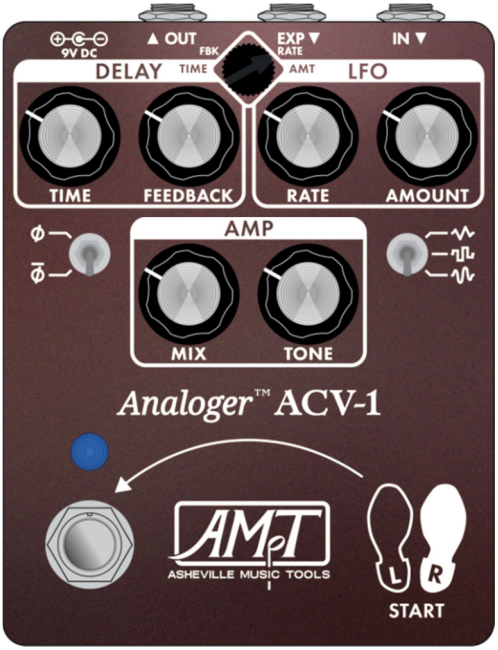
ASHEVILLE MUSIC TOOLS

Analoger™ ACV-1

100% Analog Bucket Brigade Chorus Vibrato
Time Warping Modulator

User Manual Revision A

Last Revision 8/3/2022



Introduction

Thank you for your purchase of the Asheville Music Tools Analoger™ series ACV-1 Chorus/Vibrato & Time Warp Modulator. This pedal, engineered by renowned analog designer Hawker, features a reissue Bucket Brigade Delay line to give classic Chorus and Vibrato sounds with the most natural modulation possible. The onboard Low Frequency Oscillator and sophisticated control voltage topology guarantee the best sound, features, and control available in any fully analog modulation pedal currently on the market. We hope you enjoy many years of use from your ACV-1 and find it as inspiring and fun to play as we have.

The ACV-1 is a marriage of vintage audio processing techniques and advanced, high-tech electronics. It is designed using modern, quality components for uncompromising sound, features, and reliability. We started with a studio-grade MN3007 BBD, unlike the lower cost MN320x pedal-grade BBDs found in most stompboxes. We powered it with a clean, high voltage 15V power supply. Next, we coupled it with a special blend of two tightly tuned high-Q 5th order anti-alias and reconstruction filters, a compandor with emphasis/de-emphasis, VCA feedback control, a unique 5-amp high current BBD driver, and an analog clock with exponential modulation technology to obtain unprecedented sound and richness, clean, precision regeneration, and true fractional delay in a compact footprint.

This is the second in our line of time, phase, and frequency modulation effects with a synthesizer-inspired control voltage approach. The ACV-1 draws upon Hawker's decades of experience and expertise designing modulation and delay-based effects for other companies.

A special thank you to the entire Hypertriangle team, including our sister companies Asheville Music Tools and Electronic Audio Experiments. Plus John, Liz, Miranda, Cam, Brad, Hawker and all the other people who contributed. This design was truly a team effort, and it was a joy to work with every one of you to bring this pedal to market.

Hawker's Log: About BBDs

I am often asked what gives analog delay-based effects their characteristic sound. The reason for me is different than I see others usually mention.

A BBD (Bucket Brigade Delay) works by storing a momentary snapshot in a capacitor isolated by a FET network. It passes this sample from one capacitor to the next via a bi-phase clock until it reaches the output. These samples are like water in a bucket brigade line, passing the audio from one "bucket" to the other until it reaches the "fire" at the end. BBDs were originally designed for distance measurement with radar. When the radar signal was sent out, a copy was delayed through a BBD and compared to the reflected signal. By sweeping the time until the reflection cancels out the delayed sample, the delay time, and thus distance, is measured. Early digital oscilloscopes, like the Tektronix 2440, also used them as temporary storage since Analog to Digital converters of the time were too slow. CCD cameras still do this today for the same reason. Today they are used almost exclusively for audio processing in delay, chorus, and flanger effects.

