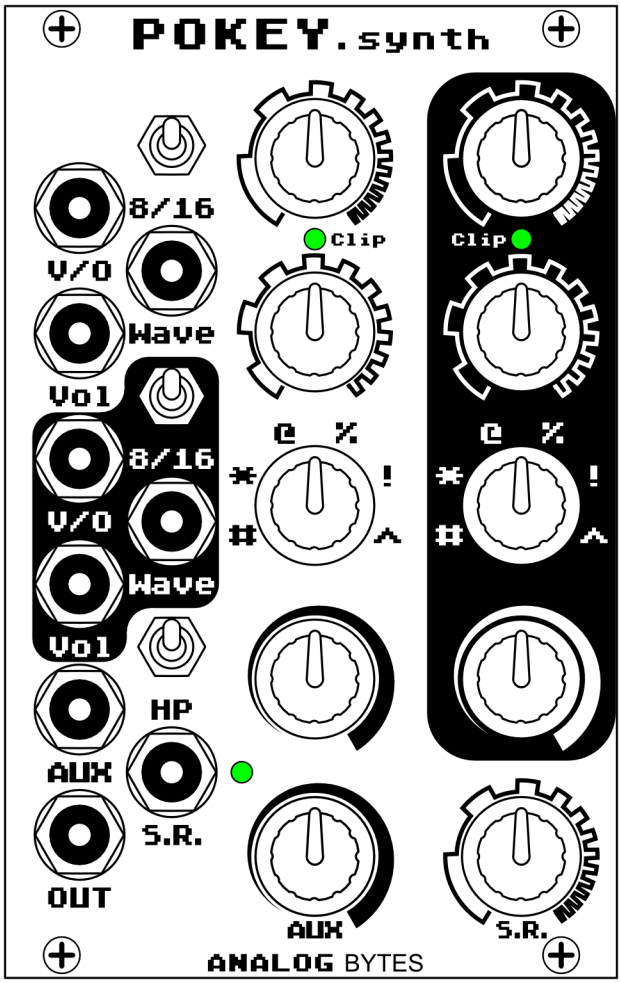
ANALOG BYTES

PRESENTS

POKEY.SYNTH

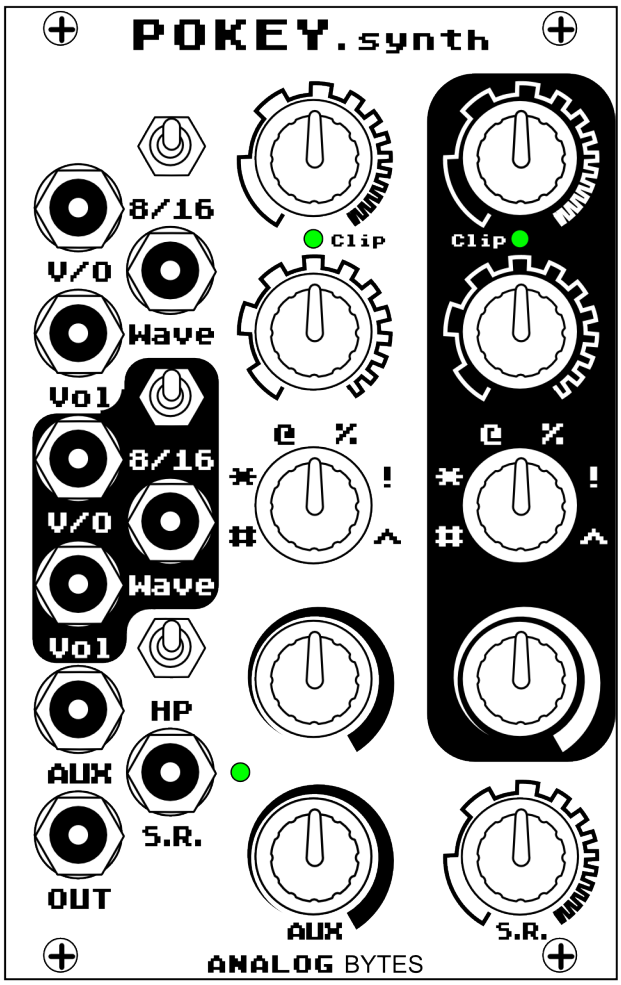
EURO SYNTH MODULE



FOR USE WITH THE
EURORACK SYNTHESIZER SYSTEM

Quick Panel Overview

Knobs



Coarse Pitch

Fine Pitch

Waveform

Volume

External Input
Volume / Sample Rate

Jacks

V/O: Volt/Octave Pitch Control Input

Wave: Waveform Voltage Control Input

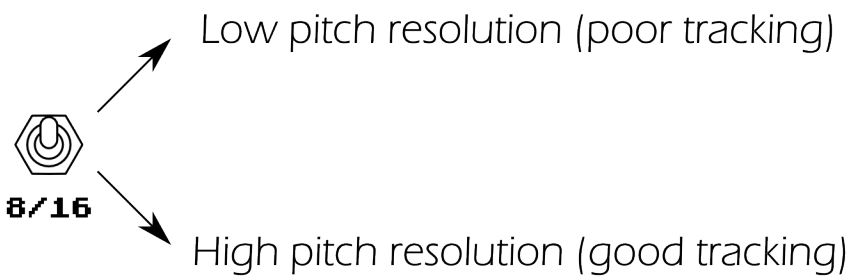
Vol: Volume Voltage Control Input

AUX: External Audio Input

S.R.: Sample Rate Voltage Control Input for External Audio Input

