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Usage of Different Antennas in Ultra Wide Band

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ABSTRACT: To Enhance the Bandwidth of Patch Antenna using Ultra Wide Band. Although there has been conventional micro strip antennas in general have a conducting patch printed on a grounded microwave substrate, and have the attractive features of low profile, light weight, easy fabrication, and conformability to mounting hosts. However, micro strip antennas inherently have a narrow bandwidth, and bandwidth enhancement is usually demanded for practical applications, so bandwidth enhancement are becoming major design considerations for practical applications of micro strip antennas. Much significant progress in the design of compact micro strip antennas with broadband, dual-frequency, dual polarized circularly polarized, and gain-enhanced operations have been reported over the past several years. Ultra wideband (UWB) systems are attracting more and more attentions in a wide range of applications, including ground penetrating radars, high data rate short range wireless local area networks and communication systems for military purposes etc., due to their fine spatial resolution, extraction of target feature characteristics, and low probability of interception and non-interfering signal waveform. The UWB channel model is developed by the IEEE 802.15.3a

Keywords: Ultra Wideband, Bandwidth

I. INTRODUCTION

Conventional microstrip antennas in general have a conducting patch printed on a grounded microwave substrate, and have the attractive features of low profile, light weight, easy fabrication, and conformability to mounting hosts. However, microstrip antennas inherently have a narrow bandwidth, and bandwidth enhancement is usually demanded for practical applications. In addition, applications in present-day mobile communication systems usually require smaller antenna size in order to meet the miniaturization requirements of mobile units. Thus, size reduction and bandwidth enhancement are becoming major design considerations for practical applications of microstrip antennas. For this reason, studies to achieve compact and broadband operations of microstrip antennas have greatly increased. Much significant progress in the design of compact microstrip antennas with broadband, dual-frequency, dual polarized circularly polarized, and gain-enhanced operations have been reported over the past several years [1].

Numerous multiband and wideband antennas have been developed [2]–[3] in response to the recent demand for wireless communication systems. Ultra wideband (UWB) systems are attracting more and more attentions in a wide range of applications, including ground penetrating radars, high data rate short range wireless local area networks and communication systems for military purposes etc., due to their fine spatial resolution, extraction of target feature characteristics, and low probability of interception and non-interfering signal waveform.

The UWB channel model is developed by the IEEE 802.15.3a . A February 14, 2002 FCC Report and Order authorized the unlicensed use of UWB in the frequency range from 3.1 to 10.6 GHz. As an important component of the UWB system, the UWB antenna with simple structure, wide impedance bandwidth (BW), linear phase delay, stable radiation patterns, and constant gain in desired directions is required for the smallest degradation of the radiated pulses.

Moreover, WiMAX antennas, just like the antennas for car radio, cell phone, FM radio, or TV, are designed to optimize performance for a given application. Strong subscriber growth over the past year has demonstrated the appeal of WiMAX technology.

The UWB technology has experienced many significant developments in recent years. However, there are still challengers in making this technology live up to its full potential. One particular challenge is the UWB antenna. In recent years, many varieties of UWB antennas have been proposed and investigated. They present a simple structure and UWB characteristics with nearly Omni-directional radiation patterns. However, for some space-limited applications, UWB antennas need to feature a compact size while maintaining UWB characteristics. Therefore, miniaturization of UWB antennas becomes an interesting research topic and deserves a comprehensive investigation and analysis. In recent years, many significant developments and high attention are being paid to UWB Technology since the FCC allocated 3.1 - 10.6 GHz of the frequency spectrum for commercial UWB communications and applications [3].

The potential of UWB technology is enormous due to its tremendous advantages such as the capability to provide extremely fast data rates at short transmission distances while requiring low power dissipation. The attractive nature of UWB coupled with the rapid growth in wireless communication systems has made UWB an outstanding candidate to replace the conventional and popular wireless technology in use today like Bluetooth and wireless LANs.

