Erratum: Plane-wave solutions to frequency-domain and time-domain scattering from magnetodielectric slabs [Phys. Rev. E 73, 046608 (2006)]

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In the first paragraph of Sec. III B of this paper, we stated that after a long time the fields of the time-domain solution (sinewave beginning at $t=0$) for a lossless, -1 double negative (DNG) slab of width L, illuminated by a line source a distance d in front of the slab, approached those of the frequency-domain solution (single frequency) for the lossless slab. This is not true within a distance $L-d$ of the front face of the slab where the lossless frequency-domain fields remain bounded, whereas the lossless time-domain fields within a distance $L-d$ of the front face of the slab continually increase with time. To explain this erratum, we begin with some background material.

In the frequency-domain solution for a DNG slab with a loss tangent equal to δ, that is, $\mu/\mu_0=\epsilon/\epsilon_0=-1+i\delta$, we found in Eq. (31) of this paper that the magnitude of the electric field outside the back face of the slab ($d+L<z<2L$) was proportional to $E\propto\delta^{z/L-2}$, which also holds in the region inside the back face of the slab ($2d<z<d+L$). Thus, the power dissipated per unit length inside the back face of the slab is

$$P_{\text{loss}} \propto \delta E^2 \propto \delta^{2z/L-3} \propto \delta^{2d/L-1}, \tag{1}$$

which implies that the power dissipated per unit length approaches an infinite value as $\delta\to 0$ if the line source is located a distance $d<L/2$ from the front of the slab—a result that appears to violate energy conservation. However, it was also shown in this paper that the scattered fields in the region out to a distance $L-d$ in front of the lossy slab, unlike the lossless slab, diverge as $\delta\to 0$. Thus, these divergent scattered fields act back on the line source to produce the divergent power loss given in Eq. (1) for $d<L/2$ as $\delta\to 0$.

For the time-domain solution to a lossless slab illuminated by a sinusoidal line source that turns on at $t=0$, we found in Eq. (62) of this paper that the time-domain electric field in the region outside the back face of the slab ($d+L<z<2L$) behaves asymptotically with time as $E\propto t^{2-z/L}$. Thus, the energy per unit length built up with time in this region is

$$W \propto E^2 \propto t^{4-2z/L} \propto t^{2-2d/L}. \tag{2}$$

Since the line source delivers an energy per unit length in free space proportional to t, the energy W in Eq. (2) seems to violate energy conservation if the line source is a distance less than $L/2$ from the slab. However, the time-domain source that turns on at $t=0$ has a bandwidth over which μ/μ_0 and ϵ/ϵ_0 are not exactly equal to -1 [see Eq. (41) of this paper] and thus, like the frequency-domain and time-domain solutions with a decreasingly small loss in the slab, the lossless time-domain solution has scattered fields that diverge as time $t\to\infty$ out to a distance $L-d$ in front of the slab. These increasingly large time-domain scattered fields a distance $L-d$ in front of the slab act back on the impressed line source located a distance less than $L/2$ from the slab to produce the power given in Eq. (2).

In our discussion in the first paragraph of Sec. III B of this paper, we overlooked the fact that the time-domain solution to the lossless slab always has a nonzero bandwidth in which μ/μ_0 and ϵ/ϵ_0 differ from -1, and this difference leads to increasingly large fields with increasing time about the front face of the slab. This divergence can be understood in terms of the frequency-domain solution to the lossless slab with index of refraction slightly different from -1 [1]. (We have confirmed this with numerical computations as well.)

The solution of Milton *et al.* [2] for an exponential time-domain line source produces similar divergent fields with increasing time about the front face (as well as the back face) of the slab, and we are indebted to Milton *et al.* for discovering these divergent front-face fields in the lossless time-domain solution.

[1] R. Merlin, Appl. Phys. Lett. **84**, 1290 (2004); **85**, 2144(E) (2004).

[2] G. W. Milton, N.-A. P. Nicorovici, and R. C. McPhedran, Physica B **394**, 171 (2007).