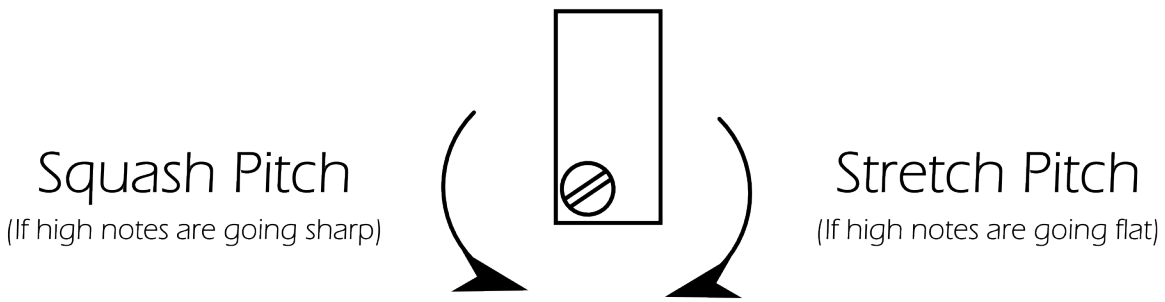
OUT: Audio Output

Switches



Intonation

If your POKEY.synth goes out of tune for CV inputs spanning several octaves, an intonation adjustment (like that of a guitar) is available via R38 on the main PCB. It is a multi-turn trimpot, but even small turns can have a large impact between notes that are several octaves apart.



Voltage Ranges

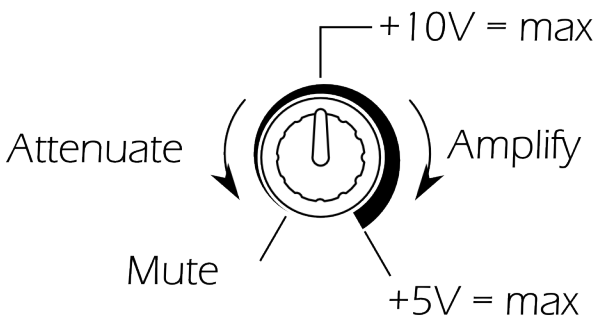
-5 to +5V

0 to +5V (roughly)

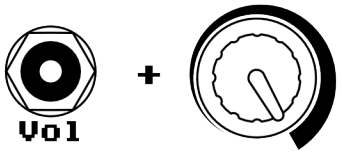
Any 5V Span / Any 10V Span (see jumpers)