Among the classical broadband antenna configurations that are under consideration for use in UWB systems, a straight wire monopole features a simple structure, but its bandwidth is only around 10%. A Vivaldi antenna is a directional antenna [4] and hence unsuitable for indoor systems and portable devices. A biconical antenna has a big size which limits its application [5]. Log periodic and spiral antennas tend to be dispersive and suffer severe ringing effect, apart from big size [6]. There is a growing demand for small and low cost UWB antennas that can provide satisfactory performances in both frequency domain and time domain.

In this thesis, micro strip line feed printed rotated slot and rotated ground antenna with a parasitic center patch introduced. With this the broadband characteristic of the wide-slot antenna is achieved. Also, a stable and Omni directional radiation pattern is observed within the operating bandwidth.

II ANTENNA THEORY

The antennas are an essential part of any wireless system. According to *The IEEE Standard Definitions of terms for Antennas*, an antenna is defined as a means for radiating or receiving radio waves [2]. In other words, a transmit antenna is a device that takes the signals from a transmission line, converts them into electromagnetic waves and then broadcasts them into free space, as shown in Figure 1.1; while operating in receive mode, the antenna collects the incident electromagnetic waves and converts them back into electrical signals. In an advanced wireless system, an antenna is usually required to optimize or accentuate the radiation energy in some directions and suppress it in others at certain frequencies. Thus the antenna must also serve as a directional in addition to a transition device. In order to meet the particular requirement, it must take various forms. As a result, an antenna may be a piece of conducting wire, an aperture, a patch, a reflector, a lens, an assembly of elements (arrays) and so on. A good design of the antenna can relax system requirements and improve overall system performance.

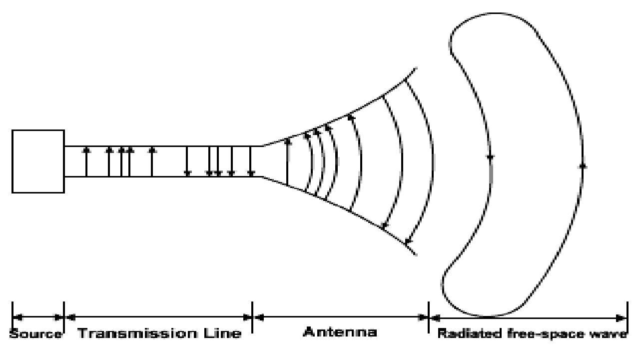

Fig. 1. Antenna as a transition device.

III. MICROSTRIP ANTENNA

The Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Figure 1.2 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. The patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape as shown in Figure 1.

Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. 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 [2]. However, such a configuration leads to a larger antenna size. In order to design a compact Microstrip patch antenna, higher dielectric constants must be used which are less efficient and result in narrower bandwidth. Hence a compromise must be reached between antenna dimensions and antenna performance.

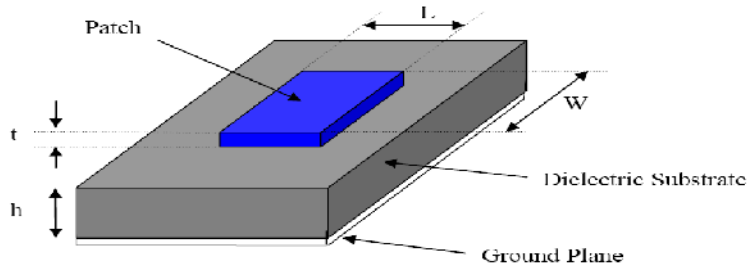

Fig. 2. Structure of a Microstrip Patch Antenna.

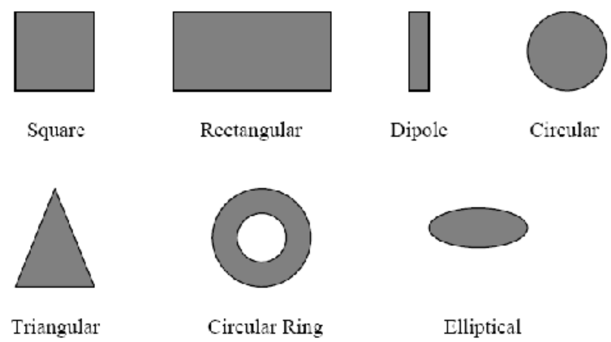

Fig. 3. Common shapes of microstrip patch elements.

