



BROAD BAND COMB SHAPED MICROSTRIP PATCH ANTENNA FOR X-BAND & Ku-BAND APPLICATIONS

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Abstract: A new broad band comb shaped microstrip patch antenna is proposed. The proposed antenna is having partial ground plane and etched on FR4 substrate with dielectric constant 4.3 of height 1.6mm. The simulation results shows large Bandwidth 11.38GHz is obtained which covers the entire X-band and Ku-Band region. The return loss of -48.264dB and -42.498dB at 11.012 GHz & 17.504 GHz frequencies respectively are obtained. A good VSWR is achieved which is less than 2 for the entire operating frequency range. It is depicted that Antenna prototype shows that stable radiation pattern which gives 6.733dB and 4.955dB at 11.012GHz & 17.504GHz respectively. The simulation is carried by using CST Microwave studio.

Keywords: Comb Shaped Microstrip Patch Antenna-CSMPA, Rectangular shaped DGS, X-band, Ku-band, Return loss.

I. Introduction

With the rapid development of modern Wireless Communication Technology, microstrip antenna is in researchers' good graces because of its advantages; such as a low profile, light weight, high-gain and simple structure that ensure reliability, mobility and efficiency [1]. In addition, it is characterized by relative ease of construction, low cost, conformability to complex mounting surfaces and compatibility with printed circuit boards. In fact, this antenna provides all the advantages of printed circuit technology [2].

Thus, this type of radiating element becomes day after day popular in many wireless systems such as satellite communications, radar, medical applications, etc. [3]. However, the main disadvantage of patch antenna radiator is its narrow bandwidth. Recently, many techniques have been developed to enhance the bandwidth. The most commonly used ones are adding slots to radiating element [4–7] and partial ground plane [8, 9]. In addition, the microstrip antennas are known by their disability to operate at high power levels. Therefore, the challenge in microstrip antenna design is to increase the bandwidth and gain [10]. Patch antenna arrays in the X-band have been widely reported in literature [11–15]. Several authors [16–19] have focused on technical design of microstrip patch antennas for X-band applications. The proposed antenna operates at X-band frequency for RADAR, Satellite communication, Radio locations etc. It also serves for Ku-band frequency i.e. fixed and broadcasting satellite in frequency range of (12.2 to 12.7) GHz; Earth exploration satellite, aeronautical radio navigation and space research from (13.24 to 13.4) GHz; fixed mobile, fixed satellite (earth-to-space) and mobile satellite (earth-to-space) from (14.4 to 14.5) GHz [20–21]. Ku-Band [12–18GHz] is used for most VSAT systems on yachts and ships today.

II. Antenna Design

A broad band comb shaped MPA for X-Band and Ku- band applications is proposed. The antenna is designed using FR-4 substrate of dielectric constant 4.3 having the dimension of 40X40X1.6 mm³. The rectangular shaped patch is modified into comb shaped to operate at higher frequency band like X-Band and Ku-bands. To improve the performance of the designed antenna a rectangular shaped Defected Ground Structure (DGS) is introduced on the ground plane. The antenna is well suitable for RADAR, satellite and VSAT applications. The geometry of the devised antenna is shown in figure.1.

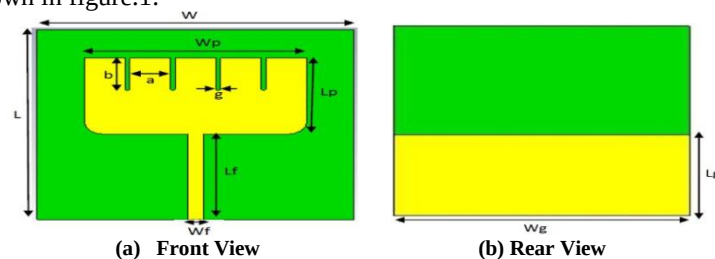


Figure.1 Geometry of the devised antenna

The dimensions of the proposed antenna is shown in figure is tabulated in table.1

Table.1 Dimensions of the proposed antenna

Antenna parameters	Dimensions(mm)	Antenna parameters	Dimensions(mm)
L	40	Lg	17.11
W	40	Wg	40
Lp	16	G	0.6
Wp	28	A	5.12
Lf	18	B	6.6
Wf	2		

The rectangular shaped patch of dimension $28 \times 16 \text{ mm}^2$ is taken on the FR4 substrate. The shape of the patch is modified to comb shaped by itching 4 slots of size $6.6 \times 0.6 \text{ mm}^2$. The rectangular DGS is itched on the ground plane with the dimension of $40 \times 17.11 \text{ mm}^2$ and feed with microstrip line of size $2 \times 18 \text{ mm}^2$. The designed antenna is optimized to provide enhanced impedance bandwidth, directivity and gain.

III. Results and Discussion

The performance of the proposed antenna is analyzed by using CST MWS software which has accurate time domain solver and designed using Finite Integration method (FIM). The simulation results clearly show the broad band characteristics in the entire X-band and Ku-bands. Based on the return loss values, VSWR and radiation patterns the designed antenna is well suited for RADAR, Satellite and VSAT applications. The return loss plot of the proposed antenna is shown in Figure.2.

