EXPERIMENT 4

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ACTIVE LOW PASS FILTERS

AIM

To familiarize with 2nd order Sallen Key active low pass filters and to measure their frequency responses.

REPORT

(1) LT Spice Circuit Diagram

Attached below.

(2) $R_1 = R_2 = 10\,k\Omega$, $C_1 = C_2 = 1\,nF$, $Q = 1$

$$\Rightarrow Q = \frac{1}{3-K} = 1 \Rightarrow K = 2 \Rightarrow 1 + \frac{R_f}{R} = 2 \Rightarrow \frac{R_f}{R} = 1$$

Hence, we can chose $R = R_f = 1\,k\Omega$.

$$\Rightarrow f_c = \frac{1}{2\pi\sqrt{C_1 R_1 C_2 R_2}}\,Hz = \frac{1}{2\pi \times 10^3 \times 10^{-9}}\,Hz = \frac{10^9}{2\pi}\,Hz = 15915\,Hz$$

Experimentally the peak in gain is obtained around 11.3 kHz. The peak is not very sharp though owing to the low Q-factor. The transition is not very sharp.

(3) $Q = 1.5 , 2.5$

$$\Rightarrow Q = \frac{1}{3-K} = \frac{3}{2} \Rightarrow K = \frac{7}{3} \Rightarrow 1 + \frac{R_f}{R} = \frac{7}{3} \Rightarrow \frac{R_f}{R} = \frac{4}{3}$$

Hence, we can choose $R_f = 2k\Omega$ and $R = 1.5k\Omega$

$$\Rightarrow Q = \frac{1}{3-K} = \frac{5}{2} \Rightarrow K = \frac{13}{5} \Rightarrow 1 + \frac{R_f}{R} = \frac{13}{5} \Rightarrow \frac{R_f}{R} = \frac{8}{5}$$

Hence, we can choose $R_f = 2k\Omega$ and $R = 1.25k\Omega$.

As expected, when we increase the Q-factor the sharpness of the peak increases. The filter now offers a much sharper transition. The peak in gain now occurs around a frequency of 14.5 kHz. Also the initial fall (roll off) after the peak is much steeper than for $Q = 1$. Thus this offers a comparitively higher selectivity.

(4) $R_1 = R_2 = 10\,k\Omega$, $C_1 = C_2 = 1\,\mu F$, $Q = 2.5$

$$\Rightarrow Q = \frac{1}{3-K} = \frac{5}{2} \Rightarrow K = \frac{13}{5} \Rightarrow 1 + \frac{R_f}{R} = \frac{13}{5} \Rightarrow \frac{R_f}{R} = \frac{8}{5}$$

Hence we can choose $R_f = 2k\Omega$ and $R = 1.25\,k\Omega$.

$$\Rightarrow f_c = \frac{1\ Hz}{2\pi\sqrt{R_1 C_1 R_2 C_2}} = \frac{1}{2\pi RC}\ Hz = \frac{1}{2\pi 10^4 10^{-12}}\ Hz = \frac{10^8}{2\pi}\ Hz = 15915\ kHz$$

As expected even experimentally the cut off frequency shifts forward with a decrease in capacitance value. Experimentally the gain starts to drop around 150kHz and reaches -3dB value at around 300kHz. The low capacitance value which leads to a high impedance and parasitic effects at higher frequencies cause deviation from ideality.