A Feeding Mechanisms of Microstrip Antenna

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 [2]. 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). Power can be coupled in or out of an antenna by a variety of methods that can be broadly classified to contacting and noncontacting. Contacting feeds means direct connection of a transmission lines, can be coax or microstrip lines to the patch antenna. The input impedance depends on the location of the connection within the patch boundaries Moreover, for non-contacting feeds electromagnetic fields coupling used to transfer the power between feed lines and the radiating patch. The non-contacting feed is hard to design but provides more degree of freedom than contacting feed.

- Microstrip-Line Feed
- Coaxial Feed
- Aperture Coupled Feed
- Proximity Coupled Feed

IV. SLOT ANTENNA

Slot antennas are used typically at frequencies between 300 MHz and 24 GHz. The slot antenna is popular because they can be cut out of whatever surface they are to be mounted on, and have radiation patterns that are roughly omnidirectional (similar to a linear wire antenna). The polarization of the slot antenna is linear. The slot size, shape and what is behind its (the cavity) offer design variables that can be used to tune performance. Slot antennas can be considered a very special group of aperture-type antennas. They are very low-profile and can be conformed to basically any configuration, thus they have found many applications, for example on aircraft and missiles. The ground plane is part of the antenna. Ideally, the ground plane should be infinite as for a monopole antenna. But, in reality, a small ground plane is desirable. The radiation of a microstrip antenna is generated by the fringing field between the patch and the ground plane, the minimum size of the ground plane is therefore related to the thickness of the dielectric substrate. [10].

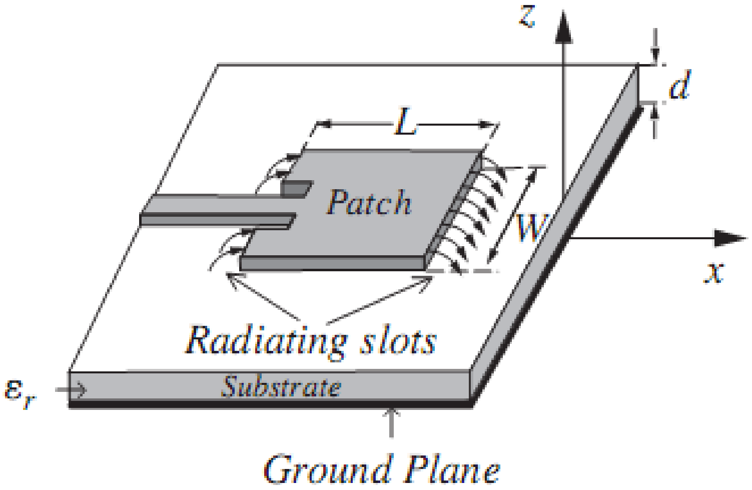

Fig. 4. Fringing Filed between the Patch and the Ground Plane.

Bandwidth Enhancement using Slot Antenna

A slot antenna consists of a metal surface, usually a flat plate, with a hole or slot cut out. When the plate is driven as an antenna by a driving frequency, the slot radiates electromagnetic waves in similar way to a dipole antenna. The proposed antenna is designed by using reference structure of paper titled as "Ultra wideband strip-loaded circular slot antenna with improved radiation patterns," which originates from the plane square patch and slot cut in the ground with suitable parasitic geometry. The slot size is optimized by exhaustive analysis by varying its orientation and dimensions. For designing this slot antenna IE3D software is used which is based on method of moment (MoM).

