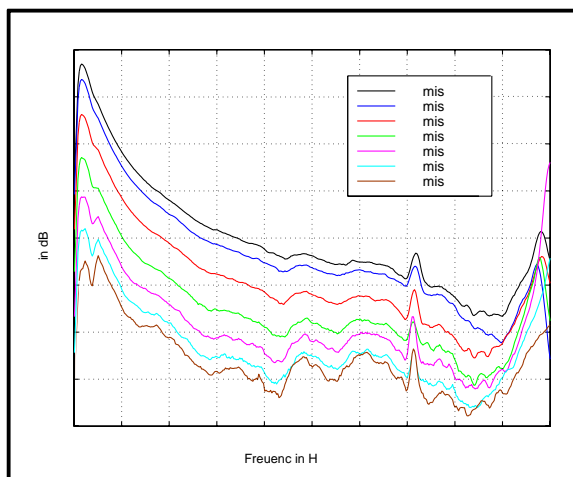




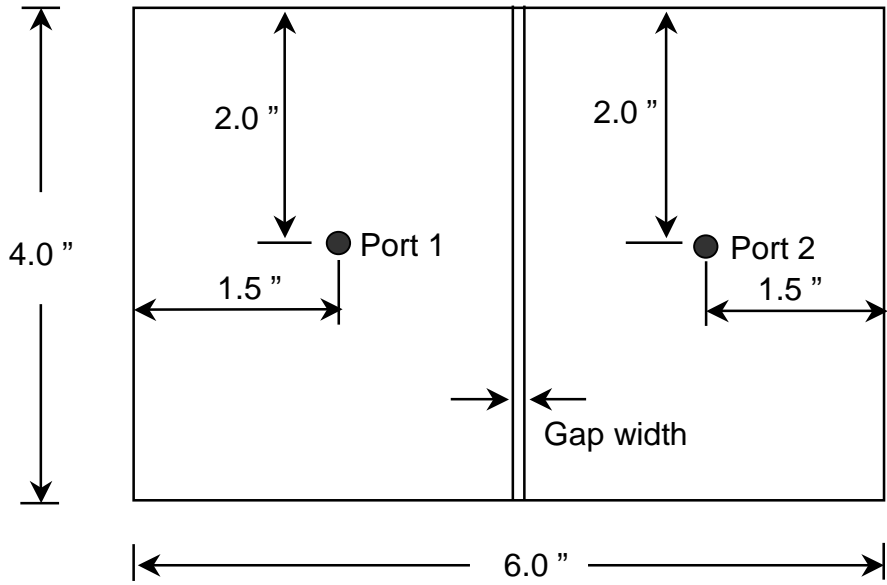
Power Bus Noise Reduction using Power Islands in Printed Circuit Board Designs



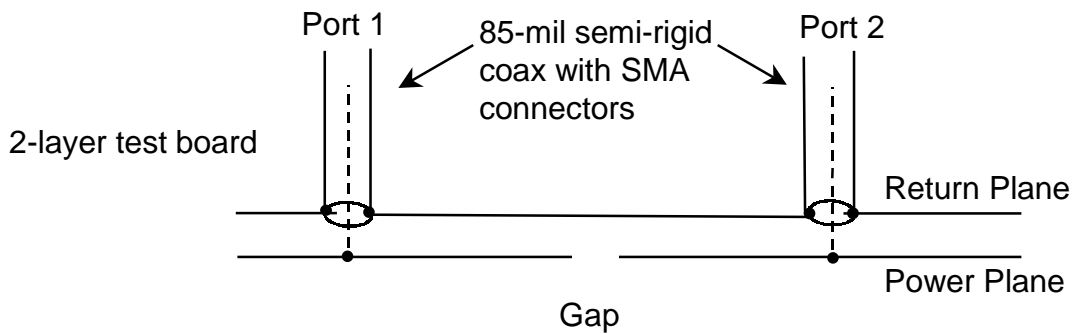
Todd Hubing
Juan Chen
James Drewniak
Tom Van Doren
Yong Ren
Jun Fan
Richard DuBroff

