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Coplanar Capacitive Coupled Probe Fed Microstrip Antenna for C and X band

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Abstract: The design and simulation of a coplanar capacitive fed mirostrip antenna suspended above the ground plane is presented. The proposed antenna is excited by a single probe feed. This antenna operates in two different bands C band having frequency range 4-8 GHz and X band having frequency range 8-12GHz .IE3Dsoftware is used for simulation. It is demonstrated that the proposed antenna can be used for wideband applications with impedance bandwidth of 53.74% at center frequency 7.015 GHz with good gain in microwave bands. Capacitive coupling is used to improve the results. Polyolefin is used as a dielectric material having dielectric constant 2.3.2.

Keywords: Microstrip antennas, Capacitive fed, Wideband, Absolute gain, Efficiency.

I. INTRODUCTION

Wireless technology is one of the main areas of research in the world of communication systems today and a study of communication system is incomplete without an understanding of the operation of radiating system especially planner antennas. With the rapid advancement of various applications, these antennas need to work at several frequency bands such as dual, triple and sometimes multiband operations are needed. An antenna is that part of a transmitting or receiving system that is designed to radiate or receive electromagnetic waves. A microstrip antenna consists of conducting patch on a ground plane separated by dielectric substrate. Low dielectric constant substrates are generally preferred for maximum radiation. The conducting patch can take any shape but rectangular and circular configurations are the most commonly used configurations. Other configurations are complex to analyze and require heavy numerical computations. A microstrip antenna is characterized by its length, width, input impedance, and gain and radiation patterns. The length of the antenna is nearly half wavelength in the dielectric; it is a very critical parameter, which governs the resonant frequency of an antenna. [2]

Due to increase of wireless standards, multiband and wide band antenna designs have become very important for wireless communications to fulfill the requirement of modern hand held communications devices like WLAN, Wimax, Bluetooth UMTS bands etc, ability to integrate more than one communication standards in a single compact module. There are several techniques for impedance bandwidth enhancement such as impedance matching network, stacked patches, by changing shape of the geometry, by cutting slots into basic stapes. [1]

To understand the physical behavior of microstrip antennas it is essential to model the patch antenna. The models used for the analysis of microstrip patch antennas are the transmission line model, cavity model and full wave model which include primarily integral equations/ Moment method. The transmission line model is the simplest of all and it gives good physical insight but it is less accurate. The cavity model is more accurate and gives good physical insight but it is complex in nature. The full wave models are extremely accurate, versatile and can treat single elements, finite and infinite arrays, stacked elements, arbitrary shaped elements and coupling. These give less insight as compared to the two models discussed earlier.[5]

The narrow bandwidth property of a microstrip antenna is one of the important reasons to restrict its wide application. A new method for designing broadband microstrip patch antenna in capacitive-coupled structures is presented. Bandwidth can be improved by increasing the overall height of the composite air-dielectric medium. But the use of the air gap increases size of the antenna which is undesired in several applications. Therefore antenna should be designed with small air gap[3].

Bandwidth can also be increased by changing dielectric constant. Bandwidth can be increased by selecting the dielectric material having lower dielectric constant. The second method to increase bandwidth is adding multiple layers on the patch of same or different dielectric constant. Bandwidth can also be increased by inserting hole on the patch having different shape like rectangular, circular etc.[2]

II. ANTENNA GEOMETRY AND ITS OPTIMIZATION

Basic geometry of the antenna is shown in Figure 1 and its optimized dimensions are listed in Table 1. It consists of radiating patch and a rectangular feed strip which are etched on the same plane. The substrate is placed above the ground plane at a height equal to air-gap. This height of air gap plays a vital role for broad banding. The substrate used for the antenna design is a Polyolefin with dielectric constant 2.34, loss tangent (tan (δ)) = 0.01 and thickness (h) = 1.00 mm.

