X2Y® Inductance Ratings

Summary

X2Y® capacitors excel in low inductance performance for a myriad of applications including EMI/RFI filtering, power supply bypass / decoupling. Device inductance as mounted in the application determines performance. This application brief explains inductance values published by X2Y®.

Introduction

X2Y® capacitors are four terminal parts most commonly used in one of two configurations: Circuit 1 for EMI filtering, or Circuit 2 for power delivery bypass / decoupling.

Device Only & Mounted Inductance

Inductance always evaluates around a loop. Capacitor inductance ratings reflect the conditions under which they are tested and after fixturing effects have been deembedded. To obtain "device only" inductance, X2Y® performs 2 port VNA measurements using advanced test fixtures from InterContinental Microwave. These fixtures connect to the DUT using low-loss grounded coplanar waveguides. Across all licensee manufacturers X2Y® 0603 capacitors exhibit 56pH or less parasitic inductance.

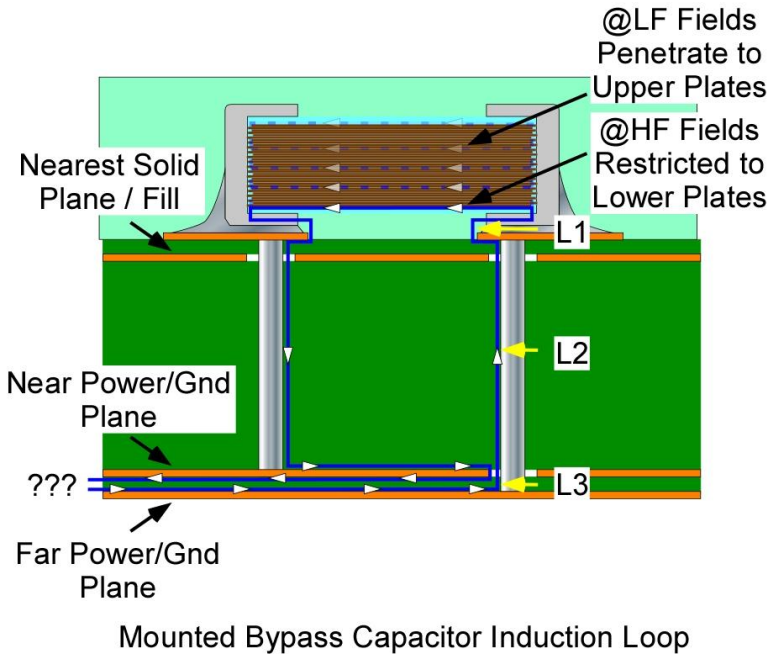

Figure 1, Bypass Capacitor Mounted Inductance

For bypass applications, X2Y® obtains values for L1 in Figure 1. To do this, X2Y® uses a series of three layer fixtures developed by Teraspeed Consulting Group and SigCon. These fixtures permit accurate characterization of device

plus attachment plus via inductance for capacitors mounted at various heights above the PCB RF plane closest to the DUT.

