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Design and Fabrication of Ultra Wide Band Antenna With Band Notching Property: A Review

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Abstract - *This work provide a review on, a microstrip feed line antenna with defected ground plane for ultra-wide band (UWB) application is presented. Insertion of defected ground plane just beneath the radiating patch, results in UWB characteristics. A big challenge in the design of a UWB antenna is to avoid the interference from narrow band systems like WLAN operating in the environment so that UWB technology can be operated in parallel with other existing systems. To solve this problem the UWB antennas one should have band notching properties for the minimization of the interference from other active environment. DGS affects the current distribution and hence antenna performance parameters, therefore in order to achieve band notching at WLAN frequency, a patch antenna with defected ground structure just beneath the radiating patch is designed using HFSS 13.*

***Key Words*: UWB, Microstrip Feeding, Band Notching.**

1.INTRODUCTION

Antennas are a very important component of communication systems. By definition, an antenna is a device used to transform an RF signal, traveling on a conductor, into an electromagnetic wave in free space. Antennas demonstrate a property known as reciprocity, which means that an antenna will maintain the same characteristics regardless if it is transmitting or receiving. Most antennas are resonant devices, which operate efficiently over a relatively narrow frequency band. An antenna must be tuned to the same frequency band of the radio system to which it is connected, otherwise the reception and the transmission will be impaired. When a signal is fed into an antenna, the antenna will emit radiation distributed in space in a certain way. A graphical representation of the relative distribution of the radiated power in space is called a radiation pattern.

UWB (Ultra Wide-Band) is a radio correspondence innovation that utilizations low vitality beats and it is planned for short-run cum-high-transfer speed interchanges by utilizing an enormous piece of the radio range (in GHz Range). UWB interchanges transmit in a way that doesn't meddle with other customary thin groups and persistent bearer wave frameworks working in a similar recurrence band. UWB is a Very High-speed contrasting option to the current remote advances, for example, WLAN, Hyper LAN.

A February 14, 2002 Report and Order by the FCC (Federal Communication Commission) approved the unlicensed utilization of UWB in the scope of 3.1to10.6GHz for commercial applications [1].

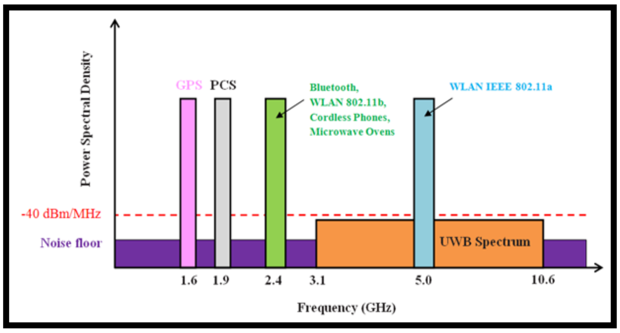

FIGURE1:UWB Spectrum[1]

2. RELATED WORK

Broad banding of antenna can be done by using different feeding techniques, by varying patch geometry, by changing substrate property, by changing ground structure [8]. In Literature many such techniques have been discussed so far and some of them are categorized according to these varying geometries as given below:

Various geometries of antennas in which slotting and cutting patch in different shapes results in UWB characteristics have been studied in past and some papers using different geometries and shapes of patch are given below:

There are many metal monopole antennas with optimized structures was studied in past such as trapezium monopole antennas, antennas with an offset feed, combining the shorting post and beveling technique [8].

S.Y Suh, J.D. Karus, and X.F. Bai were proposed antenna composed of a single flat element vertically mounted above a ground plane which not only presents structures but also provides an impedance bandwidth ratio of more than 10:1 and radiation bandwidth of 3:1.Even greater bandwidth was achieved by adding two circular holes in the PICA element which providing good omni-directional performance over a bandwidth up to 7:1 due to effective change of its surface current. Another leaf shaped plate monopole antenna with three circular holes was proposed which is vertically mounted on the ground plate covered by a dielectric plate instead of conventional metal plate and it obtains impedance bandwidth of 22:1 covering frequency range from 1.3 to 29.7 GHz [9, 10, 11].

