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Comparison of Bow shape Microstrip Antenna and Rectangular patch Microstrip Antenna

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***Abstract:** In recent era, the use of wireless communication system increasing rapidly. Now a day's, there is demand of small size wireless system which requires development of small size microstrip antenna. Microstrip antenna has wide range of application in wireless communication system due to their low profile, small size, low weight and low cost. Microstrip antenna is also is used in low power transmitting and receiving application as it has capability of low power handling. Microstrip antenna can be operated over a wide range of frequency but mostly, it is operated at resonant frequency of 3GHz. At 3GHz resonant frequency, losses (return loss & tangent loss) are very low and VSWR <2. In this paper, bow shape & rectangular shape microstrip antenna of same size (Length, Height, Width) with dielectric Bismuth niobato substrate (BiNbO4) of ε_r=47.8 is designed and resonant frequency is calculated.*

I. INTRODUCTION

In present scenario, the demand of wireless technologies is increasing rapidly day by day where small size, light weight, ease of installation are constraints, low profile microstrip antenna is required. Microstripantenna becomes necessity in wireless communication system. Microstrip antenna has wide range of applications in high performance aircraft, spacecraft, missile and satellite applications. In today's world, microstrip antenna play a significant role in communication system due to it's attractive features such as light weight, low volume, low power handling, low cost, easy to fabricate & easy in construction[1]. A microstrip antenna have capability to provide better performance of radiation. A microstrip antenna has good gain as compared to other antenna because of its ability to concentrate of energy into a tight beam (expressed as narrow beam width) through a direction to provide better performance of radiation [3].

A. Basic Microstrip Antenna

A microstrip antenna is consist of a very thin metallic patch fabricated on dielectric substrate above a conducting ground plane [1]. The metallic patch or radiating patch is made of Cu (copper) & Au (gold) [2]. Microsrtip antenna having different shape like rectangular, circular, triangular, elliptical, ring, disk, square or some other shape.

Rectangle & Circular microsrtip antenna are widely used in communication.These microstripantenna have same similarities as these cover a range of frequency from 100 MHz to 100GHz.

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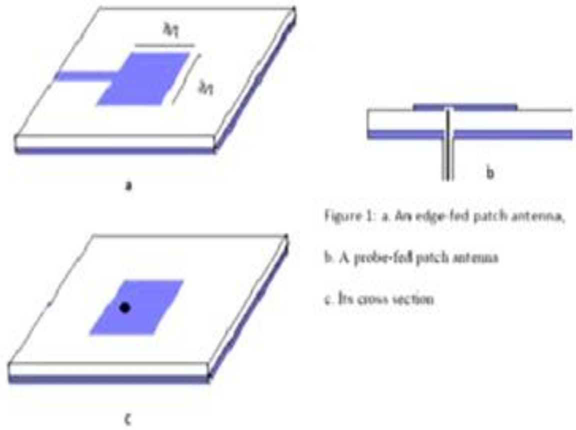

Fig. 1 Mirostrip Patch antenna construction using microstrip fabrication techniques

A microstrip antenna has same disadvantages such as low efficiency, low power, large loss, and poor performances. The losses may be reduced by reducing thickness of substrate. Microstrip patch antenna has various methods of feed lines. A microsrtip antenna having dielectric substrate on one side& patch on other side [2]. The methods of feed line to microstrip patch antenna are microstrip line, coplanar wave guide feed, coaxial probe & proximity coupling [7].

B. Substrates

Substrate plays a very important role in designing a microstrip antenna. To design an antenna, it is very important to choose a suitable substrate. A substrate is consisting of dielectric material which affects the electrical performance of antenna & transmission line[7]. High dielectric constant substrate is used to reduce size of antenna. Some of substrate are ceramic substrates, semiconductor substrates, ferromagnetic substrates ($\in = 9\ to\ 16$) & composite material subatrates ($\in = 2\ to\ 6$). Some cermaic substrates have high dielectric constant ($\in$) in range 20 to 150. Semiconductor substrates are of Si($\in = 11.9$) & GaAs($\in = 13.0$).

In this paper, both bow shape microstrip antenna and rectangular patch antenna of same size is fabricated on bismuth-niobato substrate (BiNbO4)that exhibit very high dielectric permittivity (ε_r=47.8), high Q factor, and a very small temperature coefficient at the resonant frequency and resonant frequency is calculated.

II. DESIGN OF BOW-SHAPE MICROSTRIP ANTENNA

For design of bow- shape microsrtip antenna following parameter are taken

ε_r= 47.8, h=2.9 mm, W=21 mm, L=25 mm,W_{cd} = W_{cp} =1 mm,

S_1=2.93 mm

h= height of substrate

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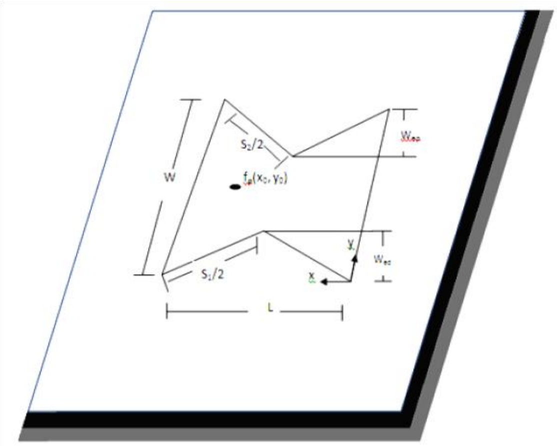


