Heatsink Grounding Simulation Example with HFSS

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ANSOFT

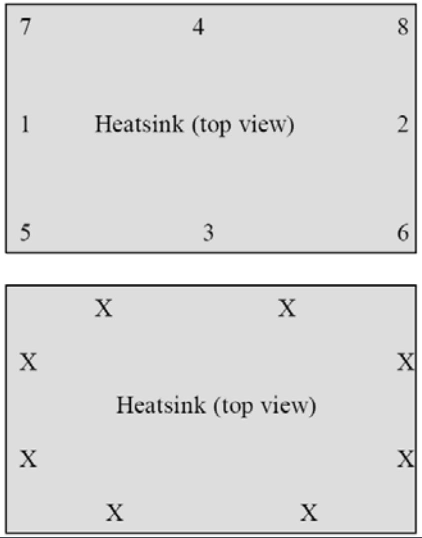
Overview

- A standard published problem is used to investigate the effects of heatsink grounding
- With many high speed signals running through high-current chips, heatsinks can be a major generator of EMI.
- Re-visit this standard benchmark to investigate how the grounding relates to EMI
- This presentation will go over the comparisons of different via strategies, and how they help reduce emissions.

Standard Problem

- The standard heatsink problem is defined in the following paper:
  - "Comparison of Various Numerical Modeling Tools Against a Standard Problem Concerning Heat Sink Emissions," B. Archambeault, S. Pratapneni, L. Zhang, D. Wittwer
- This is published as part of a standard EMI problem set on the following website:
  - http://www.ewh.ieee.org/cmte/tc9/
- All ground plane and heatsink dimensions specified
- Heatsink and ground vias modeled as solid perfect conductor objects
- Grounding vias placed in various locations to investigate effective frequency range of emissions