The ACV-1 uses a recreation of the Matsushita/Panasonic MN3007 PMOS BBD from Xvive™. The MN300x series BBDs use a higher voltage for superior clarity, noise, headroom, and distortion compared to the MN320x NMOS types typically found in most stompboxes. However, the MN320x BBDs are capable of wider delay times with a faster clock. The reissue BBDs sound very close to the Panasonic parts but are more transparent and have a lower noise floor, though with less animated character. In addition, the sound does not vary over delay times as much as their predecessors did.

Perhaps the biggest reason BBDs can do what digital often cannot is due to Fractional Delay, often referenced as the Doppler Effect. Since the clock moves continuously, delay time moves smoothly and unfixed by incremental steps. That is why analog chorus have such great feeling vibrato. The ear is very sensitive to this and perceives this as distance and movement. This trick is how movies pan sound or make you think a bullet just whizzed over your head. Most digital delays simply cannot do this.

With a fixed clock frequency, they can only take a sample step every 48 or 96KHz and step at that increment. This only simulates fractional delay and is not true fractional delay. The ear can hear the difference, and so the brain will perceive this difference as incorrect. Early digital delays like the Lexicon PCM 41/42 did use a variable clock using a different, now obsolete, process, but these are the exception not the rule. Most digitally-controlled analog delay based modulation that use a processor generated clock do not use steps small enough for true fractional delay, so while they may use a BBD, the modulation does not sound as natural as some picosecond step clocks or true analog modulation.

In addition, BBDs have some other “artifacts” that give them their unique sound. The transfer characteristics, gain, noise, distortion and frequency response vary depending on the bias voltage and clock frequency making the sound change as the delay time changes. They also do not put out the entire signal at the same time. Half the signal is a ½ clock behind the rest of the signal, yet combined at the same time, making for a strange, smeared mixing of the signal samples slightly out of time.

Other components in a BBD circuit are also responsible for the signature sound of analog delays. BBDs require companding and emphasis/de-emphasis networks to improve the signal to noise ratio, but these add limiting and an animated “breathing” compression character to the sound. The design of the filters affects the frequency response, peaking or ringing, and potential aliasing or ring modulation. There are many more parts of the analog design often overlooked in digital recreations that affect the sound as well including the clipping, feedback network, clock stability, modulation wave shaping/curves (exponential or linear, etc.) that are all important to get that great analog delay sound.

For more reading about BBDs check out these great websites:
https://www.electrosmash.com/mn3007-bucket-brigade-devices

https://www.premierguitar.com/articles/25035-behind-the-bucket-brigade

https://pedals.thedelimagazine.com/bbd-chips-the-magic-behind-analog-delay-pedals/

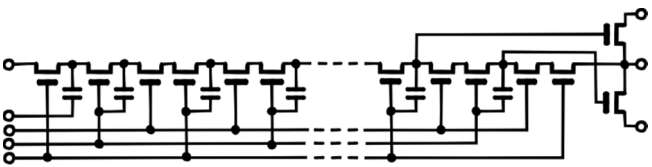
About the Firemen and the ACV-1 Artwork

Our pedal artwork pays homage to *Hawker*'s past pedals and classic modular synthesizers. The lines and boxes around function blocks lend themselves to classic modular synthesizer layouts, which were organized by function. You may notice the use of synthesizer terms such as "LFO, VCO, CV" and very literal function knob names rather than the more sonic based names of guitar pedals (FEEDBACK and TIME rather than Regeneration and Manual for example). This helps the user see the logical function blocks and signal flow to understand what is happening without obscuring the meaning.

The feet used in our artwork, you should know that to start time warping it is just a step to the left, and then time will be fleeting. Let's do it again!

The schematic drawing was adapted from the original Panasonic sketch of the BBD internals. It shows the bi-phase clock and capacitor storage to the output. The careful observer will note that each clock pulse moves only half the buckets forward preventing them from colliding with the next stage, and hence the two clocks fire at different times to move half the signal and part of the output signal is one clock behind the other part.

The firemen used in our artwork and literature come from the 1990s Panasonic data books and an applications note released for their and Digikey's marketing. On the cover and back of this book was a picture of firemen in a bucket brigade line. This represents the BBDs function of passing the sound from one capacitor or "bucket" to another many times before it is sent out by varying the clock, thus delaying the sound.



