

# LITERATURE REVIEW OF ULTRA-WIDEBAND MICROSTRIP PATCH ANTENNA FOR WIRELESS APPLICATIONS

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**Abstract :** Ultra-Wideband (UWB) wireless technology has gained significant attention in modern communication systems due to its high data rates, low power consumption, and suitability for short-range applications. One of the key components of UWB systems is the antenna, which must provide wide impedance bandwidth, compact size, and stable radiation characteristics. Microstrip patch antennas (MPAs) are widely used due to their low profile, ease of fabrication, and integration capabilities. However, traditional MPAs suffer from narrow bandwidth, which limits their UWB performance. Researchers have developed various design techniques to enhance the bandwidth, including slot loading, defected ground structures (DGS), metamaterials, and hybrid techniques. This paper reviews the recent advancements in wideband MPAs for UWB applications, highlighting the key design strategies, performance enhancements, and challenges associated with these antennas. explore new possibilities of new wideband microstrip patch antenna for next generation

**IndexTerms - MIMO, MICROSTRIP PATCH ANTENNA**

## I. INTRODUCTION

Ultra-Wideband (UWB) technology, defined by the Federal Communications Commission (FCC) in 2002, operates in the frequency range of 3.1–10.6 GHz. It is widely used in wireless communications, radar, and medical imaging due to its high data rates and low power spectral density. The design of UWB antennas is critical for the overall system performance, as they must provide wideband impedance matching, omnidirectional radiation, and compact form factors. Microstrip patch antennas (MPAs) are widely explored for UWB applications due to their low-profile, ease of fabrication, and cost-effectiveness. However, conventional MPAs suffer from inherently narrow bandwidth (typically 3–5%). This paper reviews the advancements in designing wideband MPAs for UWB wireless applications, discussing various techniques that have been employed to overcome bandwidth limitations. Ultra-Wideband (UWB) technology is an important part of modern wireless communication standards such as IEEE 802.11n (Wifi), IEEE 802.16e (WiMAX), 3GPP Long Term Evolution (LTE), 3GPP HSPA+, 4G and 5G systems to come.

## II. HISTORY OF MICROSTRIP PATCH ANTENNA

Antenna [1] is a transducer which transmits or receives electromagnetic waves. Microstrip antennas have several advantages over conventional microwave antenna and therefore are used in a variety of practical applications. Microstrip antenna was first introduced in the 1950s. However, this concept had to wait for about 20 years to be realized after the development of the printed circuit board (PCB) technology in the 1970s. Since then, microstrip antennas are the most common types of antennas with wide range of applications due to their apparent advantages of light weight, low profile, low cost, planar configuration, easy of conformal, superior portability, suitable for array with the ease of fabrication and integration with microwave monolithic integrate circuits (MMICs). They have been widely engaged for the civilian and military applications such as radio-frequency identification (RFID), broadcast radio, mobile systems, global positioning system (GPS), television, multiple-input multiple-output (MIMO) systems, vehicle collision avoidance system, satellite communications, surveillance systems, direction founding, radar systems, remote sensing, missile guidance, and so on. Microstrip antenna in its simplest design is shown in Figure 1. It consists of a radiating patch on one side of dielectric substrate ( $\epsilon_r \leq 10$ ), with a ground plane on other side.

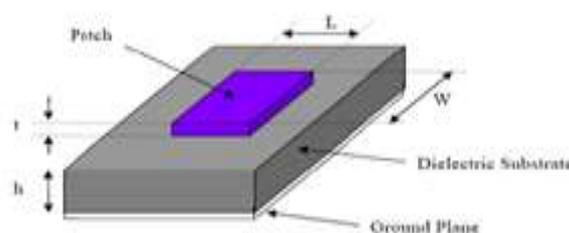
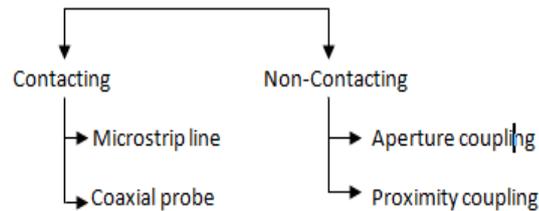


Figure 1: Microstrip antenna configuration

A microstrip patch antenna (MPA) consists of a conducting patch of any non-planar or planar geometry on one side of a dielectric substrate and a ground plane on other side. It is a printed resonant antenna for narrow-band microwave wireless links requiring semi-hemispherical coverage. Due to its planar configuration and ease of integration with microstrip technology, the microstrip patch antenna has been deeply. The rectangular and circular patches are the basic and most commonly used microstrip antennas.