The geometry of the new compact microstrip antenna
W= width of antenna
L= length of antenna
S_1= slant height of antenna
D=diameter of antenna
ε_r = Dielectric constant of substrate
C=speed of light=3×108m/s
ε_1=effective dielectric constant
Seff=effective slant height of antenna

III. CALCULATION OF RESONANT FREQUENCY FOR BOW SHAPED MICROSTRIP ANTENNA

The microstrip antenna is operated in basic TM10 mode & for this length of patch should be less than λ /2 where λ is wavelength in dielectric medium[6].

$$f_{10} = \frac{c}{2(S_{eff} + 2\Delta l_1)\sqrt{\varepsilon_1}}$$

$$\varepsilon_1 = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}(1 + 12h/W)^{-1/2}$$

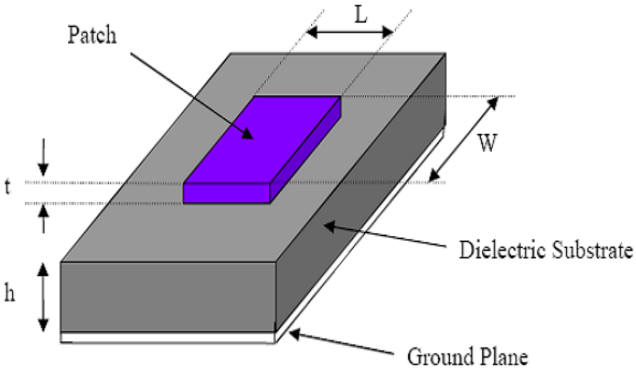
$$\Delta l_1 = \frac{0.412h(\varepsilon_1 + 0.3)(W/h + 0.258)}{(\varepsilon_1 - 0.258)(W/h + 0.8)}$$

For ($L >= W$)

$$S_{eff} = S_1 + 2.3(L - 2W - 0.0046/L)W_{cd} + 0.00006/L - 0.1(W_{cp} - 0.01) \quad \text{for } W_{cd}/W < 1$$

IV. DESIGN OF RECTANGULAR MICROSTRIP ANTENNA

For design of rectangular microsrtip antenna, following parameter are taken
ε_r= 47.8, h=2.9 mm, W=21 mm, L=25 mm



The geometry of rectangular microstrip antenna
h= height of antenna
W= width of antenna
L= length of antenna

D=diameter of antenna
ε_r = Dielectric constant of substrate
C=speed of light=3×10^8m/s=3×10^{11}mm/s
ε_1=effective dielectric constant

V. CALCULATION OF RESONANT FREQUENCY FOR RECTANGULAR MICROSTRIP ANTENNA

The patch length (L) determines the resonant frequency which is critical parameter in design of rectangular microstrip antenna. For dominant TM10 mode, the resonant frequency (f_{10}) of rectangular antenna is function of its patch length [7], given by

$$f_{10} = \frac{c}{2L\sqrt{\varepsilon_r}}$$

For a given resonance frequency fr, the effective length is given by

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}}$$

The actual length of patch is given by

$$L = L_{eff} - 2\Delta L$$

$$\Delta L = 0.412\frac{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{W}{h} + 0.8)}$$

Where

$$\varepsilon_{reff} = \left(\frac{1}{\sqrt{1 + 12\frac{h}{W}}}\right)\left(\frac{\varepsilon_r - 1}{2}\right) + \left(\frac{\varepsilon_r + 1}{2}\right)$$

Where,ε_{reff} =Effective dielectric constant

VI. EFFECT OF SIZE ON RESONANT FREQUENCY OF BOW SHAPE ANTENNA &RECTANGULAR ANTENNA

Bow shape microsrtip antenna having height=2.9mm, length=25mm & width=21mm, slant height=2.93mm and Rectangular antenna having height=2.9 mm, length=25mm & width=21mm are design using Bismuth niobato substrate (BiNbO4) having dielectric permittivity (εr=47.8) & resonant frequency is calculated as shown in table.

Type of antenna	Dielectric Permittivity of bismuth niobato (BiNbO4) substrate used in antenna	Resonant Frequency(f_{10}) GHz
Bow shape antenna	47.8	3.00
Rectangular antenna	47.8	0.86

VII. CONCLUSION

1. Bow shape mirostrip antenna with substrate (Bismuth niobato) having highest Resonance frequency 3GHz as compared rectangular microstrip antenna & size of both antenna is taken same.
2. I n case of rectangular patch microstrip antenna, for obtaining 3GHz resonant frequency with substrate (Bismuth niobato),it is found that size of rectangular microstrip antenna will be increased.

3. The overall area of the microstrip antenna is reduced greater than 30% for TM10 mode as compared to a rectangular patch microstrip antenna for 3GHz resonant frequency with same substrate (Bismuth niobato)

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