Instrumentation for electromagnetic compatibility measurements

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1. Introduction

Measurements in the electromagnetic compatibility are important because today every aspect of life and the industry depends on how much interference there is, whether some device will operate accordingly to the desire, and with what efficiency. The instrumentation for such measurements is evolving all the time, especially lately, since the number of devices and electronic disruptions is growing.
In last twenty years [1-3], extensive research has been performed regarding the improvement of the instrumentation for the electromagnetic (emc) measurements. TEM and GTEM cell have been developed, with improved characteristics [4].

2. Instrumentation

A GTEM-cell is a transmission structure based on a TEM-cell approach. Slightly spherical wave propagates from the source into a 50 Ω rectangular coaxial transmission line and its distributed hybrid termination without geometrical distortion of the TEM wave. Since the opening angle of the waveguide is small, the undistorted spherical wave can be considered as a plane wave. GTEM-cell is a tapered section of rectangular 50 Ω transmission line.

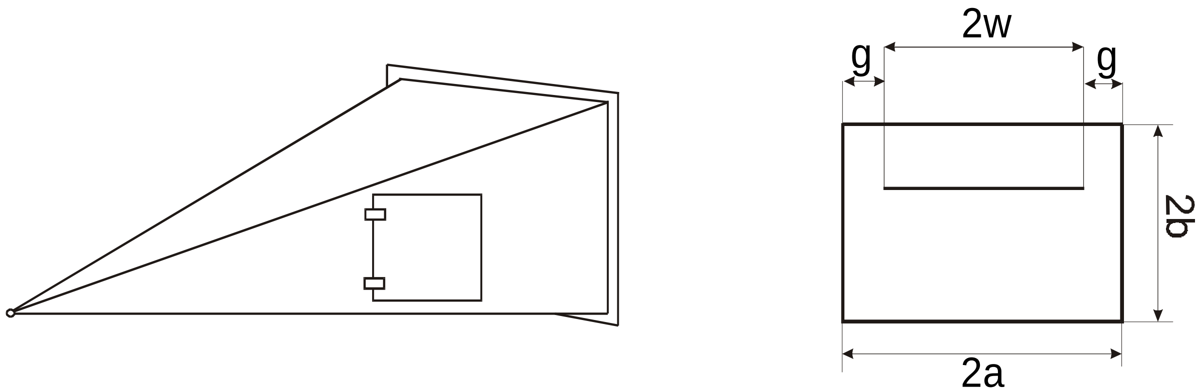


Fig. 1. GTEM-cell

The GTEM-cell (Fig. 1.) begins with a precision craft apex, where transition from the standard 50 Ω coaxial connector (N type) to the asymmetric rectangular waveguide is done. The distributed load section is made of absorbing material for electromagnetic wave termination and the distributed resistive load for current termination. At low frequencies, it operates as a circuit 50 Ω load [1]. At high frequencies, the absorber attenuates the incident wave as in an anechoic chamber. In this way, a termination from DC to several GHz is achieved. The broadband performance provided by the termination acts to suppress the creation of higher-order modes. The absorbing material significantly reduces the Q of the chamber, making the resonance effects small. The characteristics of GTEM are: 50 Ω impedance, inner conductor at 3/4 height, inner height to width ratio equals 2 to 3 and angle septum/bottom plate is 15°, with angle septum/top plate being 5°. The septum as well as coating is made of copper. The N type connector is placed at the end of the tapered section. The septum is supported by dielectric material. At the other end, there are pyramidal absorbers 0.25 m long which are used for electromagnetic wave termination and two parallel 100 Ω, distributed resistive load for current termination. The EUT size can be up to 0.20 m x 0.20 m.

