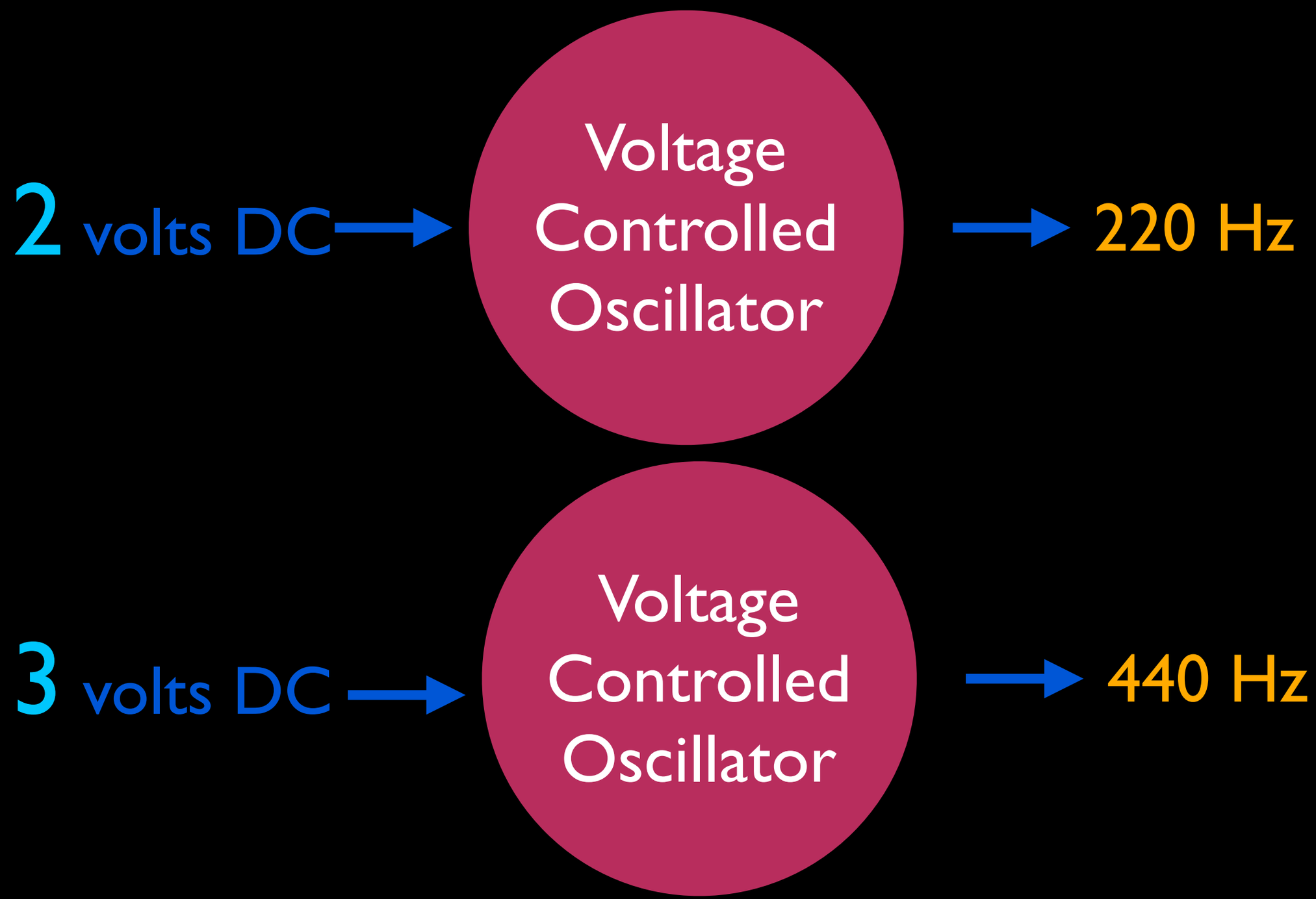
fpa 147

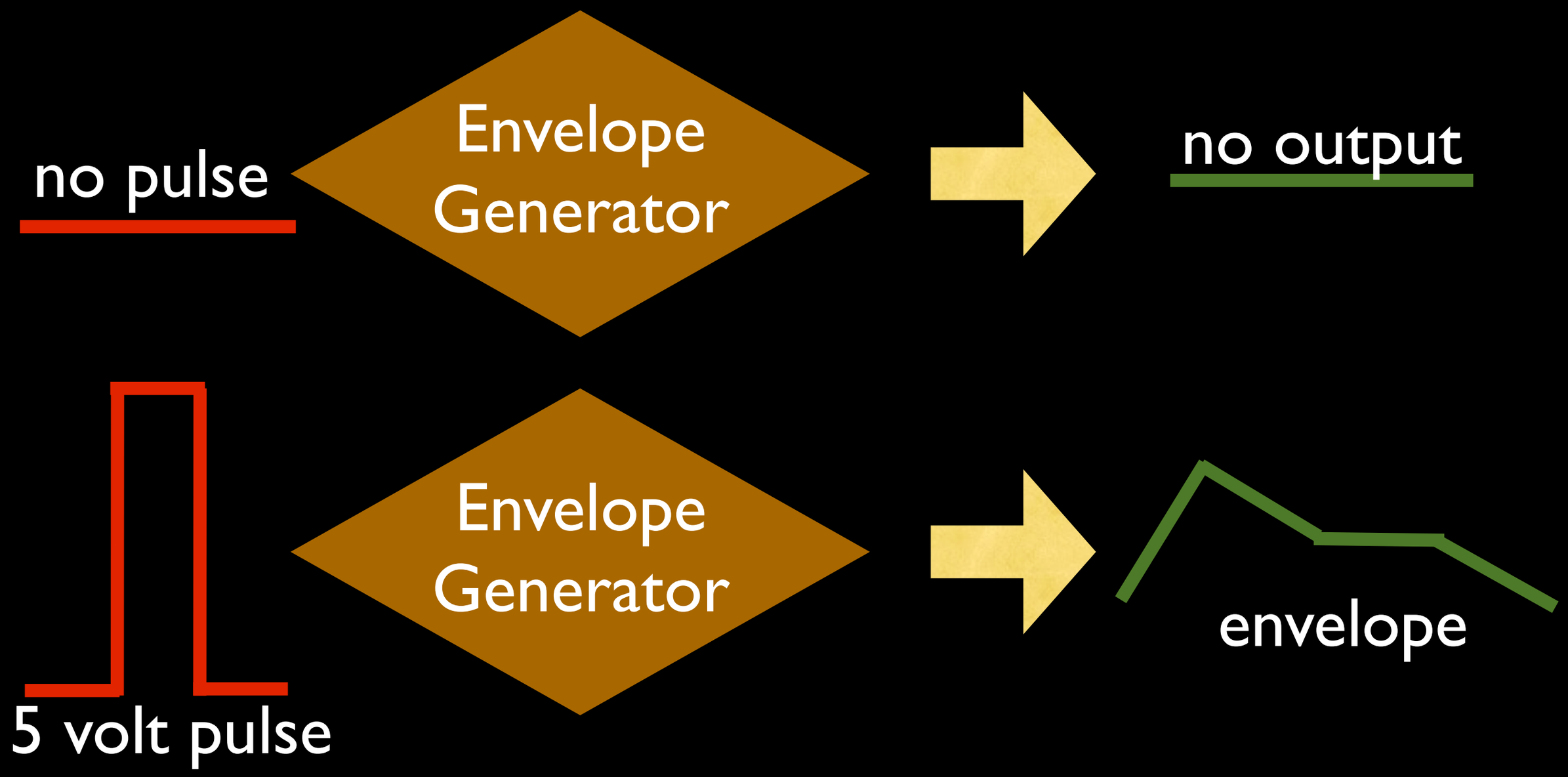
Week 6

In the early 1960s, inventors & entrepreneurs (Robert Moog, Don Buchla, Harold Bode, etc.) began assembling various modules into a single chassis, coupled with a user interface such as a organ-style keyboard or arbitrary touch switches (Buchla). The various modules were connected by patch cords, hence an arrangement resulting in a certain sound quality or timbre was called a “patch”. The principle was subtractive synthesis: complex waveforms are filtered and altered dynamically to produce the desired result. Sounds could be pitched or non-pitched, imitations of conventional instruments or “new”

Voltage Control

