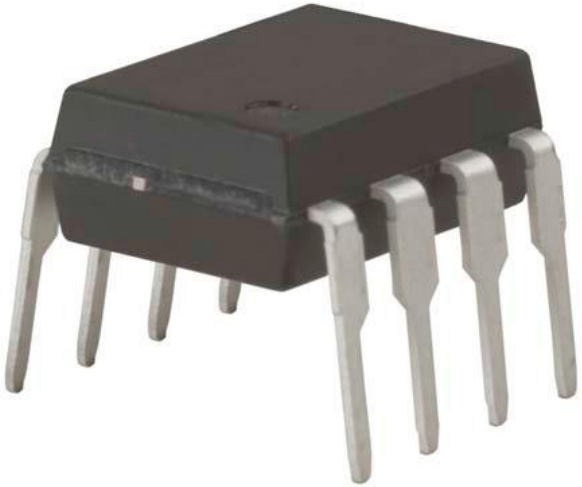
Op Amps & Instrumentation Circuits



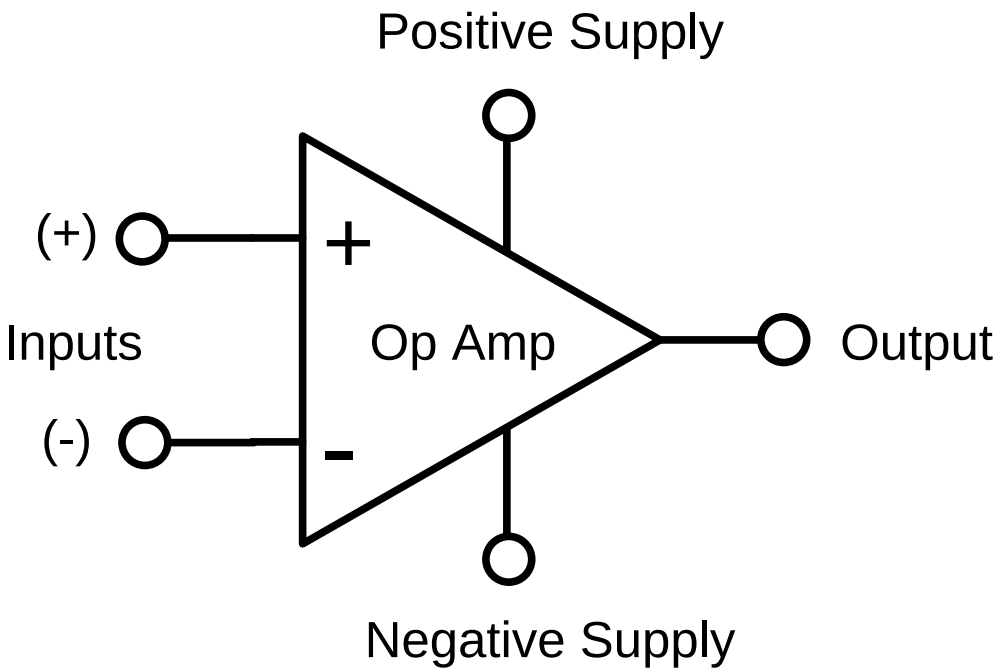
ECE Senior Design

7 February 18

Ideal Op Amp Characteristics

- Infinite Voltage Gain $A_{vo} = \infty$
- Infinite Input Resistance $r_{in} = \infty$
- Zero Output Resistance $r_o = 0$
- Infinite Bandwidth $BW = \infty$
- Zero Input Offset Voltage $V_o = 0$ if $V_{in} = 0$

