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Study Of different ETMSA for Wideband Application

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Abstract

Microstrip Patch antenna is widely used in recent many applications. From different shapes Equilateral Triangular Microstrip patch antenna (ETMSA) is used for getting wide bandwidth . For obtaining wide bandwidth different other designs are also observed like two , three, four gap coupled ETMSA on the same (FR4) substrate[1]. Then BW obtained increases from 30 MHZ to 80 MHz. For getting wide bandwidth slot is also incorporated in ETMSA and substrate changed to Foam. For single sloted patch getting BW of 280 MHz while with array of four gap coupled ETMSA getting BW of 480 MHZ. All the simulations are done in IE3D software.

Keywords: *Microstrip patch, bandwidth, ETMSA, Sotted antenna..*

1. Introduction

An antenna is a transducer designed to transmit or receive electromagnetic waves. In other words, antennas convert electromagnetic waves into electrical currents and vice- versa. Antennas are key components of any wireless system.Most antennas are resonant devices,[1] which operate efficiently over a relatively narrow frequency band. An antenna must be tuned to the same frequency band that the radio system to which it is connected operates in, otherwise reception and/or transmission will be impaired.[2]

The dipole antenna was the first type of antenna to be ever used and the simplest one to study and understand it is a strait wire fed from the centre. Tune the wire to be effective to transmit and receive electromagnetic waves; the length of it should be half the wavelength of the operating frequency.[8]

1.1 Types Of Antennas:

The basics types of antennas are classified as

- Wire Antennas
- Reflector antennas
- Log periodic Antennas
- Travelling wave Antennas
- Aperture Antennas
- Microstrip Antennas

1.2 OBJECTIVE:

- To design , simulate and fabricate the different configurations Equilateral Traingular Microstrip Patch Antenna for getting Wideband Applications.
- Single patch, Two patches of ETMSA array electromagnetically coupled are designed and simulated and results are compaired at frequency 2.4 GHZ
- U shape Slotted ETMSA single patch with different substrate Foam is used and results are observed for Wideband applications.
- U shape slotted ETMSA array of four patches results are observed .

2 General structure of Microstrip Patch Antenna

A microstrip antenna generally consists of a dielectric substrate sandwiched between a radiating patch on the top and a ground plane on the other side as shown in Figure 2.1. 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.[2]

For simplicity of analysis, the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape. For a rectangular patch, the length L of the patch is usually in the range of $0.3333\ \lambda0 < L < 0.5\ \lambda0$, where $\lambda0$ is the free space wavelength. The patch is selected to be very thin such that $t << \lambda0$ (where t is the patch thickness). The height of the substrate is usually$0.003\ \lambda0 \leq h \leq 0.05\ \lambda0$. The dielectric constant of the substrate ϵr is typically in the range $2.2 \leq \epsilon r \leq 12$.

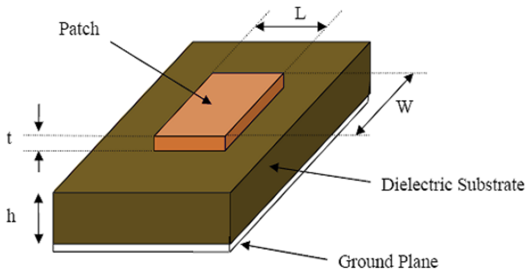

Figure 2.1 Structure of a Microstrip Patch Antenna

2.2 Advantages and Disadvantages

Microstrip antennas are used as embedded antennas in handheld wireless devices such as cellular phones, and also employed in Satellite communications. Some of their principal advantages are given below: [2]

- Light weight and low fabrication cost.
- Supports both, linear as well as circular polarization.
- Can be easily integrated with microwave integrated circuits.
- Capable of dual and triple frequency operations.
- Mechanically robust when mounted on rigid surfaces.

Microstrip patch antennas suffer from more drawbacks as compared to conventional antennas. Some of their major disadvantages are given below:

- Narrow bandwidth.
- Low efficiency and Gain.
- Extraneous radiation from feeds and junctions.
- Low power handling capacity.
- Surface wave excitation.

2.3 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.[1] 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).

