Using TL07X Op Amps in Analog Synthesizers
Presented by Ray Wilson of MFOS

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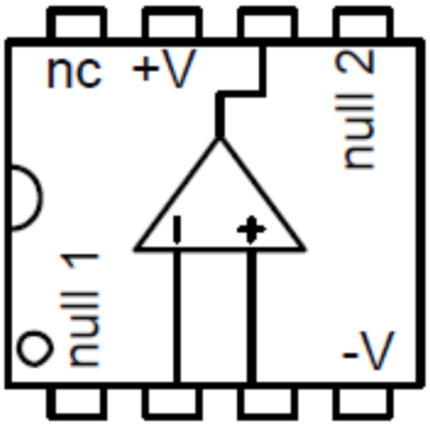
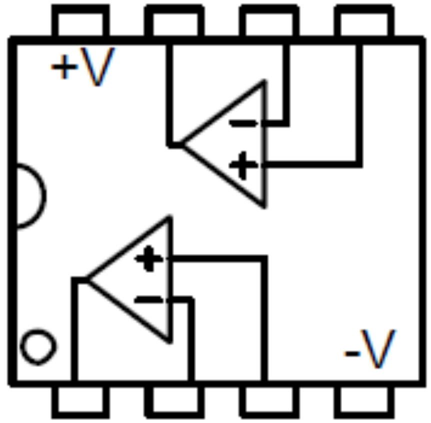
- Integrator
- Battery Power
- Active Lowpass, Highpass, and Bandpass Filters
- Online Filter Calculators You Should Know About

Basic TL07X Information

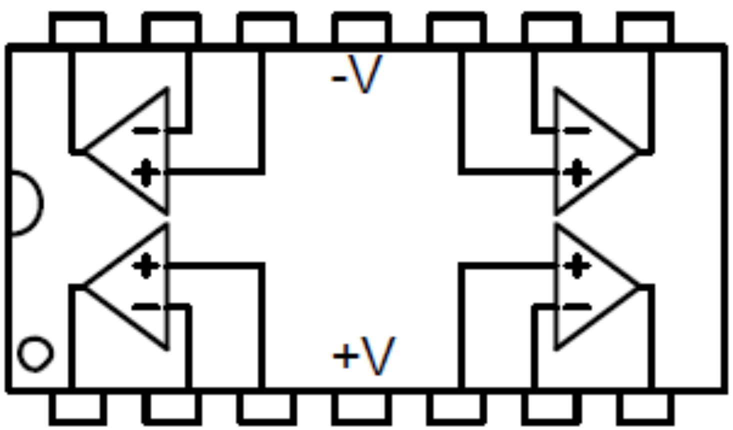
TL071CP



TL072CP



TL074CN



Read the data sheet for full details.

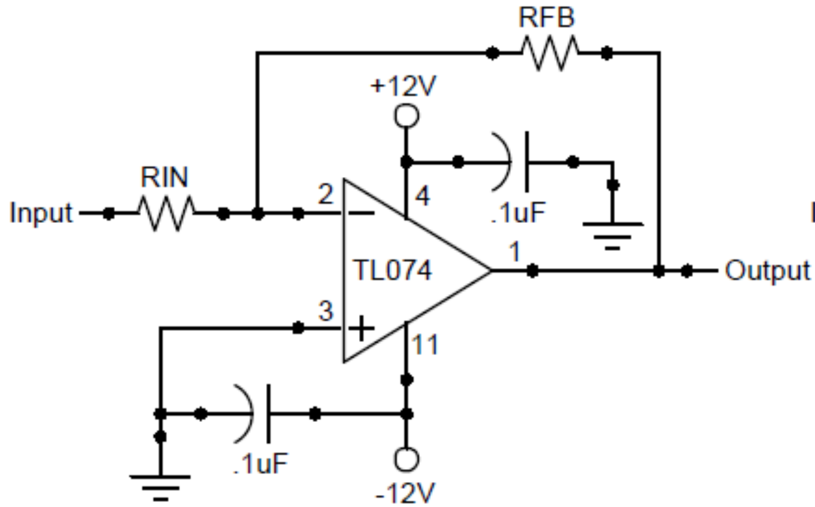
Maximum Supply V: +/-18V
Minimum Supply V: +/-3V
Maximum Input V: +/-15V
Unity GBW = 3MHz.
Current per amp ≈ 2mA.
High input impedance (10^{12} ohm)

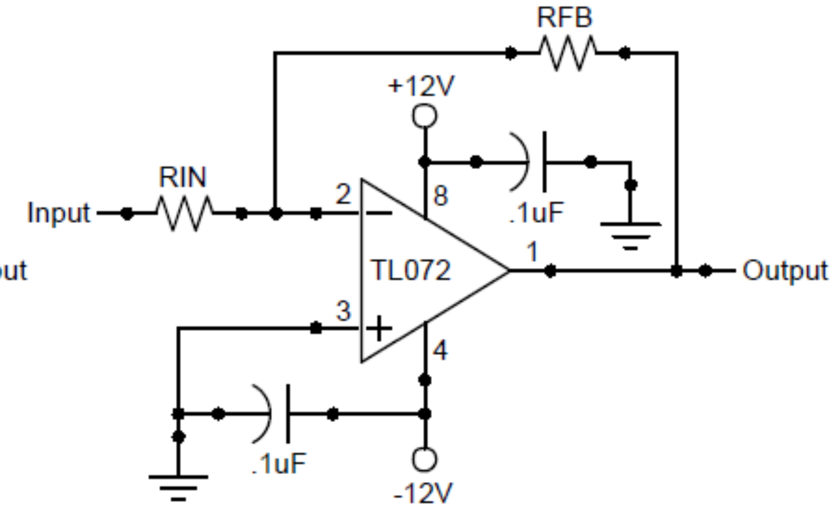
Output voltage swing with supply
+/-9V ≈ +/-7V
+/-12V ≈ +/-10V
+/-15V ≈ +/-13.5V

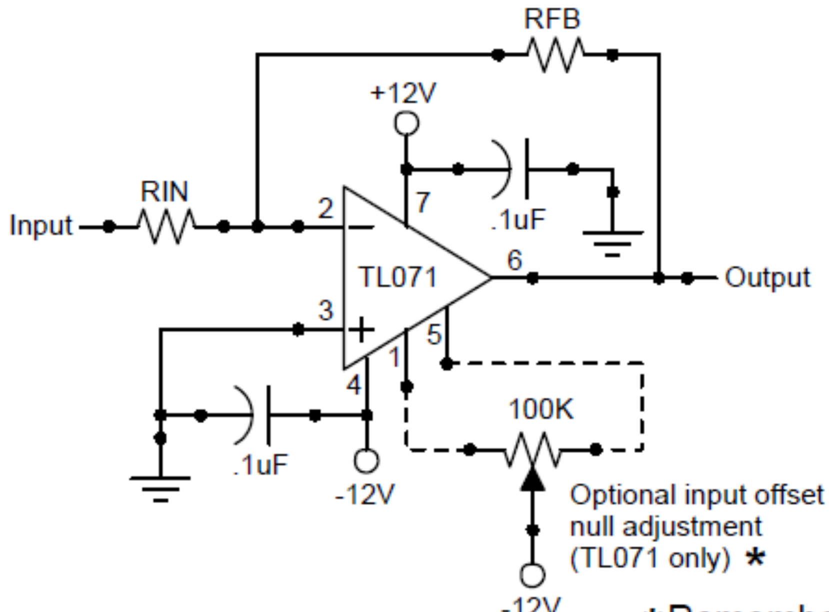
Keep output load resistance above 2K for best audio results.

ALWAYS bypass the package with 0.1uF ceramic caps close to the power pins.

Inverting Gain







Inverting Gain Formula

$$\text{Voltage Gain} = -1\left(\frac{RFB}{RIN}\right)$$

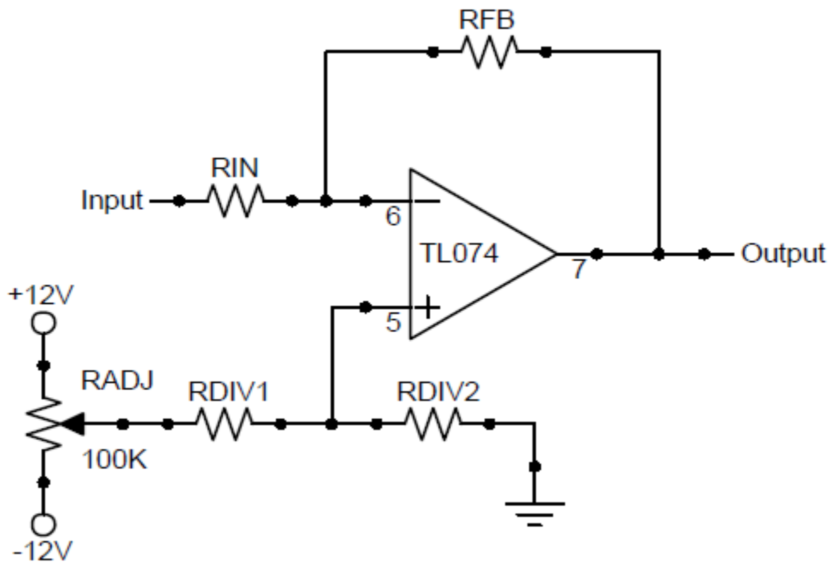
Examples:
RIN = 10K, RFB = 100K, Gain = -10
RIN = 20K, RFB = 20K, Gain = -1
RIN = 100K, RFB = 2K, Gain = -.02

*Remember - Input offset voltage gets amplified too!

