

Shaping Sounds: Design of a Diode-Ladder Voltage Controlled Filter

Grant Saggars¹ Moritz Klein²

Topics to Cover

1. Purpose of a VCF
2. Theory: Resonance
3. Theory: diodes as voltage-controlled resistors
4. Characterization

Background: Sounds and Signals

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The fully professional, digitally programmable, MIDI-interfaceable, surprisingly portable, unbelievably affordable Korg Poly 800.



KORG POLY 800

The new Korg® Poly 800 literally creates an entirely new category of professional synthesizers. Korg's constant refinement of synthesizer technology allows us to bring you a totally programmable polyphonic synthesizer, loaded with sounds and features, that sells for less than \$800.

8 VOICES
PROFESSIONAL SOUNDS
The Poly 800's unique architecture

professional would expect.
In fact, the Poly 800's powerful layering mode can give you two different sounds for each note. This means even thicker textures and more complex voicings.

64 PROGRAMS

offer only four). This feature is a significant improvement over common ADSR-type envelopes, allowing more expressive control. Your patches can be saved in the Poly 800's memory and off-loaded to tape in 14 seconds. You can

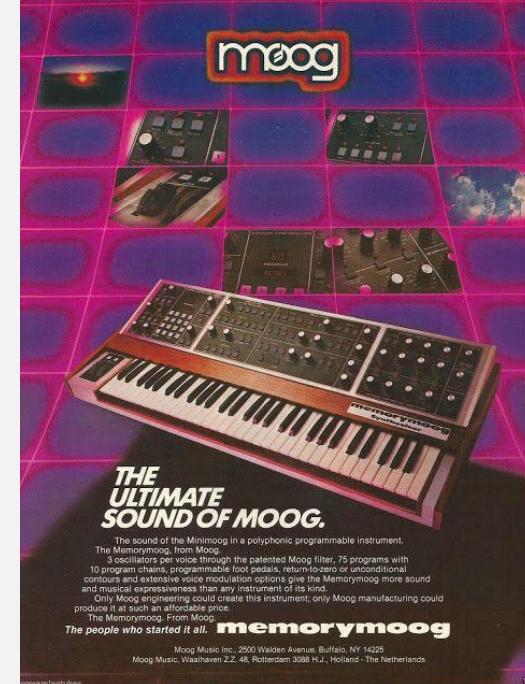
A Noise Generator with individual articulation circuitry lends realism to sounds such as flute, other woodwind instruments and dramatic special effects.

An on-board programmable Stereo Chorus adds extra depth

128 LFS THE MOST PORTABLE POLYPHONIC

And the headphone jack lets you practice anywhere.

If you want to expand your keyboard set-up or you've been held back by the high price of polyphonic synthesizers until now, investigate the unbelievably affordable Korg Poly 800 at your local Korg dealer. Or send \$3.00 (check or money order) to Unit 44, 1159 Frost St., Westbury, New York 11590 for a Poly 800 demo record.

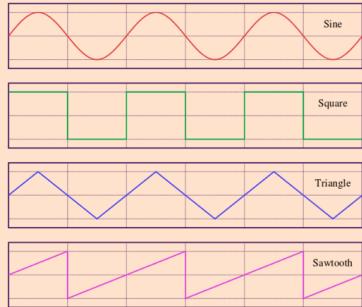


We take a lot of ideas from these guys!

Basic Operation of a Synthesizer

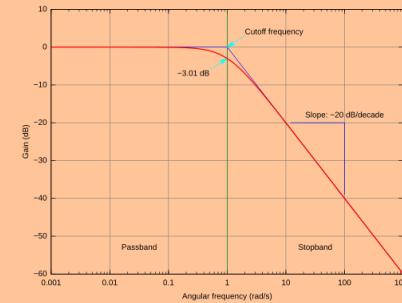
1. Make a signal

Signal Generators!



2. “Shape” a signal

Filters!



3. Output the sound

Speakers!



