URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

A ultra wide band sinuous antenna design with enhanced linear polarization purity

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Abstract

A variation on the conventional sinuous antenna design, in its slot version, is proposed, to achieve a higher degree of linear polarization purity. The antenna is designed for the UWB frequency band the 3.1-10.6 GHz band.
Simulated results shows the high degree of polarization purity attained.

1. Introduction

The sinuous antenna, introduced by DuHamel in 1987 [1], has been used since then in many ultrawideband (UWB) systems, both in its dipole version and in its slot version, with two or four arms [2–5].
Sinuous antennas are excellent for UWB applications and have advantages over other UWB antennas, such as resistive dipoles, which exhibit poor efficiency, and Vivaldi antennas, which cannot be easily extended to polarization-agile applications.
The sinuous antenna is both radiation efficient and can be used with polarization agility in its 4 arms version without excessive complications.
However, conventional two-arms sinuous antennas do present a linear polarization which oscillates in frequency. This is due to the oscillations in the active region of the antenna, where radiation occurs, and is more and more evident as the angular width of the antenna arms increases. By flipping one of the two arms, the rotation symmetry of the antenna is transformed in a planar symmetry and the azimuthal oscillations in the active region are transformed into oscillations along a linear direction perpendicular to the arms of the antenna.
This leads to a purer polarization at the price of a frequency-dependent squint in the direction of maximum radiation.

2. Antenna Layout

Figure 1 shows a conventional slot sinuous antenna fed with a matched slotline. Figure 2 shows the proposed symmetrical sinuous with one arm flipped. As stated earlier this is intended to make the oscillations of the active regions vertical in the view of Fig. 2, whereas in a standard sinuous such oscillations would be alternating clockwise and counterclockwise on the plane of Fig. 1.

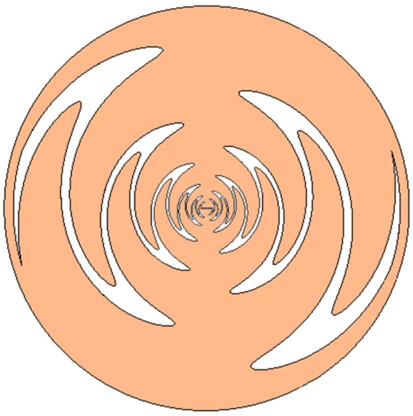

Figure 1. Conventional sinuous antenna geometry.

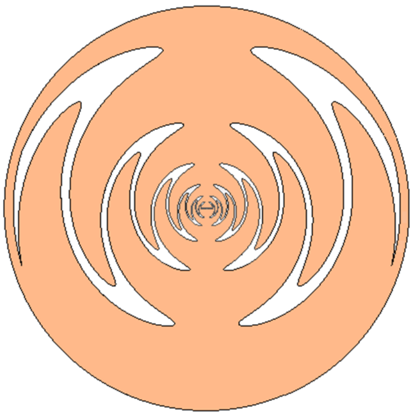

Figure 2. Symmetrical sinuous antenna geometry.

3. Paper Numerical Results

The standard and the symmetrical sinuous are dimensioned to work in the 3.1-10.6 GHz band, occupying a 55mm diameter disk (Fig. 1 and 2).

Simulations are carried out with CST microwave studio. Fields are analyzed on the E plane, that is the plane orthogonal to the antenna plane and containing the feeding slotline.
Figures 3 and 4 reports the copolar and crosspolar component of the radiated field on such plane, averaged over 70 frequency points from 3.1 to 10.6 GHz (solid lines). Figures also reports the average plus and minus the standard deviation (dashed lines).
It is apparent how the standard sinuous (Fig. 3) has a stable pattern in frequency but a very poor linear polarization purity, since the horizontal E-field field component is, in average, about 5dB below the vertical E-field component.
On the other hand, the proposed symmetric sinuous antenna (Fig. 4) has a greater variation in the copolar component amplitude, due to main beam squint, but an excellent polarization purity, being the horizontal E-field component 60dB below the vertical one, in average.

