Circular Polarized Ring Slot Antenna with Filtering Characteristics

Sekhar M, Mohan Kumar D

Abstract --- A simple ring slot antenna with a in built filter to reduce the higher order modes is proposed in this model. The proposed antenna is having circular polarization at the operating frequency of 8.6GHz. In general antenna will be having higher order modes of operation and to nullify it we will be having filters in the transceiver circuits but it will increase the mutual interference levels in the system and also the complexity of the system which will lead to reduction of the life span of the device and also effect the efficiency. So to make the system simple a antenna with inbuilt filter is proposed which will not receive the signals from the higher order modes and there will be no necessity for the additional filter circuits.

Key words- Strip Feed, Filter, Higher order modes.

I. INTRODUCTION

The fundamental nature of any antenna is that it will produce higher order modes of frequencies which are in multiples of the operating frequency of the antenna[1-3]. In general filters will be used immediately after the antenna in the transceivers circuits to eliminate these higher order modes. But the introduction of the filter will increase the design complexity of the transceivers circuits as the filters will occupy a large space. Another disadvantage of the filters is the power consumption levels, power consumed by the filters will be high which will also increase the heat dissipation by the filters in the circuit[4,5]. This will reduce the performance levels of the circuit and also reduce the durability of the circuit.

To overcome the effects of the filters in the transceivers circuits a simple technique is been proposed by antenna designers. Instead of using filters to eliminate the higher order modes a antenna is designed such that the antenna will not receive signals at the higher order modes[6]. For this the antenna will act as the filter by which there will be no need for any additional filters. A basic antenna will act as filtering by introducing a slot in the antenna[7-10].

In this paper a circular polarized ring slot antenna with filtering characteristics is presented. A circular ring slot antenna which primarily radiated at 8.6GHz is considered. For the antenna a higher order mode of 15GHz is also observed. To eliminate this a simple T structure is introduced into the antenna which will eliminate the reception of this higher order mode by the antenna. To further enhance the signal reception of the antenna a truncation is made in the antenna and circular polarization is achieved at the operating frequency

II. ANTENNA DESIGN AND CONFIGURATION

Proposed antenna is circular ring slot antenna which is resonating primarily at the frequency of 8.6GHz shown in figure 1. It is having higher order modes at the multiples of the operating frequency. To nullify these higher order modes a filtering structure is been introduced into the antenna which is shown in the figures 2. The radius of the circular ring slot are taken to be 4.79mm and 3.32mm. the microstrip feed width is taken to be 1mm with a length of 8mm. Fr4 material is been used as the substrate and the overall dimension of the antenna is 21mm×18mm×0.8mm. to achieve circular polarization for the antenna with filter a truncation of 6mm×2mm is made in the center circle of the antenna. The filter structure is a T shaped slot which is made of two rectangles of dimensions 2mm×2.2mm and 0.4mm×1mm.

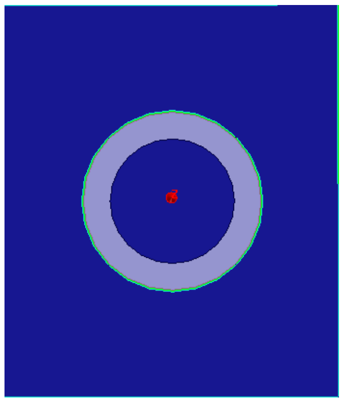

Fig. 1 Geometry of the proposed antenna without filter

Fr4 substrate has been used to design the antenna and to get circular polarization for the antenna with filter the radiating element is been truncated

The dimensions of the radiating elements were calculated based upon the following equations.

$$\mathbf{a} = F\{1 + \frac{2h}{\pi F \varepsilon_r}[ln(\frac{\pi F}{2h}) + 1.7726]\}^{-1/2} \quad (6)$$

Where

$$F=\frac{8.791\times10^9}{f_r\sqrt{\varepsilon_r}} \quad (7)$$

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$$a_e = a\{1 + \frac{2h}{\pi a \varepsilon_r}[\ln(\frac{\pi a}{2h}) + 1.7726]\}^{1/2} \quad (8)$$

The simulated antenna structures of the proposed antenna element are shown in the figure 1,2 below respectively.