Design Considerations

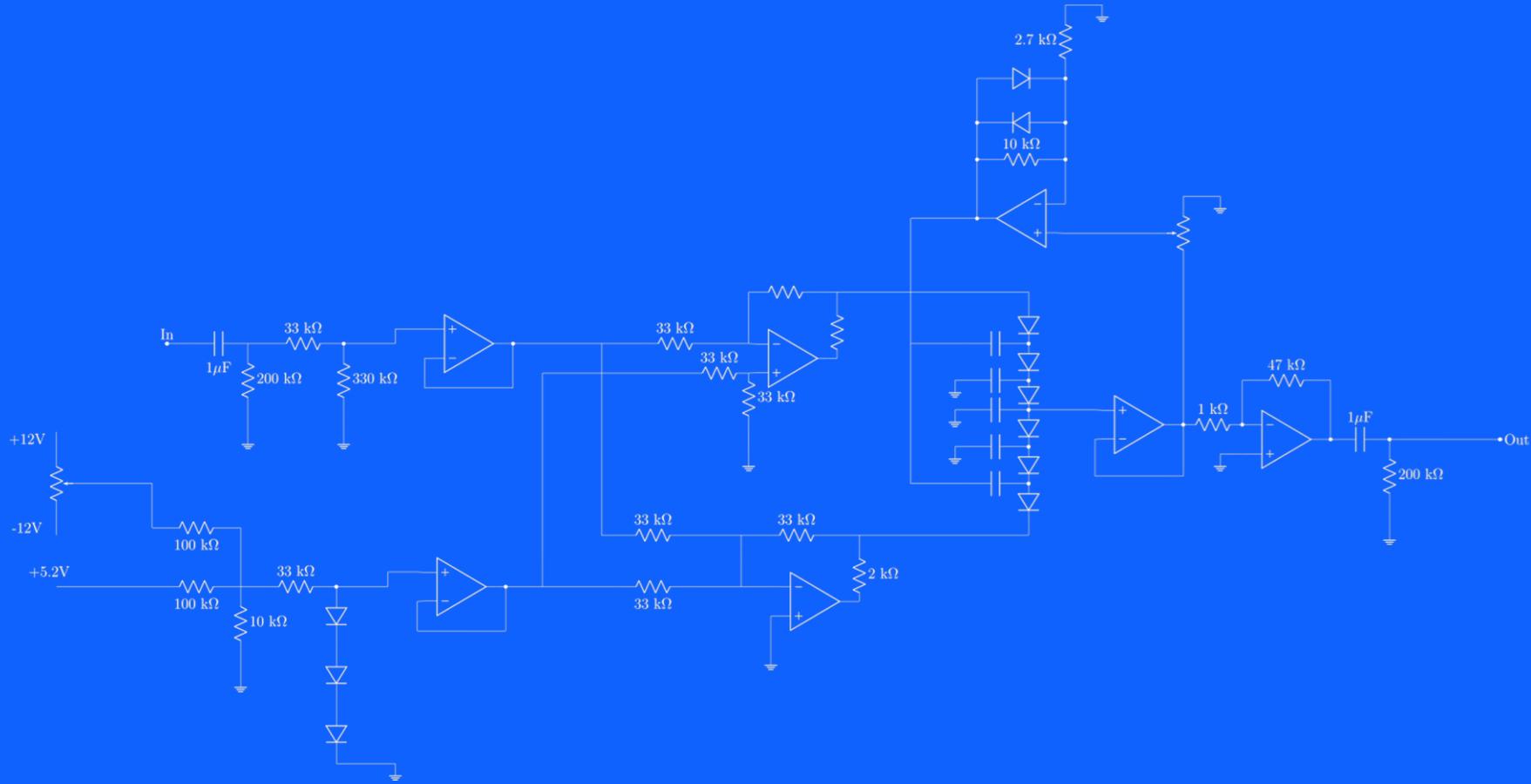
- V
- I



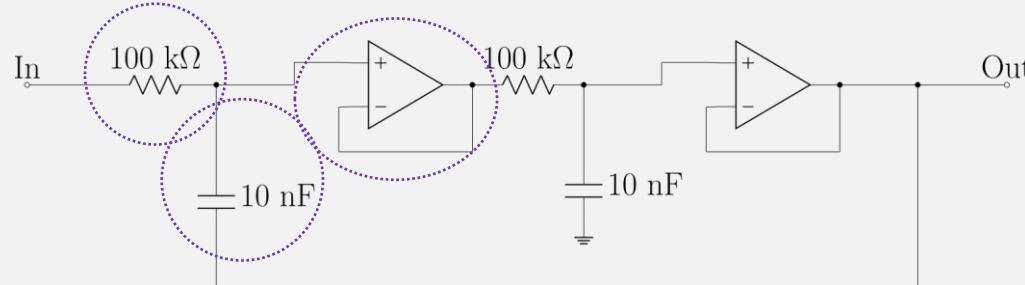
Design Considerations

- **Voltage Control:** lets an artist adjust some dials and switches to get the sound they want
- **Robustness:** Must operate on a huge range of frequencies with consistency
 - **Must** tune cutoff and resonance at least

Outcome...

