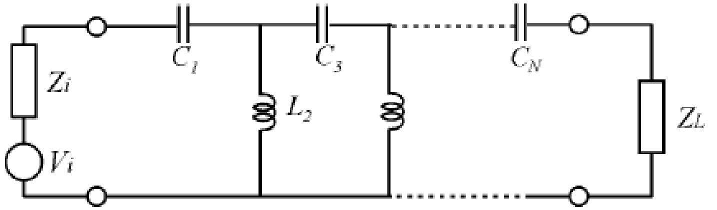
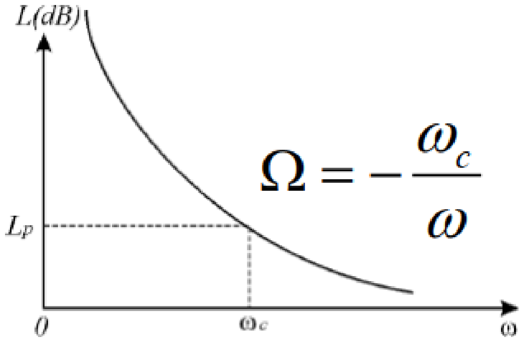
Filter Transformations

Highpass filter



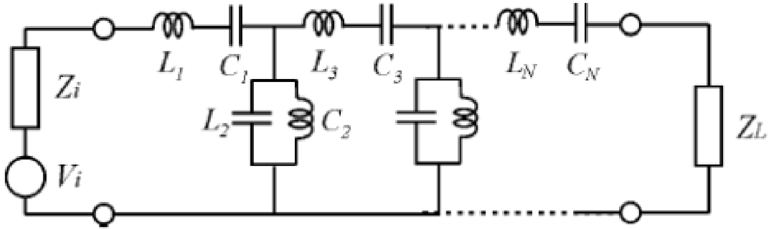
$$\frac{L_i}{Z_L} = \frac{1}{\omega_c g_i} \qquad C_i Z_L = \frac{1}{\omega_c g_i}$$

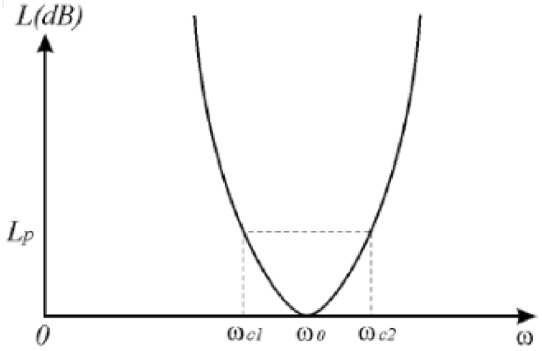


$$\Omega = -\frac{\omega_c}{\omega}$$

$$P_{LR} = 1 + k^2 P(\omega_c^2 / \omega^2)$$

Bandpass filter





Series LC:

$$\frac{L_i}{Z_L} = \frac{g_i}{\omega_{c2} - \omega_{c1}}$$

$$C_i Z_L = \frac{\omega_{c2} - \omega_{c1}}{\omega_0^2 g_i}$$

Shunt LC:

$$C_i Z_L = \frac{g_i}{\omega_{c2} - \omega_{c1}}$$

$$\frac{L_i}{Z_L} = \frac{\omega_{c2} - \omega_{c1}}{\omega_0^2 g_i}$$

$$\Omega = \frac{\omega_0}{\omega_{c2} - \omega_{c1}} \left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega} \right)$$

5.4.3 Cascading Bandpass Filter Elements

A single bandpass element as discussed in the previous section does not result in good filter performance with steep passband to stopband transitions. However, the ability to cascade these building blocks ultimately results in high-performance filters. Figure 5-48 depicts a generic multielement design.