An important principle of all these devices was the standardization of the control system. A direct current or DC voltage was used to control the parameters or various attributes of the modules. For frequency changes: 1 volt = 1 octave. So a change from 1 volt to 2 volts in the frequency control of an oscillator changes the pitch of the oscillator by 2X or 1 octave. 220 Hz -> 440 Hz. To trigger the modules (initiate an action) a pulse of 5 volts was used.

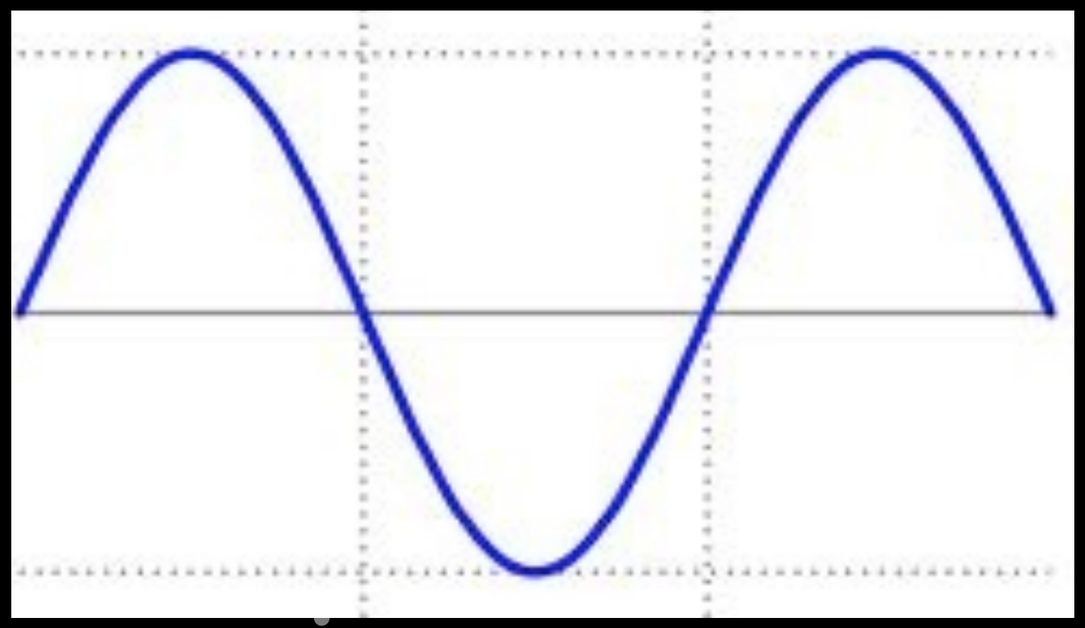

2 volts DC
Voltage Controlled Oscillator
220 Hz
3 volts DC
Voltage Controlled Oscillator
440 Hz


no pulse
Envelope Generator
no output
5 volt pulse
Envelope Generator
envelope

Synthesis sources:

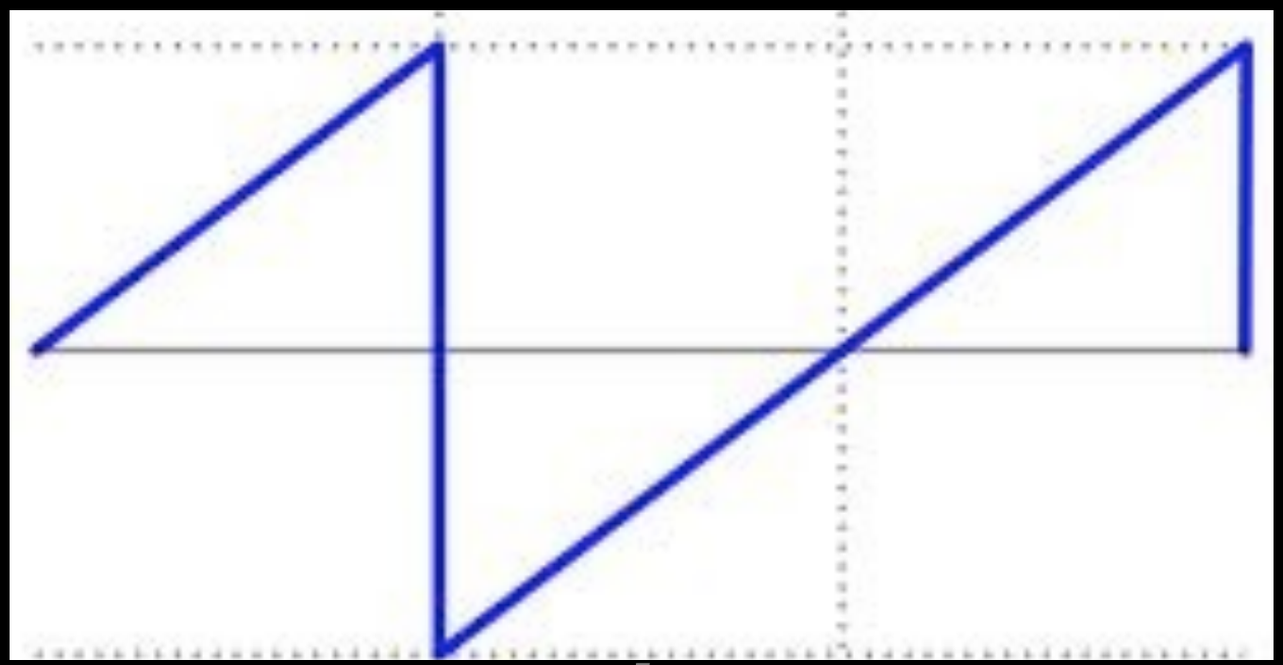
- *Voltage Controlled Oscillators*
- *Noise generators*
- *Audio from microphone or tape*

