CIRCULARLY POLARIZED TRIANGULAR RING SLOT ANTENNA WITH DGS FOR HARMONIC SUPPRESSION

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Abstract:

In this paper a triangular ring slot antenna is proposed which is designed to operate at 5.5GHz. Apart from this fundamental mode, additional harmonics are produced. These harmonics are suppressed by integrating an inverted U-shaped slot into the antenna. This defected ground structure is used to achieve harmonic suppression at 11GHz and 15GHz. Further a tilted slot is embedded in the ring slot antenna to produce circular polarization

Keywords: Defected ground structure (DGS), Circular polarization, and Triangular ring slot antenna.

1. Introduction:

The radio frequency communication device is a combination of active and passive elements. The power amplifier and low noise amplifier constitute the active elements while antenna and filter constitute the passive elements [1] [2]. The size of the RF circuit can be minimized by integrating the antenna with the power amplifier. This active integrated antenna design poses the problem of reducing the power amplifier efficiency due to electromagnetic interference caused by higher order modes excited by the antenna [3].

To avoid this problem, the higher order modes or Harmonics which are repeated at multiples of fundamental frequency are to be suppressed [4]. Thus it is ideal to use a low pass filter along with the antenna. Various methods to suppress the unwanted modes include loading of additional tuning stubs and multiple shorting pins into a patch antenna. These methods were proved to be inefficient in terms of suppressing band width. In order to obtain wide suppressing band width, defected ground structure can be used [5] [6]. This technique involves integration of various types of slots with the patch Antenna. In this paper an inverted U-shaped slot is loaded on the triangular ring slot antenna [7] [8]. The satellite communications use circular polarization since the ionosphere tends to change the polarization of the transmitted wave

. This is a problem, if linear polarization is used. In circular polarization the electric field is passing wave does not change strength but only changes direction in a rotary manner. The use of circular polarization at each end of link reduces fading and flutter.

2.Antenna design:

The satellite communication system uses the C-band with frequency range from 4GHz-8GHz. Hence the antenna designed must be able to operate in this frequency range.

The operating frequency selected for the design is 5.5GHz. And the dielectric material is FR4 which has a dielectric constant of 4.4.
The side of the inner triangle is t1= 10mm and
Side of the outer triangle is t2=14mm is calculated by the formulae

Circle radius (a) = side of the triangle (t)/sqrt (3),
a1= inner circle radius and
a2 = outer circle radius.

$$F_0 = \frac{c}{\prod(a1+a2)}.\sqrt{\frac{\xi r+1}{\xi r}}\ .$$

Where F_0 = operating frequency,
ξ_r = relative permittivity of the substrate,
c= velocity of light,

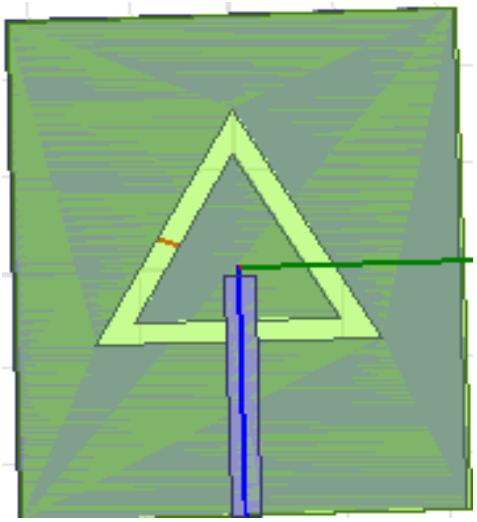

Fig: 1. C-Band antenna without defected ground structure

The harmonics obtained for this antenna are suppressed by using defected ground structure (DGS). The antenna with defected ground structure is shown below.

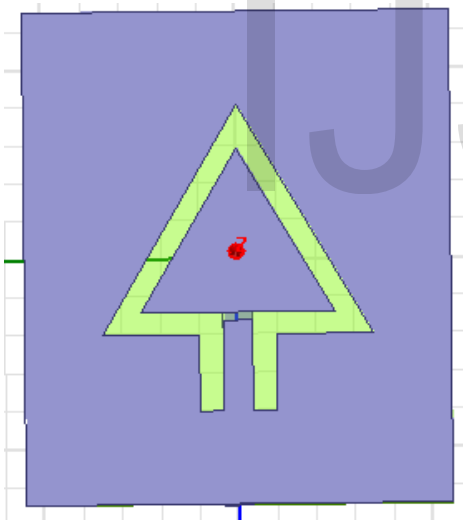

Fig: 2. proposed antenna with defected ground structure

3.Circularly polarized ring slot antenna:

To achieve circular polarization for the triangular ring slot antenna mentioned above, a tilted slot is cut as shown in below figure.

