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Design and Analysis of E-Shaped Multiband Microstrip Feed antenna For Wireless Applications

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ABSTRACT:

An Antenna is the most important element of the wireless communications. This paper is highly focused on the H-Shaped Multiband Microstrip feed Rectangular Patch antenna for Wireless Applications. In this we also discuss the basics of microstrip patch antenna and the various feeding technique design model and their design parameters with their advantage and disadvantages.The antenna is mainly intended to be used for 2.4GHz and 3.98GHz.Wireless Local Area Network and Worldwide Interoperability Microwave Access(Wimax) have been widely applied in mobile devices such as handheld computers and smart phones.These techniques have been widely considered as low cost effective, more flexibility ,reliable and high speed data connectivity solution enabling user mobility and it provides high efficiency.The electrical parameters of the antenna like return loss, radiation pattern and rectangular plot are investigated.The dielectric permittivity is 4.4(ε_r) and FR4 substrate material is used. The simulated results for the multiband microstrip feed antenna is designed by using the Ansoft HFSS13.0 (High Frequency Structural Simulator) Software.

1. INTRODUCTION:

An Antenna is the both transmission and receiving the information.So it is the essential part of the microwave system. Here the antenna essence the reciprocity property. In communication a multiband device including the dualband, triband devices.The multiband device is a communication device (mobile phone and satellite) that supports multiple radio frequency bands. All the devices which we use as the multiband devices.In multiband devices more than one applications are used. Therefore the multiband is better than single band. Multiband in mobile devices that support roaming between different regions where different standard are used for telephone services where the bands are widely separated in frequency, parallel transmit and receive signal path must be provided.

Microstrip antenna have been widely used because of narrow band and wide beam width and also it relatively inexpensive to manufacture and design because of the simple 2-dimensional physical geomentry, they are light in weight and the capability to be integrated with other microwave circuits. A single patch antenna provides a maximum directive gain of around 6-9Db.It relatively easy to print an array of patches on a single large substrate using lithographic techniques patch antenna can easily be designed to have vertical,horizontal, using multiple feed points.

Here the rectangular patch is used because, it looks a truncated transmission line,it is approximately of one half wavelength long.When air is used as the dielectric substrate.The length of the rectangular microstrip antenna is approximately one half of a free-space wavelength.As the antenna is loaded with a dielectric as its substrate,the length of the antenna decreases as the relative dielectric constant of the substrate increases.The microstrip antenna used in more applications.Because the microstrip antenna has more advantage than other antennas they are providing the microstrip has low profile that can even be conformal .And easy to us fabricate that use etching and photolithograpy.microstrip antenna is easy to use in any array.

Microstrip antenna have some distinct properties:

- The bandwidth is directly proportional to substrate thickness and width.
- The resonant input resistance is almost independent of the substrate thickness.
- The resonant input resistance is proportional to dielectric permittivity.
- The directivity is insensitive to the substrate thickness.
- The radiation efficiency is less than 100%. Due to conductor loss ,dielectric loss and surface wave power.

2.DESIGN PROCEDURE:

1.The designed antenna has been optimized using High Frequency Simulator Software of Ansoft HFSS 13.0 software.

- The slots are Introducing on the patch by varying the various slots in the patch radiator.The Four slots are cut along the patch,the rectangular polarized radiation can be achieved with compact size.
- The performance of the antenna is compared,based on fixed overall antenna size and patch radiator size.the copper

material used in the patch radiator.

- The E-Shaped slots are cut along the patch radiator.the material used same in the patch radiator.the strip is after search by an slots on the antenna.

