A Printed Ultra Wide Band Semi Circular Antenna

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Abstract: Micro strip antennas became very popular within the wireless communication hyper market. These antennas can be easily fabricated, less expensive and of low profile, therefore these structures are used in mobile and laptops. In this paper we have designed and proposed a ultra wide band (UWB) printed monopole antenna. After repeated more no. of simulations with changes in the various antenna parameters a huge band width is obtained. a feeding mechanism of a strip line is used. In the proposed design which is well suited for ultra wide band frequency from 1.5 to 19 GHz.

Index Terms: Ultra Wide Band (UWB), Multi resonance, High Frequency Structure Simulation (HFSS).

I. INTRODUCTION

Ultra-Wide Band technology offers many advantages, mainly in terms of very high data transmission with low power for a short distance with precision, high precision ranging, low complexity and low cost [2]. For transmitting large amounts of digital data over a wide spectrum of frequency bands The Federal communications Commission (FCC) has been defined and declared the frequency band from 3.1 to 10.6 GHz band with Effective Isotropic Radiated Power for UWB Communications[1][3].

Ultra Wideband Radio (UWB) is a potentially revolutionary approach to wireless communication in that it transmits and receives pulse based waveforms compressed in time rather than sinusoidal waveforms compressed in frequency [4]. This is contrary to the traditional convention of transmitting over a very narrow bandwidth of frequency, typical of standard narrowband systems such as 802.11a, b, and Bluetooth. This enables transmission over a wide swath of frequencies such that a very low power spectral density can be successfully received. The allocation of the 3.1–10.6 GHz frequency spectrum by the Federal Communications Commission (FCC) for Ultra Wideband radio applications has presented a myriad of exciting opportunities and challenges for antenna designers [5]. Pulsed UWB, by definition, refers to any radio or wireless device that uses narrow pulses (on the order of a few nanoseconds or less) for sensing and communication. This requires sufficient impedance matching, proper return loss and VSWR <2 throughout the entire bandwidth. In this paper a new low profile, multi resonator microstrip antenna is presented for UWB application [6]. The bandwidth of a microstrip antenna increases with an increase in substrate thickness and decreases in the dielectric constant also, the bandwidth of the antenna increases when multi resonators are coupled in planar or stacked configurations [7].

There are many issues involved in designing of UWB systems [1], 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[8]. In addition, they are required to have a non-dispersive characteristic in time and frequency domain, 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 [9]. 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 [10].

II. ANTENNA DESIGN

A. Frequency of Operation

The Federal communications Commission has declared the frequency band from 3.1 to 10.6 GHz band width for UWB Communications. So the frequency of operation is considered accordingly.

B. Dielectric Constant of Substrate

The dielectric material selected is FR4 which has a dielectric constant of 4.4. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna.

C. Design Parameters

The dimensions of the ground [Width × Length × Height] are 26.6mm × 46mm × 0.5mm. The substrate is 46mm × 52mm × 1.6mm, and the length of the feed is 27.5 mm, width is 2.6mm and height is 0.035mm. The radius of the patch is 12.26mm is calculated by the formula:
\[ a = F \left( 1 + \frac{2h}{\pi F_{e_r}} \left[ \ln \left( \frac{\pi F}{2h} + 1.7726 \right) \right] \right)^{1/2} \]

where

\[ F = \frac{8.791 \times 10^9}{f_{e_r} \sqrt{e_r}} \]

\[ a_e = a \left( 1 + \frac{2h}{\pi a e_r} \left[ \ln \left( \frac{\pi a}{2h} + 1.7726 \right) \right] \right)^{1/2} \]

The simulation of the antenna design is as shown below.

![Fig. 1: Ultra Wide Band Antenna top view](image)

![Fig. 2: Ultra Wide Band Antenna bottom view](image)

The proposed model is a Ultra Wide Band antenna with a band width of 1.5 to 19 GHz. Perfect Electric Conductor (PEC) has been used as the conducting material for patch and ground. The radiating element is not a perfect semi circle and is been optimised. Ultra wide bandwidth has been achieved by optimising the dimensions of the ground and also the dimensions of the patch. A detailed explanation of the various parameters of the antennas like Return Loss, Voltage Standing Wave Ratio (VSWR), Radiation Pattern of the antenna for both electric field and magnetic field and Gain of the antenna at different frequencies are given below.

![Fig. 3: Adaptive Meshing](image)
Return Loss:
S11 versus frequency plot has a return loss of -43.73 dB at 3.2GHz, -33.93 dB at 8.60GHz, -35.71 dB at 12.20GHz, -23.22 dB at 15.20GHz.

VSWR:
Antenna has a VSWR of 0.113 dB at 3.2GHz, 0.349 dB at 8.60GHz, 0.284 dB at 12.20GHz, 1.199 dB at 15.20GHz.

3D Polar Plot:
A total Gain of 6.037 dB is observed in the 3D Polar plot at 3.2GHz

A total Gain of 9.338 dB is observed in the 3D Polar plot at 8.6GHz
A total Gain of 4.5332 dB is observed in the 3D-Polar plot at 12.2 GHz

A total Gain of 3.528 dB is observed in the 3D-Polar plot at 15.2 GHz

Radiation Pattern:
E-plane and H-plane radiation patterns at different frequencies are as shown below:
The Radiation Pattern of the antenna at 3.2 GHz is as shown below

The Radiation Pattern of the antenna at 8.6 GHz is as shown below

The Radiation Pattern of the antenna at 12.2 GHz is as shown below
The Radiation Pattern of the antenna at 15.2 GHz is as shown below

IV. CONCLUSION

In this paper investigation of a printed ultra wide band semi circular antenna is performed for UWB applications with a band width of 17.5 GHz ranging from 1.5 GHz to 19 GHz. A good impedance matching is observed in the entire band. E-field and H-field are shown at various frequencies along with the gain plots. A minimum gain of 3.5 dB and a maximum gain of 9.3 dB is observed making this antenna perfect for UWB applications. A Bi-directional radiation pattern is observed for the E-field and Omni directional radiation pattern is observed for the H-field at all the frequencies, the simulations are carried out using the software ANSYS HFSS.

REFERENCES