2.3.1 Coaxial Feed Technique Used:

The Coaxial feed or probe feed is one of the most common techniques used for feeding microstrip patch antennas.[3] As seen from fig 2.3, 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.[10]

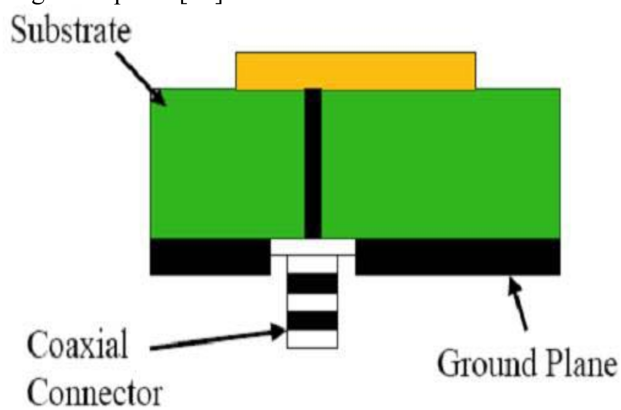

Fig 2.3 Coaxial feed

The main advantage of this type of feeding scheme is that the feed can be placed at any desired position inside the patch in order to obtain impedance matching. This feed method is easy to fabricate and has low spurious radiation effects. However, its major disadvantage is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled into the substrate. Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems.[5]
By using a thick dielectric substrate to improve the bandwidth, the microstrip line feed and the coaxial feed suffer from numerous disadvantages such as spurious feed radiation and matching problem. The non-contacting feed techniques which have been discussed below, solve these problems

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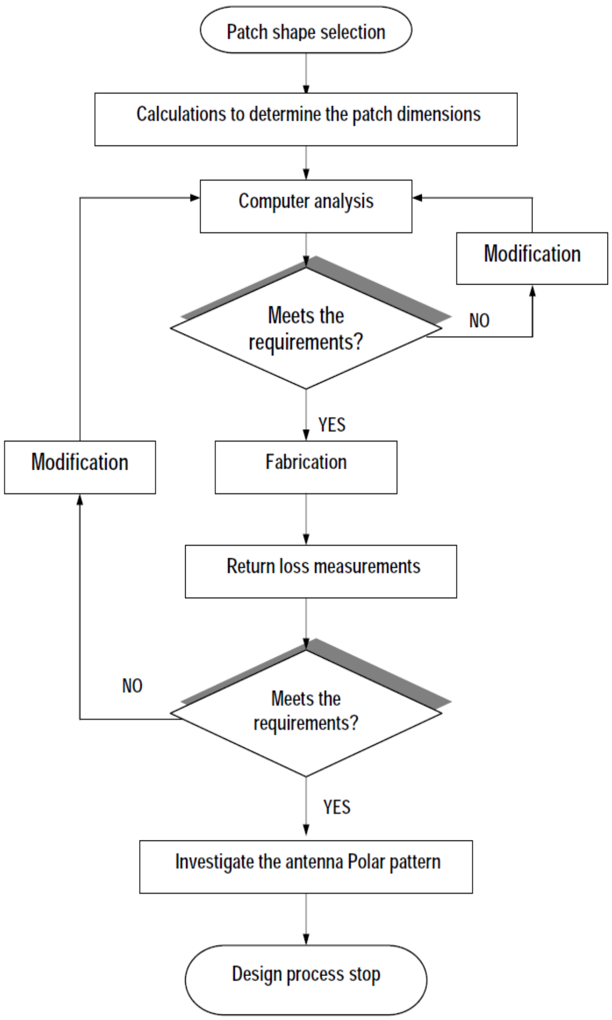
3 Design Methdology:



3.1 Equations

Specifications of the ETMSA is obtained from following formulae

$$f_0 = \frac{2c}{3S_e\sqrt{\varepsilon_e}} \quad (3.1)$$

Where , S_e = effective side length,

ε_e = effective dielectric constant.

$$S_e = S + \frac{4h}{\sqrt{\varepsilon_r}} \quad (3.2)$$

S = side length of ETMSA ‘

h = Thickness of Patch,

$$\varepsilon_e = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+10\frac{h}{w}\right]^{-1/2} \quad (3.3)$$

