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Square Patch Micro-strip Antenna Using Dual Feed

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Abstract

The communication devices utilized the portion of the electromagnetic spectrum. The electromagnetic spectrum outside the visible region has been employed for communication by the use of radio wave. A two port Square Microstrip Patch Antenna is investigated in this paper. The antenna was designed for operating in S band (2 – 4 GHz) frequency range with a circular polarization. Microstrip patch antenna used to send onboard parameters of article to the ground while under operating conditions. The aim of the paper is to design and fabricate an probe-fed Square Microstrip Patch Antenna and study the effect of antenna dimensions length, and substrate parameters relative Dielectric constant, substrate thickness on the radiation parameters of bandwidth.

Keywords: Square Patch, Dual feed, S- parameter, VSWR

1. Introduction

A microstrip antenna consists of conducting patch on a ground plane separated by dielectric substrate. This concept was undeveloped until the revolution in electronic circuit miniaturization and large- scale integration in 1970. The microstrip antennas are the present day antenna designer's choice. 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 configuration. 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 the antenna. There are no hard and fast rules to find the width of the patch [1-3].

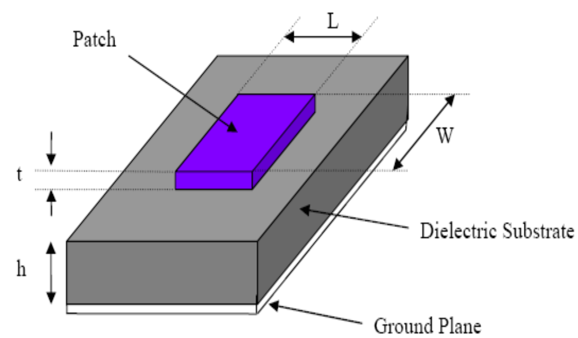


Fig.1. Structure of Microstrip Patch Antenna

1.1 Antenna Characteristics

An antenna is a device that is made to efficiently radiate and receive radiated electromagnetic waves. There are several important antenna characteristics that should be considered when choosing an antenna for your application as follows[1]:

- Antenna radiation patterns
- Power Gain
- Directivity
- Polarization

2. Feed Techniques

Microstrip patch antennas can be fed by a variety of methods. These methods can be classified into two categories- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non- contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The four most popular feed techniques used are the microstrip line, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes)[1-5].

2.1 Microstrip Line Feed

In this type of feed technique, a conducting strip is connected directly to the edge of the Microstrip patch. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure. This is an easy feeding scheme, since it provides ease of fabrication and simplicity in modeling as well as impedance matching. However as the thickness of the dielectric substrate being used, increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation also leads to undesired cross polarized radiation performances [1-3].

2.2 Coaxial Feed

The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. The inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. However, a major disadvantage is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates ($h > 0.02\lambda o$).

2.3 Aperture Coupled Feed

In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane. The coupling aperture is usually centered under the patch, leading to lower cross polarization due to symmetry of the configuration. The amount of coupling from the feed line to the patch is determined by the shape, size and location of the aperture. Since the ground plane separates the patch and the feed line, spurious radiation is minimized [1-5].

Generally, a high dielectric material is used for bottom substrate and a thick, low dielectric constant material is used for the top substrate to optimize radiation from the patch. The major disadvantage of this feed technique is that it is difficult to fabricate due to multiple layers, which also increases the antenna thickness. This feeding scheme also provides narrow bandwidth [2-3].

2.4 Proximity Coupled Feed

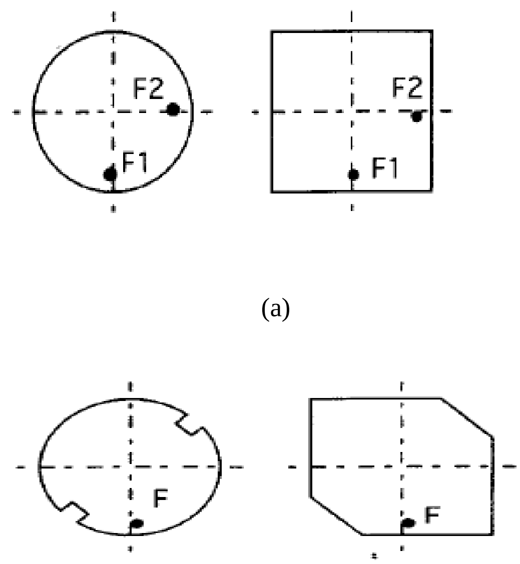
This type of feed technique is also called as the electromagnetic coupling scheme. Two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides very high bandwidth (as high as 13%), due to overall increase in the thickness of the microstrip patch antenna. This scheme also provides choices between two different dielectric media, one for the patch and one for the feed line to optimize the individual matching can be achieved by controlling the length of the feed line and the width to-line ratio of the patch. The major disadvantage of this feed scheme is that it is difficult to fabricate because of the two dielectric layers which need proper alignment. Also, there is an increase in the overall thickness of the antenna [1-5].

3. Circularly Polarized Microstrip Antenna

Generally antenna radiates an elliptical polarization, which is defined by three parameters: axial ratio, tilt angle and sense of rotation. When the axial ratio is infinite or zero, the polarization becomes linear with the tilt angle defining the orientation. The quality of linear polarization is usually indicated by the level of the cross polarization. For the unity axial ratio, a perfect circular polarization results and the tilt angle is not applicable. In general the axial ratio is used to specify the quality of circularly polarized waves. Antennas produce circularly polarized waves when two orthogonal field components with equal amplitude but in phase quadrature are radiated. Various antennas are capable of satisfying these requirements. They can be classified as a resonator and traveling-wave types. A resonator-type antenna consists of a single patch antenna that is capable of simultaneously supporting two orthogonal modes in phase quadrature or an array of linearly polarized resonating patches with proper orientation and phasing. A traveling- wave type of antenna is usually constructed from a microstrip transmission line. It generates circular polarization by radiating orthogonal components with appropriate phasing along discontinuities is the travelling-wave line [1].