Offset Adjust or Biasing an Inverting Op Amp

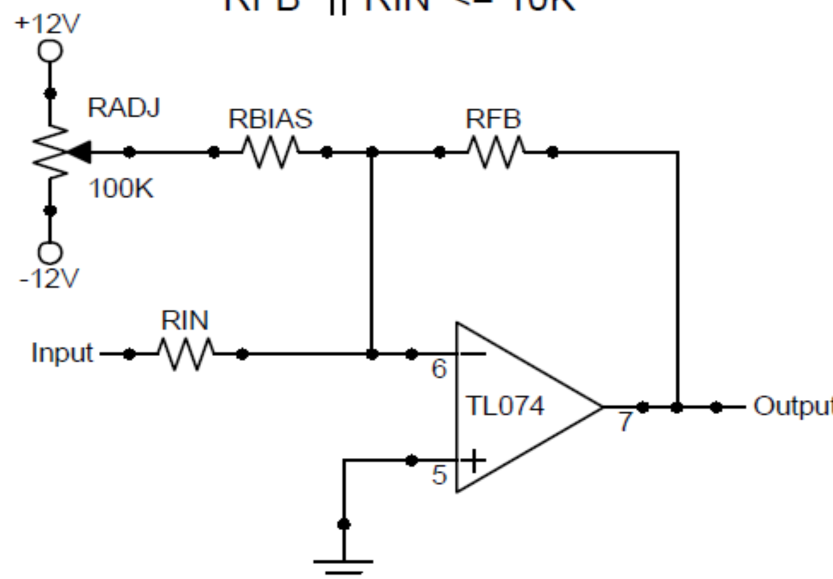
For more information see: National Semiconductor LINEAR APPLICATIONS HANDBOOK
Linear Brief 9 - “Universal Balancing Techniques”, Aug 1969 by Robert C. Dobkin

$$\text{Range} = \pm V \left(\frac{RDIV2}{RDIV1}\right) \times \text{Gain}$$



$$\text{Range} = \pm V \left(\frac{RFB \parallel RIN}{RBIAS}\right)$$

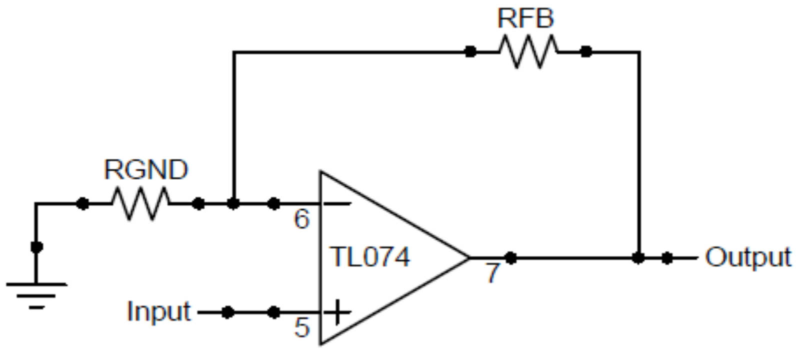
$$RFB \parallel RIN <= 10K$$



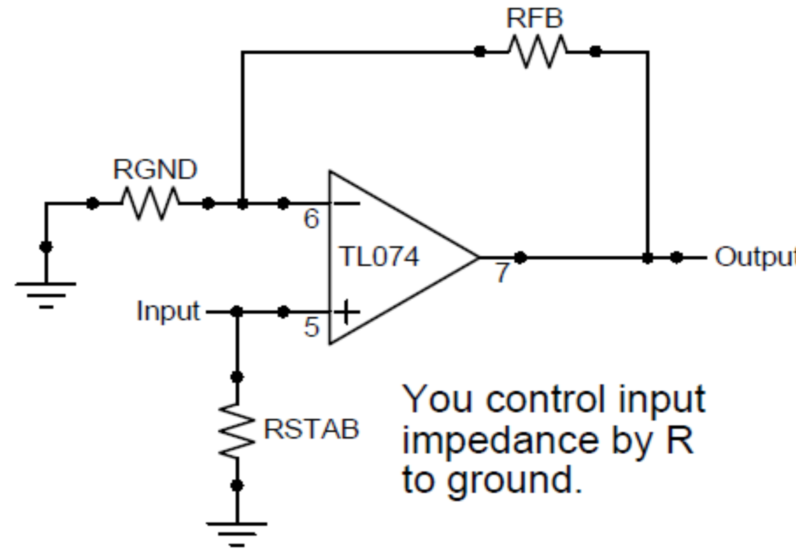
The gain supplied by the op amp’s inverting feedback configuration will multiply the bias voltage applied to the non-inverting input so for high gain scenarios make RDIV1 high in relation to RDIV2.

RBIAS should be selected based on the range of adjustment needed. Higher values of RBIAS will result in a smaller range of adjustment and vice versa.

Non-Inverting Gain



Highest impedance condition with no resistor to ground.



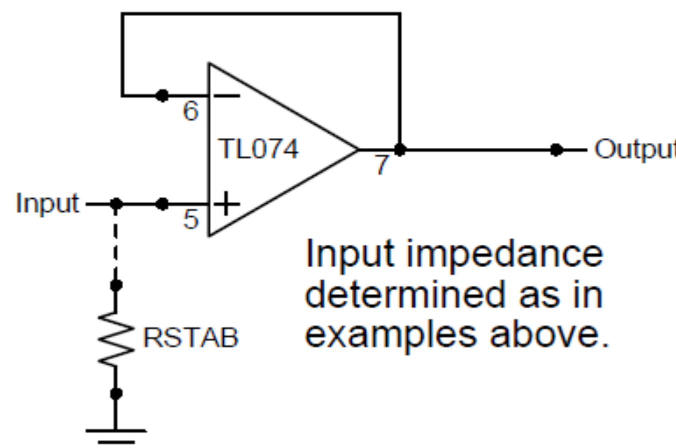
You control input impedance by R to ground.

Non-inverting Gain Formula

$$\text{Voltage Gain} = \left(\frac{RFB}{RGND}\right) + 1$$

Examples:
RGND = 10K, RFB = 100K, Gain = 11
RGND = 20K, RFB = 20K, Gain = 2
RGND = 100K, RFB = 2K, Gain = 1.02

Unity Gain Follower



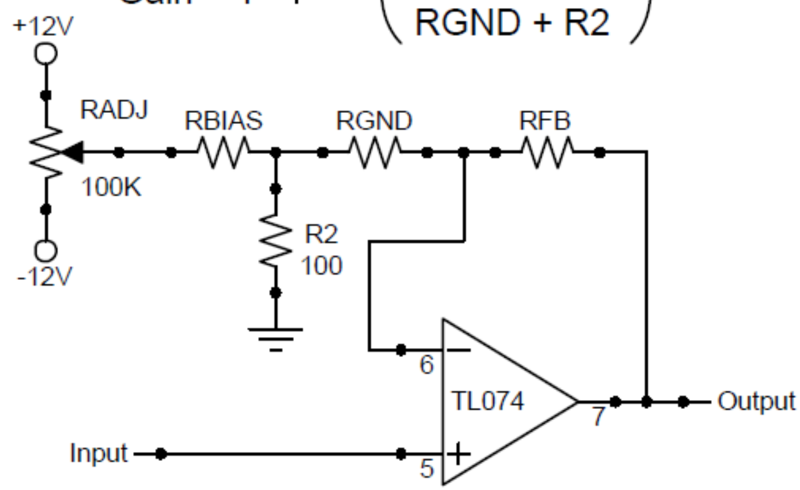
Input impedance determined as in examples above.