Waveform pots add offset to Wave CV inputs

Volume Pots Scale Vol Inputs



Turning clockwise amplifies the input, so it takes a lower input voltage to be max volume



= 0 to +5V for max

-10 to +10V

AUX pot scales AUX input

-5 to +5V

S.R. pot adds offset to S.R. CV input

All inputs safely accept -12V to +12V

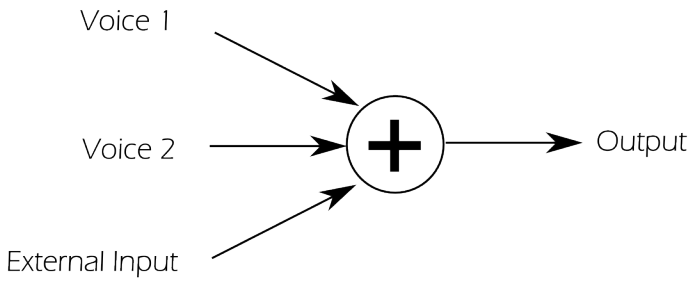
LEDs

Each of the three LEDs indicates when an input is out of range. LEDs blink for signals that are too high and hold for signals that are too low.

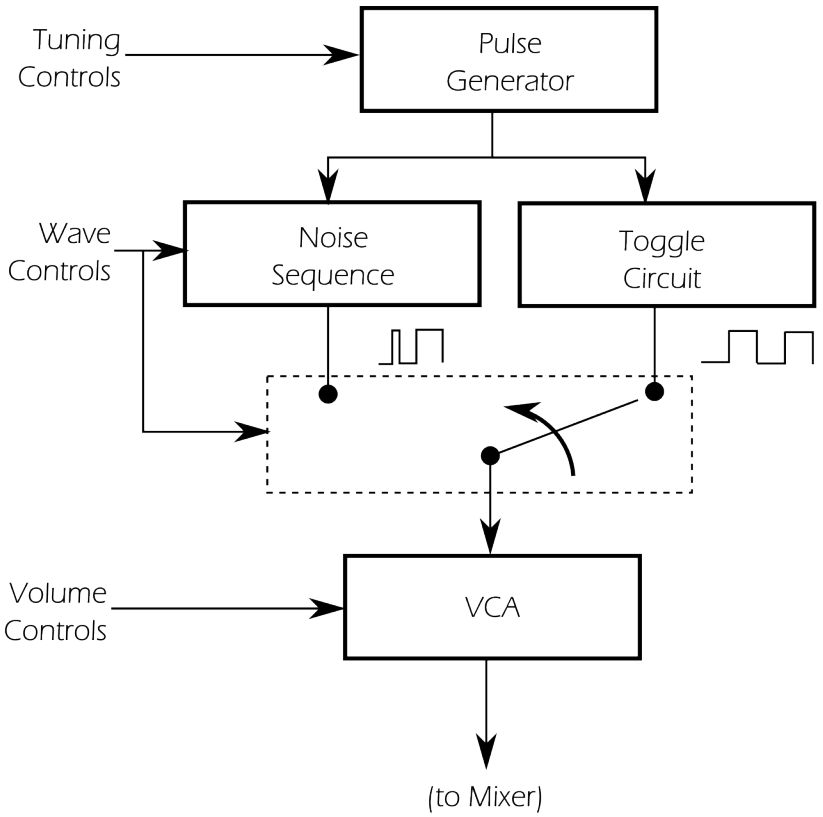
When the combination of V/O input and tune knobs for a channel are beyond what the POKEY chip can create in the given pitch mode, the light labeled "clip" by the tune knobs will light.

When the AUX input is overdriven after applying the AUX scaling knob, the LED next to the SR jack will light.

