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OPTIMAL WIDE BAND SINUOUS ANTENNA BASED ON DUAL-POLARIZED FEEDING METHOD FOR AEROSPACE APPLICATIONS

[1]S.Archana PG scholar, [2]Dr.S.Venkatesh

[1,2]Department of ECE, Dhirajlal Gandhi College of Technology, Salem, Tamilnadu, India.

ABSTRACT: The sinuous antennas have a numerous applications in military and civil systems such as direction finding systems and reflector feeds due to their superior broadband characteristics and simultaneous polarization capability. In this paper, design, construction and measurements of planar sinuous antennas are investigated for 1–5 GHz frequency range. Feeding sections of this antenna are realized by using microstrip tapered baluns. With an increase in the application of UHF frequency usage in the spacecraft sphere, it is required to extend feed capability in the lower operating frequency range of facility. In view of this, it was proposed to design and develop an UWB antenna operating in the frequency band from 200 MHz - 1 GHz so that facility measurement capabilities can be extended.In this paper, design aspects of antenna, feeding network, fabrication, pattern and gain measurement procedure are discussed. Comparison of simulated & measured pattern and gain values shows good match between them.

Key words: Sinuous antenna; Microstrip tapered balun; Dualv Polarization, Advanced Design System, High frequency Structural Simulator, Radar Cross Section

I. INTRODUCTION

Many research is concentrated on reducing spiral antenna size , but as the spiral antenna radiates two main lobes, one above and one below its plane, when a single radiation lobe is needed, an absorbing cavity is used to prevent radiation in one of the two half spaces .
To the spiral antenna, the sinuous antenna is a good alternative. It shares many of its features: it is planar, broadband and presents two lobes. On the other hand, while spirals have a circular polarization, sinuous antennas exhibit a linear polarization in their two-arm version, and dual linear polarization in their four arms version. Indeed the two available orthogonal linear polarizations can be used for polarization diversity in transmit/receive as well as to produce simultaneously a Left Hand Circular Polarization (LHCP) and a Right Hand Circular Polarization (RHCP). The antenna lower and higher frequency operation limits are determined, respectively, by the outer and inner diameters of the structure.
As the theoretical sinuous antenna radiates both above and below its plane, a broadband absorbing cavity is typically used to eliminate the radiation in one direction as any

reflections from a metallic bottom would couple back to the antenna feed and radiate with the opposite sense of polarization, spoiling polarization purity. Typically, the absorber-filled cavity for this antenna has a depth on the order of the antenna radius. Although the lossy cavity drastically reduces antenna efficiency below 50% and makes the complete structure quite bulky, most commercial sinuous antenna are realized this way.

Better results might be reached via a stepped or conical cavity, so as to keep the back wall at a quarter wavelength from the active region. This can be done more compact by properly loading with a high permittivity material the cavity or by exploiting metamaterials; some interesting results for this two configurations are presented in the following. If, on the other hand, a flat ground is preferred, then a stepped permittivity can be used in the substrate to vary the electrical distance of the planar ground. Both these possibilities will be addressed in the following. In any case these configuration still needs a backing, possibly lossy, cavity of nonnegligible thickness.

A sinuous antenna in slot configuration is not burdened with most of these issue. Additionally, while the slot spiral also radiates bidirectionally, a deep, absorbing cavity is not necessary to force unidirectional radiation. In fact, a very shallow reflecting cavity is sufficient and leads to an appreciable increase in gain. The resulting complete antenna is very thin, making mounting much easier. Notwithstanding its better behavior, little research has been carried out for slot-sinuous antennas.

This paper is focused on the design of three four-arm sinuous antennas, enabling polarization agility if backed by an appropriate feeding network, and with increased efficiency (with respect to the lossy cavity backed one). Two of the proposed configurations exhibit a strip sinuous over a properly design backing cavity, while the last is a slot-sinuous configuration with a closer ground. In this latter configuration, by varying the distance from the ground, some control over the half power beam width (HPBW) can be obtained.

