ANTENNA DESIGN COURSE

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CHAPTER 5

ANTENNA SIZE REDUCTION

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The objective is to obtain a given electrical size, with a smaller physical size that the corresponding one.

5.1 Introduction to Size Reduction Techniques

Size reduction in the field of antennas has an important impact, not only for saving material in its construction, but also because if the antenna is installed in a tower, the reduction of size reduces the wind resistance, and then the antenna can be installed higher in the tower without risk or more antennas can be installed in the same tower. Due to the importance of size reduction for antennas, this topic has been extensively studied.

For size reduction, several techniques has been proposed, based in different principles, as a rough description can be mentioned techniques based on: shape modification, slot insertion and embedding antennas in materials with high relative permittivity. Here the first two techniques looks for achieving longer ways for the current inside a reduced size antenna, for example, the slots force the current inside the antenna to follow longer ways. The third technique, looks for achieving a change in the wavelength by using a material with different electric constants (different than the ones for the air).

In this chapter we will make focus in size reduction by embedding the antenna in a dielectric with with a high Relative Electric Permittivity (REP).

5.2 Size Reduction by Embedding in High REP Materials

In [DEEAA] is presented a work for size reduction of a wire antenna by embedding it in a cylindrical rod of ceramic. This article can be accessed by the following link.

C:\Users\Benigno\DOCENCIA\Diseno de Antenas\Documentos\Dielectric_embedded_ESPAR_DE-ESPAR_antenna_for_WC.pdf

In the rest of this section, the size reduction of the SPIDA with 3 director elements will be presented.

As a high REP material distilled water was used. The REP of the Distilled Water (DW) is ε_{DW}=80. Then the size reduction (SR) achieved is, as it is indicated in (1).

$$SR=\sqrt{\varepsilon_{DW}}\approx 9 \qquad (1)$$

That means that the size needed is approximately nine times less than the needed without using DW, which is a very important size reduction. Then an antenna that was created for a central frequency f_c=2,4525 GHz (as the SPIDA), can be used at a frequency of approximately $f'_c = f_c / 9 \sim 270$ MHz.

In Fig. 5.1 a photo of the SPIDA antenna embedded in DW is shown.

Fig. 5.1: SPIDA antenna embedded in DW.

In Fig. 5.2 is presented the model used for this simulations.

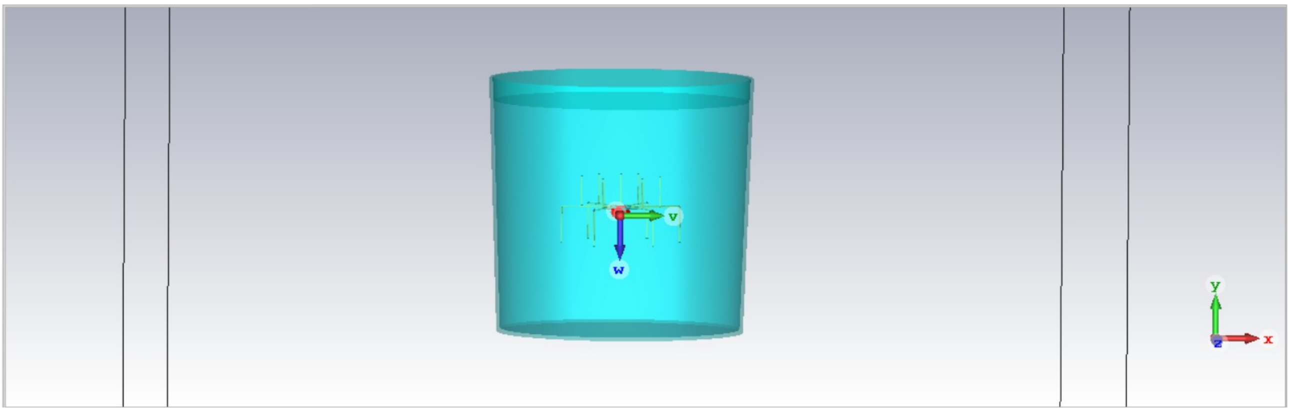

Fig. 5.2. Model of SPIDA3dir in a “cylindrical” brick of DA of 220 mm of height.

In Fig. 5.3 the $|S_{11}|_{dB}$ is presented for the SPIDA antenna with 3 director elements, the container and 155 mm height of DW (“SPIDA3dir220mm”). There the resonance for frequencies much lower than 2,4525 GHz, near to 270 MHz can be observed. These results were obtained by simulation and later this effect caused by the DW was confirmed by measures.

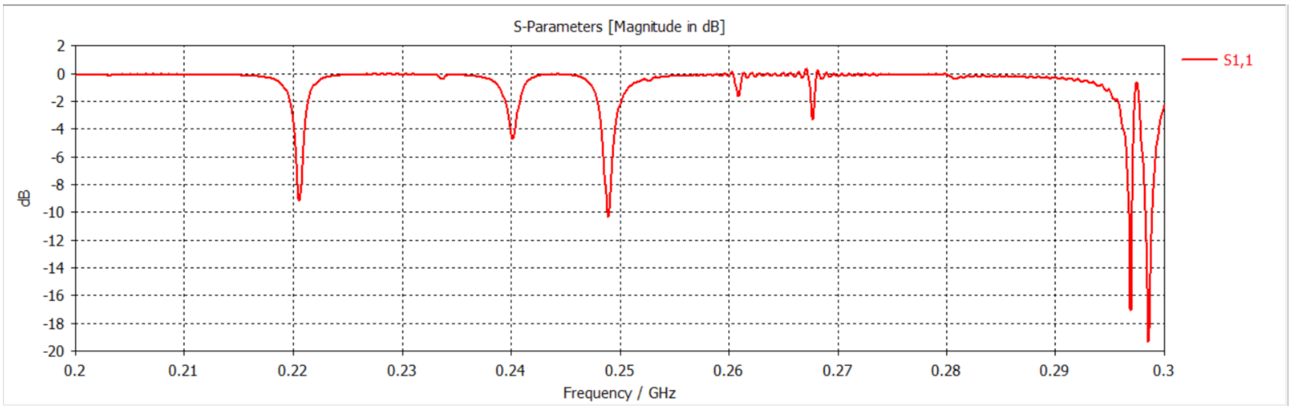

Fig. 5.3 $|S_{11}|_{dB}$ for SPIDA3dir220mm.

REFERENCES

[DEEAA] Junwei Lu, David Ireland, Robert Schlub, Dielectric Embedded ESPAR (DE-ESPAR) Antenna Array for Wireless Communications, IEEE Transactions on Antennas and Propagation, Vol. 53, No. 8, 2005.

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