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Compact Dielectric Annular Grating Antenna for Millimeter-Wave Applications

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ABSTRACT

This paper reviews a simple and compact dielectric annular grating antenna. The proposed antenna made of high resistivity silicon using silicon platform. The antenna is fed through Dielectric image guide (DIG), with a maximum gain of 18 dB, and wide bandwidth more than 7 GHz which is suitable for commercial applications, such as mobile radio, short range wireless communication and W-band applications in Millimeter Applications requiring high Gain, efficiency, data rate, and large bandwidth. The main features of the proposed antenna that is achieved by designing low-cost, compact size, and ease of fabrication and integration. The simulation gain of the antenna is 18 dB at 102 GHz with radiation efficiency better than 95%.

Keywords: Dielectric antenna; Millimeter wave (mm-wave); Dielectric Image Guide (DIG); CST- Microwave Studio Circuits.

1. INTRODUCTION

In this section, Dielectric Grating Antenna design is presented for millimeter Wave Applications. With the development of Millimeter wave communication (MMW) technology, there is increasing demand for compact antennas with low cost and high gain. Dielectric antenna is described for millimeter wave communication systems [1]. The dielectric antennas have received great attention in MMW applications due to their advantages of low cost, low profile, light weight, simple structure, easy fabrication, and easy integration with other circuits. There exist several bands that are used by short range millimeter wave communication systems and other Applications, such as Point-to-point communications, Imaging Applications and Automotive Radar [1]. In which they were able to achieve a Low-Cost and High-Efficiency and compatible integration with current Silicon micro fabrication technologies. The antenna will be fabricated using the Si-based technology platform [2]. This technology platform is capable of integrating passive components and active components along with high efficiency dielectric antenna on one platform. The proposed antenna is a half-disk with annular multi-step grating. The antenna is fed via a dielectric image guide (DIG) fabricated of high resistivity Si [2]. The other end of the DIG has a tapper section that will be inserted into a standard metallic wave-guide WR10. WR10 will be excited with the dominant mode that will couple to the DIG through the taper section to minimize the return loss.

We performed a parametric sweep of the physical dimensions of the dielectric grating antenna in order to optimize the performance in terms higher gain and better efficiency with compact size [4]. We used only one annular ring with multi-step grating [5]. The simulated gain of the antenna is 18 dB at 102 GHz with radiation efficiency better than 95% and wide bandwidth approximately from 98 GHz to 105 GHz. The simulation process was done using Computer Simulation Technology (CST) Microwave Studio.

2. ANTENNA GEOMETRY AND DESIGN

This design presents the optimization of a dielectric annular grating antenna to work in the W-Band. The proposed antenna is a half-disk with only one annular ring with multi-step grating connected to the feed line (DIG) on a grounded dielectric substrate [3] with overall thickness= 0.63 mm. The other end of the DIG has a tapper section that will be inserted into a standard metallic wave-guide WR10 are shown in Fig. 1.The grating profile will be discussed shortly as shown in fig. 2. The antenna will be fabricated using the Si-based technology platform. This technology is capable of integrating

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communication devices with high efficiency dielectric antenna on one platform [6]. WR10 will be excited with the dominant mode that will couple to the DIG through the taper section to minimize the return loss.

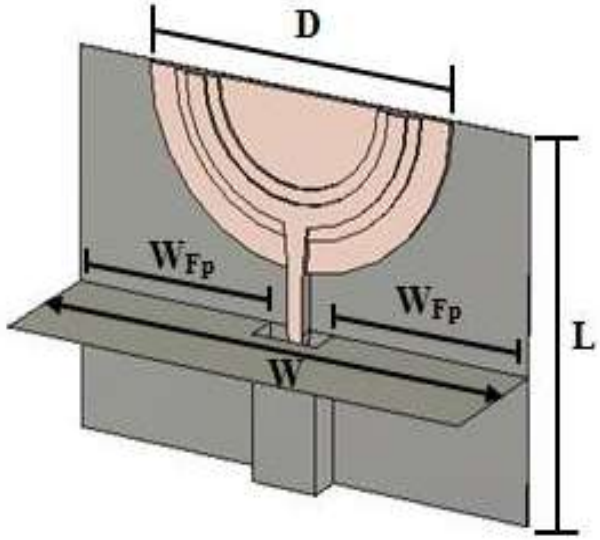

Figure 1: Schematic drawing of the proposed dielectric antenna

Table 1: Design Dimensions. All Dimensions Are In Millimeters

L	W_{FP}	D	W	W_1	W_2	t	W_f	L_f
13	7.73	12	18	1.70	0.72	0.13	0.6	8.64

3. ANTENNA SIMULATION RESULTS AND DISCUSSION

We able to achieve the higher performance (higher gain and larger bandwidth) with compact size and low cost. The grating profile takes crucial role in this design [2]. By using a parametric sweep of the physical dimensions of the dielectric grating antenna in order to optimize the performance in terms higher gain and better efficiency while decreasing the overall size of the antenna. The parametric sweep will be reviewed. The effect of varying the grating dimensions and Grating Thickness on the parameters of the antenna[3]. They are very critical to study carefully. We have used the CST built-in optimizer. Optimization variables were the grating width (multi-step) and thickness. The selection criterion used, based on some preliminary trial. The final optimized grating design (the grating profile) is shown in Fig. 2.and we also performed a parametric sweep for the Feeder (DIG). The results of simulation are presented the in following figures, (Fig. 3-4-5). First, fig. 3 illustrate wide bandwidth over 98 to 105, fig. 4 maximum gain "G" is 18.