Set up

Use only a standard, **9VDC REGULATED**, center-negative power supply rated for at least 200mA, from a reputable vendor for all your Asheville Music Tools effects. Vintage style rectified & filtered, but unregulated, supplies are **not acceptable** for use with this product. We like the Truetone™ One Spot® and similar products. When using other pedals in your signal chain, we recommend an isolated power supply.

The ACV-1 may draw over 200mA when engaged. Use caution if using multi output supplies with 100mA outputs. **Use the higher current outputs when using this type of supply. Never use a higher voltage with this product.** There are no sonic benefits, and you risk damaging the pedal and voiding the warranty. The pedal will not turn on if it detects an overvoltage supply or high ripple from an unregulated supply. Our products do not use a conventional 9V battery due to the high current draw.

Your Analoger™ Series Pedal ships with a clear plastic protector over each of the knobs. Feel free to peel it off if its presence shows on the knob top.

The ACV-1 has a flexible bypass making it able to be used in various configurations for guitar, synthesizer, or line level applications, including:

- **Standard pedal use:** ACV-1 connected into an amplifier input, with or without other pedals. You may use the pedal in either Buffered or True bypass mode in this configuration.
- **Insert Effect:** Connect the ACV-1 to the effects send/return of your preamp, power amp or mixing console. You may also use the ACV-1 to replace the existing preamp if connected to just the return. Use this way in buffered Bypass mode only.
- **DI (Direct Input):** The ACV-1 can be used to line match to a mixer or DAW input for the correct drive and signal conversion from the guitar's high impedance out to a console or DAWs low impedance line in. It can also be used as a buffer placed before other pedals. For best results use with 10K or higher line input. Not suitable for 600ohm input impedance of some classic consoles. Use this in buffered Bypass mode only.

Getting Started

Let us explore the range of controls on your ACV-1.

Connect your guitar or other instrument to the **IN**put jack. Connect an amplifier, mixer, or DI box to the **OUT**put jack. If you have an expression pedal (or 0-5V control voltage source like a synthesizer output), connect it to the **EXP**ression input.

Use a 9V regulated 2.1mm, center-negative, power supply, capable of providing at least 150mA of power and connect it to the 9V DC input.

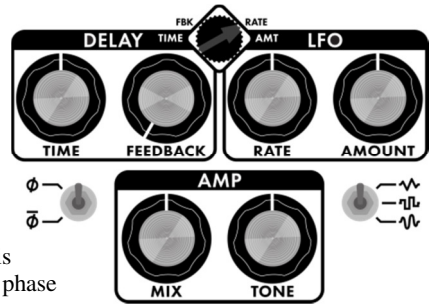
Be sure to power up the ACV-1 **BEFORE** turning on your amplifier to prevent speaker pop and the potential to damage your speakers or headphones.

To start, set the ACV-1 to the *Home* position and take a step to the left. This will produce a basic chorus sound, shown in the graphics to the right.

Set **TIME**, **RATE, AMOUNT, MIX** & **TONE** to be straight up 12:00 position.

Set **FEEDBACK** knob fully counterclockwise (7:00).

Set the **EXP** switch clockwise to **RATE** and set the **PHASE** and **LFO** switches to the up position. This represents wet and feedback in phase and a triangle LFO shape.

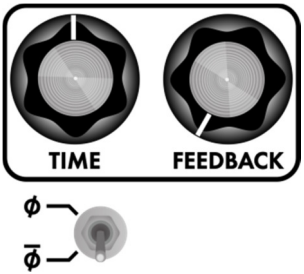


There is no way to damage the ACV-1 through knob settings so feel free to have some fun exploring how each control works There are some hidden tricks, gotchas, and advanced possibilities, so once you are done having fun read on to learn more about the ACV-1.

Operation

The ACV-1 is laid out in homage to modular synthesizers with three main modules. They are the **DELAY** Module, the **LFO** (Low Frequency Oscillator) and the **AMP** Module. Let us look closer at these modules.