November 11, 1999

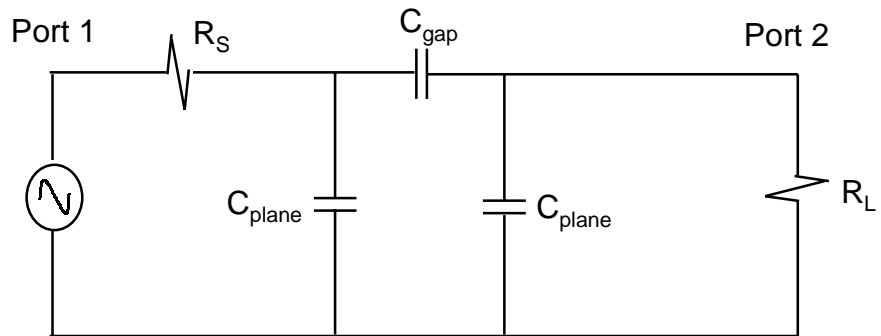
Test Board #1



Thickness: 63 mils



Lumped Circuit Model



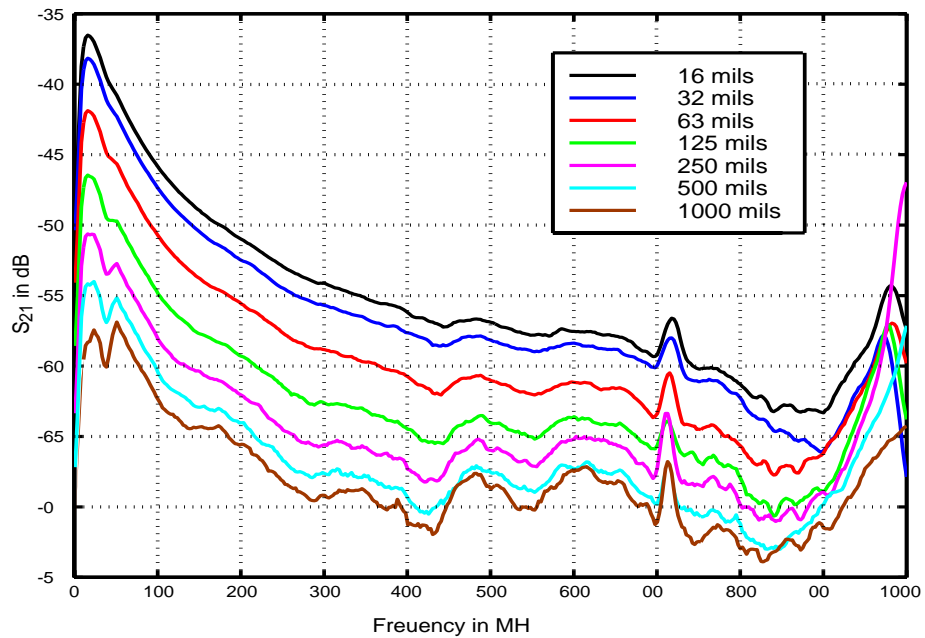
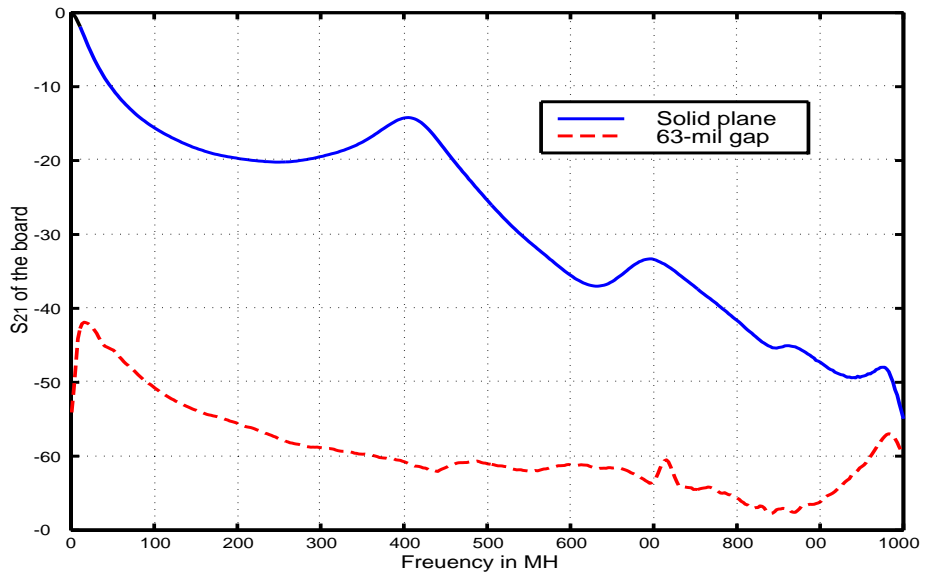
$$R_s = R_L = 50 \text{ ohms}$$