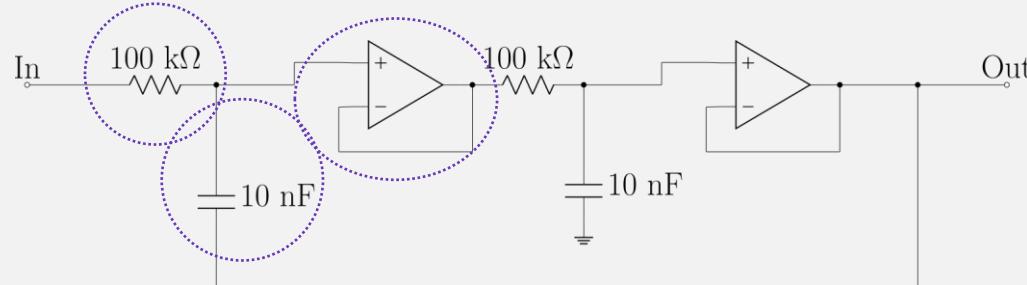


Basic Resonant Filters



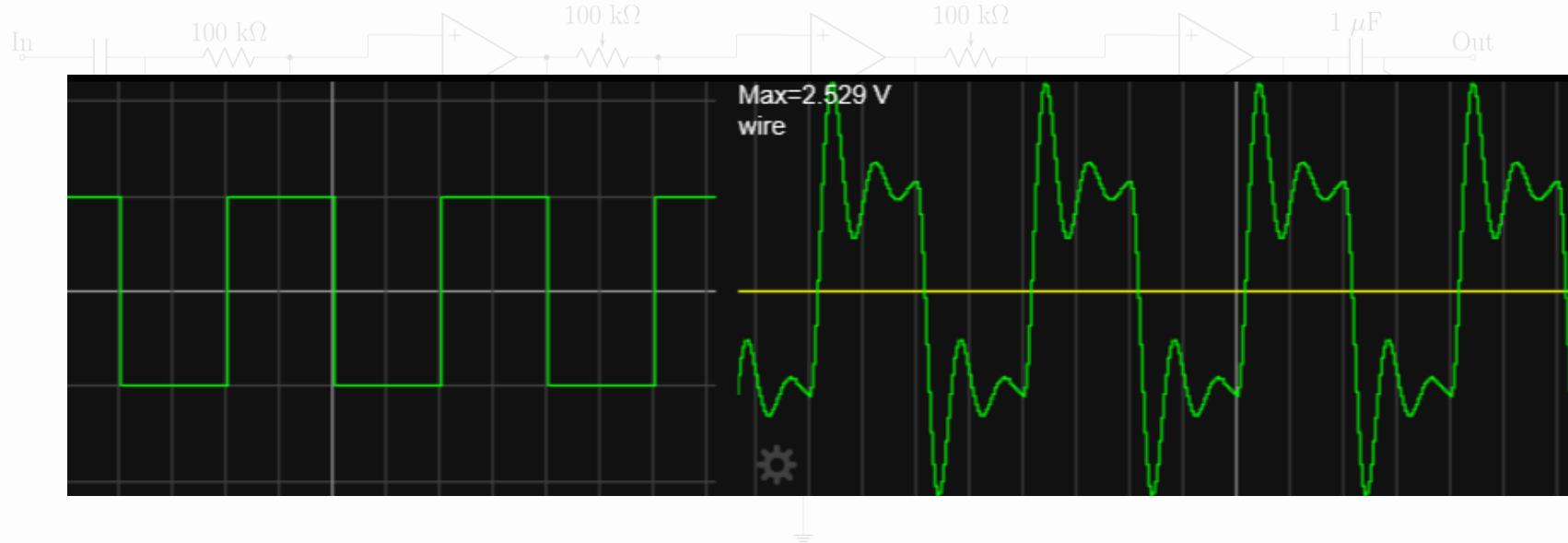
Interesting, but not very useful yet!

Basic Resonant Filters



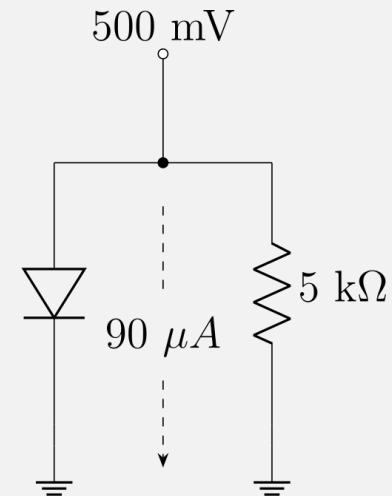
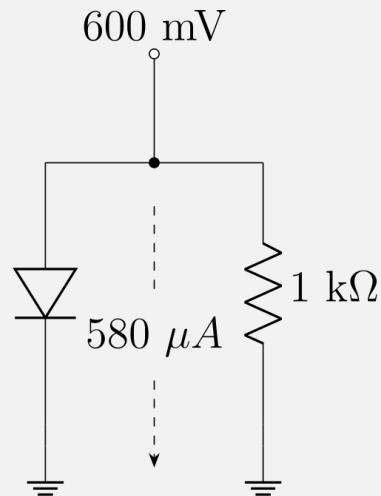
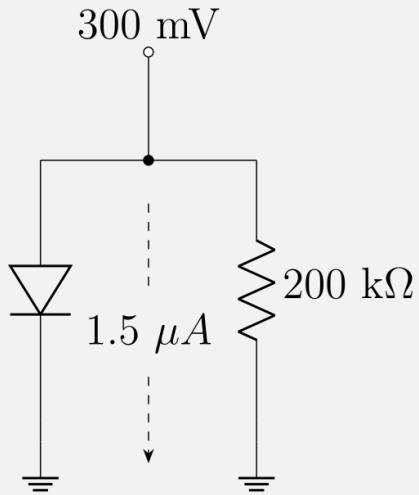
Interesting, but not very useful yet!

