DESIGN AND DEVELOPMENT OF LINEARLY POLARIZED PATCH ANTENNA OF CIRCULAR SHAPE FOR LOWER UWB BAND

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Abstract— *the paper shows the results for design and computer simulation for the Ultra-wideband antenna of WPAN application. It also explains the difference between narrow band and ultra wide band. The antenna has excellent performance for lower-band frequency of UWB system, ranging from 3.1 GHz to 5.1 GHz. Over the entire frequency band, the antenna has a 10 dB return loss bandwidth .The antenna is designed on Rogers RT/duroid 5880 substrate and fed with 50 ohms coupled tapered transmission line. The proposed antenna designs and performances are examined using Ansoft High Frequency structure Simulator (HFSS).*

Index Terms— UWB, Antenna design, broadband wireless communication, and WPAN

I. NTRODUCTION

Ultra-wideband (UWB) system is ideal candidate that can be used for commercial ,small range ,low power , cost effective indoor communication system such as wireless personal area network (WPAN)[1]-[3]. In UWB communication systems, the antennas are pulse-shaping filters. Any distortion of the signal in the frequency domain results to the distortion of the transmitted pulses shape. Consequently this can increase the complexity of the detection mechanism at the receiver. The antenna design for UWB signal radiation is one of the main challenges. Specially, cost effective, geometrically small and still important structures are needed for typical wireless applications such as WPANs. The UWB technology offers several benefits over conventional communications systems. For instance, there is no carrier Frequency. Therefore transmitter and receiver hardware's can be made very user friendly, which is necessary for the portable devices. There is a wide range of applications for UWB technology, which includes wireless communication systems, position and tracking, sensing and imaging, and radar. Antenna plays an essential role in UWB system, which is different from narrowband system. UWB systems send very narrow pulses of the order of 1 ns or fewer results to bandwidths in excess of 1 GHz or more. But, the design and construction of high-performance conveying/acceptance antennas are always present substantial Challenges in the application of these systems. The impulse response of the antenna is vital because it has the affinity to change or shape the transmitted or received pulses. In run-through, attempt must be made to limit the amplitude and group delay misrepresentation below certain threshold that will ensure consistent system performance. The aim of the current study is to establish guidance for the UWB antenna designers, make notes on the required parameters of UWB antennas, and provide an example of UWB antenna. The challenge found in the development of an antenna, capable of handling these high-speed pulse trains. Because the fractional bandwidth is actually large hence UWB antenna design is very complicated, and antenna must cover multiple-octave bandwidths in order to transmit pulses that are of the order of a nanosecond in duration. Since data may be contained in the shape of the UWB pulse, antenna pulse distortion must be kept to a smaller side.

II REVIEW OF THE STATE-OF-ART:

In the early days of radio the concept of ultra wideband communication created. In the 1900s, the Marconi spark gap transmitter (the beginning of radio) communicated by spreading a signal over a very wide bandwidth. For distribution this use of spectrum did not permit, so the communications world sudden wideband communication in favor of narrowband or tuned communication in which the FCC governed spectrum allocation. The FCC provides guidelines for radiated power in the bandwidths of these communications systems and for incidental out of band radiated power. This incidental radiated power limits were the motivation for various organizations to challenge the paradigm of narrowband communications, in an ongoing effort to grab the capacity out of a highly regulated spectrum. The Shannon-Hartley theorem states that channel capacity increases linearly with increases in bandwidth and decreases logarithmically with decreases in the signal to noise ratio (SNR). Although this relation is only exact under a considerable caution, it does suggest how capacity is an boost for UWB communication. Many companies argued that they should be allowed to intentionally transmit at the incidental radiated power limits (where they could already transmit accidentally) over an ultra-wide bandwidth to take advantage of this capacity potential. For the FCC approval of UWB devices this dispute was the inspiration. In February of 2002, the FCC amended their Part 15 rules (concerning unlicensed radio devices) to include the operation of UWB devices without a license. UWB signals as having a fractional bandwidth of greater than 0.20 or a UWB bandwidth greater than 500 MHz, the FCC states. UWB bandwidth is defined as "the frequency band bounded by the points that are 10 dB below the highest radiated emission" The FCC ruling allows UWB communication devices to function at small power (an EIRP of -41.3 dBm/MHz) in an unlicensed spectrum from 3.1 to 10.6 GHz (see Figure1). The low emission limits for UWB are to ensure that UWB devices do not cause harmful interference to (i.e. coexist with) "licensed services and other important radio operations" (e.g. 802.11a devices).