Offset Adjust or Biasing a Non-inverting Op Amp

For more information see: National Semiconductor LINEAR APPLICATIONS HANDBOOK
Linear Brief 9 - “Universal Balancing Techniques”, Aug 1969 by Robert C. Dobkin

$$\text{Range} = \pm V \left(\frac{R2}{RBIAS} \right) \times \text{Gain}$$

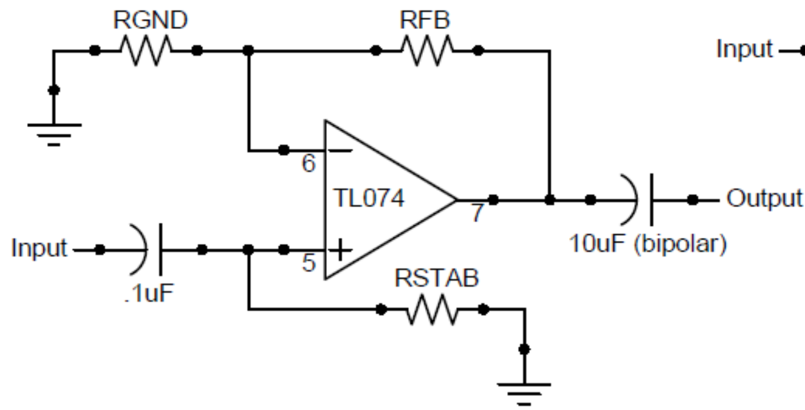
$$\text{Gain} = 1 + \left(\frac{RFB}{RGND + R2} \right)$$



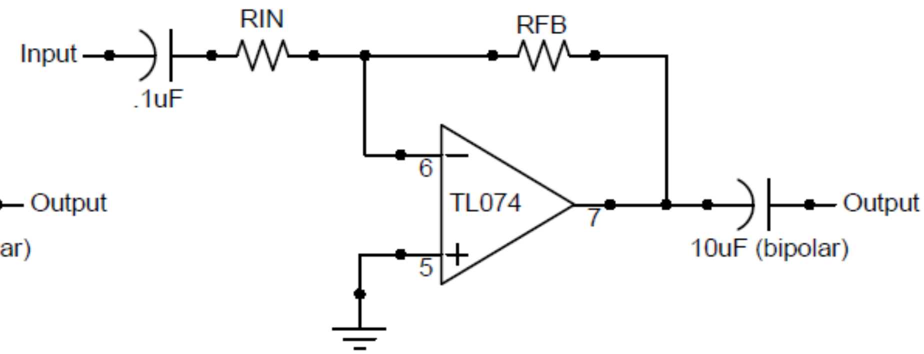
RBIAS should be selected based on the range of adjustment needed. Higher values of RBIAS will result in a smaller range of adjustment and vice versa. Again note that the offset voltage appears at the output multiplied by the op amp’s gain.

Input/Output Coupling AC vs. DC

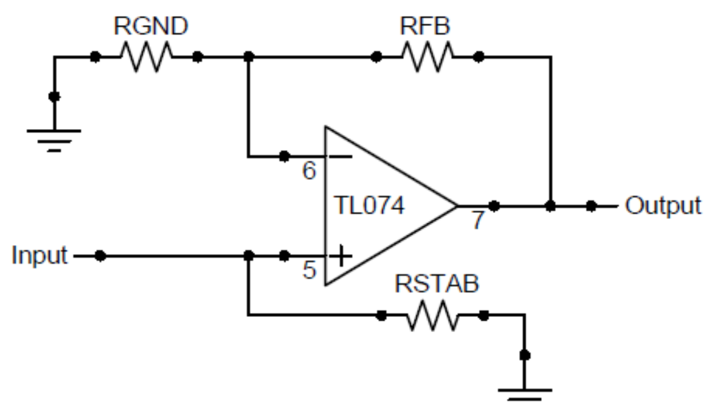
Non-inverting Configuration AC Coupled.



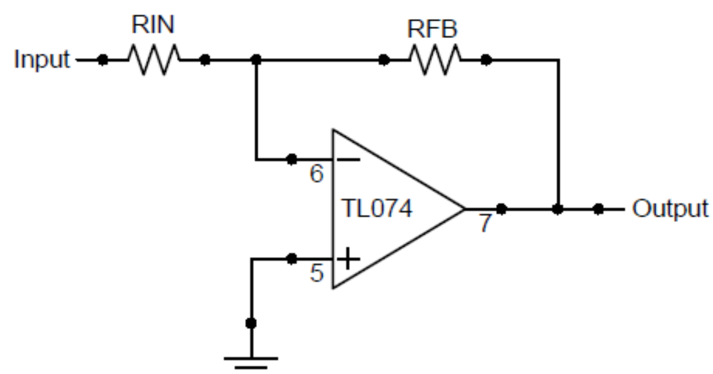
Inverting Configuration AC Coupled.



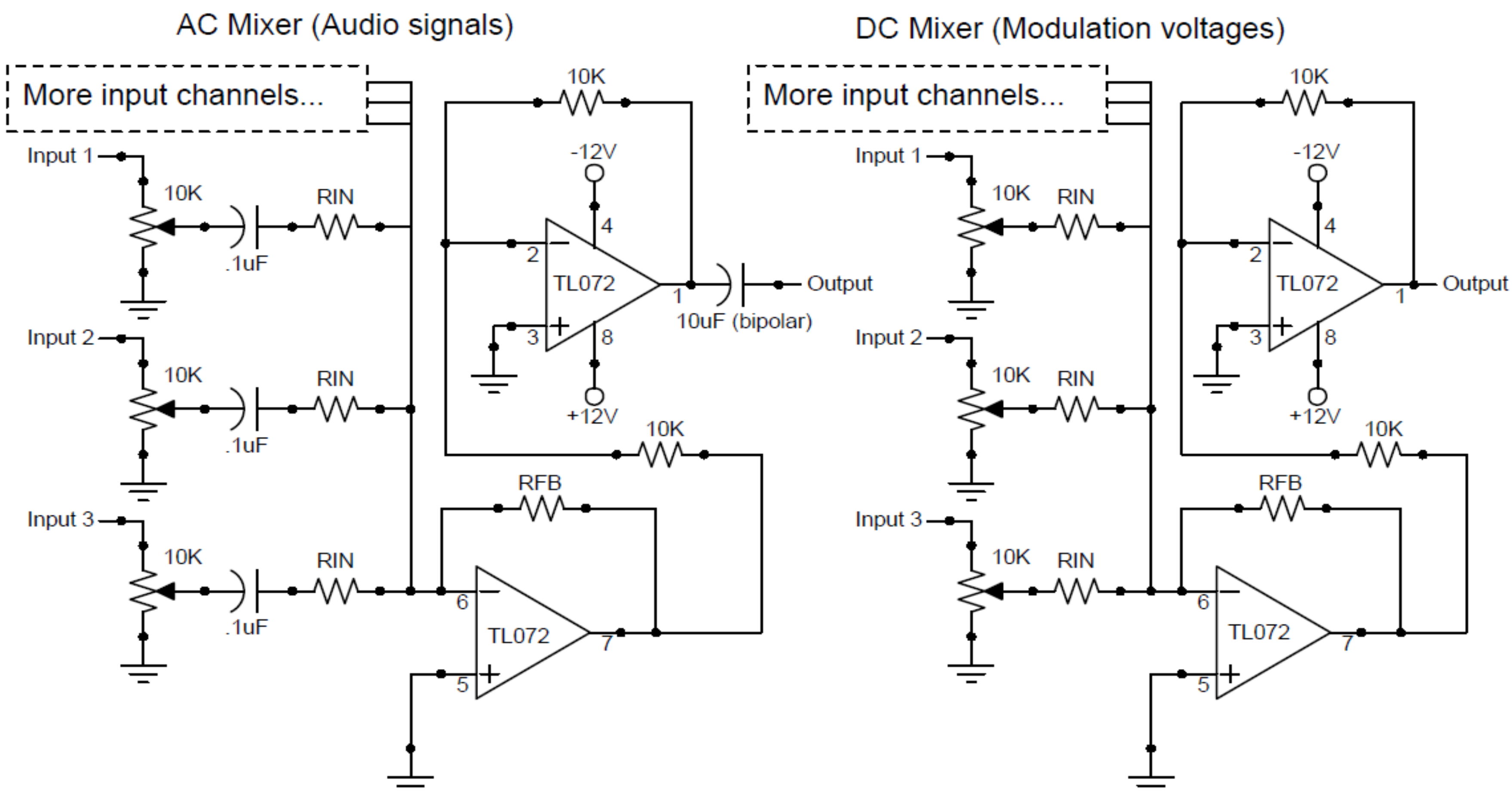
Non-inverting Configuration DC Coupled.



