ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 10, October 2013

Survey of Bandwidth Enhancement of Microstrip Patch Antenna Using H Shaped Patch

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Abstract: This paper represents the enhancement of bandwidth for microsrip antenna along with its structure. The survey includes the way to enhance bandwidth using special structure of patch instead rectangular patch. The antennas are very essential device for communication as it is used as a transmitter device and receiving device. For the microwave frequency communication the Microstrip patch antenna is the best choice. But it suffers from the problem of narrow bandwidth hence it necessary to overcome this disadvantage. There are lots of methods that are adopted to remove this disadvantage. This survey shows the bandwidth enhancement using H shaped patch.

Keywords: H shape patch, microstrip patch antenna, bandwidth improvement of MSA, structure of MSA

I. Introduction

The rapid evolution of information technology and wireless communications has enabled the development of applications that one was not even able to dream of a few decades ago. Personal communication has become an integral part of our everyday lives. Almost everything has gone wireless and mobile today. An antenna should radiate efficiently in an intended manner to free space, while other components should be more or less isolated from their surroundings. Along with the increased functionality of devices, a growing number of wireless communication standards are used in a device. Devices need to accommodate an ever-increasing number of antennas, or there would be a need for a significant bandwidth enhancement for the existing ones. Meanwhile the reduction in device size has caused an increasingly higher space constraint in the implementation environments for antennas. In addition, MSAs are manufactured using printed-circuit technology, so that mass production can be achieved at a low cost. MSAs, which are used for defences and commercial applications, are replacing many conventional antennas. However, the types of applications of MSAs are restricted by the antennas' inherently narrow bandwidth (BW). Accordingly, increasing the BW of the MSA has been a primary goal of research in this paper[1].

II. MICROSTRIP PATCH ANTENNA

The microstrip is a type of electrical transmission line which can be fabricated using PCB and it is used to convey microwave frequency signals.It has conducting strip separated from ground plane by dielectric layer known as substrate. A microstrip patch antenna (MPA) consists of a conducting patch of any planar or non planar geometry on one side of a dielectric substrate with a ground plane on other side. It is a popular printed resonant antenna for narrow-band microwave wireless links that require semi-hemispherical coverage. Due to its planar configuration and ease of integration with microstrip technology, the microstrip patch antenna has been heavily studied and is often used as elements for an array. A large number of microstrip patch antennas have been studied to date. An exhaustive list of the geometries along with their salient features is available. The rectangular and circular patches are the basic and most commonly used microstrip antennas. These patches are used for the simplest and the most demanding applications**.** The rectangular and circular patches are the basic and most commonly used microstrip antennas. These patches are used for the simplest and the most demanding applications. These antennas are low profile, conformable to planar and non planar surfaces simple and inexpensive to manufacture using modern printed-circuit technology, mechanically robust when mounted on rigid surfaces, compatible with MMIC designs, and when the particular patch shape and mode are selected, they are very versatile[3].

III **Structure of MSA**

1. Substrate: It allows isolation for conductive planes.
2. Patch: It is the radiant conductive element.
3. Ground plane: conductor situated below the circuit on which is substrate is placed. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate[6].

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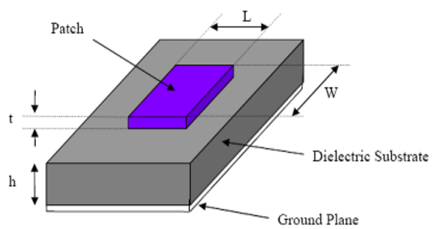

Fig.1.Structure of MSA

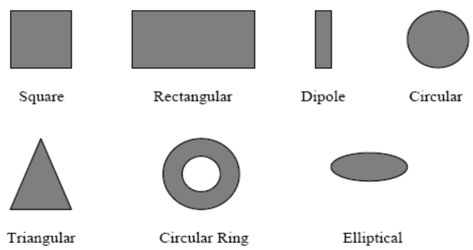

Fig.2.Various shapes of MSA

IV FEEDING 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). The techniques are as follows.

1. Microstrip line feed
2. Coaxial Feed
3. Aperture Coupled Feed
4. Proximity Coupled Feed
5 Coplanar Waveguide Feed

V ADVANTAGES

Microstrip patch antennas are increasing in popularity for use in wireless applications due to their low-profile structure. Therefore they are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers etc. The telemetry and communication antennas on missiles need to be thin and conformal and are often in the form of Microstrip patch antennas. Another area where they have been used successfully is in Satellite communication[2][3].

The main advantages of MSAs are listed as follows:

- Light weight and low volume.
- Low profile planar configuration which can be easily made conformal to host surface.
- Low fabrication cost, hence can be manufactured in large quantities.
- Supports both, linear as well as circular polarization.
- Can be easily integrated with microwave integrated circuits (MICs).
- Capable of dual and triple frequency operations.
- Mechanically robust when mounted on rigid surfaces.