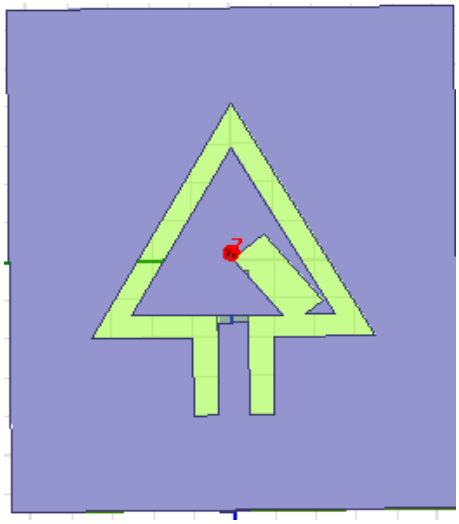

Fig: 3. proposed circularly polarized antenna

4.Simulation:

The simulation of patch antenna is done using HFSS (high frequency structural simulator) version 14.0. It uses finite element method (FEM) for solving electromagnetic structures and designs of antennas, RF electronic circuit elements such as filters and transmission lines.

5.Results and analysis:

For this C-band triangular ring slot antenna the Return loss of -23.3db is obtained at 5.5GHz. The harmonics are obtained at 11GHz, 15GHz.

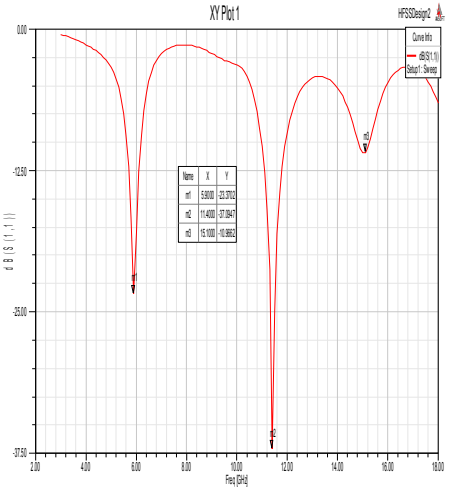

Fig: 4. Return loss without DGS

The harmonics 12GHz and 15GHz are suppressed by using defected ground structure. The return loss curve for defected ground structure antenna is shown below. The return losses at 12GHz

and 15GHz are reduced to 7.6db and 8.21 db respectively.

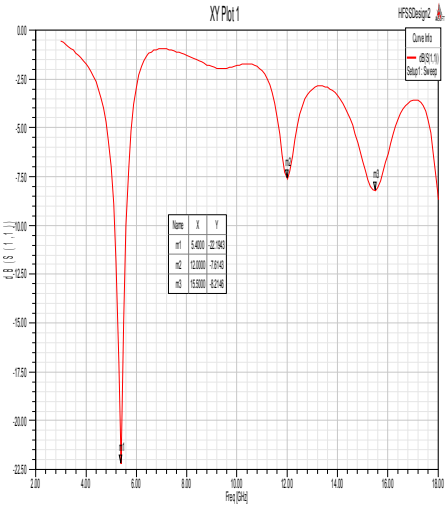

Fig: 5. return loss of DGS antenna

The polarization is observed to be linear from the axial ratio curve shown below.

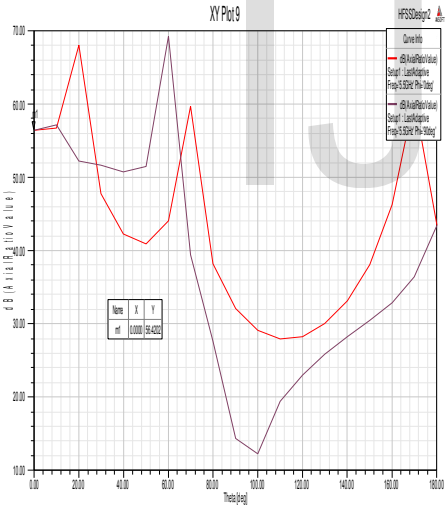

Fig: 6. axial ratio curve of DGS antenna

3D-polar plot:

The total gain of 3.74dB is observed from 3D-polar plot is shown in below figure.