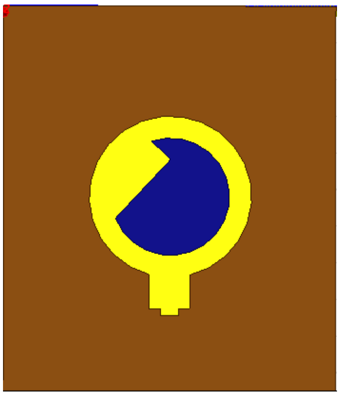
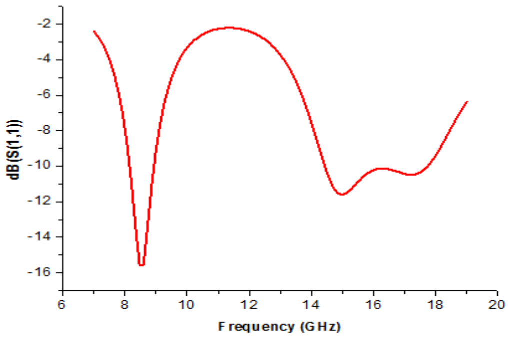


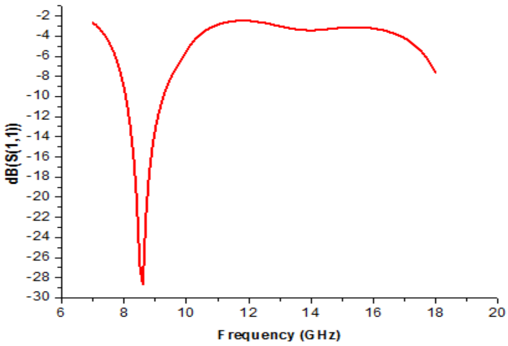
Fig. 2 Geometry of the proposed antenna with filter

III. RESULTS

The performance of the proposed antenna are analysed and studied using Ansys HFSS software. Various antenna parameters like return loss, VSWR, gain, radiation pattern, directivity and impedance matching were studied. All the above mentioned parameters were analyzed for both the antennas. Figure 3 below depicts the return loss plot of the antennas with and without filtering structure. It can e clearly observed from the figures that the antenna without filter is having higher order mode of operation at 15GHz which is been eliminated by introducing the filter structure.



(a) Antenna without filter

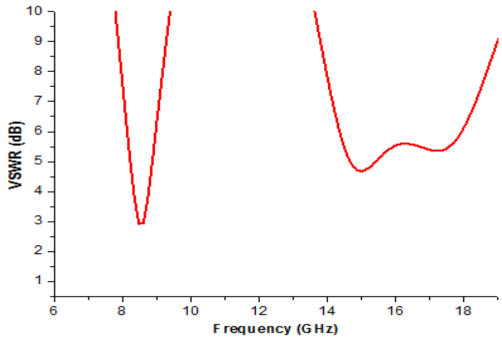


(b) Antenna with filter

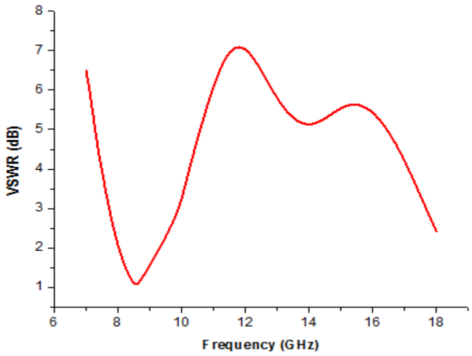
Fig. 3 Return loss of antenna element

Observed a return loss of -15dB for antenna without filter and-28dB for the antenna with filter at the center frequency of 8.6GHz. By introducing the filter impedance matching of the antenna has also increased.

Figure 4 below depicts the VSWR plot of the proposed antenna with and without filter. We can observe that the VSWR levels of the antenna at the higher order mode has increased with the introduction of the filter structure.



(a) Antenna without filter



(b) Antenna with filter

Fig. 4 VSWR of antenna element

Figure 5 below depicts the axial ratio of the antenna. Observed a axial ratio of 2.86dB at the operating frequency of 8.6GHz which represents the circular polarization for the antenna with inbuilt antenna structure.

