A REVIEW OF ULTRAWIDE BAND ANTENNAS WITH AND WITHOUT BAND NOTCHED CHARACTERISITCS

Nitin Kathuria[1], Prem Bhushan Mital[2]

[1]Reseach Scholar, [2]Professor, ECE, FET, Manav Rachna International University (India)

ABSTRACT

Mobile & wireless communication technologies are rapidly growing industrial markets from last two decades. The future of communication system is to provide voice, image & data at high speed anytime, anywhere in the world. These communication devices need proper antenna to fulfill the requirements of wide band & multiband. The difficulty is that the advancement of the antenna design is required with increase in the operating frequency. The problem for the required antenna arises with increasing number of operating frequency bands and miniaturizing. In order to transmit and receive more information large bandwidths are required and bandwidth enhancement is currently a popular topic of research. This is achieved by the introduction of UWB range with the specific bandwidth of 7.5GHz. The studies and research for UWB antenna is of much attention these days due to its high data rate capability. Basic key requiremts for antenna to operate in UWB range are capability of operating over an ultra wide bandwidth allocated by the FCC, group delay for UWB antenna must be in 10ns range, radiation pattern should be omni-directional, compact in size, planar, cheap and low profile, VSWR ≤ 2 across the whole band of operation so as to maintain good matching and efficient operation and constant gain. The focus of this paper is to study and analyse the types of UWB band antennas available and previously designed, which are physically compact, planar profile, sufficient impedance bandwidth, stable and near omnidirectional radiation pattern along with different method of notching the frequency bandwidths for filtering purpose.

***Keywords:* Ultra-Wide Band , Band-Notched & Multi-Band Antenna, Slot Antenna, Bandwidth Enhancement**

I. INTRODUCTION

The increasing demand for wireless communication systems spurs on the need for antennas capable of operating at a wide frequency band. Owing to their attractive merits such as simple structure, pure polarization and omnidirectional radiation pattern, the conventional monopole and its variants have been widely used in wireless communications. Wireless multimedia systems are receiving increasing research and application interests. But improvements are still required to provide higher data-rate links, for instance, the transmission of video signals. Therefore, ultra-wideband (UWB) communication systems are currently under investigation and the design of a compact wideband antenna to overcome the narrow bandwidth limitation of microstrip antennas.

The Federal Communication Commission (FCC)'s allocation of the frequency band 3.1–10.6 GHz [1] for commercial use has a sparked attention on ultra wideband (UWB) antenna technology in the industry and academia. [2] [3].

After recognizing the potential advantages of UWB, the FCC developed a report to allow UWB as a communications and imaging technology. A UWB definition was designed as a signal with a fractional bandwidth greater than 0.2 or which engaged more than 500 MHz of spectrum. The fractional bandwidth [1] is defined as

$$2*\frac{(fH-fL)}{(fH+fL)}$$

Where f_H and f_L are the upper and lower frequencies respectively measured at -10 dB below the peak value. The comparison of different wireless systems is shown in figure1.

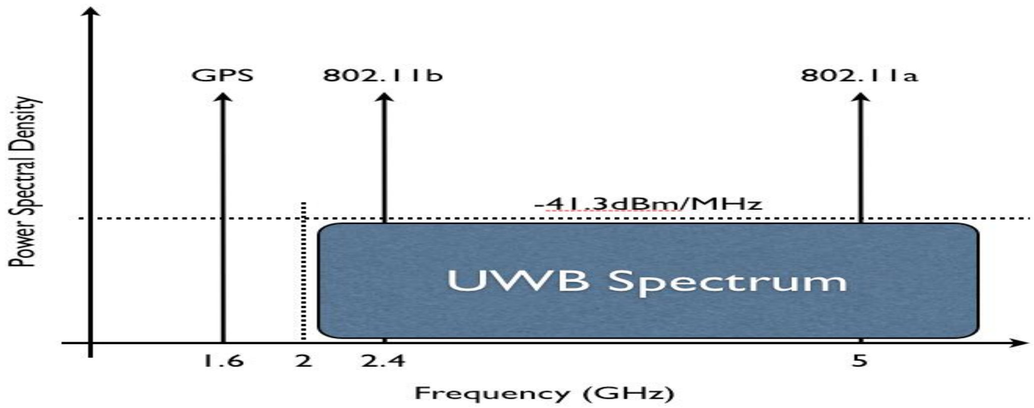

Figure 1: Comparison of Different Wireless Communication Systems in the Frequency Domain [1]

