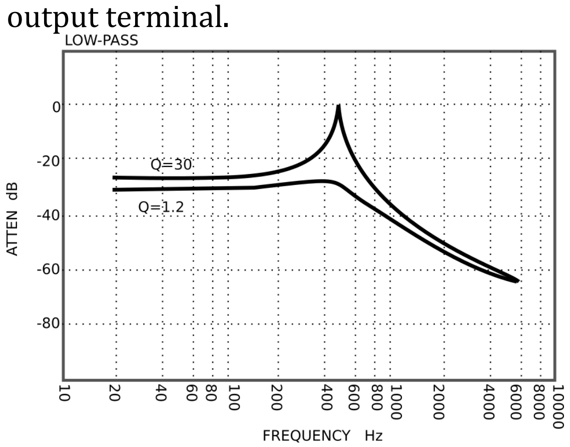
Voltage-tunable active filter features low, high and bandpass modes

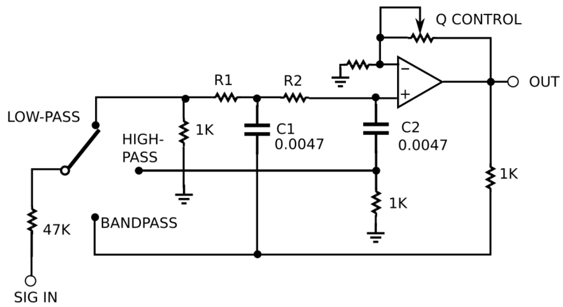
You can build a voltage-tunable filter with low-pass, high-pass and bandpass characteristics and variable Q. Just four discrete general-purpose transistors and a few other discrete components are required. The circuit can tune accross the whole audio spectrum (20 Hz to 20 kHz) without the need for range switching. The design is particularly suited for electronic-music synthesis.

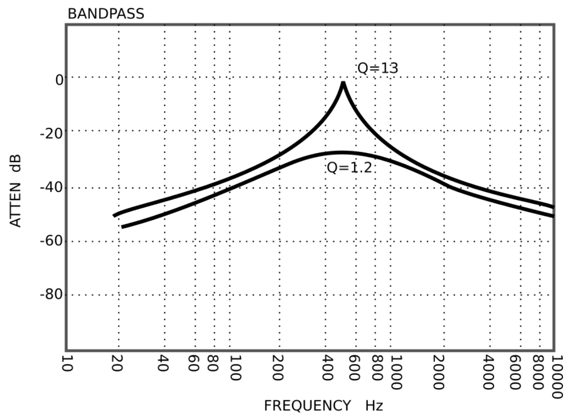
The circuit uses a standard, noninverting amplifier configuration. as in the simplified diagram of Fig. 1. The three-modes are obtained by the introduction of the signal into three different points of the circuit. An increase in the gain of the amplifier increases the filter's Q. The Q remains almost constant as the filter's cutoff frequency is tuned across the audio spectrum. Cut-off frequency is changed when R_1 and R_2 are varied simultaneously.

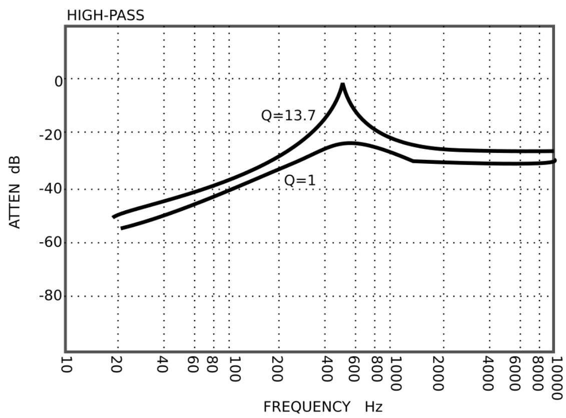
In the actual circuit. silicon diodes replace R_1 and R_2 (Fig. 2). The diodes change resistance when their forward bias voltages are changed. The differential amplifler transistors Q_1 and Q_2 apply the bias voltage in opposing phase to the two RC diode networks in parallel. The opposing phases cancel the control voltage so that the control voltage doesn't appear at the signal output terminal.