II. LITERATURE SURVEY

The proposed fully differential CMOS tunable OTA cell with its simulation results. In section 3; the Master/Slave tuning scheme is discussed. The proposed OTA is used to realize a tunable third-order low-pass filter using cascading topology. A low voltage low power tunable fully differential OTA is introduced[1-3]. A tunable third-order low-pass filter using cascaded topology is presented. The filter's cutoff frequency is tuned using a Master/Slave tuning scheme through a trans-conductance division scheme consisting of a PLL and a simple control loop. The filter is realized using 90nm CMOS technology model under 1V single ended voltage supply. The filter's cutoff frequency is varied from 4.76MHz to 12.95MHz.

The purpose of this paper is to design amicrostrip rectangular antenna in Advance DesignSystem Momentum (ADS). The resonant frequency ofantenna is 4.1GHz. The reflection coefficient is less than -10dB for a frequency range of 3.1GHz to 5.1 GHz. Theproposed rectangular patch antenna has been deviseusing Glass Epoxy substrate (FR4) with dielectricconstant equal to 0.02. Thisrectangular patch is excited using transmission lines ofparticular length and width. Various parameters, forexample the gain, S parameters, directivity and efficiencyof the designed rectangular antenna are obtained fromADS Momentum.[4-10].

In this letter, a microstrip-fed dual-polarized stepped-impedance (SI) slot antenna element with a low profile is firstly proposed. The antenna is composed of two pairs of SI slots excited by two orthogonal stepped microstrip feedlines. The broadband characteristic is achieved by combining the fundamental and spurious resonances of the SI slot resonators, while the good cross polarization is mainly due to the introduction of the shorting pins. Secondly, based on the proposed antenna, a four-element antenna array is designed, constructed and measured for base-station applications. Measured results demonstrate the bandwidths (return loss > 10 dB) of the antenna array are 46.9% (1.55-2.5 GHz) and 38.7% (1.69-2.5 GHz) for Port 1 and Port 2, respectively. The isolation between the two ports is greater than 35 dB whereas the cross polarization level maintains lower than -27 dB across the entire operating band[11-19]. In addition, the antenna array prototype achieves average gains of 13.5 dBi and 13.9 dBi for horizontal polarization and vertical polarization, respectively.

III. PROPOSED METHODOLOGY

To meet the challenge posed by hostile signals that can be arbitrarily polarized, Randtron Antenna Systems has developed a common aperture element capable of simultaneously receiving or transmitting radio frequencies of any two orthogonal polarized signals on two isolated ports. The model 54727 antenna derives its dual circular polarization from the natural dual linear polarization of the sinuous antenna via an internal quadrature hybrid. The result is low ellipticity over wide spatial angles verifying that the *E*- and *H-plane* patterns are produced from collocated phase centers.

3.1.The feed structure

To match the 50 ohm unbalanced source to the balanced impedance presented by the element, a “tapered microstripline” balun was used. A linearly tapered impedance transformer was used, and the ground plane was tapered simultaneously to provide the required transitionfrom a balanced line to an unbalanced line. The balun used was designed to transform a 200ohmbalanced impedance to a50ohmunbalanced impedance.

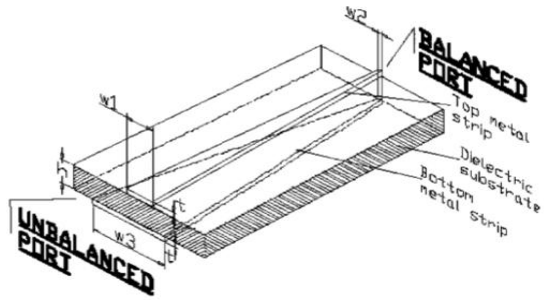

Fig.1. Linearly tapered microstrip balun.

Polarization wobble and cross-polarization rejection the polarization wobble was measured by turning the polarization of the transmit LP Antenna, and locating its orientation for the sharply defined minima in the received signal strength as a function of frequency in the 1.0–5.0GHz band.