- *Voltage Controlled Oscillators*
  - Sine
  - Triangle
  - Sawtooth
  - Pulse



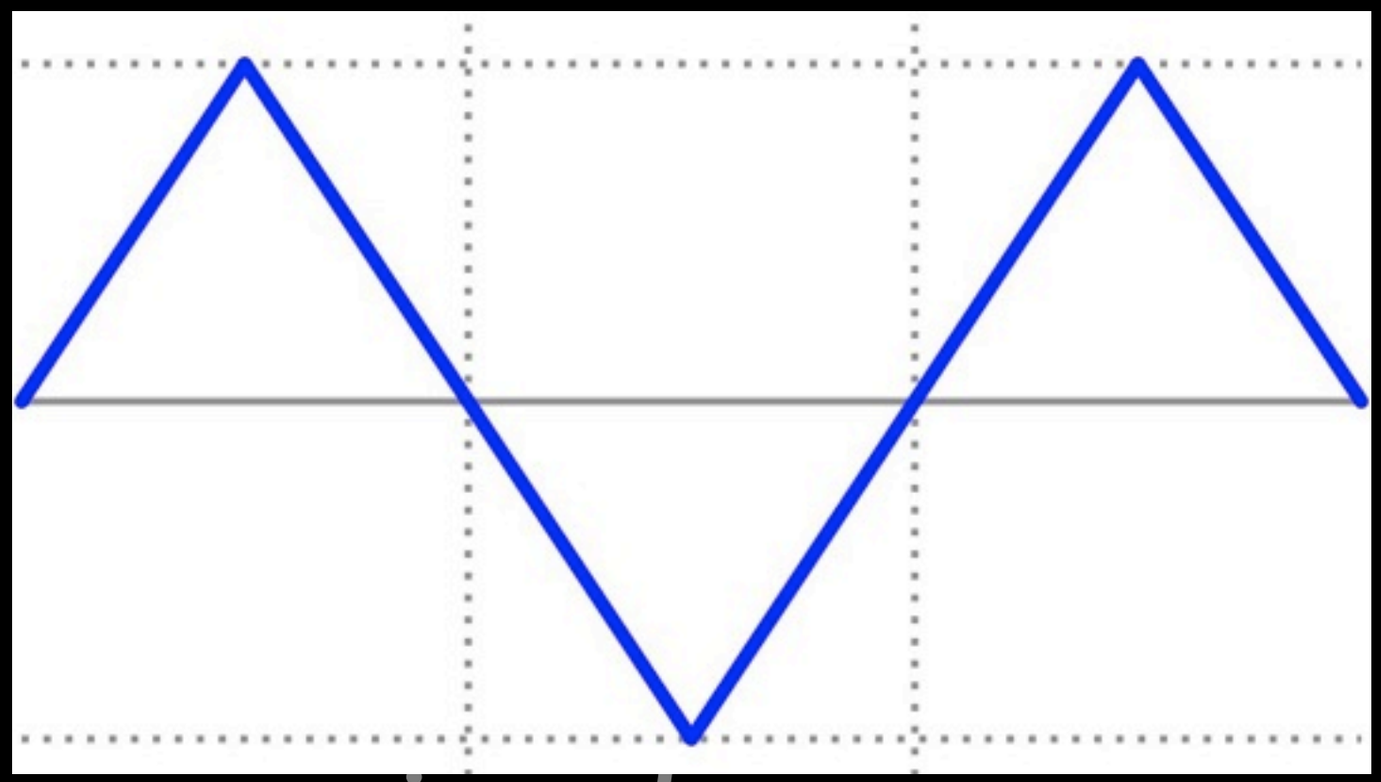
sine wave

Sine: Also known as pure tone. Fundamental frequency only.