$$C_{plane} = 180 \text{ pFs}$$

$$C_{gap} = \text{several pFs}$$

This is a simple circuit model for an S21 measurement of our test board that has a power bus with a gapped power plane.

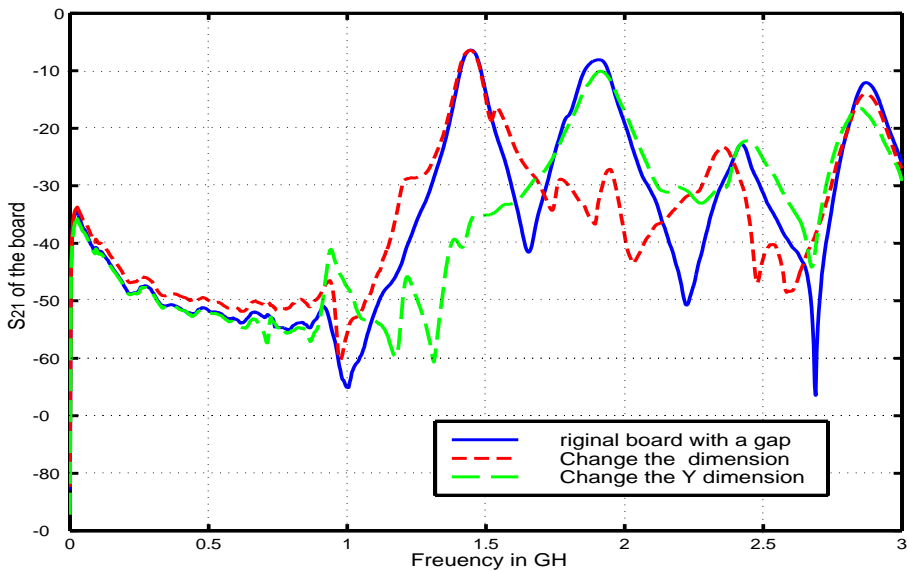
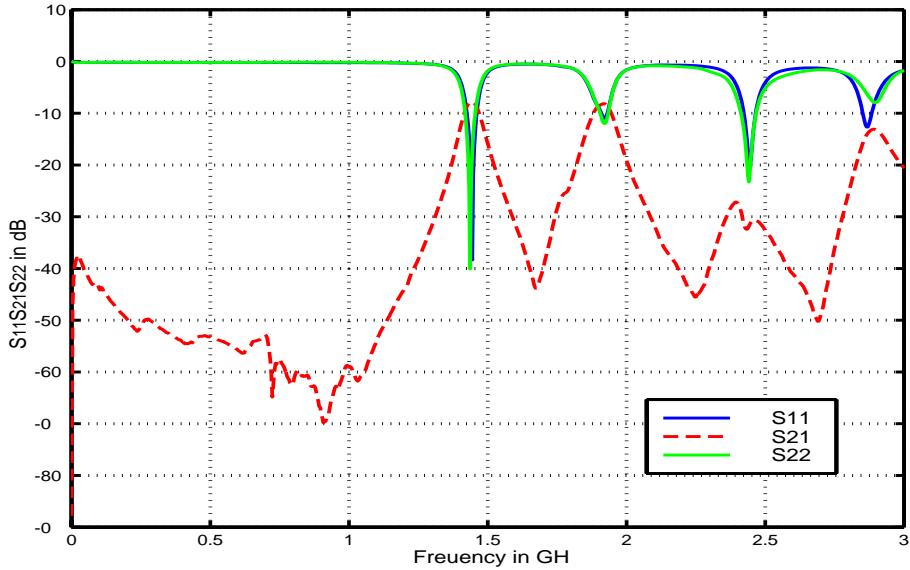
Effect of Gap (0 - 1 GHz)