### III. FEEDING TECHNIQUES

Microstrip patch antennas can be fed by a variety of methods. The 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 are



#### Microstrip Line Feed

In this type of feed technique, a conducting strip is connected directly to the edge of the Microstrip patch. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure. This method is advantageous due to its simple planar structure.

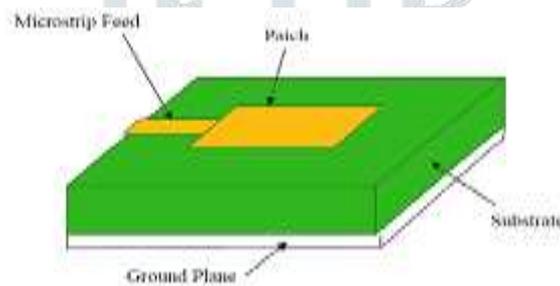


Figure 2 Microstrip Line Feed

#### Coaxial Probe Feed

The Coaxial probe feed is a very common technique used for feeding Microstrip patch antennas. 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. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance.

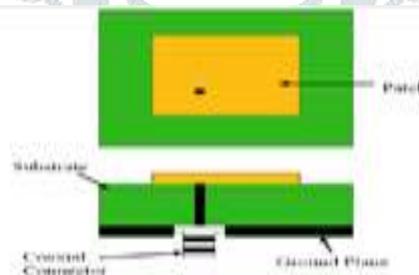


Figure 3 Coaxial probe Feed

#### Proximity coupled Feed

This type of feed technique is also called as the electromagnetic coupling scheme. Two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides very high bandwidth (as high as 13%) due to overall increase in the thickness of the microstrip patch antenna. This method is advantageous to reduce harmonic radiation of microstrip patch antenna implemented in a multilayer substrate

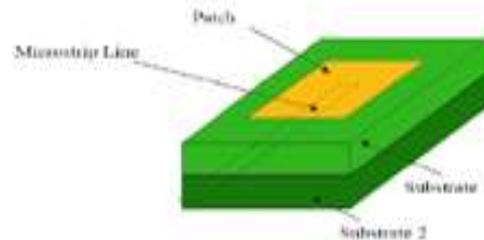


Figure 4 Proximity coupled Feed

#### Aperture coupled feed

In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane and variations in the coupling will depend upon the size i.e. length and width of the aperture to optimize the result for wider bandwidths and better return losses. The coupling aperture is usually centered under the patch, leading to lower cross-polarization due to symmetry of the configuration.

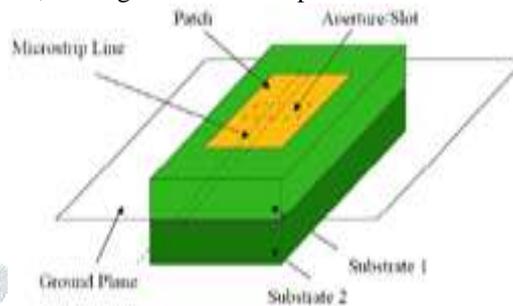


Figure 5 Aperture coupled Feed

#### IV. CURRENT CONFIGURED PATCH ANTENNAS TECHNOLOGY

Hamid reza Dalili [2] described a new planar microstrip ultra-wideband antenna for multi-input and multi output applications. To reduce the interference problems, UWB antennas with various band notch properties have used. His proposed antenna consists of hexagonal patch and a partial ground which the both of its edge has been etched. And using semicircular slot in different position to increase the bandwidth with semi-circular slot become better on the upper band with creating a resonant frequency at nearly 16.3GHz. Also, two element arrays of such antenna in four different configurations for MIMO applications were analyzed. Slot important roles to create the notches but leads a disadvantage i.e when this type of antenna is integrated with printed circuit board, the RF circuit cannot be very close to ground plane.