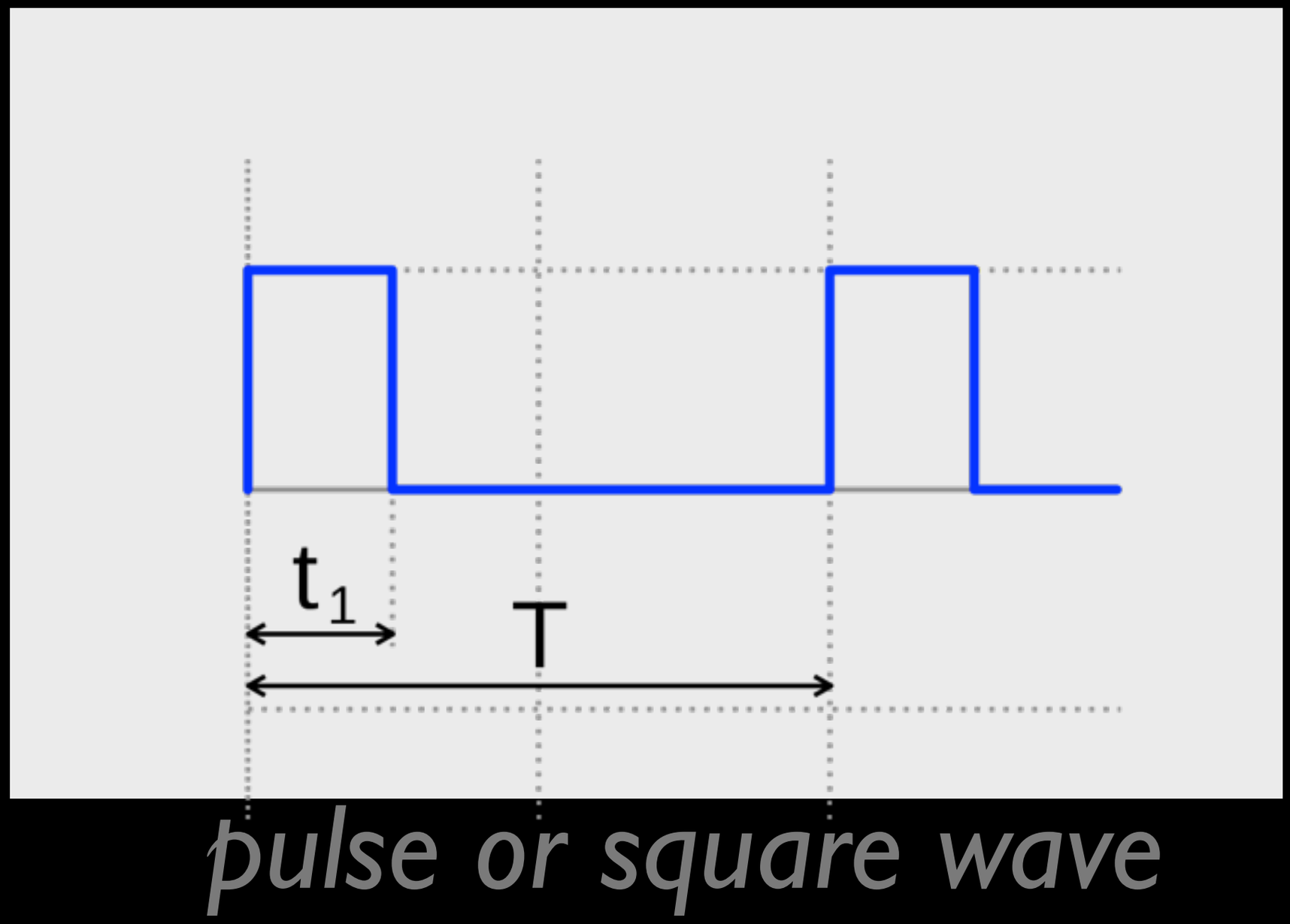
sawtooth wave

Contains all the odd harmonics. Fundamental or 1, 3, 5, 7, 9, 11, etc. Much energy in the upper harmonics - bright sounding, often used with low pass filter to create rich timbres.



triangle wave

Contains all the odd harmonics. Fundamental or 1, 3, 5, 7, 9, 11, etc. Energy in the harmonics is less than sawtooth – clarinet like, less high frequency energy.



pulse wave contains only odd harmonics but the mix can be altered by changing the duty cycle or the ratio of on/off (t1 to T). If t1=1/T then it is a square wave. Modulating the pulse width or duty cycle is a common feature in synthesizers.

- *Noise generators*

- `white`
- `pink`

as per previous classes. White noise is equal energy over audio spectrum (20 – 20KHz) while pink more closely resembles the energy distribution of music – equal energy per octave.

- *Audio from microphone or tape*

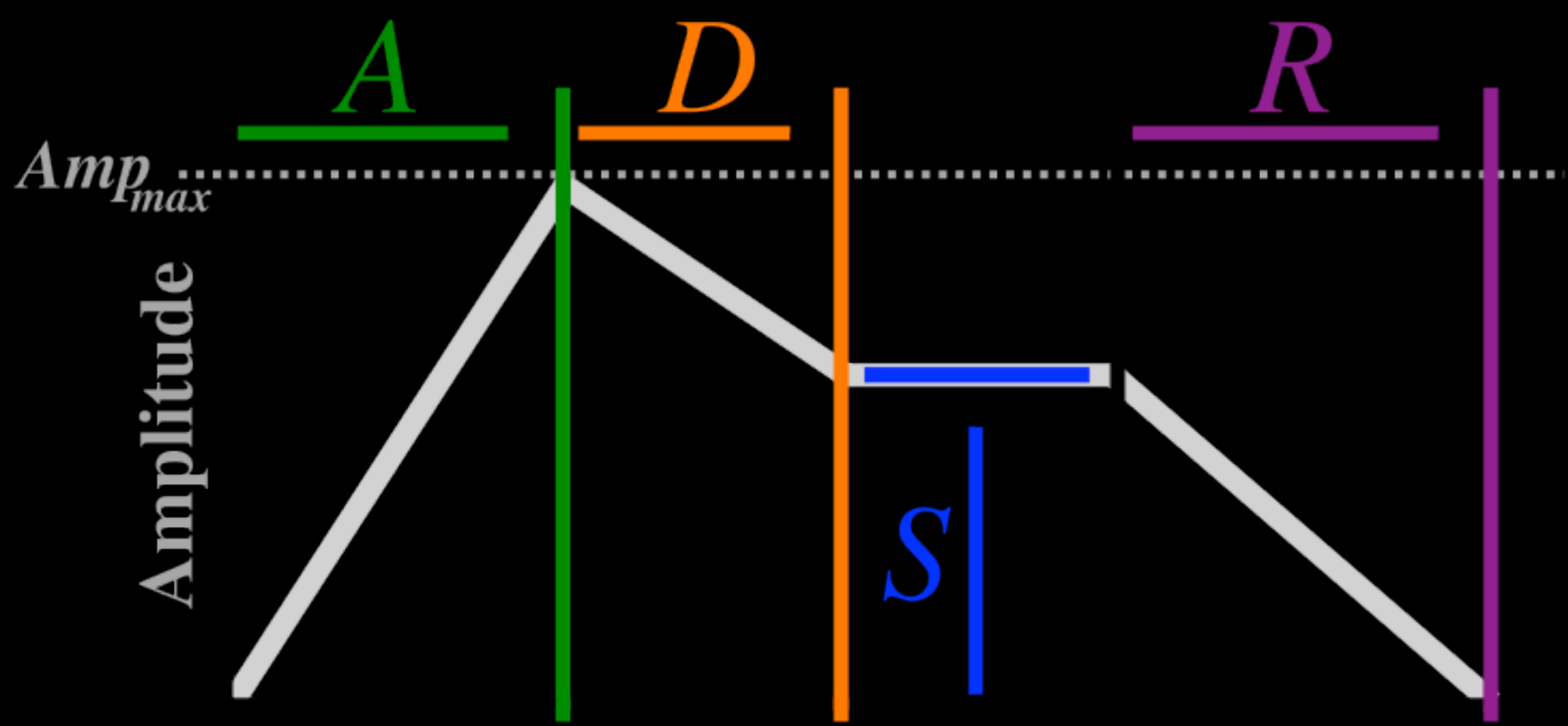
External sound sources often can be used as a signal source or a modulation source as well.

- *Voltage Controlled Filters*

  - Low Pass
  - High Pass
  - Band Pass
  - Band Reject

As per our look at filters. Voltage control of filter cut-off, “Q” or resonance, bandwidth and amount of effect.

- *Voltage Controlled Amplifier*



- Often coupled with an envelope generator

Adjusts volume of signal depending on voltage. It is often coupled with an envelope generator which then creates the class “ADSR” or attack, decay (initial) sustain and release.