Wider gaps are more effective than narrow gaps. Gaps should be at least as wide as the power plane spacing.

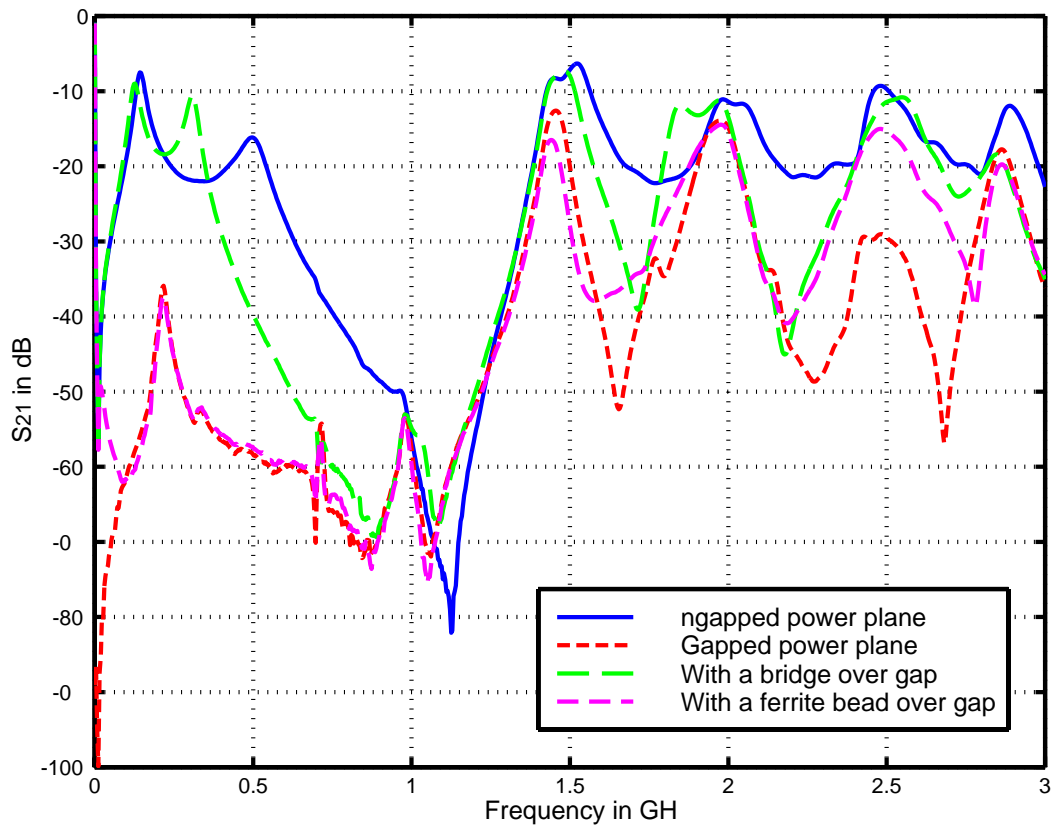
Effect of Gap (0 - 3 GHz)