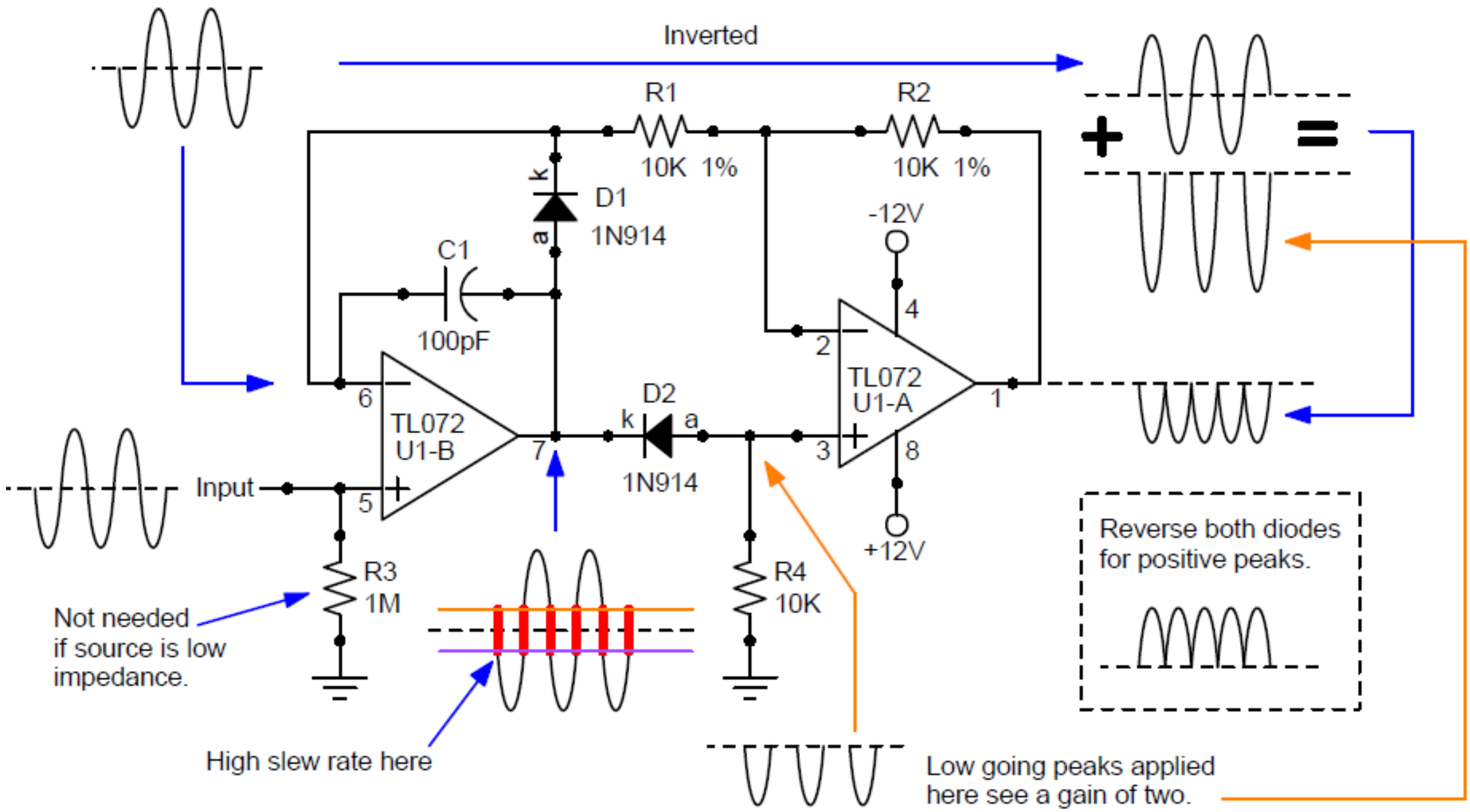
Inverting Configuration DC Coupled.