4. Conclusions

A sinuous antenna with a modified geometry enhancing its linear polarization purity has been presented. The average cross-polarization level of the proposed antenna is, in average over the frequency band, more than 50dB lower than a corresponding conventional sinuous antenna o similar dimensions.

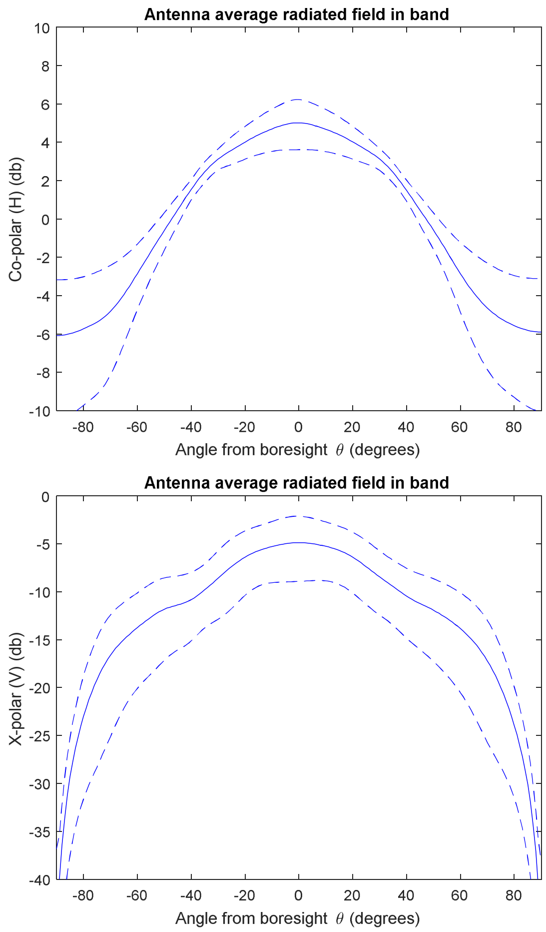

Figure 3. Copolar (top) and Crosspolar (bottom) radiated field for the conventional sinuous antenna on the E-plane.

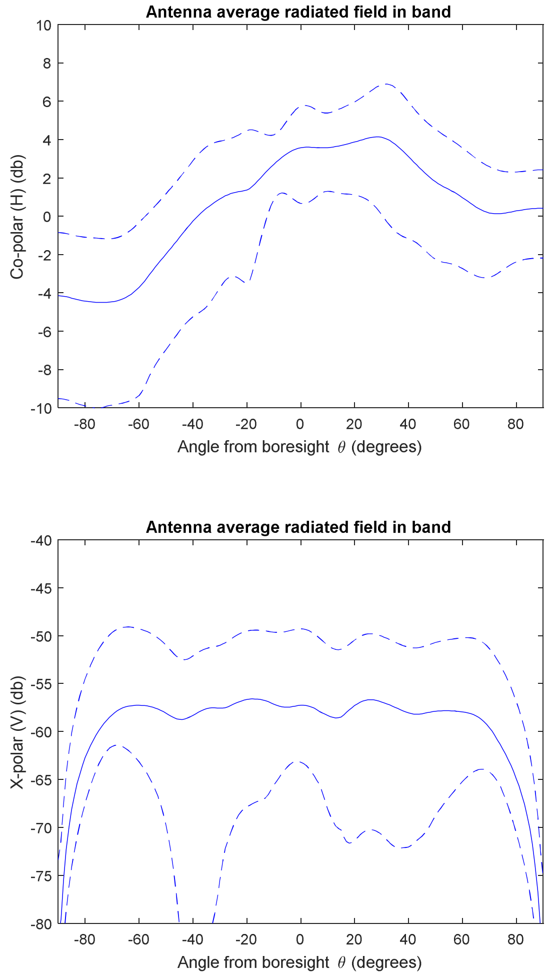

Figure 4. Copolar (top) and Crosspolar (bottom) radiated field for the symmetrical antenna on the E-plane.

5. References

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