Power Plane Resonances



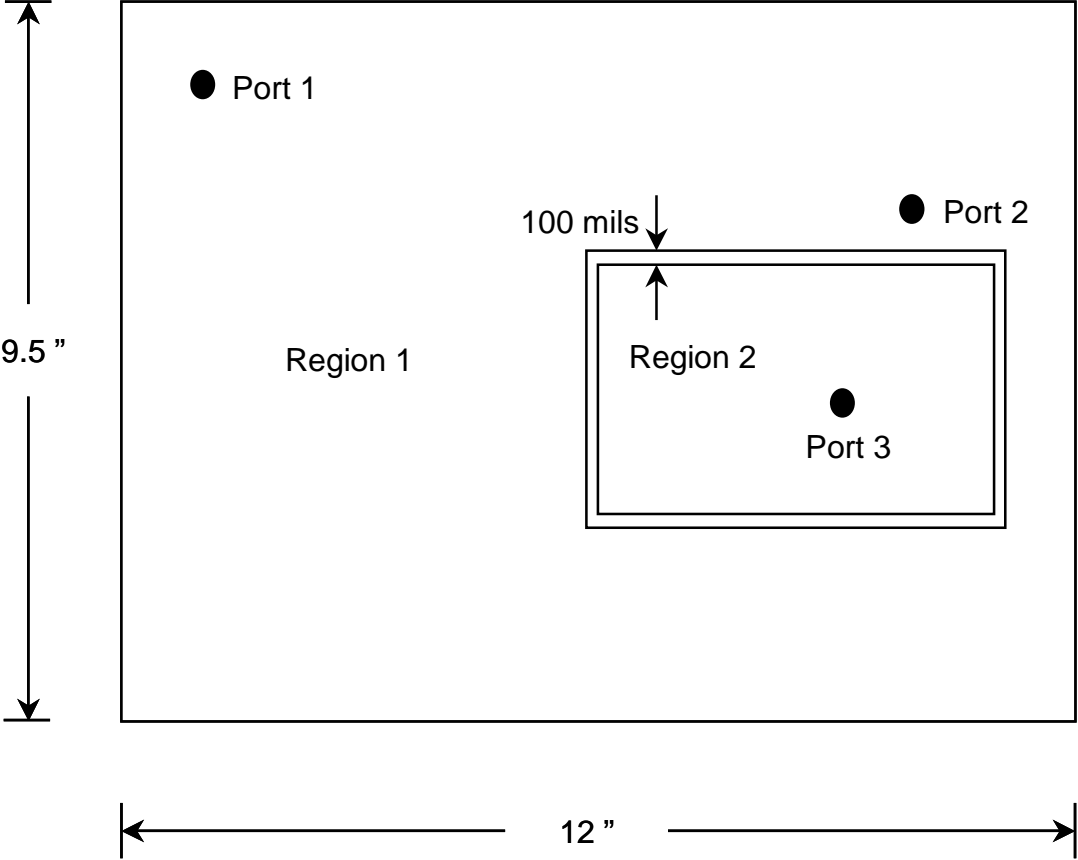
At high frequencies, gaps may be ineffective due to power bus resonances.