Where , w = S/2 ,

4 Different Patches

4.1 Single ETMSA Patch :

In this FR4 substate having dilectric constant 4.2 and thickness 1.6 is used to make ETMSA having 40mm width and results are observed then got tunning at frequency 2.48 GHZ and return loss is -20 db and bandwidth is 25 MHz

Fig.4.1 Single ETMSA fabrication on FR4 substarte

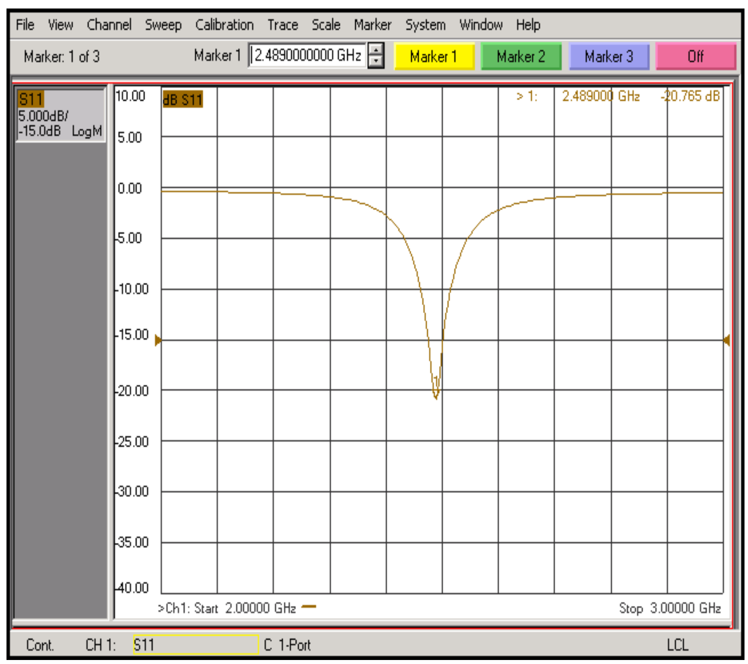


Fig.4.2 Practical return Loss.

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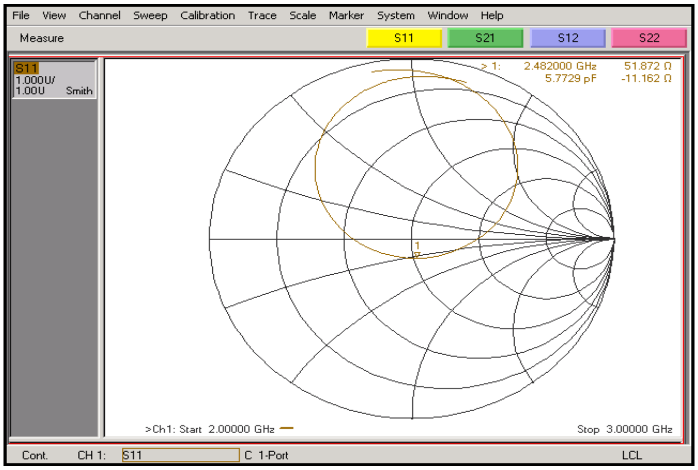