Module Guts



Voice Anatomy

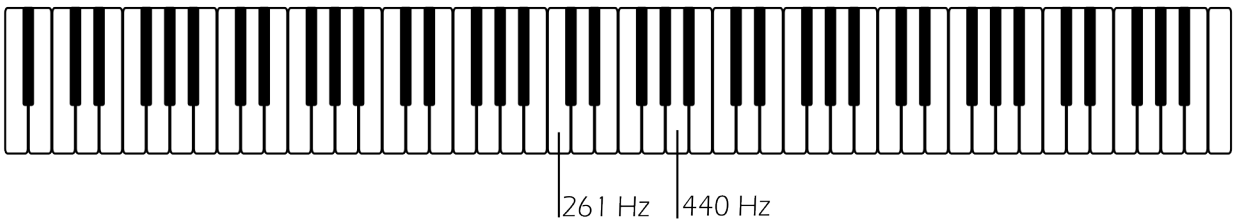


The noise sequence block uses pulses to step through a "pseudo-random" binary pattern. Digital noise generators from this era generally used a circuit called a Linear Feedback Shift Register (LFSR). The Atari Pokey chip uses not one, but three LFSRs. While the LFSRs run at speeds far above human hearing, the Pokey noise output comes from sampling their outputs at audio rates. Between the resulting 1-bit aliasing and synchronization patterns that form, the actual "noise" is a pitched sound that changes in timbre depending on both the wave control inputs *and* the pulse generator tuning.

A small change in pitch can mean a big change in timbre. Even better, the synchronization that happens can cause a pitch sequence to result in different sounds for the same note played at different times! Such characteristics give the Pokey a reputation for being slightly unpredictable.

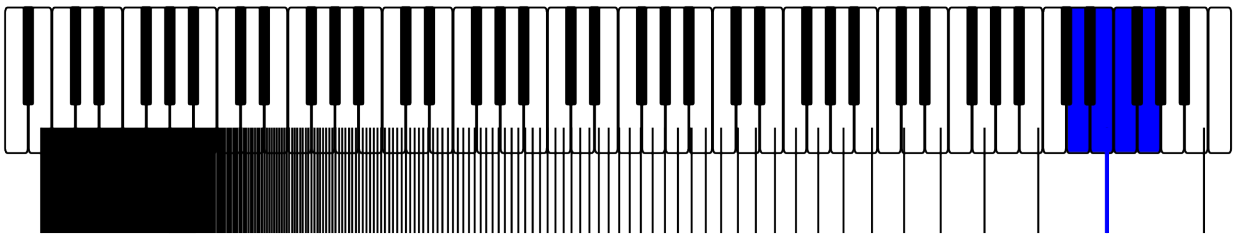
Pitch

Unlike an analog oscillator, where pitch can slide and bend freely, the POKEY only has fixed pitches. Start by thinking of a piano. Each key on a piano corresponds to a pitch with a specific frequency.



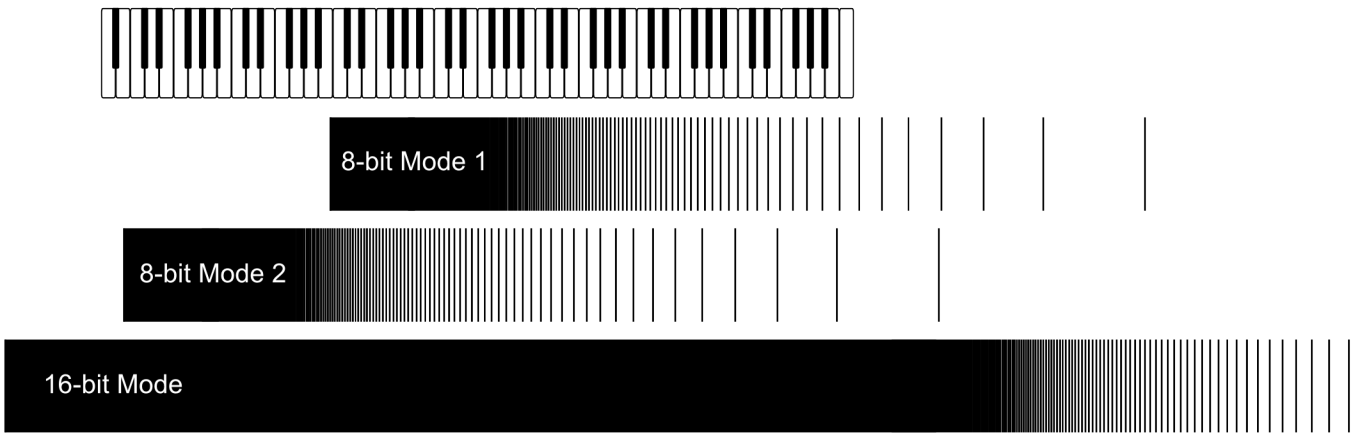
Other frequencies exist between keys, but a piano cannot recreate them without modification. In the same way, the POKEY can only play specific frequencies. Many of them fall in the space between musical notes, and they do not spread evenly through a musical scale.

