Spectral Response of the Conical Monopole Sensor Calibration Setup

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Abstract**—**This work presents experimental results of the conical monopole over a ground plane when used as a calibration setup for electric and magnetic field sensors working up to several GHz.

Keywords-component; conical monopole antenna, sensor calibration, D-dot, B-dot, spectral response.

I. INTRODUCTION

The measurement of the transient electromagnetic fields from high-power electromagnetic (HPEM) sources demands the spectral characterization of wideband sensors. A calibration setup with a known multi-decade spectral response is preferred to obtain meaningful results when the sensor under test (SUT) is present. The use of a short conical monopole over a ground plane has been first proposed in [1] to calibrate D-dot and B-dot sensors up to 3 GHz. The authors presented the spectral response analysis of the conical monocone in [2].

The calibration setup scheme is shown in Fig. 1a. The ratio of the electric field E_θ to the input voltage V_{in}, namely the calibration setup transfer function TF_{CS}, can be expressed in a closed form for θ close to 90º (i.e., near the ground plane), as

$$TF_{CS}=\frac{\tilde{E}_\theta}{\tilde{V}_{in}}=\frac{Y_{in}}{f}\frac{a_2}{4\pi}\eta_0\left(j\frac{2\pi f^2}{c_0 r}+\frac{f}{r^2}-j\frac{c_0}{2\pi r^3}\right)e^{-j2\pi r f/c_0} \qquad (1),$$

where E_θ is the radiated electric field, V_{in} is the input voltage, Y_{in} is the monocone input admittance, a_2 is the generatrix, r is the distance between the monocone and the SUT, f is the frequency, c_0 is the speed of light, and η_0 is the free space impedance.

II. EXPERIMENTAL SETUP

A stainless steel, 2.4 x 2.4 m^2 table is used as the ground plane. A resin base was 3D printed to hold the conical monopole. An RG405 coaxial cable with an SMA connector is used to feed the monopole. A picture of the calibration setup is shown in Fig. 1b.

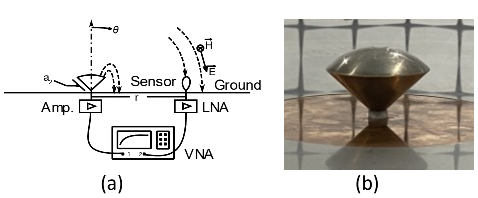

Figure 1: Short-Monocone Setup. (a) Test scheme. (b) Fabricated setup inside a semianechoic chamber

A. Impedance characterization

A comparison of the measured, simulated, and calculated input impedance of the monopole is shown in Fig 2. The shifting towards lower frequencies in the measurements can be attributed to a higher permittivity of the resin in the apex of the monopole.

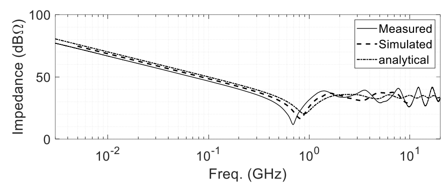

Figure 2: Conical monopole impedance

B. Radiated Field Response

Fig. 3 shows TF_{CS} computed as (1), for the setup in Fig. 1a., comparing both cases of the analytical and the measured conical monocone impedances. An R&S® VNA is used to measure the S_{21} parameter from 100 kHz to 20 GHz, with a resolution bandwidth of 5 kHz. This test considered three distances 150 mm, 300 mm, and 500 mm.

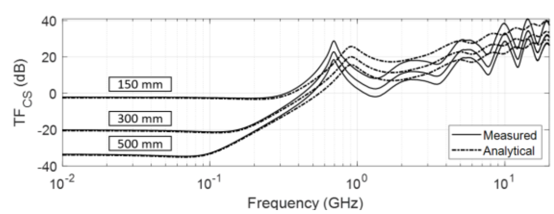

Figure 3: $TF_{CS}(f)$ experimental response

A steeper increase in the magnitude of TF_{CS} is observed around 700 MHz, this is due to the inverse relation of E_θ with the cone impedance in (1). Fluctuations in TF_{CS} at higher frequencies are expected due to imperfections in the coaxial-monocone transition, and the presence of the resin support. The response at lower frequencies agrees on the analytical up to 300 MHz. The upper bound of the available bandwidth is the frequency at which the TF_{CS} is predictable. The lower bound depends on the noise floor of the VNA, once the amplifiers are included. These results are promising for the calibration of commercial electric and magnetic sensors.

REFERENCES

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