3. Results

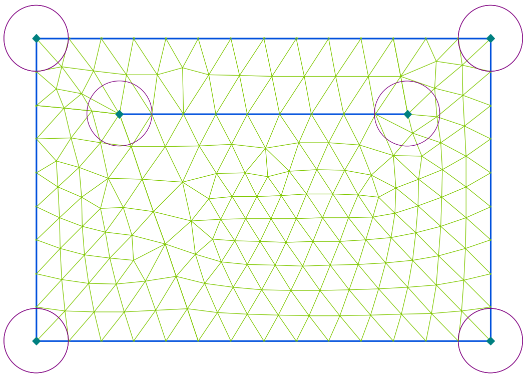


Fig. 2. FEM model

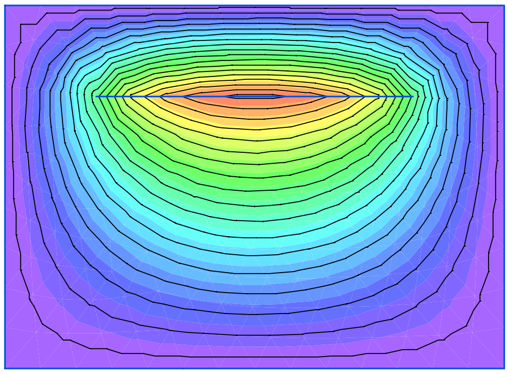
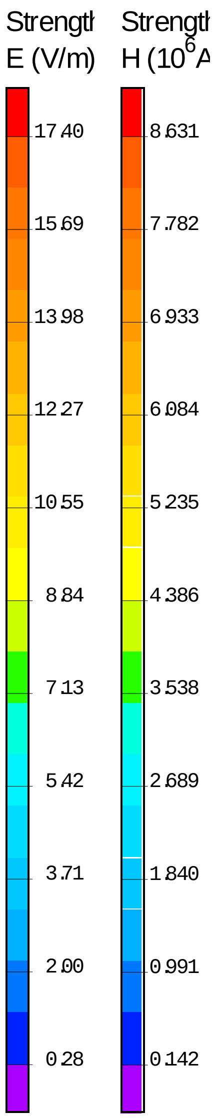


Fig. 3. Potential lines



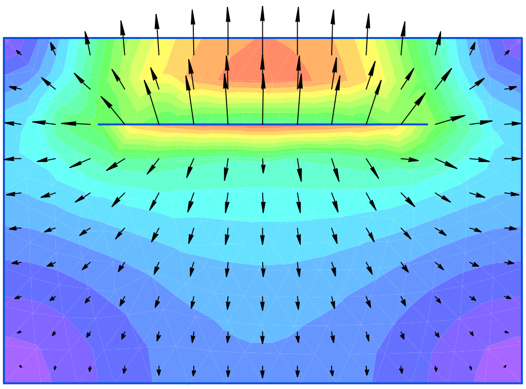


Fig. 4. Strength and vectors of E

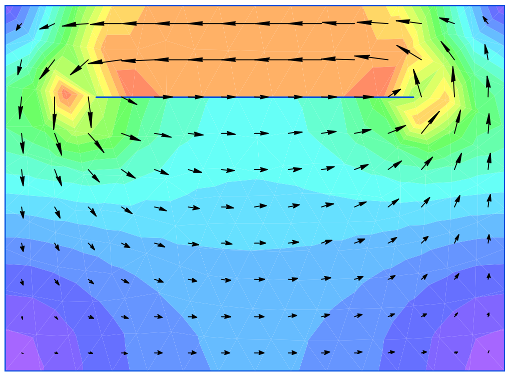


Fig. 5. Strength and vectors of H

Finite element method is used to solve complex, nonlinear problems in magnetics and electrostatics. The first step in finite-element analysis is to divide the analyzed configuration into small homogeneous elements. The model contains information about the device geometry, material constants, excitations and boundary constraints. In each finite element, a linear variation of the field quantity is assumed. The corners of the elements are called *nodes*. The goal is to determine the field quantities at the nodes.

Figs. 2. through 5. are showing FEM model, the potential lines, the electric field vectors and the magnetic field vectors in the GTEM-cell, respectively. The above figures were generated using the numerical modeling analysis performed using the finite element method (QuickField).

