Box with Slot Shielding Effectiveness

The aim of this application note is to calculate the shielding effectiveness of a PEC box with a slot, excited with a plane wave incident in the direction perpendicular to the slot.

A rectangular metal enclosure with an aperture on one face can be modelled as a waveguide, shorted at one end, with the aperture at the other side of the waveguide. The model is quickly created with just a few plates in WIPL-D Pro (Figure 1).

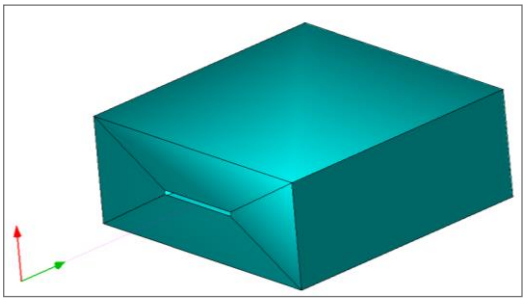

Figure 1. Rectangular box with an aperture

The electric field shielding effectiveness is calculated as the ratio of the impinging field to the field measured at certain point within the waveguide, distant from the slot.

The theory assumes that a single TE_{10} waveguide mode propagates from the aperture and normal to it. Higher order modes, and modes propagating in other directions may exist which will complicate the results, and introduce need for EM simulation in order to predict the shielding effectiveness. The box is taken to be empty. The results of EM simulation are in excellent agreement with results obtained by using intermediate level simulation tools from University of York, and easily obtainable by using their online calculator [1].

The objective is to investigate the influence of changes in box and slot geometry as well as in position inside the box at which field is calculated on shielding effectiveness (Figure 2).

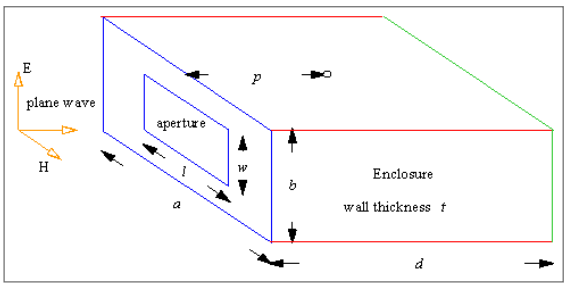

Figure 2. Explanation of geometry of the box with a slot (taken from [1])

For fixed dimensions of the box and of the aperture (*a*=30 cm, *b*=12 cm, *d*=30 cm, *l*=10 cm, *w*=0.5 cm), shielding effectiveness at various positions within the box (at the symmetry plane) is displayed in Figures 3 and 4.

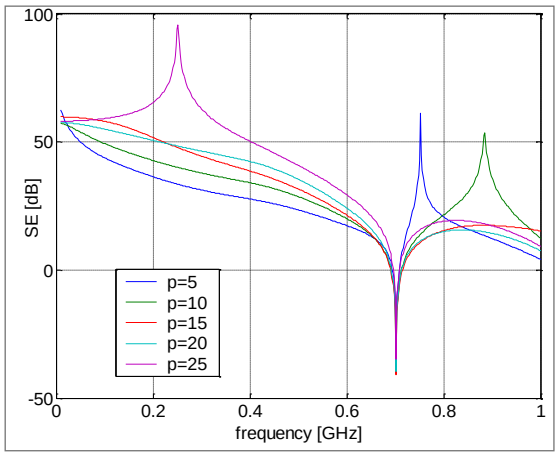

Figure 3. Shielding effectiveness of electric field for *p* varying from 5 cm to 25 cm.

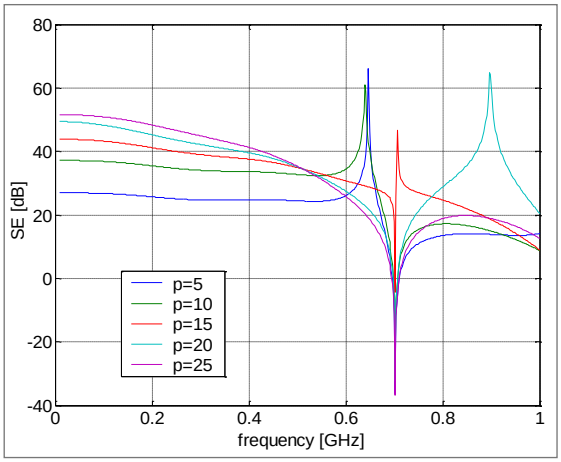

Figure 4. Shielding effectiveness of magnetic field for *p* varying from 5 cm to 25 cm.

If only the width of the box (*a*) is varied, then for *b*=12 cm, *d*=30 cm, *l*=10 cm, *w*=0.5 cm and *p*=15 cm, and by varying *a* from 20 cm to 40 cm, the shielding effectiveness is shown in Figs 5-6.

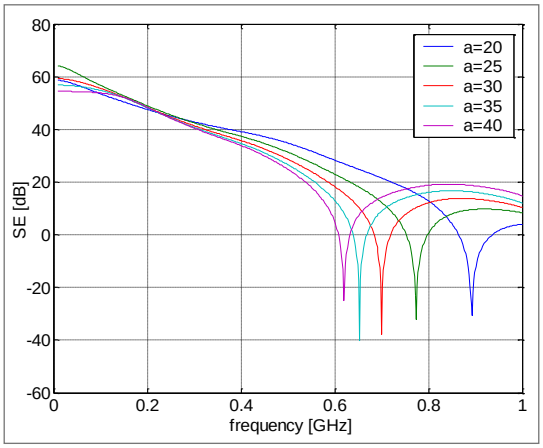

Figure 5. Shielding effectiveness of electric field for box width *a* varying from 20 cm to 40 cm