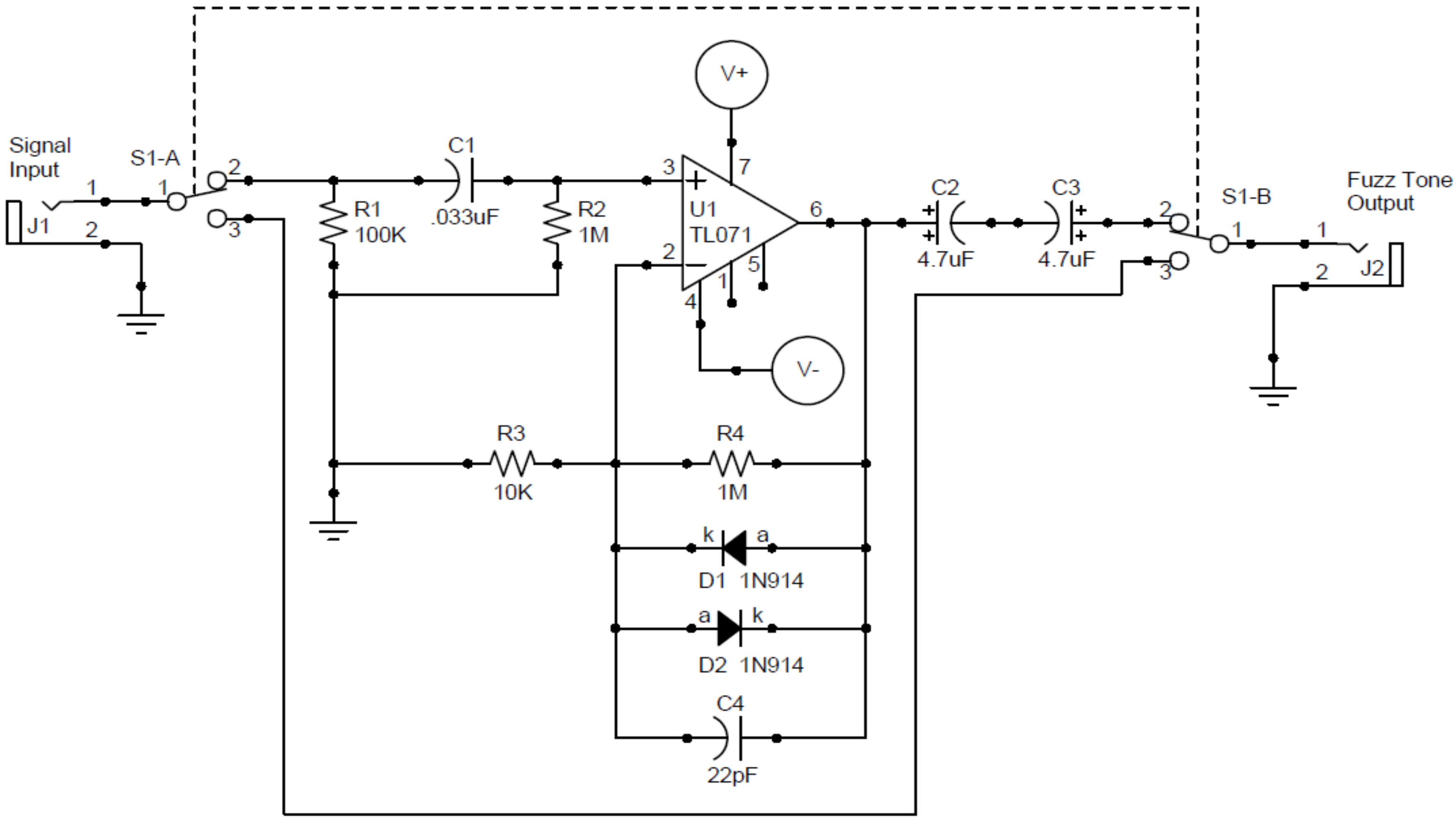
AC Mixer vs. DC Mixer



Active - Precision Full Wave Rectifier



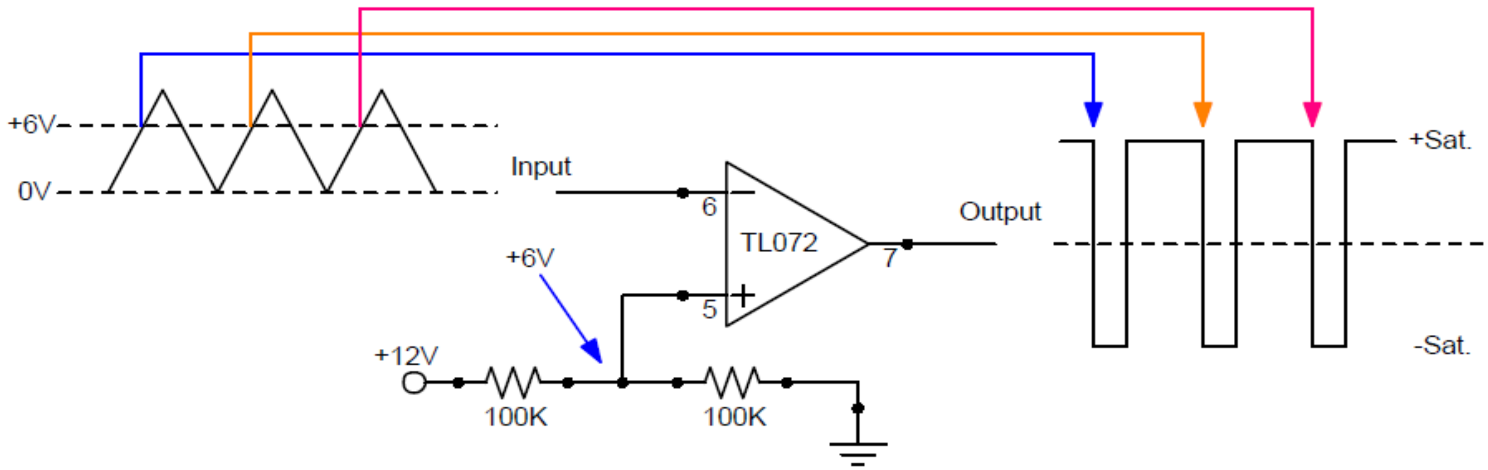
Fuzz Tone



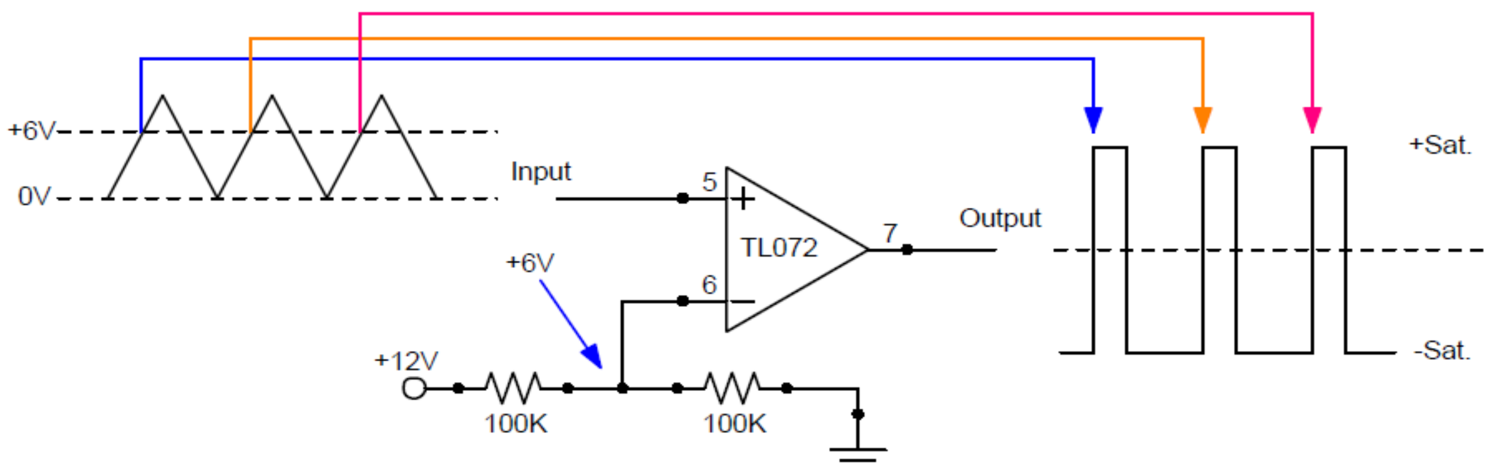
Signal Input
J1
1
2
S1-A
1
2
3
C1
.033uF
R1
100K
R2
1M
3
7
U1
TL071
6
2
5
1
4
V+
V-
C2
4.7uF
C3
4.7uF
S1-B
Fuzz Tone Output
J2
R3
10K
R4
1M
k
a
D1 1N914
D2 1N914
C4
22pF