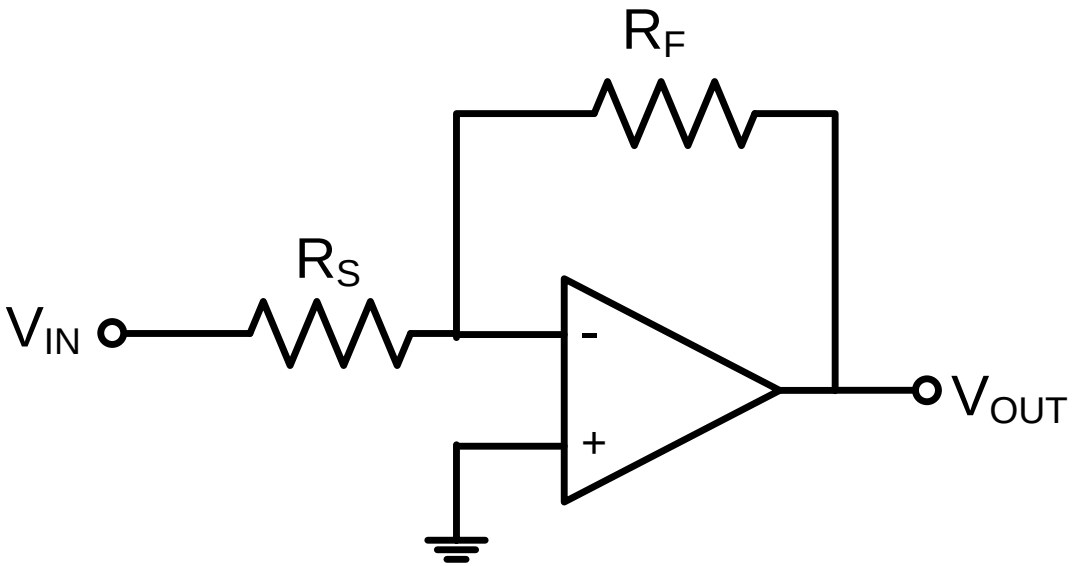
Op Amp Symbol



Op Amp Topologies

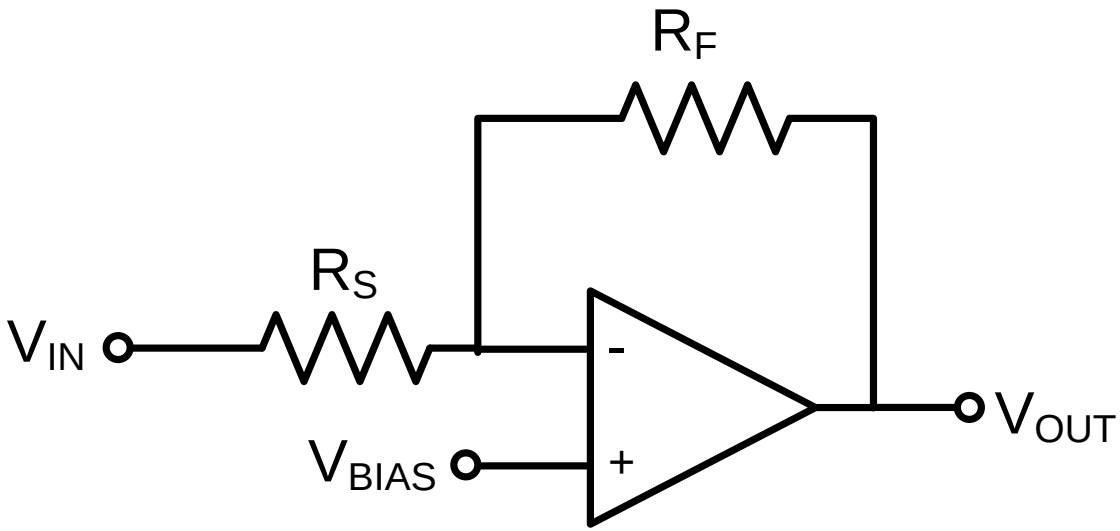
- Inverting Amplifiers
- Non-Inverting Amplifiers
- Differential Amplifiers

Inverting Op Amp



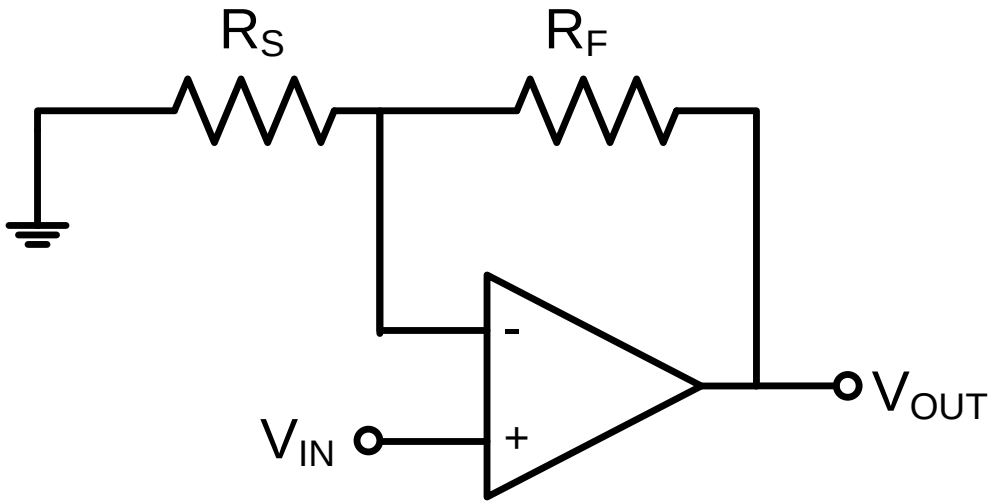
$$\frac{V_{OUT}}{V_{IN}} = \frac{-R_F}{R_S}$$