Standard Heatsink



One Ground Point #1

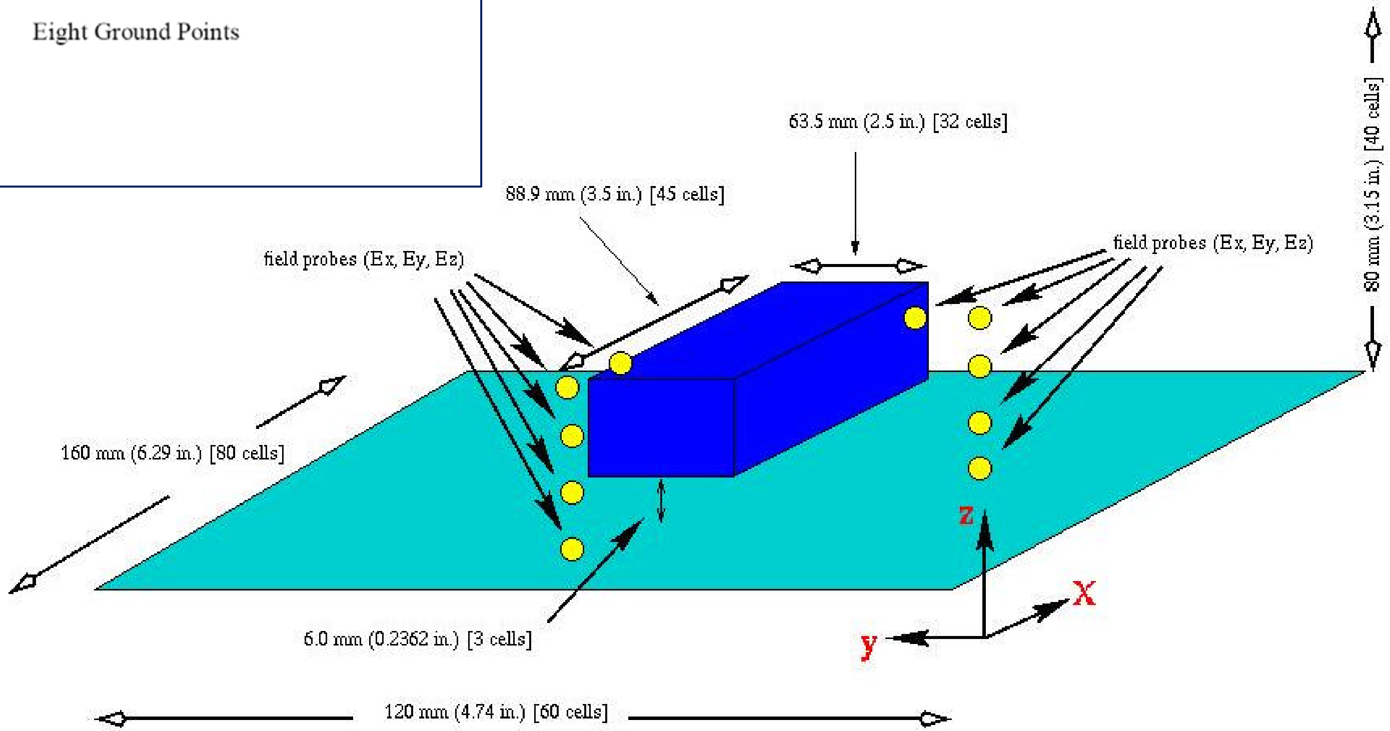
Two-end Ground Points #1,2

Two-side Ground Points #3,4

Four Edge Centered Ground Points #1,2,3,4

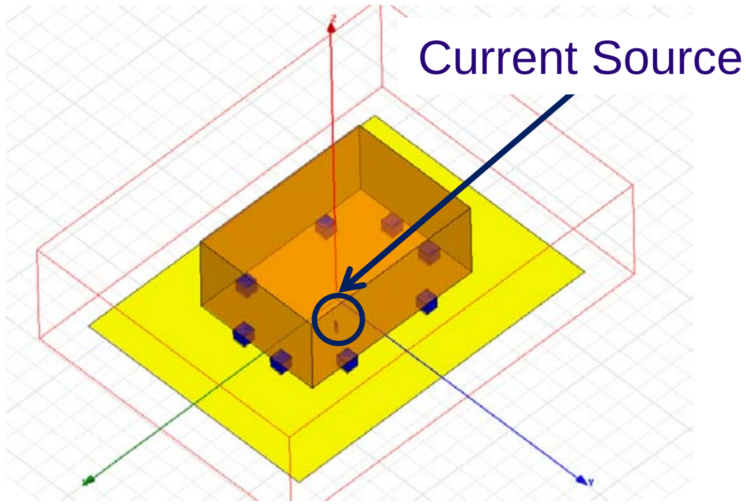
Four Corner Ground Points #5,6,7,8

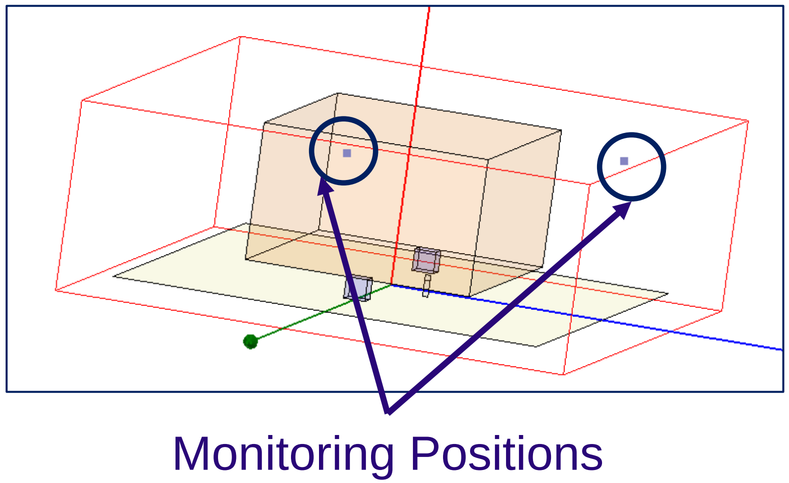
Eight Ground Points



Heatsink Stimulus & Observation

- The excitation position is fixed as slightly offset from center of heatsink:
  - Excites multiple modes of heatsink
- A Current source was chosen for simplicity
  - Excites 1A of current between heatsink and ground plane
- Two points were chosen to monitor the field values – (80mm, 0, 44.1mm) & (0mm, 60mm, 44.1mm)
- The cmplxMag of E_x, E_y, and E_z were monitored at both of these points along with cmplxMag(E_{total})

