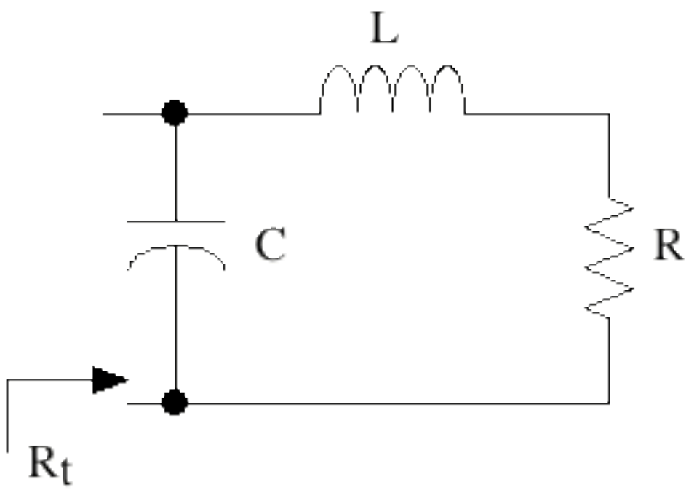
Impedance matching networks

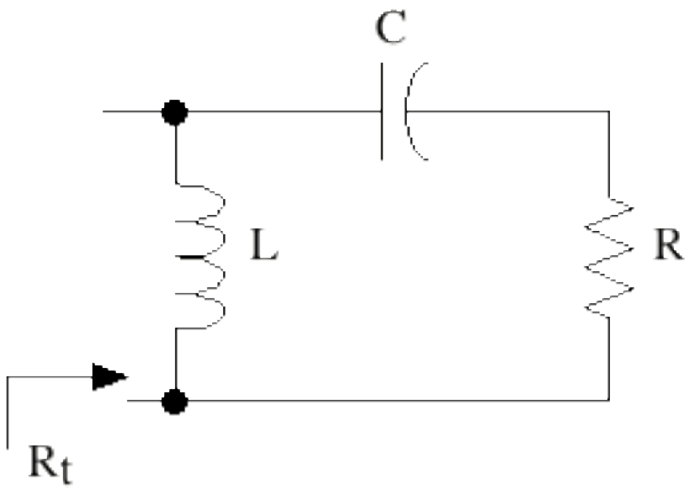
Note that each set of analysis/design formulas has two columns labeled “Exact” and “Approximate” The approximate column is valid when the Q_t of the network is ≥ 10 (they are about 10% accurate when $3 \leq Q_t \leq 10$). This type of network is known as a L network because the basic output element looks like a letter “L” turned on its side. Note that because these networks only have two resonant elements you cannot simultaneously design for a specific bandwidth, resonant frequency and impedance transformation ratio; you can only do that by adding reactive components to the network.

Design formulas for RL||C “L” network



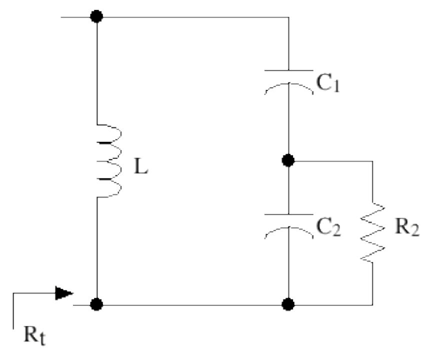
Quantity	Exact Expression	Units	Approximate expression when $Q_t \geq 10$
ω_o	$\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$	Radians/sec	$\approx \frac{1}{\sqrt{LC}}$
Q_t	$\equiv \frac{\omega_o L}{R} = \omega_o C R_t$		$\approx \frac{1}{\omega_o C R}$
$\omega_o L$	$\frac{1}{\omega_o C}\left(\frac{Q_t^2}{Q_t^2 + 1}\right)$	Ohms	$\approx \frac{1}{\omega_o C}$
R_t	$= \frac{L}{CR} = \frac{Q_t}{\omega_o C}$ $= R\left(Q_t^2 + 1\right)$	Ohms	$\approx Q_t^2 R = \omega_o L Q_t$
B		Hertz	$\approx \frac{1}{2\pi C R_t} = \frac{R}{2\pi L} = \frac{f_o}{Q_t}$

