Re: How to optimize parameters for making a coil with high−Q?

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Arthur C. wrote:

> I want to make a simple coil (inductor) with a Q value as high as possible.
> Now, I would like to know if there are simple guidelines on how to choose
> the parameters to obtain this. Parameters are:
>
> − thickness of the wire
> − number of rounds
> − length of the coil
> − area of cross−section

I assume you are talking about an air core coil. Things get even more involved when you include a high permeable core material, but higher Q is often possible in a smaller volume with a core.

Also, I assume you are talking about a lumped inductor, where the length of the wire is very short compared to the signal wavelength (this implies that the current is instantaneously the same in every part of the wire). Otherwise, the effective inductance involves waves reflecting back and forth along the wire.

> I understand that a realistic description of a coil involves (at least) a
> parallel parasitic capacitance C and a series resistance R.
> The resulting Q value would then be Q = (1/R) sqrt (L/C). Is this indeed the
> relevant expression for Q?

Only if you are using the inductor as a self resonant system, since that is the formula for the Q of a resonance. If you use the inductor well below its self resonant frequency, the effect of the stray capacitance is to just reduce the total inductance a bit, and the formula for Q is more closely, Q=w*L/R, where w (omega or frequency in radians per second) is 2*pi*frequency in hertz.

> If the coil is operated at a frequency of the order 1 MHz, can we assume for
> R just the 'DC' series resistance of the wire, or does it change with
> frequency?

Unfortunately, it is not so simple. Any time the magnitude or direction of magnetic flux penetrating a conductive material changes, a current is induced to circulate around that changing flux. The magnetic field produced by that circulating (eddy) current bucks the field that is causing the flux to change, slowing the change. The effect in wire is that the current first changes along the surface, and those changes sink into the conductor over time. This "skin effect" causes the current to use less than the full cross section of the wire, raising the effective AC resistance above the DC resistance