DELAY MODULE



TIME: The TIME knob adjusts the center delay time from ~3ms to ~60ms (more using LFO and control voltages). If you modulate the delay time while playing, you will also notice a pitch change as the signal currently captured in the BBDs is spit out faster or slower, therefore compressing or expanding the delay time. Between about 9:00 and 3:00 produce chorus sounds. Further CW becomes more of a slap back, while CCW more flanging or comb filter.

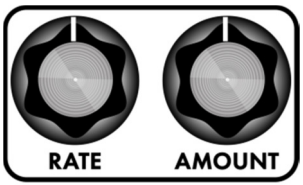
PHASE SWITCH: selects whether the delayed sound mixes and feeds back in phase or out of phase. This difference is most pronounced with shorter settings of the time knob or higher amounts of feedback. With shorter time and lots of feedback this can produce a very vocal like quality similar to a talk box. It is also more pronounced on bass notes than higher pitch notes.

FEEDBACK: The FEEDBACK knob affects how much post TONE signal is fed back into the buckets. It equates to the regeneration knob on a flanger and creates deeper time-based peaks in the signal. At longer delay times it acts more like a delay feedback control providing multiple repeats. At extreme settings it may go into self-oscillation providing drone tones that are affected by the time knob setting. Try it out, get lost. Come back after and read the next section.

Be sure to read the control voltage section for information on this module with expression pedals or control voltages.

LFO MODULE

The Low Frequency Oscillator (**LFO**) module is a modulation source for animating the delay time and phase as well as for bending the pitch of the signal. Unlike traditional chorus or vibrato units, our LFO provides sine wave and square options and uses exponential modulation for musical and balanced movement, the way the ear and brain want to hear it. In the synthesizer world this is the familiar Volt/Octave tracking used for pitch and frequency. Our modulation is symmetrical around the TIME setting, changing above and below it. This means that as you reduce the LFO amount the pitch and time will stay centered, where you have it, and not shift offset with the AMOUNT setting (requiring TIME to be adjusted) as with traditional modulation devices.



RATE: The RATE knob adjusts the speed or rate of modulation from about 0.10Hz to 15Hz (wider range via control voltages). Lower settings provide a slow whoosh or a rhythmic pitch shift. Medium speeds provide a chorus or vibrato effect while faster rates provide a gargle or, bubble sound.

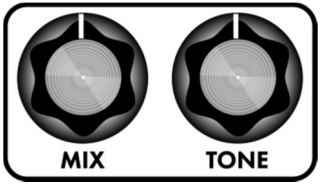
AMOUNT: The AMOUNT knob controls the depth or range of pitch movement at the speed of the LFO, or the amount of effect. Use low amounts for subtle shimmer and larger amounts for vibrato or octave or greater pitch shifts or spaceship warbles.

LFO SHAPE SWITCH: Selects a triangle wave (up), slewed square wave (middle), or a sine wave (down). Use triangle wave for traditional gradual ramped chorus type modulation, square waves for rapid pitch jumps and sine for a smooth continual movement vibrato or flange sound.

Be sure to read the control voltage section for information on this module with expression pedals or control voltages.

AMP MODULE

The **AMP** modules provide wet and dry signal blending as well as tonal control of the ACV-1 wet signal.



MIX: The MIX knob provides a cross-faded wet/dry mix between the delayed wet and clean tone. A 1:1 mix, providing the deepest comb notches, is at about 11:00 and not 12:00. It may be easier to find this with shorter delay times. When turned fully CW the ACV-1 will produce vibrato effects similar to a rotating speaker.

*Note: If you are applying a sustained steady pitch to the ACV-1 and have the **MIX** knob set near 12:00, you may find that the direct and delayed signals alternately will reinforce or cancel each other as the **DELAY TIME** is varied. This is a normal result of mixing a steady pitch with a delayed replica of itself. This phase cancelation is the chorus/delay equivalent of "standing waves" in a reverberant room.*

TONE: The TONE knob is a continuation of *Hawker*'s highly acclaimed ADG-1 tone control that has been re-voiced slightly higher for the ACV-1. It is a modified, non-symmetrical, "tilt type" filter with a soft curve and center flat position. It provides both high pass and low pass control with a knee around 740Hz. It is placed after the bucket and INSIDE the feedback loop and will bring out or dampen the delayed mix allowing it to become more present or fit under your playing. Extreme settings of this will accentuate the feedback amount and cause self-oscillation.