3.1 Circularly Polarized Patch

A microstrip patch is one of the most widely used radiators for circular polarization. When two signals of equal amplitude but 90^{o} phase shifted the resulting wave is circularly polarized. Some patches such as square, circular, pentagonal, equilateral triangular, ring, and elliptical shapes which are capable of circular polarization operation. However square and circular patches are widely utilized in practice. A single patch antenna can be made to radiate circular polarization if two orthogonal patch modes are simultaneously excited with equal amplitude and out of phase with sign determining the sense of rotation. Two types of feeding schemes can accomplish the task as given in the figure 3.1; first type is a dual- orthogonal feed, which employs an external power divider network. The other is a single point for which an external power divider is not required [1-5].



(a)

(b)

Fig.2. Two types of excitations for circularly polarized microstrip antennas: (a) dual-fed patch and (b) singly fed patch[1]

4. Experimental Results

The dielectric material selected for our design is silicon which has a dielectric constant of 2.55. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna. For the microstrip patch antenna to be used in cellular phones, it is essential that the antenna is not bulky. We have designed the square patch dual feed antenna for circular polarization at frequency 3.2 GHz. This patch antenna is simulated by IE3D software

.We have observed that from following Fig.
5. & 6. shows that Return loss with frequency of antenna is found to be -27 dB at resonant frequency 3.2 GHz. Smith chart which is a polar plot of the of the complex reflection coefficient determine the input impedance of the designed antenna in our simulated result it is closed to 50 ohms. Fig.3.&4. show the smith chart of s- parameter for s(1,1) and s(2,2).

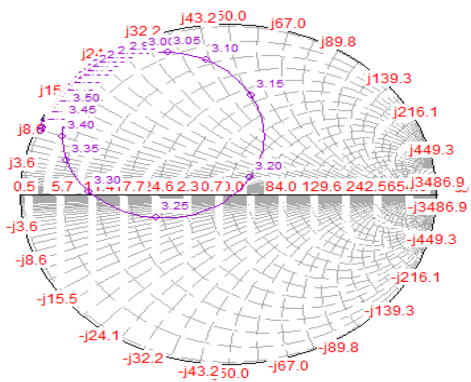


Fig.3.Smith chart for S (1,1)

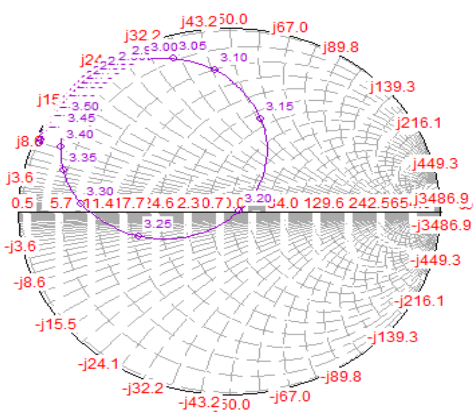


Fig.4. Smith Chart for S (2,2)

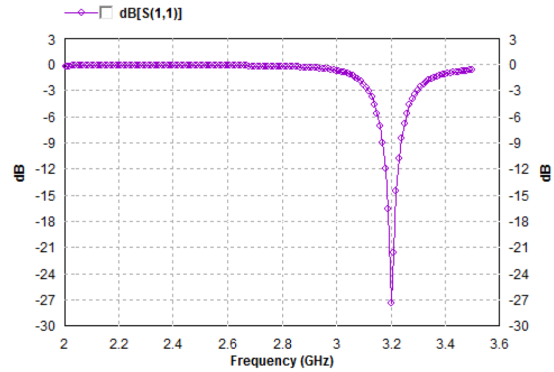


Fig.5. S-parameter for S (1,1)

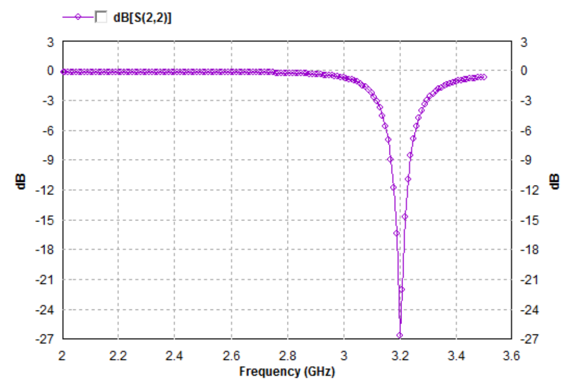


Fig.6. S-parameter for S (2,2)

5. Conclusion

The design of Square patch dual feed (Probe Feed) antenna for circular polarization has been completed using IE3D software. The simulation gave results good enough to satisfy our requirements to fabricate it on hardware which can be used wherever needed. Simulation results of a microstrip patch antenna covering 2 to 3.5 GHz frequency have been presented. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation. However, such a configuration leads to a larger antenna size. In order to design a compact microstrip patch antenna, substrates with higher dielectric constants must be used which are less efficient and result in narrower bandwidth. Further size reduction improvement is possible by using slits.

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