Wideband RCS Reduction in a Planar Configuration Using AMC Structures

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Abstract

In this paper a combination of two different Artificial Magnetic Structures (AMC) properly combined in a chessboard like configuration are presented to reduce Radar Cross Section (RCS) in a wideband. Several designs can be seen in the literature reducing RCS in a narrow band or in several frequency bands, but presenting each of them narrow band behaviour. In this case, the design presented in the paper achieves more than a 40% working band.

1. Introduction

RCS reduction can be obtained by several techniques as RAM materials, passive cancellation or active cancellation and also by redirecting waves out from the source [1]-[3]. One of the main limitations of these systems is the operational bandwidth. Nearly all RCS solutions are narrow band configurations. At the same time thickness is usually a problem.

Artificial Magnetic conductor (AMC) structures have already been used to reduce RCS in a chessboard like configuration [1]-[3]. Several working frequencies can be achieved combining AMC structures [1], which redirects power in direction different from the specular one. However, each of this frequency is narrow band.

In this paper a broadband planar chessboard structure combining AMC structures is presented. Two Jerusalem crosses AMCs with different working frequencies have been selected to fill the cells of the chessboard. These AMC have been design to keep 180º of phase difference in a broadband.

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2. AMC structure design

Jerusalem Crosses (JC) AMC structure [4, 5] has been selected to fill the cells of a chessboard like configuration. Black cells have been filled with a JC AMC array with 0º phase at 18 GHz (see figure 1)while white cells have been filled with a JC array working at 13.5 GHz and 22.5 GHz. No vias have been included to simplify the design and the manufacturing process.

These JC AMC have been optimized to obtain 180º of phase difference introduced to the reflected waves in a large bandwidth, as can be seen in figure 1. This 180º creates a destructive interference that redirects the incident power to directions different from the specular.

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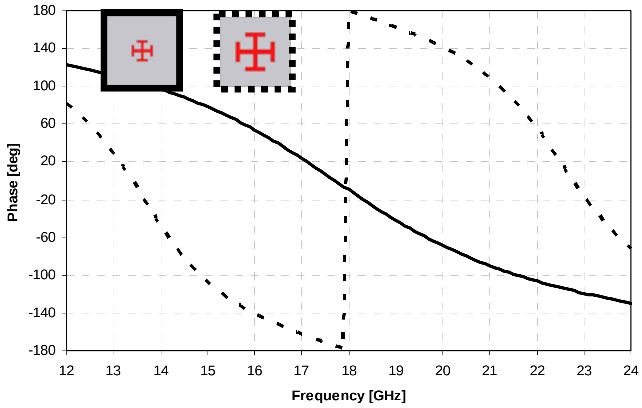

Fig.1: Phase versus frequency for Jerusalem Cross AMCs

The difference in between these two curves is presented in figure 2. The phase difference introduced to the reflected wave keeps around 180° (using an interval of ±20°) from 14.4 to 21.8 GHz (40.88%).

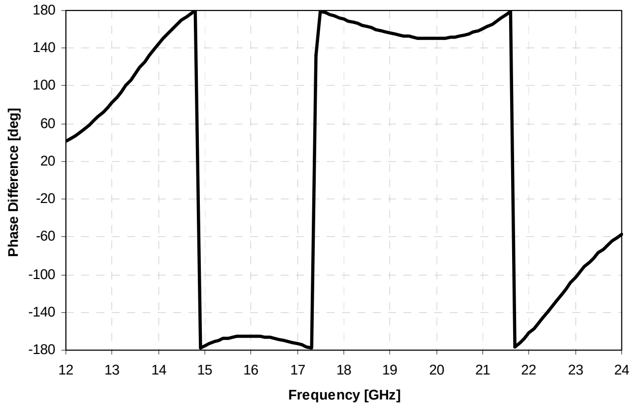

Fig.2: Phase difference versus frequency between Jerusalem Cross AMCs

3. Chess configuration

A unitary cell of the chessboard like configuration has been simulated in HFSS including infinite structure boundary conditions. The RCS of the AMC chessboard structure has been depicted in figure 3. This RCS has been normalized to the RCS of a metallic plate simulated with the same symmetry conditions. As it can be seen a 40.22% working bandwidth has with a reduction larger than 10 dB of the RCS been obtained.