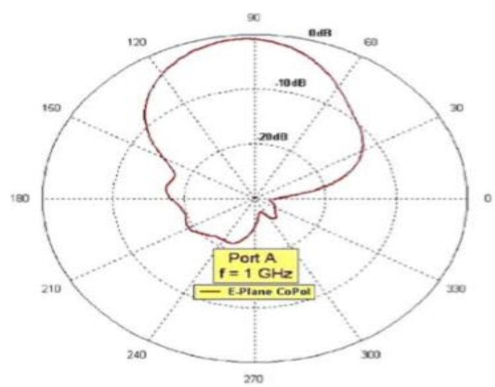

Fig.2Measured E-plane radiation pattern of port A

The polarization wobble was ±5◦ in this frequencyrange. The cross-polarization rejection was better than −15dB throughout the band (See Fig. 2.).

The performance of the antenna is similar to a cavity backed spiral antenna with the exception that pattern performance is superior at broader angles from bore site. The VSWR is typically less than 1.5:1. Power handling is typically 7-Watts CW. Actual performance depends on installation and environmental conditions. The antenna can be provided with or without an aperture environmental random cover.

3.2. ANALYSIS OF THE PROPOSED antenna

3.2.1. Impedance of Input

The following mathematical equation (1) has been utilized to calculate the value of Input Impedance of proposed antenna design

Zin= (Z+XL1)//XC1+XL2, Z = 50Ohm (1)

$$Zin=\frac{Z+SL1}{1+SC1(Z+SL1)}+SL2 \quad (2)$$

3.2.2. Analysis of stability

Stability Factor (K) is used to specify the stability of the amplifier. The use of this aspect scatter parameter (S-parameter) is detected and the foreground formula is shown below.

$$K=\frac{1-(S11)^2 \quad -(S22)^2}{2(S21)(S12)} > 1 \quad (3)$$

Where; $|\Delta|=|S11S22-S12S21| > 1$ with $S11 < 1$ and $S22 < 1$

3.2.3. Figure of Merit (FOM)

A K-factor> 1 of LNA is unconditionally stable. The Figure of Merit is mainly depends on following parameters such as Power consumption dc (Pdc) , Bandwidth(B) ,Gain (G) ,Interception point of third order and resonant frequency (W0). The following equation (4) is used calculate the value of FOM

$$FOM=-NF+IIP3+G-10\log\frac{Pdc}{1mW}-20\log\frac{w0}{2dB} \quad (4)$$

3.2.4. Gain Analysis

The voltage ratio of input (V_{in}) and output (V_{out}) is used calculate the value of gain. Small signal equivalence gain analysis is shown in Figure.3.

The voltage level of Output is calculated as,

$$V_{out}=I_{out}\left(\frac{XL6.XC6}{XL6.XC6}\right)+I_{out}C_5+I_{out}C_3+I_{r0} \quad (5)$$

$$I_{out}=-\frac{Vout}{R01} \quad (6)$$

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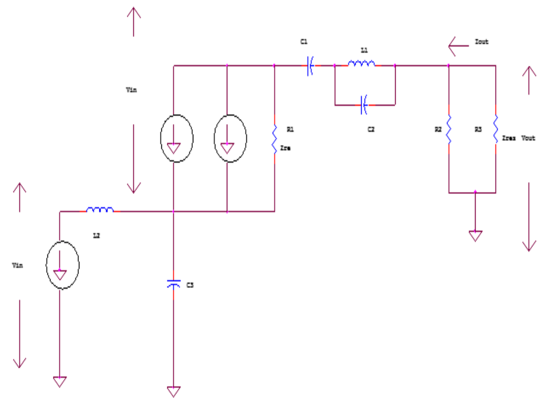

Fig.3. Signal equivalent circuit

3.3. ADVANTAGES

- 2 - 18 Ghz Frequency Operation
- Dual Circular Polarization Enhanced Gain Cavity
- Internal Polarization Switching
- Designed For RWR Application
- Designed For Military Airborne Environment
- It Consumes Less Power I.E. The Power Consumption Is Low.
- The Power Dissipation Is Also Low.
- Most Of The Modern Devices Need To Operate At Low Power.

IV. SIMULATION RESULTS

themagnitude response of ads tool .the output waveform magnitude response is shown as below.

