Time Fabric

Pitch Programs for Z-DSP

TIPTOP audio

Time Fabric' Pitch Programs for Z-DSP

"It fucks with the fabric of time!"
Tony Visconti describing Pitch Shifting to Brian Eno and David Bowie in 1976

That not so subtle description does quite neatly sum up what the Pitch Shift programs on the 'Time Fabric' card do! In the second half of the 1970s, digital technology became 'affordable' enough to start showing up in professional audio equipment. Digital memory allowed the sampled audio to remain in memory without degradation and this ability led not only to delay and reverb devices, but some clever people (like Tony Agnello at Eventide) found that playing the samples back at a different rate than recorded produced pitch changes. With some careful engineering this effect could work in real time on any audio signal, and thus pitch shifting emerged.

First, Lexicon released their Varispeech device aimed at aiding in transcription and speech research (dubious for the intended use, but great at mangling sounds), but it was really the Eventide H910 'Harmonizer' that made Pitch Shifting a must have effect. Although designed to provide automatic 'Harmony' for any signal, the effect was so wild and new it became instantly recognizable when abused. Pitch shifting became the method for the wacky sounds and voices on P-Funk records, snare drum on the above mentioned Bowie album 'Low', and any male voice shifted down an octave became the voice of Satan in countless 80s horror films.

Pitch shifting would eventually have both more experimental applications like the Eno/Lanois 'Shimmer' and crazy backwards Eventide 'Crystals' effects, but also be relegated to mundane tasks like doubling country music vocals and widening hair metal guitars. Both paths have made Pitch Shifting into an essential effect for any studio and now your Eurorack rig.

This collection of Pitch Programs for the Tiptop Audio Z-DSP module use a pitch shifting algorithm much like the earliest digital pitch shifters released. Sounds similar to the Eventide H910, AMS 15-80 (with Pitch board) and Publison DHM 89 can be achieved. These programs are intended more for pure effects rather than the complex multiple harmony lines later devices and plugins became known for producing. Chords from single VCOs can easily be made using the 'Interval' programs on the card though.

Pitch shifting in the Z-DSP uses a technique called 'rotating tape head' delay lines named after pioneering tape based experiments in Germany in the 1960s. The tape heads move at speeds independent of the tape playback path and two heads are crossfaded to make a continuous output. Much of Karlheinz Stockhausen's output of that era heavily (ab)uses the two tape machine method of changing pitch. Digital memory and processing allows the same method by manipulating two playback positions in memory and crossfading them using DSP. This is a fairly primitive process compared to what can be done today using FFTs (phase vocoder) and Time Compression and Expansion, but there is a certain sound associated with it that is undeniably classic.

The first 6 programs all use the same basic algorithm for independent processing of the Left and Right Inputs on the Z-DSP. The algorithm looks like this:

Left In ---> Pitch Shifter ---> Delay Line ---> Left Output ---> [Analog Feedback to Left In]

Right In ---> Pitch Shifter ---> Delay Line ---> Right Output ---> [Analog Feedback to Right In]

The differences in the programs come from the controls and their ranges to give more access to certain parameters of the algorithm and make certain effects easier to create.

The delay lines have roughly 500ms of delay on the Left and 250ms on the Right channel. This gives a nice 2:1 rhythmic effect to the delay.

1> Dual Pitch Shift

Has independent control of the Pitch of the Left and Right channels and combined Delay time control. The delay for the Right channel is half of the Left channel to give rhythmic variation between the two.

VC-P1 - Pitch shift of the Left channel from -1 to 1 octave
VC-P2 - Delay time of both channels. Left < 500ms; Right < 250ms
VC-P3 - Pitch shift of the Right channel from -1 to 1 octave

The Pitch control is not quantized so it can be tuned (or not) by ear. For very small shifts under 1 semitone, use Program #5 Dual Microshift. Programs 3 and 4, Interval shift, will tune the Pitch to specific intervals.

The delay line feedback is controlled using the Analog Feedback for each channel. This also puts the Pitch Shift in the feedback path to create arpeggios and other effects.

2> Dual Delay Shift

The same algorithm as Program #1 but with independent control of the delay times. Left delay line has roughly 500 msec of delay at the default sample rate. The delay for the Right channel is half (250 msec) of the Left channel to give rhythmic variation between the two.