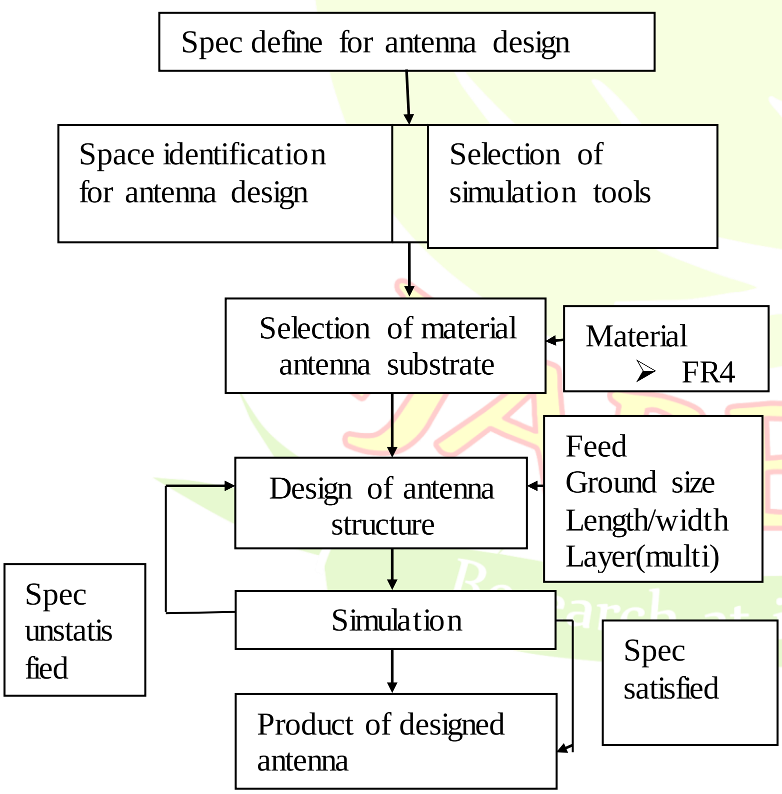
- The feed point is search on the trial by approach,after that the wave port is assigned in the antenna design.In the analysis setup the 3D modulation of validation check is analyzed.the Radiation Boundary is assigned on the design of E Shaped slots.

2.Using the Simulation we can observe the following Electrical Parameters like Radiation Pattern,Rectangular Plot,Return Loss Gain and Bandwidth.

3.Fabrication of Multiband microstrip Feed antenna Using E-slots on FR4 substrate and verify all above mention Parameters.

4.Compare Simulation Results and Hardware Implementation results.

Proposed antenna design:



3.ANTENNA GEOMENTRY:

In this antenna ,the three assumption are made in the proposed system.

1.The substrate of the material(ε_r) is FR4.

2.The operating frequencies are 2.4GHz,3.98GHz.

3.Height of the substrate is (h) is 1.67..The length and width of path are L=30.96mm and w=38.04mm respectively.The length and width of ground plane are L=39.44mm and w=48.06mm respectively.Edges along the width are called radiating edges and that along the width are called non radiating edges.E shaped slot is formed on the patch.The four slots are formed on the patch,one is the vertical shape and three slots are the horizontal shape. The dimensions of vertical slot is taken as length=18.98mm and width=2mm and the second slot is taken as length=9.49mm and width=20.94mm.the third slot are taken as L=1.0 and W=9.47.the fourth slot is length=7.49 and width=9.47mm.By unite these shapes E shaped slot is formed on the patch.finally The strip line feed is used and lumped parameter is assigned.

DESIGN SPECIFICATION:

A microstrip antenna in its simplest configuration consists of a radiating patch on one side of a dielectiric substrate,which has a ground plane on the other side.The patch conductors normally of copper or gold,can assume virtually any shape but regular shapes are generally used to simplify analysis and performance prediction. Ideally, the dielectric constant of the substrate should be low to enhance the fringe fields that account for the radiation. However other performance requirements may dictate the use of substrate materials whose dielectric constant can be greater than four.various types of substrate having a large range of dielectric constant and loss tangent values have been developed.some of these substrate are flexible in nature,which makes them suitable for conformal wrap around the antennas. Microstrip antennas are widely used in the microwave frequency regions because of their simplicity and compatability with printed – circuits technology making them,easy to manufacture either as stand alone elements or as elements of arrays.A microstrip antenna consists of a radiating structure over a ground plane separated by an electrically thin layer of dielectric substrate. The rectangular patch are the basic and the most commonly used microstrip antennas.These patch can be used for the simplest and the most demanding applications.For an efficient radiator a practical width that leads to good radiation efficiencies is given in equation(1).equation(2) to equation(7) are used to calculate the design parameters of microstrip patch antennas.These equations are used to calculate any shape of patch antenna.

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For designing rectangular microstrip patch antenna following procedure is required

$$1.\ W = \frac{1}{2f_r\sqrt{\mu_\circ \varepsilon_\circ}} \sqrt{\frac{2}{\varepsilon_r+1}} = \frac{V}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \quad (1)$$

Where,
C is the velocity of light, $3*10^8$ m/s,
ε_r is the dielectric constant of the substrate,
f_r is the resonant frequency,
Effective dielectric constant of the microstrip is determined as

$$2.\ \varepsilon_{reff} = \frac{\varepsilon_{r+1}}{2} + \frac{\varepsilon_{r-1}}{2}\left[1 + 12\frac{h}{w}\right]^{-0.5} \quad (2)$$

