Title:

FDTD Model of Wire Antenna with Incident Wave for EM Field Measurement

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FDTD Formulation of the Problem

- FDTD computations a uniform space lattice cubic Yee cells having $\Delta x = \Delta y = \Delta z = \Delta$
- 10 Δ thick unsplit Perfectly Matched Layer (PML) is considered
- This PML is spaced 3 Δ cells from the closest surface of the scatterer.
- Gaussian pulse is taken as the excitation source

$$E^{t}_{z_{i,j,k}} = Ae^{-0.5\left(\frac{t-t_0}{t_\omega}\right)^2}$$

where, t_w is the standard deviation and relates the line width at half-height by the relationship

$$t_{1/2} = \sqrt{8\ln(2)}\ t_\omega = 2.35482\ t_\omega$$

Calculation

For a receiving antenna, the open-circuit voltage due to the incident field E_Z at the gap between the monopole and the conducting ground plane is

$$V_{oc}|^{n} = -\triangle z E_z|^{n}_{i_a, j_a, k_a+1/2}$$

and

$$V_{oc}(\omega) = F\{V_{oc}(t)\}$$

The voltage into a section of transmission line matched at the far end is

$$V_{50}(\omega) = \left[\frac{50}{Z(\omega)+50}\right] V_{oc}(\omega)$$

Where Z (w) is the input impedance of the antenna.

Complex Antenna Factor (CAF)

CAF is defined as

$$CAF = 20 \cdot \log\left(\frac{E_i(\omega)}{V_{50}(\omega)}\right) \quad [dB\,(m^{-1})]$$

where, $E_i(\omega)$ is the electric field incident on the antenna, and $V_{50}(\omega)$,is the voltage induced across a 50ω load at the feed point of the antenna.

Calculation of CAF

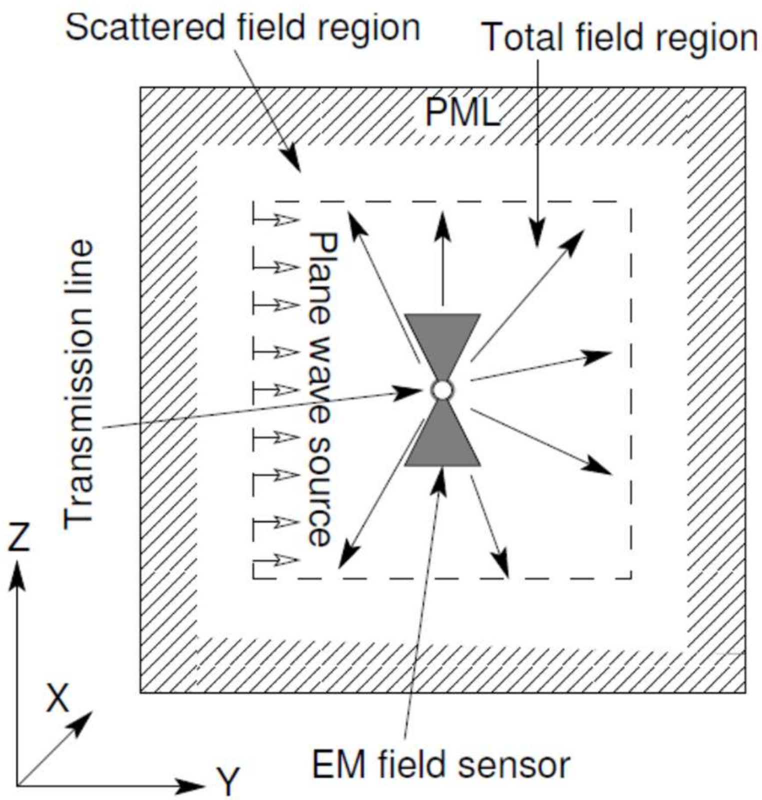


Fig. 1. Receiving antenna case. A antenna under plane-wave illumination within the FDTD grid [1].

[1] Dennis M. Sullivan, *Electromagnetic Simulation Using The FDTD Method*. New York: IEEE Press, 2000.

