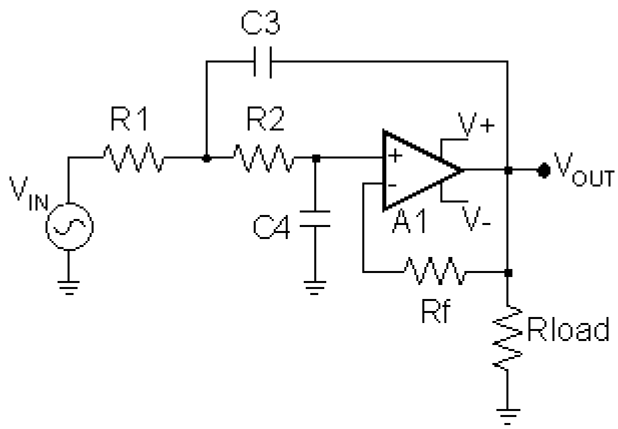
Linear integrated circuit

A linear integrated circuit (linear IC) is a solid-state analog device characterized by a theoretically infinite number of possible operating states. It operates over a continuous range of input levels. In contrast, a digital IC has a finite number of discrete input and output states.

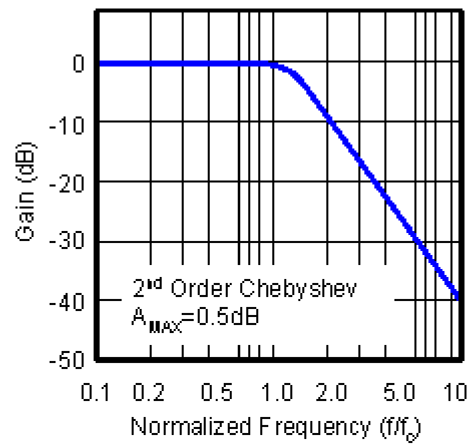
Within a certain input range, the amplification curve of a linear IC is a straight line; the input and output voltages are directly proportional. The best known, and most common, linear IC is the operational amplifier or *op amp*, which consists of resistors, diodes, and transistors in a conventional analog circuit. There are two inputs, called inverting and non-inverting. A signal applied to the inverting input results in a signal of opposite phase at the output. A signal applied to the non-inverting input produces a signal of identical phase at the output. A connection, through a variable resistance, between the output and the inverting input is used to control the amplification factor.

Linear ICs are employed in audio amplifiers, A/D (analog-to-digital) converters, averaging amplifiers, differentiators, DC (direct-current) amplifiers, integrators, multivibrators, oscillators, audio filters, and sweep generators. Linear ICs are available in most large electronics stores. Some devices contain several amplifiers within a single housing.

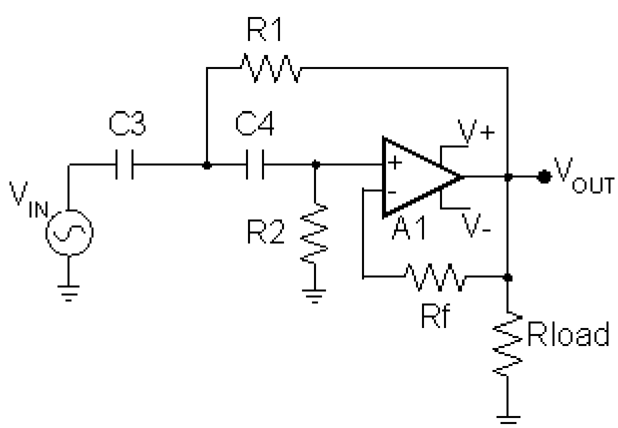
Lowpass Filter



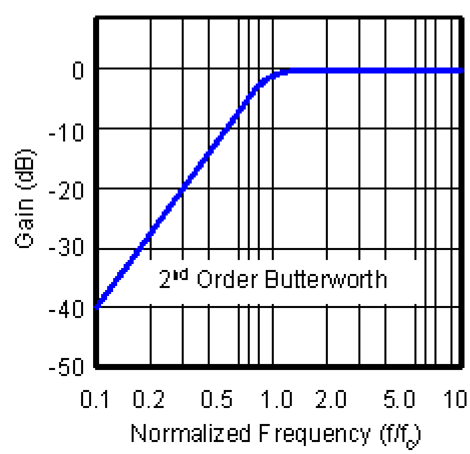
The Sallen-Key lowpass biquad filter is a classic design. This implementation has low sensitivity to changes in component values over process, environment, and time. Using the 2nd-order Chebyshev approach gives a relatively steep rolloff near the cutoff frequency fc. For more information on this design, see application note [OA-27](OA-27).