For example, in 8-bit pitch mode there are 256 possible frequencies. Trying to point them out on a piano keyboard looks something like this...



Pokey.synth V/Oct input and tune knobs work exactly how they do on other synth modules, but the pitch gets rounded to the nearest frequency that the POKEY can create. The blue region on the keyboard above will come out at the frequency marked by the blue segment.

Each channel has a switch for low resolution (8-bit) or high-resolution (16-bit) pitch. Changing to 16-bit pitch increases the pitch resolution to be closer to an analog oscillator. A rough illustration of frequencies relative to a piano keyboard is shown below.

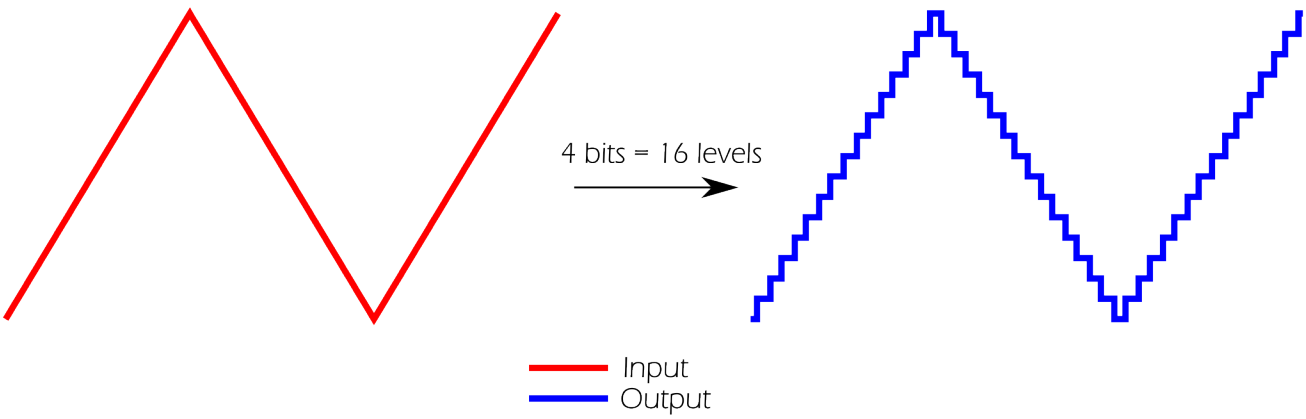


Switching between the two 8-bit pitch modes is done via back panel jumpers.

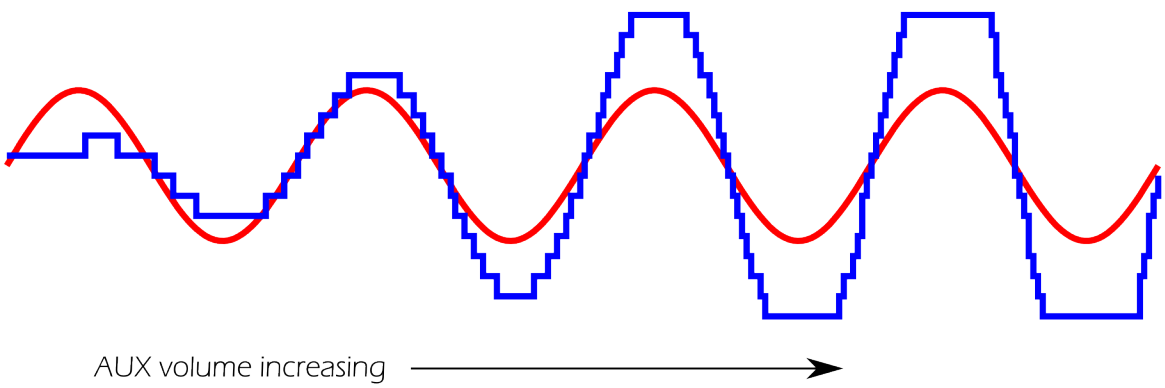
16-bit pitch mode includes an "LFO mode" switch that happens automatically when the combination of CV input and tuning controls goes subsonic. Very low frequencies of the various waveforms give a Geiger counter-like sound. The chip runs down to about 0.5 Hz.

