration signal, but also loses resolution so plots may appear “spikier”.
5. Freq mode – only one parameter is used to control the span of the frequency plot. Three spans are available: 3kHz/division, 6kHz/division, and 12kHz/division. The vertical axis has a fixed scale of 20dB/division.
6. VU mode – no parameters are used for this mode. The meter is scaled such that the +3dB limit represents the full 14Vpp input range for a sine waveform. The 0dB tic is the nominal 10Vpp level of a Synthesis Technology oscillator. Note that like a normal analog VU meter, this level meter is sensitive to wave shape, so a 10Vpp square wave will peg the meter even though it doesn’t actually saturate the codec input.
7. Tune mode – One parameter is used for this mode which allows setting the frequency of the A1 note to 440.0Hz +/-50 cents. The frequency estimation process requires about 10ms to settle to an accurate measurement (usually about +/-0.1Hz) and will present tuning error on a scale of +/-50cents. A caveat: for some complex waveforms the estimate may be off by one or more octaves, but the quantized note on the scale and relative cents error estimate will still be correct.
8. Tap mode – no parameters affect this.

## Buttons

Three button functions are supported:

1. L Mode - Selects operating mode for the Left channel.
2. R Mode - Selects operating mode for the Right channel.
3. Trigger – selects the trigger mode for both channels in Time or X-Y modes.
  1. Auto – the sweep is initiated when the input signal rises through 0V, or after an internal timer expires. This ensures that even in the absence of a true trigger you’ll still see a sweep.
  2. Ext – the sweep is initiated only when a rising edge is seen on the SYNC input jack, or the Tap Tempo button is pressed.

## Feedback

Feedback is not active for this mode.

## Page 2 Settings

There is one additional setting available on Page 2:

1. Large Mode – Changes the display to one large grid with only one channel displayed.

## Readouts

There are two readout areas for this effect – basically two small screens in which the signals are plotted and/or results summarized.

## Tap Tempo

Tap Tempo is used for external triggering.

## Auxiliary Output

This effect has no auxiliary output.

## Revision History

V0.1 – Oct 10, 2019: Initial release

V0.2 – Nov 4, 2019: Updates for new functionality. Added Main Page P2, P3, Clean Delay Tap offset, Scope mode.

V0.3 – Nov 22, 2019: Updates for new effects and functionality. Added Flanger, Chorus, Tap LFO setting, Auto-Wah.

V0.4 – Dec 2, 2019: Updates for new aux outputs on freq shift and flanger. Updates to Looper UI.

V0.5 – Dec 6, 2019: Updated for new Time Machine UI.

V0.6 – Dec 31, 2019: Updated for new Stereo Chowder Delay.

V0.7 – Jan 10, 2020: Updated for new Spectral Drone, added frequency shift BPM, Shimmer RT and filter unit displays.

V0.8 – Apr 21, 2020: Updated with Dual Mono and Voder. Changed some algo names per Robert's suggestions.

V0.9 – Apr 24, 2020: Added Pattern Delay.

V0.10 – May 25, 2020: Minor tweaks and added menu description.

V0.11 – May 27, 2020: Notes about Feedback Guard. Remove LCD dimming.

V0.12 – June 1, 2020: Added tap mode to scope, hysteresis to global prefs.

V0.13 – June 12, 2020: Added Feedback Limiter details, Overload section. Dualmono L/R tap tempo.

V0.14 – June 18, 2020: Correct cross / blur params on spect pitch+delay. Misc typos.

V1.1 – Nov 15, 2020: New algos:

Hi-Res Spectral Drone

Resonators

Headspace

Dirt

New features:

Wet/Dry mix prefs selections

Sync div rate prefs selection & logic for algos w/o divs

Buffer load for looper and spectral time

Time Machine factor quantization on Pg2

Flanger sweeps 20Hz-20kHz in freq mode

Tap ratios in clean, mini, resamp, reverse algos

Vref & die temp readouts to About pg.

Freeze option on pg2 for Spectral Drones

Bugfixes:

Fix freeze mode click in minidelay

Lower limiter threshold on minidelay for saturation bug.

Spectral delay sync BPM miscalcs

V1.2\_p11 – Aug 11, 2021

New Algos:

Resampling Reverb

Convolution

Multitap Delay

New Features

More resampling quantization options

Multi-chorus feedback swap

Wet-only W/D mix option

LFO Sync

More phase blur control

Filter type settings

Trigger outputs

More patches per algorithm



Live tap tempo ratios

Bugfixes

A few minor ones

V1.2 RC1 – Aug 12, 2021

Added more detail on Tap Tempo and “Live Tap” mode.

V1.2 RC5 – Aug 20, 2021

Added detail about V1.1 Sys Load conversion.

V1.2 RC6 – Aug 23, 2021

Added Pg2 Phase Morph options to Deflector Shield and Frequency Shift

V1.2 RC10 – Sept 2, 2021

Remove quantize option on Pg2 for Prime Delay

V1.2 – Sept 11, 2021

Bump revision to final.

V1.3 pre5 – June 2, 2023

Updates for V1.3 features

V1.3 pre9 – June 18, 2023

More new stuff, edits for clarity

V1.3 RC1 – July 9, 2023

Added Introduction, Interfaces and Table of Contents.

V1.3 RC2 – July 16, 2023

Updated with Looper Bypass disable.

V1.3 RC3 – July 23, 2023

Bump for RC3 (bugfix only).

V1.3 RC4 – July 25, 2023

Added info on inverting feedback and Prime Delay BPM readout.

V1.3 – July 30, 2023

Bump for general release.