CONTROL VOLTAGE or EXPRESSION SECTION:

Using the EXP knob and an external EXPression pedal or control voltage with your ACV-1 will greatly increase the dynamic playing and tonal possibilities as well as expand the control range beyond the extent of the front panel knobs alone. Use a standard 10-50K linear expression pedal that uses the +5V voltage supplied on the ring jack and outputs the control voltage on the tip or use a 0-5V external CV voltage from a Eurorack module, Synthesizer, DAW, or similar source.

CAUTION: Voltages over +5V or below 0V may damage your ACV-1. Use only standard 0-5V control voltages. If your expression pedal has a trim knob, you may find it helpful to use this feature to reduce the range of the expression pedal to less than a full knob sweep to make it easier to dial in the exact sound you seek.

Please note: In order to give a wider playing capability with expression inputs, the control setting selected by the EXPression switch will reduce the knob range and setting slightly. Think of it as turning the knob to -1. The EXP controls are additive with their corresponding knob in that the EXP input is added to the knob. For full control voltage range set the knob to the most counterclockwise (CCW) setting, however using both you may get delay times, feedback amounts, LFO rate or amount beyond those that can be achieved using just the knob. Unlike the ADG-1, the ACV-1 time is additive like the rest of the controls. Delay times beyond the normal TIME knob position will produce an aliased or ring modulated sound.

Use only your fingers, a plastic screwdriver, guitar pick or similar plastic device to turn the 4-position EXP rotary switch. Never use a metal object that could damage the shaft. If you use this feature frequently, we have included a knob (C&K part # 297F02000). Note this knob will turn the shaft but there is not enough shaft length through the enclosure to permanently secure the knob to the shaft and it may fall off. Do not glue the knob to the shaft or your ACV-1 will not be serviceable.

FOOT SWITCHES

BYPASS FOOTSWITCH: Turns the effect on or off. The LED is lit when engaged and will modulate to the LFO rate in a triangle wave shape regardless of LFO switch shape. A switch inside the ACV-1 is user selectable for true bypass or buffered bypass.

TRUE BYPASS / BUFFERED BYPASS:

If you carefully remove the 4 screws holding the cover on to the back of your ACV-1 you will see a bypass setting switch underneath the jack board on the edge of the PCB. This is the ONLY user accessible option on your ACV-1.

Do not adjust any of the carefully calibrated factory set trim pots.

Use the switch, on the left side of the jack board, to select true bypass (Default – switch to the outside of the enclosure) or buffered bypass (switch towards the inside of enclosure). In true bypass when the effect is not engaged the input is coupled directly to the output and does not pass through any electronics. If you have loading, tone or noise issues from long cable runs select buffered bypass to use the internal JFET as a simple buffered output with approximately 4K ohm output impedance. Buffered bypass may have a slight gain loss depending on the impedance match. This is normal.

Technical Overview

Utilizing over 350 carefully selected components, the entire ACV-1 is designed for a 100% analog signal chain. We began with a classic chorus architecture using an Xvive™ MN3007 reissue BBDs and a step-up boost power supply to power our premium audio-grade op amps and high-tolerance, non-microphonic capacitors, providing performance, temperature & voltage stability, low noise and maximum headroom.

We then implemented a vintage-style compandor with emphasis/de-emphasis coupled with two discrete transistor, 5th-order discrete, anti-aliasing and reconstruction filters to provide a familiar character with superior clarity, noise reduction, and dynamic feel. The feedback circuit uses a voltage-controlled transconductance amplifier as a VCA, to provide classic, warm regeneration tone while offering an accurate method of dialing in the perfect controllable amount of deep notch cancellation effect.