Microstrip patch antennas have a very high antenna quality factor (Q). It represents the losses associated with the antenna where a large Q leads to narrow bandwidth and low efficiency. Q can be reduced by increasing the thickness of the dielectric substrate. But as the thickness increases, an increasing fraction of the total power delivered by the source goes into a surface wave. This surface wave contribution can be counted as an unwanted power loss since it is ultimately scattered at the dielectric bends and causes degradation of the antenna characteristics. Other problems such as lower gain and lower power handling capacity can be overcome by using an array configuration for the element.

VI BANDWIDTH OF MSA

The bandwidth of the patch is defined as the frequency range over which it is matched with that of the feed line within specified limits. In other words, the frequency range over which the antenna will perform satisfactorily. This means the channels have larger usable frequency range and thus results in increased transmission. The bandwidth of an antenna is usually defined by the acceptable standing wave ratio (SWR) value over the concerned frequency range.

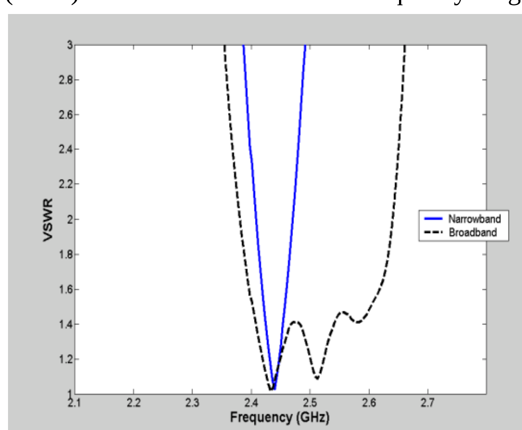

Fig.3 Typical Bandwidth curve of VSWR vs Frequency

VII. HOW TO IMPROVE BANDWIDTH OF MSA

The demand for wireless communication is designing of proper wideband antenna. The microstrip is the best choice for wireless communication, but before using it in the field it is necessary to improve the bandwidth of it. There are lots of issues regarding the bandwidth enhancement of

MSA. The possible ways to increase the bandwidth are as follows.

1 multilayer structure.

2 varying the patch size

3 stacked patches

4 parasitic patches.

The patch sizes are available such as U shape, E shape, L shape. This paper represent the H shape for bandwidth enhancement.

VIII. H shaped MSA

The H-shaped microstrip antenna consists of an H shaped patch; supported on a grounded dielectric sheet of thickness h and dielectric constant εr. An H-shaped microstrip patch antenna, shown in figure is obtained by cutting equal rectangular slots along both the non radiating edges of the rectangular MSA. The H-shaped patch antenna reported here has a size about half that of the rectangular patch, with larger bandwidth. The H-shaped microstrip patch antenna, because of its considerably smaller size, could replace the rectangular patch at UHF frequencies.

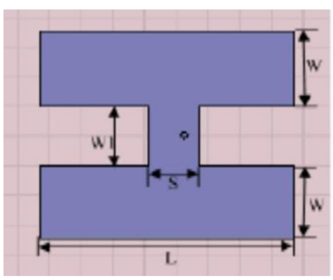

Fig. 4 H shape MSA

IX Designing method of proposed antenna

a) Software:

HFSS is a high-performance full-wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modelling that takes advantage of the familiar Microsoft Windows graphical user interface. It integrates simulation, visualization, solid modelling, and automation in an easy-to-learn environment where solutions to your 3D EM problems are quickly and accurately obtained. Ansoft HFSS employs the Finite Element Method (FEM), adaptive meshing, and brilliant graphics to give you unparalleled performance and insight to all of your 3D EM problems. Ansoft HFSS can be used to calculate parameters such as S Parameters, Resonant Frequency, and Fields.HFSS is an interactive simulation system whose basic mesh element is a tetrahedron. This allows you to solve any arbitrary 3D geometry, especially those with complex curves and shapes, in a fraction of the time it would take using other techniques.The name HFSS stands for High Frequency Structure Simulator. Ansoft pioneered the use of the Finite Element Method (FEM) for EM simulation by developing/implementing technologies such as tangential vector finite elements, adaptive meshing, and Adaptive Lanczos-Pade Sweep (ALPS). Today, HFSS continues to lead the industry with innovations such as Modes-to-Nodes and Full- Wave Spice [3],[5].

X .ANTENNA FABRICATION

The antenna can be fabricated using the photolithographic technique. This is a chemical etching process by which the unwanted metal regions of the metallic layer are removed so that the intended design is obtained. Depending upon the design of the antenna as bi planar or uniplanar dual or single side substrates are used. The selection of a proper substrate material is the essential part in antenna design.