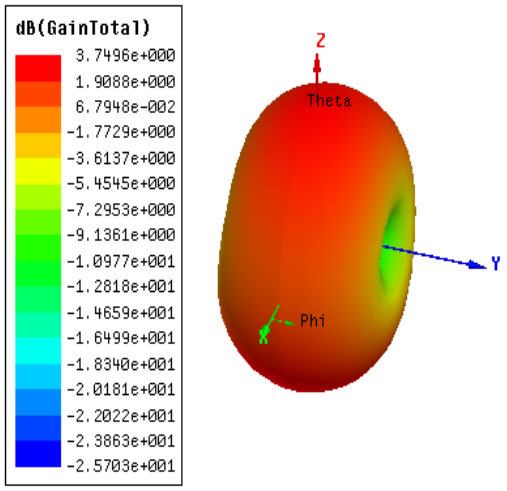

Fig: 7. 3D-polarplot

Circularly polarized ring slot antenna:

The tilted slot which is cut on the triangular ring slot antenna gives circular polarization. The axial ratio measured is found to be 2.69db.

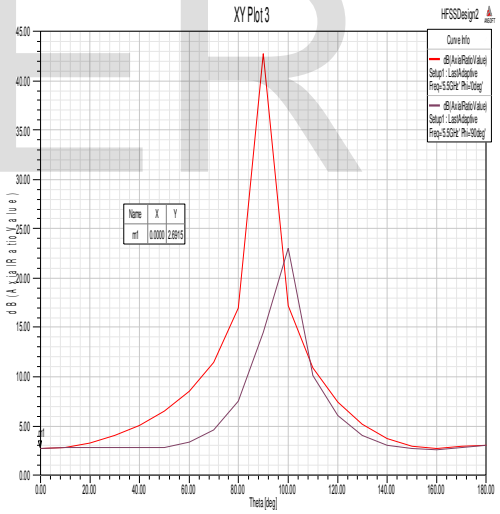

Fig: 8. axial ratio of circularly polarized antenna

3D-polar plot and radiation pattern:

The total gain of 3.20 dB is observed from 3D-polar plot as shown in figure.9. The simulated radiation pattern of the antenna at 5.5GHz is shown in figure.10.

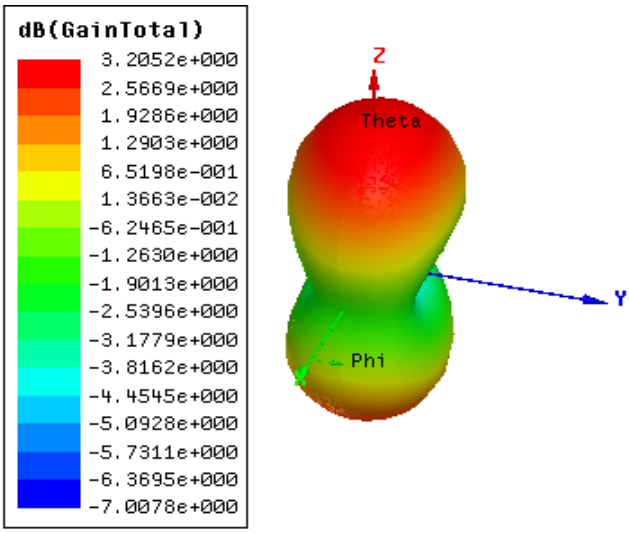

Fig: 9. 3D-polar plot

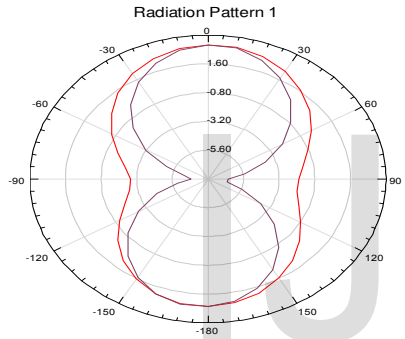

Fig: 10. Radiation pattern

Conclusion:

A U-shaped defected ground structure is designed and loaded onto the triangular ring slot antenna for harmonic suppression. The higher order modes at 11GHz and 15GHz are effectively suppressed. Along with this, circular polarization is achieved by the use of a tilted slot on the triangular patch. The Axial ratio thus observed is 2.69dB.

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