III ANTENNAS FOR UWB APPLICATION

Directional and Omni- directional are two main groups of several different types of antennas. This might be used in narrowband or wideband systems. Directional antenna is suitable for long distance communications as they have focused beam with high gain, while Omni-directional antenna covers a wide area with reasonable gain. Therefore for small distance and covered environments, for example office or room Omni-directional antenna is appropriate. Wireless antennas may be classified into two separate classes, narrowband and wideband. The narrowband class demonstrates tremendous smallness for a given operating bandwidth. The wideband class possesses extreme bandwidth capability, capable of covering multiple octaves. Together classes accomplish performance very near to the hypothetical Chu-Harrington limit, representing that they are as small as possible for the showed bandwidth. The Chu- Harrington graph is a theoretical limit concerning the volumetric size of an antenna element to its quality factor or Bandwidth of operation. This relationship gives the antenna bandwidth of operation. Bandwidth of operation. This relationship gives the antenna designer an approximation of a switch between size and desired bandwidth. There are many issues involved in designing of UWB systems, such as antenna design, channel model, and interference. UWB antennas must cover an extremely wideband of 3.1-10.6 GHz (lower band 3.1-5.1 GHz, upper band 5.85-10.6 GHz) for the indoor and handheld applications, have electrically small size, and high efficiency. In accumulation, they are required to have a no dispersive characteristic in time and frequency area, providing narrow pulse duration to enhance a high data throughput. Antennas in the frequency domain are typically characterized by radiation pattern, directivity, impedance matching, and bandwidth. However, there are certain requirements for the antennas in the wireless system regardless of ultra-wideband or narrowband same as regulatory issues, antenna gain, antenna efficiency, and group delay of antenna.

IV.ANTENNA GAIN AND EFFICIECY

The required gain is decided by link budget, which is calculated by taking into account the required channel quality. As mentioned above a directional antenna will provide high gain in narrow field with large size radiator, while an Omni- directional antenna has low gain in wide field with small size of radiator. When high gain directional antenna is in use, because the peak radiated emission limit must meet the regulatory limit and it should be taken very seriously in mind the regulatory issues, therefore transfer power should be reduced, when spending a high gain directional antenna. In fact regulatory limits are well-defined in terms of Effective Isotropic Radiated Power (EIRP), system stylish should try to keep EIRP as much as possible constant and matching to the regulatory limit. The EIRP is

$$EIRP = P_{Tx} G_{Tx} \quad (1)$$

$$\eta = R_{rad}/(R_{rad}+R_{loss}) \quad (2)$$

Where P_{Tx} transmitting antenna power GTx is transmitting antenna gain

IV ANTENNA SIZE AND GAIN

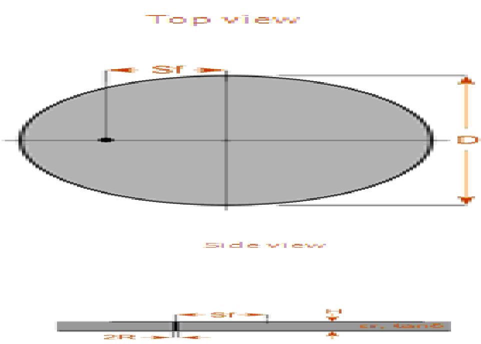
Wireless systems needs antennas with small geometrical dimensions. An antenna is said small when its geometrical size is small compare to the operating wavelength and can be fit into a radian sphere of $\lambda/2$. Particular consideration should be taken in the time of small antennas design, as small antennas are inefficient by nature and have high quality factor. The electrical size of a small Omni-directional antenna may in point of circumstance be significantly greater than the actual area of antenna. This follows from the ability of electromagnetic waves to couple to objects within about $\lambda/2$. Therefore, Even a small physical size antenna can receive or transmit electromagnetic radiation.

V.ANTENNA SIZE AND BANDWIDTH

The Chu-Harrington limit has investigated basic limits on antenna size, efficiency, and bandwidth and re-examined by McLean. This limit is related to the quality factor of small antenna, which is inverse fractional bandwidth of antenna too. That means, due to high superiority factor small antenna provides thin bandwidth. Generally the antenna bandwidth is limited by size relative to the wavelength. But, a small antenna could be made wideband by reducing its internal reflections at its discontinuities. It is impossible to make an antenna without discontinuities, because of finite size of antenna, It is likely to make an antenna as wideband as possible by constructing a gradual transition between the metal surface of the antenna and free space. Different approach can be used for doing this, such as antenna profile, external resistance or reactance.

VII. CIRCULAR PIN FED LINEARLY POLARIZED PATCH ANTENNA DESIGN AND ANALYSIS

A planar antenna can be designed based on the above analysis. The proposed design is described in detail, and simulation results of the antenna are presented. The simulation results have been obtained from ANSOFT DESIGNER 2.0. The structure of antenna is illustrated in Fig.2a&b. The total length of outer limits of the square loop antenna should be in one wavelength to have a linearly polarized radioactivity. Designing the antenna for 3.1 GHz will give the wavelength of = 96.77 0 mm. The present antenna composed of a single metallic layer and printed on a side of a FR4 substrate with dielectric same side with similar metallic layer. A copper of 0.018 mm thickness has been used as a metallic layer. As shown in Fig.1 projected antenna is 24 x 25 x 1 mm dimensionally, which is quite appropriate for wireless system. The rectangular loop has 98 mm length, which is fairly close to one wavelength of designed antenna. In this effort we have used narrowing transmission line for impedance corresponding, and we modified the shape of conventional loop antenna with introducing an L portion to its arms, as shown in Fig. 1, to reduce the antennas internal reflections at its is continuities and make gradual transition



a)

b)

