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COMPARISON OF PERFORMANCE CHARACTERISTICS OF GAP COUPLED ANNULAR RING MICROSTRIP ANTENNA AND A FREQUENCY AGILE GAP COUPLED ANNULAR RING MICROSTRIP ANTENNA IN C BAND

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ABSTRACT

In the present paper the performance characteristics like VSWR and return loss of gap coupled annular ring microstrip antenna and a frequency agile gap coupled annular ring microstrip antenna are compared. The operating frequency of the gap coupled annular ring microstrip antenna is electronically controlled by the bias voltage of the gunn diode. When the patch is loaded with the gunn diode the value of VSWR decreases and comes closer to the ideal value. Also the value of return loss for the gunn integrated antenna is less as compared to the unloaded patch antenna.

KEYWORDS: *Microstrip patch antenna, Gunn Diode, VSWR, return loss*

I. INTRODUCTION

The antenna is often the most visible element of a radio system. The sizes and shapes of the conductors that comprise the antenna determine the directional characteristics of the electro magnetic (radio) waves it radiates. Microstrip devices have been used wisely as a microwave circuit elements such as transmission lines, filter, resonator etc. Microstrip antennas have received much attention in recent years because of their much unique and attractive properties-low profile, light in weight, compact and comfortable in structure and easy to fabricate and to be integrated with solid state devices. They are superior to the conventional antennas. Despite narrow bandwidth and low efficiency, microstrip antennas find potential application in various diversified fields especially in high speed space vehicles, missiles, tanks and other strategic defiance equipments. While the rectangular and circular patches are probably the most extensively studied patch shapes. The annular ring has also received considerable attention. There are several interesting features associated with this patch. First, for a given frequency, the size is substantially smaller than that of the circular patch when both operated in the lowest order mode. In application to arrays, this allows the element to be more densely situated, thereby reducing the grating-lobe problem. Secondly, it is possible to combine the annular ring with a second microstrip element, such as circular disc within its aperture, to form a compact dual band antenna system. Thirdly the separation of the mode can be controlled by the ratio of outer to inner radii. Finally, it has been found that, by operating in one of the higher- order broadside mode, i.e. TM, the impedance bandwidth is several times larger than is achievable in order patch of comparable dielectric thickness. Many of the antenna applications for satellite links, mobile communications, wireless local area networks, and so on, impose constraints on compactness, dual frequency operation, frequency agility, polarization control, radiation pattern control and so on. These functions can be achieved by suitably loading simple micro strip antennas with active devices like gunn diode and hence these antennas are becoming more commonly used. Such antennas are called active antennas. Hence, active antenna is an antenna having all of the necessary components, such as an antenna element, a feeding circuits, active devices or active

circuits, integrally provided on a monolithic substrate, thus producing compact, low cost and multi-function antenna equipment.
In this paper the comparison of performance characteristics of gap coupled annular ring microstrip antenna and gunn loaded gap coupled annular ring microstrip antenna is done. Introduction of the patch antenna is given in Section I. Section II describes the antenna designing of the gunn integrated gap coupled ARMSA and the various design specifications are given in section III. Section IV shows the results and discussion and the comparative study of different parameters for loaded and unloaded patch is given in Section V. Conclusion is given in Section VI.

II. ANTENNA DESIGNING

The gap coupled AR-MSA and a gunn integrated gap coupled concentric AR-MSA is shown in figure 1 and 2:

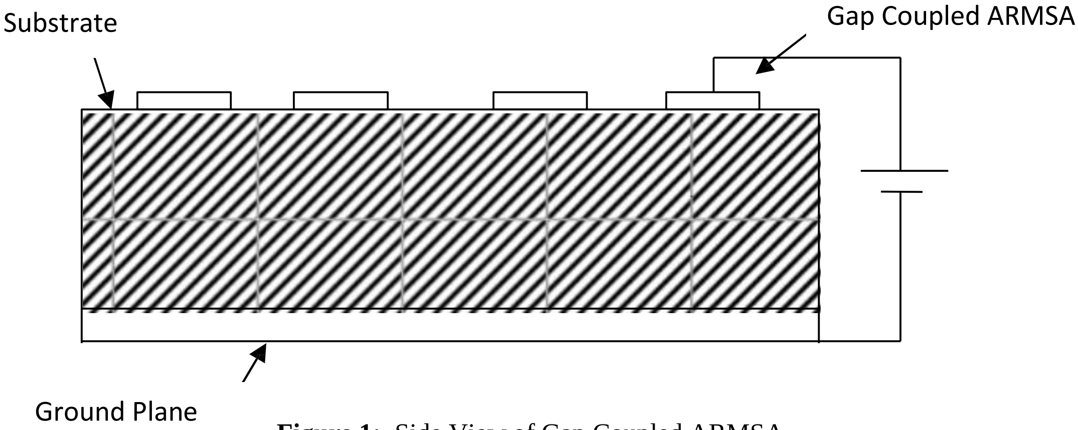

Figure 1: Side View of Gap Coupled ARMSA

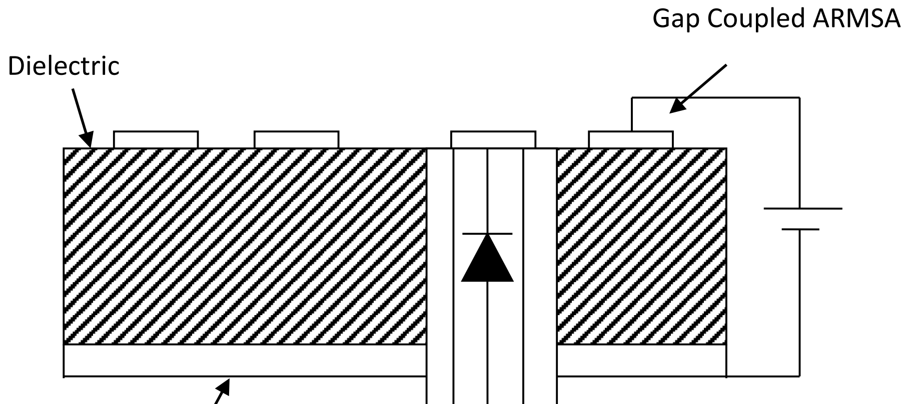

Figure 2: Side View of Gunn Integrated Gap Coupled ARMSA

The above figure shows two gap coupled gunn integrated annular ring antennas in which inner one is feeded at point(c, 0) by a coaxial cable (a1<c<b2) where a1 and b1 is inner and outer radius of the inner ring and a2 and b2 is inner and outer radius of the outer ring. The gap length 'S' between the two rings is taken as 0.095cm.The inner ring is fed with the coaxial cable while the outer ring is kept parasitic. The diode is integrated on the inner ring of the patch. The thickness of the substrate h is small as compared to the difference between the inner and outer radius of the inner ring. The analysis is done using only one parasitic antenna.

III. DESIGN SPECIFICATIONS

Here we use the substrate PTFE Glass micro fiber reinforced i.e. RT Duroid (5870), having the dielectric constant 2.32, in both, in the single patch and in case on mounting the parasitic element. There are numerous substrate that can be used for the design of ARMSA and there dielectric constant are usually in the range of 2.2 < ε**r** <12. the once that are most desirable for antenna performance are thick substrates whose dielectric constant is in the lower end of the range because they provide better efficiency, larger bandwidth, loosely bound field for radiation into space, but at the expense of larger element size. Thin substrate with higher dielectric constant are desirable for microwave circuitry because they require tightly bound field to minimize undesired radiation and coupling and lead to smaller element size however, because of their greater losses they are less efficient and have relatively smaller bandwidths. That's why we use that substrate through our work. The thickness of dielectric substrate is 0.159cm. The Inner and outer radius of the inner ring is1.518 cm and 3.187cm respectively. The Inner and outer radius of the outer ring is 3.282 cm and 6.892cm respectively. The distance between the two rings is 0.095 cm and the feed point location is 1.715 cm. The design parameters define the operation and the performance of the antenna. The operating frequency determines the size of the patch antenna while the distance between the ground plane and the patch affects the bandwidth. On the other hand, the size of the feed gap influences the impedance matching.