1.1 Advantages of UWB

1. **Power Consumption:** The Federal Communications Commission power requirement for UWB systems is -41.3dBm/MHz (75nW/MHz). It uses 1/1000 of the power required for equivalent conventional transmission methods.
2. **High Security:** Because of their low average transmission power, Systems offering UWB communication have an inherent immunity to detection and interception. The time modulation of exceedingly narrow pulses adds security to UWB transmissions.
3. **Resistance to Interference:** UWB signals are therefore relatively resistant to intentional and unintentional jamming.
4. **High Performance in Multipath Channels:** It reduces Multipath Fading**.**
5. **Strong Penetration Ability:** UWB signals penetrate through the walls and make through the wall communication possible.

The key requirements for UWB antennas that should be considered are :

1. The bandwidth specified by the FCC is 7.5GHz (3.1 to 10.6 GHz).
2. Secondly group delay for UWB antenna must be in 10ns range.
3. Radiation Pattern should be Omni-directional with constant gain
4. Antenna should be compact in size, planar, cheap and low profile.

5. VSWR should be less than two (2) across the whole band of operation so as to maintain good matching and efficient operation.[4]

II. LITERATURE REVIEW

As we know the several design methods and structures have been reported. UWB antenna designs with filtering property or band notch characteristics have been proposed not only to mitigate the potential interferences but also to remove the requirement of an extra band stop filter in the system.

Mike W. K. Lee et.al. (2015) proposed a wideband dual-polarized two-layer patch antenna using the 4-C shaped slot structure and T-shaped probe feeding. The novelty of the antenna is that a T-square stub feed is providing an extra resonance which is increasing the bandwidth. The antenna is miniaturized to size but with excellent port isolation. The T-probes used to feed the 4-C slot-cut patches widen the bandwidth. [5]

Yingsong Li et.al. (2014) presented multi-function circular wide-slot configurable UWB antenna which can be used as a dual band-notched UWB antenna, a single band notched UWB antenna, a UWB antenna, or even as a multi-band antenna. The frequency band-notched characteristics is achieved by using a stepped impedance resonator (SIR) and an arc-shaped parasitic element (ASPE), and the multi-function design is attained by the use of four switches. [6

QiangWang & Yan Zhang (2014) presented UWB band notched antenna for the Frequency bands of 3.3–3.7GHz (Wimax) and 5.15–5.35GHz (WLAN) and in 7.25–7.75GHz (X Band Satellite Communication). They Introduced modified ground with two fillets and three steps to produce smooth transition from one resonant Frequency to another. two arc shaped slots were etched in the radiation patch which notched bands of 3.3–3.7 GHz and 5.15–5.35 GHz. A U-shaped slot in the ground plane generated the third notched band in 7.25–7.75GHz for the X-band satellite communication systems. [7]

Sai K. Venkata et. al.(2014) proposed an UWB Band Notched antenna by etching two round shape slots in radiating patch the at WiMax band (3.3-3.7 GHz) and WLAN band (5.15-5.875 GHz). They introduced a a pair of rotated V-shape slot are etched on the ground plane to realize notch band at X-band downlink satellite communication band (7.1-7.76 GHz). [8]

M. N. Shakib et.al.(2014) proposed a compact planar Tuning Fork-shaped notched UWB antenna for 5.28–6.97GHz (WiMAX, WLAN, and C-band).. The bandwidth of the proposed antenna is increased by using rectangular radiating patch and an arc shaped strip in between radiating patch and feed line. [9]

Ronghua Shi et.al. (2014) presented a novel dual band notched UWB antenna. The band rejection is achieved by an arc H-shaped slot on the radiating patch. By varying the parameters of these slots band notched at 3.3–3.6 GHz for WiMAX and 5.1–5.9 GHz for WLAN is achieved. [10]

Tzu-Chun Tang & Ken-Huang Lin (2014) proposed a dual band notched UWB antenna. In the presented antenna the radiation patch is connected to conduction strip on the other side of patch with avia hole which is providing a coupling path as well as dual band rejection at WiMAX (3.4–3.7 GHz) and WLAN (5.15–5.35 and 5.725–5.825 GHz) frequency bands. [11]

M. Ojaroudi et al. (2013) proposed a small, printed UWB monopole antenna with dual notch band characteristics at 5.2-5.8 GHz (WLAN), 3.5-5.5 GHz (WiMAX) , and 4-GHz C-bands. An inverted fork-shaped slit etched out on the ground plane which provides and an additional resonance which provides a wide impedance bandwidth. Dual notch band characteristics, were achieved using a coupled inverted U-ring strip in the radiating patch. [12]