Katsuki Kiminami was proposed an antenna is used in UWB applications for linear phase and flat gain. Patch is etched in form of bow tie. The frequency band considered is (3.1–10.6 GHz) as governed by FCC i.e. Federal Communications Commission as a commercial UWB band. Return loss is about -16 dB and quasi-omni directional pattern is obtained [12].

Zengrui Li was proposed a microstrip wide slot antenna with band notching property for Ultra-Wide band application. The proposed antenna is with an E-shaped radiation patch and is fed by Microstrip line. The finite difference time domain method is used to analyze and the results of the FDTD are found to be in agreement with the experimental results. The antenna shows a low return loss within the UWB frequency band, excepting for the notched band from 4.98 to 5.57 GHz which is assigned to the WLAN systems. A very wide impedance bandwidth of about 9.5 GHz (defined by return loss less than -7.5dB) has been achieved, and at the same time, a notched band from 4.97 to 5.57 GHz occurs [13].

Chien Dao-Ngoc was proposed a printed monopole antenna consists of a rectangular radiating patch and a gradual transformer, is fed by a co-planar waveguide which supports a quasi-TEM mode of propagation with low dispersion was reported. There are three main reasons for making use of CPW for feeding antennas. First, it simplifies fabrication and is easily integrated with active devices in the same side of the planar substrate; second, it reduces radiation loss; and third the quasi-TEM mode of propagation on CPW has low dispersion and hence offers the potential to construct wide-band feeding configuration. For impedance matching between CPW and the radiating patch, a gradual transformer with two steps is used for connecting them.The antenna is then modified to possess band rejection at the wireless local area network (WLAN) (5.1-5.8 GHz) frequency band by etching a pair of slots within the radiating patch. In principle, the slots are designed to resonate at WLAN frequency band, acting as a band-stop filter. The modified antenna has been obtained to possess band rejection at the wireless local area network (5.1-5.8 GHz) frequency band by etching a pair of slots within the radiating patch. The results have been shown that the length of slots controls the center of rejected frequency band while its width makes effects to the rejected bandwidth [14].

Fatma Zengin, Eren Akkayahe was proposed an Ultra Wide-Band implant antenna for biotelemetry systems by and small size implantable antenna involving Industrial, Scientific and Medical(ISM) (2.4 GHz-2.48 GHz) band was obtained.The goal of designing antenna is to obtain physiological information pertaining to person. Firstly, the parameters of the antenna are calculated and numerical models for the first design were produced in the frequency range. In the first case, the antenna is in air, and then the antenna has been analyzed according to the functionality in human skin tissue. Some gels are used to verify results. VSWR Less than 2 and return loss of -25 dB is obtained [15].

J Liang, Choo C were proposed an antenna which possesses the features such as light weight, low cost, and eases of fabrication. However, it provides the impedance bandwidth ratio only about 3.52, with the frequency range from 2.78 to 9.78 GHz [16].

Cheng Hsing was presented to broaden the impedance bandwidth, providing an impedance bandwidth ratio about 5:1 (3.06to 15 GHz) [17].

The ground structure can be etched to make a broad band antenna by reducing the parasitic effect in ground plane. This technique can be categorized as defected ground structure i.e. DGS. The work done by various researchers for broad banding the antenna by producing defects in ground structure are explained below:

Yu- Zhan Li was proposed a compact CPW-Fed elliptical slot UWB antenna with dual band notched features .A elliptical slot is cut on ground and similar stub is made on metal plate. Two band notches at 3.3 to 3.7GHz and 3.7 to 4.2GHz and 5 to 6 GHz for WiMax, C band and WLAN has been proposed in this paper. Impedance between of 3.38 and return loss less than -10 dB is achieved [19].

Li Zhiyong was proposed a novel miniature UWB Microstrip-fed antenna with L-shape ground. The proposed antenna is operated over 3.3 to 12 GHz for return loss of -30 dB and relative bandwidth is over 120% and impedance bandwidth is about 3.63[20].

Pradeep Kumar was proposed an antenna with DGS for UWB applications. Impedance bandwidth is 3.38 and center frequency is 6.9GHz.This antenna exhibits radiation pattern <2dBi gain for entire bandwidth [21].

Xian Ling Liang proposed an antenna which is CPW-fed hollowed elliptical printed monopole antenna with a measured impedance bandwidth from 0.44 to 10.6 GHz (24.1:1) for VSWR 2 [22].

