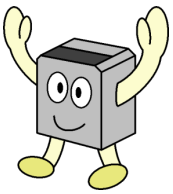


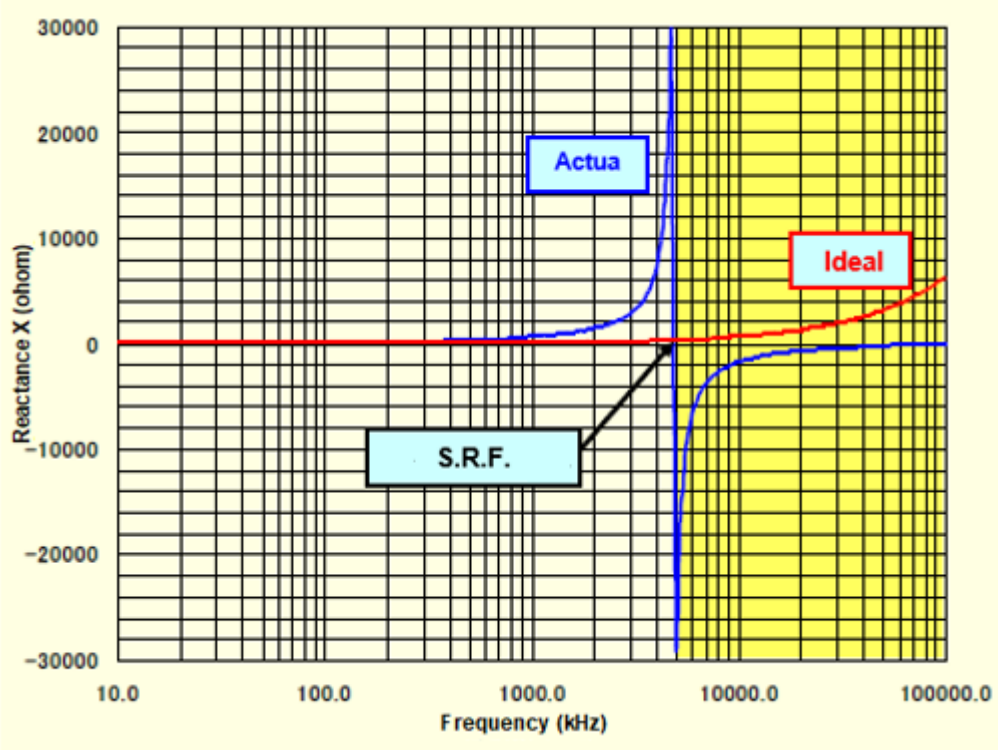
Tips for COIL users (6)

● Introduction

The sixth topic is about "**self resonance frequency of inductor**". Actual components are different from ideal ones in many aspects. Some aspects show unexpected characteristics.

● What is self resonance frequency?

Normal frequency characteristic of impedance of inductor（$Z=R+jX$）is measured like a blue line in **Graph-1**（plotted only jX）. (Graph is according to our **CER1277B**, 100uH) For your reference, red line shows the frequency characteristics of 100uH at ideal conditions.
In **Graph-1**, the frequency which shows reversed impedance polarity is called **S**elf **R**esonance **F**requency = **SRF.**



Graph-1 Impedance（*X*）characteristic

● Source of SRF

In actual world, if electrodes have width (size), capacitance (capacitor) occurs. Such capacitance is called as the parasitic capacitance, the distributed capacitance, the floating capacitance, and the stray capacitance. Therefore, in general the capacitance (capacitor) ***Cp*** is added to the equivalent circuit of inductor in parallel as **Figure-1**.

