TEST CASE 4: GPR Scenario

Backscattered field depending on frequency and angle

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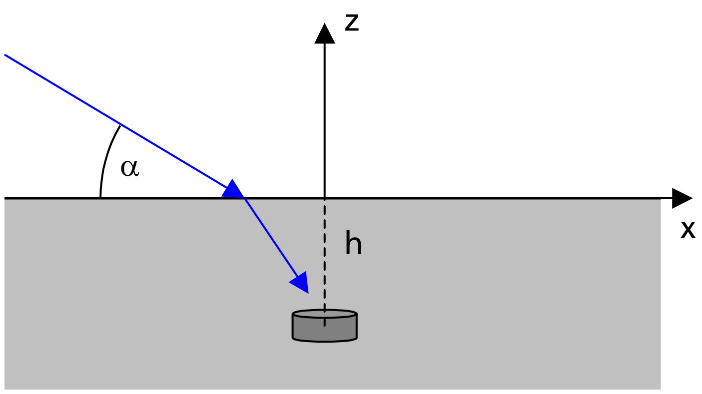
1. *Definition of the Geometry*

The target is a cylinder of radius R_c and height h_c, which is located beneath the surface of a dielectric medium (half space) with relative permittivity ε_r. The distance from the surface to the mass centre of the target is denoted as h.



2. *Simulation Parameters*

The time dependency is assumed to be exp(jωt).

The dielectric ground medium is assumed to have the relative permittivity ε_r = 4 - j 0.05.

The cylinder is assumed to be located at h = 0.3 m below the surface of the dielectric medium. The radius of the cylinder is R_c = 0.1 m and its height is h_c = 0.1 m (cylinder axis parallel to z-axis of the coordinate system, mass centre of the cylinder at (x, y, z) = (0, 0, -0.3), vertical extension from z_{min} = -0.35 m to z_{max} = -0.25 m).

For the target described above, the monostatic scattered far-field shall be simulated depending on the aspect angle in the frequency range 0.3-5.0 GHz.

Depending on the method used for modelling this test case, further assumptions and/or simplifications need to be made, e.g., finite scenario, near-field set-up, etc. – in this case, the simplifications shall be documented in an additional document (see section 4.).

2.1. Case (a): PEC cylinder, α = 90°, frequency scan

The monostatic scattered far-field shall be simulated for a metallic (PEC) sphere. Simulation data shall be calculated for the frequency range 0.3-5.0 GHz, Δf = 50 MHz, for both vertical polarisation ($\theta\theta$-polarisation, i.e., electric field in the *xz*-plane) and horizontal polarisation ($\phi\phi$-polarisation, i.e., electric field perpendicular to the *xz*-plane).

2.2. Case (b): dielectric cylinder, α = 90°, frequency scan

The dielectric cylinder shall be simulated with the same parameters as in Case (a) using a relative permittivity $\varepsilon_r = 3$ for the cylinder.

2.3. Case (c): PEC cylinder, elevation and frequency scan

The PEC cylinder shall be simulated with the same parameters as in Case (a). The aspect angle of the incidence wave shall be α = 45° to α = 90° in 0.5° steps. The frequency scan is the same as in Case (a)

2.4. Case (d): dielectric cylinder, elevation and frequency scan

The dielectric cylinder shall be simulated with the same parameters as in Case (b). The aspect angle of the incidence wave shall be α = 45° to α = 90° in 0.5° steps. The frequency scan is the same as in Case (a).

Note: Case (a) and (b) are actually sub-cases of case (c) and (d). They have been separated, in order to give participants the option of submitting results only for (a) and (b), if they do not have time for all the calculations involved in (c) and (d).

3. Data Formats

The results will be stored in ASCII files, labelled as:

- *test_case_2a_CONTRIBUTOR_NAME.txt*
- *test_case_2b_CONTRIBUTOR_NAME.txt*
- *test_case_2c_CONTRIBUTOR_NAME.txt*
- *test_case_2d_CONTRIBUTOR_NAME.txt*

where "CONTRIBUTOR_NAME" should be replaced by the name of the contributing institution, if necessary followed by a postfix indicating the method used for the simulations, e.g., Contributor1_FDTD, Contributor1_MoM,…

The field scattered by the cylinder has the following general form in the far field:

$$\mathbf{E}_i(\theta,\phi)\frac{\exp(-j\mathbf{k}\cdot\mathbf{r})}{r}$$

where $i=\theta$ or ϕ, depending on the incident field (vertical or horizontal polarization respectively). The components of $\mathbf{E}_i$ in spherical coordinates are E_{ij} where $j=\theta$ or ϕ, where $i=j$ for the co-polar component and $i\neq j$ for the cross-polar component.

Each file will contain on each row the data :

f α Re($E_{\theta\theta}$) Im($E_{\theta\theta}$) Re($E_{\phi\phi}$) Im($E_{\phi\phi}$) Re($E_{\theta\phi}$) Im($E_{\theta\phi}$) Re($E_{\phi\theta}$) Im($E_{\phi\theta}$)

where f is the frequency in GHz, α is the angle in degrees associated with the observation point, E_{ij} are the above defined vector components in Volt. The E_{ij} shall be normalized so that the following relation holds:

$$10\log_{10}\left(4\pi\left|E_{ij}\right|^2\right)=\sigma_{ij}$$

where σ_{ij} is the respective co- or cross-polar RCS in dBsm.

4. Additional Information

Each *.txt*-file should be accompanied by a *.info*-file, stating additional information relevant for the simulation, e.g., short description of the method used, CPU time, memory usage, number of unknowns, characteristics of simulation hardware (number of cores, processor speed),…