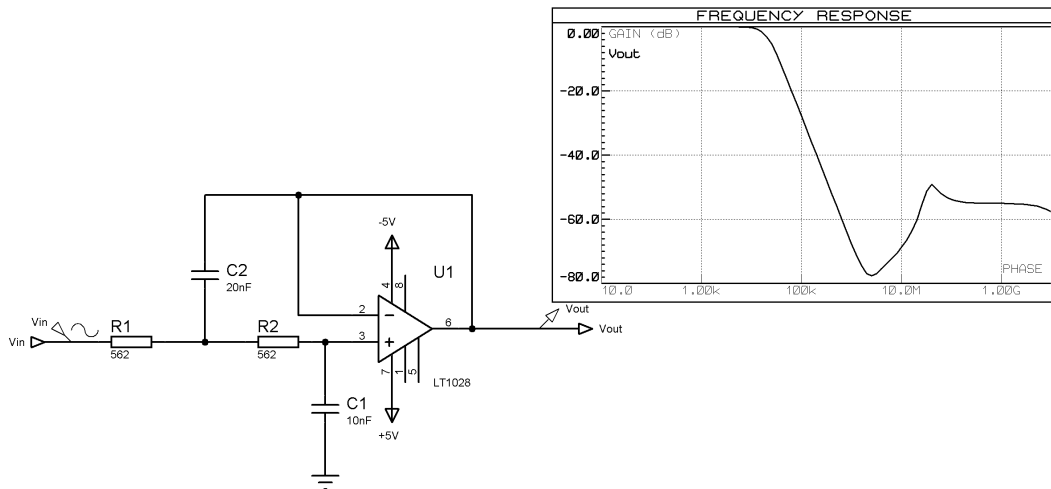


## Task 6

A roll of rate of 40dB/decade indicates a second order filter. A pass band of DC to 20KHz (audio) can be achieved using an op amp and some other passive components. The LT1028 is perfect for audio applications.

The configuration that we will be using is a low pass sallen-key filter with TF:

$$A(s) = \frac{1}{1 + \omega_c C_1 (R_1 + R_2)s + \omega_c R_1 R_2 C_1 C_2 s^2}$$



Comparing coefficients;

$$A_0 = 1$$

$$a_1 = \omega_c C_1 (R_1 + R_2)$$

$$b_1 = \omega_c^2 R_1 R_2 C_1 C_2$$

Selecting standard values for  $C_1$  and  $C_2$ ,  $R_1$  and  $R_2$  can be derived by;

$$R_{1,2} = \frac{a_1 C_2 \mp \sqrt{a_1^2 C_2^2 - 4b_1 C_1 C_2}}{4\pi f_c C_1 C_2}$$

To get real values,  $C_2$  must satisfy this condition:

$$C_2 \geq \frac{C_1 4b_1}{a_1^2}$$

for a maximally flat response, we will consider Butterworth filter coefficients;

$$a_1 = 1.4142$$

$$b_1 = 1$$

$$Q = 0.71$$

$$\frac{R_4}{R_3} = 0.568$$

Therefore if we consider a  $C_1$  of 10nF;

$$C_2 \geq \frac{10nF \times 4 \times 1}{2}$$

$$C_2 = 20nF$$

$$R_{1,2} = \frac{\sqrt{2} \times 20nF \mp \sqrt{(2 \times 20nF^2) - (4 \times 1 \times 10nF \times 20nF)}}{4\pi \times 20,000 \times 10nF \times 20nF}$$

$$R_{1,2} = \frac{\sqrt{2} \times 20nF}{4\pi \times 20,000 \times 10nF \times 20nF}$$

$$R_{1,2} = 563\Omega, 563\Omega$$

$$A(s) = \frac{1}{1 + \omega_c \times 10nF \times (1125)s + \omega_c \times 563 \times 563 \times 10nF \times 20nF \times s^2}$$

$$A(s) = \frac{1}{1 + \omega_c \times 10nF \times (1125)s + \omega_c \times 563 \times 563 \times 10nF \times 20nF \times s^2}$$

$$A(j\omega) = \frac{1}{1 + (j\omega)\omega_c(1.126 \times 10^{-5} + 6.34 \times 10^{-11}(j\omega))}$$

$$A(j\omega) = \frac{1}{1 + (j\omega)(0.225 + 1.268 \times 10^{-6}j\omega)}$$

$$A(j\omega) = \frac{1}{1 + 0.225j\omega + 1.268 \times 10^{-6}(j\omega^2)}$$

$$A(j\omega) = \frac{1}{(-4.44 + j\omega)(-177598 + j\omega)}$$

$$H(j\omega) = -20 \log \left| -4.44 \left( 1 - \frac{j\omega}{4.44} \right) \right| - 20 \log \left| -177598 \left( 1 - \frac{j\omega}{177598} \right) \right|$$

