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A Review on Ultra wideband Micro Strip Patch Antenna

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ABSTRACT*:* In this paper, we work at micro strip patch antenna design with form of substrate, feed techniques and slots for UWB based system applications. The operations, characterizing parameters and different structures proposed are presented in fundamental form. The various applications and methods that make the micro strip patch advantageous over the conventional antenna have been discussed.

KEYWORDS: Micro strip patch antenna, Ultra Wide band, operating frequency, feeding techniques

I.INTRODUCTION

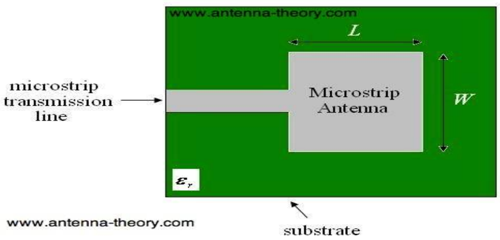
An antenna can do both transmitting and receiving the information so antenna is the essential device in the microwave communication. It is a device that is used to efficiently radiate and receive the radiated electromagnetic waves. It is act as transducer which turns the voltage and current on a transmission line into an electromagnetic field in a free space, which consists from an electric and magnetic field that travelling perpendicular to each other. [1]

Micro strip patch antenna was invented by Bob Munson in 1972 (but earlier work by Dechamps goes back to1953) and it became popular starting in the 1970s.Ultra wide band (UWB) systems have been growing quickly in wireless mobile communication because of it has advantage over conventional spread spectrum technique like lower interference, no need of dedicated frequency, security, using a unique timing code for a pair of specific trans receivers, multiple pulse includes each bit, use full in noisy environment ,enhance process gain on received signal.UWB systems have been used for radiolocation applications, data communications etc. The UWB antennas systems embedded into these transmission device., In networking system, UWB antenna is widely utilized, UWB antenna also use in transmission devices like HDTV's ,cameras and personal computers through the UWB service channels

This paper is organized as follows. A brief review of micros trip patch antenna and its structural features are accounted and discussed in section II. In section III, principal of operation is discussed. Section IV presents the special variants of feeding techniques. Transmission line analysis is discussed in section V and design considerations are discussed in section VI. Result and discussion is presented in section VII and Conclusions are drawn in section VIII.

II. STRUCTURAL OVERVIEW OF MICROS TRIP PATCH ANTENNA

Micro strip patch antennas are used to all-round across the board in mobile phone market because of they have low fabrication cost, inconspicuous and are easily fabricated in bulk amount. Here micro strip antenna shown in Figure.



(a) Top View of Patch Antenna

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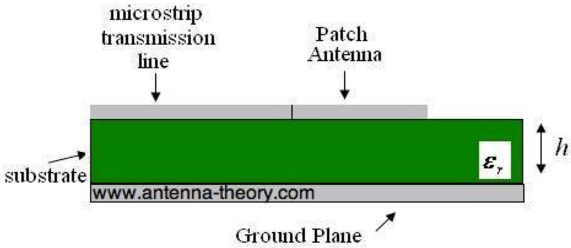

(b) Side View of Micro strip Antenna

Fig.1 Geometry of Micro strip (Patch) Antenna

The patch antenna consists of micro strip transmission line and ground plane which are made up of high conductivity metal like copper. Here patch length is L (m), patch width W (m), which is fabricated on a substrate which is a dielectric circuit board with thickness h and with permittivity or dielectric constant. For an efficient antennas, subtract height h is smaller than the operational wave length, but it should not be smaller than 1/40th of a wavelength.

Operational frequency of the patch antenna F is determined by the length L (meter). The center frequency will be approximately given by:

$$F \approx \frac{c}{2L\sqrt{\varepsilon_r}} = \frac{1}{2L\sqrt{\varepsilon_0 \varepsilon_r \mu_0}} Hz \qquad (1)$$

From eq. 1, micro strip antenna should have a length equal to one half of a wavelength within the dielectric (substrate) medium. The width W of the micro strip antenna is responsible for the input impedance. Results increase widths also increase the bandwidth. By increasing the width, the impedance can be reduced. However, to decrease the input impedance to often require a very wide patch antenna, which takes up a lot of valuable space. The width also controls the radiation pattern. [2]- [3]

III. PRINCIPAL OF OPERATION

The patch creates a resonant cavity with short-circuit (PEC) enclosures on top and bottom and open-circuit (PMC) enclosures on the edges. At different resonance frequencies, certain mode is allowed to be present in cavity. When antenna is excited at a resonance frequency then a strong field is build up in the cavity and strong current flows on the ground plane of the patch. This results a significant radiation for proper antenna and vice versa.