Inverting Op Amp Single Supply



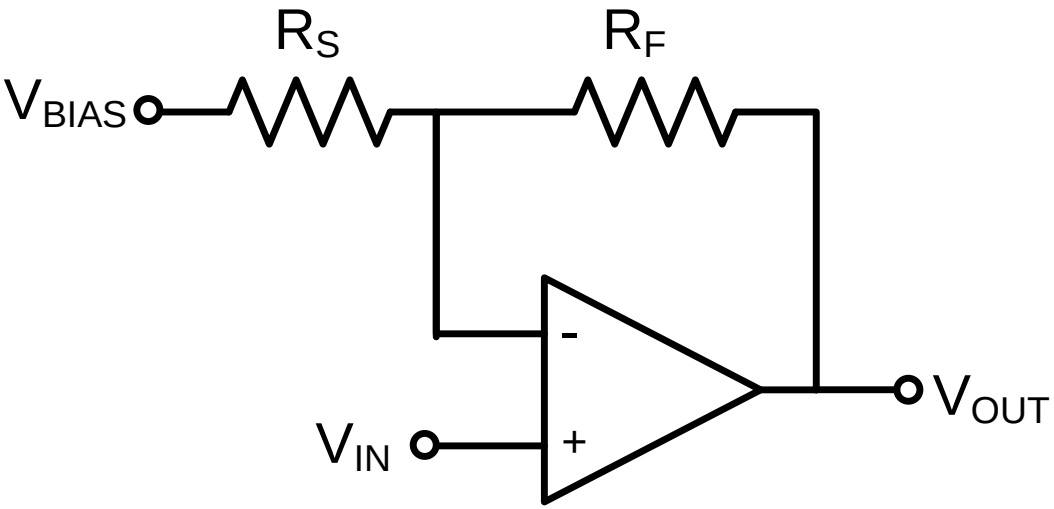
$$\frac{V_{OUT} - V_{BIAS}}{V_{IN} - V_{BIAS}} = \frac{-R_F}{R_S}$$

Non-Inverting Op Amp



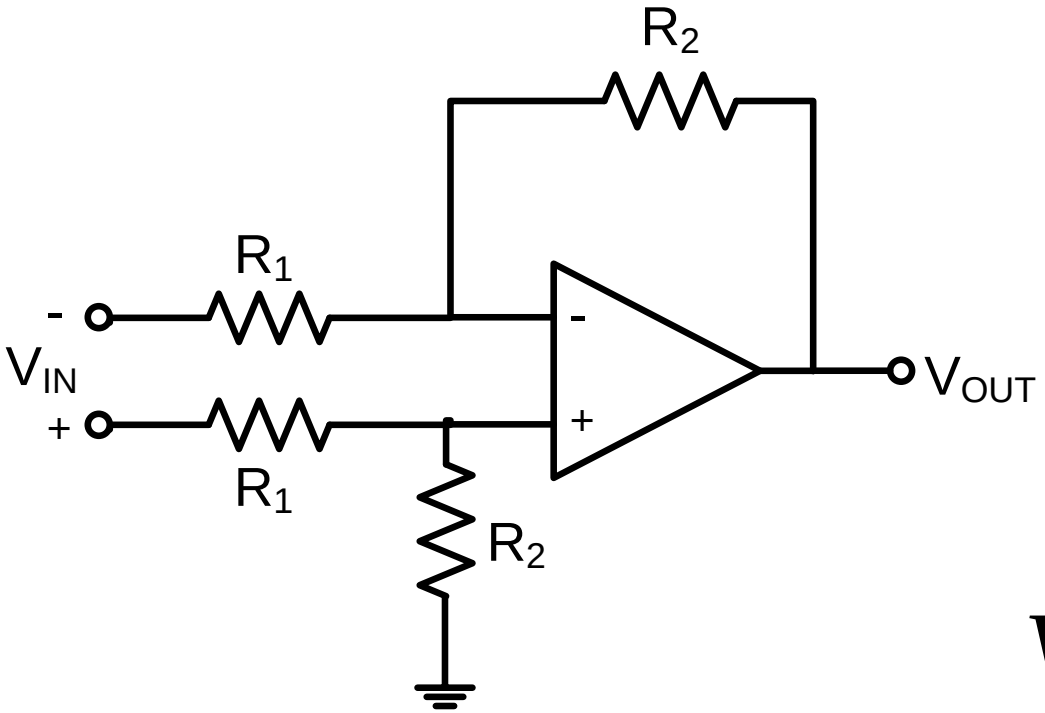
$$\frac{V_{OUT}}{V_{IN}} = 1 + \frac{R_F}{R_S}$$