External Input

The AUX jack takes an input, converts it to a digital signal, then runs it out through the POKEY chip's digital-to-analog converter. The output uses at most 4 bits.

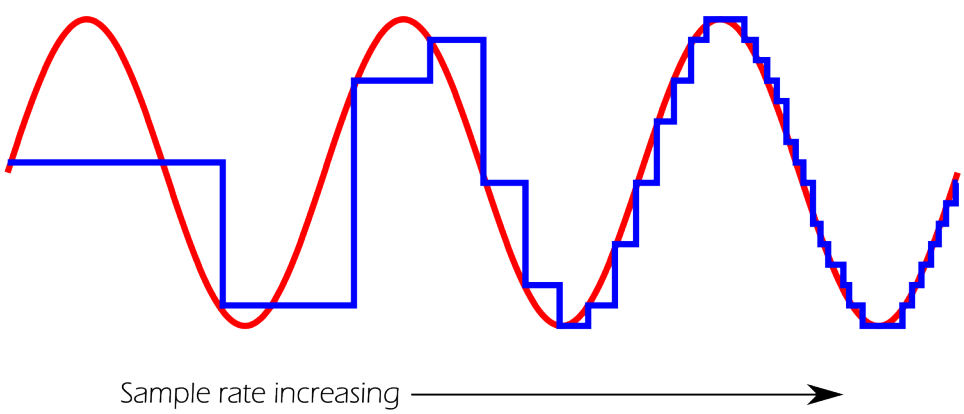


Volume is adjustable via the AUX volume knob. It can amplify the signal into clipping.



When the external input mixes with the square waves of the two oscillator voices, it will generally sound quieter. That is partially because square waves have high energy. To get an even mix, try turning down the oscillator voices or distorting the input by cranking the AUX volume knob.

The sample rate is voltage-controllable and adjusts how often the output is updated

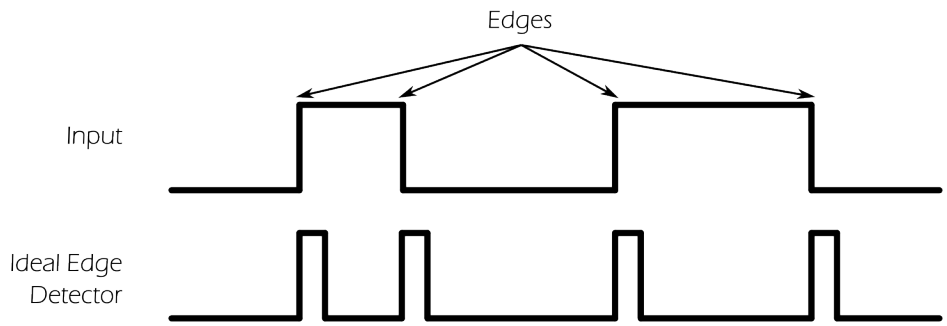


The sample rate tracks roughly 1V/Oct.