CAF of Monopole Antenna

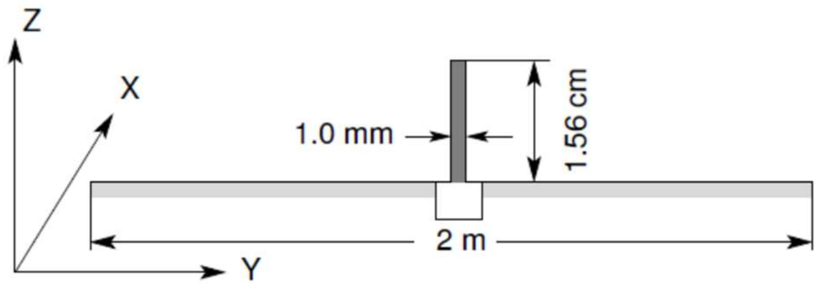
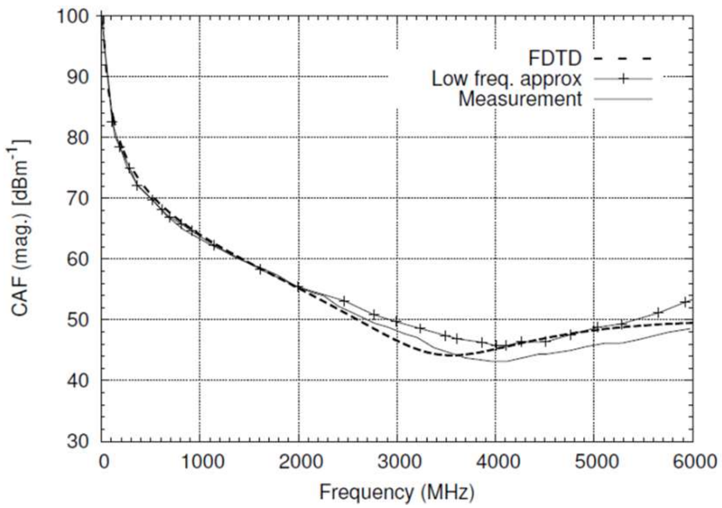
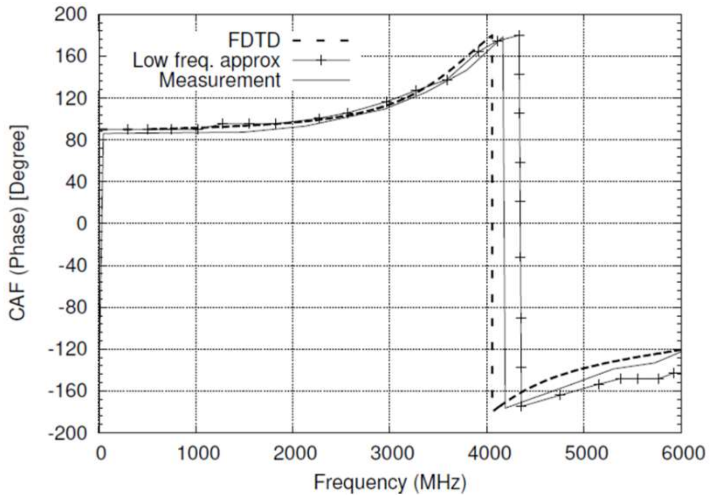


Fig. 1. Monopole antenna on perfectly conducting ground plane





Comparison of the amplitude of the far field CAF of the monopole antenna using FDTD with published [2] measurement and low frequency approximation results.

[2] S. Ishigami, H. Iida, and T. Iwasaki, .Measurements of Complex Antenna Factor by the Near-Field 3-Antenna Method *IEEE Transactions on Electromagnetic Compatibility*, vol. 38, no. 3, pp. 424.432, Aug. 1996.