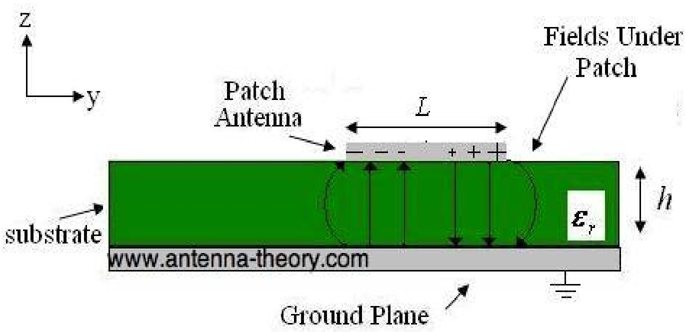

Fig .2 principal of operation

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Here substrate thickness is directly proportional to the patch current due to image cancellation and Q of the resonant mode also increases which results patch currents stronger at resonance. So patch radiates well even for small substrate thicknesses.

IV. FEEDING TECHNIQUES

For achieve the contacting feed method, the RF power is directly fed to micro strip line which is used as connecting element for radiating patch. Electromagnetic field and coupling is used for energy transfer between the micro strip line and the radiating patch. Patch antenna can be fed by coaxial probe or inset micro strip line. Coaxial probe feeding is used for active antennas and line feeding is used for high-gain micro strip array antennas. Here position of probe and inset length regulate with respect to the input impedance. [3]- [4]

4.1 Micro strip Line Feeding

In Micro strip line feed conducting strip is directly connected to patch. As compare in width, strip is smaller than the patch it makes easy that feed can be etched on the same substrate to achieve a planar structure. So here modelling and impedance matching is easy and control by the inset position. [4]- [3]

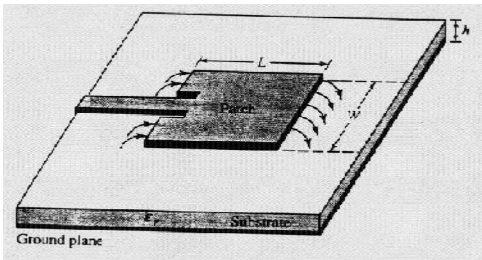

Fig. 3-Inset feed

Here substrate thickness is directly proportional to the surface wave and spurious feed radiation which results the limitation of bandwidth [3] - [4]

4.2 Coaxial Feeding

In Coaxial feeding method coaxial inner conductor is attached to the patch and the outer conductor is connected to the ground plane. Here feed can be placed at any desired location inside the patch of antenna so as to pairing with it input impedance, as shown in Fig.

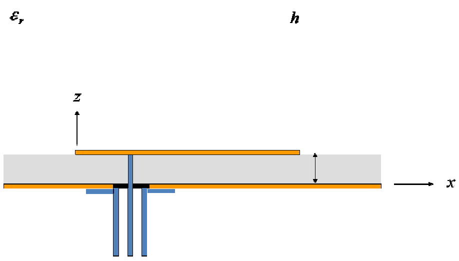

Fig. 4 Coaxial Feeding

It is easy to fabricate and match also provide minimum trumped up radiation. Disadvantage of coaxial feeding is narrow bandwidth, difficult in modelling for thick substrate and own inherent imbalance which produce higher order modes which results as cross polarization radiation. [4]

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4.3 Aperture Coupling

Aperture coupling makes use of different substrates for radiating patch and micro strip feed line which is separated by the ground plane. Feed line is coupled to the patch through an aperture on the ground plane partitioning substrates to achieve effective coupling. Here upper substrate has a thick low dielectric constant while the bottom substrate has of high dielectric substrate. [12]

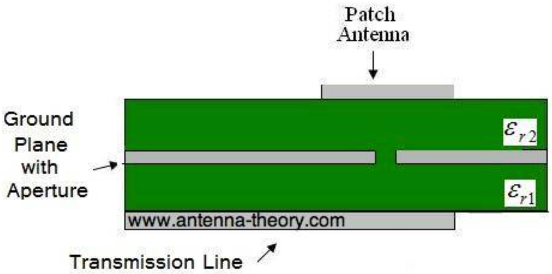

Fig. 5 Aperture Coupled Feeding

The ground plane sandwich's between subtracts with slot and isolates the feed from radiation element and for pattern formation and polarization purity it minimizes interference due to spurious radiation. It is used to achieve broad bandwidth and makes isolation between antennas and the feed network and independent optimization of the feed mechanism and the radiating element.