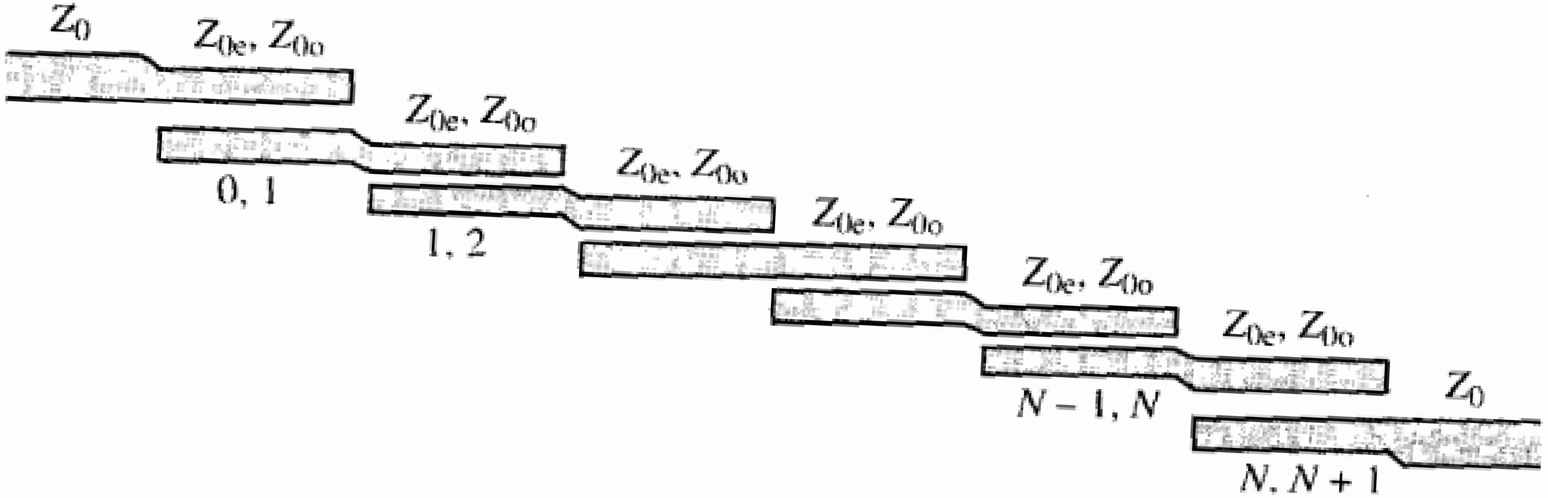


Figure 5-48 Multielement configuration of a fifth-order coupled-line bandpass filter ($N = 5$).

To design such a structure that meets a particular bandpass filter specification, a number of computations have to be performed. The following sequence of steps is needed to translate a set of design requirements into a practical filter realization (see Matthaei et al. in Further Reading).

- ***Identification of normalized bandwidth, upper, and lower frequencies.*** From the desired filter specifications for lower and upper frequencies ω_L, ω_U and the center frequency $\omega_0 = (\omega_U + \omega_L)/2$, we define the normalized bandwidth of the filter as

$$\mathrm{BW} = \frac{\omega_U - \omega_L}{\omega_0} \tag{5.78}$$

This factor allow us to compute the following parameters:

$$J_{0,1} = \frac{1}{Z_0}\sqrt{\frac{\pi \mathrm{BW}}{2g_0 g_1}} \tag{5.79a}$$

$$J_{i,i+1} = \frac{1}{Z_0}\frac{\pi \mathrm{BW}}{2\sqrt{g_i g_{i+1}}} \tag{5.79b}$$

$$J_{N,N+1} = \frac{1}{Z_0}\sqrt{\frac{\pi \mathrm{BW}}{2g_N g_{N+1}}} \tag{5.79c}$$

which in turn permit us to determine the odd and even characteristic line impedances:

$$Z_{0o}\big|_{i,i+1} = Z_0[1 - Z_0 J_{i,i+1} + (Z_0 J_{i,i+1})^2] \tag{5.80a}$$

and

$$Z_{0e}\big|_{i,i+1} = Z_0[1 + Z_0 J_{i,i+1} + (Z_0 J_{i,i+1})^2] \tag{5.80b}$$

where the indices i, $i + 1$ refer to the overlapping elements seen in Figure 5-48.
Here, Z_0 is the characteristic line impedance at the beginning and the end of the filter structure.

filter, which consists of a complementary low-pass and high-pass filter connected to a single point junction, or tee-junction. As a result, the first radio would operate below the 3 dB cutoff of the low-pass filter where the high-pass filter attenuates the second radio and vice versa.