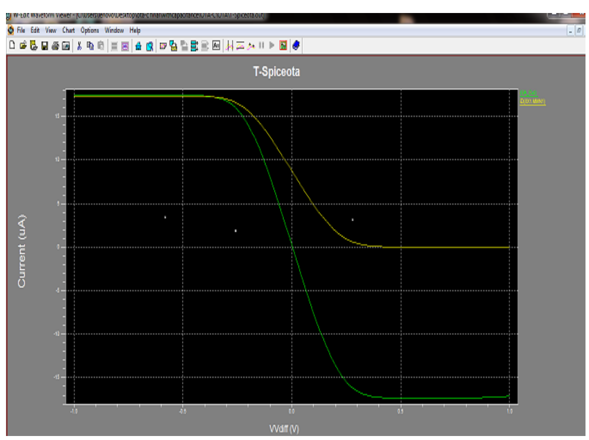

Figure 4 Magnitude response Amplitude response of Gm cell:

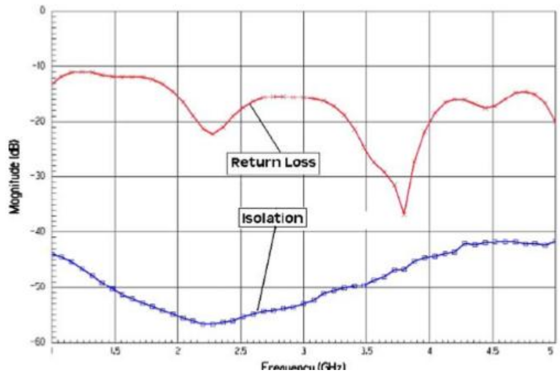

Figure**. 5. Return loss and isolation of two ports of balun card, simulated with HFSS**

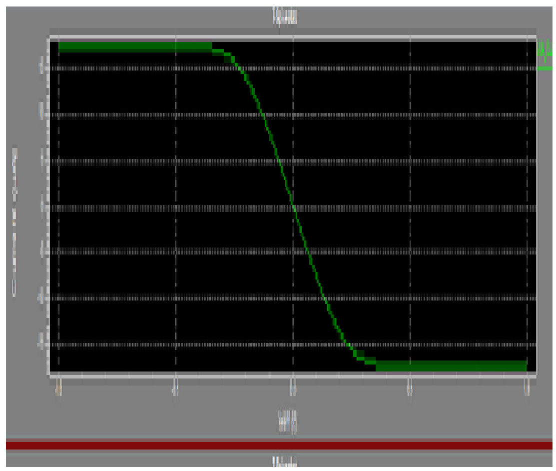

Figure 6 Amplitude response of gm cell

TheAmplitude response of low trans conductance obtain in ads Tool.

The gain of the designed transconductance cell is 57 dB and the power consumption is 15 nW. The low pass filter with pass band gain 0 dB and cut off frequency of 250 Hz is designed. The total power consumption is 157.5 nW

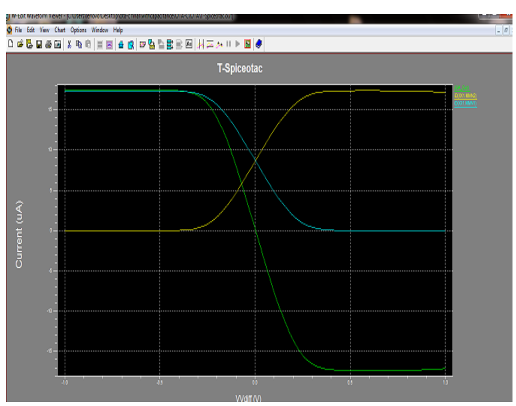

Figure 7. Overall simulation results

V. CONCLUSION

Antennas are impedance matching devices that transform the impedance of the RF source to that of free space. To be useful they should be capable of achieving this transformation over the entire band of operation (frequencyindependent input impedance). A high bandwidth systemtherefore requires a wideband antenna. Additionally, the radiation pattern should be the same at all frequencies over the desired band. Further, some applications require the antenna to be polarized, while some require that the physical structure be as small as possible. The ease of fabrication of the structure should be viewed as an added advantage. The sinuous antenna described above, has all these specifications, and should be particularly useful for reflectorbased searching systems and phased focal plane array applications.

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