IV. RESULTS AND DISCUSSION

Before loading the gap coupled ARMSA with gunn diode, the gap coupled ARMSA is designed and simulation process has been carried out using Computer Simulation Technology (CST) software to analyze the performance of the antenna. The software brings much benefit to the antenna researcher because the performance and characteristics of the antenna can be analyzed before proceed to the fabrication process.
Variation of resonance frequency with bias voltage at constant threshold voltage is shown in the graph below:

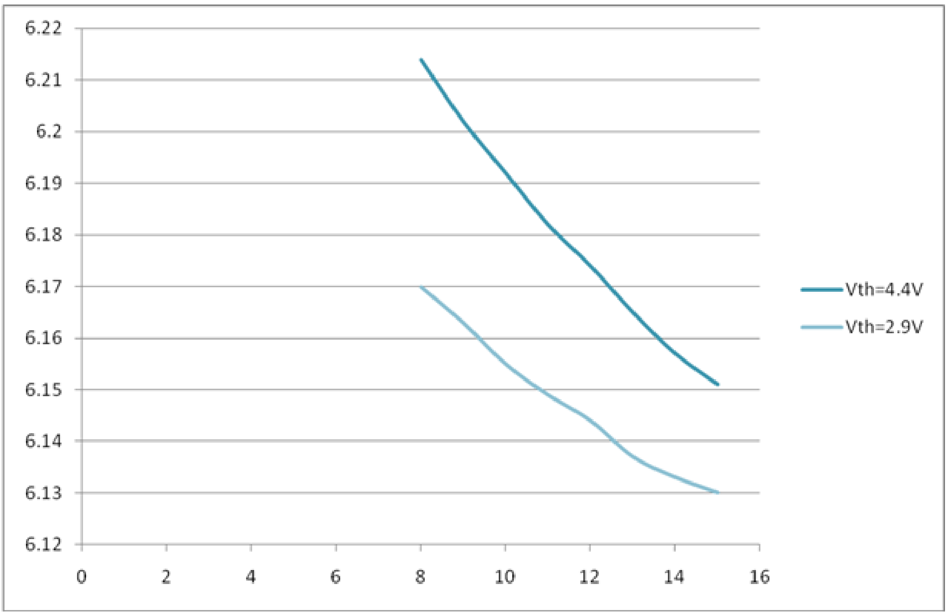

Figure 3: Variation of resonance frequency with bias voltage

It is shown that resonance frequency decreases with increasing bias voltage for all the value of Vth. But at the same time it is also clear that the resonance frequency is higher for higher values of Vth at a given bias voltage. It is observed that the operational frequency is 6.17 GHz at 8V bias voltage and 6.13GHz at 15V bias voltage for Vth =2.9V. And for Vth =4.4V, the operational frequency is 6.214GHz at 8V bias and 6.151V for 15V bias voltage. Thus it is clear that the operating frequency of the gunn integrated gap coupled ARMSA can be controlled by changing the bias voltage of the gunn diode. Thus we have made our antenna frequency agile.

V. COMPARATIVE STUDY

The comparison of variation of VSWR and return loss for gap coupled annular ring microstrip antenna and a gunn loaded gap coupled annular ring microstrip antenna with frequency is shown in table 1 and 2.