Fig.2.a) Top view(b) side view of the antenna structure (Unit: mm)

Among the metal exterior of the antenna and free planetary. The narrowing transmission lines have shown good impedance matching over a wide range of frequency. The geometry of the taper is chosen to minimize the reflection and optimize impedance matching and bandwidth. Also, the use of narrowing in the antenna structure can make more magnitude of pulse due to more radiation near to the feed point. The achieved impedance bandwidth is in the order of 2 GHz (3.1-5.1 GHz) for VSWR 1.6, as illustrated in Fig. 2. The antenna gain is illustrated in Fig. 3. It has been detected that the designed antenna attained almost more than 1.4 dBi improvement in the complete frequency. Fig. 3 shows that the designed antenna gain variation is less then 0.8 dBi in the total frequency band. The most problematic part is to preserve the stability of the radiation pattern across the frequency band for UWB antenna,. The proposed antenna radiation patterns at 3.1, 4.1, and 5.1 GHz for = 0 and = 90 are illustrated in Fig. 4. It may be possible to be understood that antenna almost attained radiation pattern stability across the frequency band.

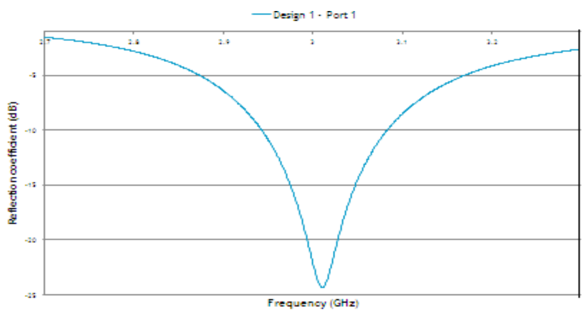


Fig.3. Reflection coefficient of proposed antenna

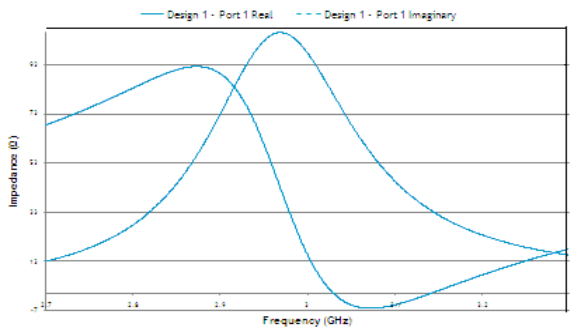


Fig.4 input Impedance Vs frequency Response

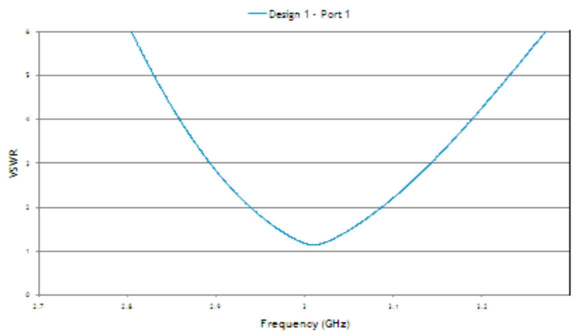


Fig.5.VSWR of proposed antenna

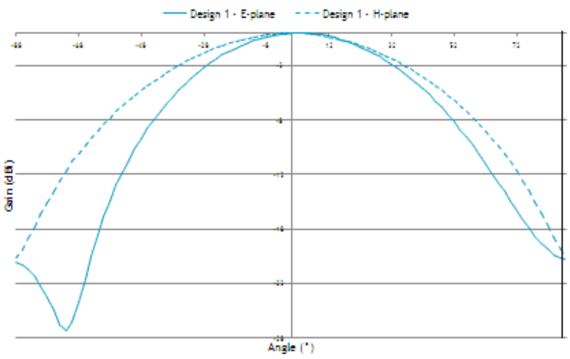


Fig.6 Gain (Total –Normalised)

VIII. CONCLUSION

The important thing of this study was to know the significant aspects of UWB antenna design and how they are associated to the system performance. UWB antennas should be designed with specification of flat amplitude and linear face response over the desired bandwidth. For UWB system antenna is the significant part of the system. Its characteristics have an effect on the overall system performance. An UWB CIRCULAR PIN FED LINEARLY POLARIZED PATCH ANTENNA was presented in this work. By introducing an L pattern to the printed rectangular loop antenna an impedance bandwidth of 2 GHz can be achieved. The projected antenna has outstanding performance for smaller band of the UWB structure and has the attractive features of small size, low-cost, and easy to design

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