Non-Inverting Op Amp Single Supply



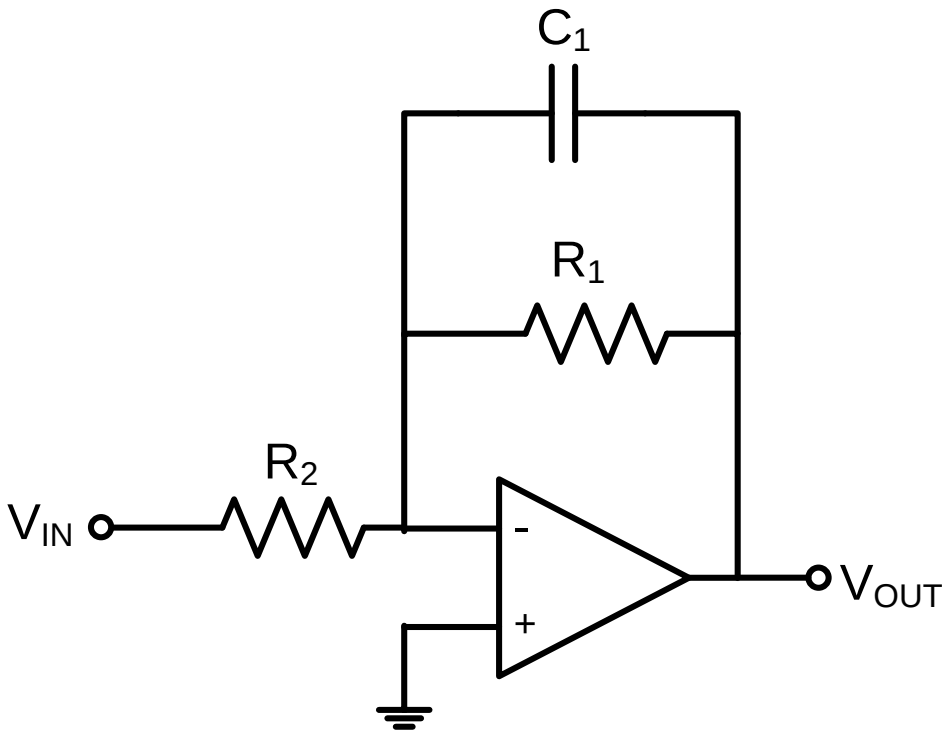
$$V_{OUT} = V_{IN} + \frac{(V_{IN} - V_{BIAS})R_F}{R_S}$$

Difference Amplifier



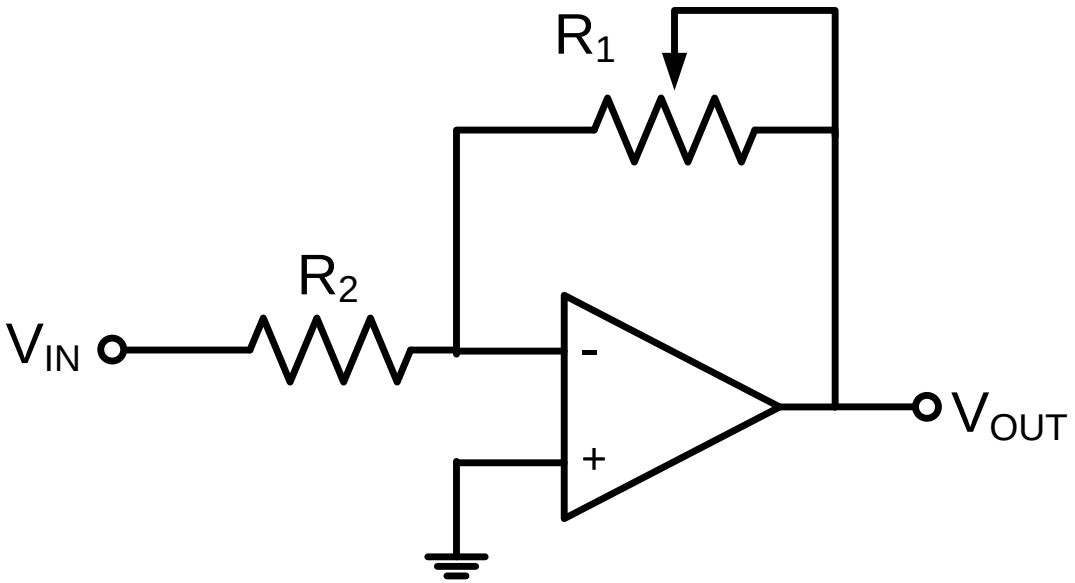
$$\frac{V_{OUT}}{V_{IN}} = \frac{R_2}{R_1}$$

