

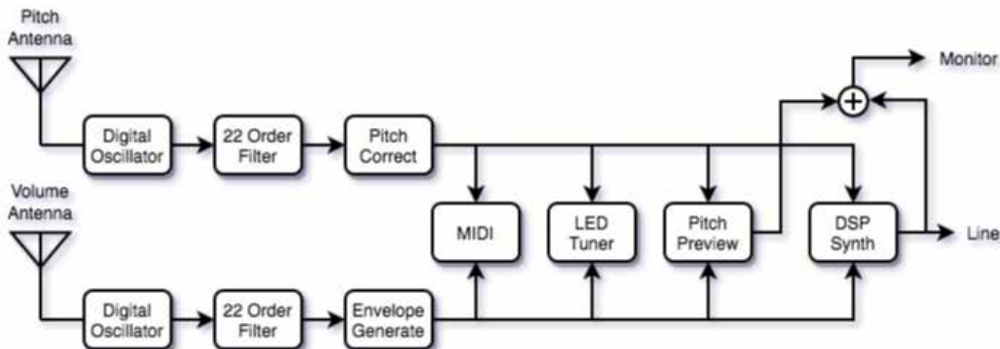
## A (MOSTLY) DIGITAL

**THEREMIN** The D-Lev is a (mostly) digital Theremin with many unique features designed from the ground up by Eric Wallin, and American telecom industry engineer who retired early to develop his own soft processor. The D-Lev uses FPGA technology and incorporates Eric's Hive soft processor core and phase locked peripherals to offer precision and versatility both to casual enthusiasts and the world's top concert Thereminists.

Wallin lists the linearity of the D-Lev's pitch and volume fields as primary achievements. Unlike traditional analog Theremins and other digital hybrids, the D-Lev's field sensitivity can be precisely configured to suit playing style, and its volume field has an adjustable knee. Sophisticated pitch correction and real-time visual pitch feedback are other features unique to the D-Lev, in addition to near-instantaneous boot time and null calibration. The D-Lev's synth can emulate human vocals, strings, brass, woodwinds, bells, percussion, sound effects, or custom timbres. MIDI out lets the performer control almost any outboard synth.

## IS THE D-LEV A TRADITIONAL THEREMIN?

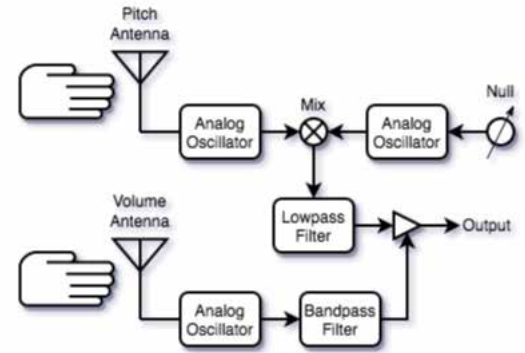
No. A traditional Theremin heterodynes, or non-linearly mixes, the outputs of two ultrasonic analog oscillators. One oscillator operates at a fixed frequency, and the frequency of the other varies with the capacitance of the pitch hand. Mixing generates frequency images at  $F_1+F_2$  and  $F_1-F_2$ . Lowpass filtering removes the upper image, leaving the lower image, which is within the range of human hearing. Though the frequency of the variable oscillator only changes a few percent over the full range of pitch hand movement, the difference frequency varies over many octaves.



The major D-Lev modules.

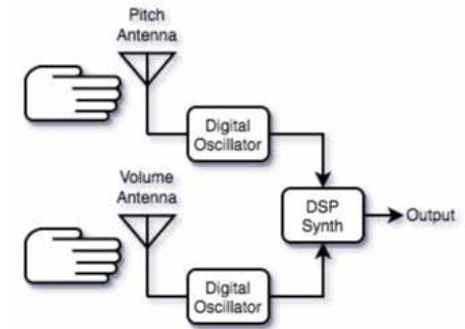
## HOW A TRADITIONAL ANALOG THEREMIN WORKS

Traditional volume control can take many forms. Similar to the pitch side, the frequency of the volume oscillator varies with the capacitance of the volume hand. One common technique to produce a large change in signal over a relatively short range of hand movement is to sharply filter the oscillator output, rectify and filter it (not shown) and use the result to amplitude modulate the heterodyned pitch side signal.



How a traditional analog Theremin works

Heterodyning inextricably links the pitch and timbre of the resulting audio, which ties the Theremin designer's hands when it comes to altering the basic (non) linearity, sensitivity, timbre, octave, etc. Quite often, a second resonance is employed to improve near-field pitch linearity, but this makes the analog Theremin much more difficult to keep in proper adjustment. Coupling the fixed and variable oscillators can enrich low end timbre, but this also negatively impacts far-field linearity.



How a digital Theremin works.

A traditional Theremin that works pretty well can be made with only a handful of parts, but the engineering constraints present at the lowest level will remain almost no matter how fancy any additional circuitry gets. The near and far fields will always be somewhat cramped, and the mid-field will always have the same sensitivity (which Wallin feels is too high).

## IS THE D-LEV A REAL THEREMIN?

Yes. Exactly like a traditional analog Theremin, the digital Theremin employs oscillators that vary in frequency with the capacitance of the player's hands. The exact same electrostatic interaction is at work, and the heterodyned frequency difference is replaced by a simple and noiseless arithmetic subtraction. Musicians who are accustomed to traditional analog Theremins needn't alter their fundamental style or technique in order to play the D-Lev.

## HOW A DIGITAL THEREMIN WORKS

The variable oscillators in the D-Lev are almost entirely digital, which makes them quite stable. Their operating frequencies are therefore just a series of numbers which are fed to an internal DSP (Digital Signal Processing) based music synthesizer in order to produce audio.

## THE MAJOR D-LEV

**MODULES** Separating hand capacitance sensing from sound generation opens up a new world of possibilities for both the Theremin designer and the player. The pitch and volume numbers are digitally filtered to dramatically reduce environmental noise and hum. The responses of the fields are linearized mathematically via a set-and-forget process. The octave and timbre are entirely defined by the synth, with presets to easily switch among a variety of different voices. In terms of technology and features, the D-Lev is a stand-out amongst Theremins, past and present.

*Excerpted and edited with permission from <https://d-lev.com/>  
Eric Wallin, D-Lev designer  
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