Modulation sources:

- *Low frequency oscillators*
- *Voltage Controlled Oscillators*
- *Noise generators*
- *Audio from microphone or tape*

An LFO or low frequency oscillator is used to control a variety of parameters as a control voltage source

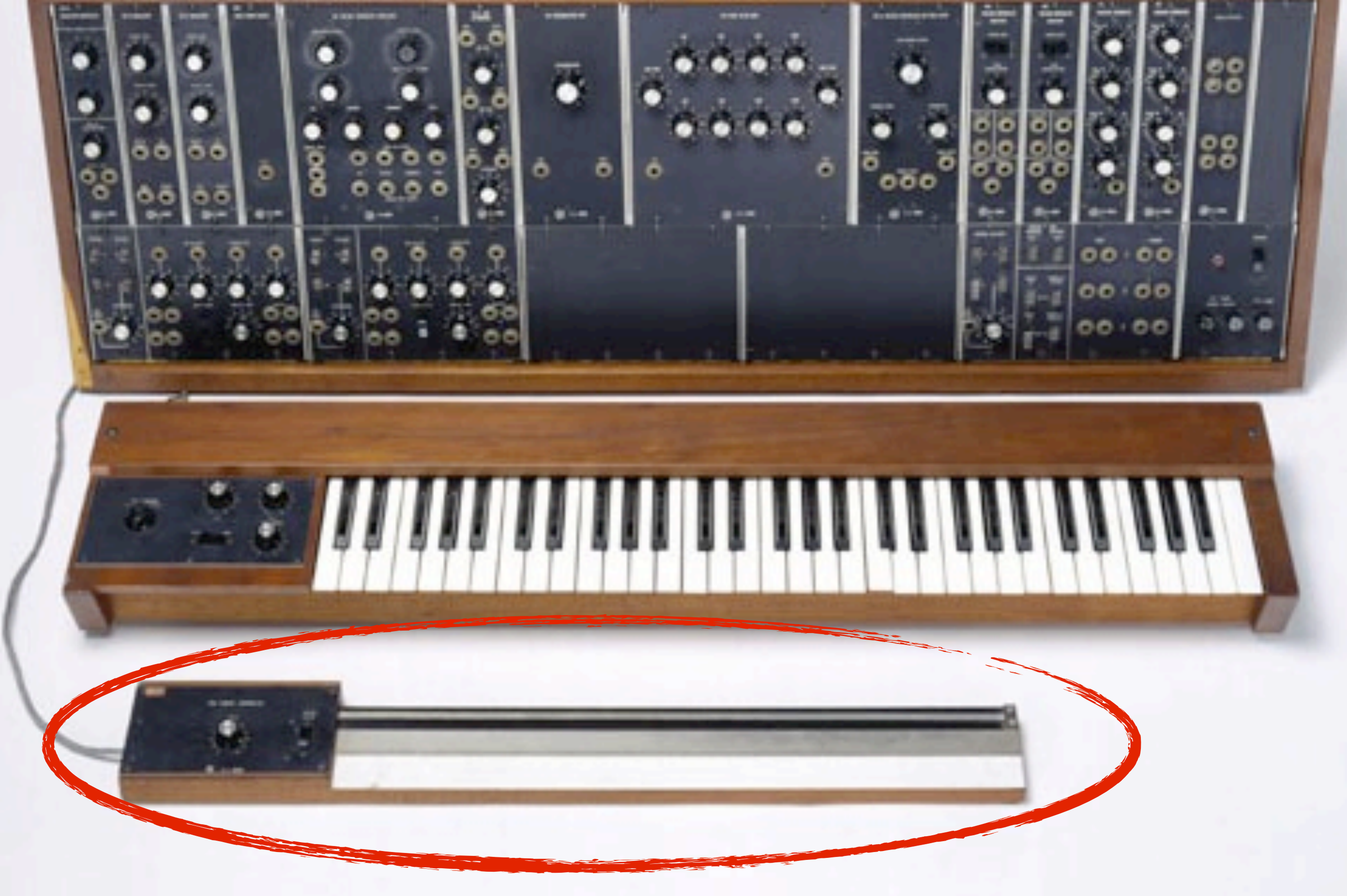
- *Low frequency oscillators*
  - *Sub audio to low frequency range*
  - *Variety of waveforms plus*
  - *Random and/or noise*

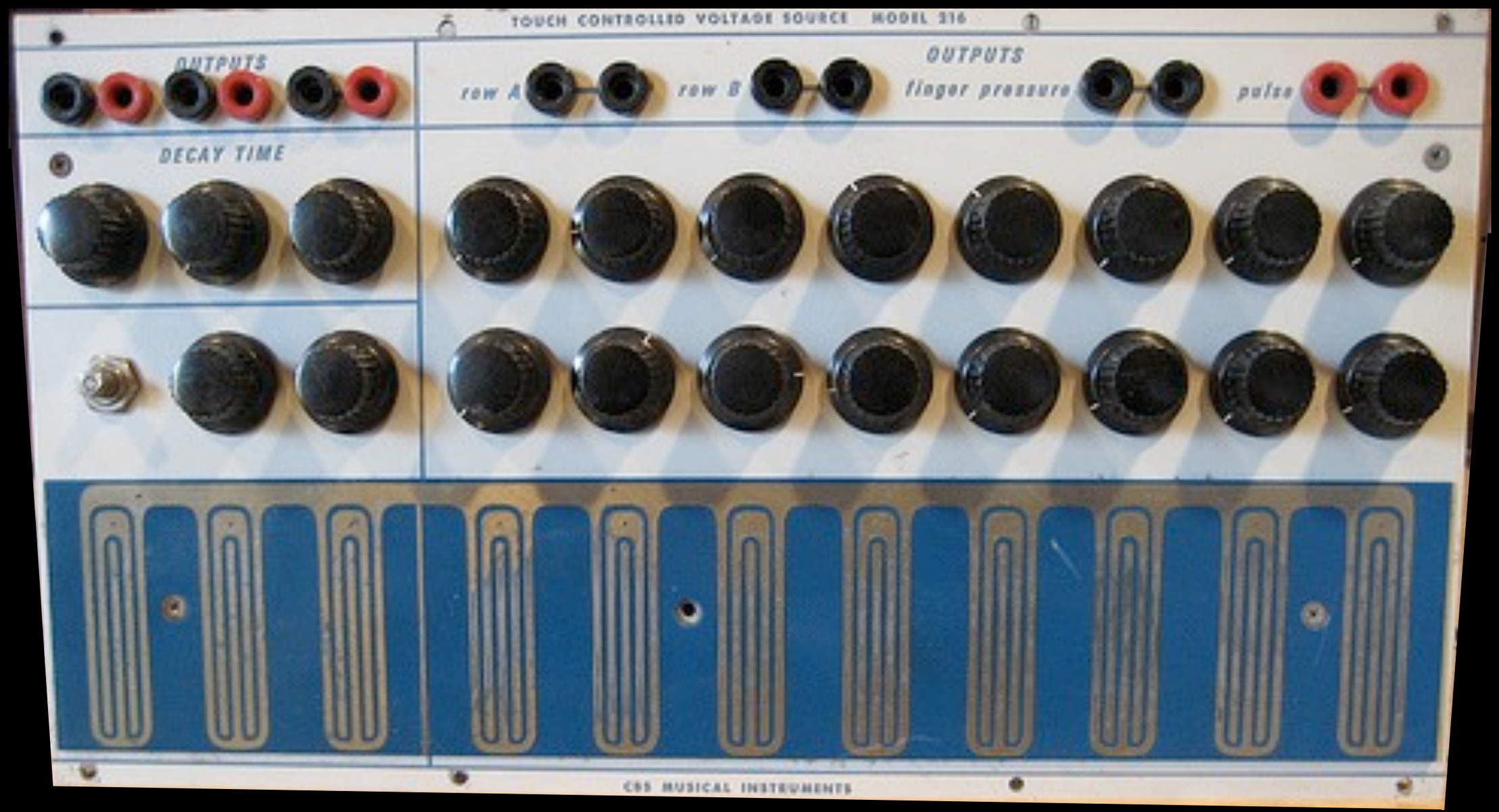
An LFO or low frequency oscillator is used to control a variety of parameters as a control voltage source

Controllers:

- *Clavier style keyboards*
- *Touch switches, etc.*
- *Slider*
- *Wheel*
- *Instrumental models: Drum, wind instrument,*
- *Gestural: Baton, etc.*

All of these calibrated to 1 volt/octave. Various manufactured or custom interfaces.