The input preamplifier consists of a discrete, high impedance, JFET input stage that can also be used as an always-on buffer. When engaged, the preamplifier circuit provides impedance matching and gain for optimal signal to noise ratio. It contains some limiting to provide character from hot signals and prevent transients from overloading the delay section.

The analog clock, modulation, oscillator, and even the switch logic are all fully analog. Our VCO, with temperature compensated exponential modulation, drives the BBD at extremely high current to eliminate artifacts and provide a clear tight sound and gain consistency. An assignable expression input increases the flexibility and control available to the user.

The ACV-1 is designed using a multi-layer PCB with dedicated split power and ground planes for low noise and cross talk. The power input is fully protected from reverse polarity and over-voltage conditions. Our MHz range, step up, high voltage power supply is designed to eliminate sources of noise and radio frequency interference (RFI/EMI) and the I/O is designed to protect from electrostatic discharge (ESD) spikes to ensure carefree operation in any studio or performance environment.

Specifications:

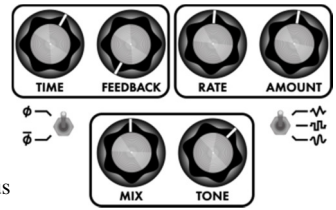
- **Type: 100% Analog signal and control path**
- **Delay Time**: 3.1ms - 59ms. 1.9ms - 95ms with LFO and to 155ms with external Control Voltages
- **Feedback:** 0 to near infinite. Capable of self-oscillation using tone or EXP input coupled with knob position.
- **Rate:** LFO RATE, from 0.1Hz to 14Hz (28Hz with CV control)
- **Amount:** LFO depth control from OFF to 60% of TIME sweep
- **Mix:** Center 50%. Adjust from full wet to full dry
- **Tone:** ~740Hz center tilt filter. Center = Flat to 0.3dB
  High +5dB to -10dB, Low +4dB to -7dB.
- **Phase Switch:** 180° phase shift of wet signal and feedback signal.
- **LFO**: Selectable Triangle, Sine or slewed Square wave
- **Expression Switch:** 4 position rotary selects Time, Feedback, Rate or Amount external control. All controls are additive to the front panel knob adding extended range. TRS jack usable with CV or Expression pedal, (CV range is 0-5V). Ring supplied current limited 5V output. Control input on Tip.
- **Bypass Footswitch:** effect on/off user selectable True Bypass or JFET Buffered (Accessible by removing ACV-1 Cover)
- **Power:** 9VDC @ <150mA. 70-90mA typical. Up to 250mA start up. Standard pedal center negative 2.1mm x 5.5mm barrel.
- **Input impedance:** >1MΩ
- **Output impedance**: 1KΩ Max (5k max for buffered bypass)
- **Max input level:** +14.25dBμ (4.0V RMS)
- **Max output level:** +14dBμ (3.9V RMS)
- **Noise Reduction:** 2:1 broadband with 10dB HF emphasis
- Genuine Hammond™ die-cast aluminum enclosure,
- Dimensions: D=4.95" (12.5 cm), W=3.75" (9.4 cm), H=2.25" (5.8 cm)
- Weight: 15oz (425g)

Note: All specifications subject to change at the whim of our overloads.

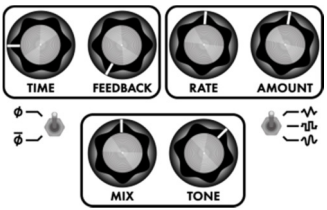
Presets:

Let's try out some sound ideas for the ACV-1 using it to Warp Time. So with a bit of a mind flip, you'll be into the time slip where nothing can ever be the same. Remember kids, since analog products have some variability, the exact knob setting may be slightly different from those shown below.

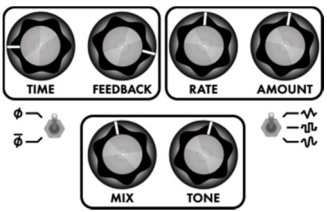
Classic Chorus: It's so dreamy, fantasy free me. All knobs, except feedback, near 12:00. Phase and LFO switches up. Adjusting the time knob to the right will achieve a more drippy 80s chorus, try adding some feedback to this. Or stepping to the left a more 90s tight shimmery chorus sound. Now from there...