Fig.4.3 Practical Input Impedence Result

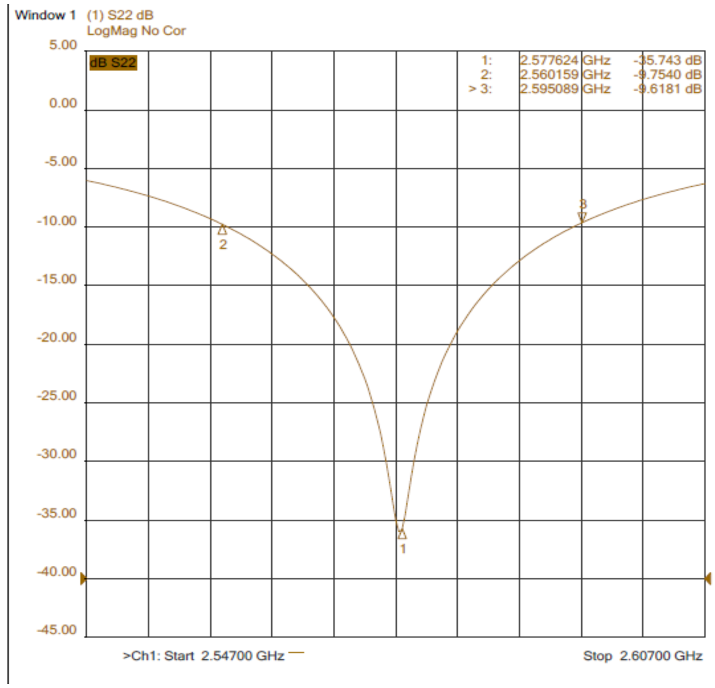

Fig4.5 Practical Return Loss

4.2 Two Gap Coupled ETMSAs:

In this type of Antenna Parasitic patch is electromagnetically coupled with ETMSA having Coaxial feed. Upper ETMSA having Side length 36mm and lower patch side length is taken 37mm to get better results. And space between two patches is taken 0.6mm to get electromagnetic coupling. This configuration is used to get large bandwidth than that of single patch so that antenna can be used for wideband application. This antenna can be used ISM band 2.4 GHz to 2.48GHz . we get 40 MHz bandwidth which is improvement

Fig 4.4. Practical Antenna

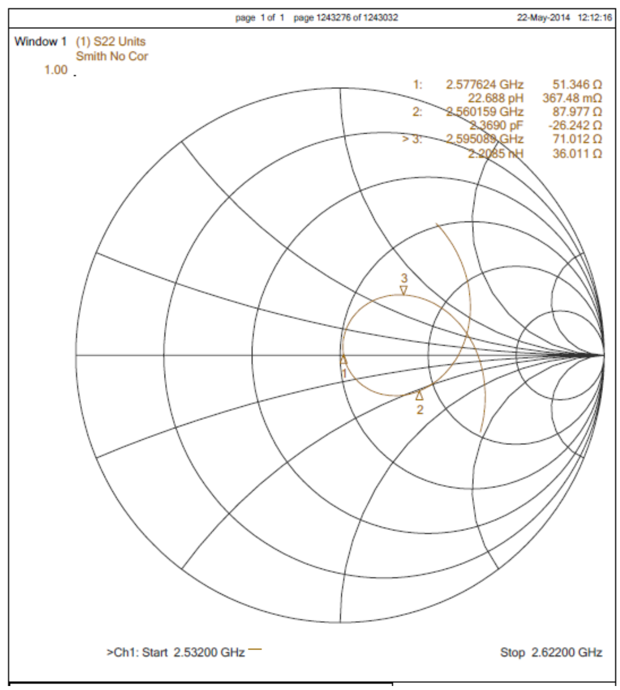

Fig 4.6. Pracical Input Impedence

4.3 ETMSA with U slot:

In this design instead of using FR4 substrate I have used Foam material as a substrate having dielectric constant 1.07. Patch and ground plane are of copper material. By using the U slot with triangular patch wide bandwidth obtained getting BW of 280 MHz . Dimensions of antenna are obtained from calculations done according to book Broadband Microstrip Antenna.