The Fully Resonant Low Pass

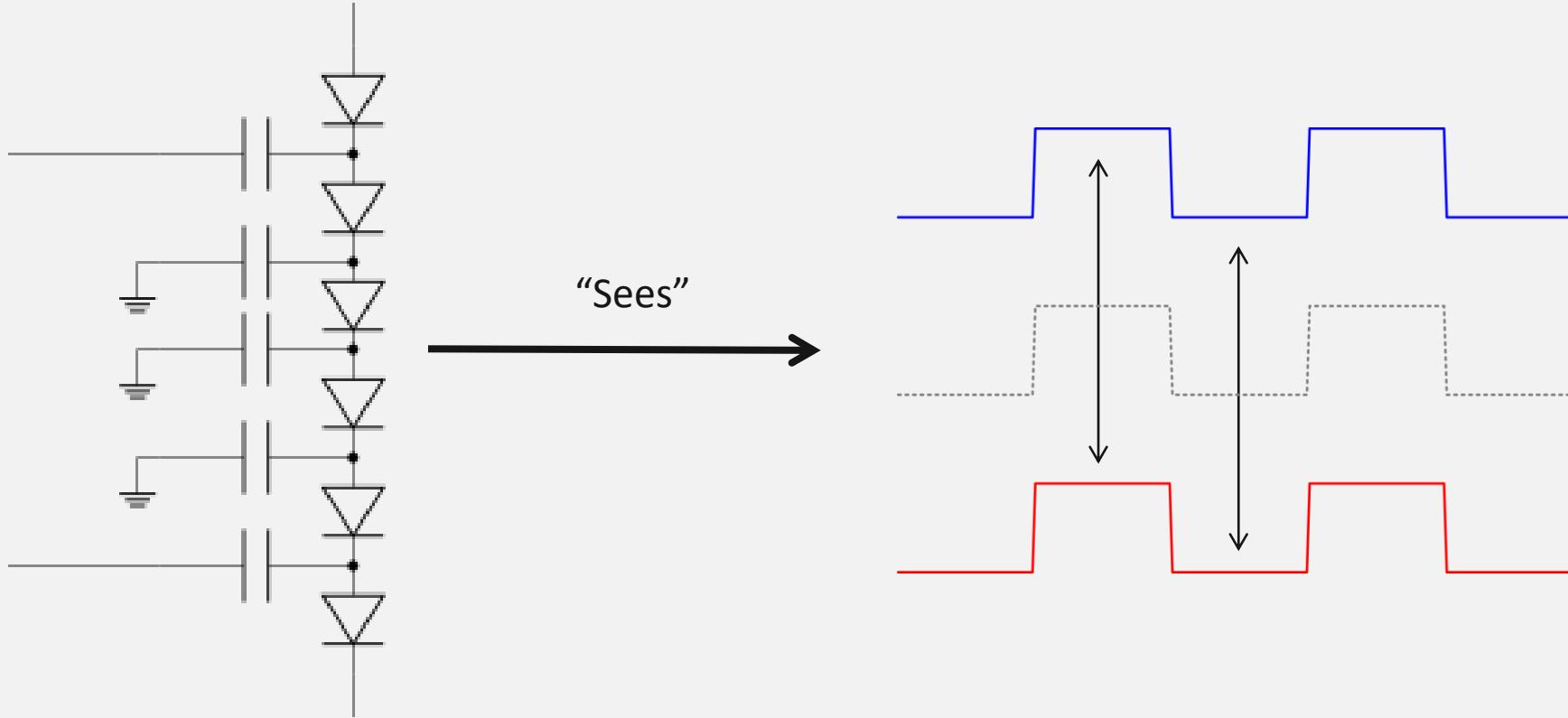


Not quite the circuit we end up with,
but this is very close...