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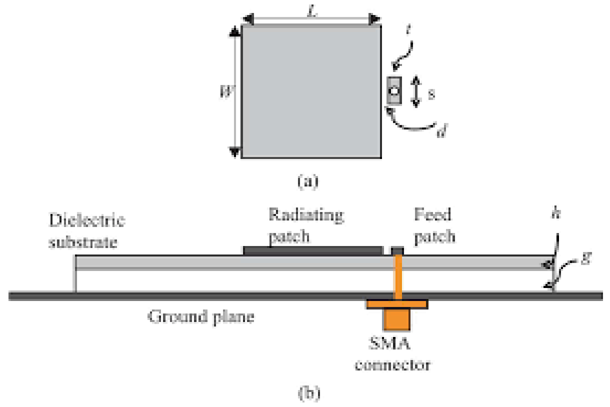


Fig 1 Basic geometry of coplanar capacitive fed microstrip antenna. a) Top view b) Cross sectional view

TABLE I DIMENSIONS FOR THE ANTENNA DESIGN

Parameter	Value
Length of the radiator patch (L)	14 mm
Width of the radiator patch (W)	8.5 mm
Length of the feed strip (s)	2 mm
Width of the feed strip (t)	2.8 mm
Separation of the feed strip from the patch	0.8 mm
Air gap between the substrates (g)	6.0 mm
Relative dielectric constant (£r)	2.32
Thickness of the substrate (h)	1 mm

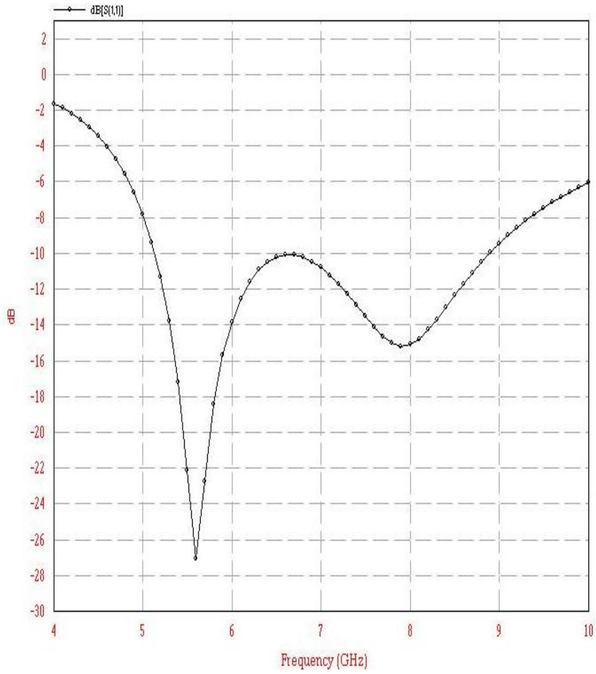
The dimension of the rectangular patch antenna is 14 mm length and 8.5 mm width. Probe fed is used to give feed to patch. The dimensions of the feed strip are 2 mm length and 2.8 mm width. Patch of the antenna and feed strip are separated by distance of 0.8 mm. This separation is provided to generate capacitive coupling. Capacitive coupling is used to improve bandwidth of an antenna. [1]

III. EXPERIMENTAL RESULTS AND DISCUSSION

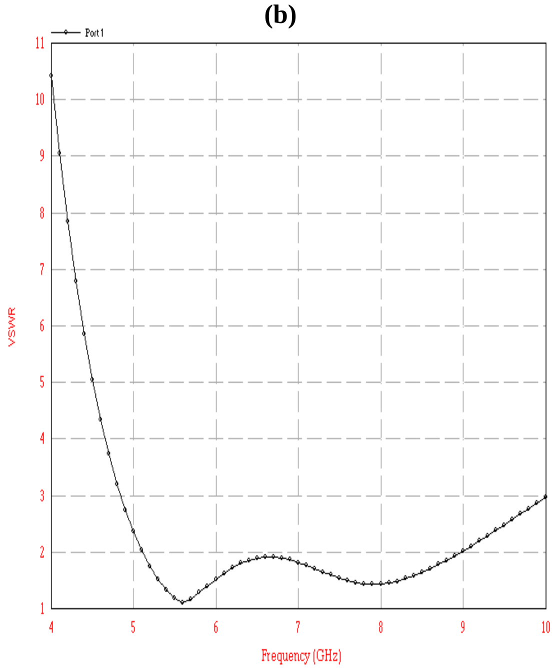
IE3D software is used for simulation of optimized structure. Return loss and VSWR plot is observed with respect to frequency which is given in fig. The Geometry of an antenna is shown in fig (a).