CAF of the Anritsu MP 651A dipole antenna

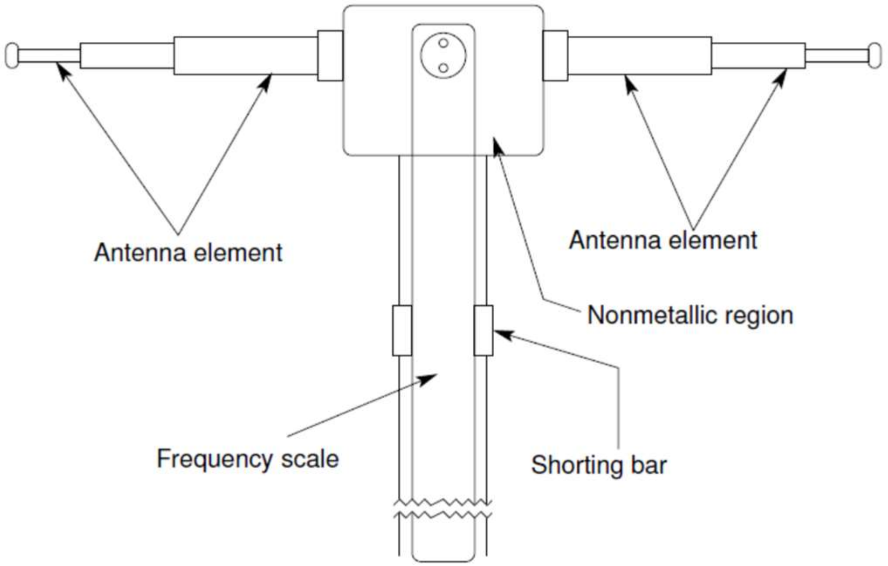


Fig. 1. An Anritsu MP651A dipole antenna.

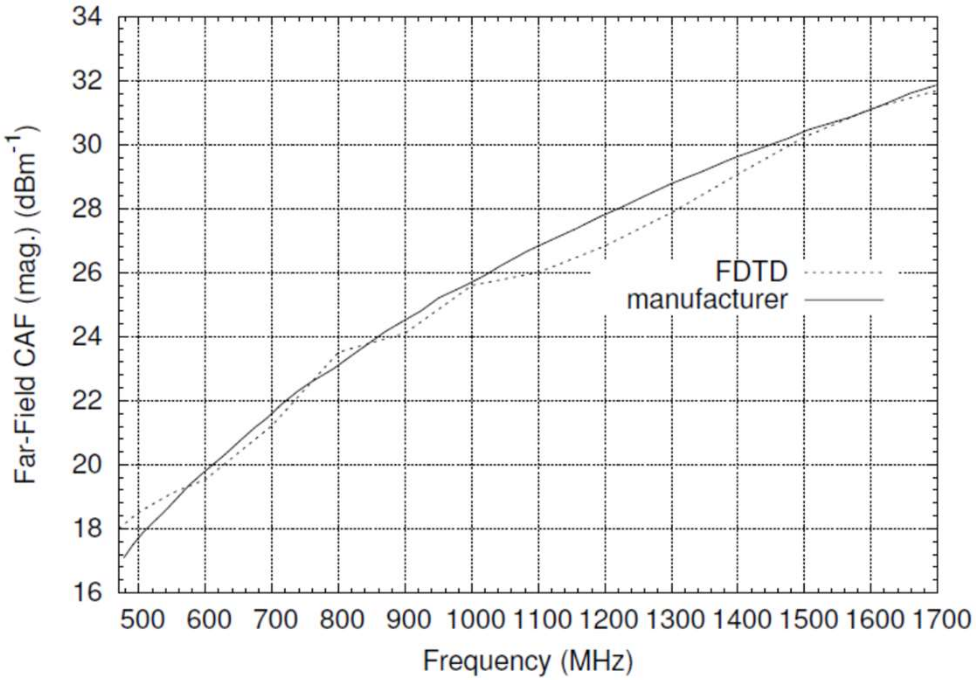


Fig. 2. Comparison of the magnitude of CAF of an Anritsu MP651A dipole antenna using FDTD and data from Anritsu Manual [3].

[3] Instruction Manual, Dipole Antenna MP651A/B, ANRITSU CORP, Japan.