Comparators

Inverting Comparator

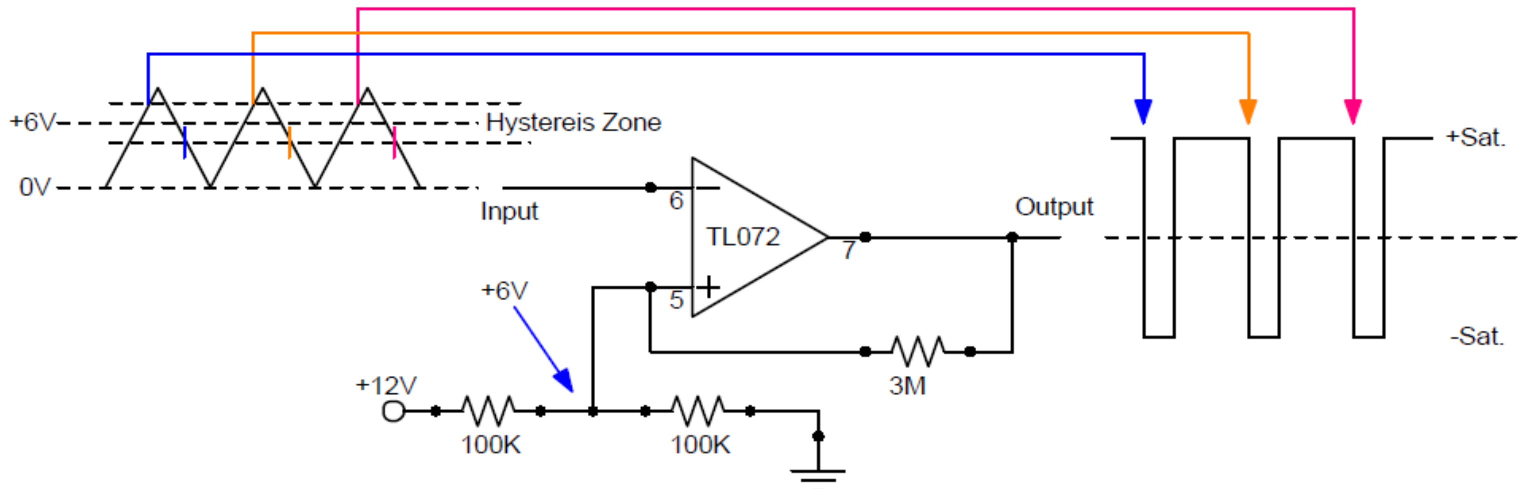


Non-inverting Comparator

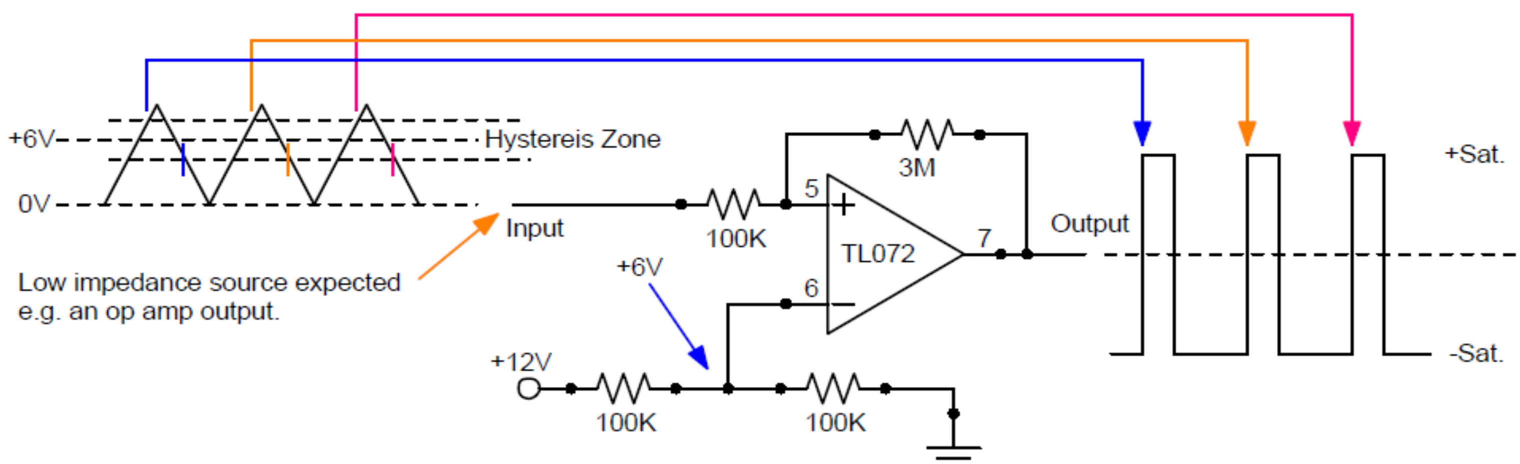


Comparator Hysteresis

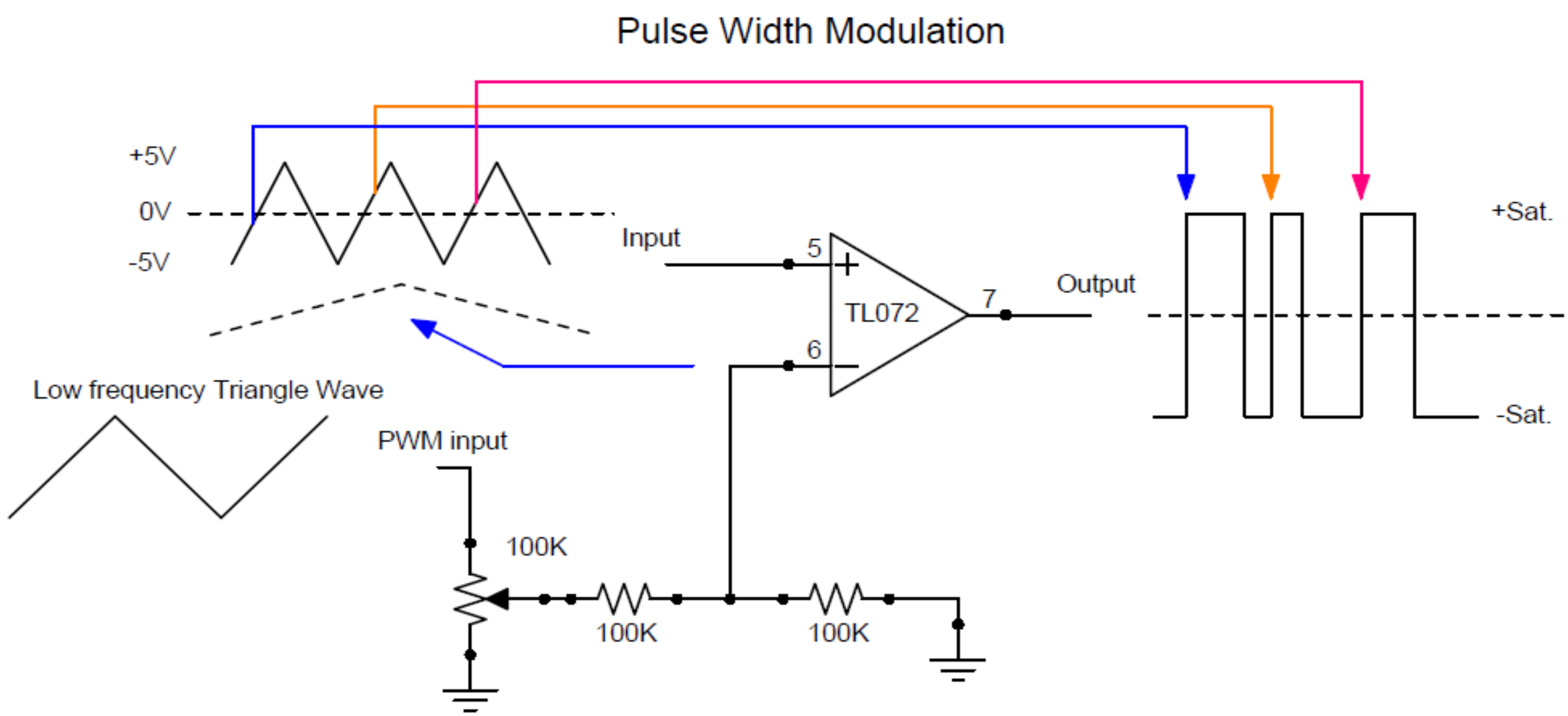
Inverting Comparator With Hysteresis



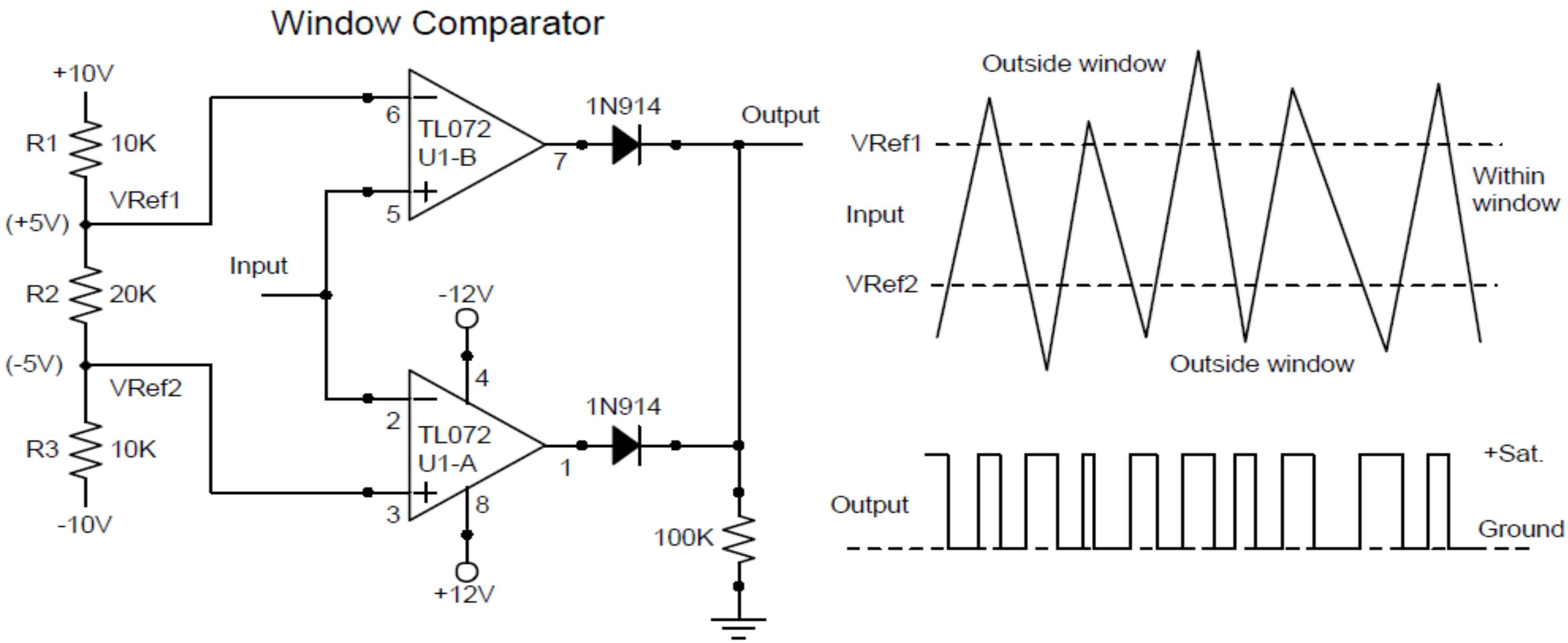
Non-inverting Comparator With Hysteresis