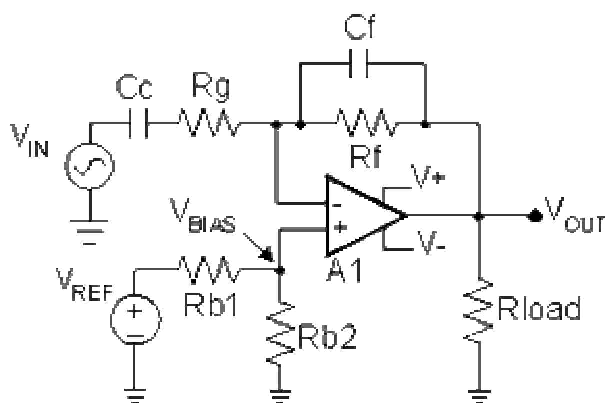
Highpass Filter



The Sallen-Key highpass filter is a classic design. This implementation has low sensitivity to changes in component values over process, environment, and time. Using the 2nd-order Butterworth approach gives a straight-forward design with no peaking at the cutoff frequency fc. For more information on this design, see application note [OA-29](OA-29).



AC-Coupled Inverting Amp



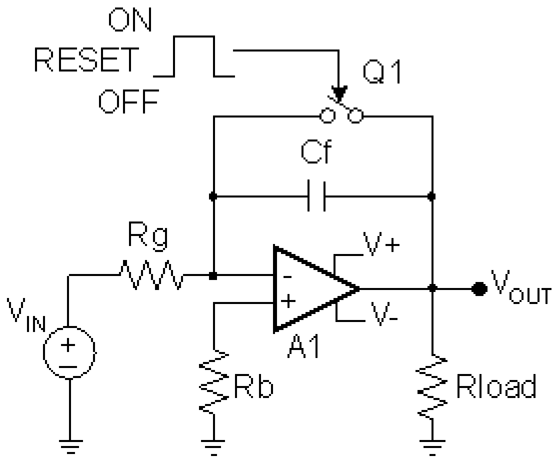
The AC-Coupled Inverting Amplifier multiplies the non-DC input voltage by the desired negative gain:

Vout = [-(Rf/Rg) x Vin(p-p)] + Vbias

Vbias is added to the op amp noninverting input to bring that input pin voltage within the normal operating range of the amplifier. It also provides an offset for the output, so that it is within its operating range.

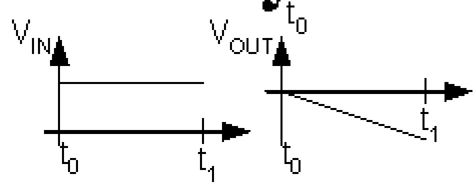
The AC-Coupled Inverting Amplifier can also be used as a **wide-bandwidth Bandpass Filter**. Below the Minimum Signal Frequency, the signal will be attenuated at 20dB decade; above the Maximum Signal Frequency the attenuation will also be 20dB/decade. The attenuation at Maximum and Minimum Signal Frequency is approximately 1dB. For a narrow bandwidth Bandpass Filter, see the WEBENCH Active Filter Designer Custom Filters.

Integrator



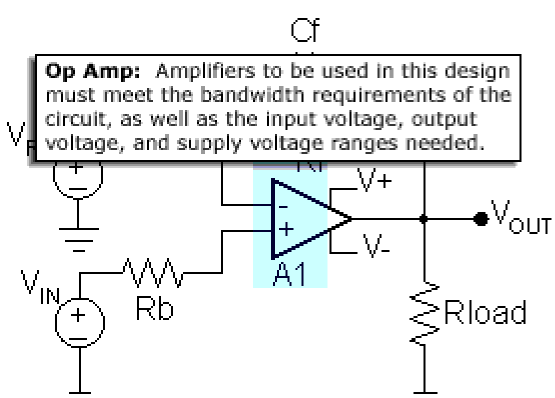
The Integrator is used to calculate the integral of a signal. The output of the integrator is proportional to the area under the plot of voltage vs. time. For example, if the input signal is DC, then the output is a voltage ramp.

$$V_{OUT} = \frac{-1}{RgCf}\int_{t_0}^{t_1} V_{IN}\,dt$$



Because integration involves a known start time and end time, a reset circuit must be included to establish the start time before each integration time period. The integration end time occurs when the measurement is read.

NonInverting Amp



The Non-Inverting Amplifier multiplies the input voltage (Vin) by the desired positive gain, and subtracts a voltage proportional to the applied reference voltage:

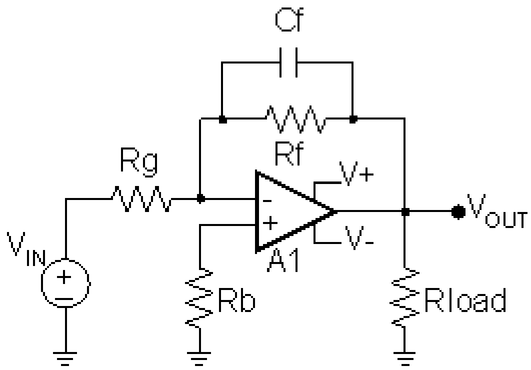
Vout = Vin x (1 + Rf/Rg) - Vref x (Rf/Rg)

Note that if Vref = 0V, then the output voltage equation simplifies to:

Vout = Vin x (1 + Rf/Rg)

The feedback capacitor Cf rolls off the gain at frequencies above 1/2pi x RfCf, to attenuate high-frequency noise.

Inverting Amplifier



The Inverting Amplifier multiplies the input voltage by the desired negative gain:

Vout = -(Rf/Rg) x Vin

Note that, with a single positive supply voltage, the input voltage must be negative, so that a positive output can be developed.