4.4 Proximity Coupling

Proximity coupling define as electromagnetic coupling feeding here feed line placed at the middle two substrates and the radiating patch is on the top of the upper substrate as shown

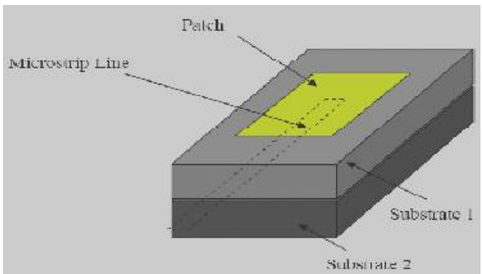

Fig. 6 Proximity coupled Feeding

However fabrication is difficult and length of feeding stub and width-to-length ratio of patch is used to control the matching. [4]

V. TRANSMISSION LINE ANALYSIS

Micro strip patch antenna has two slots with width (W) and height (h) detached by transmission line of length (L). The width of the patch

$$w = \frac{c}{2 f_o \sqrt{\varepsilon_r + 1 / 2}} \text{ Meter} \qquad (2)$$

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The effective dielectric constant (ε_{eff}) is less than (ε_r) results the fringing field around the periphery of the patch is not enclosed to the dielectric bayoneted in the free space.

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\sqrt{\frac{1}{1 + 12\, h/w}} \qquad (3)$$

For TM10 Mode the length of the patch must be less than (λ /2) this difference in the length (ΔL)

$$\Delta L = 0.412h \frac{(\varepsilon_{eff} + 0.3)(w/h + 0.264)}{(\varepsilon_{eff} - 0.258)(w/h + 0.813)} \text{ Meter} \qquad (4)$$

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{eff}}} \text{ Meter} \qquad (5)$$

Where c=speed of light, L_{eff}= effective length. F_r= resonance frequency, ε_{eff}= effective dielectric constant.

$$L = L_{eff} = 2\Delta L \qquad (6)$$

For a rectangular micro strip patch antenna, the resonance frequency for any TMmn mode is given:

$$f_0 = \frac{c}{2\sqrt{\varepsilon_{eff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right]^{1/2} \qquad (7)$$

VI. DESIGN CONSIDERATION

1. Substrate selection

For design prospective selection of a suitable dielectric substrate is important here subtract has thickness h with appropriate loss tangent. For example thicker substrate has to be mechanically strong as well as it will increase the radiated power and reduce the conductor loss and also improve impedance bandwidth.

2. Width and length parameters

Patch width is directly proportional to power radiated and indirectly proportional to resonant resistance which results increased BW and increased radiation efficiency. With proper excitation one may choose a patch width W greater than patch length. It has been suggested that 1 < W/ L < 2.
In case of micro strip antenna, it is proportional to its quality factor Q and given by as:

$$BW = \frac{VSWR - 1}{Q\sqrt{VSWR}} \qquad (8)$$

The percentage bandwidth of the rectangular patch micro strip antenna in terms of patch dimensions and substrates parameters is given as follows.

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$$BW\% = \frac{Ah}{\lambda_0}\sqrt{\frac{W}{L}} \tag{9}$$

Where

$$A = 180 \quad \text{For } \frac{h}{\lambda\sqrt{\varepsilon_r}} \le 0.045$$

$$A = 200 \quad \text{For } 0.045 \le \frac{h}{\lambda\sqrt{\varepsilon_r}} \le 0.075$$

$$A = 220 \quad \text{For } \frac{h}{\lambda\sqrt{\varepsilon_r}} \ge 0.075$$

Where h is the substrate thickness, λo is the wavelength in the substrate, ε_r is the dielectric constant of substrate, W, L is the width and length of patch dimension. [5]

VII. RESULT AND DISCUSSION

Fig 1 is showing the general structure of rectangular micro strip patch antenna with its corresponding parameters here fig (a) shows controlled top view of antenna assembly and other hand fig (b) shows the side view for detailed study of thickness of various layers.

Fig 2 shows operational principal of patch antenna where we can see the effect of E-M field on subtract material that placed between patch and ground plane.

Fig 3 shows structural orientation of inset feed micro strip patch antenna. This type of antenna suitable for the range 2.4 GHz S-band applications like satellite, Radar, Medical filed, and many other Wireless systems.

Fig 4 gives general idea of coaxial line feed antenna structure. It is used for C band radar based applications.

Fig 5 shows the structural overview of aperture coupled antenna which is used in GPS, GSM, WLAN and cellular phone etc.

Fig 6 shows proximity coupling feeding method for micro strip patch antenna and applications of this type antenna are broadband services such as Voice over IP (VOIP), portable mobile connectivity, Digital Subscriber Line (DSL), etc

VIII. CONCLUSIONS

This is a review paper demonstrated that study of the Micro strip Patch Antenna using UWB frequency ranges for Wireless communication devices applications. After study of literature survey it is concluded that multi resonance characteristics of patch antenna like return loss, VSWR, Radiation pattern, impedance bandwidth can be improved by changing the parameters such as operating frequency, ground plane structure dimensions, feeding techniques. These are many aspects that affect the performance of the antenna within UWB ranges for many wireless devices communication applications.

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