RLC BAND PASS AND NOTCH FILTERS

The filters shown have their pass band and notch centered at ω = 1 rad/sec, because we have chosen R = 1 Ω, C = 1 F, and L = 1 H. The center of frequency is determined by $\omega_0 = \frac{1}{\sqrt{LC}}$ for both cases. The width measured at the 3 dB points is $\Delta\omega$. The *quality factor Q* is a measure of the sharpness of the resonance and is defined as

$Q = \frac{\omega_0}{\Delta\omega}$; for series RLC cricuits: $Q = \omega_0 L / R$; and for parallel RLC circuits: $Q = \omega_0 RC$

alternately we can substitute $\omega_0 = \frac{1}{\sqrt{LC}}$

With this substitution the relationship between the Q of series and parallel circuits then becomes clear.

$$\text{series: } Q = \omega_0 \frac{L}{R} = \frac{1}{\sqrt{LC}} \frac{L}{R} = \frac{\sqrt{\frac{L}{C}}}{R} = \frac{Z_0}{R}$$

$$\text{parallel: } Q = \omega_0 RC = \frac{1}{\sqrt{LC}} RC = \frac{R}{\sqrt{\frac{L}{C}}} = \frac{R}{Z_0}$$

$Z_0 = \sqrt{\frac{L}{C}}$ is the characteristic impedance of the LC circuit.

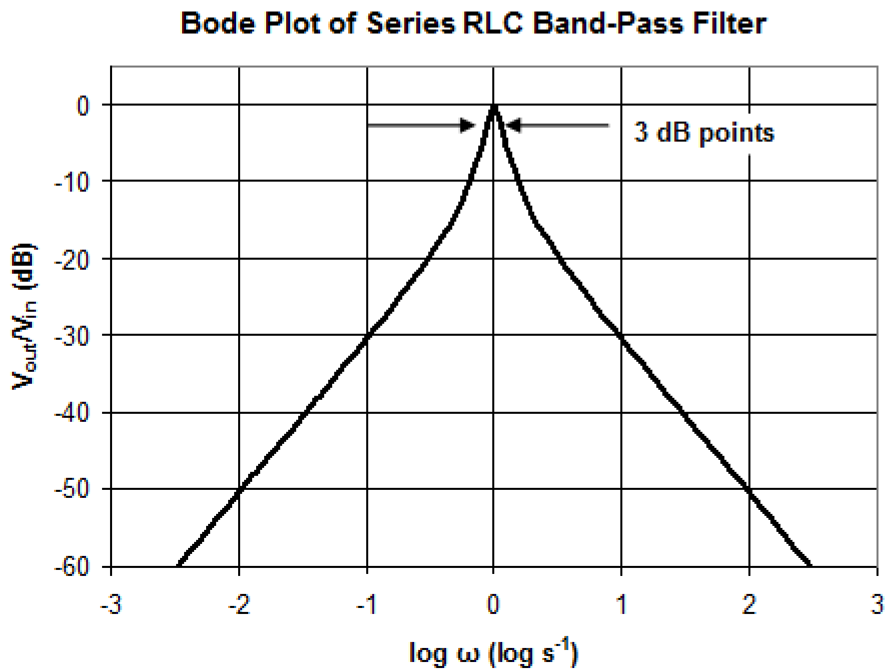
Units: In these calculations remember that farad × henry = second^2. You will also need use the context of the equation to distinguish between ω and f, because formally they both have units of second^{-1}, so be careful!

Note also that Henry / Farad = Ohm^2.

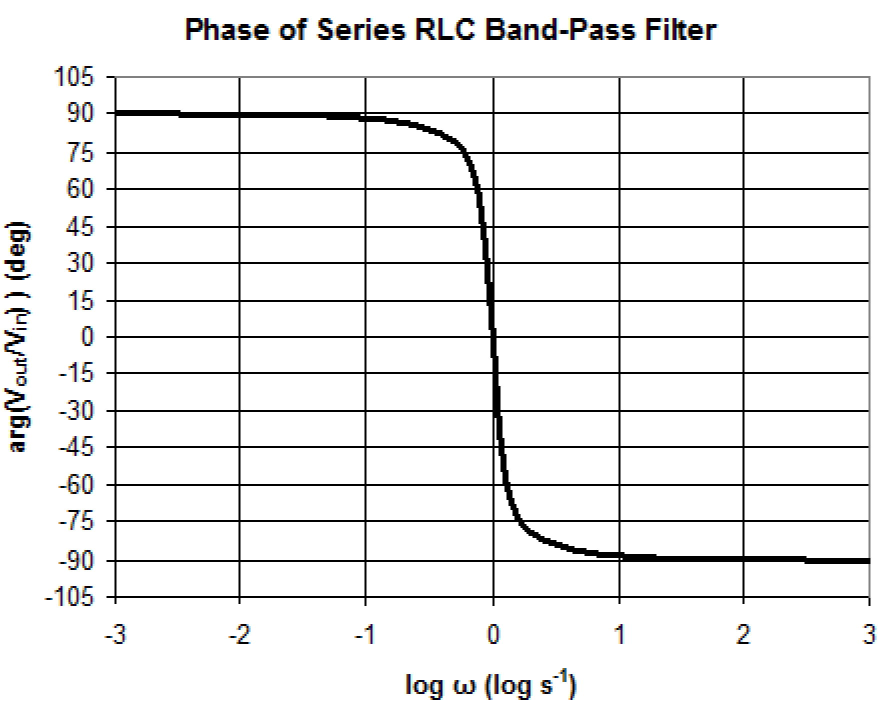
Band Pass Filters

Q is also related to the dissipation (damping) in the resonant circuit.