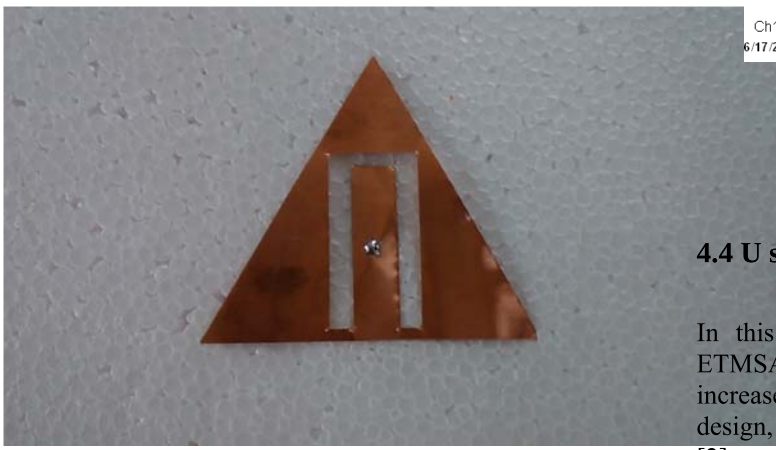

Fig 4.7 Practical U slotted Antenna

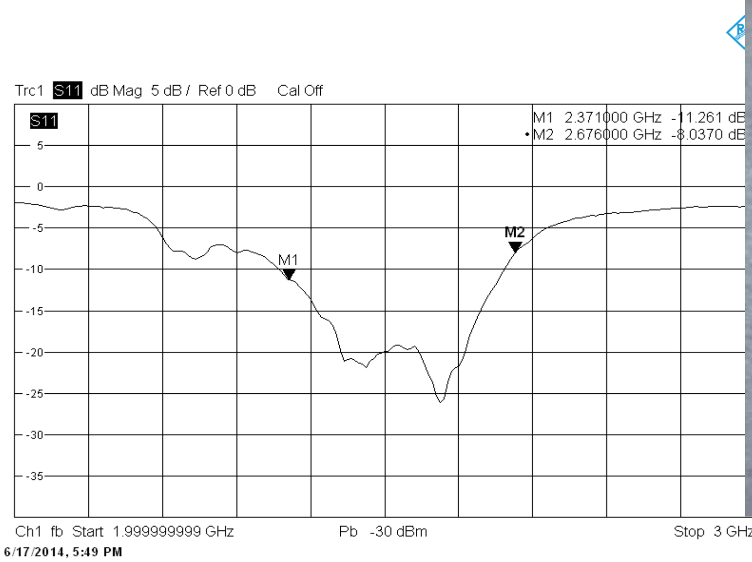

Fig 4.8. Return loss

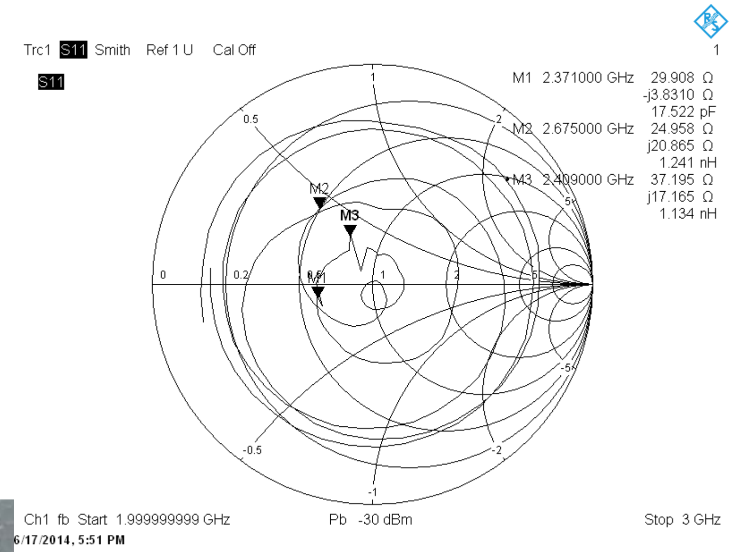

Fig. 4.9 Input impedence

4.4 U slot ETMSA array:

In this type design like previously four gap coupled ETMSA four Slotted ETMSA are gap coupled for getting increased bandwidth. We get BW of 480 MHz from this design, which is used for Wide bandwidth application.[1] [2]