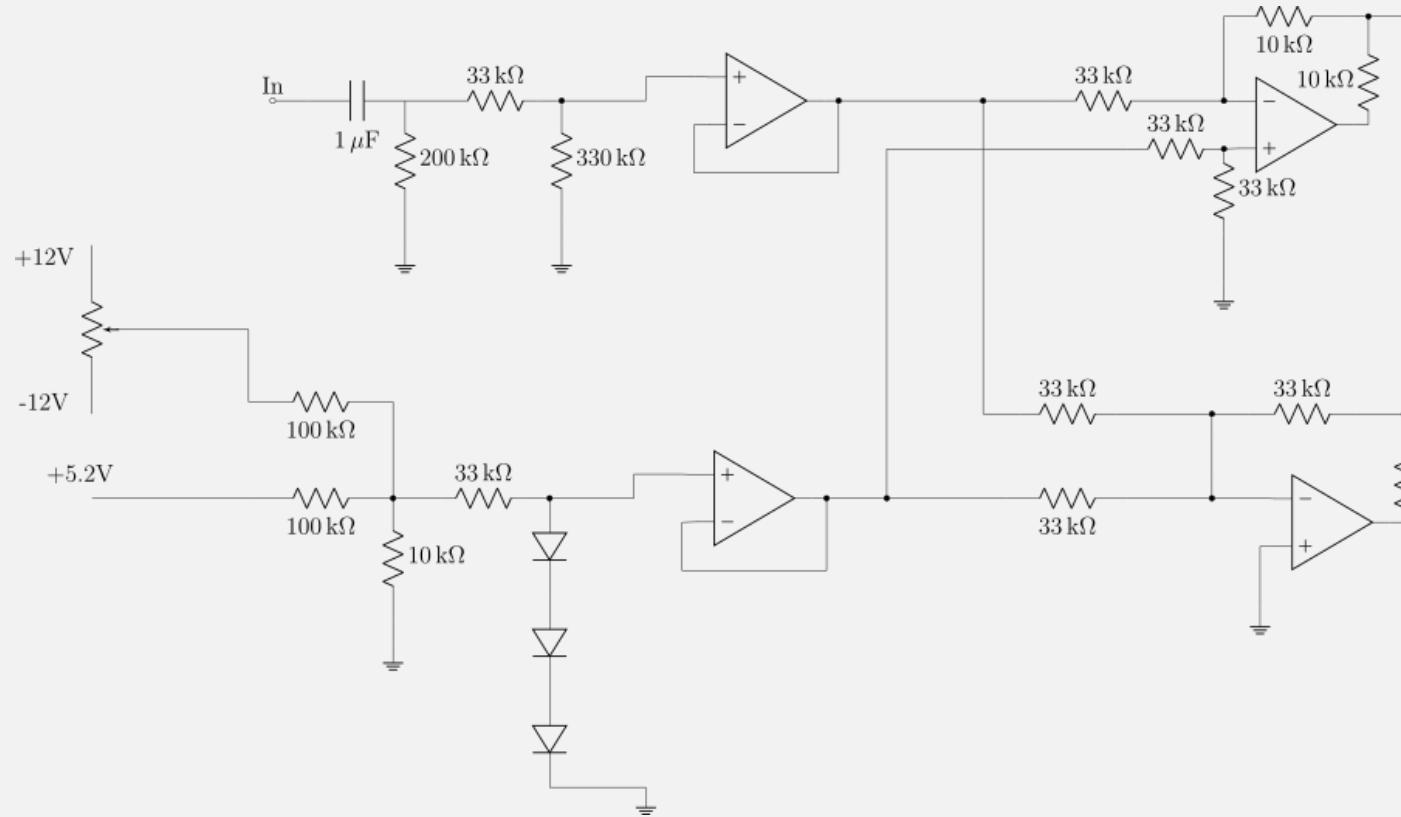
Diodes as Voltage Controlled Resistors



The Multi-Pole Diode Ladder

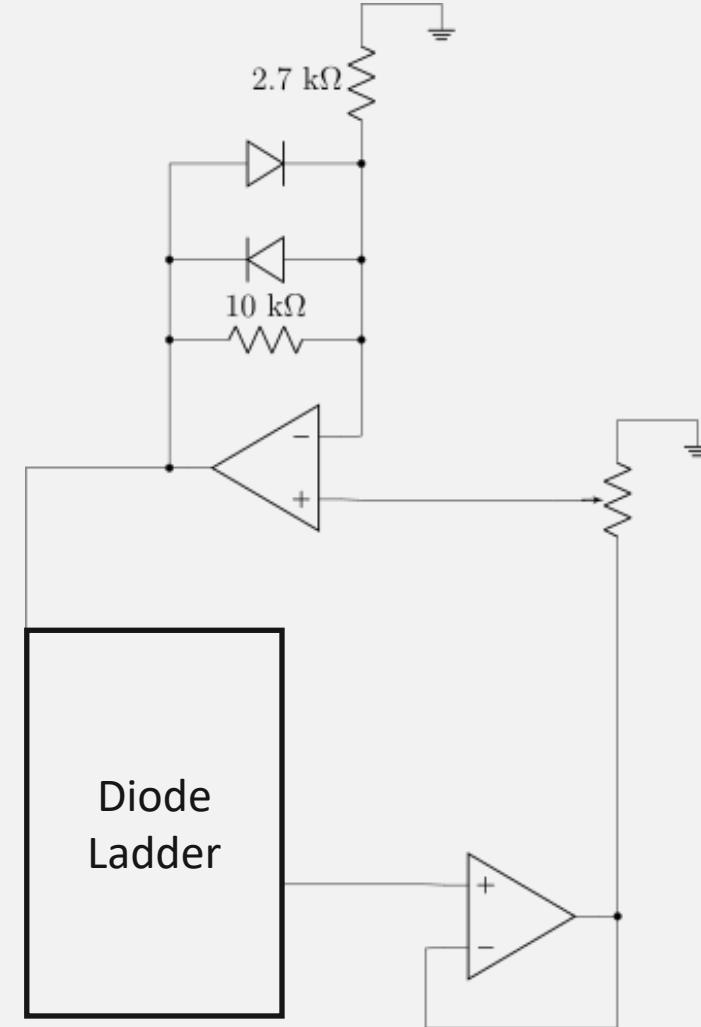


Input Stage and Driver

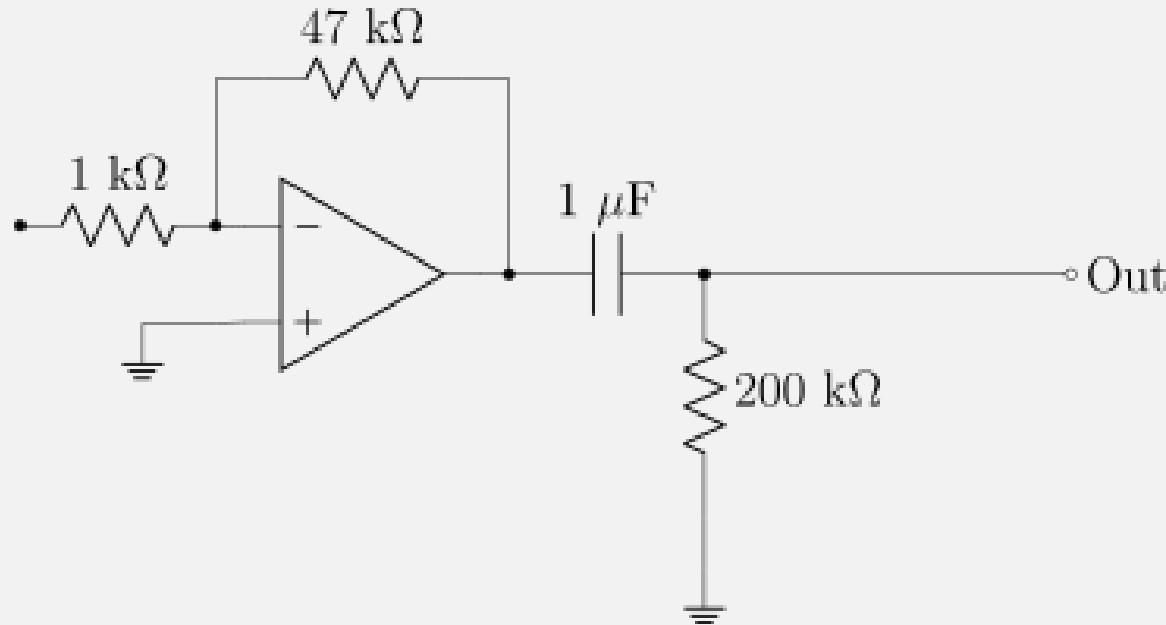