TOUCH CONTROLLED VOLTAGE SOURCE MODEL 316
OUTPUTS
row A
row B
OUTPUTS
finger pressure
pulse
DECAY TIME
CBS MUSICAL INSTRUMENTS

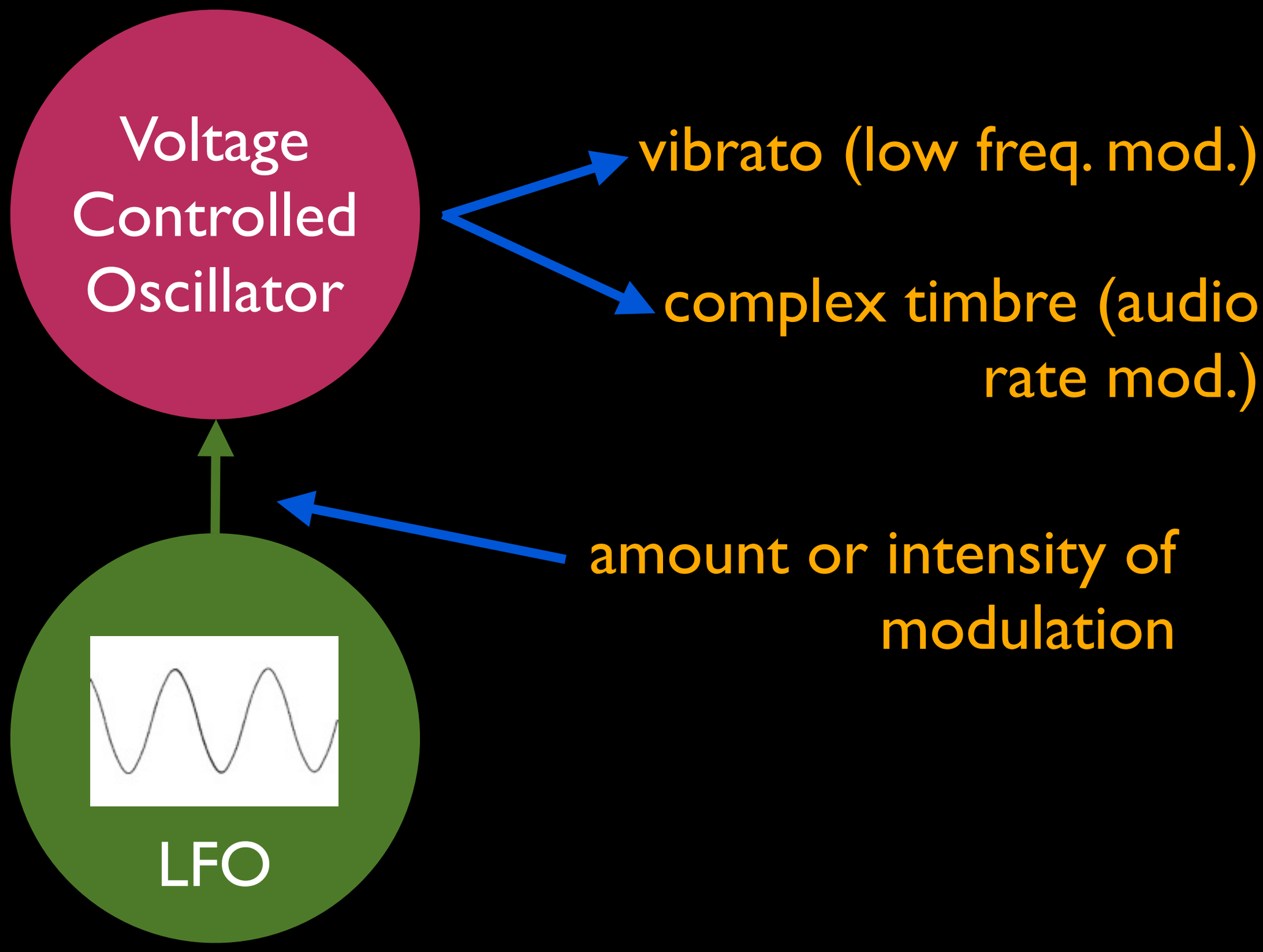

moog


SCALE
moog
PERCUSSION CONTROLLER
MODEL 1130
SENSITIVITY
AKAI
AKAI EWI USB

Modulation:

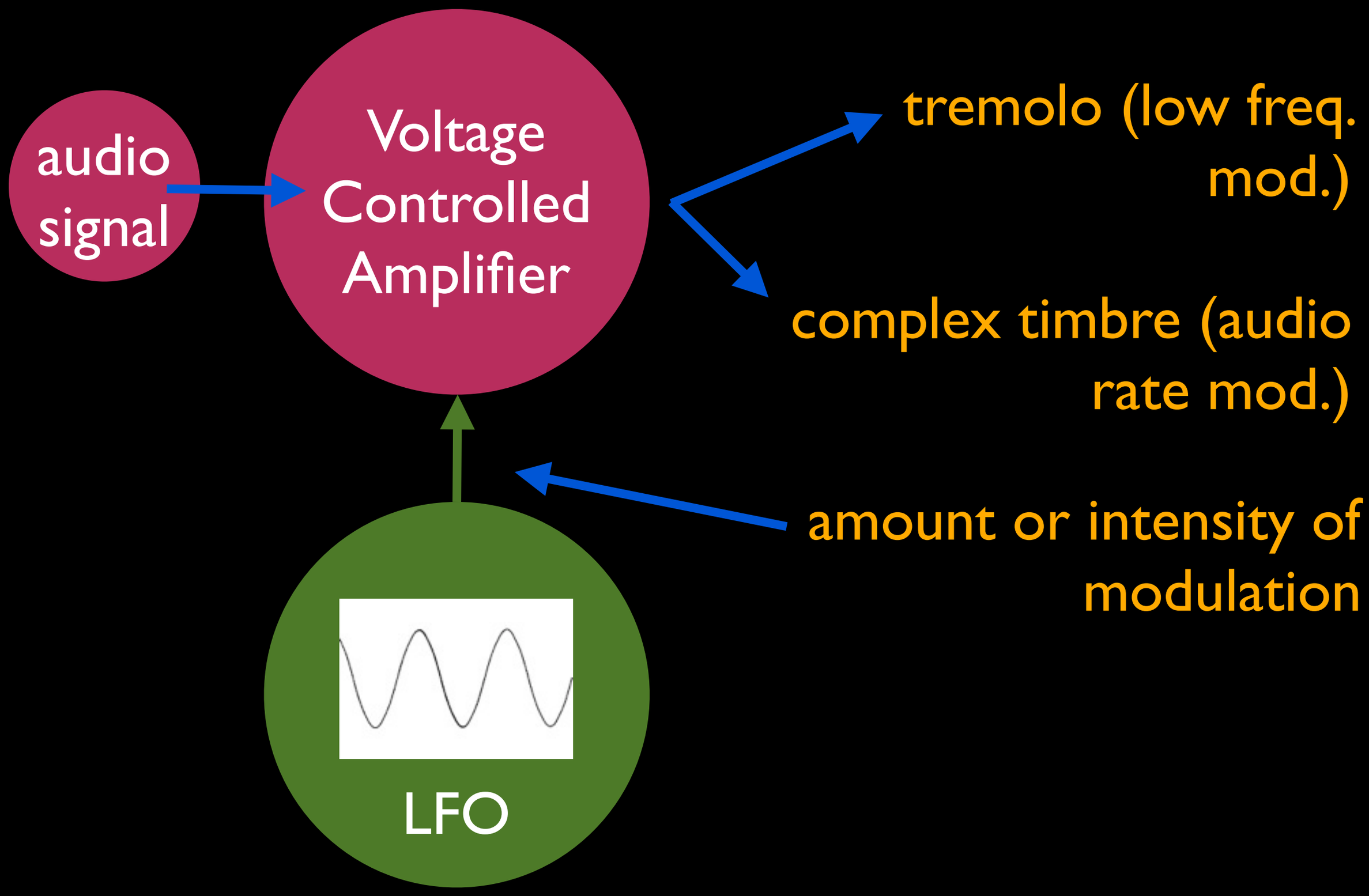
- *Frequency modulation (non-linear)*
- *Pulse width modulation*
- *Amplitude modulation*
- *Ring modulation*
- *Linear Frequency Modulation*

Frequency modulation (non-linear)



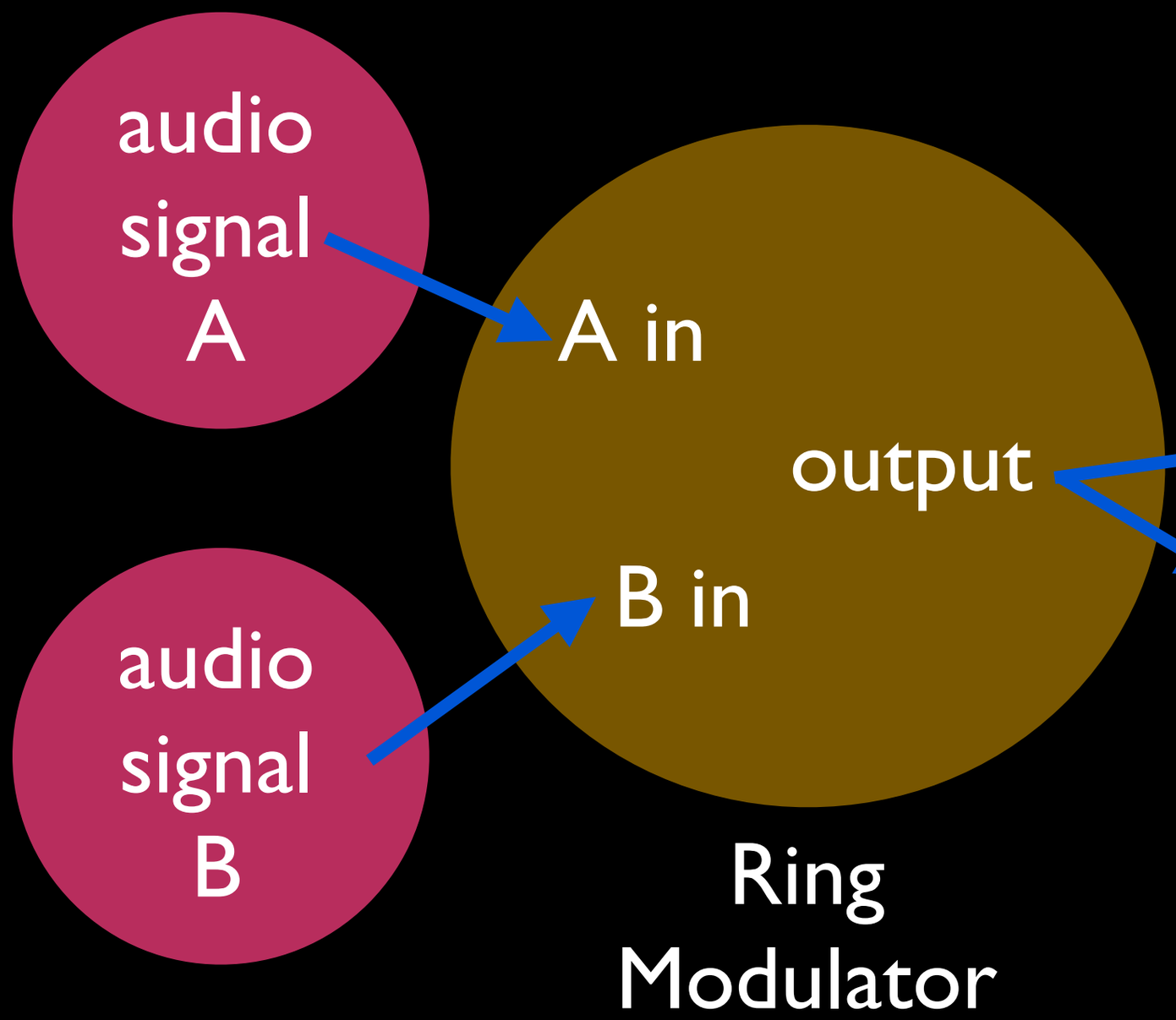
With sub audio rates for the LFO, the effect is vibrato, audio rates create a complex timbre with “sidebands”.

Amplitude modulation



With sub audio rates for the LFO, the effect is tremolo, with audio rates there is a complex timbre.