M. Moghadasi et al. (2013) proposed a small dual-band coplanar waveguide (CPW)-fed antenna. The proposed antenna is a rectangular patch that is surrounded by upper and lower ground-plane sections that are interconnected by a high-impedance microstrip line. [13]

A. H. Shah et al. (2013) presented A Tri-band G-shaped Microstrip Monopole antenna. The proposed antenna is fed with CPW waveguide and the parameters have been optimized to obtain the resonant modes at 2.4 GHz, 4.2 GHz, and 6.07 GHz as the centre frequencies of the said three frequency bands. [14]

Zheng Guo et.al .(2013) proposed methods of bandwidth enhancement in UWB Antennas tion. The original antenna covers the frequency range of 1.73GHz –11 GHz ie. bandwidth of 9.27 GHz. By cutting two new slots on the ground plane, bandwidth is expanded to 9.33 GHz (1.67–11 GHz) and by the use of conventional mushroom-type electromagnetic band-gap enhances the bandwidth to 9.47 GHz (1.53–11 GHz) with the extra GPS covered. [15]

Mubarak Sani Ellis et.al. (2013) presented a small band-notched wing shaped monopole ultrawideband (UWB) antenna covering 5–15 GHz with a notched band of 6.7–7.1GHz which is is achieved by attaching a strip to the hollow center of a wing-shaped monopole. [16]

Fuguo Zhu et.al. (2013) proposed, four novel coplanar waveguide (CPW)-fed consisting of half-circle shaped patch with an open rectangular slot and a half-circle shaped ground plane. The proposed designs can reject the frequency bands in 3.3–3.6 GHz, 5.15–5.35 GHz or 5.725–5.825 GHz without using an additional band-stop filter. [17]

Jian-Feng Li et.al. (2013) proposed compact dual band-notched ultra-wideband (UWB) multiple-input multiple-output (MIMO) antenna at 5.15 to 5.85 GHz and 3.30–3.70 GHz with high isolation. The two protruded ground parts are connected by a compact metal strip to reduce the mutual coupling for the band of 3.0–4.0 GHz. and the measured results show a bandwidth with ranged from 3.0 to 11.0 GHz excluding the two rejected bands. [18]

H. F. Abutarboush et al (2012) proposed a U-slot tri-band monopole antenna on a low- cost paper substrate using inkjet-printed technology. The U- shaped slot is designed to enhance the bandwidth and to achieve tri-band operating resonant modes at 1.57, 3.2, and 5 GHz with measured impedance bandwidths of 3.21%, 28.1%, and 36%, respectively. [19]

Ali Foudazi et.al.(2012) presented small-size planar UWB antenna with extended frequency band covering GPS/GSM/WLAN i.e. frequency bands of 1.3 GHz, 1.8 GHz and 2.4 GHz . The proposed antenna is a microstrip-fed multi-band planar diamond-shaped patch monopole antenna that covers the ultrawideband (UWB) i.e. from 3.1-10.6 GHz. Several narrow strips, acting as resonance paths, are integrated with the antenna gives the multiband design. It is also shown that by removing the centre part of the antenna, without distorting the UWB behavior, quarter-wavelength strips are added to the notched region. [20]

S.Theepak & Sachendra Sinha (2012) proposed dual band notched UWB monopole with Coplanar wave Guide (CPW) feed. The presented antenna covers the entire UWB range of 3.1 GHz to 10.6 GHz with notched band at 5.2GHz and 5.8 GHz. This double band notching technique has been introduced by reducing the mutual coupling between the notch filter in the patch and in the ground plane antenna by combining two traditional techniques. [21]

Seyed Ramin Emadian et.al. (2012) proposed a single-layer printed circle like slot antenna with dual band notch characterstics for ultrawideband (UWB) applications. The presented antenna antenna consists of a circle-like slot, a trident-shaped feed line, and two nested C-shaped stubs. By using such a feed line, much wider impedance bandwidth is obtained. Two frequency band-notches of 5.1–6.2GHz (WLAN) and 3–3.8 GHz (WiMAX) are achieved by inserting a pair of nested C-shaped stubs on the back surface of the substrate. [22]

Bing Li et.al. (2012) proposed a dual band switched antenna that for the WLAN frequency bands (2.4–2.485, 5.15–5.35, and 5.725–5.825 GHz) and with the band-notched characteristics i.e. the stop band for the frequency band of 5.15 to 5.825 GHz. The presented antenna is composed of a rectangular ring slot, four switches, a coplanar waveguide (CPW) feeding line, a T-shaped stub, and two inverted S-shaped slots. [23]

M. Koohestani et al. (2011) presented a microstrip-fed planar monopole antenna for ultra-wideband (UWB) systems. The antenna structure consists of a dome-topped, bowl-shaped patch and a truncated ground plane structure. The ground plane is tapered and has a notch below the feed-line in the vicinity of the patch. [24].

