Printed Crescent Shaped Monopole Antenna

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ABSTRACT

This paper presents a printed crescent shaped antenna with a rectangular ground plane which belongs to the class of printed monopole antenna. The size of the antenna is very compact with an area of 15.75 square cm. It exhibits the omnidirectional property of monopole antennas.

General Terms

Printed monopole antenna, UWB Specification.

Keywords

S- Parameter, Reflection Coefficient, VSWR, Directivity.

1. INTRODUCTION

Ultra Wide band (UWB) is a technology for the transmission of data using techniques which cause a spreading of the radio energy over a very wide frequency band, with a very low power spectral density. The low power spectral density provides better isolation from the other radio networks. This prevents cross interference problems among the radio networks. Furthermore, the high bandwidth enables high data throughput.

The technology can be used in various developing fields such as wireless USB, wireless high-definition video, next-generation Bluetooth, peer-to-peer connections.

UWB technology transmits message signal as pulses in time domain which occupies a large bandwidth in frequency domain. Hence the devices that would have antennas in them that can cover a wide range of frequencies are required. Moreover, since they are transmitted at low power, interference with other systems is effectively avoided. [6] Hence the antenna that would operate in an UWB device must be highly efficient so as to minimize the losses The size of the antenna plays a significant role in the portability and uses of the antenna. Hence a small and compact antenna is desirable. The combination of compactness and the omnidirectional pattern of monopole antennas is ideal.

Monopole antenna is a class of antenna where the antenna is mounted perpendicular to a ground plane. The antenna is usually a rod shaped metal conductor. The omnidirectional pattern is notable. It radiates power equally in all azimuthal directions perpendicular o the antenna.. However the radiated power differs with the elevation angle, and drops to zero at zenith on the antenna axis. If the thickness of the monopole antenna is reduced to that of a plane the resultant antennas are called planar antennas. These provide a larger bandwidth than their monopole counterparts but still these are not compact enough to be incorporated into smaller devices.[4]

Contrary to the monopole antennas, the micro strip patch antennas are compact and conformal but their resonant nature causes them to operate only in narrow bands. Many techniques have been propose to enhance the bandwidth of micro strip patch antennas but these would either increase the size of the antenna or upset the uniformity of the impedance match throughout the UWB band. [2]-[10]

Printed antennas have the design of patch antennas but envisage characteristics similar to that of a monopole antenna. These are small, conformal and have a wide impedance bandwidth. Many printed antennas have been discussed in literature.[12]

This paper discusses a crescent shaped printed antenna which belongs to a class of printed monopole antennas that meets the above UWB requirements. All the simulations are carried out using CST Microwave studios.

2. DESIGN

The Structural design of the proposed printed monopole [9] antenna fed by a 58 Ω microstrip feed line is shown in Figure 1. It is printed on a Roger RT/ Duroid 5880(tm) substrate. This material is 1.6mm thick, with a relative permittivity of 2.2 and a dielectric loss tangent of 0.0009. The length of the patch is L=24.8 mm and width is W= 15.3mm.The width of the microstrip feed line is fixed at W2=4.9 mm for 58 Ω impedance. A rectangle of cross section 3.2 mm × 15 mm is connected between the patch and the 58 Ω feed line for impedance matching (quarter wave transformer). The dimensions of the feed line are shown in Figure 2.
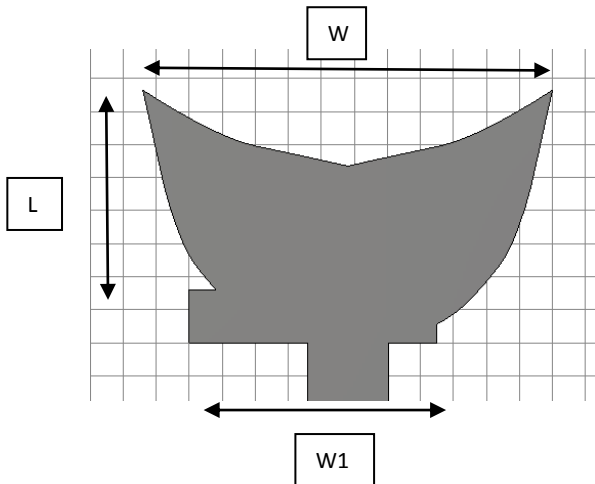
Fig.1 L=15.3mm, W=24.8mm, W1=15mm