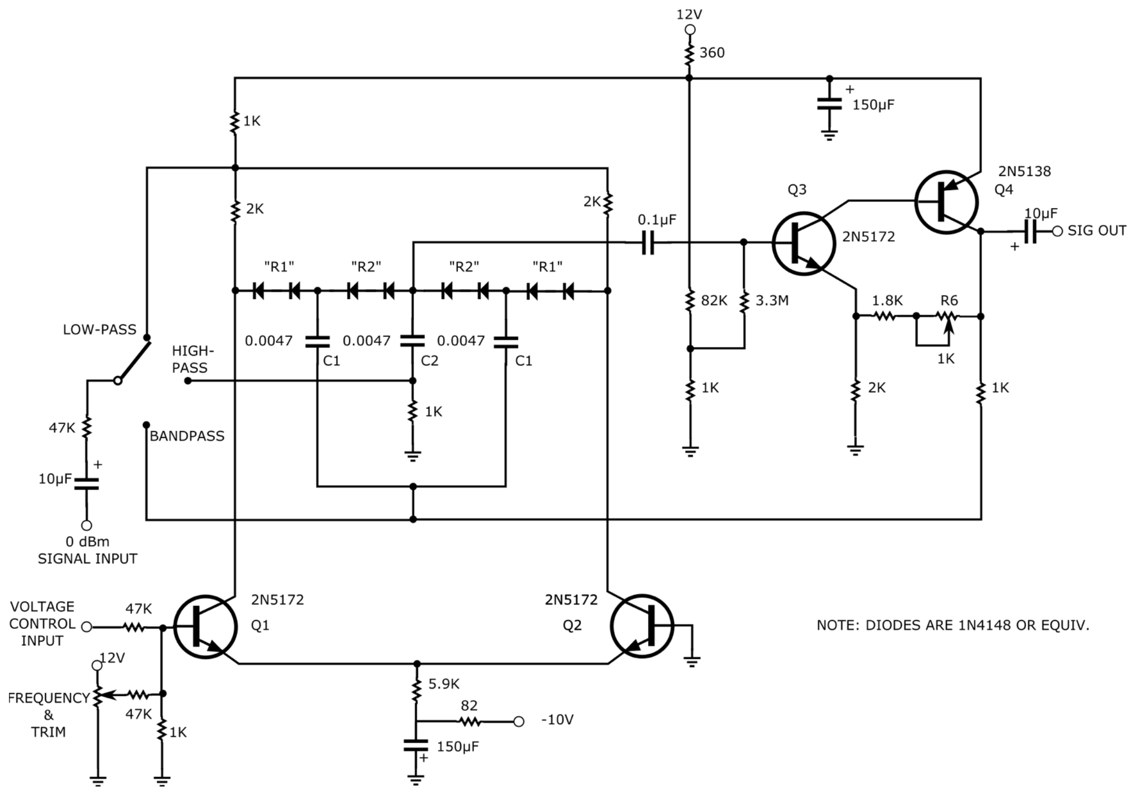
The noninverting amplifier's transistors, Q_3 and Q_4, and potentiometer R_6 control amplifier's gain, and consequently, the Q of the filter. The bias effect of the input signal on the diodes is also cancelled, when the signal level across each diode pair is kept below 50 mV.







1. To select the filter's frequency response mode. the signal is applied to one of three different input points, as shown in this simplified diagram.



2. The Q of the voltage-tuned active filter is: adjusted by R_6. The Q remains almost constant over the complete frequency range. At high Qs the input signal level should be limited to -10 dBm

But excessive gain can cause the circuit to oscillate. An op amp can also be used for the non-inverting amplifier.

The plots shown were made with the center frequency set arbitrarily at 500 Hz. Pass characteristics and Q remain essentially the same as the center frequency is changed. The output amplitudes in the pass portions of the curves are approximately -25 dB from the input signal. The circuit operates well with an input signal level of 0 dBm (0.77 V rms) at low Q.

However, with a Q of 10 or higher, the input signal should be limited to about -10 dB to prevent the circuit from being overdriven. Plots were made with an HP-650A oscillator and an HP-400-L ac voltmeter.

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