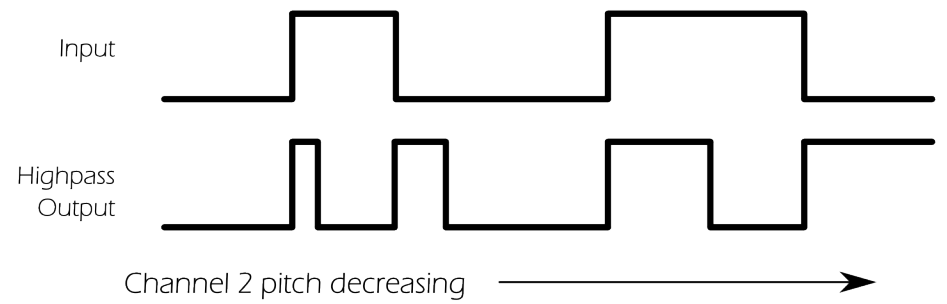
Highpass

The "HP" switch puts a 1-bit highpass filter on channel 1 with a cutoff frequency controlled by channel 2.

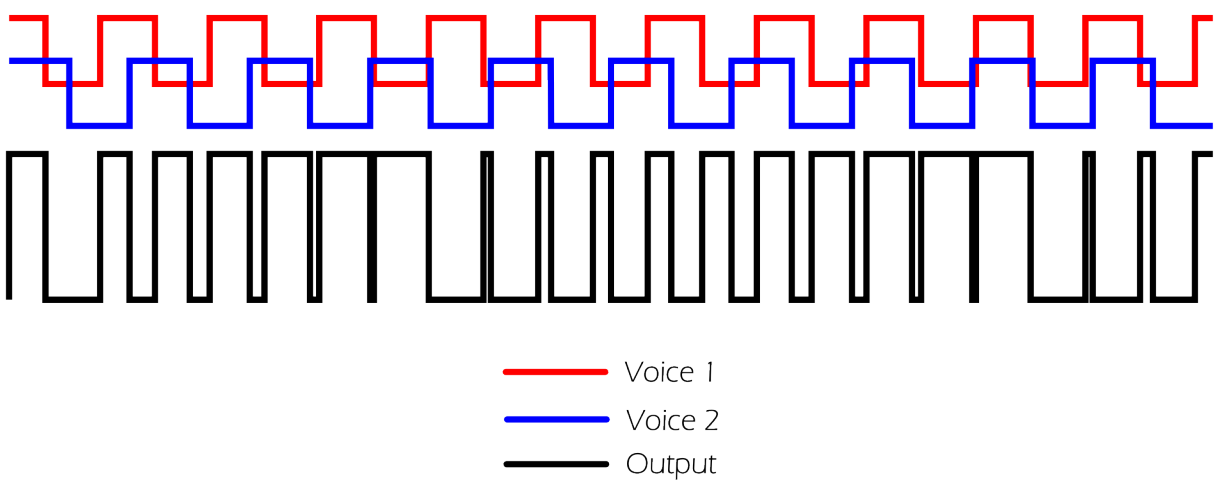
Being 1-bit, it specifically mangles pulse waves. The basic idea is an edge detector.



The pitch of channel 2 attempts to control the length of the output pulses like this:



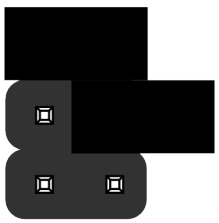
The key word is "attempts." In practice each edge on channel 1 inverts the output, and each edge on channel 2 sends it low. The resulting interference patterns resemble PWM. If channels 1 and 2 are tuned closely together, octaves form.



The POKEY chip highpass always uses the equivalent of a square wave from channel 2, so the wave setting of voice 2 does not impact filtering.

Jumpers

The POKEY.synth circuit board includes five jumpers for customizable behavior



If you want a jumper disconnected, remove it and reconnect it to a single pin. This makes it less likely to be lost compared to removing it completely.

Auto Mute:

If a jumper is *not* connected here, the corresponding channel's volume will drop to zero whenever its pitch clips.

Example use - two voices both tracking the same pitch voltage, but tuned an octave apart. If the lower octave voice goes lower than the Pokey can create, the result will sound out of tune. Enabling auto-muting would silence the out-of-tune voice, instead.

Polynomial Length:

This changes the length of one of the random noise generation sequences inside the POKEY chip. If a jumper is *not* connected, the "!" and "*" waveforms become less periodic and closer to white noise.