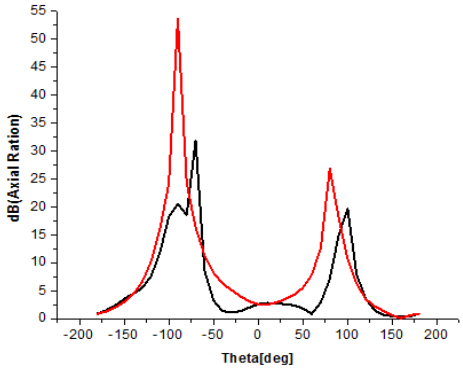


Fig. 5 Axial Ratio

Figure 6 below depicts the Directivity and gain of the antenna. Observed a directivity of 4.22dB and a gain of 3.99dB for the proposed antenna with filter at the operating frequency of 8.6GHz.

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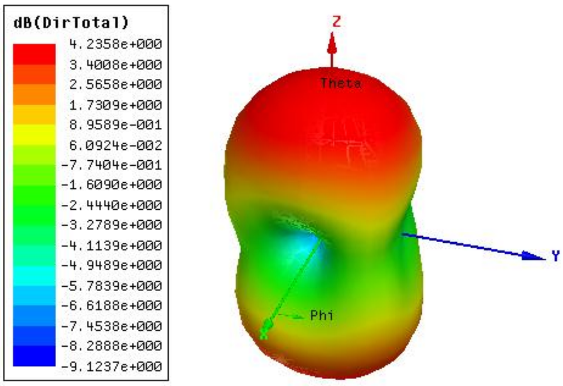
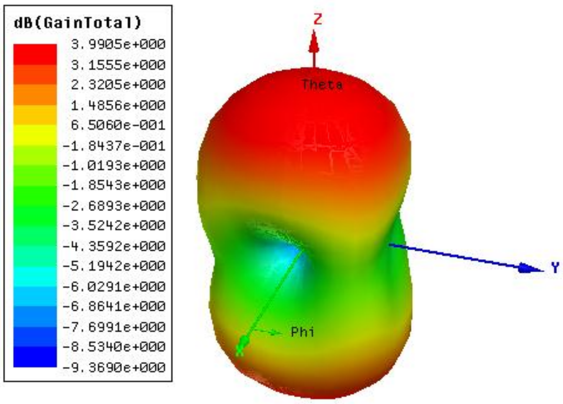


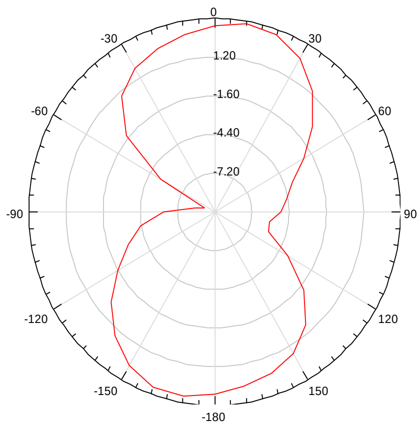
(a) Directivity



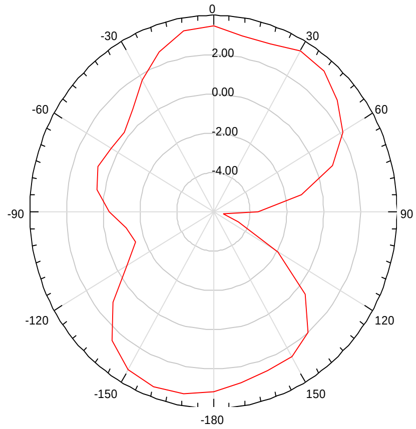
(b)Gain

Fig. 6 Directivity and Gain of antenna

Figure 7 below depicts the elevation plane and azimuthal plan radiation patterns of the antenna with filter. Observed a uniform radiation pattern without any nulls at the operating frequency of 8.6GHz.



(a) E-plane



(b) H-plane

Fig. 7 Radiation Pattern of antenna

IV. CONCLUSION

In this paper, a simple technique to eliminate the higher order modes of operation of an antenna is proposed and investigated. A circular ring slot antenna which primarily radiated at 8.6GHz is considered. For the antenna a higher order mode of 15GHz is also observed. To eliminate this a simple T structure is introduced into the antenna which will eliminate the reception of this higher order mode by the antenna. It is also observed that by this filtering structure the impedance matching levels of the antenna also increased. To further enhance the signal reception of the antenna a truncation is made in the antenna and circular polarization is achieved at the operating frequency.

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