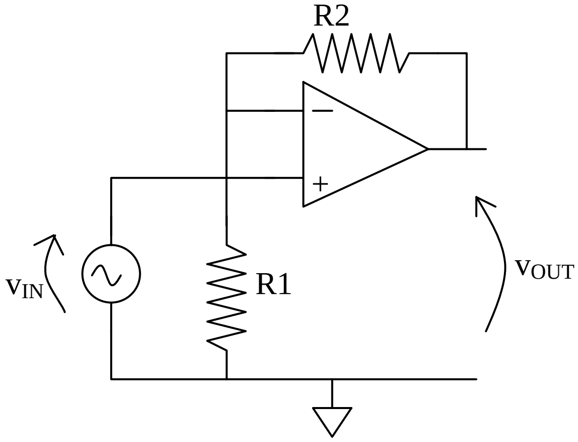
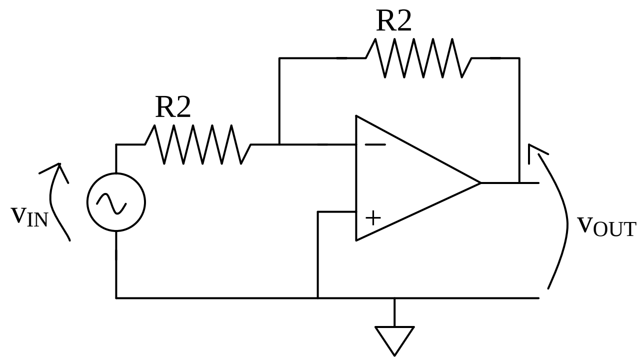
Some Basic Operational Amplifier Circuits Derived from an Ideal Model





Non-inverting Gain Block

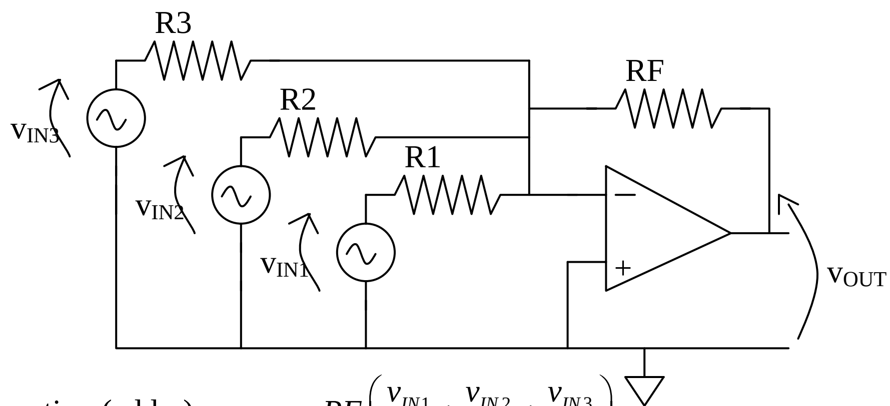
DC Gain: $G_0 = 1 + \frac{R2}{R1}$

Bandwidth: $f_C = f_{GBW} / G_0$

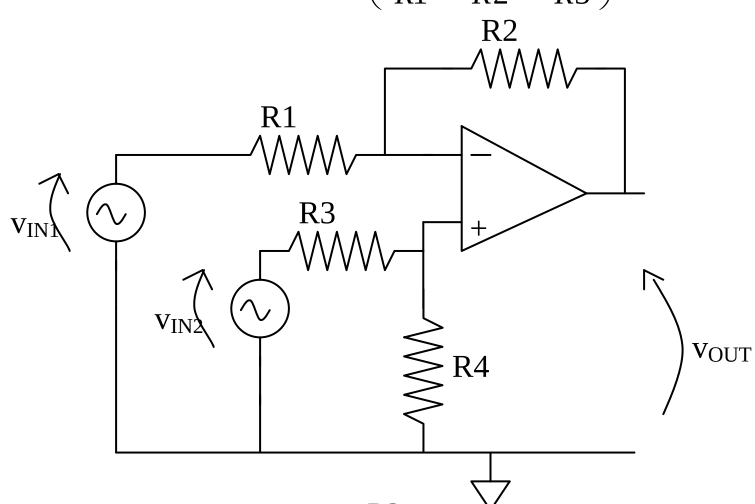
Inverting Gain Block

DC Gain: $G_0 = -\frac{R2}{R1}$

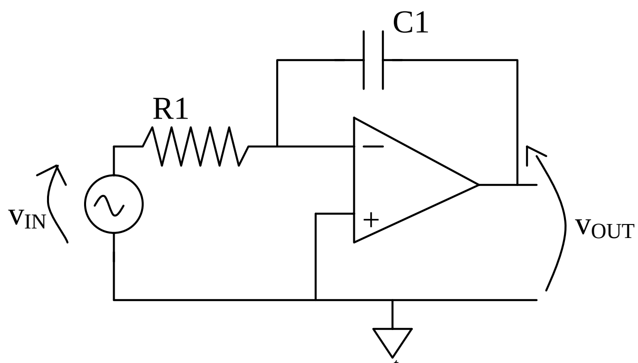
Bandwidth: $f_C = f_{GBW} / \left(1 + G_0\right)$