From the return loss plot we are observing an impedance bandwidth of 3.71 GHz with lower and upper cut off frequency extending from 5.13 GHz to 8.9 GHz with center frequency of 7.015 GHz. Same results are observed from the VSWR plot.

(a)



(b)



(c)

Fig 2 (a) geometry of antenna (b) Return loss plot (c) VSWR plot

The return loss is showing two resonant frequencies at 5.6 GHz and 7.9 GHz with return loss of -27 dB and -15 dB respectively. VSWR plot is showing maximum impedance matching at these resonant frequencies.

A. Radiation Pattern

Radiation pattern is nothing but graphical representation of characteristics of an antenna. It shows the antenna's directivity as well as gain at various points in space. The proposed antenna is showing an effective return loss from 5.13 GHz to 8.9 GHz. That is why, the antenna should have similar radiation pattern in this entire range. The radiation pattern at frequencies 5.52 GHz and 7.5 GHz is

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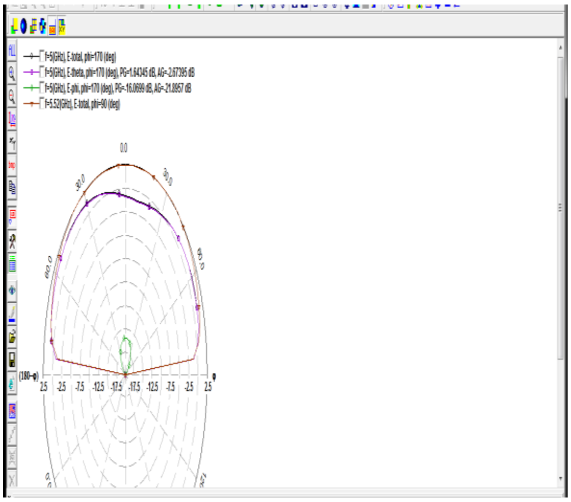
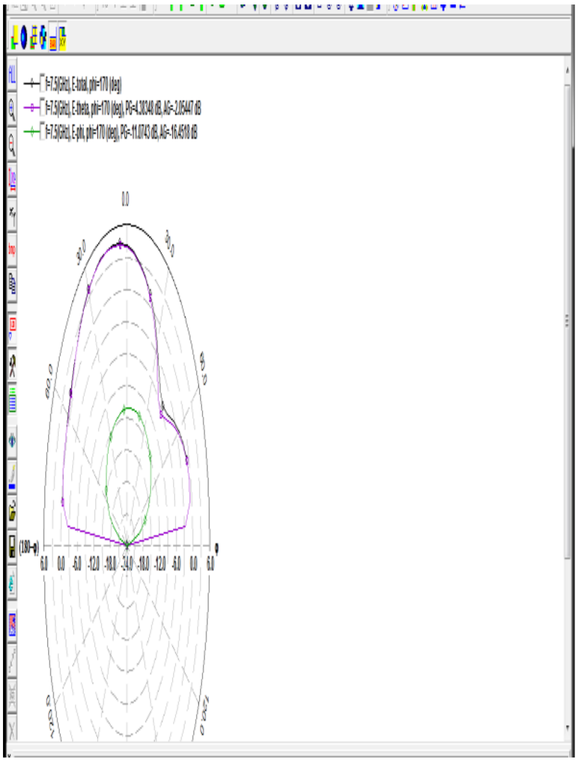
observed. The two dimensional E-plane radiation patterns at these frequencies are shown in fig3.



(a)



(b)

Fig 3 (a) Radiation pattern at 5.52 GHz (b) radiation pattern at 7.5 GHz

IV. CONCLUSION

A coplanar capacitive coupled microstrip antenna for dual frequency band is designed. Feeding technique used is probe fed. Simulation is done in IE3D software which is based on finite element method. The operating bandwidth of the designed antenna is 53.74% with center frequency 7.015 GHz. The operating range of antenna is from 5.13GHz to 8.9 GHz. The antenna is showing very good radiation pattern for the entire frequency range. The return loss is showing two resonant frequencies at 5.6 GHz and 7.9 GHz with return loss of -27 dB and -15 dB respectively. VSWR plot is showing maximum impedance matching at these resonant frequencies. Thus this design can be utilized in microwave C band which has frequency range of 4-8GHz and X band which has frequency range of 8-12 GHz for wideband communication.

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