Dipole Antenna for Experimental EMI Shielding Effectiveness

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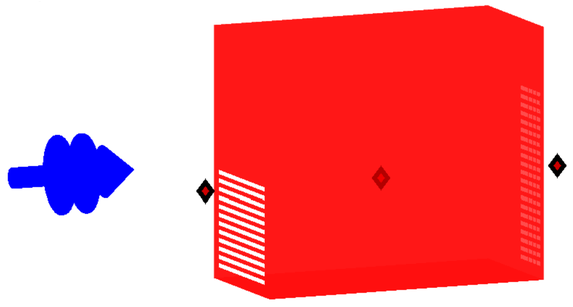
Introduction

- Electromagnetic interference (EMI) is a growing concern for modern technologies in both civilian and defense applications.
- Modern devices operate at higher frequencies to support wireless communication and radar capabilities.
- Higher frequencies are more susceptible to EMI, making shielding solutions a high priority.
- Simulations with computational electromagnetic tools, such as CEMS, often assume an ideal plane wave, which does not reflect real-world constraints.
- As a result, we designed a modified half-wave dipole antenna that generates a realistic incident wave for shielding effectiveness tests.
- Our solution leverages successes and failures from previous iterations [1, 2], including the effectiveness of shunt elements.

Shielding Solution

- Testing the shielding effectiveness of a computer case.
- Apertures are made to provide ventilation while still offering proper protection.



Antenna Design

Classic Dipole (left):

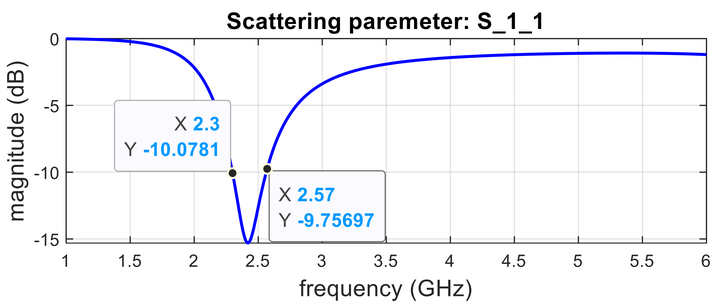
- Arms: 1mm x 1mm x 29mm each
- Port: 1mm x 1mm x 2mm

Modified Dipole (right):

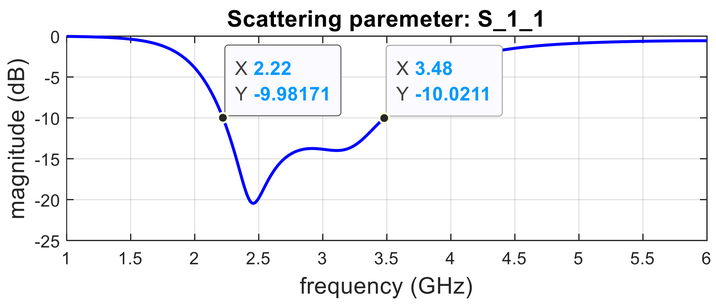
- Four shunt elements added.
- Two extend in the x-direction, two in the y-direction.
- In each direction, one shunt points up (+z) and the other down (–z)

S11 Scattering Parameters

- Classic dipole bandwidth at -10dB: 11.09%

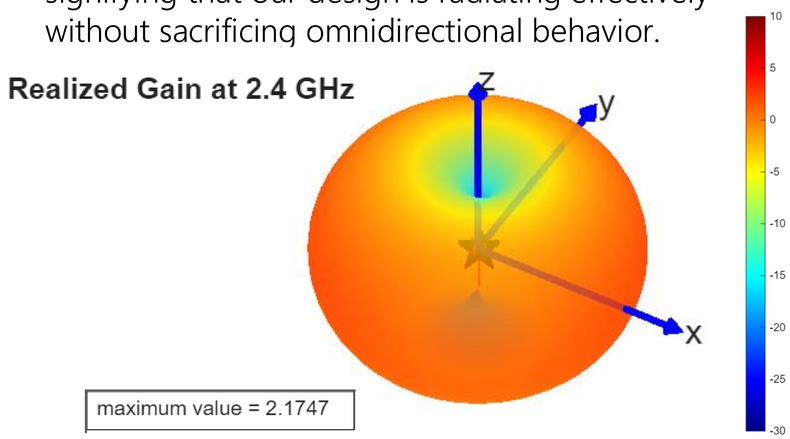


- Modified dipole bandwidth at -10dB: 44.5%
- Demonstrates a bandwidth increase of over 30%



Analysis

- Our dipole was designed to be 60 mm in length, derived from the half-wave dipole antenna equation at 2.4 GHz.
- The S11 plot shows reflected power and resonance.
- The modified dipole achieves 44.5% bandwidth at –10 dB, far greater than the classic dipole.
- Shunt elements improve matching and maximize power transfer.
- We achieved a realized gain of 2.17 at 2.4 GHz, signifying that our design is radiating effectively without sacrificing omnidirectional behavior.



Conclusion and Future Work

- Our modified dipole achieved over a 30% improvement in wideband performance.
- This provides a viable alternative to the unrealistic plane wave typically used in EMI shielding simulations.
- The next step is to replicate or improve bandwidth results with a monopole antenna.
- Early results are promising, with ongoing iterations expected to further improve performance.

References

- [1] G. R. Hoch, P. Nayeri and A. Elsherbeni, "Bandwidth enhancement of dipole antennas using parasitic elements," 2015 31st International Review of Progress in Applied Computational Electromagnetics (ACES), Williamsburg, VA, USA, 2015, pp. 1-2.
- [2] H.-T. Hsu, J. Rautio, and S.-W. Chang, "Novel planar wideband omni-directional quasi logperiodic antenna," Asia Pacific Microwave Conference (APMC), Suzhou, China, Dec. 2005.

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