Pulse Width Modulation

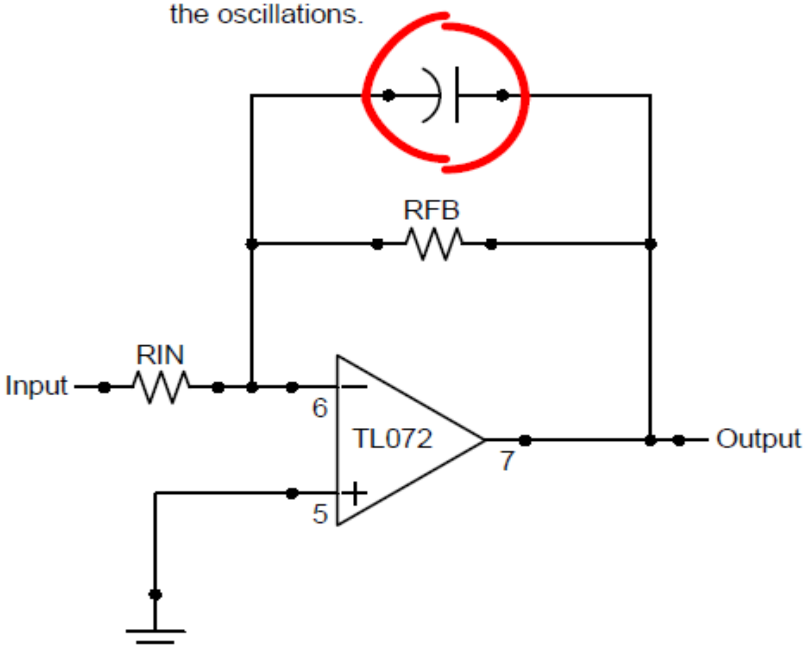


Window Comparator

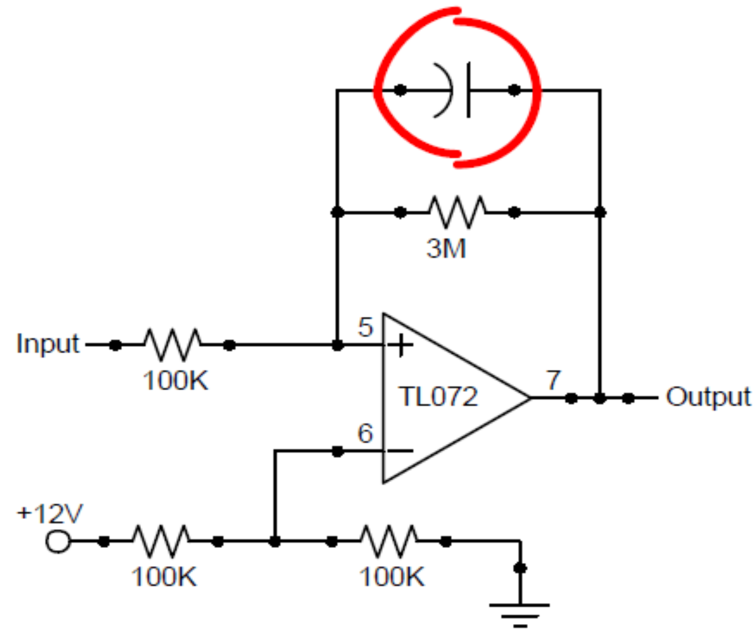


Capacitors to the Rescue

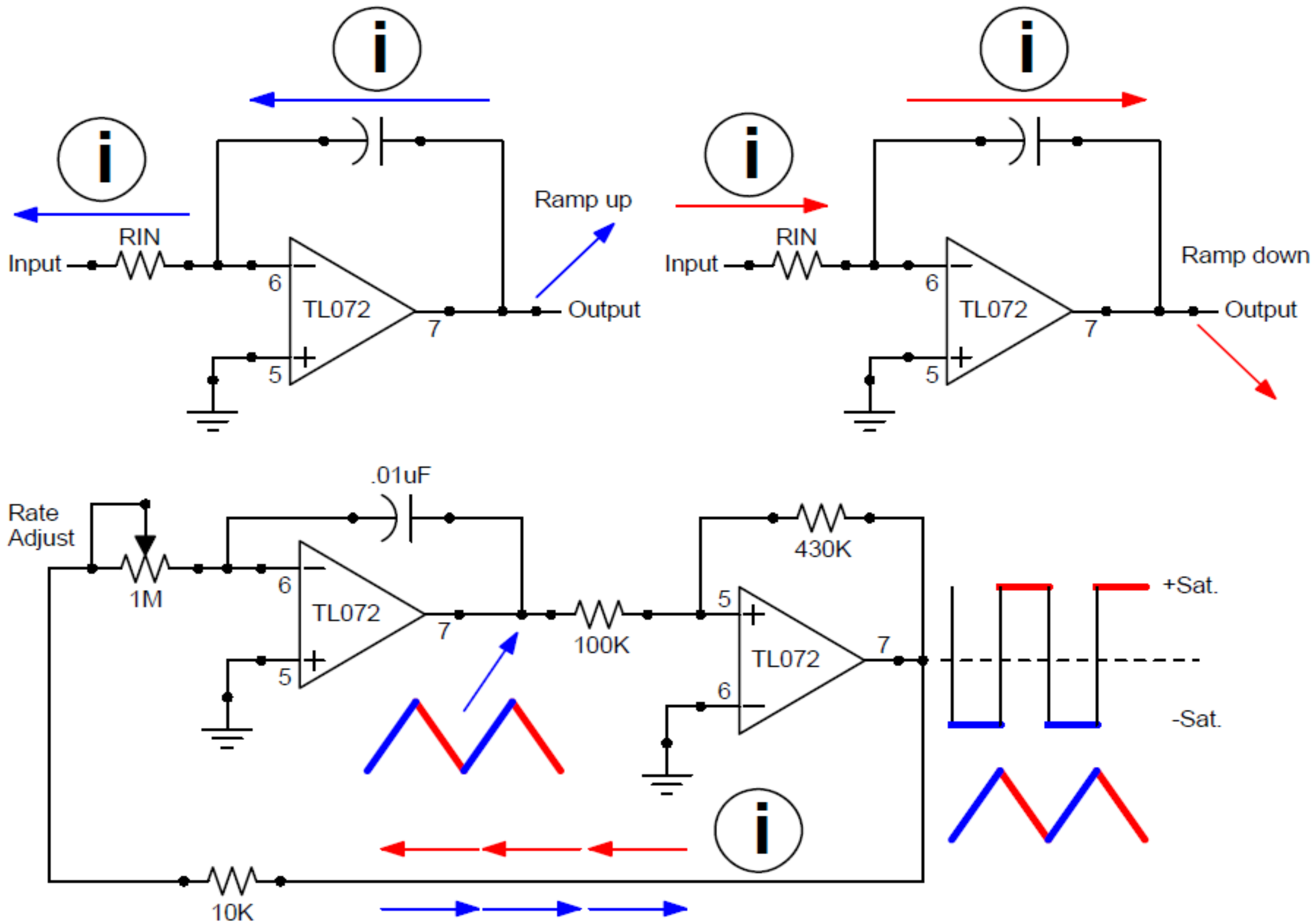
With high gain some op amps may oscillate at a high frequency. Placing a small value cap (10 to 100pF) across the negative feedback resistor can quell the oscillations.



To speed up your comparator's risetime place a small value cap (10 to 100pF) across the positive feedback resistor.

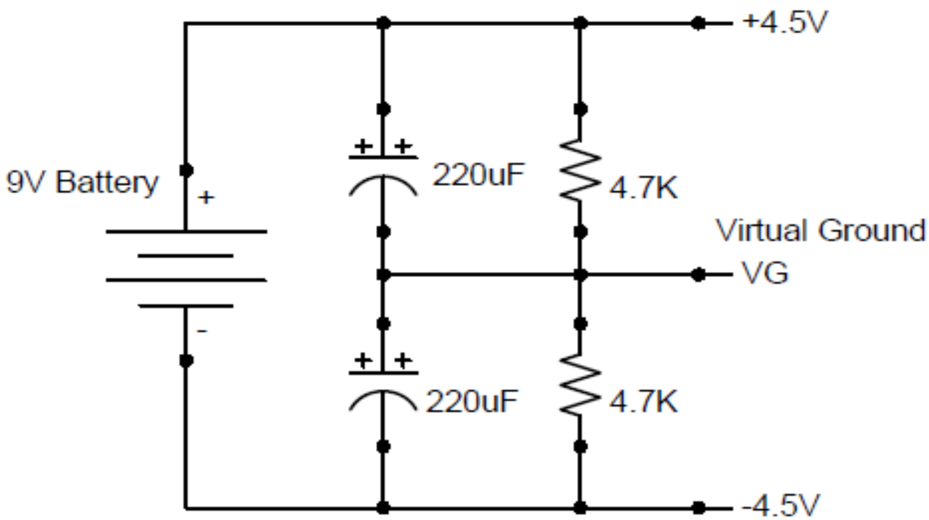


Integrators

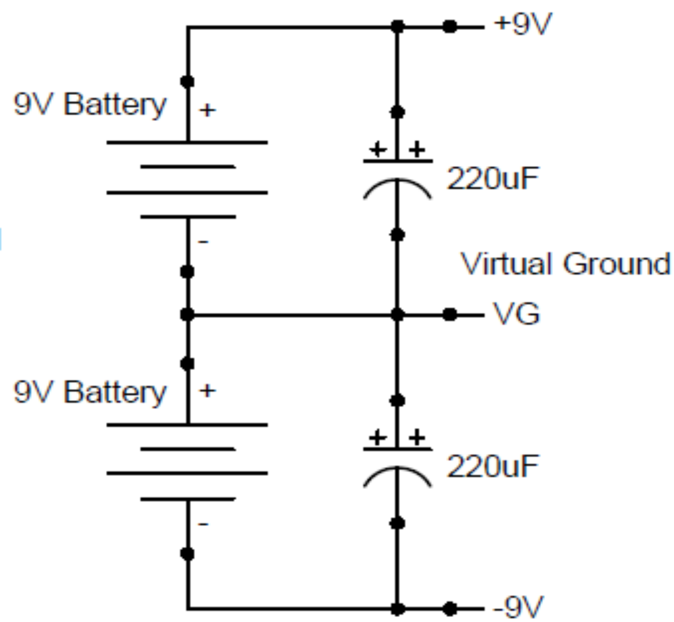


Battery Power

One nine volt battery can be used as a "split" +/-4.5V and virtual ground supply. Low current applications only.