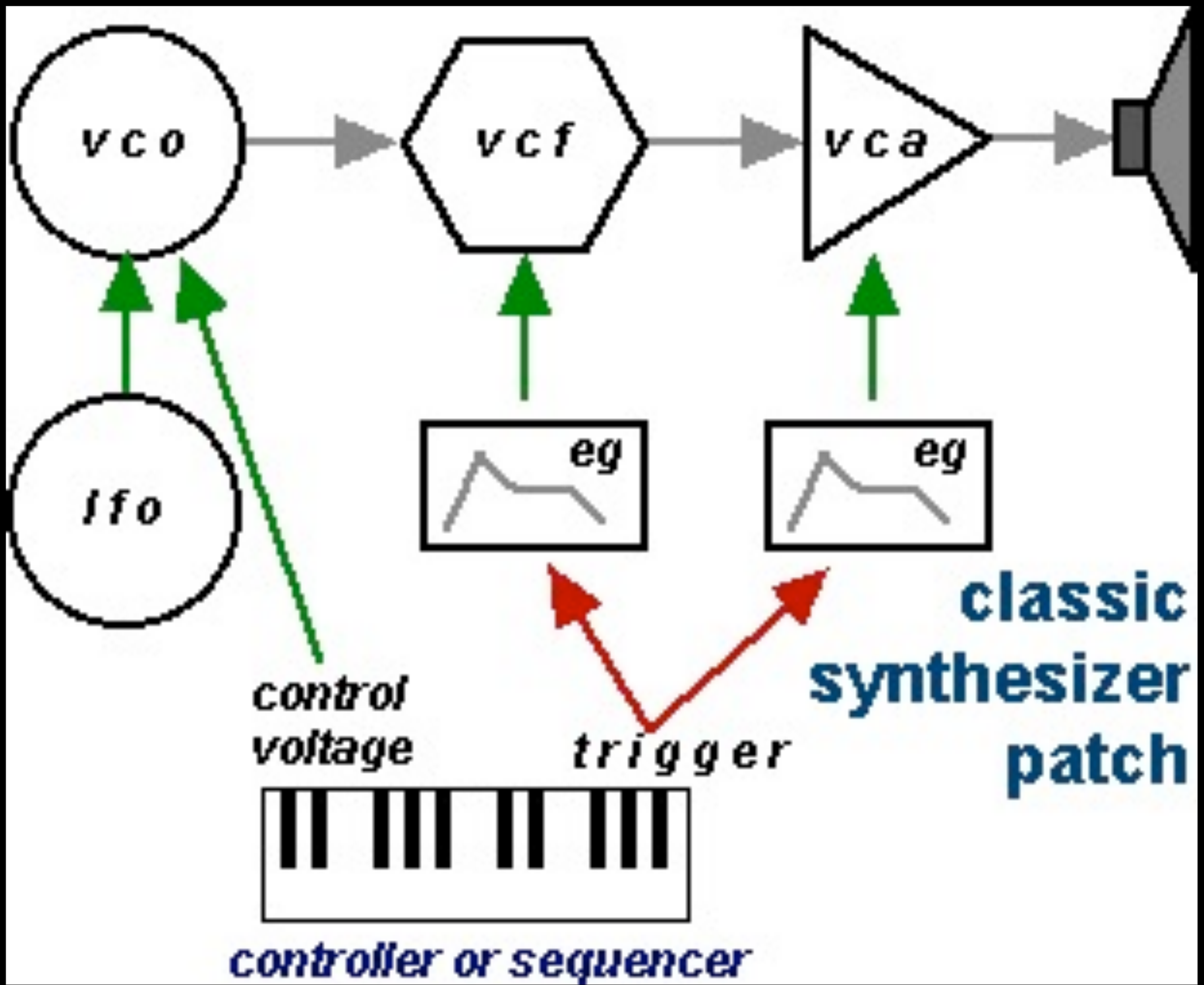
Ring modulation



A+B, A-B, no A, no B

Output is addition of all the frequencies in A with all the frequencies of B and the subtraction of A from B. Original A & B are blocked!

Ring or four quadrant multiplication takes A, B in and outputs all the frequencies in A + all the frequencies in B, and A – B, but blocks A and blocks B. So 400Hz sine in A, 300 HZ sine in B – output is 700 Hz sine and a 100 Hz sine only.



The “Classic Patch” has the vco into a vcf into a vca with the keyboard controlling the pitch and the start of the filter and amplifier envelope.


TAE
TUNE
OSCILLATOR MODULATION
GLIDE
MOD. MIX
OSC. 3
NOISE
CONTROLLERS
RANGE
OSCILLATOR - 1
FREQUENCY
WAVEFORM
OSCILLATOR - 2
OSCILLATOR - 3
OSC. 3 CONTROL
OSCILLATOR BANK
VOLUME
EXTERNAL INPUT VOLUME
OVERLOAD
NOISE VOLUME
WHITE
PINK
MIXER
FILTER MODULATION
KEYBOARD CONTROL
CUTOFF FREQUENCY
FILTER EMPHASIS
AMOUNT OF CONTOUR
ATTACK TIME
DECAY TIME
SUSTAIN LEVEL
LOUDNESS CONTOUR
MODIFIERS
A-440
VOICE DETUNE
minimoog V
GLIDE ON
DECAY ON
LEGATO ON
BEND
ON
BEND
RANGE
BEND
MOD.


TAE
TUNE
OSCILLATOR MODULATION
GLIDE
MOD. MIX
CONTROLLERS
RANGE
OSCILLATOR - 1 FREQUENCY
WAVEFORM
OSCILLATOR - 2
OSCILLATOR - 3
OSC. 3 CONTROL
OSCILLATOR BANK
VOLUME
EXTERNAL INPUT VOLUME
OVERLOAD
NOISE VOLUME
WHITE
PINK
MIXER
FILTER MODULATION
KEYBOARD CONTROL
CUTOFF FREQUENCY
FILTER EMPHASIS
AMOUNT OF CONTOUR
ATTACK TIME
DECAY TIME
SUSTAIN LEVEL
LOUDNESS CONTOUR
MODIFIERS
VOLUME
MAIN OUTPUT
UNISON
A-440
VOICE DETUNE
POLYPHONIC
OUTPUT
SOFT CLIPPING


TAE
TUNE
OSCILLATOR MODULATION
ON
GLIDE
MOD. MIX
OSC. 3
NOISE
OSC. 3 CONTROL
RANGE
OSCILLATOR - 1
FREQUENCY
WAVEFORM
OSCILLATOR - 2
OSCILLATOR - 3
CONTROLLERS
OSCILLATOR BANK


VOLUME
ON
OUT ON
ON
ON
EXTERNAL
INPUT VOLUME
OVERLOAD
NOISE VOLUME
WHITE
PINK
MIXER


FILTER
CUTOFF FREQUENCY
FILTER EMPHASIS
AMOUNT OF CONTOUR
VOLUME
MAIN OUTPUT
FILTER MODULATION
ON
UNISON
ON
KEYBOARD CONTROL
ON
ATTACK TIME
DECAY TIME
SUSTAIN LEVEL
A-440
ON
M-SEC
SEC
LOUDNESS CONTOUR
ATTACK TIME
DECAY TIME
SUSTAIN LEVEL
VOICE DETUNE
POLYPHONIC
SOFT CLIPPING
ON
MODIFIERS
OUTPUT