Op Amps in Active Filters

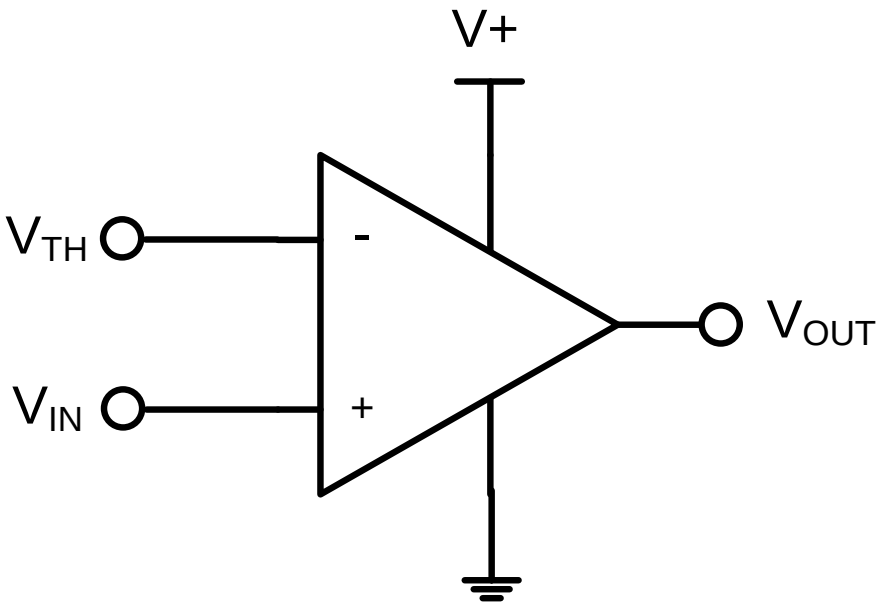


$$f_C = \frac{1}{2\pi(R_1 C_1)}$$

Adjusting Gain



Op Amp as a Comparator



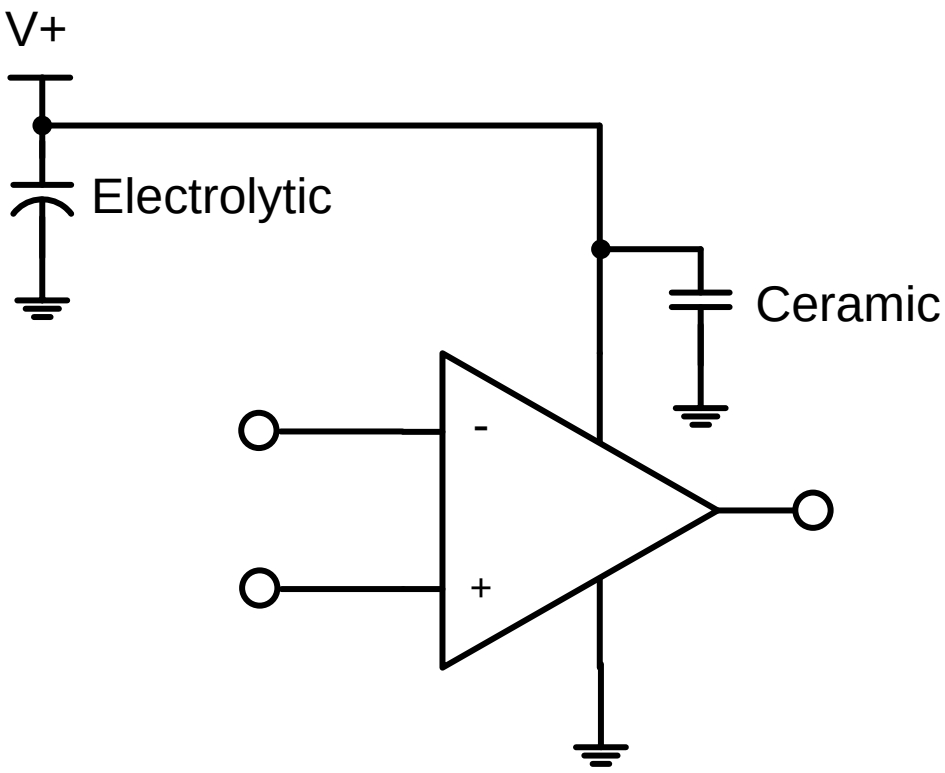
IF ($V_{IN} > V_{TH}$)