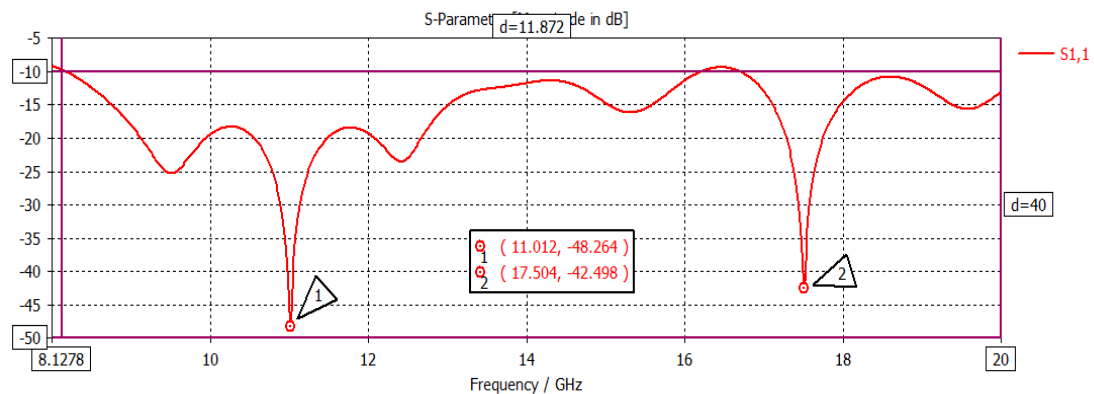


Figure.2 Return loss vs. frequency plot of the devised antenna

From the figure.2 it gives the broad band operation in the entire X-band frequency range i.e from 8.1 GHz to 12GHz with minimum return loss of -48.264dB at 11.012GHz and in the Ku- band frequency range from 12- 18 GHz with minimum return loss of -42.498dB at 17.504 GHz respectively. The operating bandwidths of the proposed antenna are 3.88GHz in the X-band and 6GHz in Ku-band with small rejection band of 500 MHz from 16.2 GHz – 16.7 GHz. The VSWR plot of the proposed antenna is shown in figure.3.

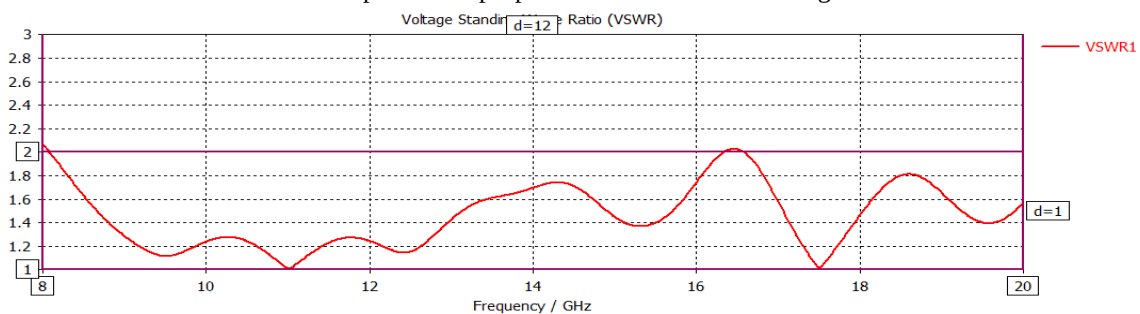


Figure.3 VSWR plot of the devised antenna

VSWR plot exhibits the values less than 2 for entire operating frequency range with 1.0075 at 11.012GHz and 1.015 at 17.504GHz. The proposed antenna exhibits stable radiation patterns with the directivity of 6.73dBi at 11.012GHz and 4.96dBi at 17.504GHz respectively. The 3D-directivity plots are depicted in figure.4. The different characteristic parameters of the designed antenna are depicted in table. 2

Table.2 The characteristic parameters of the designed antenna

Frequency(GHz)	Return loss(dB)	VSWR	Directivity(dBi)	Gain(dB)
11.012	-48.264	1.007	6.73	5.18
17.504	-42.498	1.015	4.96	2.32

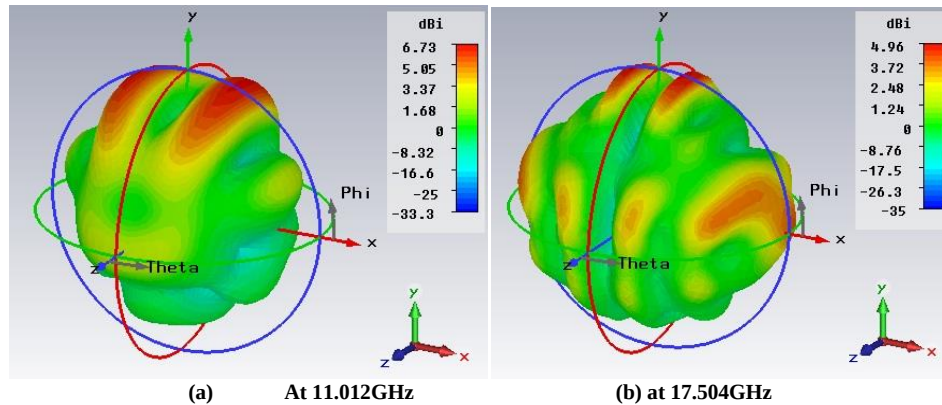


Figure 4. 3D-radiation pattern (directivity) of the devised antenna

IV. CONCLUSION

The broad band comb shaped MPA for X-band and Ku-band applications are redesigned with return loss values of -48.264 dB and -42.498 dB at 11.012 GHz and 17.504 GHz frequencies respectively. The Directivity values of the antenna are 6.73 dBi and 4.96 dBi at the operating frequencies. The VSWR value is also less than 2 for the entire X-band and Ku-band except the notch frequency band from 16.2 GHz – 16.7 GHz. It offers an excellent bandwidth of 3.88 GHz in the entire X-band and 6 GHz in Ku-band with band notch of 500 MHz. The designed antenna is well suited for all X-band applications like RADAR, Satellite Communications and radio location and also applicable for VSAT Broadcasting in Ku-band.

V. References

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