Connections Bridging the Gap

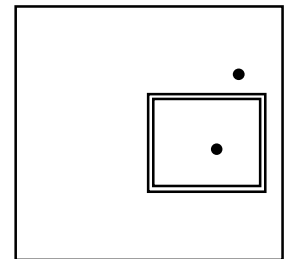
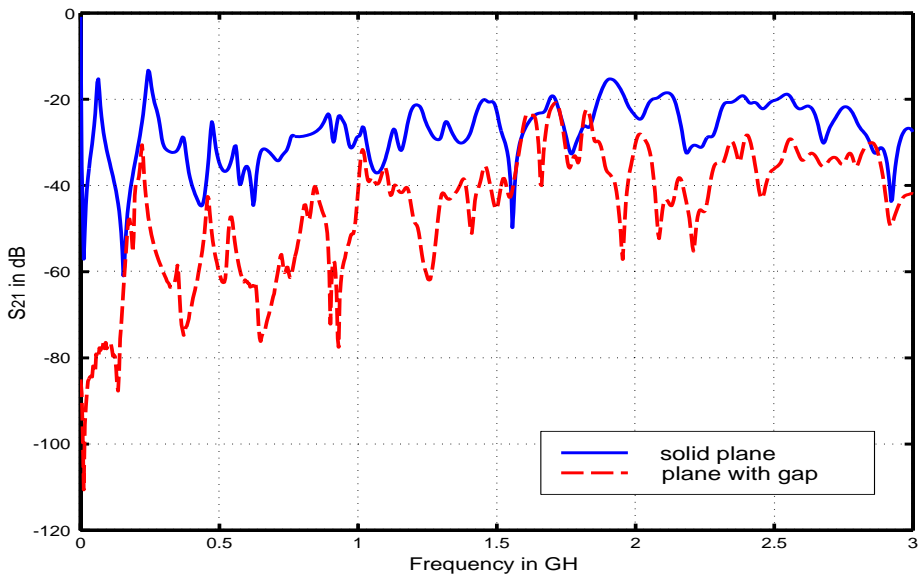
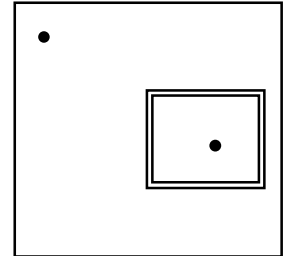
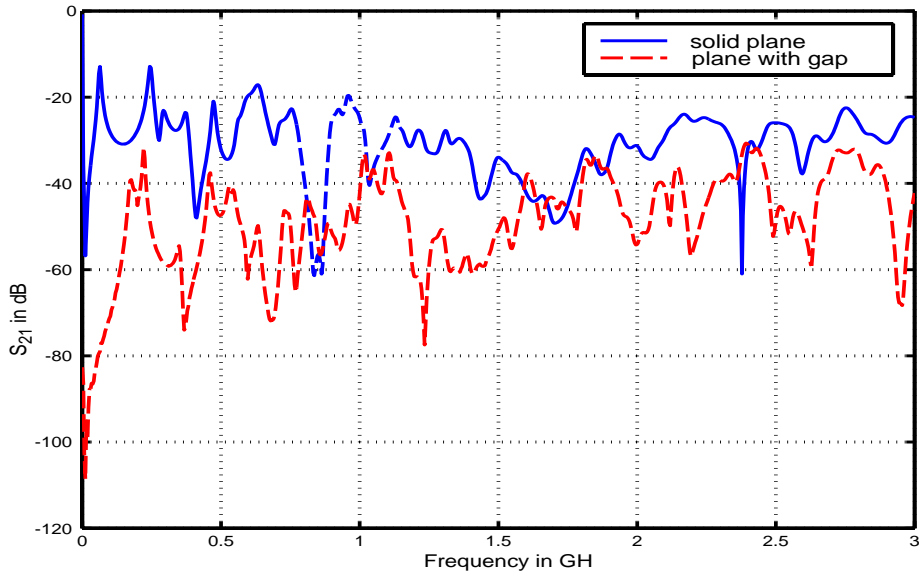


A power “peninsula” is not as effective as a power “island”. Connections to a power “island” can be made using an appropriate ferrite bead. Be careful that the power currents do not saturate the ferrite.