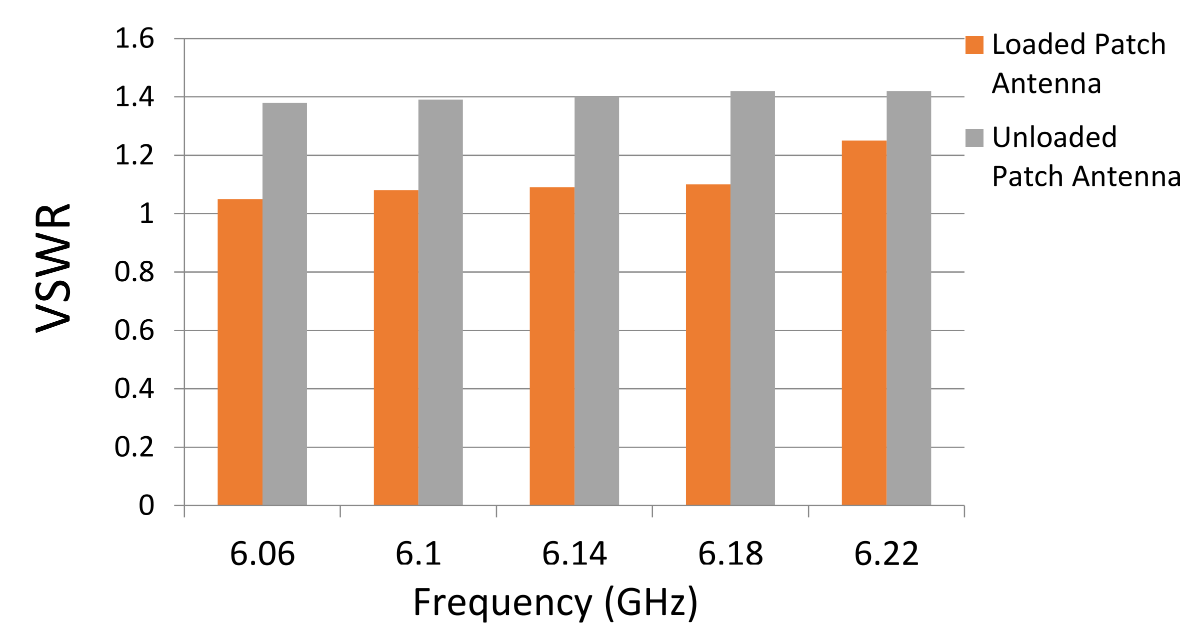

Figure 4: Comparison Chart of VSWR with Frequency for Loaded and Unloaded Patch Antenna

Figure 5: Comparison Chart of Return Loss with Frequency for Loaded and Unloaded Patch Antenna

The figure 4 shows the variation of VSWR with the frequency for both loaded and unloaded gap coupled ARMSA. It is clear from the graph that when the antenna is loaded with the gunn diode, VSWR decreases and comes closer to the ideal value of 1. It is also noticible that there is not a sufficient increase in VSWR from the frequency range of 6.06GHz to 6.18GHz. But at 6.22 GHz there is a sudden increase in the value of VSWR for both loaded and unloaded patch.

Figure 5 shows the comparative study of return loss of a gunn integrated gap coupled ARMSA to the unloaded patch alone. As shown in the graph the value of return loss for gunn integrated patch is lower as compared to the return loss of the patch alone. This results into better impedance matching. The resonant frequency is found to be 6.1 GHz at which the value of return loss is found to be minimum which is -36dB for the loaded patch and -32dB for the unloaded patch antenna.

VI. CONCLUSION

In this paper the comparative study between the different performance characteristics like VSWR and return loss of loaded and unloaded gap coupled annular ring microstrip antenna is presented and the effect of the bias voltage on the operational frequency of the microstrip antenna is investigated. It is found that the operating frequency of the antenna is tuned by changing the bias voltage of the diode. It is also evident from the above tables that by loading the antenna with gunn diode, both VSWR and return loss is improved. Thus by selecting appropriate substrate thickness, dimensions of the parasitic patch and by loading the antenna with gunn diode, a frequency agile microstrip antenna with improved VSWR and return loss is achieved.

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