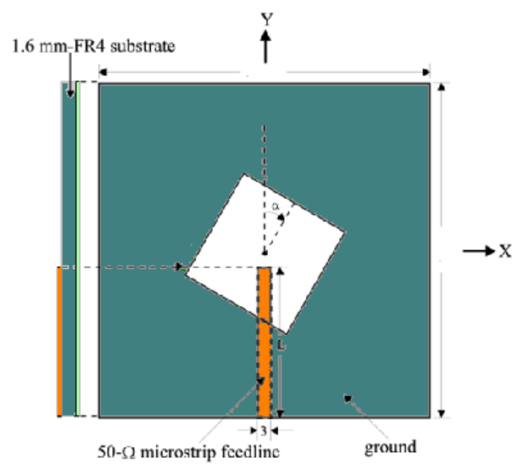

Fig. 5. Basic geometry of slot Antenna.

A Layout Design on IE3D

A) Dielectric Substrate: As with this design, the only available dielectric substrate is fr-4, with a relative dielectric constant εr = 4.4 and thickness 1.6 mm. when electromagnetic waves propagate through a dielectric, they travel at a speed is given by.

$$V = 1/\sqrt{\mu\varepsilon}$$

Where $\varepsilon = \varepsilon_o \varepsilon_r$, since $\lambda = v/f$ the wavelength inside of the dielectric can be expressed by:

.

$$\Lambda = 1/f\sqrt{\mu\varepsilon}$$

B) SLOT ANTENNA AND PARASITIC ANTENNA CONFIGURATION: Figure.6 shows the geometry and dimensions of the proposed microstrip-line-fed wide-slot antenna. the printed wide slot is chosen to be a square in order to excite two modes with close resonant frequencies. for exciting the operating frequencies at around 4.5 Ghz, this printed square slot rotated with a angle has dimensions of 7 x 7 mm^2 and is printed on an fr4 substrate of thickness 1.6 mm and ε_r = 4.4

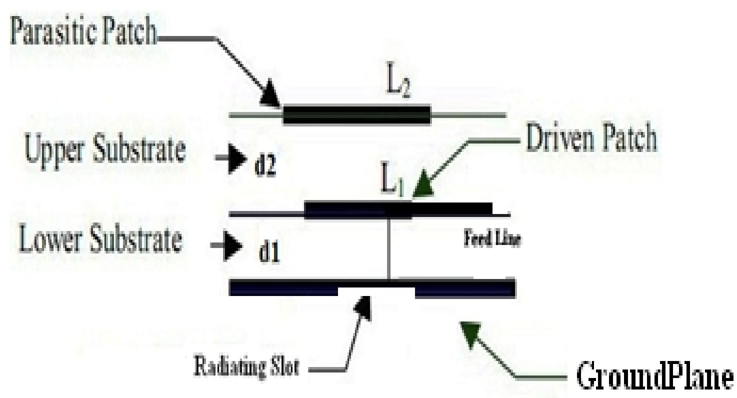

Fig. 6. Layered Architecture of Proposed geometry.

The ground plane is also chosen to be square with a dimensions 37 x 33.5 mm2. In this geometry to enhance the bandwidth we use a parasitic patch and its height is optimized to 2.9 mm. This square slot is fed by a 50 ohm microstrip line with a simple tuning stub having a straight length of L mm, which is printed on the opposite side of the microwave substrate. For design simplicity, the width of the tuning stub is chosen to be the same as that of the 50 ohm microstrip line. Simulated results show that square slot antennas with various rotated angles need different tuning-stub length (L in Fig. 1) to be matched. The correct values can be optimized by observing the reflection coefficient of the antenna.