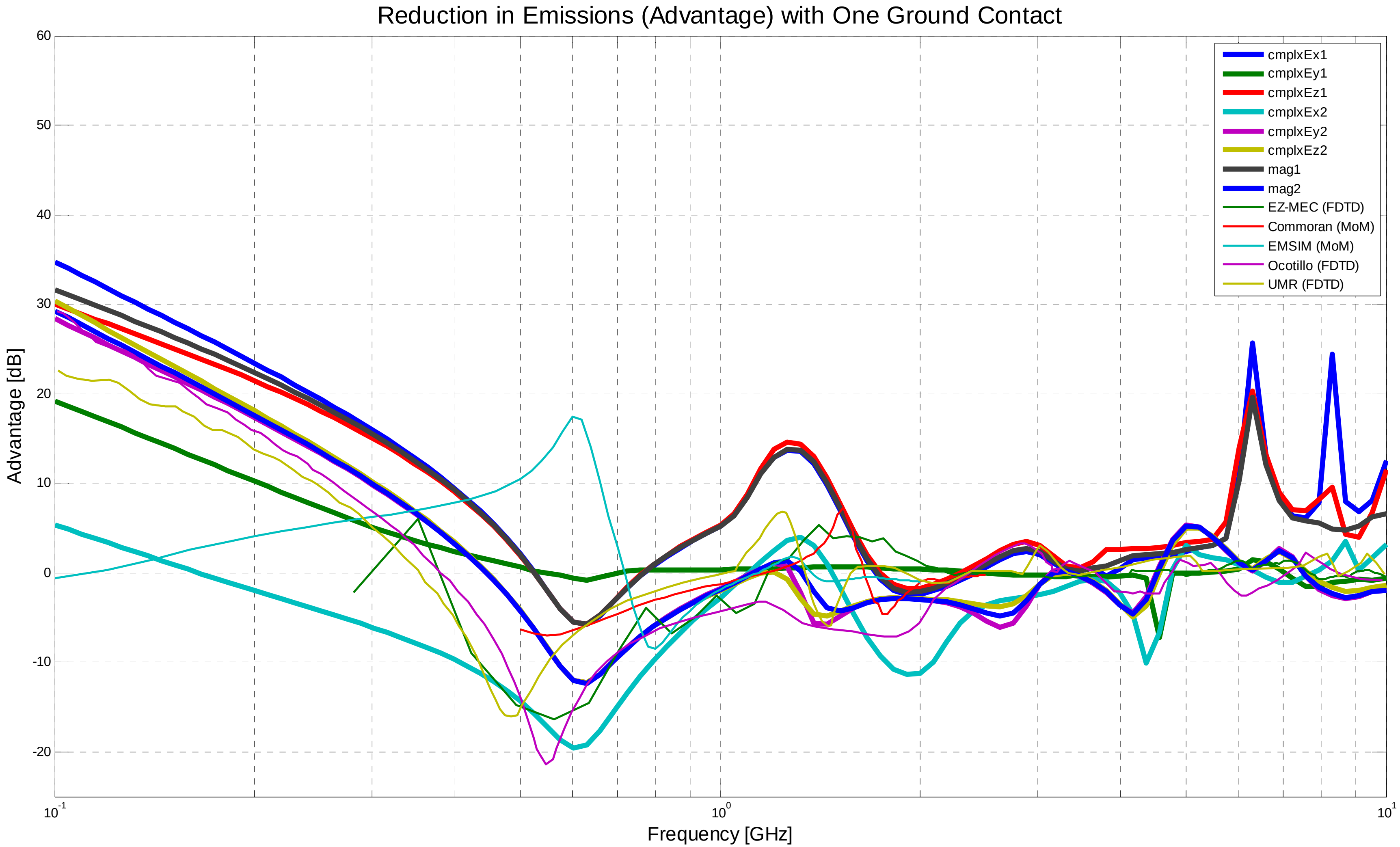




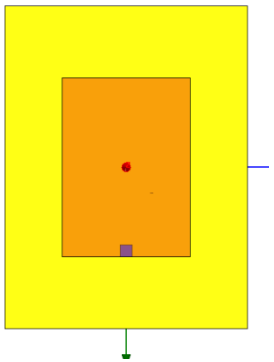
Heatsink Calculations

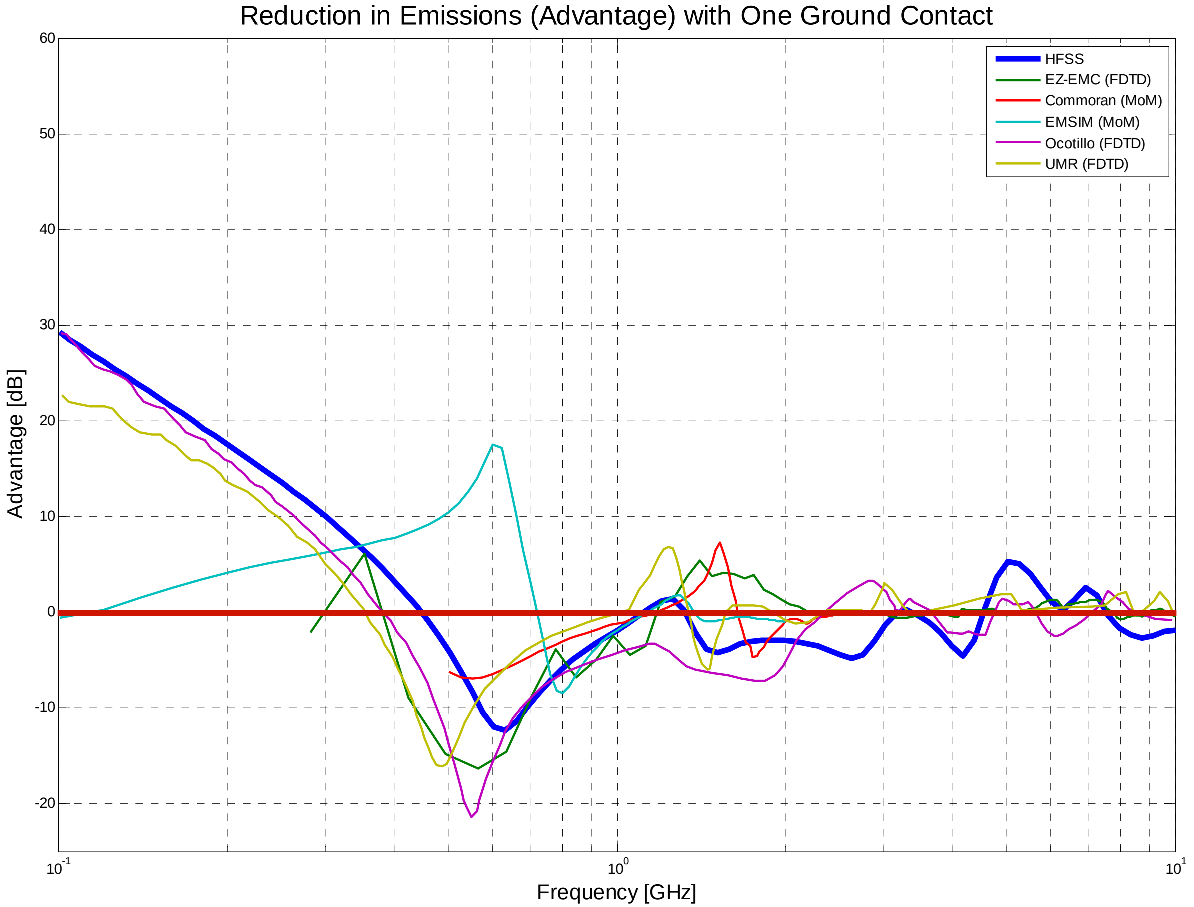
- Generating an absolute EMI measurement is extremely difficult
- An "Advantage" quantity is defined for the purposes of this investigation
- Using the heatsink problem with NO grounds as the reference:
  - Advantage(dB) = reference(dB) – trial(dB)
  - advantage = 20 * log(mag2_no_grounds / mag2_1_ground)
  - mag2_ground = sqrt(cmplxEx^2+cmplxEy^2+cmplxEz^2)
- To determine the best observation quantity and position, the various advantage curves were overlayed with the previously published results in the paper.
- While most observations followed the trend nicely, cmplxMag(Etotal) at observation point 2 matched the best, and was used throughout the rest of the trials.

