Series and Parallel Coil Transforms

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Practical Series Coil to Parallel Equivalent

Assume that a practical series coil exists with the components R and jX. What are the values of the equivalent parallel circuit? We shall use A and jB to represent the parallel version and reduce confusion. First, start with the standard parallel formula, and then proceed.

$$R + jX = \frac{1}{\frac{1}{A} + \frac{1}{jB}}$$

$$\frac{1}{R + jX} = \frac{1}{A} + \frac{1}{jB}$$

$$\frac{1}{R + jX} \bullet \frac{R - jX}{R - jX} = \frac{R}{R^2 + X^2} + \frac{-jX}{R^2 + X^2}$$

Therefore,

$$\frac{1}{A} = \frac{R}{R^2 + X^2}$$

$$\frac{1}{jB} = \frac{-jX}{R^2 + X^2}$$

and thus

$$A = \frac{R^2 + X^2}{R}$$

$$jB = j\frac{R^2 + X^2}{X}$$

If X >> R, then

$$A \approx \frac{X^2}{R} = Q_{coil}X$$

$$jB \approx j\frac{X^2}{X} = jX$$

Parallel to Series Coil Equivalent

Assume that a parallel inductor network consisting of R and jX exists. What is the equivalent series network? Again, we shall name the series components A and jB to avoid confusion. First, start with the product-sum rule, and then expand.

$$A + jB = \frac{RjX}{R + jX}$$

$$\frac{RjX}{R + jX} \bullet \frac{R - jX}{R - jX} = \frac{X^2 R}{R^2 + X^2} + \frac{jXR^2}{R^2 + X^2}$$

Thus,

$$A = \frac{X^2 R}{R^2 + X^2}$$

$$jB = j\frac{XR^2}{R^2 + X^2}$$

If R >> X, then

$$A \approx \frac{X^2 R}{R^2} = \frac{X^2}{R} = \frac{X}{Q_{parallel}}$$

$$jB \approx j\frac{XR^2}{R^2} = jX$$