- G- Ground Plane (37x33.5 mm^2)
- S1- Ground Slot (7x7 mm^2)
- S2- Parasitic Patch (12.5x 12.5mm^2)
- L- Feed Line Length (15mm) at 3mm Left from center
- Wf- Feed Line width (3mm)

V. SIMULATED RESULTS AND DISCUSSION

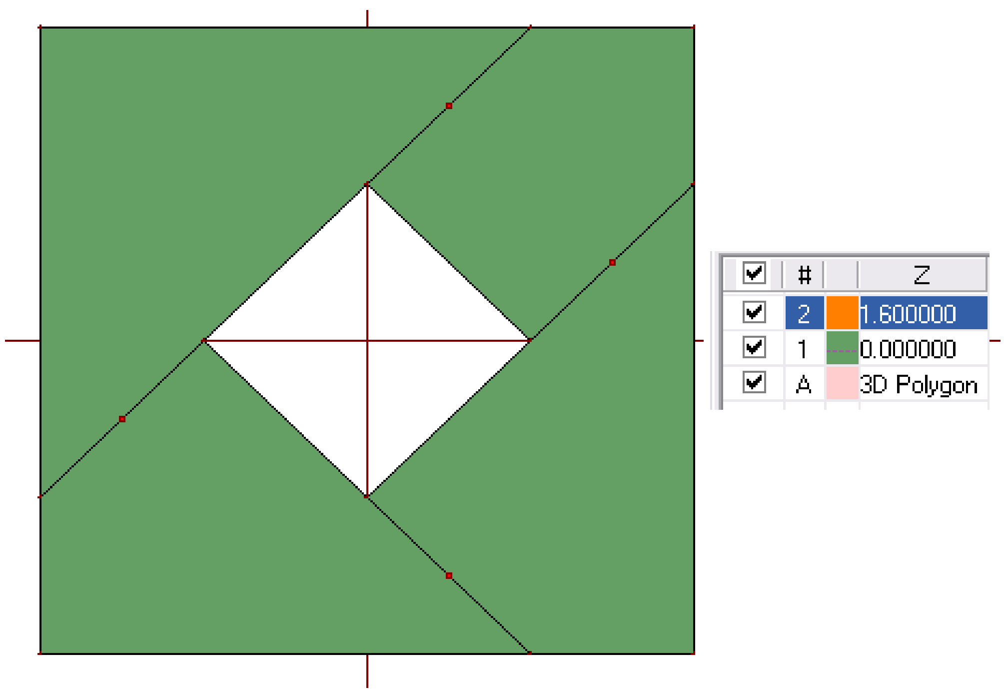

Fig. 7. Square patch with square slot at 45 degrees.

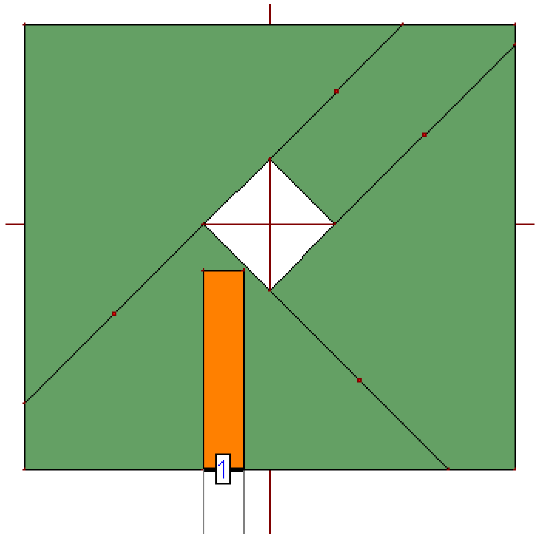

Fig. 8. Slotted Square patch with Feed Line.

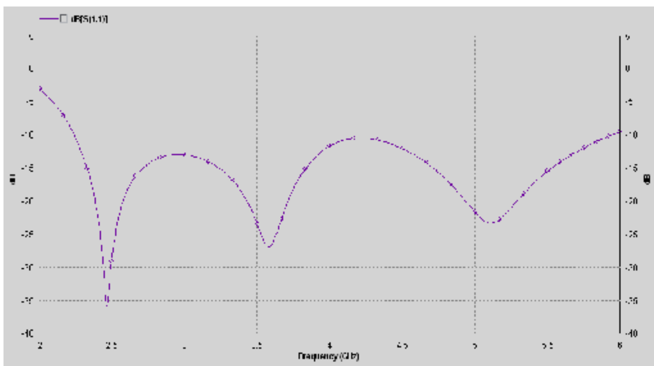

Fig. 9. Simulated reflection coefficient (S11 in dB) characteristics of Square patch with slot (Getting three resonant frequencies at 2.45 GHz, 3.55 GHz and 5.1 GHz and their respective Return Losses are -35 dB, -26dB and -24 dB).