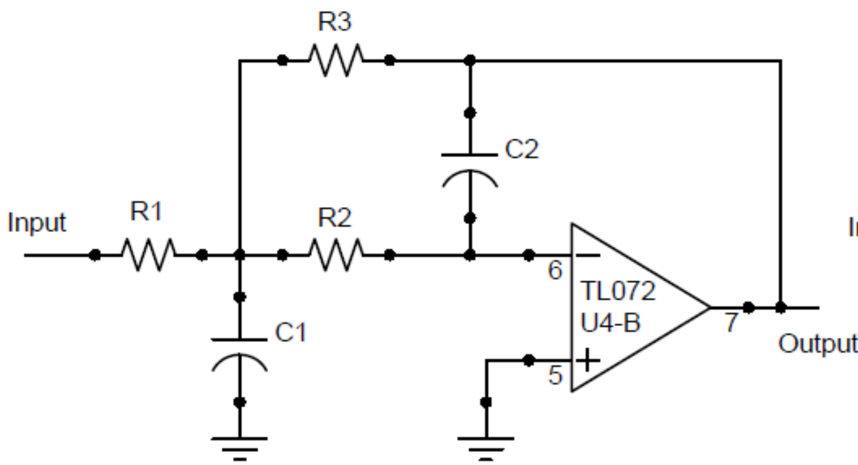


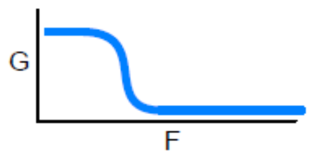
Two nine volt batteries can be used as a "split" +/-9V supply with a much lower impedance virtual ground. Low to medium current applications only.



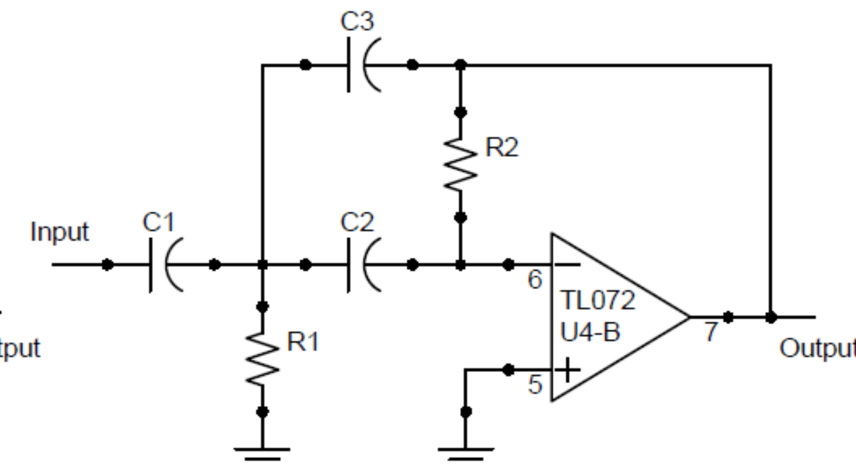
Active Lowpass, Highpass, and Bandpass Filters

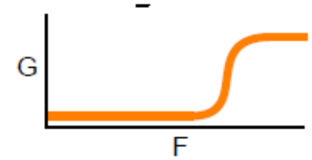
Multiple Feedback Lowpass Filter



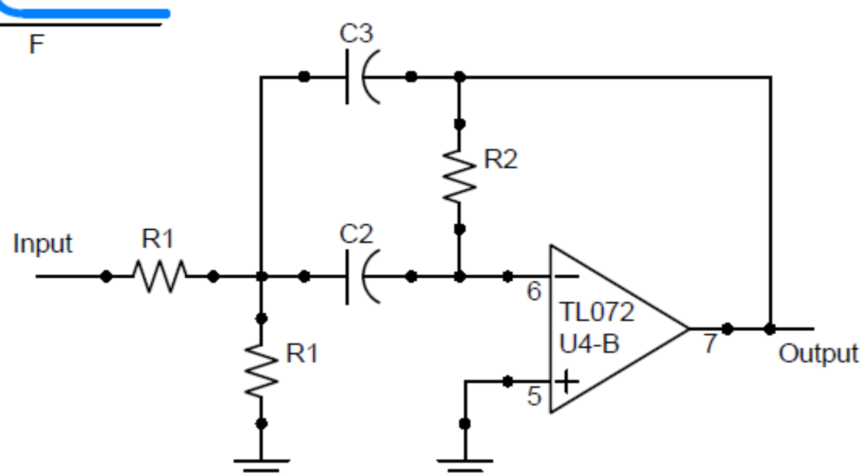


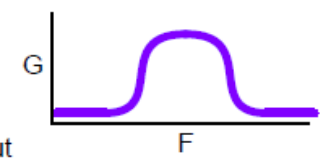
Multiple Feedback Highpass Filter





Multiple Feedback Bandpass Filter





Online Filter Calculators You Should Know About

OKAWA Electric Design - Filter Design and Analysis

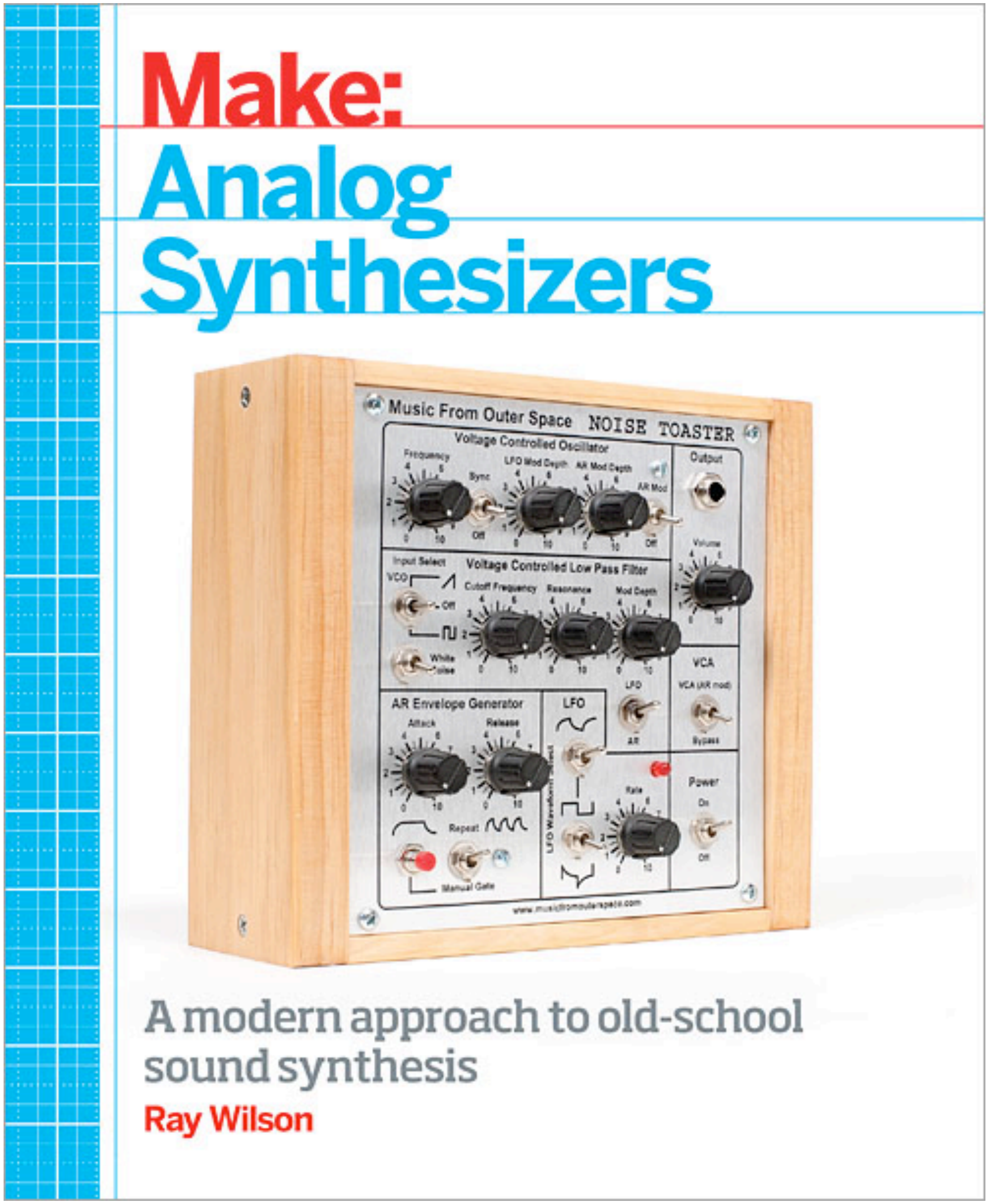
http://sim.okawa-denshi.jp/en/Fkeisan.htm

Texas Instruments FilterPro

http://www.ti.com/tool/filterpro

Texas Instruments WEBENCH Filter Designer

http://www.ti.com/lsds/ti/analog/webench/webench-filters.page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