Then $V_{OUT} = V+$

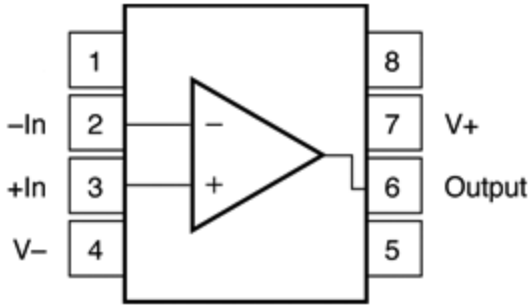
Else

$V_{OUT} = GND$

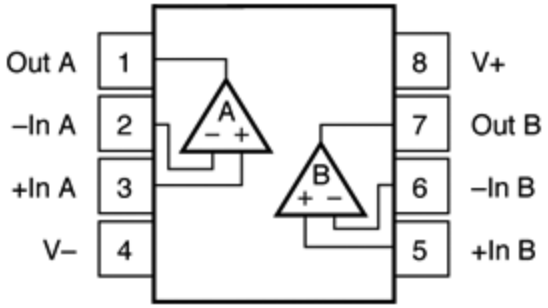
Power Supply Decoupling



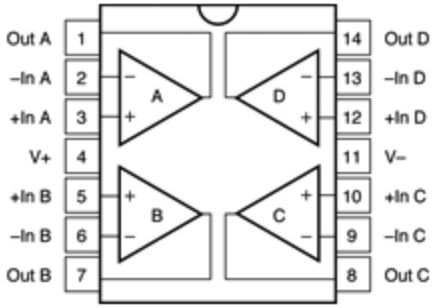
Common Op Amp Packages



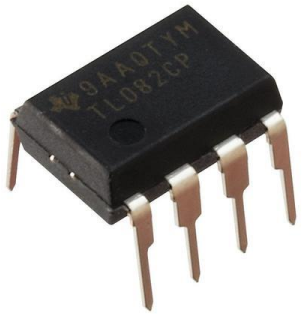
Single

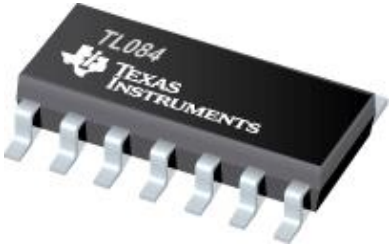


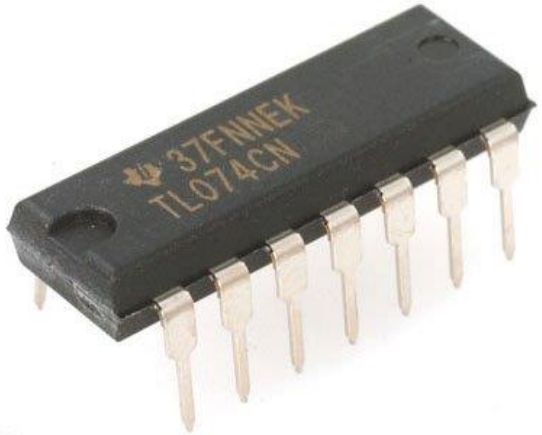
Dual



