Enhanced radiation properties of a rectangular waveguide by means of a Left Handed Media

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In this paper, the results of experimental investigations to improve the gain between two antennas by means of a Left Handed Material (LHM) are presented. The basic idea is the use of a LHM media acting as a resonator to concentrate the power radiated by a rectangular waveguide achieving larger directivities and consequently larger gains. The transmission and radiation properties of this metamaterial (MTM) have been measured using a network analyser and two rectangular waveguides in the X band. Comparing the transmission parameter S_{21} with and without the LHM media between the waveguides, an appreciable improvement in the power received can be observed.

Different Left Handed unit cells are available in the literature. In this case, a unit cell designed by Professor Ziolkowski [1] has been used. It is based on a substrate with embedded capacitively loaded strips (CLSs), or negative permittivity elements, and split ring resonators (SRRs), or negative permeability elements, used to obtain a negative refraction index. The LHM-media were formed by these unit cells, which were characterised with ANSOFT's High Frequency Structure Simulator (HFSS).

These unit cells were constructed applying a layer by layer technique measuring the transmission and radiation properties. The dielectric selected to construct the layers was the RT/Duroid 5880, a low loss dielectric characterized by the parameters ε_r = 2.2, μ_r = 1.0 and dissipation factor $tan\ \delta$ = 0.0009.

A LHM media composed by 12 periods in transversal direction and 1 in the propagation one was fabricated. To measure the transmission and radiation properties, the LHM media was inserted in between the two waveguides and covered with absorbing material to avoid reflections. The transmission properties, showing that losses are negligible and the radiation properties were measured for different distance between the waveguides. Defining the enhanced gain as the improvement in the S_{21} parameter with the LHM media in between the waveguides and without it, and plotting this value vs the distance between the waveguides, an average improvement of 7 dB in gain terms can be observed.

It is the first the first time that LHM media are applied to improve radiation properties of convencional devices. Although this proof of concept has been performed by means of rectangular waveguides, it is possible to be applied to any kind of radiating devices by means of using the LHM media as superstrate.

[1] R. W. Ziolkowski, *IEEE Transactions on Antennas and Propagation*, Vol. 51, No. 7, 1516-1528 July 2003.