Heatsink Calculations



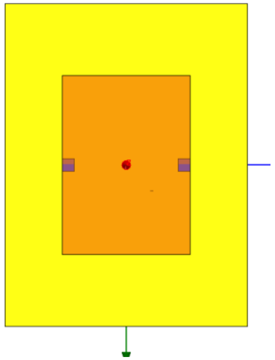
Comparison – 1 Ground

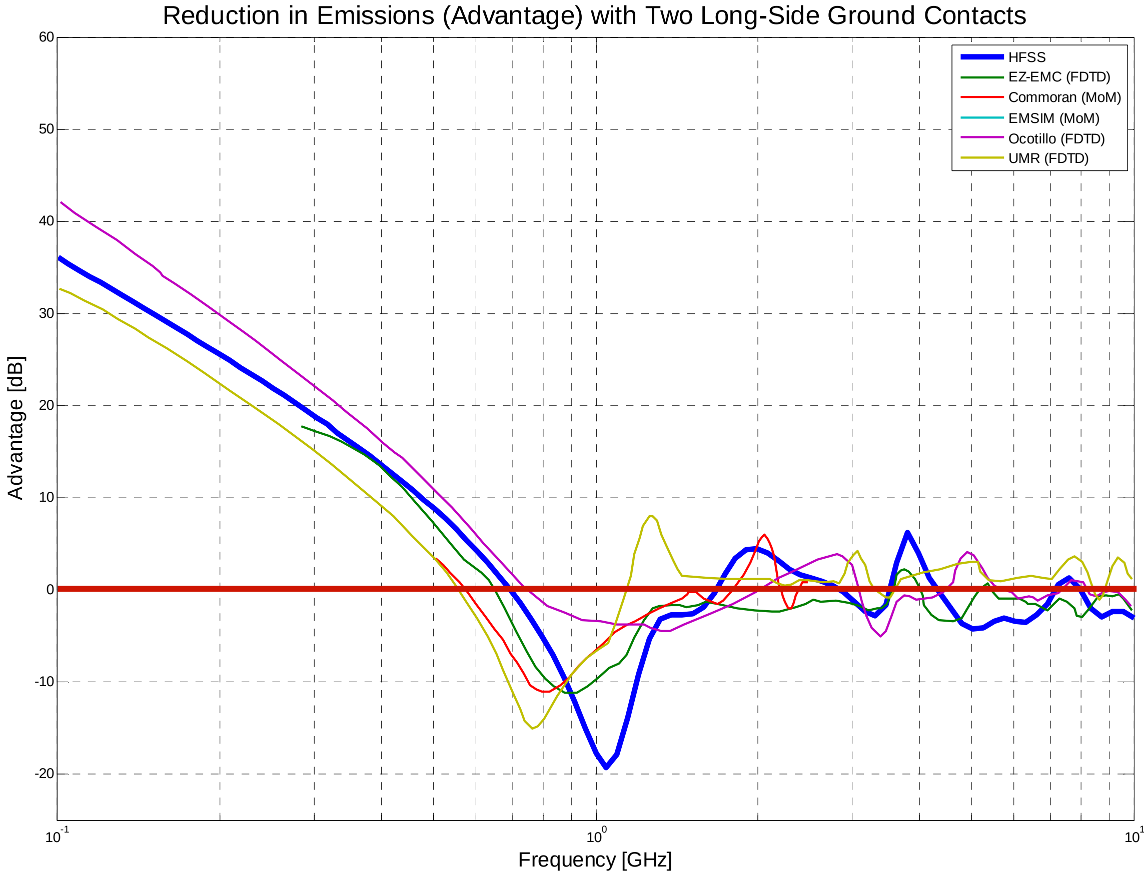




- One ground via provides an “advantage,” or reduction in emissions over no grounds, for frequencies up to 450 MHz.

