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A Dome Shaped Curved Fss with Extra Wide Band Applications: Design and Theoretical Analysis

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Abstract: *This paper deals with the theortical investigation on curved FSS with wide band frequency. The FSS structure is designed by projecting some circular patches of same dimension on the dome shaped substrate. Compared to conventional Flat type FSS this design provide more wider band of frequency(7.09 GHz). Theoretical investigations have been done by CADFEKO(suite5.5) Designer® software.*
Keywords: *Frequency Selective Surface, Method of Moment, Curved FSS, Resonating Frequency, Wide Bandwidth.*

I. Introduction

In microwave engineering Frequency selective surfaces or dichroics can be regarded as filters of electromagnetic waves [1-4]. An array of periodic metallic patches on a substrate, or a conducting sheet periodically perforated with apertures, constitutes a frequency selective surface (FSS) to electromagnetic waves. Such structures have been well known in antenna theory for over half a century. They exhibit total reflection for patches and total transmission for apertures in the neighborhood of element resonance. The reflection and transmission band can be predicted theoretically by different methods viz. Finite Difference Time Domain method (FDTD), Finite Element Method (FEM) & Method of Moment (MOM).[5] The frequency selective properties of FSS are exploited to make a more efficient use of reflector antennas in satellite communication systems which results weight reduction of the satellite and increases its working life. The other application of FSS is to protect the Radar system using radome. FSS is also used in the domestic microwave oven Screen Window which blocks the microwave from coming out but passes the visible spectrum. Conformal structures can be mounted on various airborne objects (fighter jets, smart missiles, rockets) without disturbing their aero dynamical properties. This definition should be broadened with antennas or periodic structures whose shape is not planar and is determined with specific electromagnetic reasons like coverage requirements. For example, arrays on cylindrical structures offer a possibility either to create directed beams in arbitrary direction in horizontal plane, or to create an Omni directional pattern [1]. Spherical arrays have the capability of directing single or multiple beams through a complete hemisphere. Therefore, spherical arrays are a good candidate for satellite terminals, telemetry and command applications, performed from a ground station [2], [3]. Curved periodic structures are mainly used in multi-frequency reflector systems where one reflector is reflectivein one frequency band and it is transparent in another frequency band [4]. Curved periodic structures are also used in realization of frequency selective radomes, i.e. radomes that provide mechanical and electromagnetic protection [5].

This article presents the analysis of frequency selective surfaces (FSS) embedded in a curved supporting structure. This very complex task is simplified by combining rigorous spectral domain approach with simple free-space analysis method [6]. For distant elements the analysis is based on the free-space approach modified with an additional correction term. Verification of the new method is shown using a spherical FSS composed of circular rings, but also a way to extend the method to arbitrary curved structures is proposed [7]. Curved frequency selective surfaces (FSS) are mostly used for achieving frequency selective sub-reflectors in multi frequency reflector systems, or for making frequency selective radomes. In the first case, curved FSS enables the use of a reflector system for more than one frequency band, i.e. there is a separate feed antenna for each frequency band. In the second case, curved FSS enables mechanical and electromagnetic protection of objects (mostly antennas) inside the radome[6].

II. Fss Substrate

The relative permittivity of the substrate (dielectric) is taken as 3.2. Thickness of the dome (hemisphere) type substrate is 2mm.Radius of the outer surface of the dielectric is 10mm and the radius of the inner surface is 8mm.

III. Patch Shape And Dimension

There are 17(seventeen) circular metal patches which are projected on the upper surface of the dome in particular manner as shown in figure 1 & figure 2. Radius of each circular patch is 2mm.Each patch is placed on the outer surface of the dome substrate**.**

IV. Design Model

A dome is created according to hemisphere shape having outer radius 10mm and inner radius 8mm.The thickness of the dome is 2mm. Seventeen 2mm circular patches are created. All the patches are projected on the upper surface of the dome as shown in figures. A horizontal plane wave excitation is given to the dome for the excitation purpose. All the patches and dielectric are meshed properly. The side view, top view and bottom view are shown in figures.

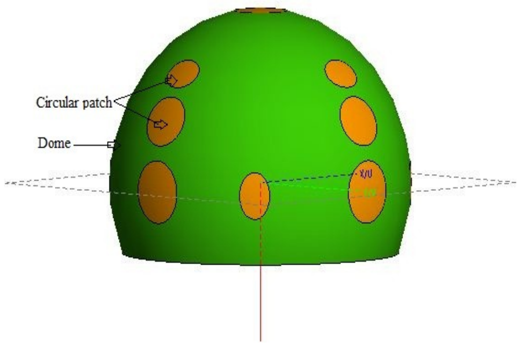

Figure1: Proposed Curved FSS structure

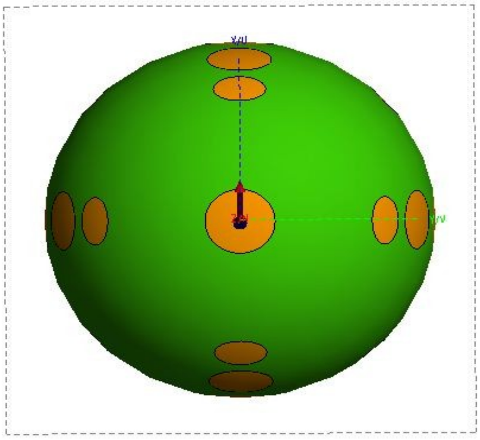

Figure 2: Top view of the structure

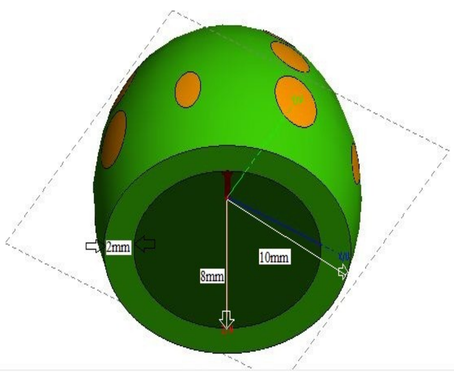

Figure 3: Bottom view of the structure

V. Results & Discussions

After simulating the proposed design in CADFEKO (suite 5.5) the result shows that an extra wide band is achieved. The lower cutoff frequency of the band is at 0.48 GHz and the upper cutoff frequency is at 7.57 GHz. The resonating frequency is at 4.22 GHz and the band separation is -35.57 dB. The frequency bandwidth is 7.09 GH & the percentage bandwidth achieved is 168%.

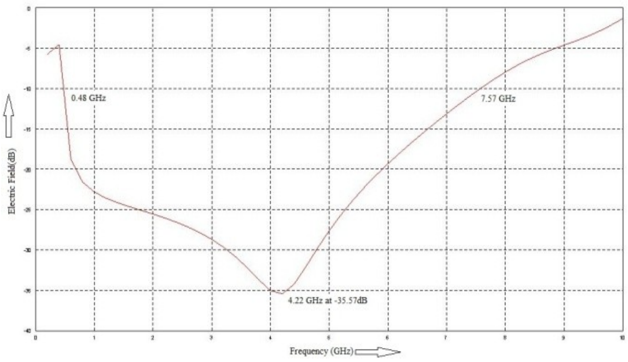

Figure4: Study of normalized transmitted electric field vs. frequency.

VI. Conclusion

The proposed curved FSS has a wide range of band reject frequency (0.48 to7.57 GHz). It rejects L, S, C, and some portion of J band frequency region. So, this dome shaped curved FSS can be used as a perfect radome of the antenna in these bands properly.

Acknowledgement

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