Layout of an Asymmetric Power Bus

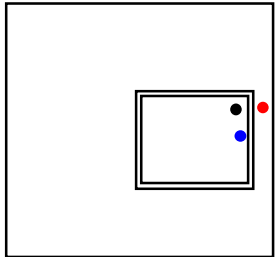
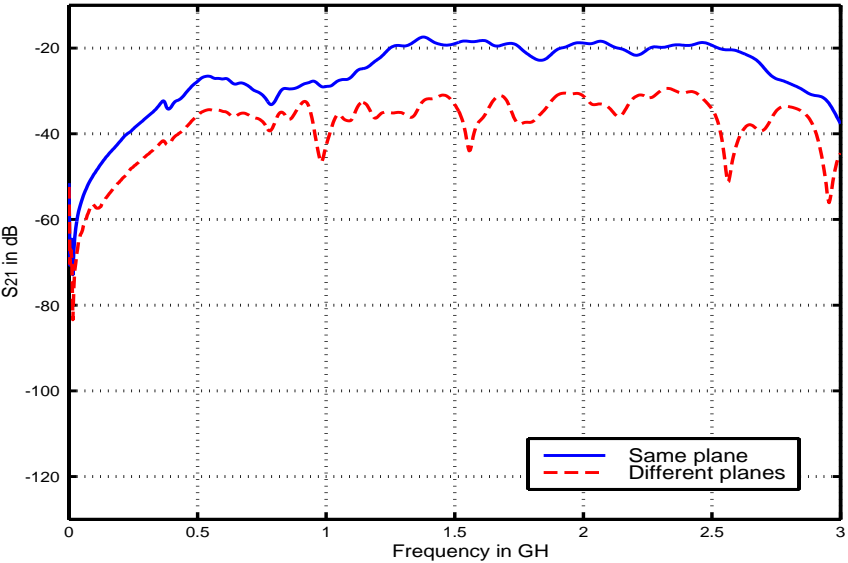
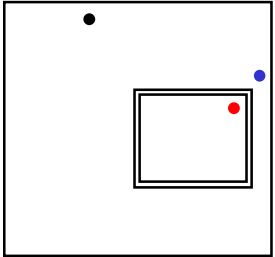
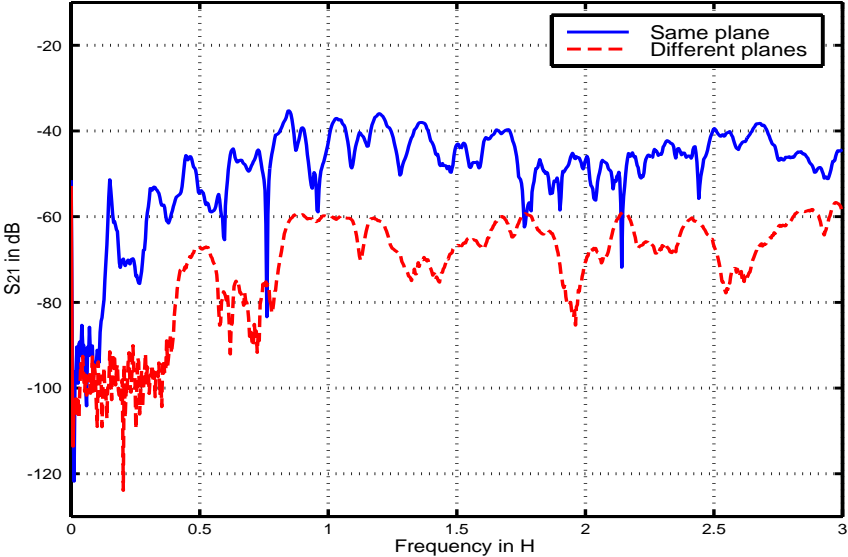