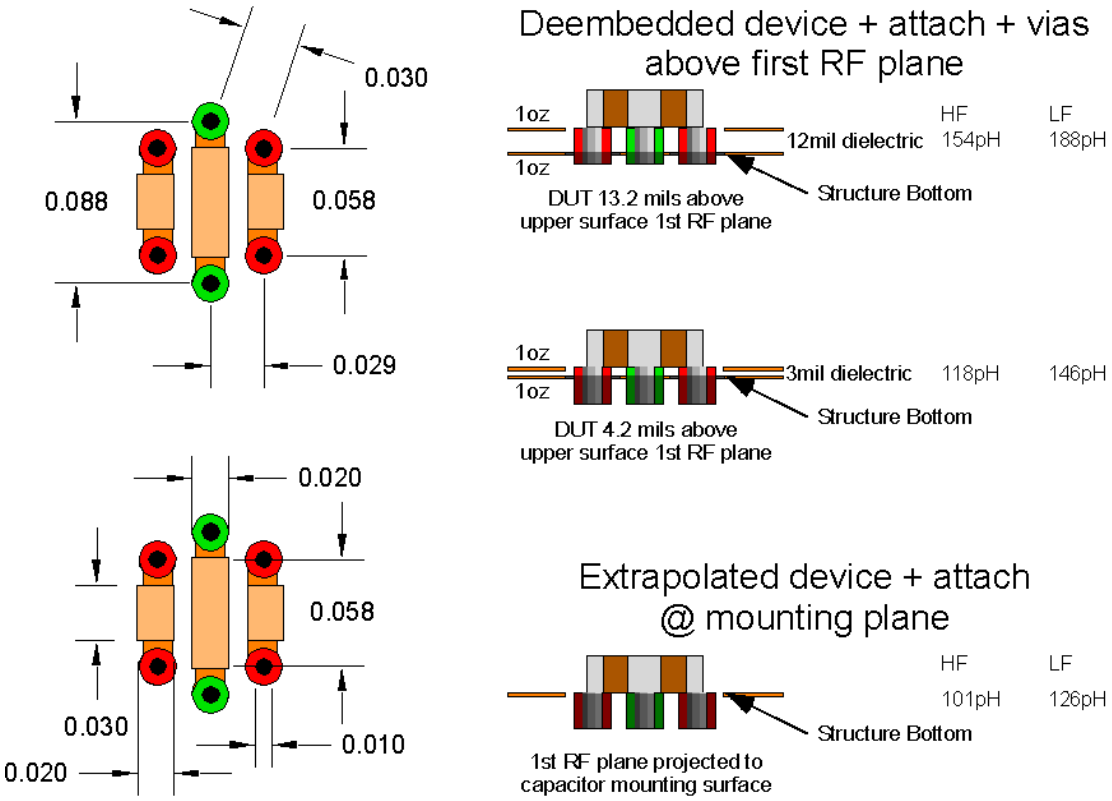

Figure 2, X2Y® Recommended Layouts, and Bypass Measurements

Figure 2 illustrates X2Y® recommended 0603 layouts, and the test fixture configurations used. Measured results include values for both low and high frequency operation. The inductance of a mounted MLCC capacitor decreases with increasing frequency due to skin effect in the plates of the capacitors themselves. Low frequency fields penetrate the capacitor body more deeply, increasing the mean Z axis height, loop size and inductance. High frequency fields cannot penetrate beyond the bottom device plates. This reduces the mean Z axis height, loop size and inductance compared to low frequency operation.

For X2Y® capacitors connected in a Circuit 2 configuration (power supply bypass), mounted inductance decreases by about 40pH at frequencies above 100MHz compared to operation at a few MHz.

Measurements show that over a dielectric thickness range of 3-12mils between the top PCB foil and the first PCB RF plane, mounted inductance changes by less than 5pH / mil. Field solver and measurement results also show that as vias extend past the first RF plane, attached inductance increases by 5pH / mil. The effective device plus mount inductance is 126pH at low frequency, and 101pH at high frequency.

Closer Plane Depth (Distance from capacitor mounting surface to closest surface of power cavity plane)	Typical Inductance LF	HF
4mils[1]	146pH	118pH
10mils	177pH	146pH
15mils	198pH	164pH
20mils	218pH	184pH
25mils	238pH	204pH
30mils	258pH	224pH
35mils	278pH	244pH
40mils	298pH	264pH
45mils	318pH	284pH
50mils	338pH	304pH
55mils	358pH	324pH
60mils	378pH	344pH
65mils	398pH	364pH
70mils	418pH	384pH
75mils	438pH	404pH
80mils	458pH	424pH
85mils	478pH	444pH
90mils	498pH	464pH
95mils	518pH	484pH
100mils	538pH	504pH
105mils	558pH	524pH
110mils	578pH	544pH
115mils	598pH	564pH

Table 1, Typical Mounted Inductance by Plane Location, X2Y® 0603

Conclusion

X2Y® capacitors exhibit low "device only" inductance as characterized using low-loss grounded coplanar waveguides. However, many power supply bypass / decoupling applications use vias for attachment to PCB planes and device inductance as mounted in the application determines performance. X2Y® capacitor mounted inductance for recommended mounting configurations has been shown for various PCB plane depths.

Contact Information

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To visit us on the web, go to http://www.x2y.com.

[1] 4.2 mils as 3mils dielectric + 1.2mils 1oz/sq ft Cu