Passive High-Pass Filter

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***Abstract*—**
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I. Introduction

II. Methodology

From "Table A-1 Element values for low-pass single-resistance-terminated lossless-ladder realizations" in *Introduction to the Theory and Design of Active Filters* [1], the following values are given for a 3rd-order butterworth low-pass filter with a 1 $\mathrm{rad/s}$ bandwidth terminated with a resistance of $R = 1\Omega$:

$$\begin{aligned} C_1 &= 1.5000 \\ L_2 &= 1.3334 \\ C_3 &= 0.5000 \end{aligned} \tag{1}$$

To transform the low-pass filter into a high-pass filter, the inductors become capacitors with $C = 1/L$ and the capacitors become inductors with $L = 1/C$. The values for the high-pass filter are thus:

$$\begin{aligned} L_1' &= \frac{1}{C_1} = 0.6667 \\ C_2' &= \frac{1}{L_2} = 0.7500 \\ L_3' &= \frac{1}{C_3} = 2.0000 \end{aligned} \tag{2}$$

To denormalize the filter such that the cutoff frequency is $f_c = 500$ Hz or $w_c = 2\pi f_c = 3141.59$ $\mathrm{rad/s}$, the component values should be scaled by R/w_c. Letting $R = 10\mathrm{K}\Omega$ gives the following values:

$$\begin{aligned} L_1'' &= \frac{L_1'}{R * w_c} = 0.2122 \\ C_2'' &= \frac{C_2'}{R * w_c} = 0.2387 \\ L_3'' &= \frac{L_3'}{R * w_c} = 0.6366 \end{aligned} \tag{3}$$

References

[1] L. P. Huelsman and P. E. Allen, *Introduction to the Theory and Design of Active Filters*. New York: McGraw-Hill, 1980.