$$Q = 2\pi \frac{(\text{energy stored})}{(\text{energy dissipated per cycle})}$$

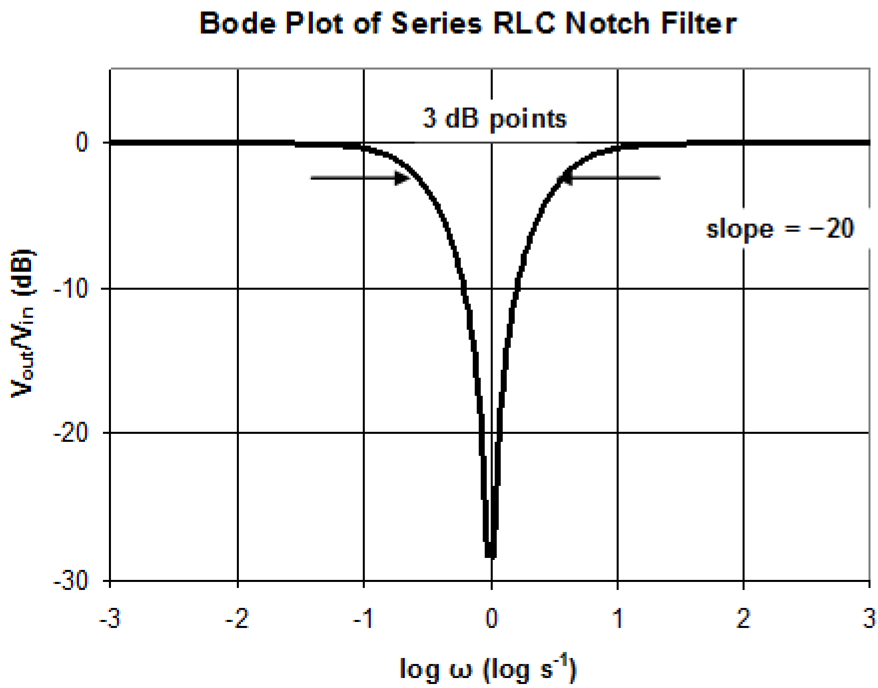


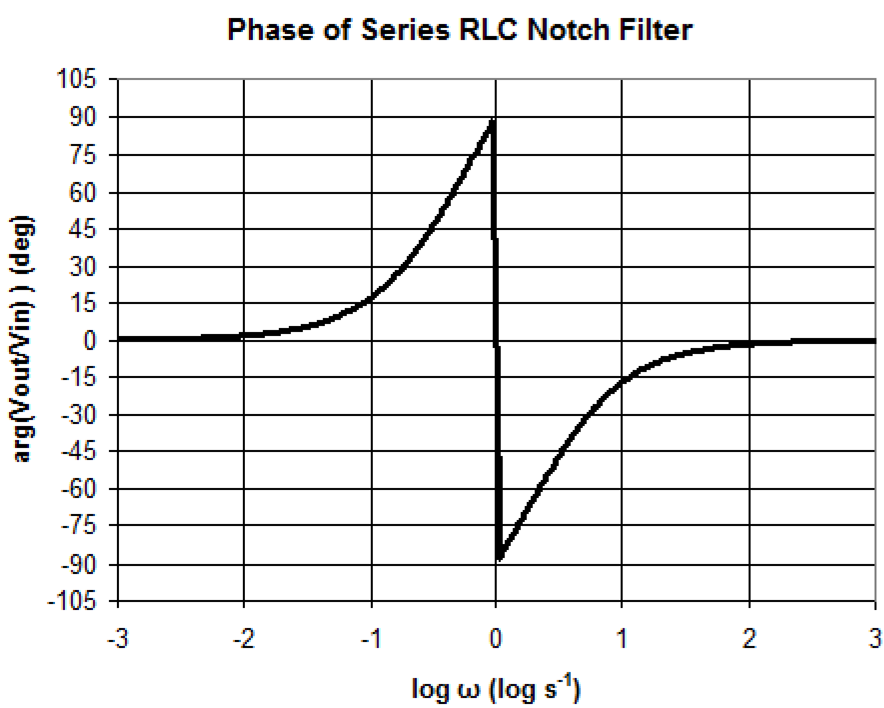
Bode Plot of Series RLC Band-Pass Filter
3 dB points
0
-10
-20
-30
-40
-50
-60
Vout/Vin (dB)
-3
-2
-1
0
1
2
3
log ω (log s-1)



Phase of Series RLC Band-Pass Filter
105
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-105
arg(Vout/Vin)) (deg)
-3
-2
-1
0
1
2
3
log ω (log s-1)

Notch Filters (Band Reject Filters)





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