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Research Paper

DESIGN AND DEVELOPMENT OF SMALL SIZE ANTENNA FOR UWB APPLICATION

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ABSTRACT

This paper introduces antenna designs for Ultra Wideband 3.1-10.6 GHz communications. The inherent potential of UWB systems and techniques for use in communication was demonstrated in various ways by many researchers in the past. An effort made in the direction of utilizing the entire wideband spectrum is presented through this paper. The antenna exhibits a -10 dB return loss bandwidth over the entire frequency ban. [1].The antenna is designed on FR4 substrate. The proposed antenna designs and performances are analyzed using Ansoft High Frequency structure Simulator (HFSS).

KEYWORDS return loss, Antenna design, broadband wireless communication, and ultra-wideband antenna.

I NTRODUCTION

Most of the existing systems permit narrowband operations since they cover only a fraction of the entire spectrum. Narrowband systems concentrate all of their power in fairly narrow channels. Due to the narrow bandwidth it is not possible to achieve high speed and high data rates to carry out communication [1]. The possible remedy is the use wide bandwidth. The word ‘ultra-wideband’ (UWB) commonly refers to signals or systems that have large bandwidths. Ultra Wideband is defined as any communication technology that occupies greater than 500 MHz of bandwidth, or greater than 25% of the operating centre frequency. Such large bandwidth offers advantage with respect to signal robustness, information content and/or implementation Simplicity.

Although the research in UWB radio and Communication gained significant momentum in late 1999[2], this technology dates back to more than a century. Electromagnetic communication actually started with UWB. In the late 1800s, the easiest way of generating an EM signal was to generate a short pulse: a spark-gap generator was used by Hertz in his experiments and by Marconi for the first EM data communication. Thus, the first practical UWB systems are really more than 100 years old [1]. However, after 1910, the general interest turned to narrowband communications and UWB research fell dormant. Ultra-wideband communication received renewed interest in the early 1970s. At that time it was called ‘baseband’ or ‘carrier-free’ communication. Around 1973, it was recognized that short pulses, which spread the signal over a large spectrum, are not significantly affected by the existing narrowband interferers, and do not interfere with them, either limited mostly to the military sector.

Frequency regulators all over the world assign narrow frequency bands to specific services and/or operators. UWB systems violate these frequency assignments as they emit radiation over a large frequency range, including the bands that have already been assigned to other services. A major concern for the frequency regulators was that the emissions from UWB devices would interfere with the other services [7]. The Federal Communications Commission (FCC) finally allocated

The 3.1-10.6 GHz spectrum used for Ultra Wideband (UWB) radio applications, in February 2002. This momentum shift presented a myriad of exciting opportunities and challenges for design in the communication arena, including antenna design [3]. Recognizing this trend early on, the Institute of Electrical and Electronics Engineers (IEEE) established a working group (IEEE 802.15.3a) with a task of standardizing a physical layer for high throughput wireless communications based on UWB. Thus, began a new era in the ultra-wideband communication.

Ultra Wideband: The Evolution Traditionally, the FCC has favored narrowband radios, which concentrate all of their power in fairly narrow channels within the radio frequency spectrum. However, as the number of users sharing the spectrum was increased, the number of available channels became limited [1]. Shannon, in 1948, offered a new paradigm, redefining the relationship among power density, noise, and information capacity. Shannon said that under certain specific conditions, the more an information signal is spread in bandwidth, the more information it is capable of holding [5]. Because one signal spread in this way resembles noise to another signal that is similarly spread, both can coexist.

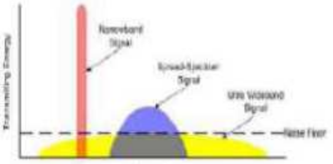

Fig.1Frequency Versus transmission energy representation of various signals

Hence, an alternative to transmitting a signal with a high power density and low bandwidth would be to use a low power density and a wide bandwidth. Shannon’s observations led to “spread-spectrum” modulation in which the signals are intentionally spread to many times their original information bandwidth [2].

