Diffraction by dielectric wedges: high frequency and time domain solutions

Abstract

The knowledge of the propagation characteristics of the electromagnetic fields is fundamental in the analysis and planning of modern radio communication systems. When the dimensions of the systems are large in terms of the electromagnetic wavelength, diffraction contributions due to material discontinuities can’t be negligible and must be accurately calculated.

In this work are presented the explicit closed form solutions for the high-frequency evaluation of the electromagnetic field produced inside and outside an arbitrary-angled lossless penetrable wedge. Primarily, the full problem of the diffraction of plane waves by an acute-angled dielectric wedge is analyzed and solved. Then, its solutions are generalized to the cases of right- and obtuse-angled wedges. Both cases of *E*- and *H*-polarized incident plane waves are addressed in the study. The problems is tackled and solved in the framework of the uniform theory of diffraction, so that the total field at the observation point is determined by adding the geometrical optics contributions and the diffraction one. This last is obtained by performing a uniform asymptotic evaluation of the radiation integrals arising from a physical optics approximation for the equivalent electric and magnetic surface currents lying on the wedge boundaries. The solutions for the diffracted field are able to compensate the discontinuities of the geometrical optics field at the shadow boundaries and their accuracy is assessed by comparisons with data produced by numerical tools.

The big advantage of this approach consists in the possibility of evaluating the corresponding diffraction coefficients in the time domain for the same geometries. The inverse Laplace transform is applied to the frequency domain solutions for the diffraction coefficients and the transient diffracted field is evaluated via a convolution integral. Simulations have verified the goodness of the time domain solutions, too. To the author’s knowledge, no other closed form solutions for time domain scattering problems involving penetrable wedges are available in literature.