Dielectric Waveguide Simulation by FDTD

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Abstract

Electromagnetic wave with a sinusoidal source is sent through a dielectric medium. Coupling between two waveguides is also explored in this assignment

1 Set up

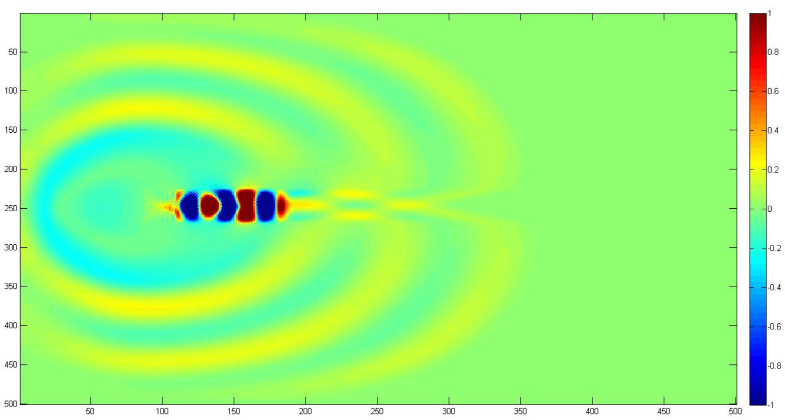
The frequency used here is 1 gigahertz, of the order used in radio communicarions. A straight dielectric waveguide is placed next to a small line source which emits E waves at 0.7 gigahertz, 1 V/m amplitude.

1 gigaherz leads to a wavelength in the order of 10 centimeter = 0.1 meter inside the dielectric. In order to observe this clearly, one wavelength length is chosen to be of around 50 units. Hence grid spacing = 0.1/50 = 0.001 meter is chosen. The sine source is run for 1500 time units

PML boundary condition has been applied, with the conductivity of the matched layer varying as a square law from 0 to 1 ohm-inverse. 1 ohm-inverse is chosen by trial and error. This chosen value seems to work well with not much reflection across the layers. The thicknss of the layer is chosen to be 80 units, which is 16 centimeter of PML cladding.

2 Observation

On running the simulation for a line source near the absorbing boundary, we can observe that the waveguide carries the wave along with it, and transports it across. Also observe that there are no boundary reflections,indicationg that the absorbing boundary condition is working as expected. The simulation results are shown as follows:



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When two waveguides are placed near to each other, we can observe that they can interfere with each other's signal. We can observe this kind of coupling in this case. Another dielectric is placed just below the first dielectric, and the source remains as it was before. After a while, observe that the EM wave propagates through the first waveguide, then it transfers it's power to the second waveguide. This buildup of wave in the second waveguid can be observed from the evanascent wave emanating from the first waveguide. Also, after a while, it can be seen that the wave in the second waveguide starts to lose it's power, and the wave is back in the first waveguide. A 0.7Ghz wave is sent into one of the waveguide and a grid spacing of 13 nm is assigned.

The results of the simulation are as shown:

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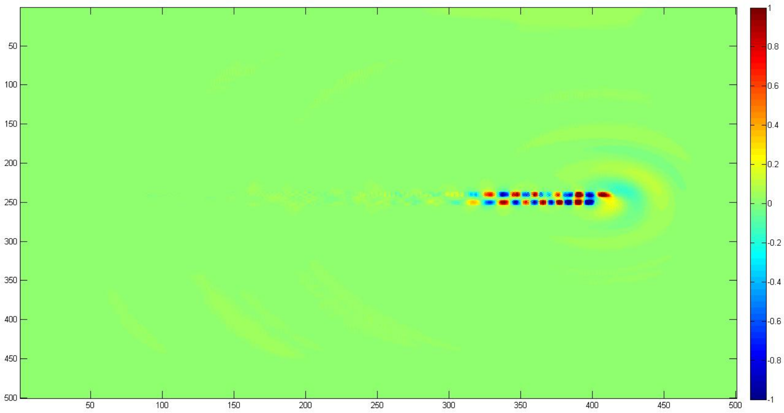

The frequency with which this power switching happens appears to be dependant on the distance between the waveguides. On bringing the waveguides closer, the coupling can be seen to be occuring more frequently/ within smaller distances.

3 Result and Discussion

Whenever this type of dielectric waveguide has bends/turns, the wave only spills out and does not efficiently go into the bent out branch. Hence this type of waveguide can only be used where a signal is taken in a straight line.