The pitch ratio between the left and right channels are inverted, so a positive shift on the Left will be a negative shift on the Right. The maximum shift is one octave up or down.

VC-P1 - Delay Time of the Left channel from 0 to 500 msec
VC-P2 - Pitch Shift of Left and Right. The shift amount is inverted between channels
VC-P3 - Delay Time of the Right channel from 0 to 250 msec

The Pitch control is not quantized so it can be tuned (or not) by ear.
For very small shifts under 1 semitone, use Dual Microshift. Interval shift will tune the Pitch to specific intervals.

The delay line feedback is controlled using the Analog Feedback for each channel. This also puts the Pitch Shift in the feedback path to create arpeggios and other effects.

3> Interval Shift 1

The same design as Program #1 but with the Pitch values quantized to semitone inter vals. The intervals are the same on both channels which allows for chords. Intervals:

-12 - One octave down
-7 - Fifth down
-5 - Fourth Down
-3 - Minor Third Down
+3 - Minor Third Up
+5 - Fourth Up
+7 - Perfect Fifth Up
+12 - Octave Up

Left delay line has roughly 500 msec of delay at the default sample rate. The delay for the Right channel is half (250 msec) of the Left channel to give rhythmic variation between the two.
The delay line feedback is controlled using the Analog Feedback for each channel.
This also puts the Pitch Shift in the feedback path to create arpeggios easily.

VC-P1 - Pitch shift of the Left channel (-12 to +12 semitones as above)
VC-P2 - Delay time of both channels. Right is half the time of the Left
VC-P3 - Pitch shift of the Right channel (-12 to +12 semitones as above)

4> Interval Shift 2

The same design as Program #1 but with the Pitch values quantized to semitone inter vals. The intervals are the same on both channels only the Left shifts up and the Right down. Intervals:

Left		Right
+2	Major Second	-2
+3	Minor Third	-3
+4	Major Third	-4
+5	Perfect Fourth	-5
+7	Perfect Fifth	-7
+9	Major Sixth	-9
+11	Major Seventh	-11
+12	Octave	-12

Left delay line has 16000 samples or roughly 500 msec of delay at the default sample rate. The delay for the Right channel is half (250 msec) of the Left channel to give rhyth mic variation between the two. The delay line feedback is controlled using the Analog Feedback for each channel. This also puts the Pitch Shift in the feedback path to create arpeggios easily.

VC-P1 - Pitch shift of the Left channel (+2 to +12 semitones Clockwise)
VC-P2 - Delay time of both channels. Right is half the time of the Left
VC-P3 - Pitch shift of the Right channel (-12 to -2 semitones Clockwise)

5> Dual MicroShift

Similar to Program #1 it has independent control of the Pitch of the Left and Right chan nels and combined Delay time control. The Shift amounts are only about a semitone +/- each side for detuning effects. Left delay line has roughly 500 msec of delay at the default sample rate. The delay for the Right channel is half (250 msec) of the Left channel to give rhythmic variation between the two.

VC-P1 - Pitch shift of the Left channel from -1 to +1 semitone
VC-P2 - Delay time of both channels. Right is half the time of the Left
VC-P3 - Pitch shift of the Right channel from -1 to 1 semitone

The Pitch control is not quantized so it can be tuned (or not) by ear. The small pitch range is ideal for subtle detuning effects and stereo widening.

The delay line feedback is controlled using the Analog Feedback for each channel. This also puts the Pitch Shift in the feedback path to create arpeggios and other effects.

6> Dual Delay MicroShift

The same algorithm as #5 but with independent control of the delay times.

The Shift amounts are only about a semitone +/- each side for detuning effects and the Shift amount is opposite for Left and Right. A slight shift up on the Left channel will be a shift down on the Right. The Pitch control is not quantized so it can be tuned (or not) by ear. The small pitch range is ideal for subtle detuning effects and stereo widening.

Left delay line has 500 msec of delay at the default sample rate. The delay for the Right channel is half (250 msec) of the Left channel to give rhythmic variation between the two.

VC-P1 - Delay Time of the Left channel from 0 to 500msec
VC-P2 - Pitch Shift of Left and Right. The shift amount is inverted (-1 semitone L = +1 R)
VC-P3 - Delay Time of the Right channel from 0 to 250msec

The Pitch control is not quantized so it can be tuned (or not) by ear. The very small amount of shift is ideal for stereo widening effects.