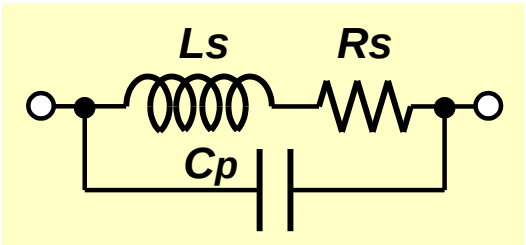
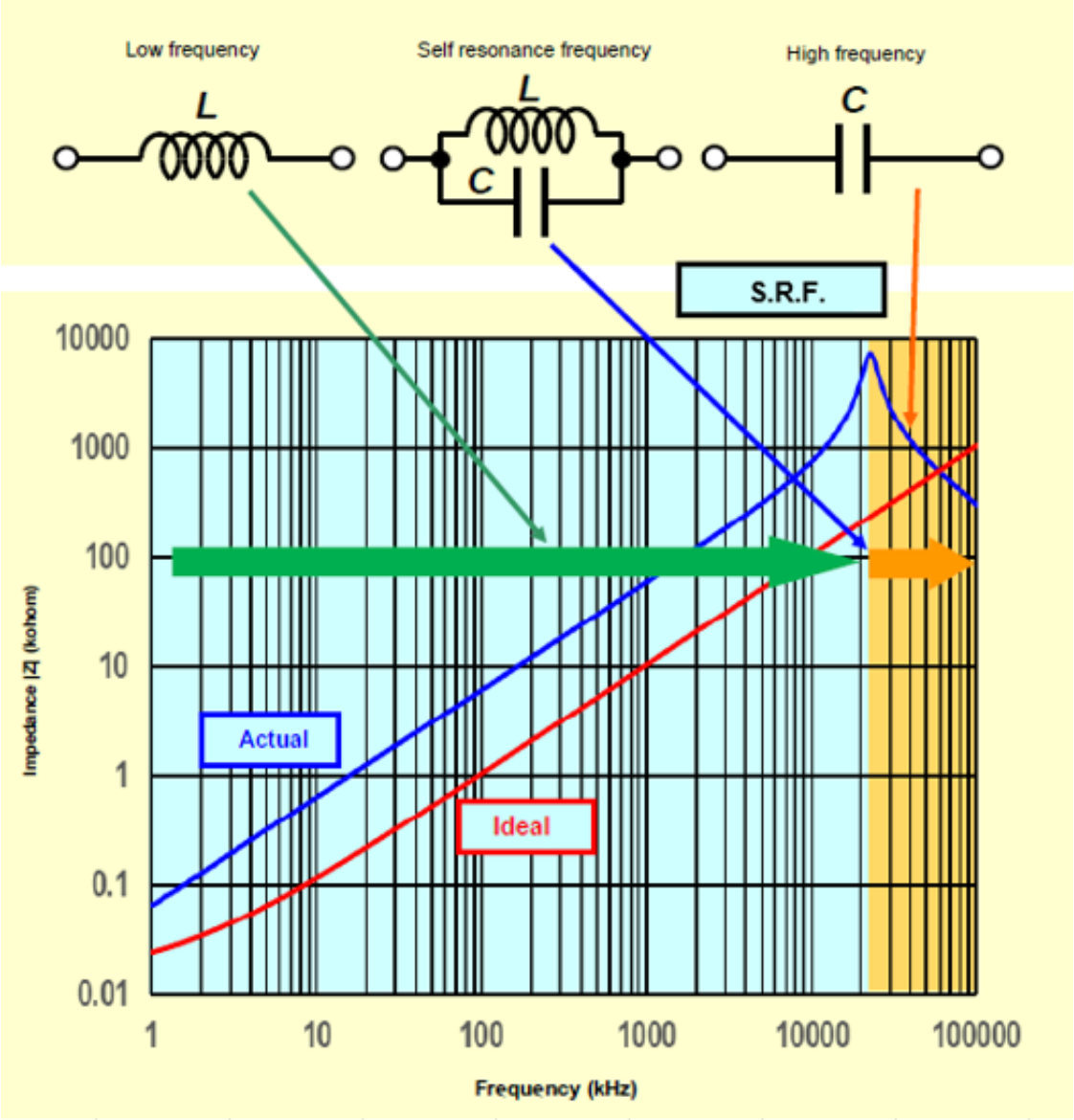


Fig.-1 Equivalent circuits

This capacitance ***Cp*** and own inductance ***Ls*** of inductor resonate, and the frequency response is as **Graph-1**.
Generally, the resonance phenomenon doesn't happen only (with?) the inductance. However, it happens by the resonance itself without connecting capacitor in parallel, so it is called self resonance frequency (**SRF**).
The **SRF** is inevitable, but special coils exist, which decrease ***Cp*** and move the SRF to higher value by devising the coil structure.