Structure of crescent antenna L = 15.3mm, W = 24.8mm.The substrate is of length 45 mm and width 35 mm. The dimensions of the ground plane are 35 mm × 15.4 mm. The above dimensions of the antenna are for optimum performance got as a result of extensive simulations. Compared to center feed, it was found that for an offset feed (offset distance f =2.1mm) better impedance match is obtained.[6].
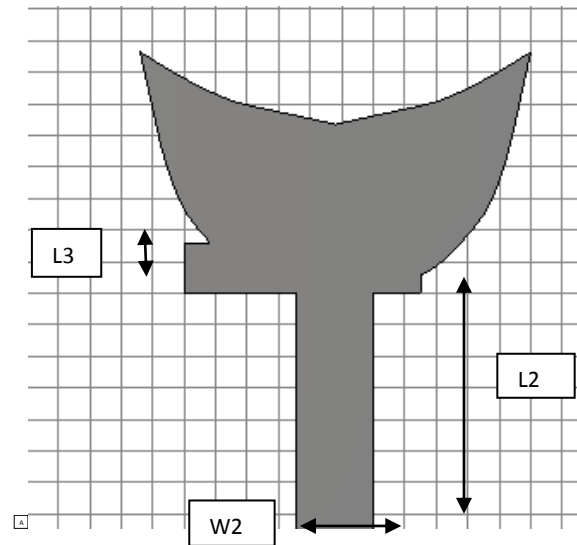
Fig.2 Feed dimensions L2 = 15mm, L3 = 3.2mm, W2 = 4.9mm.

3. SCATTERING PARA

The reflection coefficient( ) describes the amplitude or the intensity of the reflected wave relative to the incident wave. The scattering parameter is found by taking 10 log of the reflection coefficient.

S parameter= 10 log

For an antenna to transmit 90 % of the power in the output, the S1 parameter has to be below -10dB. This antenna satisfies the -10dB constrain, over the range of 3.7Ghz to 14 Ghz. Hence, within this bandwidth, 90% power efficiency is obtained, suggesting the minimal loss of power.
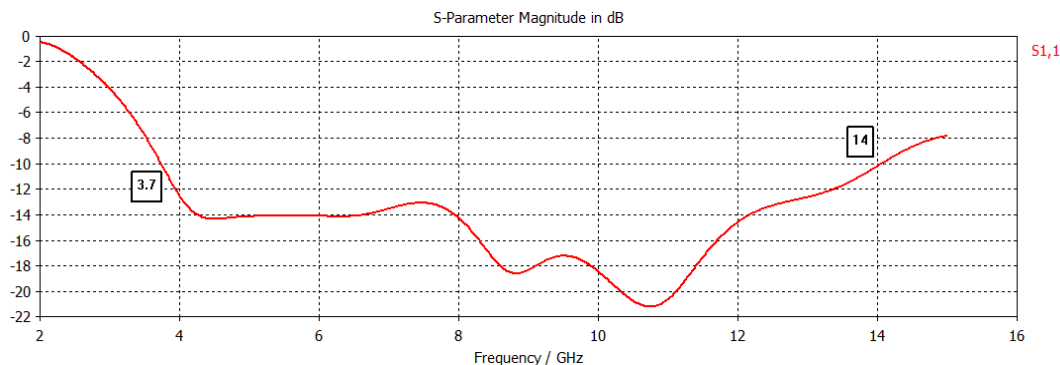
Fig 3 Reflection coefficient versus frequency

4. VSWR

VSWR (Voltage Standing wave ratio) is a function of the reflection coefficient, which describes the power reflected from the antenna. If the reflection coefficient is given by , then the VSWR is given by :

$$VSWR = \frac{1+ |\Gamma|}{1- |\Gamma|}$$

The VSWR is a positive real number. If there is no power reflected from an ideal antenna, the VSWR would be 1. Smaller value of the VSWR indicates that the antenna is

properly matched to the transmission line and that the reflected power is negligible.

