Series to Parallel Conversions

Jacques Audet VE2AZX

Rs, Ls, Cs = Series Resistance, Inductance, Capacitance, all connected in series.

Rp, Lp, Cp = Parallel resistance, Inductance, Capacitance, all connected in parallel.

Q is the quality factor. It is identical for the series or parallel networks.

$$Rp = Rs \cdot \left(1 + Q^2\right)$$

$$Xp = Xs \cdot \frac{1 + Q^2}{Q^2}$$

Xs, Xp = are series reactance and parallel reactances respectively. The parallel reactance is in parallel with Rp.

$$Lp = Ls \cdot \frac{1 + Q^2}{Q^2}$$

$$Cp = Cs \cdot \frac{Q^2}{1 + Q^2}$$

There are many ways to calculate the Q factor:

$$Q = \frac{Xs}{Rs} = \frac{Rp}{Xp} = \frac{\omega \cdot Ls}{Rs} = \frac{Rp}{\omega \cdot Lp} = \frac{1}{\omega \cdot Cs \cdot Rs} = Rp \cdot \omega \cdot Cp$$

Where $\omega = 2*\pi*f$ and f = frequency in Hz

For a given frequency, there is always a unique equivalent parallel circuit, and vice versa.

Impedances are generally expressed as series components unless noted otherwise.

Example of calculation of the parallel values

Measured Impedance values:

$Rs := 25 \;\; \Omega$ $\qquad Ls := 10^{-6} \;\; H \quad (1\mu H)$ $\qquad f := 1 \cdot 10^{6} \quad (1MHz)$

The Q factor is calculated first:

$$Q := \frac{2 \cdot \pi \cdot f \cdot Ls}{Rs} = 0.251$$

The parallel values are calculated:

$$Rp := Rs \cdot \left(1 + Q^2\right) = 26.579$$

$$Lp := Ls \cdot \frac{1 + Q^2}{Q^2} = 1.683 \times 10^{-5} \quad H$$

or 16.83 µH

NOTES

Conversion to parallel is useful when the device under test is known to be a parallel circuit.
Example: a parallel L-C circuit.

The impedance value is normally given using the series components: Rs + jXs