Scientists, over the years have worked to develop various techniques for sending and receiving short impulse signals between antennas. Impulses are short time signals – the shorter the impulse, the wider its bandwidth. These experiments led to the development of “impulse radio,” later dubbed as UWB radio. The practicality of modern low-power impulse radio techniques for communications and positioning/location was demonstrated by Fullerton and later by Fleming using UWB spread-spectrum impulse techniques. Since the United States Federal Communications Commission (FCC) adopted the first UWB Report and Order on February 14, 2002, the interest in UWB technology has increased substantially in both academics and the market place. Interest is stimulated by the expectation that UWB can solve the shortage of the available frequency resources. UWB also represents potential for higher data throughput.[5]

Ultra Wideband Radio is a potentially revolutionary approach to wireless communication where it transmits and receives pulse based waveforms compressed in time rather than sinusoidal waveforms compressed in frequency. This enables transmission over a wide range of frequencies. The UWB spectral mask was defined to allow a spectral density of -41.3 dBm/MHz throughout the UWB frequency band [7]. Operation at such a wide bandwidth involves lower power that enables peaceful coexistence with narrowband systems.

There are many issues involved in designing UWB systems, such as antenna design, interference, propagation and channel effects, and modulation methods. Designing the UWB antenna can be one of the most challenging of these issues. The main challenge in UWB antenna design is achieving the wide impedance bandwidth while still maintaining high radiation efficiency. Spanning 7.5 GHz, almost a decade of frequency, this bandwidth goes beyond the typical definition of a wideband antenna [14]. The goal is to achieve wide impedance bandwidth while still maintaining high radiation efficiency. Successful transmission and reception of an Ultra Wideband requires an antenna that

- ✓ covers an extremely wide band, (3.1 GHz to 10.6GHz) for the indoor and handheld UWB applications
- ✓ has high radiation efficiency
- ✓ has linear phase
- ✓ offers low dispersion
- ✓ has a VSWR _ 2 throughout the entire band
- ✓ has minimum power loss due to dielectric and Conductor losses
- ✓ has electrically small size
- ✓ holds a reasonable impedance match over the Band for high efficiency
- ✓ has a non-dispersive characteristic in time and Frequency, to provide narrow pulse duration to
- ✓ Enhance a high data throughput [7]

II REVIEW OF THE STATE-OF-ART

The UWB technology has undergone remarkable achievements during the past few years. In spite of all the promising prospects featured by UWB, there are still challenges 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. The objective is to design and evaluate performance a compact sized antenna that operates in ultra-wideband range[10]. Several factors need to be considered while designing the antenna, including bandwidth, directivity, polarization, power gain, radiation pattern and return loss. The whole project can be divided in two parts – antenna simulation and measurement. The software HFSS would be used to simulate the proposed antenna. The simulated results would then be compared with the measured results of the practically fabricated antenna

III ANTENNA GEOMETRY:

CIRCULAR RING ANTENNA

The geometry and parameters of the circular ring antenna are shown in Fig. 2. The antenna is supported by a dielectric substrate of a height equal to and a relative dielectric constant of 4.4 and dielectric loss tangent equal to 0.02. This UWB antenna has a structure similar to the microstrip patch antenna, it consists of three layers: the top is a radiator; the middle is a substrate with dielectric constant; the bottom is an etched ground plane. This type of antenna can easily be integrated into system circuits for a compact design and fabricated at a very low manufacturing cost. This antenna is optimized to cover UWB Bandwidth and to miniaturize the antenna size .The feed line is 3.5-mm wide for a characteristic impedance of 50 ohms The patch is a circular with radius 9 mm. The rectangular part of the ground plane is 25mm×5mm. The result have been shown with the effect of ground plane keeping the operating frequency same.

In S11 Parameter plot, Fig (i) has operating frequency of 7 GHz with ground plane along Y-axis is 5mm for which the simulated result is below -10 db for complete band.but in Fig. (ii) and Fig.(iii) as the ground plane changes the simulated result below -10 db is not for complete band. In VSWR Parameter, Fig. (iv) shows VSWR 1 at 5GHz, VSWR 0 for 7 GHz .Approximately VSWR is less than 2 for complete band. In Fig. (v) and Fig. (vi),VSWR Changes with the change in ground plane.

In Radiation Pattern, Fig (vii), shows the simulated result in which 0 db gain is obtained at 7GHz. In Fig.(viii) and Fig.(ix) simulated result obtained is not desirable.

