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TEST CASE: CAVITY IN A METALLIC PLANE

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GEOMETRY

3D structure and cavity:

The study case consists in a cavity inserted in a truncated planar metallic structure, whose geometry is described in Figure 1.

Such structures play the roles of pseudo carriers: they are used to assess the radar signatures of the equipment placed in the cavity. In measurement facilities, the RCS of the pseudo carrier without the cavity (case A) and the RCS of the pseudo carrier with the cavity and equipment (case B) are separately measured. The results are subtracted, giving the differential RCS due to the cavity and its equipment (ideally a reasonable approximation of their intrinsic RCS).

Therefore, the specific shape of the truncation has been proposed to reduce the signature of the pseudo carrier itself, in particular by employing misaligned and bevelled edges.

Main dimensions of the structure:

- Upper surface: length 600 mm, width 538.5 mm,
- Lower surface: length 540.3 mm, width 538.5 mm,
- Thickness: 16 mm.
- Angular misalignment (w.r.t. y-axis) of leading and trailing edges: 21.8°

Cavity dimensions:

- Square of 301 mm x 301 mm, depth 10.1 mm.

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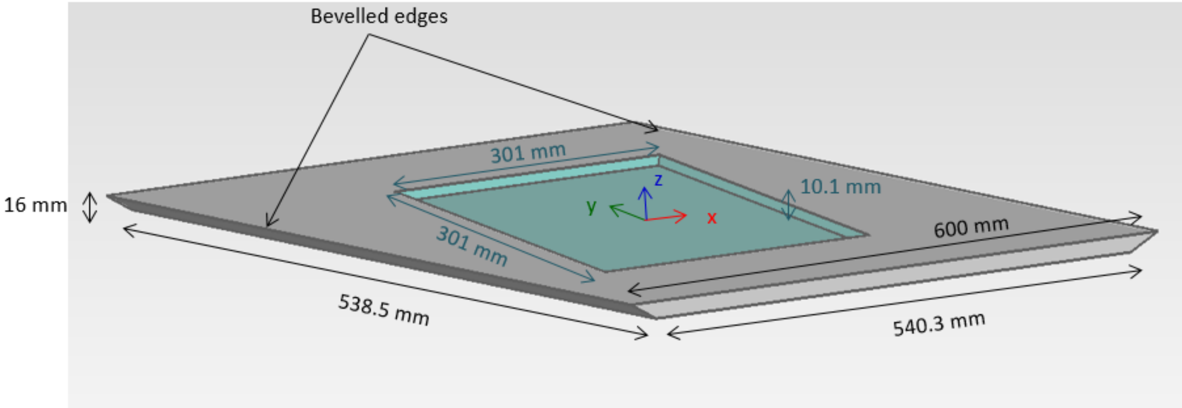
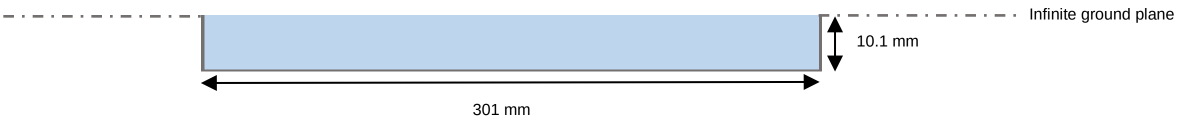


Figure 1: 3D structure and cavity dimensions

2D structure

The physical phenomenon that contributes the most to the RCS of the above-described structure is the diffraction of the edges of the cavity oriented along the y-axis.

Therefore, in the design phase of the material, it is convenient to focus on those contributions by reducing simulations to a 2D problem lying in the plane orthogonal to the y-axis, and using a simulated infinite metallic ground plane instead of a truncated pseudo-carrier.



Dielectric material inside the cavity:

A slab of acrylic material is inserted in the cavity as depicted in Figure 2.

The dielectric slab characteristics are the following:

- Thickness: fits the entire cavity (10.1 mm),
- Relative Permittivity: 2.6,
- Loss tangent: 0.02.