Graph-2 Impedance characteristic and Equivalent circuits

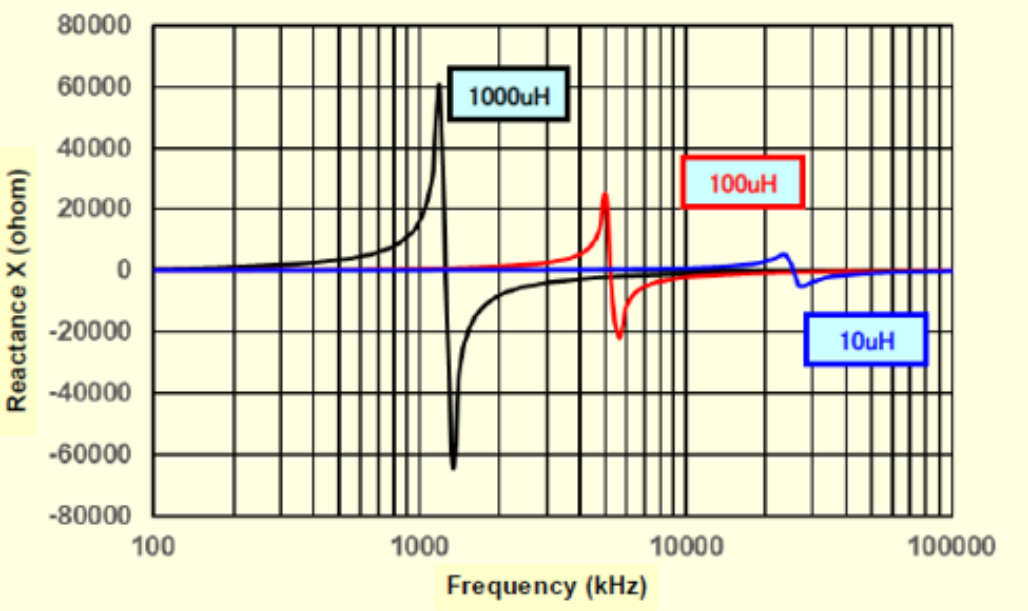
● Actual SRF of inductor

Measurement value for the SRF and stray capacitance (***Cp***) of our power inductor (**CER8065B**) are described in the **Table-1**. In general, the value of stray capacitance does not increase in proportion to the inductance. However, although it doesn't increase so much as the inductance, when the inductance value increases, the stray

Table-1 S.R.F. vs Stray Capacitance

Inductance *Ls* (uH)	Self Resonance Frequency (MHz)	Stray Capacitance *Cp* (pF)
10	26.0	3.7
100	5.2	9.4
1000	1.2	17.6

capacitance will also increase and the self resonance will decrease.
The differences of impedance characteristic for each inductance (position of **SRF**) are shown in **Graph-3**.



Graph-3 Impedance characteristics with different inductance

●Precautions for use related to SRF

1) When the inductors are mounted on a printed wiring board, the stray capacitance increases due to wiring. Therefore, the SRF moves to lower area compared with the case of single inductor.
2) The stray capacitance of inductor is relatively small. So, the self resonance frequency value may significantly change due to increased stray capacitance (capacitance between printed patterns) by mounting.
3) Usually, if the frequency is less than or equal to 1/10 of the self resonance frequency, such effect should not be a big problem.
4) Impedance value increases around the SRF. So if you make better use of that, you may expect to obtain the effect more than inductance value. However it requires a care, for the SRF may vary widely because it is not created intentionally.

Y.Hoshino