Ghyda'a M et.al [3] focuses on to enhance the bandwidth of the printed slot antenna with center E-shaped patch the overall size of this antenna is 37x37 mm<sup>2</sup> mounted on top of FR4 dielectric material with relative permittivity of  $\epsilon_r = 4.4$ , and fed by a microstrip feed line printed on the bottom of the dielectric material. From the simulation results, it has been found that the antenna is able to operate at wide BW ranging from (2.35-6.91) GHz.

K. Jagadeesh Babu et.al [4] have been presented a two element MIMO system is using a multi slot patch antenna employing orthogonal polarization diversity. The proposed antenna array resonates at dual band offering an improved bandwidth of 16% with return loss and mutual coupling  $< -27$ dB. These characteristics are well suited for all 4G MIMO applications. The proposed MIMO system, the separation between the elements is 10 mm which is  $0.17\lambda$ . This separation is much smaller compared to the conventional arrays which are separated by  $0.5\lambda$ . The proposed MIMO array exhibits improved return loss (S11) and excellent isolation properties (S12) at the resonant frequencies 5.35 GHz and 5.81GHz. The antenna gives the -10dB bandwidth of 16%. At the resonant frequencies the values of S11 are -27dB and -32dB respectively, which gives good impedance matching for the antenna.

Rezaul Azim et al [5] described a compact planar antenna operating at a frequency range of 3–16 GHz is presented for wideband applications. The antenna is composed of a square patch fed by a microstrip line and a partial ground plane with a rectangular slot. The proposed antenna is very easy to be integrated with microwave circuitry for low manufacturing cost. The Experimental result shows that the measured impedance bandwidth (VSWR  $\leq 2$ ) of the proposed antenna is 3.2-15.44 GHz, with a notch from 4.7 to 5.8 GHz.

Henridass Arun et.al [6] has been proposed MSS acts like a band-reject filter to reduce the coupling between the radiators in the antenna array. The serpentine structure along with resonators helps in reducing the mutual coupling between the antenna elements operating at a frequency of 2.45 GHz. The proposed modified serpentine structure (MSS) occupies only 3 mm spacing between the antenna elements. This compactness brings the suitability of the structure at high frequencies. An isolation improvement of 34 dB has been achieved with an edge-to-edge spacing of between the radiators. The antenna array is constructed using square patch radiators designed to operate at a frequency of 2.45 GHz. The dimension of the square patch radiator is 30X29.52 mm<sup>2</sup>. The antenna elements are placed in H-plane, and the spacing between the elements is chosen to be 6 mm, which is 1/20 of the free-space wavelength.

Arvind Kumar [7] et al focused on novel approach for gain enhancement in microstrip patch antennas using metallic rings. The design forces conversion of the surface wave energy into the space wave energy by scattering of surface waves. Electric field intensity of antenna with ring is eight to nine times higher as compare to antenna without ring and from the several simulations it

is observed that whenever there is higher field intensity, antenna exhibits higher gain and the patch antenna with metallic rings achieves average gain of 10.88 dB in the frequency range of 5.5–6 GHz Hence patch with metallic ring have higher average gain as compared to patch without metallic ring.

A.A. Asaker [8] et al design of a wideband microstrip patch antenna for LTE-A. The bandwidth of the conventional patch is enlarged by using etched slots at the antenna patch. The designed antenna has been fabricated by using thin film and photolithographic technique and has been measured by using the Vector Network Analyzer. Isolation between the microstrip elements is increased by placing metal structure between antenna elements. For more isolation between antenna elements, Slotted Ground Plane SGP is utilized.

## VI. CONCLUSION

Wideband MPAs play a crucial role in UWB wireless applications by providing high bandwidth and compact form factors. Various design techniques, such as slot-loading, DGS, metamaterials, and hybrid approaches, have significantly improved bandwidth performance. However, challenges remain in achieving optimal trade-offs between bandwidth, gain, and compactness. Future research should focus on novel materials, reconfigurable designs, and AI-based optimizations to further enhance UWB antenna performance. This paper is a survey on the technological advancements in microstrip patch antenna over 40 years.

A lot of research work is going on microstrip antenna for its better utilization in the next generation wireless communication. Survey shows that to enhance the features of microstrip patch antenna and enhance the bandwidth by using techniques such as introducing parasitic element either in coplanar or stack configuration, increasing the substrate thickness and modifying the shape of a patch and inserting slots to explore new possibilities of new wideband microstrip patch antenna to enhance the features of Wideband and next generation.

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