A.CHARACTERISTICS OF SUBSTRATE MATERIALS

Recent developments in the microelectronic industry demand high performance microwave materials for substrate and packaging applications. Materials for such applications should have low relative permittivity and low dielectric loss to reduce the propagation delay and to increase the signal speed. In addition the materials should have high thermal conductivity for dissipating heat. Other important substrate characteristics include the thickness, homogeneity, isotropicity and dimensional strength of the substrate.

B. DESIGN FABRICATION AND MEASUREMENT OF ANTENNAS

The selection of dielectric constant of the substrate depends on the application of the antenna and the radiation characteristics specifications. High Dielectric constant substrates causes surface wave excitation and low bandwidth performance. Also as the frequency of operation increases, the loss tangent of the material used for substrates slightly increases, which in turn adversely affects the efficiency of the antenna. Also increasing the thickness of the substrate increases the band width of the antennas at the expense of efficiency owing to increase in surface waves. FR4 with εr=4.4 tan, δ=.02, h=1.6 mm and RT Duriod substrate with εr=4.4, tan δ=.002, h=1.5 mm are used for the study.FR4 substrate are commonly used for initial studies. The final antennas are fabricated on RT Duroid to enhance the antenna efficiency. Various methods have been devised to accurately measure the dielectric properties of substrates available in market. The microwave dielectric properties of the sample were measured by the cavity perturbation technique using a vector Network Analyser. This technique is widely used for the determination of the dielectric characteristics of thin samples of low and medium dielectric loss.A rectangular S or X-band slotted wave-guide cavity with optimum iris coupling is used for the measurement of dielectric properties of the samples at the microwave frequencies. The resonant

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frequency and quality factor of the empty cavity were determined for different cavity modes. Then the extremely thin sample having known dimensions is inserted and positioned at the E-field anti node. The new resonant frequency and Q of the sample were again measured[4].

C .PHOTO LITHOGRAPHY

After the proper selection of the substrate material a computer aided design of the geometry is initially made and a negative mask of the geometry to be generated is printed on a transparent sheet. A single or double sided substrate with copper metallization of suitable dimension is properly cleaned using acetone to free from impurities. A thin layer of negative photo resist solution (1:1 mix of negative photo resit solution and thinner) is coated using spinning technique on copper surfaces and is dried. The mask is placed onto the photo resist and exposed to UV light. After the proper UV exposure the layer of photo-resist material in the exposed portions hardens when it is treated with developer solution

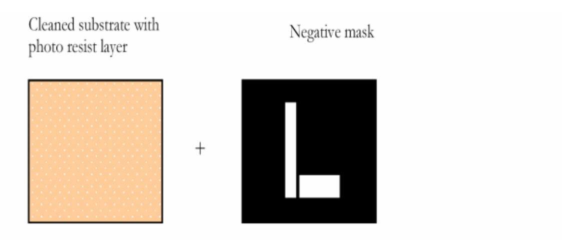

Fig. 5. Cleaning process

D. MEASUREMENT OF ANTENNAS

The board is then dipped in dye ink solution in order to clearly view the hardened photo resist portions on the copper coating The board is then washed in water. After developing phase the unwanted copper portions are etched off using Ferric Chloride (FeCl3) solution to get the required antenna geometry on the substrate. The etched board is rinsed in running water to remove any etchant. FeCl3dissolves the copper parts except underneath the hardened photo resist layer after few minutes. The laminate is then cleaned carefully to remove the hardened photo resist using acetone solution. The various steps involved in the fabrication process is illustrated.

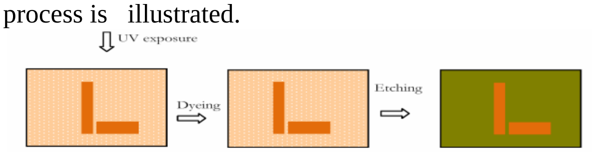

Fig.6 Photolithographic technique for antenna fabrication

E. TESTING OF FABRICATED ANTENNA

For testing of fabricated antenna vector network analyser can be used.

X. CONCLUSION

The various aspects of microstrip antennas have been studied & presented in this paper. Such as strcture of microstrip antenna its feeding techqiues advantages disadvantages, designing of antennas.. The main objective of this study is to make a special structure of patch to get better bandwidth than rectangular patch. The designing aspect related to software and fabrication processes are also presented in this paper.

ACKNOWLEDGMENT

I express my sincere gratitude and indebtedness to my guide Prof. A.K. Pathrikar for his initiative in this field of research, for his valuable guidance, encouragement and affection for the successful completion of this work. His sincere sympathy and kind attitude always encouraged us to carry out the present work firmly. I express thankfulness to Principal Dr.G.S.Sable. for providing us with best facilities and his timely suggestions.

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