APPLICATION NOTE

The Influence of Coaxial Inductors on VCO Tuning Bandwidth

Introduction

Ceramic coaxial transmission lines are commonly used to resonate with a varactor in Voltage-Controlled Oscillator (VCO) circuits. When short-circuited at one end and used below the Self Resonant Frequency (SRF), the coaxial line presents an inductive reactance to the VCO. Performance advantages of the coaxial inductor vs discrete wire coils or chip inductors are acknowledged*. The influence of the coaxial inductor is less obvious on the VCO tuning rate, which is expressed in MHz/Volts.

Unlike an ideal inductor whose reactance varies linearly with frequency, the coaxial inductor reactance increases in a non-linear (tangent-function) manner as the frequency approaches the SRF, as shown in Figure 1.

Although the varactor governs the tuning bandwidth when the inductance is constant, the effective inductance of the coaxial line increases with frequency when approaching the SRF, and opposes the varactor's control. The varactor must be "pushed" further to overcome the increase in effective inductance. For a given control voltage swing, the VCO frequency change is less than with the ideal coil. The tuning bandwidth is reduced when the coaxial inductor is operated near the SRF. Two coaxial lines of a different characteristic impedance (Z_0) but the same SRF have a different effective inductance at f_0.

Figure 1 shows that for a specified nominal reactance of X_L at the VCO f_0 frequency, a lower coaxial line of Z_0 leads to a lower SRF and a more rapid reactance change in the vicinity of f_0. This component gives a lower:

- SRF and a more rapid reactance change in the vicinity of f_0.
- Tuning bandwidth than either a higher-impedance coaxial line or an ideal inductor.

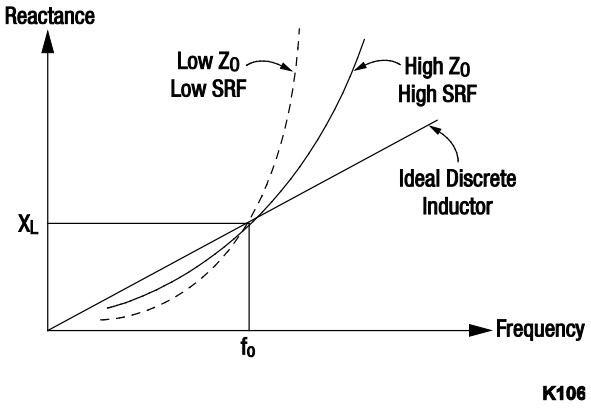

Figure 1. Impedance vs Ideal Inductance

Guidelines

- For widest tuning bandwidth, choose a coaxial inductor with an SRF that is as far as possible above the VCO operating frequency (f_0). Coaxial lines with highest Z_0 and lowest dielectric constant (ε_R) have the highest SRF.
- To restrict tuning sensitivity, use a part with the SRF near f_0. Choose a coaxial inductor with a low Z_0 and high ε_R.

1.8 GHz Direct Frequency VCO with CAD Assessment, RF Design, p29. Brendan Kelly , February 1993.

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