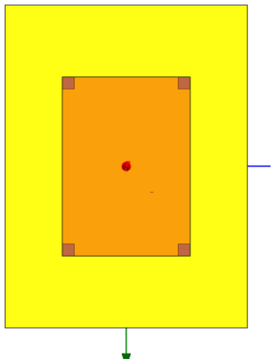
Comparison – 2 Side Grounds

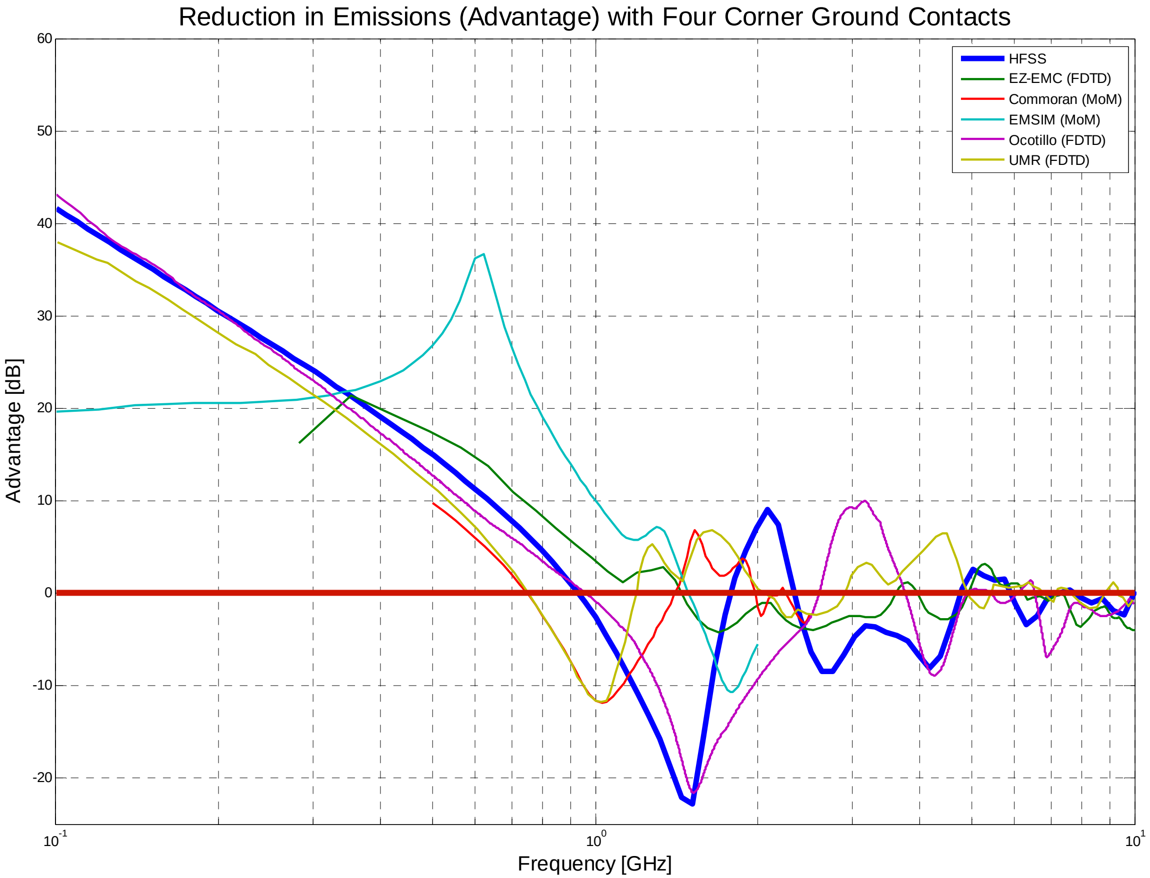




- Ground vias now placed on either long side of the heatsink
- This increases the effective frequency range to 700 MHz