The delay line feedback is controlled using the Analog Feedback for each channel. This also puts the Pitch Shift in the feedback path to create arpeggios and other effects.

The delay line feedback is controlled using the Analog Feedback for each channel. This also puts the Pitch Shift in the feedback path to create arpeggios and other effects.

The last two programs use variations on the algorithm used in programs 1-6. The major difference is the use of an internal feedback path only around the delay which allows for repeats without pitch shifting and infinite repeats at maximum feedback.

7> Pitch -> Delay

Program 7 places the Pitch Shifter before the Delay and the feedback taps the output of the delay only.

Pitch control is the same as Program 2 where the Pitch of the Left and Right channels are inverted: an upward shift on the Left results in a corresponding downward shift on the Right. Pitch is directly applied to the incoming signal and not the output of the Delay.

The Delay control is the same as Program 1.
Left delay line has 500 msec of delay at the default sample rate. The delay for the Right channel is half (250 msec) of the Left channel to give rhythmic variation between the two.

Feedback routes the output of the delay line without Pitch Shift back into itself for repeats that are not shifted. If feedback is set to 100% the repeats will run forever, but Pitch Shift will not be applied to it.

VC-P1 - Pitch Shift -1 to +1 octaves
VC-P2 - Delay Time (0-500ms Left, 0-250ms Right)
VC-P3 - Feedback 0-100%

8> Delay -> Pitch

Program 7 places the Pitch Shifter after the Delay and the feedback taps the output of the delay only.

Pitch control is the same as Program 2 where the Pitch of the Left and Right channels are inverted: an upward shift on the Left results in a corresponding downward shift on the Right. Pitch is directly applied to the output of the Delay.

The Delay control is the same as Program 1. Left delay line has 16000 samples or roughly 500 msec of delay at the default sample rate. The delay for the Right channel is half (250 msec) of the Left channel to give rhythmic variation between the two.

Feedback routes the output of the delay line without Pitch Shift back into itself for repeats that are not shifted each time. If feedback is set to 100% the repeats will run forever, and Pitch Shift will be applied to it. At this setting audio can be captured and the combination of Delay time and Pitch Shift can be used for crude Time Compression and Expansion effects.

VC-P1 - Pitch Shift -1 to +1 octaves
VC-P2 - Delay Time (0-500ms Left, 0-250ms Right)
VC-P3 - Feedback 0-100%

Be aware of the following limitations built into the Z-DSP and algorithms:

- The POT/CV inputs are filtered in hardware and also software. This is most evident on the Delay controls which have noticeable pitch bending when swept. Apply slower LFOs and envelopes to the CV for best results. The Pitch control has less filtering, but is pro bably not responsive enough to be sequenced at 16th notes at 128 BPM!

- In the Z-DSP, the digital code uses linear crossfading between two points in a delay line to achieve the Pitch Shift effect. One byproduct of the crossfade is amplitude modulation which adds a slight tremolo warble to the sound. The frequency of the AM is based on the amount of shifting.

- Programs 1-6 use all 3 POT/CV controls for Pitch Shift amount and Delay times so they do not have internal feedback paths for the Delay lines. Use the analog Feedback controls to create repeats. The repeats will have the Pitch Shift amount applied to each repeat making arpeggiated up and down patterns. One limitation of the analog Feedback path is infinite repeats are not possible without extra gain from another source, but additional modules such as filters can be patched into the Feedback path to create unique processing chains.

- The interpolation resources in the Z-DSP are used for the pitch shifting delay lines and not the echo delay lines. Changes in the Delay time are not interpolated which can result in some noise buildup when the time is changed. This is most noticeable when the Feedback is 100% to capture audio in Programs 7 and 8 and the delay time is shortened then lengthened again.

- On programs with the center delay control knob and that knob is at 0 when a program is loaded, the other two controls will not function correctly until the delay time is changed.

- External control of the clock using a z3000 VCO can reduce the sampling rate down to what the very early digital devices used. Also, modulating the z3000 frequency can produce chorusing and flanging effects.

Tony Visconti quote from interview at Red Bull Music Academy 2011
https://www.youtube.com/watch?v=m1bczJ2DFC8

Testing:
Dr Richard Boulanger
Chris Clepper
Richard Devine
Joeseph Fraioli
Gur Milstein
BT

Manual:
Chris Clepper
Piero Fragola

Card Graphic Design:
Piero Fragola