Key Parameters for Selecting RF Inductors

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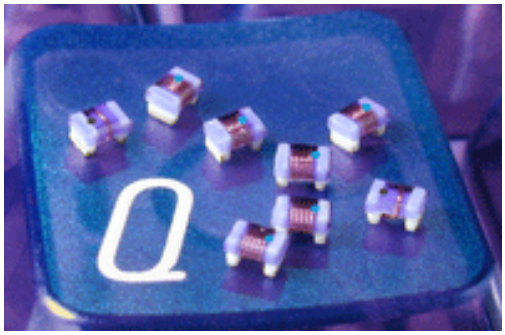
What factors do I need to consider?

RF inductor selection involves seven key parameters: mounting (surface mount or through-hole), inductance value, current rating, DC resistance (DCR), self-resonant frequency (SRF), Q factor, and temperature rating. While small size is typically desired, the laws of physics limit how small an inductor can be for a given application. Inductance value and current rating are the chief determinants of size; other parameters can then be optimized.

What determines my required inductance value?

If the inductor is to be used as a simple one-element (1st order) high-frequency choke, the selection is based on the frequency of peak noise to be choked out. At the



self-resonant frequency (SRF) of an inductor, the series impedance is at its maximum. So for a simple RF choke the selection is based on finding an inductor whose SRF is near the frequency where choking is needed.

For higher order filters, the inductance value for each element must be calculated based on the filter cutoff frequency (for low-pass and high-pass filters) or bandwidth (for bandpass filters). These calculations are frequently performed using commercial circuit simulation programs, such as SPICE, AWR’s Microwave Office, and Agilent’s Eagleware or ADS.

For tuned circuits or impedance matching, a tight inductance tolerance is desirable. As shown in Table 1, wirewound inductors typically achieve tighter tolerances than multilayer or thick film type inductors.

How does my current requirement affect my selection?

Higher current requires larger wire or more strands of the same wire size to keep losses and temperature rise to a minimum. Larger wire lowers the DCR and

increases the Q, but at the expense of larger part size and possibly lower SRF. The current ratings shown in Table 1 indicate that wirewound inductors are superior to multilayer inductors of the same size and inductance value.

Higher current capacity and lower DCR can be achieved by using a ferrite core inductor with a lower turn count. Ferrite, however, may introduce new limitations such as larger variation of inductance with temperature, lower Q, and reduced saturation current ratings. Some manufacturers offer ferrite inductors with an open magnetic structure which ensures that the core will not saturate, even at full rated current.

It looks like my current requirement determines the DC resistance. Current ratings and DCR are closely related. In most cases, if all other parameters are held equal, a larger part size is needed to decrease the DCR.

How high must the Self-Resonant Frequency be for the inductor to work?

For choke applications, the SRF is the frequency that provides the best signal blocking. At frequencies below the SRF, impedance increases with frequency. At the SRF, impedance is at its maximum. At frequencies above the SRF, impedance decreases with frequency.

For higher order filter or impedance matching applications, it is more important to have a relatively flat inductance curve (constant inductance vs. frequency) near the required frequency. This suggests

	Table 1 Inductance nH	Inductance Tolerance	Q@1.8 GHz	Current Rating(mA)
Wirewound (Coilcraft 0402HP-2N7XGL)	2.7	2%	85	1500
Multilayer (TDK MLK 1005S2N7ST)	2.7	11%	31	500
		Q@900MHz		
Wirewound (Coilcraft 0402HP-68NXGL)	68	2%	50	310Mh
Multilayer (TDK MLK 1005S68NJT)	68	5%	20	150

[1]

selecting an inductor with an SRF well above the design frequency. A rule of thumb is to select an inductor with an SRF that is a decade (10X) higher than the operating frequency. In general, the choice of inductance value typically determines the SRF and vice versa. The higher the inductance value, the lower the SRF, due to increased winding capacitance.

When is Q factor important?

A high Q value results in a narrow bandwidth, which is important if the inductor is to be used as part of an LC tank (oscillator) circuit or in narrow bandpass applications. High Q also leads to low insertion loss, minimizing power consumption. The Q factor of inductors is mainly a function of part size, but also wire size and winding patterns. Q is a relative measure of the efficiency of the inductor, which varies with frequency, making comparisons between inductor series a bit complicated. As indicated in Table 1, wirewound inductors have much higher Q values than multilayer inductors of the same size and value.

How do I select the temperature rating I need?

Power loss increases with current and DC resistance, causing the component's temperature to rise. Inductors are typically rated for a specific ambient temperature and a temperature rise above ambient due to current through the inductor. For example, a part rated for 125°C ambient and a 15°C rise due to the full current rating (Irms or Idc) will have approximately a 140°C maximum part temperature. You only need to verify that your application ambient temperature and current draw do not exceed the inductor ratings.

How can I quickly search for inductors that have all of the characteristics I need?

Comparing data sheets of inductor manufacturers can be time consuming. A few web sites offer parametric search engines that simplify the task. Coilcraft's Inductor Finder tool (www.coilcraft.com/apps/finder_apps/finder.cfm [2]) allows selection of inductors based on six different parameters. By entering just the inductance value and operating frequency, a list of all inductors that meet your requirements is presented.

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