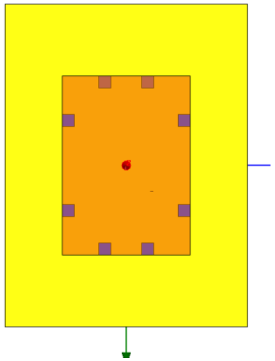
Comparison – 4 Corner Grounds

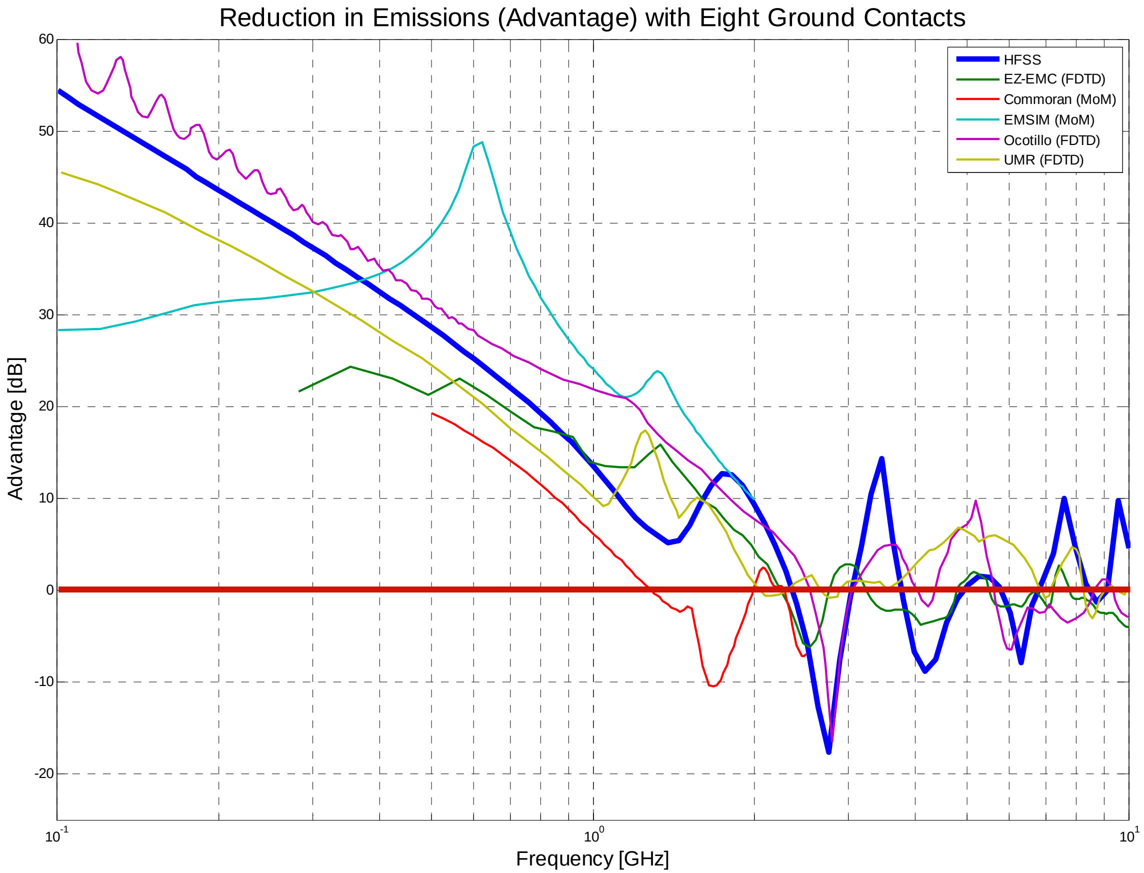




- Ground vias added to all four corners of heatsink
- Pushes the frequency advantage to 900 MHz

Comparison – 8 Grounds





- For this example, ground vias removed from corners, and multiple vias placed along sides of heatsink
- Improved effectiveness range to > 2 GHz

Conclusions

- Adding more vias to ground a heatsink improves the EMI performance relating to the frequency content of the emissions.
- More vias pushes out the “cutoff” frequency of the EMI advantage