Where,
ε_r is the dielectric constant of the substrate, 4.9mm,
h is the height of the substrate,
w is the width of the substrate.
Once width is found, extension of the length ΔL can be determined and denoted as,

$$3.\ \Delta L = h\left[0.412\frac{(\varepsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{w}{h}+0.264\right)}\right] \quad (3)$$

Where,
ε_{reff} is the effective dielectric constant,
actuall length of the patch and also the substrate can now be determined by using effective length as

$$4.\ L_{eff} = \frac{c}{2fr\sqrt{\varepsilon_{reff}}} \quad (4)$$

$$5.\ L = L_{eff} - 2\Delta L \quad (5)$$

Where, L_{eff} is the effective length.
ΔL is the extension of length.

$$6.\ L_g = 6h+L \quad (6)$$

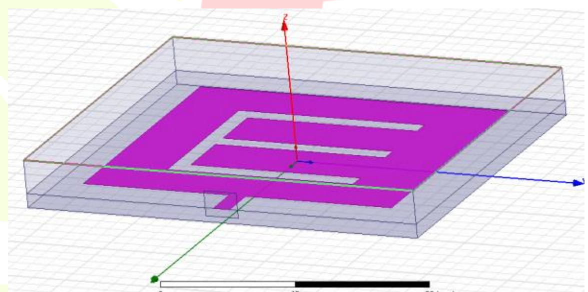
Where, L_g is the length of the ground plane.

$$7.\ W_g = 6h+w \quad (7)$$

Where, W_g is the width of the ground.

STRUCTURE AND DESIGN:

For desiginig E shaped patch antenna first the basic rectangular patch has been designed.From the paper the E-shape antenna is designed.the bandwidth and efficiency of E-shaped patch can be further improved by introducing the slot in a patch.The figure 1 shows the E-shaped slot antenna.In these design 4 slots are introduced to obtain the desired shape.The slot are introducing one by one,the horizontal slots have the same width,the vertical slot also have the same width.The two different frequency bands used these are 2.4GHz and 3.98GHz.The frequencies are used in the slot one by one.The vertical slot have the dimension of 18.98mm*2mm and the horizontal three slots have the same dimension is 2mm*20.94mm.The E-shaped compact design of multiband figure is shown in above fig.(1) and fig(2) is the Return loss of the multiband antenna.the return loss is found to be varying at 1.15GHz,1.60GHz and 3.40GHz and 4.10GHz is -25.00dB,and 3.40GHz is -20dB and 1.60GHz is-19.30dB and 1.15GHz is -7.50dB.

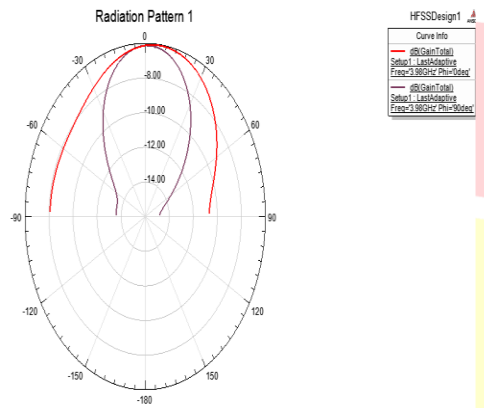


Fig(1)

Fig(2)

The figure(2) shows the simulated result of the return loss in the XY-plot.

The Fig(3) shows simulated results of the radiation pattern in the E-Shaped antenna.



Design parameters of multiband antenna:

Patch shape	Rectangle
Patch length/width	30.96*38.04mm
Substrate len/width	39.44*48.06mm
Height of substrate	1.67
Material	FR4
Slot length/width	18.98*2mm,2*20.94mm
Dielectric constant(ε_r)	4.4

The Radiation Pattern is the variation of power radiated by an antenna as a function of the direction away from an antenna.when a signal is fed into an antenna ,the antenna will emit radiation distributed in space a certain direction.the graphical representation of relative distribution in space is known as radiation Pattern.the radiation pattern establishes the contact between the signal source and its target.

The parameter vswr is a Measure that numerically how well the antenna is impedence matched to the transmission line it is connected to.Vswr is a function of reflection coefficient,which describes the power reflected from the antenna.The smaller the vswr is the better the antenna is matched to the transmission line and the more power is delivered to the antenna.The minimum vswr is 1.0.In these case no power is reflected from the antenna, which is ideal,measured vswr is 1.0.

CONCLUSIONS:

The stimulated and fabricated antenna results show that the proposed antenna can be used for Wireless applications.The E–shaped patch antenna can be used for higher bandwidth and more efficiency applications.The performance of the proposed antenna structure can be futher improvised using FR4 material, and slots are cut along the material are futher investigated.The structure can be futher miniaturized to perform for ultra wide band applications.

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