Design formulas for RC||L "L" network:



Quantity	Exact Expression	Units	Approximate expression when $Q_t \geq 10$
ω_o	$= \sqrt{\dfrac{1}{LC - R^2C^2}}$	Radians/sec	$\approx \dfrac{1}{\sqrt{LC}}$
Q_t	$\equiv \dfrac{1}{\omega_o CR} = \dfrac{R_t}{\omega_o L}$		$\approx \dfrac{\omega_o L}{R}$
$\omega_o L$	$= \dfrac{1}{\omega_o C}\left(\dfrac{Q_t^2 + 1}{Q_t^2}\right)$	Ohms	$\approx \dfrac{1}{\omega_o C}$
R_t	$= \dfrac{L}{CR} = \omega_o L Q_t$ $= R\left(Q_t^2 + 1\right)$	Ohms	$\approx Q_t^2 R = \dfrac{Q_t}{\omega_o C}$
B		Hertz	$\approx \dfrac{f_o}{Q_t} = \dfrac{1}{2\pi C R_t}$

Design formulas for tapped – capacitor matching network



For $Q_t = \frac{f_o}{B} \geq 10$

(1) $C = \frac{1}{2\pi B R_t}$

(2) $L = \frac{1}{\omega_o^2 C}$

(3) $Q_t = \frac{f_o}{B}$

(4) $N = \sqrt{\frac{R_t}{R_2}}$

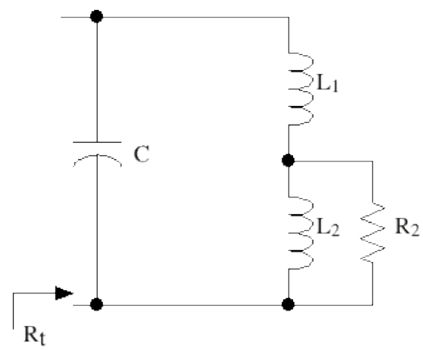
(5) $\frac{Q_t}{N} = Q_p$

NOTE: If $\frac{Q_t}{N} \geq 10$, use this value for Q_p and follow the formulas in the left-hand column.

If $\frac{Q_t}{N} < 10$, follow the formulas in the right-hand column.

Approximate formulas $Q_p \geq 10$	Formulas for $Q_p < 10$
(6) $Q_p = \frac{Q_t}{N}$	(6) $Q_p = \sqrt{\frac{Q_t^2 + 1}{N^2} - 1}$
(7) $C_2 = NC$	(7) $C_2 = \frac{Q_p}{\omega_o R_2}$
(8) $C_1 = \frac{C_2}{N - 1}$	(8) $C_{se} = \frac{C_2\left(Q_p^2 + 1\right)}{Q_p^2}$
	(9) $C_1 = \frac{C_{se} C}{C_{se} - C}$

Design formulas for tapped – inductor matching network



For $Q_t = \frac{f_o}{B} \ge 10$

(1) $C = \frac{1}{2\pi B R_t}$

(2) $L = \frac{1}{\omega_o^2 C}$

(3) $Q_t = \frac{f_o}{B}$

(4) $N = \sqrt{\frac{R_t}{R_2}}$

(5) $\frac{Q_t}{N} = Q_p$

NOTE: If $\frac{Q_t}{N} \ge 10$, use this value for Q_p and follow the formulas in the left-hand column.

If $\frac{Q_t}{N} < 10$, follow the formulas in the right-hand column.

Approximate formulas $Q_p \ge 10$	Formulas for $Q_p < 10$
(6) $Q_p = \frac{Q_t}{N}$	(6) $Q_p = \sqrt{\frac{Q_t^2 + 1}{N^2} - 1}$
(7) $L_2 = \frac{L}{N}$	(7) $L_2 = \frac{R_2}{\omega_o Q_p}$
(8) $L_1 = (N - 1)L_2 = L - L_2$	(8) $L_{se} = \frac{L_2 Q_p^2}{Q_p^2 + 1}$
	(9) $L_1 = L - L_{se}$