Antonino-Daviu E, Cabedo-Fabres M, Kim,Taeyeoul Yoon were proposed different ways of feeding the antenna it can be single feed or double feed or trident feed. Single feed is the simplest feed used so far. There can be different shape of feeding line; it can be tapered feed, slotted feed using resonators. Other way is by using double feed which aims to intense the vertical current distribution and suppress the horizontal distribution in the square planar monopole, which contributes to improvement in the impedance bandwidth and polarization properties [24, 25].

Jeongpyo Kim was proposed an Ultra wide-band printed monopole antenna using FDTD and Genetic Algorithm. This ultra-wide-band (UWB) antenna was fed by a coplanar waveguide (CPW) line. The measured frequency response shows good impedance bandwidth and VSWR less than 2 [26].

Zhi Ning Chen was proposed an antenna consists of a patch radiator with two phase-reversed auxiliary radiators. This technique allows the beam-width of a microstrip antenna with a large a spectator to be broadened at the expense of a slight increase in its lateralize. The two L-shape auxiliary radiating elements are connected to the feeding microstrip line for broadening the beam width. More significantly, with the same achieved gain, the proposed antenna has achieved a wider beam width as shown [27]

Yuan Yao was proposed microstrip-line fed wide-slot antenna. The antenna consists of slotted patch geometry and tapered feed microstrip line. The band-notched operation was achieved by using a U-slot in the circular Microstrip patch. Results clearly indicate that an UWB bandwidth (defined by) covering 3.1-10.6 GHz was obtained for the reference antenna and notched band for WLAN was obtained [28].

Y.F Weng proposed a design of multiple band-notch using meander lines for compact ultra-wide band antennas. The proposed antenna consists of an elliptical radiator, a microstrip-feed line and a ground plane. The direct connected feed are just open-circuit stubs. The parallel coupled feed have an open circuit at one end and a short circuit to the ground through a vial at the other end. Without increasing the antenna size, four MLs are etched on the antenna to generate four notches. Simulation results have been shown in that the bandwidths and center frequencies of the notches can be controlled independently by using dimensions of the MLs. The antenna has approximately omni directional radiation patterns with good band-notched characteristic. At the notch frequencies of 3.14, 4.34, 5.4 and 6.4 GHz, the measured gains are suppressed to 25.4, 24.1 and 23.7 and 22.5 dBi, respectively, with the corresponding efficiencies substantially reduced to 13.2, 24.5, 26.8 and35.4% [29].

The first step in designing an antenna is to choose an appropriate substrate. The substrate in microstrip antenna is principally needed for the mechanical support of antenna metallization. To provide this support the substrate needs to consist of a dielectric material which may affect the electrical performance of the antenna, circuits, and transmission line. A substrate must therefore simultaneously satisfy the electrical and mechanical requirements which are sometimes difficult to meet substrate choice and evaluation are essential part of design procedure. Many substrate properties need to be considered such as the dielectric constant and tangent loss and their variation with temperature and frequency, thermal coefficient, and temperature range, humidity, thickness uniformity of substrate are all of importance. Comparisons of different substrate in made in design and fabrication of 8- element high gain microstrip patch antenna and it is found that substrate with low dielectric are essentially important for broad banding of antenna [30].

3. DESIGN OF UWB ANTENNA

UWB antenna should be designed with Compact size while providing acceptable: VSWR, Bandwidth, Gain, Efficiency, Omni-directional pattern, to be suitable for on chip design, Easy impedance matching, Lightweight, Low cost. Therefore, the UWB antenna design remains to be the major face in the progress of UWB technology. UWB antenna should be designed keeping in mind the various parameters such as frequency of operation, substrate height, dielectric constant to be used. In this thesis roger 4003 dielectric 3.55 thickness 1.524has been used as substrate. UWB can be designed using by using different feeding techniques, by varying patch geometry, by changing substrate property, by changing ground structure. These are discussed below:

- By varying Patch Geometry.
- By varying feeding structure.
- By changing Substrate property.
- By slotting ground structure.