With ground plane along plane y-axis= 5mm, 7mm, 3mm respectively Operating frequency =7GHz

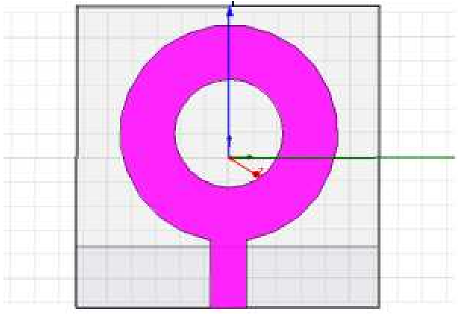

Fig. 2 Circular Ring Antenna

IV SIMULATED RESULT

A) S11 PARAMETER

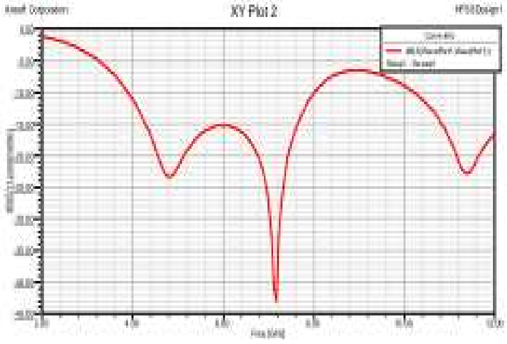

Fig.(i):s11 parameter with ground plane 5mm

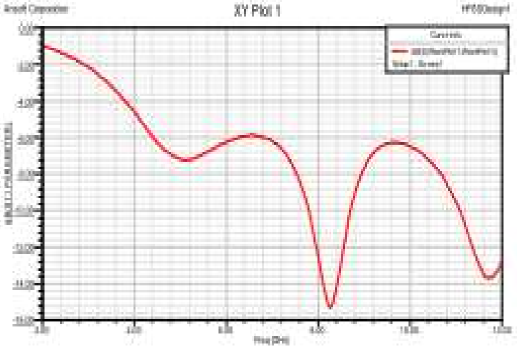

Fig.(ii): s11 parameter with ground plane 7mm

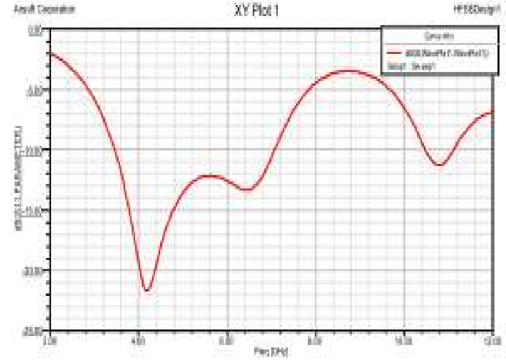

Fig.(iii): s11 parameter with ground plane 3mm

B) VSWR

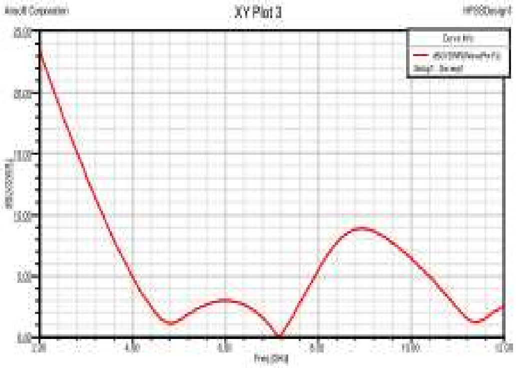

Fig.(iv): VSWR parameter with ground plane5mm

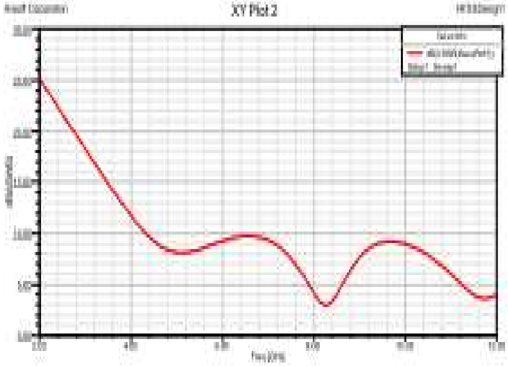

Fig.(v): VSWR with ground plane 3mm

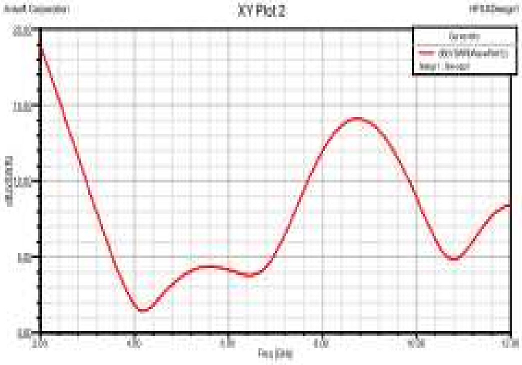

Fig.(vi): VSWR with ground plane 3mm

C) RADIATION PATTERN

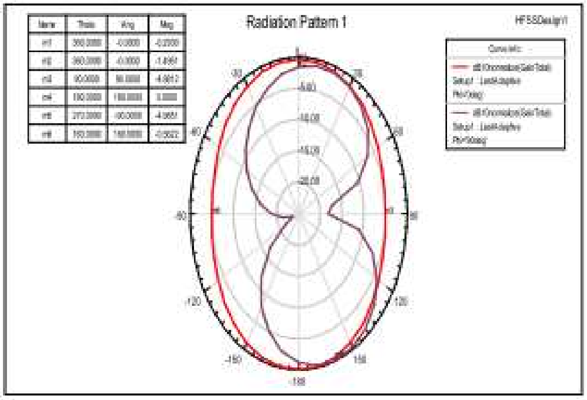

Fig.(vii): Radiation pattern parameter with ground plane 5mm