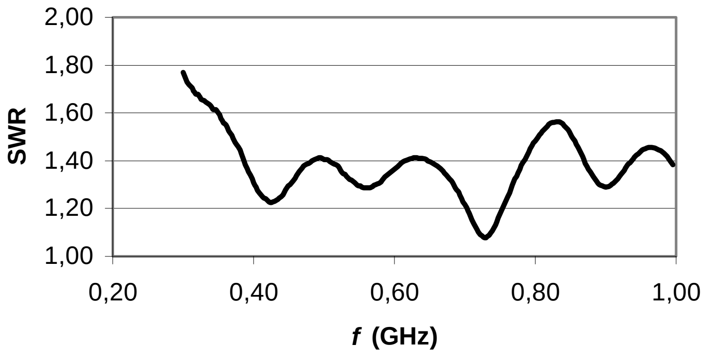


Fig. 6. SWR of GTEM-cell up to 1GHz

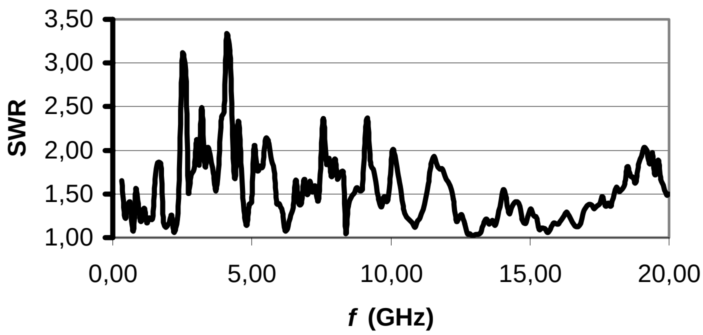


Fig. 7. SWR of GTEM-cell up to 20GHz

Figures 7. and 8. are showing SWR of GTEM-cell up to 1 and 20 GHZ, while Fig. 8 presents a photo of the same cell.

Fig 8. Photo of GTEM-cell

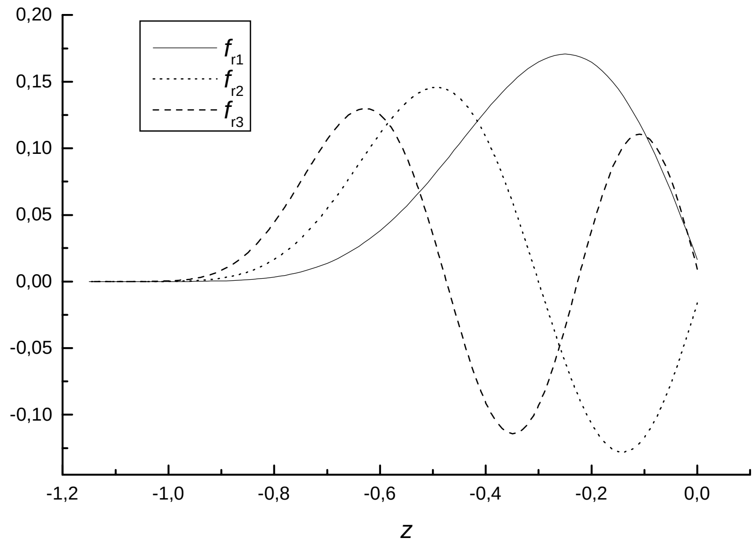


Fig. 9. H_{01} amplitudes of the first, second and third resonance in GTEM-cell

Fig. 9 shows amplitudes of the resonances inside the GTEM-cell. It is a result of a self-developed computer program. It has a good concordance with [3].

4. Conclusion

The novelty of the paper is that it gives an overview of the GTEM-cell developed at the Faculty of Electrical Engineering and Computing, University of Zagreb. The cell parameters were measured and comparison with numerical results was given. The new results are program for calculation of the higher order modes, and very good comparison with of measured result with the measured one.

References

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