1-By varying Patch Geometry

Various monopoles patch structures have been studied in past and Printed circular monopole is one of the simplest with omni directional radiation properties. Other geometries are step rectangular in which steps are slotted from original patch structure with impedance bandwidth of 3.8:1 same as circular, two circular and octagon geometry. Spline shaped, U-shaped, Knight's helm patch geometries have been studied in past few years for broad banding and good impedance bandwidth have been achieved so far.

2-By varying feeding structure and stub

There are different ways of feeding the antenna it can be single feed or double feed. Single feed is the simplest feed used so far. There can be different shape of feeding line; it can be tapered feed, slotted feed using resonators. Other way is by using double feed which aimsto intense the vertical current distribution and suppress the horizontal distribution in the square planar monopole, which contributes to improvement in the impedance bandwidth and polarization properties [4].

3-By Changing Substrate Property

In my thesis roger 4003 dielectric 3.55 thickness 1.524is used as substrate with height 1.524mm and dielectric constant of 3.55.

Why Roger 4003 is used?

Roger 4003 is a grade designation assigned to glass-reinforced epoxy laminate sheets, tubes, rods and printed circuit boards (PCB). Roger 4003 is a composite material composed of woven fiber, glass, cloth with an epoxy resin binder that is flame resistant (self- extinguishing).Roger 4003 glass epoxy is a popular and versatile high-pressure thermo set plastic laminate grade with good strength to weight ratios. With near zero water absorption, roger 4003 is most commonly used as an electrical insulator possessing considerable mechanical strength. The material is known to retain its high mechanical values and electrical insulating qualities in both dry and humid conditions.

4- By Slotting Ground Structure

The ground structure can be etched to make a broad band antenna. This technique can be categorized as Defected Ground structure i.e. DGS. In this thesis DGS in the Ground has been etched to achieve UWB characteristics. Using DGS it improves the gain, reduces the reflection coefficient, good impedance match, improvement in the bandwidth.

5-Band Notching Property

There are different services which share the same band with UWB. This may cause interference between the UWB system and other existing system .To overcome this problem we use the Filter to notch out that particular band. But use of filter increases complexity of UWB system and also insertion loss, weight and size for UWB Trans-receiver.

So the better option is to use the UWB antenna with band notching or filtering property to overcome the electromagnetic interference. Different band notched techniques are given on the next page:

- Embedded slots on patch and ground
- Parasitic Stubs/strips
- Band stop Transmission line
- Hybrid techniques such as feed line slots.

The band notching can be done using above approaches other than these band notches can be made by cutting the slots on radiating element and inserting a slip on the patch. This can also be done by embedding a certain length turning stub within a large slot on the patch. Putting a parasitic element near the printed monopole and introducing a parasitic open circuit element can also result to band notch. The band above-10dB is considered to notch and return loss over the other part of band must be less than-10dB for good signal.

4. PROPSED WORK

In this paper, we proposed the Ultra Wide Band (UWB) fed rectangular patch antenna with DGS (Defected Ground Structure) is designed with the micostrip feeding techniques. Various UWB antenna simulations was carried out to reduce overall antenna size, improve bandwidth and to achieve UWB characteristics with desired band notching and performance comparison is made to evaluate antenna characteristics like bandwidth, return loss; radiation pattern (Gain, Directivity) and voltage standing wave ratio (VSWR). In this proposed antenna U,W,B slots are made in patch. To investigate the impact of the "U", "W" and "B" slots in the proposed design, parametric analysis was carried out. This involved varying the position, length of ground to obtain the best match. Parametric was carried out for different ground length for return loss characterizes. Parametric was carried out for different ground length for return loss characterizes and it was found at length 14.5(etch part) mm, characteristics was best matched.

5. CONCLUSION

Today researcher's interest in the area of UWB technology has been increased due to many advantages such as high data rate, highly secure and immune towards multipath communication. In this paper, a microstrip feed antenna with defected ground plane for UWB application is presented. UWB characteristic has been observed by making slot in the patch.

Result, also shows band notching property therefore, the proposed antenna overcomes the signal interference problem with existing WLAN. An equivalent circuit is modeled to verify the band notching and return loss of antenna. The simulation of radiation characteristics of the designed antenna are in good agreement with each other, and therefore can be suitably used for UWB application in WLAN environments.

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