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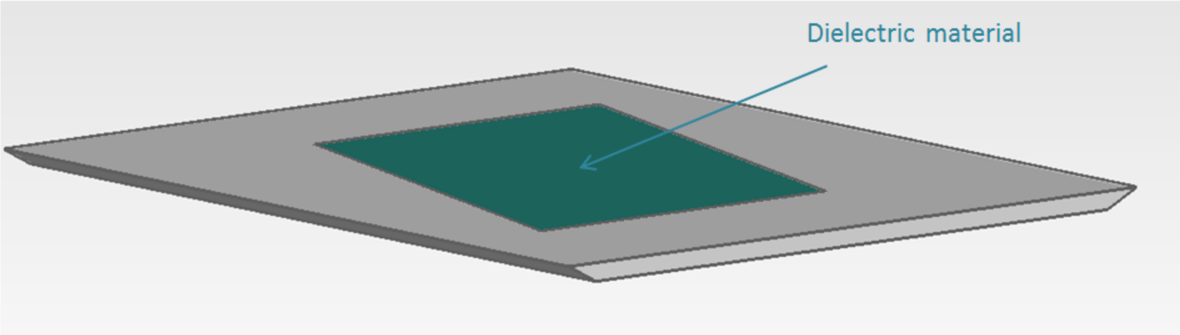

Figure 2: Dielectric material inside the cavity

Differential RCS:

One of the main objectives is to calculate the differential RCS between two different configurations:

- the cavity filled with the dielectric
- and the cavity filled by a PEC (considered as a reference case).

Figure 3 illustrates both configurations.

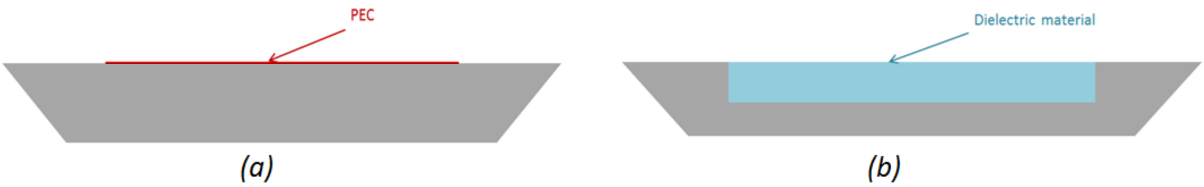

Figure 3: Reference case (a) and cavity filled with acrylic (b)

TEST CASE SETUP

Frequencies:

181 frequencies: 6 GHz to 15 GHz by steps of 50 MHz

Conventions:

Spherical angles (θ, Φ) are defined according to the common ISO/CEI 80000-2 definition of spherical coordinates (Θ is the "polar angle" measured from the z-axis), as illustrated on Figure 4.

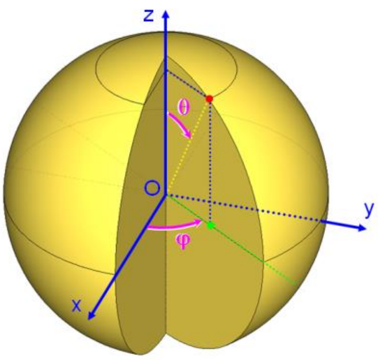

Figure 4: Definiton of the spherical angles

The time harmonic convention is $e^{-j \cdot \omega \cdot t}$.

The coordinate system is depicted in Figure 1 with the phase

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origin located in the middle of the cavity's outer interface.

Incident plane waves:

1 angular sweep: planar cut at $\Phi = 0°$ (plane xOz) and θ varying from 0° to +90°.

2 polarisations:

- TM: transverse magnetic (H-field along y-axis)
- TE: transverse electric (E-field along y-axis).

Configurations:

There are three sub test cases:

1) Reference PEC case of Figure 3(a) (3D structure),
2) 3D structure and a cavity filled with acrylic,
3) 2D infinite structure: cavity filled with acrylic on an infinite ground plane

For sub test case 3), the RCS is normalised for one meter along y-axis.

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RESULTS

Complex monostatic RCS is calculated for θ varying from 0° to +90° by 0.5° increments (Φ = 0°) in both co-polarisations (TE-TE and TM-TM) at all frequencies and for each sub test cases 1), 2) and 3).

Results will be sent in three ASCII files (one for each sub test case). Data is to be provided in real and imaginary parts (defined such that the square of the modulus of the complex number be equal to the RCS in m²).

Description of ASCII files (6 columns):

Frequency(GHz)   Θ(°)   real(TE-TE)   imag(TE-TE)   real(TM-TM)   imag(TM-TM)

181 x 181 = 32761 lines

INPUT FILES

CAD:

- 3D structure: *3D_structure.step* (with cavity and dielectric slab: sub-case 2)