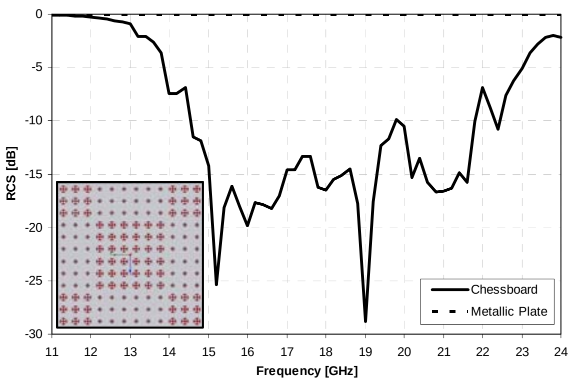

Fig.3: Normalized RCS of the chessboard AMC configuration respect a metallic plate.

Really good agreement has been achieved in between the working bandwidth predicted by the phase difference of the AMC and the chessboard RCS simulated in HFSS.

The structure has been fabricated thanks to the facilities of the Antennas Group laboratory at Public University of Navarra. The fabricated structure is shown in figure 4.

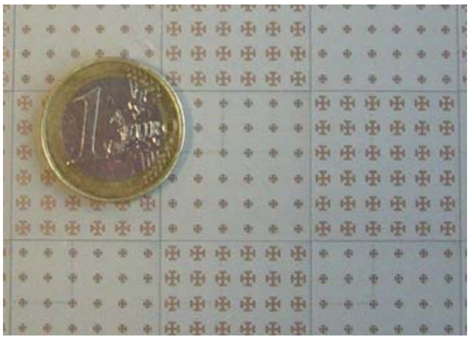

Fig.4: Fabricated broadband Chess Structure.

The structure has been measured obtaining good agreement in between the results predicted by Ansys HFSS and the measurements. Measurements will be shown in the congress.

4. Conclusion

RCS reduction around 40% bandwidth can be achieved in a planar configuration by combining AMC structures which keep constant the 180º phase difference introduced to the reflected wave.

5. Acknowledgments

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References

[1] Iriarte, J.C., Ederra, I., Gonzalo, R., de Maagt, P., “Dual band RCS reduction using planar technology by combining AMC structures”, European Conference on Antennas and Propagation EUCAP 2009, Berlin , 23-27 March 2009, 3708-3709.

[2] Paquay, M., Iriarte, J.C., Ederra, I., Gonzalo, R., de Maagt, P, “Thin AMC Structure for Radar Cross-Section Reduction”, IEEE Trans. AP., Vol. 55, Issue 12, pp:3630 – 3638 Dec. 2007

[3] M. E. de Cos, Y. Alvarez Lopez, and F. Las-Heras Andrés, "A novel approach for RCS reduction using a combination of artificial magnetic conductors," *Progress In Electromagnetics Research*, Vol. 107, 147-159, 2010.

[4] Salisbury W. W, “Absorbent body for electromagnetic waves,” U.S.Patent 2 599 944, June 10, 1952.

[5] D. Sievenpiper, D.; Lijun Zhang; R. F. J., Broas, N. G. Alexopolous, E., Yablonovitch, “High-impedance electromagnetic surfaces with a forbidden frequency band”, IEEE Trans. MTT, Vol. 47, Issue 11, Nov. 1999, pp:2059 - 2074

[6] Simovski, C.R., Tretyakov, S.A., and de Maagt, P.: “Artificial high impedance surfaces: analytical theory for oblique incidence”, Antennas Propag. Society Int. Symp., 2003, 4, pp. 434–437.