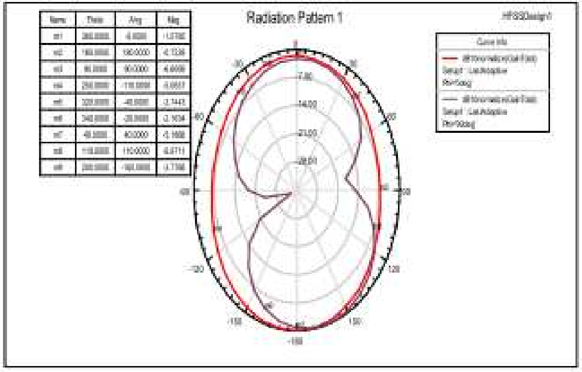

Fig.(vii): Radiation pattern parameter with ground plane 7mm

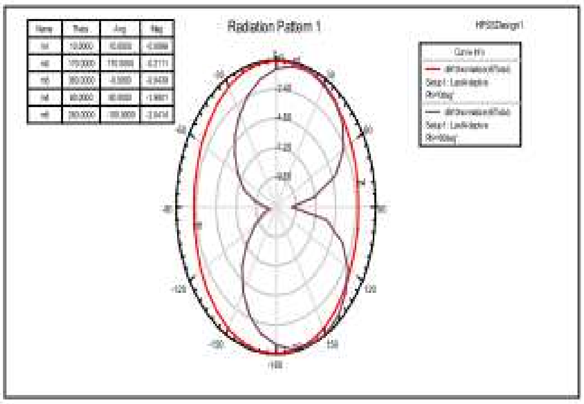

Fig.(vii): Radiation pattern parameter with ground plane 3mm

Sr.No	Quantity	Expected Value
1	Radiation Pattern	Omni-directional
2	ReflectionCoefficient	Below -10dB
3	Bandwidth	>500MHZ
4	VSWR	Between 1 and 2

V. CONCLUSION

In this paper, the designed antenna has simple configurations and is easy to fabricate. It is demonstrated by simulation that the proposed antenna can yield an ultra wide bandwidth, and that the radiation patterns are nearly Omni-directional over the entire 10 dB return loss bandwidth. Here s11 parameter is obtained at 7GHz for the complete band from 3 GHz to more than 10GHz. VSWR obtained is 1 at 5GHz and 0 for 7 GHz. Gain is 0db at 7GHz.

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