

Series – parallel conversions of LCR circuits

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In some cases a need arises for converting series LCR circuits to parallel ones (and vice versa). This memorandum presents a method to this.

Lets assume a series circuit and first write the expression for Q for it:

$$Q = X_{series}/R_{series} \quad (1)$$

Then,

$$X_{series} = QR_{series} \quad (2)$$

The terminal impedance for the series circuit now becomes:

$$Z_{series} = R_{series} + jX_{series} = R_{series} + jQR_{series} \quad (3)$$

The conversion of the series impedance into parallel admittance is:

$$Y_{par} = 1/Z_{series} = 1/[R_{series}(1 + jQ)] \quad (4)$$

Separating the real and the imaginary parts:

$$Y_{par} = 1/[R_{series}(1+jQ)] [(1- jQ)/(1 - jQ)] \quad (5)$$

$$Y_{par} = [(1 - jQ)/R_{series}(1 + Q^2)] \quad (6)$$

$$Y_{par} = 1/ R_{series}(1 + Q^2) - jQ/ R_{series}(1 + Q^2) \quad (7)$$

$$Y_{par} = 1/ R_{series}(1 + Q^2) - jQ/ [(X_{series}/Q)(1 + Q^2)] \quad (8)$$

$$Y_{par} = 1/R_{par} - j/X_{par} \quad (9)$$

If we now equate the real and imaginary terms of the series and parallel circuit expressions we get:

$$1/R_{par} = 1/ R_{series}(1 + Q^2) \quad (10)$$

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or,

$$\mathbf{Rpar} = \mathbf{Rseries}(1 + \mathbf{Q}^2) \quad (11)$$

And,

$$\mathbf{Xpar} = \mathbf{Xseries}(\mathbf{Q}^2 + 1)/\mathbf{Q}^2 \quad (12)$$

Further, the Q is:

$$\mathbf{Q} = \mathbf{[(Rpar/Rseries)-1]} \quad (13)$$