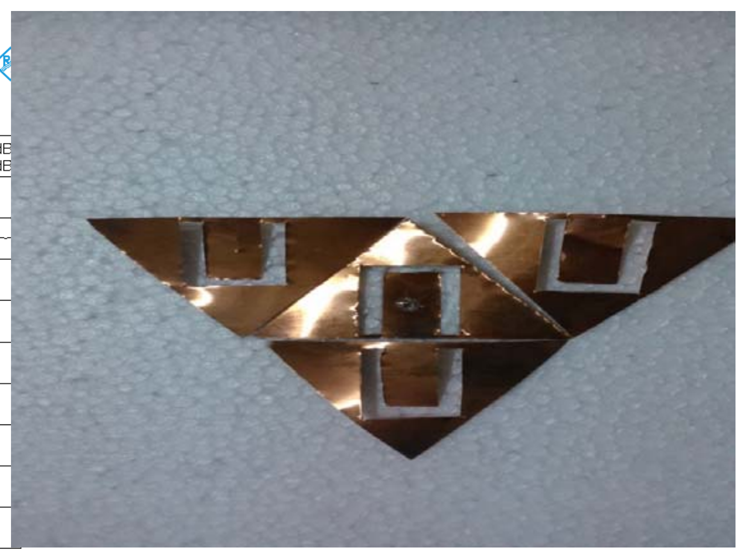

Fig. 4.10 Practical 4 U slotted antenna array

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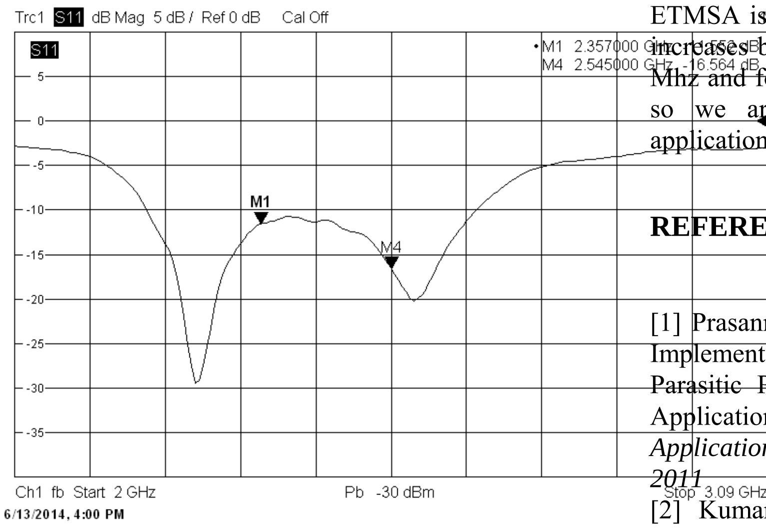
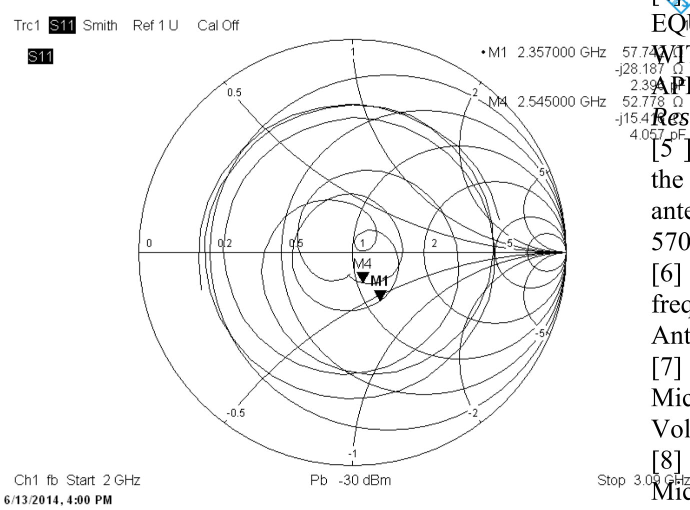


Fig. 4.11 Return Loss / S11 parameter



Conclusion:

From the simulated and practical results, it is concluded that as we increase parasitic patches we get increased BW . For FR4 substrate we designed single ETMSA to two gap coupled ETMSA and as number of patches increases we are obtaining increased bandwidth from 25 MHz to 40 MHz wich covers ISM band 2.4 to 2.48GHz . Then for getting wider bandwidth for wideband applications U slot ETMSA is designed on foam substrate so size of antenna increases but we get wide bandwidth, for sinle patch 280 Mhz and for four gap coupled ETMSA getting 480 MHz. so we are getting large bandwidth for wideband application.

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