Resonance

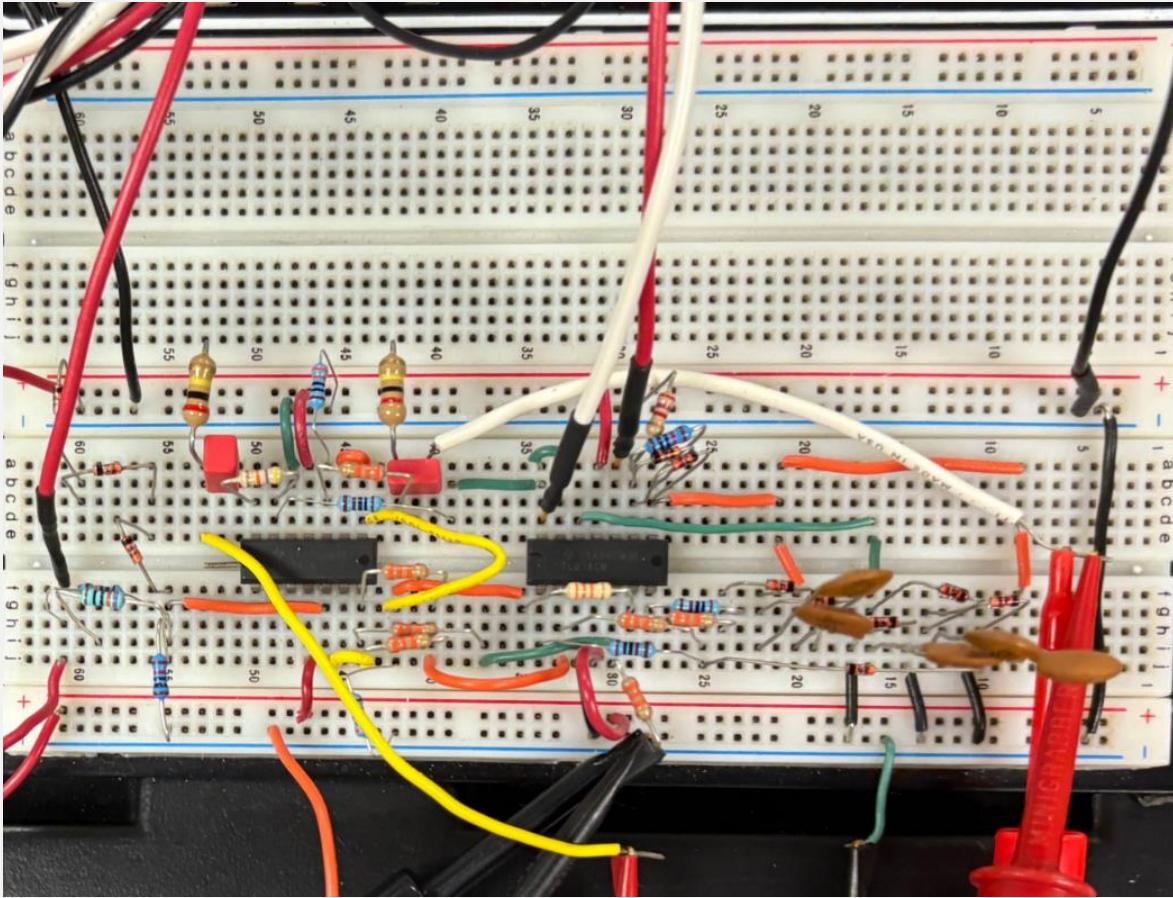
- Same as the fully resonant LPF, just with some mystery diodes
- Resonance goes into caps on diode ladder, giving the whole signal VC
- Used in certain KORG synthesizers!