Effect of Gap with Asymmetric Power Bus



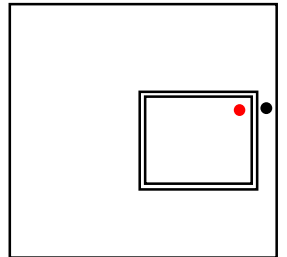
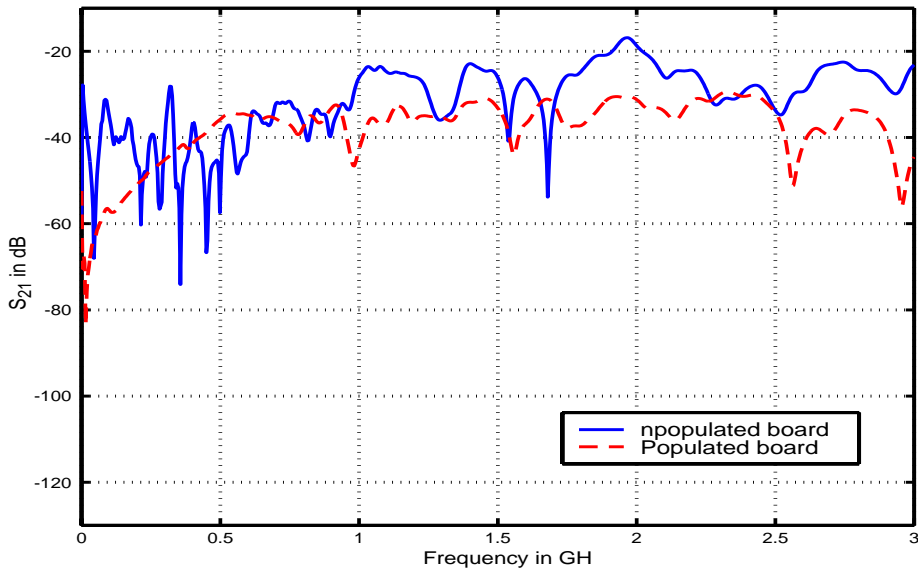
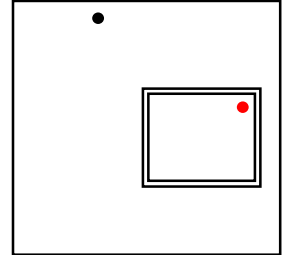
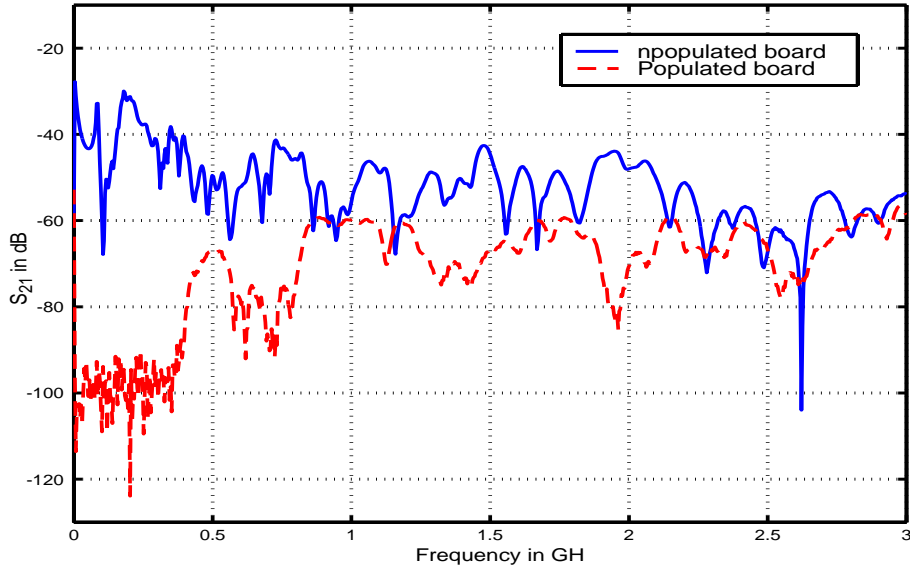
Power islands provide effective isolation at high frequencies if the island and the rest of the power bus do not share any of the same resonant frequencies.

Effect of Gap in a Populated Board



The isolation was reasonable (>5-10 dB) even when the ports were near each other on opposite sides of the gap. These boards were fully populated with components.

Isolation of Unpopulated & Populated Boards



Conclusions

- Gaps can improve isolation between power planes.
wide gaps, no necks
- Gap width should be greater than height above return plane.
typically 10 - 60 mils (0.25 - 1.5 mm)
- Gaps bridged by thin necks are ineffective.
impedance too low below 1 GHz
- Ferrites can sometimes be used to bridge gaps.
ferrite must have significant HF impedance
- Gap may be ineffective at board resonances.
if located at a null in current distribution
- Gaps can improve isolation in populated boards.
same rules as unpopulated boards
- Populated boards have better power bus isolation than unpopulated boards.
*low frequency decoupling
high frequency damping of resonances*