The proposed antenna satisfies the VSWR requirement of under 2. High values of VSWR result in a huge loss of transmitted power. If the reflected power is too huge, it may also damage the antenna. From the figure 4 and figure 5, it is observed that the VSWR remains below 2, between the frequency ranges of 3.7 Ghz to 14 Ghz.
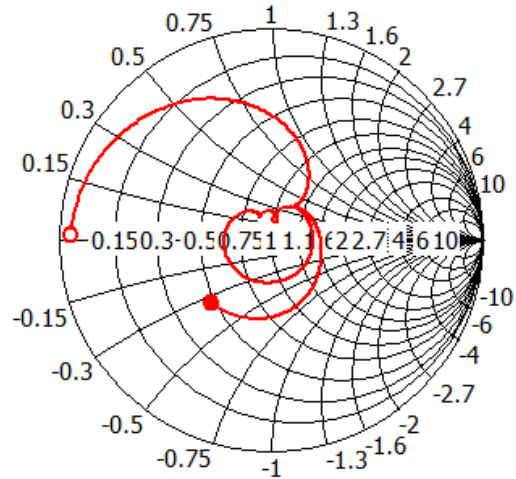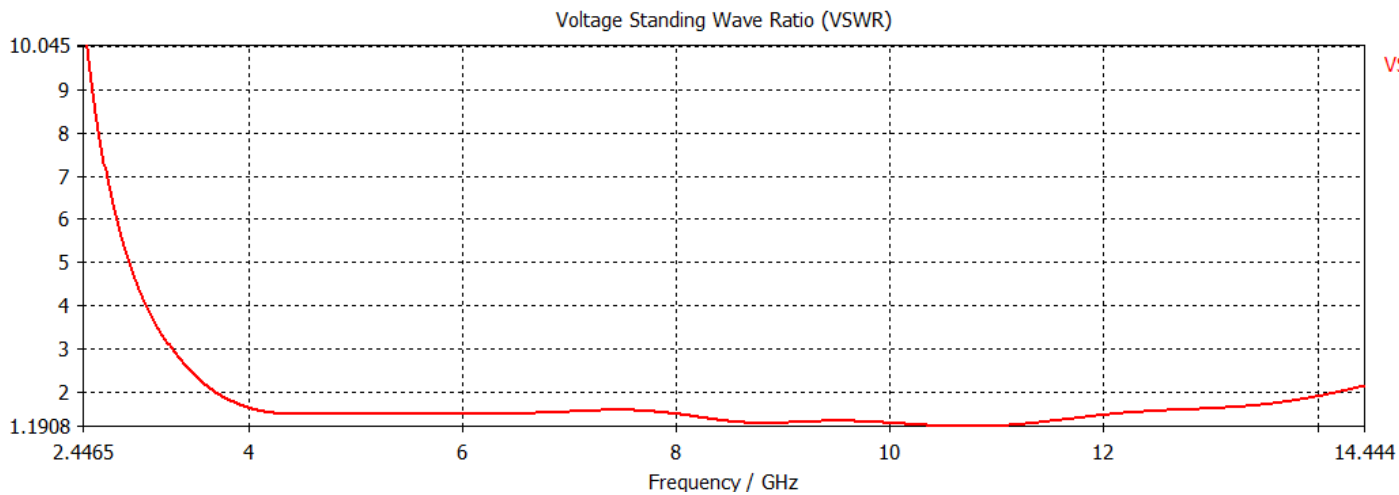

Fig 4. S-Parameter Smith Chart

Fig 5 VSWR Plot

5. DIRECTIVITY

Directivity is a figure of merit for an antenna. It measures the power density the antenna radiates in the direction of its strongest emission, versus the power density radiated by an ideal isotropic radiator (which emits uniformly in all directions) radiating the same total power.

Directivity is an important measure because most emissions are intended to go in a particular direction or at least in a particular plane (horizontal or vertical); emissions in other directions or planes are wasteful (or worse).

Below are the representations of the directivity of the antenna for 3 frequencies: 5 GHz, 7 GHz, and 9 GHz.
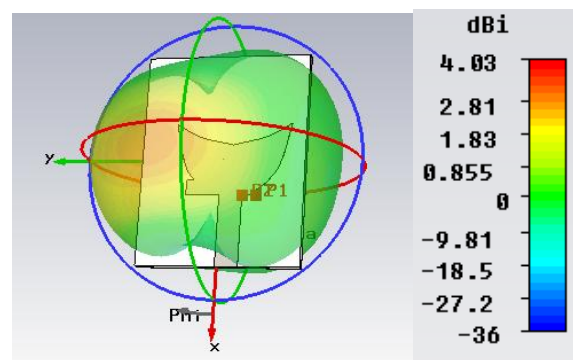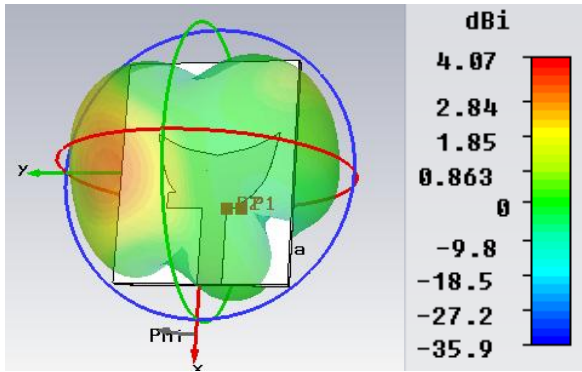

Fig.6 Directivity at 5 GHz
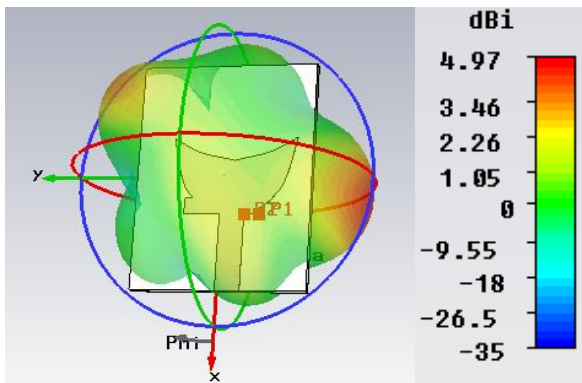
Fig.7 Directivity at 7 GHz

Fig.8 Directivity at 9 GHz

6. CONCLUSION

The printed crescent shaped antenna has been discussed as above. The analysis of various factors such as s1 parameters, VSWR and Gain has been performed. This compact antenna can be incorporated into smaller devices that operate in the UWB range. The developing UWB technology enables the utility of this antenna in various applications.

7. REFERENCES

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