Output Stage (Multiplier and AC Coupling)



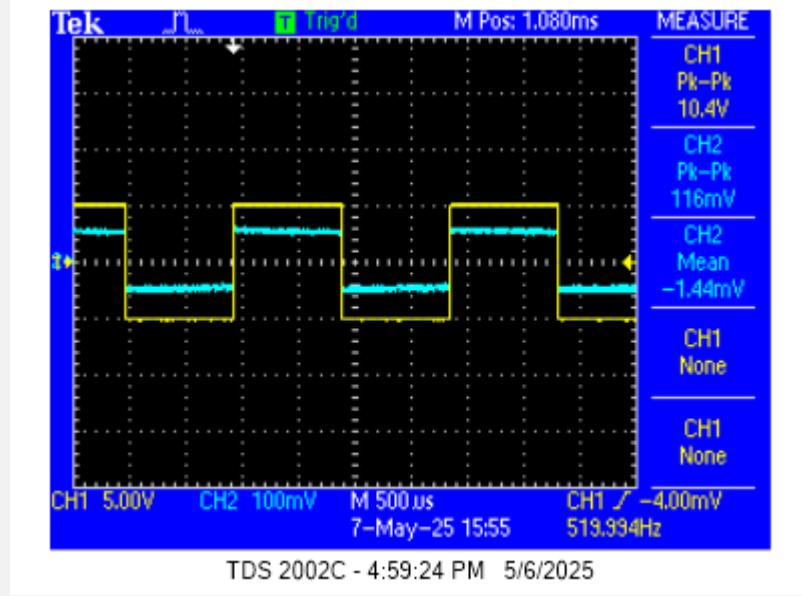
The Mess



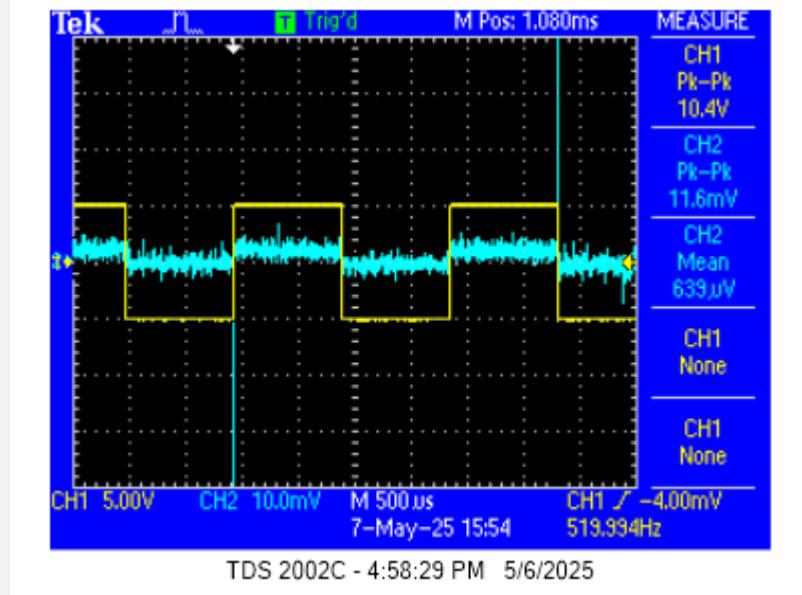
Simulation

Characterization

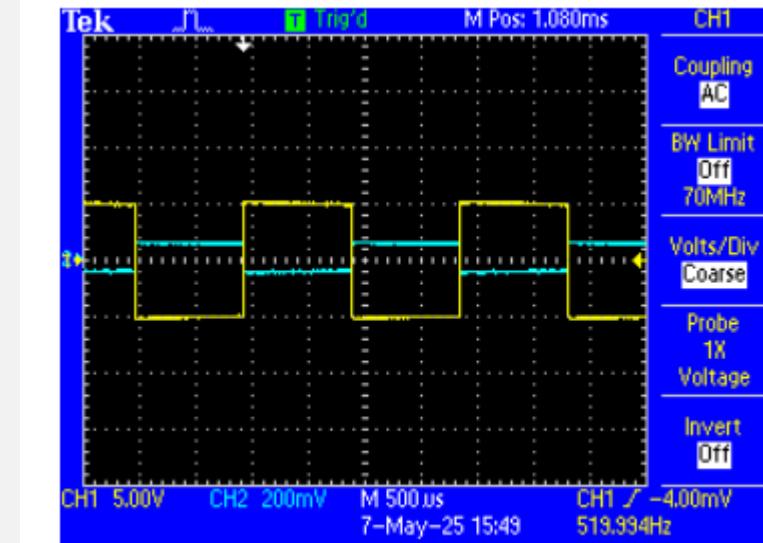
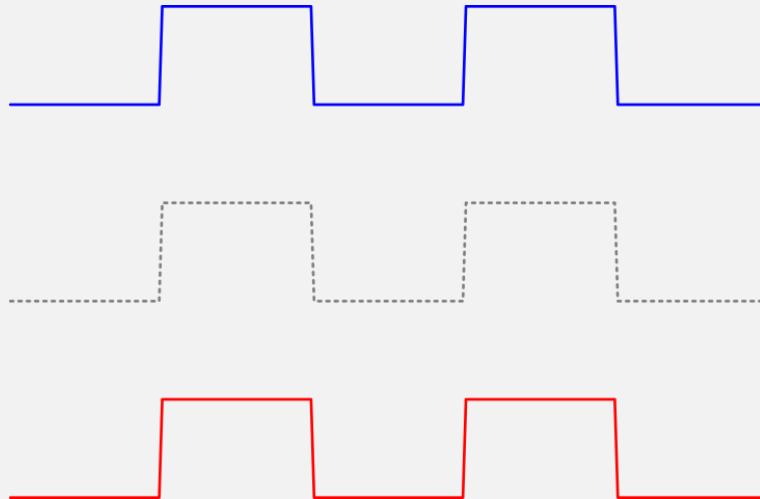
Characterization: F1



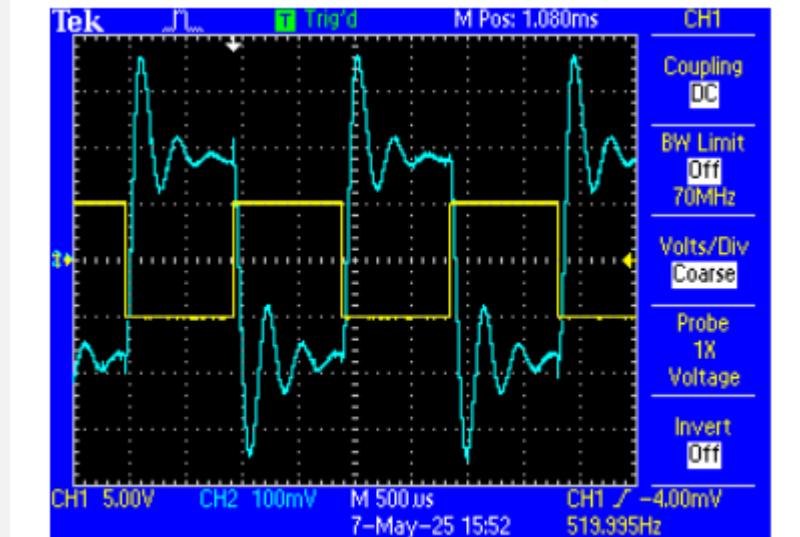
Characterization: F3



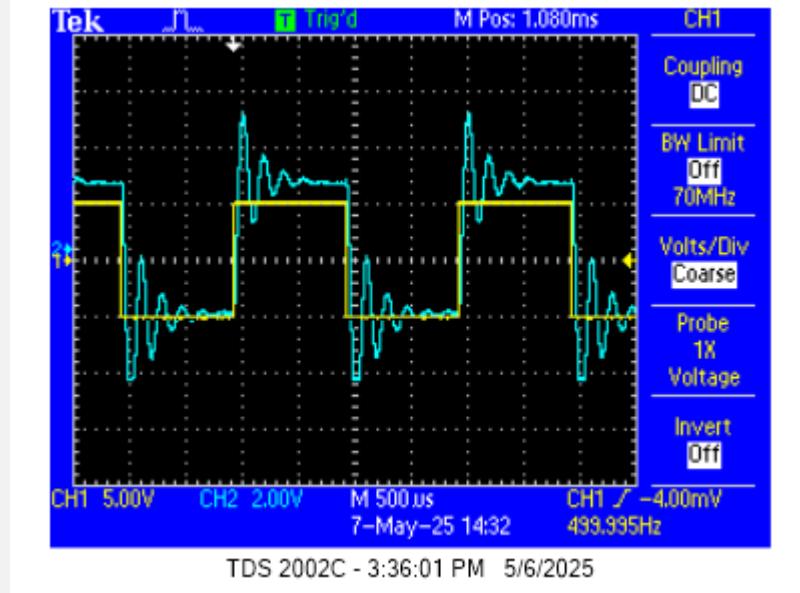
Characterization: Shifting Voltages (02, 03)



Characterization: 03



Characterization: Output



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Supplemental Slides

1N4148



Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

DigiKey Part Number	1N4148FS-ND
Manufacturer	onsemi
Manufacturer Product Number	1N4148
Description	DIODE STANDARD 100V 200MA DO35
Manufacturer Standard Lead Time	22 Weeks
Customer Reference	<input type="text"/>
Detailed Description	Diode 100 V 200mA Through Hole DO-35
Datasheet	 Datasheet
EDA/CAD Models	1N4148 Models