CAF of Disk-Loaded Thick Cylindrical Dipole Antenna

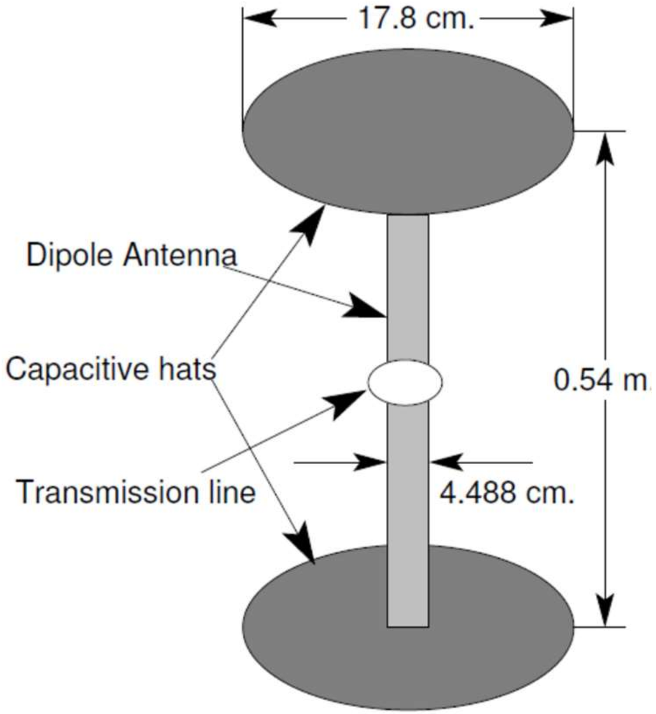


Fig. 1. Dimensions of different parts of a disk-loaded thick cylindrical dipole antenna.

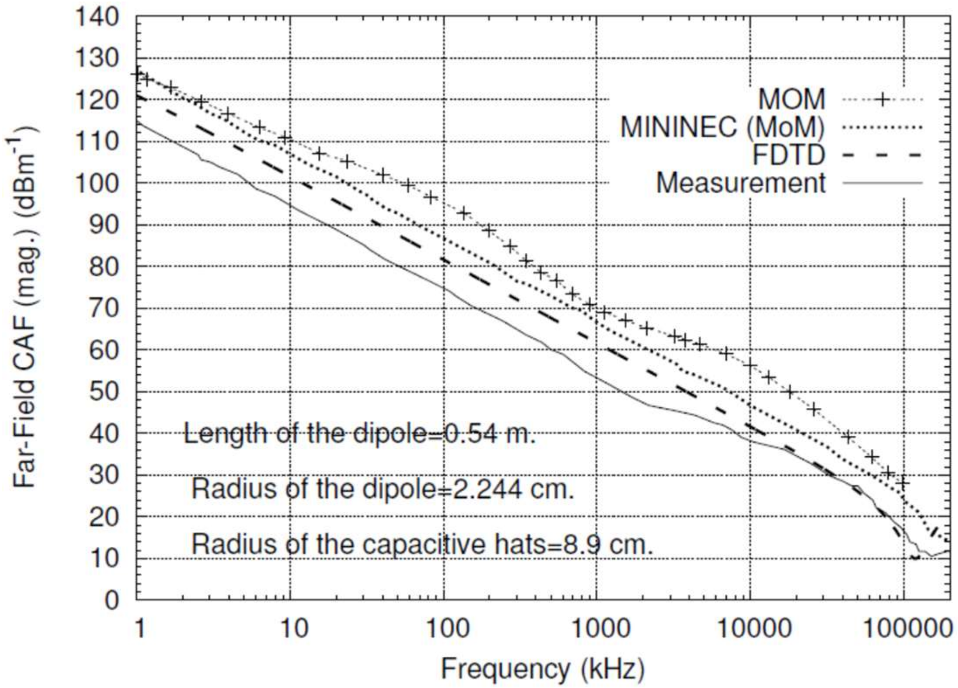


Fig. 2. Comparison of far field CAF using FDTD with Measurement, simulation [4] and MOM based numerical [5] results.

[4] Ke Wang and R. Nelson, .Numerical simulation of the antenna factor of a broadband dipole antenna,. in *Electromagnetic Compatibility, 2001. EMC. 2001 IEEE International Symposium*, vol. 1, 13 Aug. 2001, pp. 616-619.
[5] S. Ghosh, A. Chakrabarty, and S. Sanyal, .Loaded wire antenna as EMI sensor,. *Progress In Electromagnetics Research, PIER*, vol. 54, pp. 19-36, 2005.

Conclusion

- FDTD predicts CAF very easily and accurately.
- In case of FDTD, specifying a new structure to be modelled is reduced to a problem of mesh generation rather than the potentially complex reformulation of an integral equation.
- This technique can easily be extended to determine the antenna factor of any other types of antennas.

Thank you

For any interaction please contact:

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