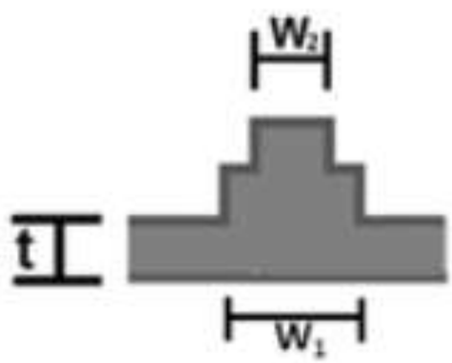

Fig.2.Grating profile

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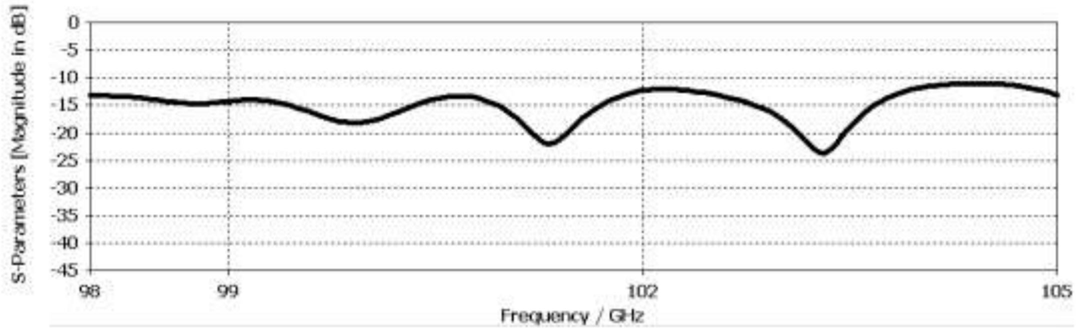

Figure 3: Simulated return loss (S11) of the dielectric grating antenna over 98-105GHz

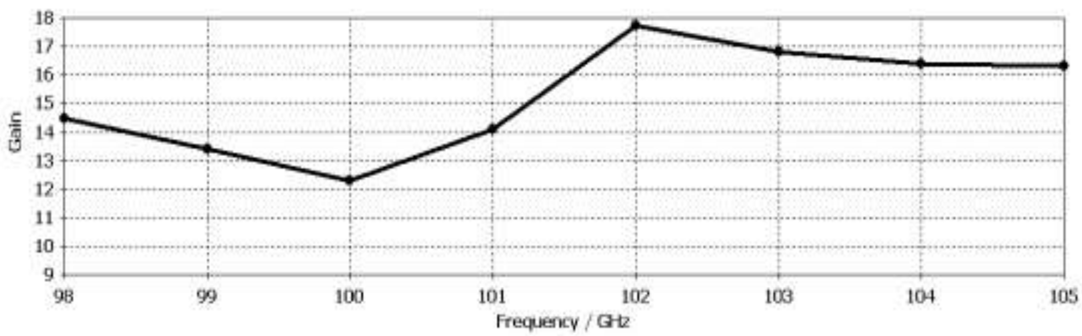

Figure 4: Simulated gain of the dielectric grating. The gain reaches 18 dB at 102GHz

The 3-D radiation pattern is shown in Fig. 5. A polar plot of the radiation patterns in the Eplane and H-plane (ϕ =0°, 90°) respectively as a function of θ is shown in Fig. 5(b). The simulated pattern shows maximum radiation at angles of θ = 90°.

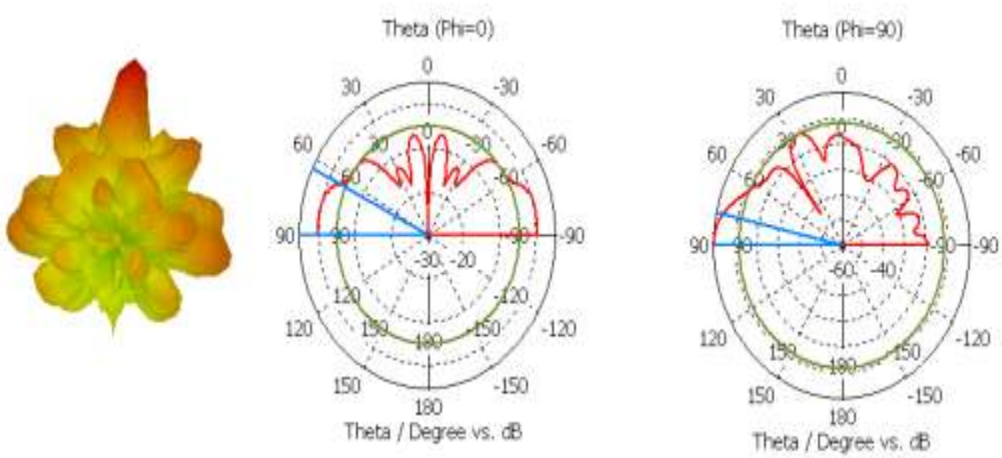

Figure 5: 3-D, b) E-Plane and H-Plane Simulated radiation patterns at 102GHz

CONCLUSION

In this design, dielectric grating antenna is presented for millimeter Wave Applications. The proposed antenna is a half-disk with annular multi-step grating. The antenna is fed via a dielectric image guide (DIG). The simulated results show that the designed the gain of the antenna is 18 dB at 102 GHz, wide bandwidth over 98 to 105 with radiation efficiency better than 95%. This covers several important application bands in current wireless communication systems. The presented grating antenna is suitable for point-to-point line-of-sight radio link, WLAN and WIMAX application.

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