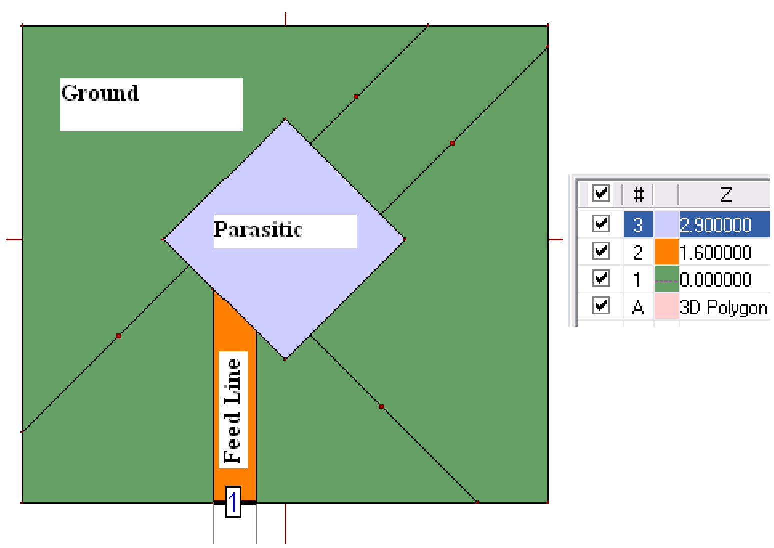

Fig. 10. Square patch with slot and parasitic Patch.

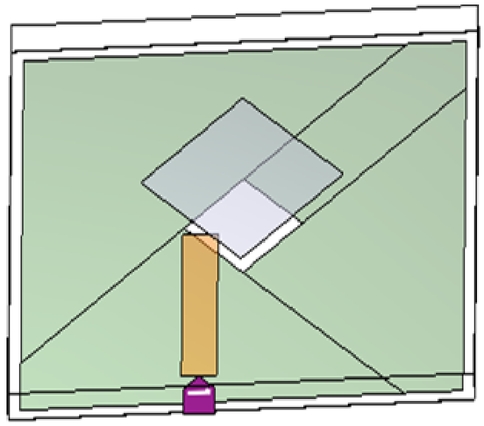

Fig. 11. D Display of Geometry.

V. CONCLUSION

A square small size rotated slot antenna, fed by a 50-microstrip line with a rotated square wide parasitic patch for bandwidth enhancement has been investigated. Multiple design examples have also been implemented to get the optimized geometry. Analyzed results show that the impedance bandwidth of a proposed antenna can be improved by rotating a suitable angle of the square slot and shifting the feed line from its central position.

For the optimized antenna parameters $\beta = 45^0$ and L = 15mm in this study, the impedance bandwidth determined by 10 dB return loss can reach nearly 2.19 GHz for the proposed antenna with designed operating frequencies around 4.5 GHz, at optimized ground of 37 x 33.5 mm^2. The proposed antenna has a size reduction of 11% to its reference geometry. Within this wide impedance bandwidth gain is greater than 2 dBi. The proposed antenna has a strong application in UWB and WiMAX devices.

Because of linear phase and good impedance matching, with some further optimization and manufacturing aspect, this antenna can serve in UWB and wireless USB applications.

Table 1: Comparison of different geometries.

Geometry	Fr (GHz)		BW (GHz)	Return Loss	Gain	Area (mm2)	% change in Area
	fL	fH			dBi		
Reference Geometry	2.23	5.35	3.12	-22	4.7	1369	Reference
Geometry with Slot in Ground	2.19	5.95	3.67	-34	4.7	1239.5	11
Geometry without Slot in Ground	2.84	6.19	3.35	-27	4.2	752	45

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