8-bit Pitch Offset:

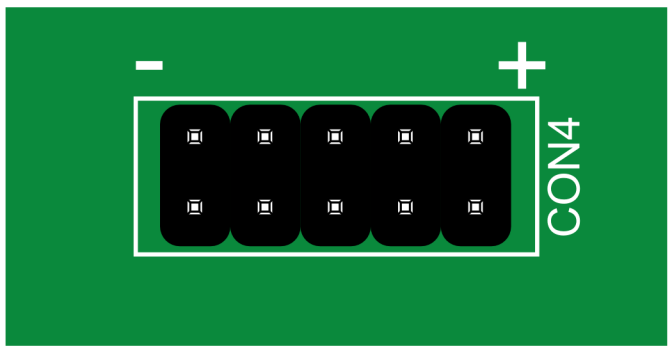
POKEY channels in 8-bit mode have two different pitch ranges (as shown on page 5). The setting applies to the whole chip instead of being configurable for each voice, so choose wisely. If a jumper is *not* connected, the 8-bit channel pitch range gets shifted up roughly two octaves.

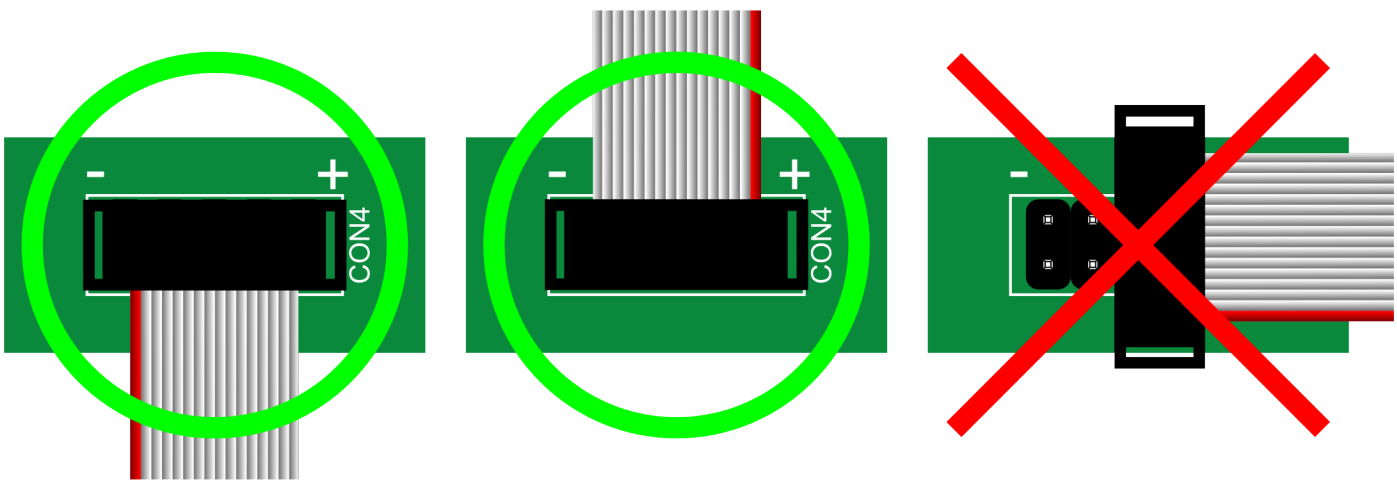
Waveform CV Scale:

The waveform for each channel comes from the sum of the Wave CV input and #*@%!^ potentiometer setting. This jumper controls the voltage range at the input that covers the full range of waveforms. If a jumper is *not* connected, it takes a 10V span to step through all the waves (ie, -5V to +5V with the knob at 12:00, 0V to +10V with the knob fully counter-clockwise). Otherwise it takes a 5V span.

Power Cable

The PCB flaunts "+" and "-" symbols near the power connector. Those are placebo markings for people who do not read manuals. In reality, the module is designed to handle a connector plugged in either way.





Max Current Draw: 130mA on +12V