TOOL: The Bode plot rules for a pair of complex conjugate poles involve approximating

$$|H(j\omega)| = \frac{1}{\left|\left(\frac{j\omega}{\omega_0}\right)^2 + \frac{1}{Q}\left(\frac{j\omega}{\omega_0}\right) + 1\right|}$$

which has a resonant peak for high Q.

In CTool "FILTERS:BODE PLOTS:2-pole low-pass:PEAK RESPONSE FREQ DERIVATION", the frequency at the peak is shown to be at a frequency slightly different than ω_0.

$$\frac{\omega_{max}}{\omega_0} = \sqrt{1 - \frac{1}{2Q^2}} \,.$$

Note that there is no resonant peak for $Q < 1/\sqrt{2}$.

In CTool "FILTERS:BODE PLOTS:2-POLE LOW-PASS:PEAK RESPONSE MAGNITUDE DERIVATION", the peak magnitude is shown to be Q scaled by a factor that is small for high Q.

$$|H(j\omega_{max})| = \frac{Q}{\sqrt{1 - \frac{1}{4Q^2}}} \,.$$

For $Q < 1$, the peak of the resonance is 15% or less and, for $Q < 0.8$, the peak of the resonance is 2% or less. Thus, we may choose to ignore the peak. If not, the above mentioned CTools have tables of peak frequencies and magnitudes that may be used.

For $Q = 1$, $|H_{max}|$ is 1.15 and $\omega_{max}/\omega_0 = 1/\sqrt{2} \doteq 0.707$.

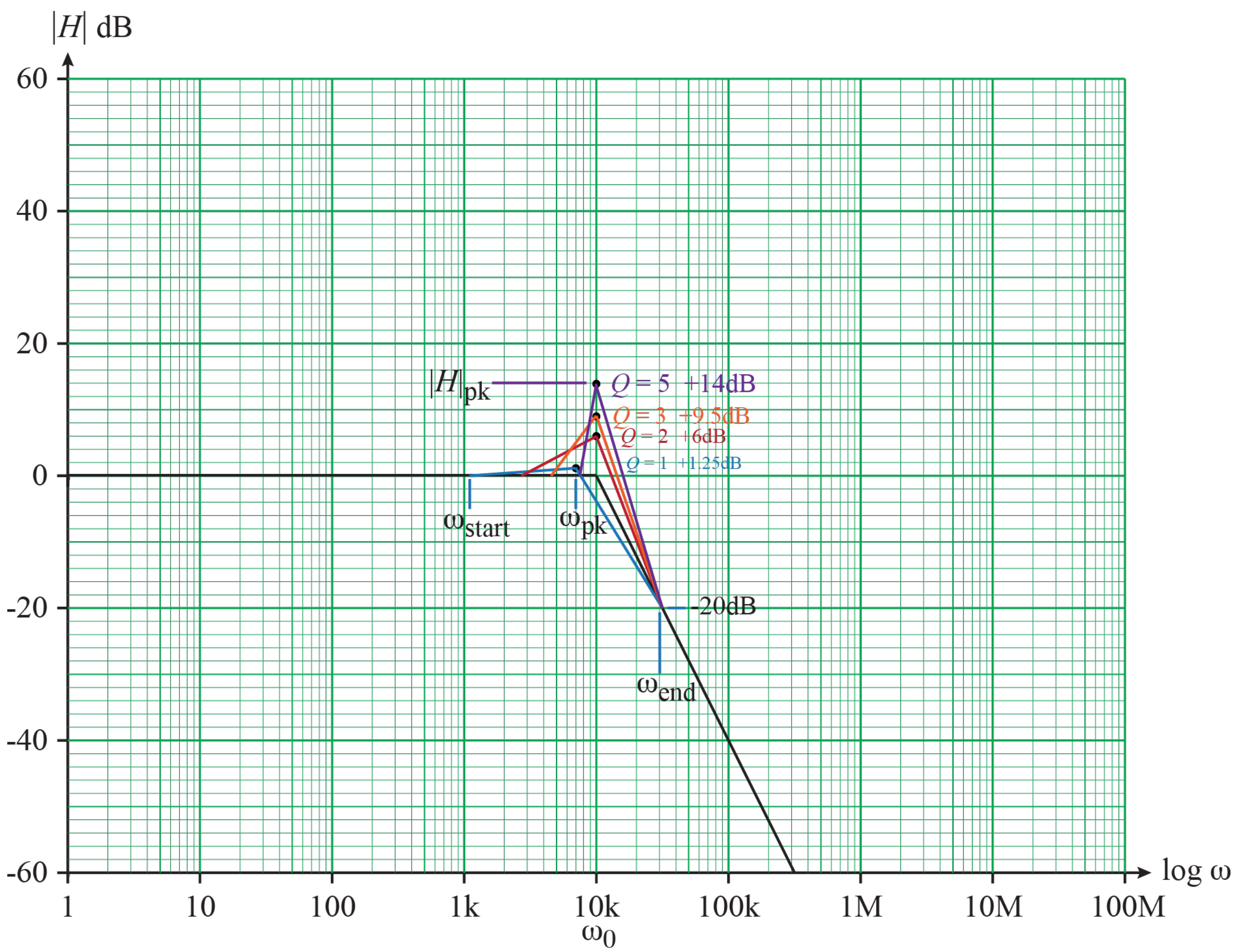
For $Q \geq 2$, $|H_{max}| \approx Q$ is very accurate and $\omega_{max}/\omega_0 \approx 1$ with error < 7% for $Q = 2$.

An approximation for the starting frequency for a line on the Bode plot that ends at the resonant peak gives a frequency in the decade before ω_0.

$$\frac{\omega_{start}}{\omega_0} \approx \begin{cases} 0.15Q & 1 \leq Q \leq 6.5 \\ 1 & Q > 6.5 \end{cases}$$

A line from the resonant peak (or the from 0dB at ω_0 for low Q) to a point at -20dB and $\sqrt{10}\omega_0$ is a good approximation for all Q values.

$\omega_{end} = 10\omega_0$ and -20dB



$Q \geq 2$, $|H_{max}| \approx Q$ and $\omega_{max} / \omega_0 \approx 1$

$$\frac{\omega_{start}}{\omega_0} \approx \begin{cases} 0.15Q & 1 \leq Q \leq 6.5 \\ 1 & Q > 6.5 \end{cases}$$

$\omega_{end} = 10\omega_0$ and -20dB