S. Jing et al. (2011) presented dual-band E-shaped monopole antenna for 2.4 and 5.2GHz bands. Dual band characteristics are obtained by adding two L-shaped stubs to a traditional monopole antenna. The feed to the antenna is done by coplanar waveguide. [25]

J. H. Yoon et al. (2011) proposed dual-band planar monopole antenna which effectively covers both the 2.4GHz and 5.2/5.8 GHz bands. The designed antenna consists of two branches, an asymmetric ground plane, a rectangular projection strip, and a rectangular slit in the ground plane. The rectangular projection strip and the rectangular slit in the ground plane were introduced to enhance the performance of the proposed antenna. [26].

Zhi-An Zheng et.al. (2011) proposed two band-notched UWB compact slot antenna. A Z-shaped slot and a split rectangle ring slot were etched nearby the slot radiator in the ground plane, respectively. Both of them can achieve a notched band in frequency range from 5.15–5.825 GHz, and the notched band can be adjusted easily by varying the width and length of the slot. [27]

S.Lin et al. (2010) proposed a new dual frequency microstrip antenna which has two operating modes. The presented antenna has two different length monopoles, out of which the larger monopole work for first resonant mode and shorter monopole for the second mode and by etching rectangular slot in larger monopole a broadband dual frequency operation was demonstrated and it cover the two frequency band 1.9 GHz to 2.2GHz and 2.2GHz to 2.8GHz.[28].

L.Y. Cai et al. (2010) presented a compact triple band antenna using two U-type slot antenna which are very effective in rejecting unwanted frequency in term of its selectivity. This antenna gives bidirectional pattern in the E-plane and omni directional radiation pattern in H-plane over the frequency range and relatively stable. This antenna offer excellent performance for Bluetooth, WiMAX and WLAN Frequency Bands [29].

K. Fuqiang et al. (2010) discussed on a triple-band microstrip antenna for WLAN application is made up of quarter wavelength resonating component operating at 2.5GHz and 4.8GHz with the bandwidth of about 500MHz and 2.63GHz covering the triple band of WLAN system. [30]

B. Vedaprabhu et al. (2010) proposed a patch antenna with two U-shaped slots to achieve dual band operation. The design of a microstrip patch antenna is done to operate for multiple wireless bands with frequency ranges of 1.7-2.2GHz, 2.4-2.5GHz, 5.15-5.35GHz, and 5.45-5.85GHz. [31]

K. Dong et al. (2010) proposed a compact dual-band planar monopole antenna for 2.4/5GHz . The two resonant Frequency modes of the presented antenna are associated with four slots which contribute to the upper resonant frequency and can reduce the size of the lower resonant length. [32]

Wei Hu et.al.(2010) proposed an dual band notched ultra-wideband antenna The antenna is based on the rectangle planar monopole structure By modifying the radiation patch to octagon and etching out two T -shaped slots from the octagonal patch, the dual band-notched characteristic is achieved around3.5GHz and 5.8GHz. [33]

L. Xie et.al.(2010) presented a compact Ultrawideband (UWB) monopole antenna with a dual band-notched characteristic at 3.5GHz and 5.25GHz. by the use of two meandered slots with the impedance bandwidth is 8.5 GHz (2.5-11 GHz). [34]

III. CONCLUSION

In this paper, we have reviewed multiple types of UWB antennas covering whole impedance bandwidth i.e. from 3.1 GHz to 10.6 GHz as well as we have also observed multiple techniques for band notch designs. In wireless communication technology UWB is growing rapidly due to its high data rate. We have also observed about the applications of the UWB its time domain analysis and practical applications. The Challenges of the feasible UWB antenna design include the UWB performances of the impedance matching and radiation stability, the compact impression of the antenna size, and the low manufacturing cost for customer electronics applications.UWB antennas show great potential with the rapid growth and developments of wireless communication technology that we will be witnessing tomorrow.

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