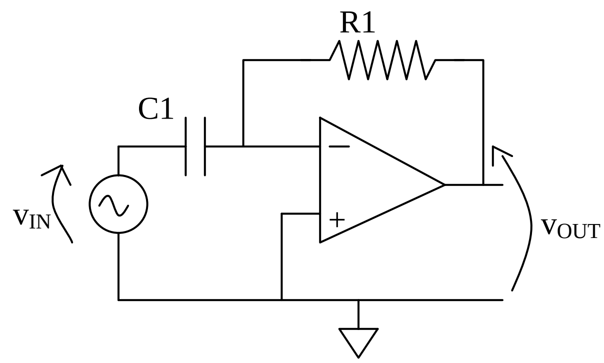


Weighted summation (adder): $v_{OUT} = -RF\left(\frac{v_{IN1}}{R1} + \frac{v_{IN2}}{R2} + \frac{v_{IN3}}{R3}\right)$



Difference amplifier (subtraction): $v_{OUT} = \frac{R2}{R1}\left(v_{IN2} - v_{IN1}\right)$ if $R1 \cdot R4 = R2 \cdot R3$ The accuracy of this differential amplifier is limited by resistor tolerances, temperature effects, and op-amp performance. More complicated circuits using multiple op-amps can do better.





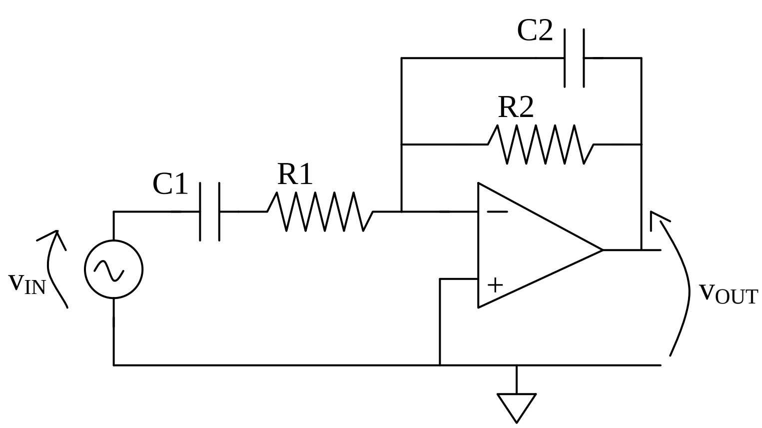
Integrator: $v_{OUT} = -\frac{1}{R1 \cdot C1}\int_{-\infty}^{t} v_{IN}(t')\,dt'$

And $v_{OUT}(s) = \frac{-1}{sRC} v_{IN}(s)$

With this circuit, DC conditions may require special care because the integral of a constant eventually becomes infinite.

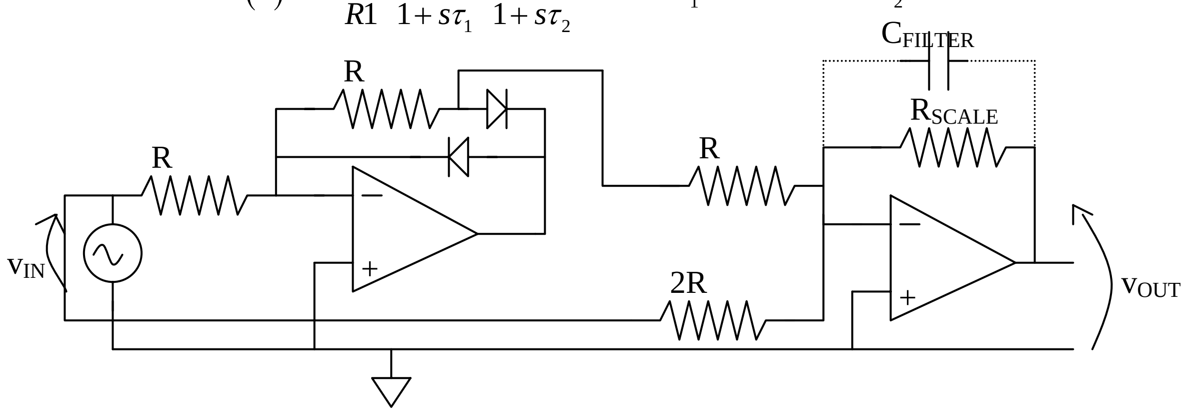
Differentiator: $v_{OUT} = -R1 \cdot C1 \frac{dv_{IN}}{dt}$

NOTE: because of bandwidth limitations, this circuit does not usually work very well.



Filter with two simple poles (high-pass and low-pass):

$$H(s) = -\frac{R2}{R1} \cdot \frac{s\tau_1}{1+s\tau_1} \cdot \frac{1}{1+s\tau_2} \text{ where } \tau_1 = R1 \cdot C1 \text{ and } \tau_2 = R2 \cdot C2$$



Precision rectifier for low voltages with optional filtering. $v_{OUT} = \frac{R_{SCALE}}{2R}\left|v_{IN}\right|$