L-C Implementation of Low-Pass Elliptic Filters

Elliptic-function filters are sometimes called Cauer filters in honor of network theorist Wilhelm Cauer. The appropriate coefficients for elliptic function filters have been extensively tabulated by Saal and Zverev based on the filter order *n* and the parameters θ in degrees and reflection coefficient ρ in percent. The tabulated results for some elliptic functions are attached. The tabulations are commonly classified using the following convention:

$$C\ n\ \rho\ \theta$$

where C represents Cauer, n is the filter order, ρ is the reflection coefficient, and θ is the modular angle. A fifth order elliptic filter having ρ = 15% and a θ = 29° is described as C05 15 θ = 29°.

The angle θ determines the steepness of the filter and is defined as:

$$\theta = \sin^{-1}\frac{1}{\omega_r} \qquad (1)$$

where $\omega_r = \dfrac{\omega_S}{\omega_C}$,

w_S is the stopband frequency in radians/second,

and w_C is the cutoff frequency in radians/second.

The reflection coefficient ρ is derived from:

$$\rho = \frac{VSWR-1}{VSWR+1} = \sqrt{\frac{\varepsilon^2}{\varepsilon^2+1}} \quad , \qquad (2)$$

where *VSWR* is the voltage standing-wave ratio,

and *e* is the ripple parameter.

The passband ripple *R* in dB and the reflection coefficient are related by:

$$R_{dB} = -10\log\left(1-\rho^2\right) \quad . \qquad (3)$$

As the parameter θ approaches 90°, the edge of the stopband w_S approaches unity. For θ near 90° extremely sharp transition regions are obtained. However, for a fixed order, the stopband attenuation is reduced as the steepness increases.

The closeness of the impedance match between the source resistance R_S and filter input resistance R_{fin} is frequency expressed as a return loss defined as:

$$A_\rho = 20\log\left|\frac{1}{\rho}\right| \quad . \tag{4}$$

Normalized elliptic function LC lowpass filters are presented in tabular form in the attachment. They are classified in the $C\ n\ \rho\ \theta$ form discussed on the previous page. As in Chebyshev filters, the normalized inductors and capacitors are denormalized using:

$$C = \frac{C_n}{2\pi f_C R} \tag{5}$$

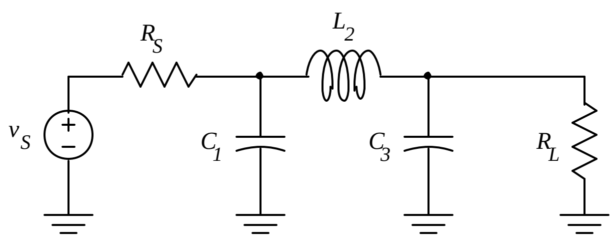
and

$$L = \frac{L_n R}{2\pi f_C} \quad , \tag{6}$$

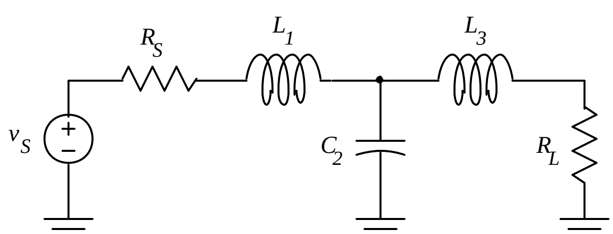
where C_n is the normalized capacitor value,
L_n is the normalized inductor value,
C is the denormalized (actual) capacitor value,
L is the denormalized (actual) inductor value,
and R is the final load resistor.

Additional Chebyshev LC Lowpass Element Values For 2 and 3 dB Ripple

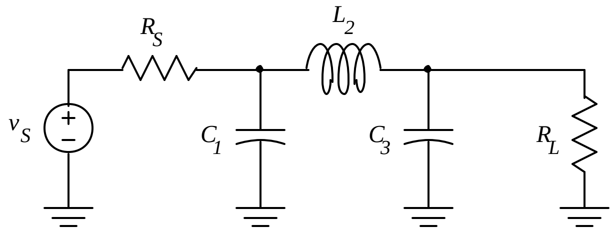
Chebyshev Lowpass Element Values for 2 dB Ripple



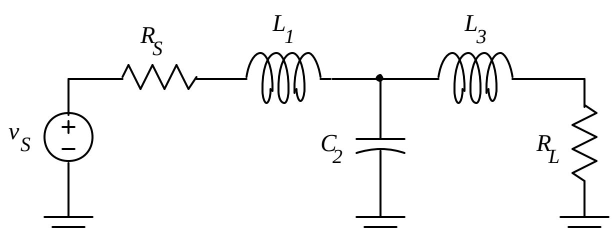
n	$\frac{R_S}{R_L}$	C_1	L_2	C_3
2	1	1.2368	1.2369	
3	1	2.7107	0.8325	2.7107
n	$\frac{R_S}{R_L}$	L_1	C_2	L_3



Chebyshev Lowpass Element Values for 3 dB Ripple



n	$\frac{R_S}{R_L}$	C_1	L_2	C_3
2	1	1.4125	1.4125	
3	1	3.3287	0.7116	3.3287
n	$\frac{R_S}{R_L}$	L_1	C_2	L_3



<u>References</u>

Williams, A. B. and Taylor, F. J., *Electronic Filter Design Handbook, 2nd Ed.*, McGraw-Hill Publishing Company, New York, 1988.

A. Zverev, *Handbook of Filter Synthesis*, John Wiley & Sons, Inc., New York, 1967.