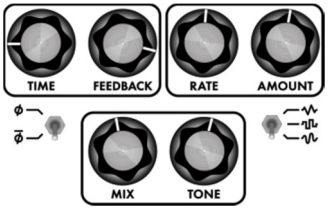
It's just a tweak to the left: As we dial the time to the left the chorus gets tighter and more shimmery. Add some tone to enhance the sparkle. Adjust the time to the thicken sweet spot and try flipping the phase switch.



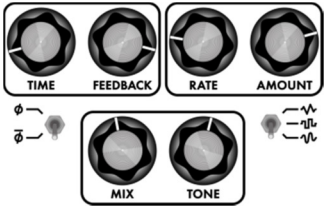
Step the feedback in right: Now add some feedback until you get a tight resonant sound ala Flanging.



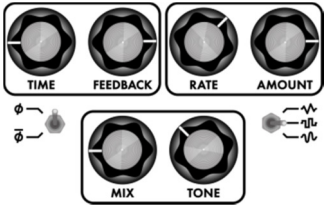
Put your hands on the switch: Flip that phase switch and you will take off to another dimension, with voyeuristic intention, giving expressive vocal sounds. Try the LFO with sine wave for smoother modulation. This sound is more pounced on lower notes.



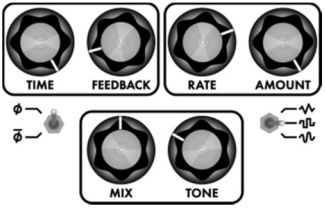
Dial the modulation in tight. Reduce the rate and increase the amount control to get deep flanging tones. You might even be able to find that Big ol' jet airliner to carry you far away. Sounds awesome with some fuzz before the ACV-1.



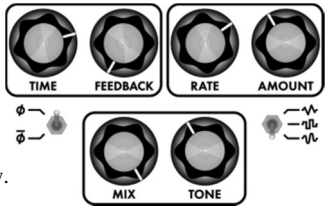
It's the LFO's thrust that really drives you insane: Now it's time to go crazy on the LFO and waveshape and see what you can come up with until you're spaced out on sensation, like you're under sedation.



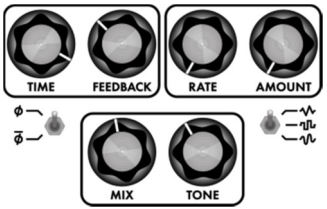
Let's tweak the time warper again. Keep going with it. See what you can come up with now. Well I was walking down the street just a-having a think and I came up with this bubbly ghost chomping goodness.



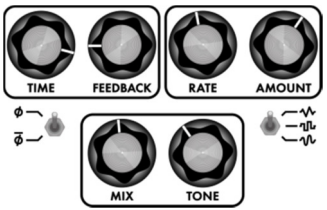
Shirley don't call me Leslie. If we remove the dry signal, we get a vibrato sound like a rotating speaker. Try this one with an octave pedal in front for some great organ sounds. It's a big rotating Doppler effect, but that's not important now.



Feeling Slap Happy and I came up with this Good ol' classic Chickein' Pickin' Goodness. Produce a great slap back sound and maybe even add some feedback for a drippy meandering dance. Use an expression pedal to get crazy long ring mod delays.

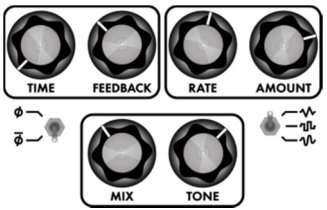


Drippy Reverberant Chorus: Let's try that original chorus sound again but this time we add some feedback, muted sounds to take a walk down the path to ambiance. With this preset time meant nothing, never would again.



Clouds of Mercury: And for our final number this dear fantasy land of hollow happy warbles. It's astounding, time is fleeting, and madness will take its toll.

Now go take off and do the Time Warp Again!



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Revision	Date	Notes
Rev A	08/03/2022	Production release
Rev 1	05/25/2022	Prototype manual

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