X2Y® Capacitor Models for Use with Cadence Allegro PCB PI OPTION XL®

Summary

X2Y® capacitors afford superior performance in power bypass / decoupling applications. This application note explains how the Cadence Allegro PCB PI tool uses X2Y capacitor models.

Introduction

Cadence Allegro PCB PI OPTION XL® is a power integrity planning and analysis add-on to Allegro PCB SI. The PI Option provides analysis of the power delivery system including: Voltage regulator modules, bulk capacitors, bypass capacitors and PCB power cavities. The tool relies on user / vendor supplied data to characterize board level components.

Power Distribution Network

A PCB power delivery system may include a number of interrelated components:

- **V**oltage **R**egulator **M**odule(s), VRM(s)

- Bulk capacitors

- High frequency bypass capacitors

- Power plane cavitie(s)

Each of these components plays a role in determining the power system impedance over a range of frequencies. Additionally, components that dominate impedance in a given frequency range interact strongly with components that dominate in the adjacent frequency range(s). The Allegro PCB PI Option endeavors to consider behavior of and interactions between the PCB power system discrete components as well as the physical interconnects and plane cavities.

Allegro PCB PI Option® Bypass Capacitor Modeling

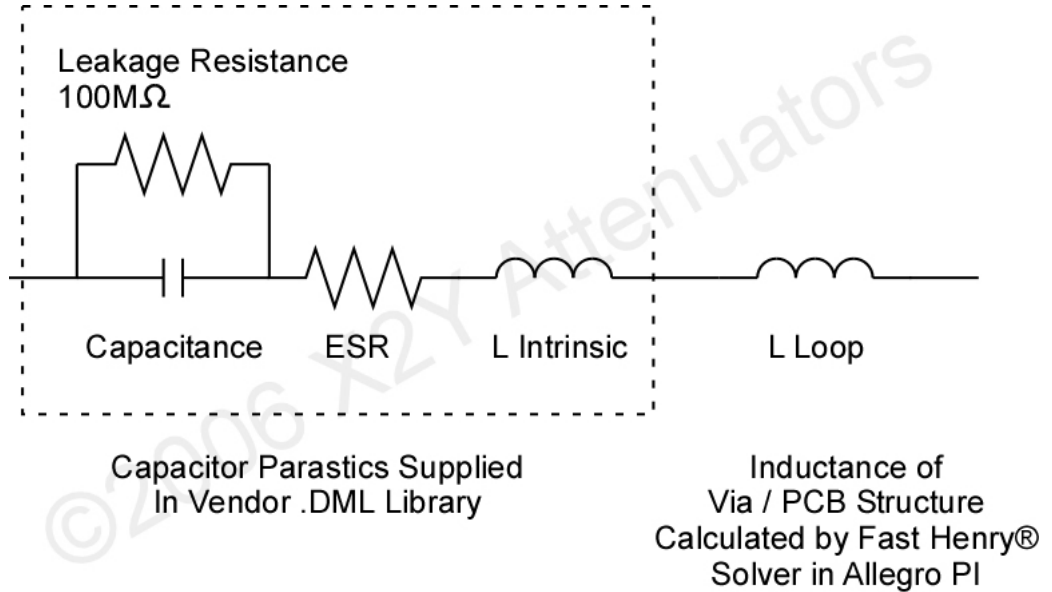Allegro PCB PI® models mounted capacitors as a single L-L-R-C branch:

Figure 1. Cadence Allegro PI® Bypass Capacitor Electrical Model

The L Intrinsic value represents the difference between the measured inductance of the capacitor on a test fixture, and the inductance measured on the same fixture replacing the capacitor with a shorting plate:
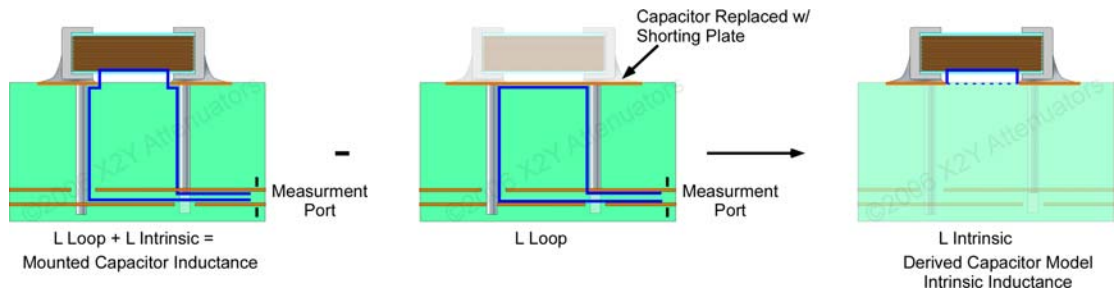

Figure 2. Allegro PI® Bypass Capacitor Modeling Method

Allegro PI® uses the Fast Henry® engine to solve for L Loop based on the via geometry and stack-up of the application PCB design. Allegro PI® then adds the calculated L Loop to the vendor supplied model L Intrinsic to arrive at the total mounted capacitor inductance.

Inductance Variation with Frequency

Mounted capacitor inductance is not constant with frequency. Physical construction details of capacitors determine how much variation occurs with frequency. X2Y® capacitors employ patented techniques that limit the inductance variation versus frequency. Figure 3 demonstrates that the effective inductance of mounted parts at low frequency is just 1.45dB (24%) higher than the effective value at 700MHz and beyond.
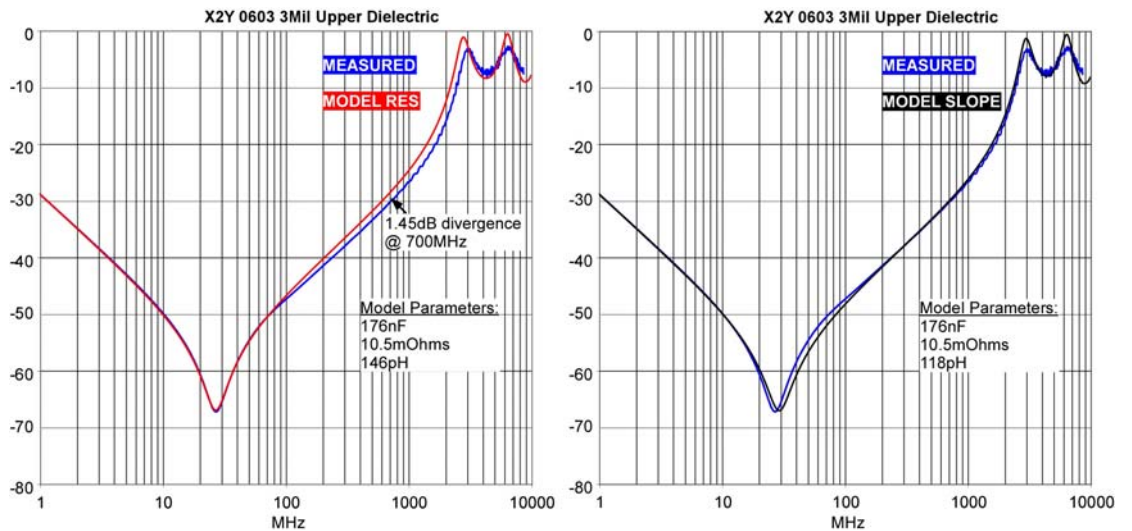

Figure 3.   Figure 3, Inductance Variation w/ Frequency Mounted Bypass Capacitors

X2Y® supplied Allegro PI® models use the more conservative higher inductance values extracted at lower frequency. Inductance values remain accurate typically to better than 1dB from DC through 300MHz+.

For best accuracy using the Allegro PI® tool, X2Y® recommended land patterns should always be used.

Conclusion

X2Y® supplied models for the Cadence Design System's® Allegro PI Option XL® simulation tool affords high simulation accuracy over a broad frequency range.

Contact Information

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