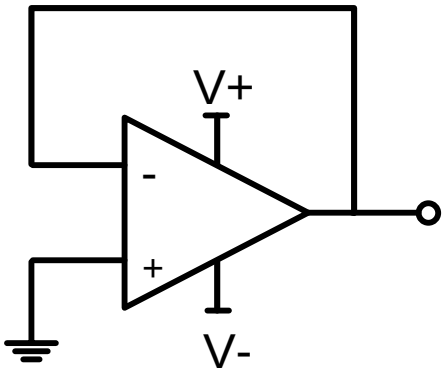
Quad



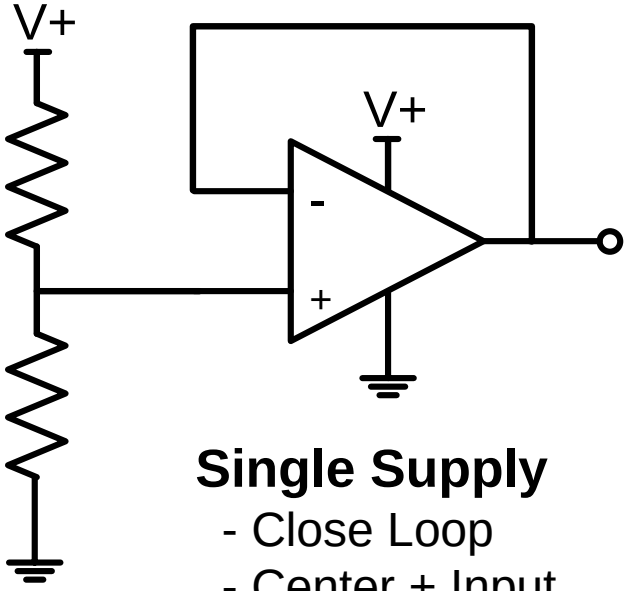




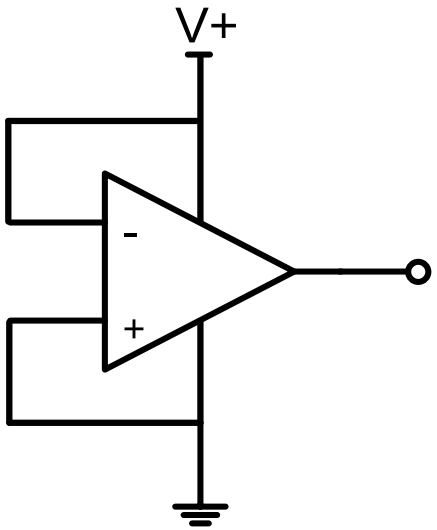
Terminating Unused Op Amps



Bi-Polar Supply
- Close Loop
- Gnd + Input

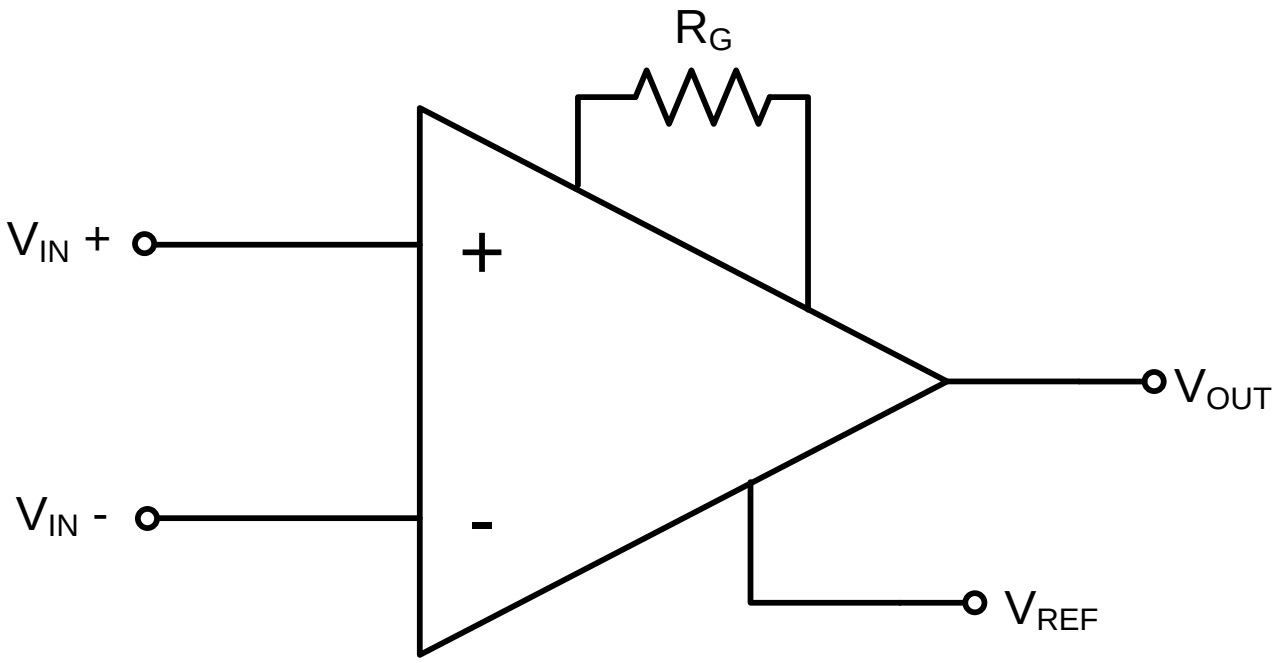


Single Supply
- Close Loop
- Center + Input

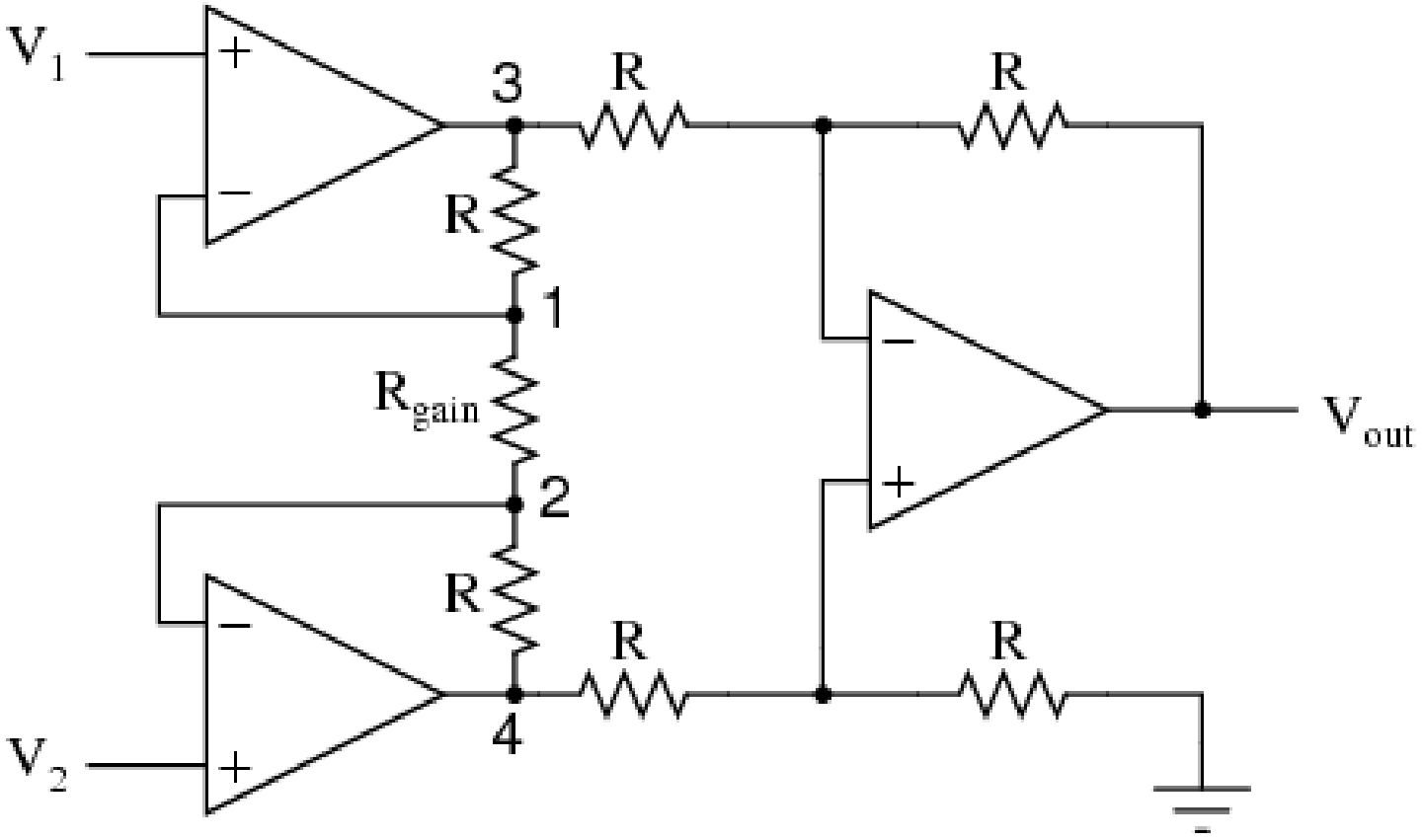


Comparator
- Tie Inputs to Rails

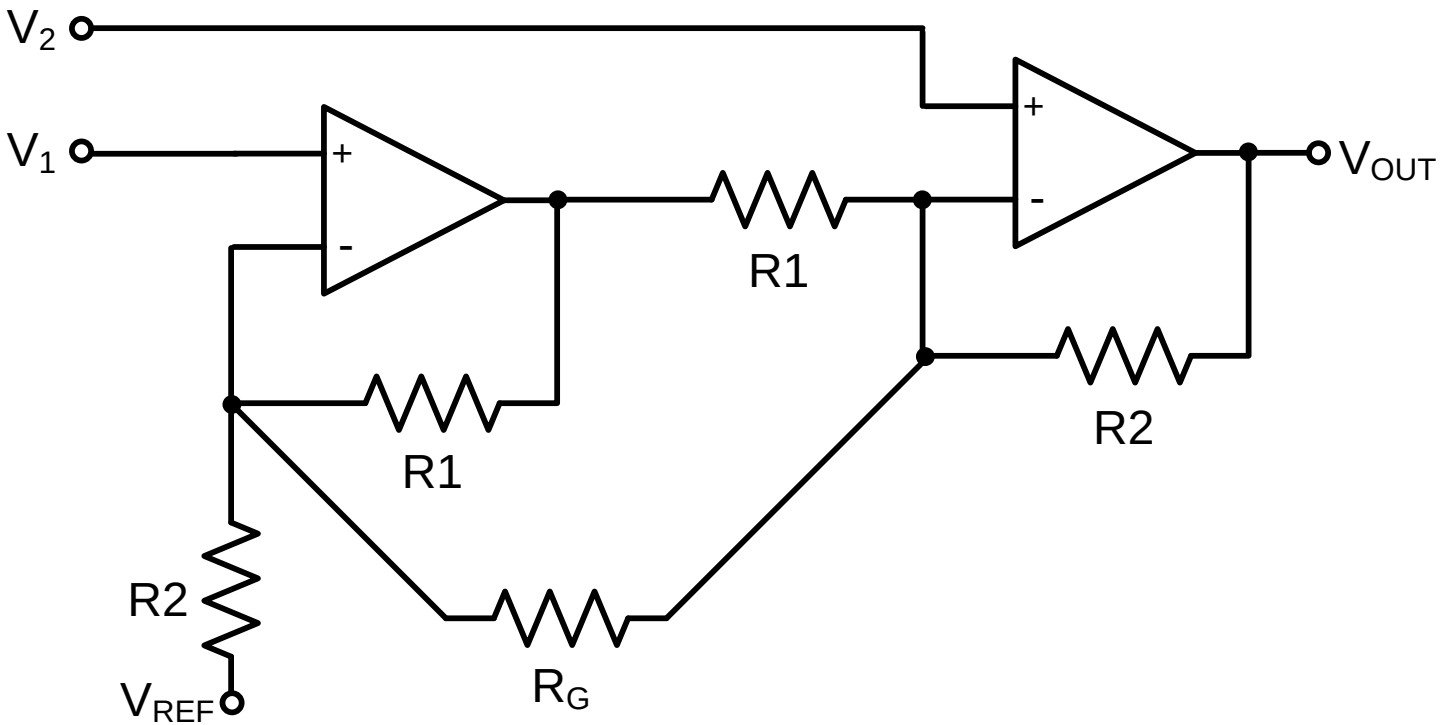
Instrumentation Amplifiers



Three-Op-Amp In Amp



Two-Op-Amp In Amp



MCP602 - Single Supply Op Amp

Rail to Rail Low Power Cost ≈ $0.50

TSSOP

SOIC

PDIP

Vos Max ……2000 µV

Iq Typical …… 230 µA

Iq Max …… 325 µA

GBWP ……2800 kHz

Operating Voltage Range ……..... 2.7 to 6.0 V

Input Voltage Noise Density ……..… 29 nV/rt(Hz)

PSRR Min ……80 dB

CMRR Min ……75 dB