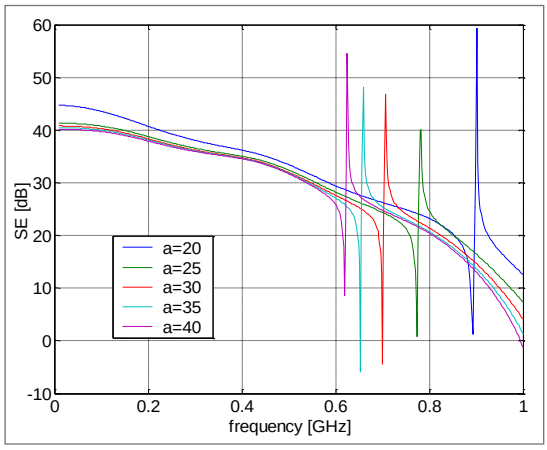

Figure 6. Shielding effectiveness of magnetic field for box width *a* varying from 20 cm to 40 cm

By fixing all parameters except the length of the slot to *a*=30 cm, *b*=12 cm, *d*=30 cm, *w*=0.5 cm and *p*=15 cm and varying *l* from 3 cm to 17 cm, we get Figures 7 and 8.

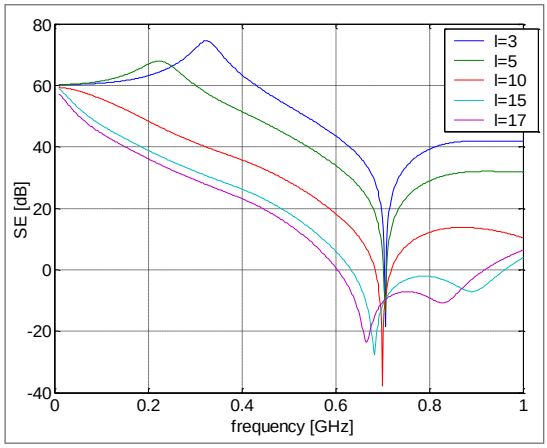

Figure 7. Shielding effectiveness of electric field for *l* varying from 3 cm to 17 cm

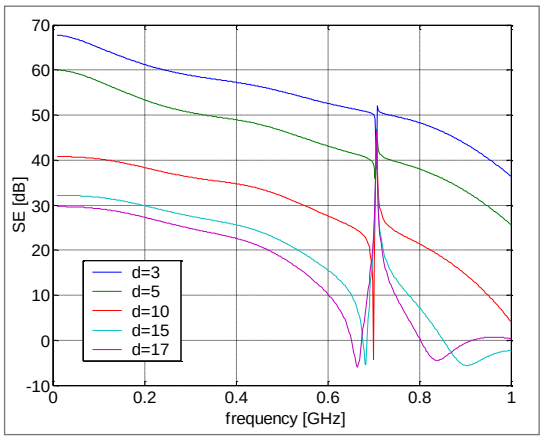

Figure 8. Shielding effectiveness of magnetic field for *l* varying from 3 cm to 17 cm

For a closer look at the fields inside the box, we calculated near fields at several frequencies within the range from 700 MHz to 1.3 GHz in order to illustrate higher order modes that form. Figure 9 shows near fields at different frequencies in case when the incident plane forms an angle of 75 degrees with the normal to the slot.

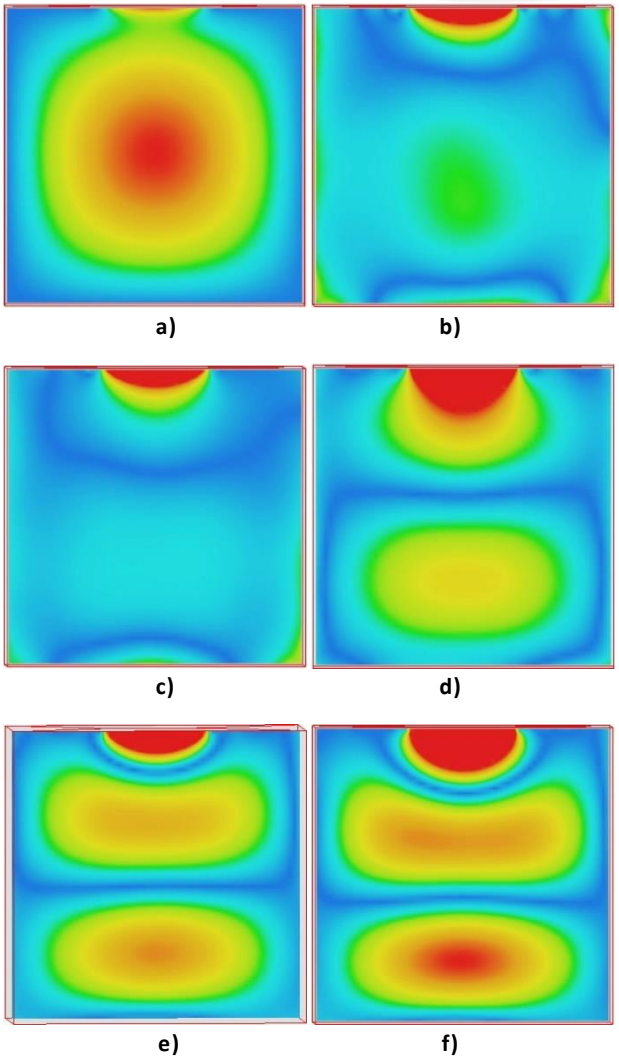

Figure 9. Electric field amplitudes inside the box at: a) 700 MHz, b) 800 MHz, c) 900 MHz, d) 1 GHz, e) 1.2 GHz, and f) 1.3 GHz.

References

[1] http://www.emc.york.ac.uk/examples/screening/screening.html