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DESIGN AND B.W. OPTIMIZATION OF UWB (ULTRA WIDEBAND) ANTENNA

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ABSTRACT

Ultra wideband (UWB) technology is an ideal candidate for a low power, low cost, high data rate, and short rang wireless communication system. According to the Federal Communication Commission (FCC), UWB signal is defined as a signal having fractional bandwidth greater than 20% of the center frequency [3]. Antennas are an integral part of everyday lives and are used for a multitude of purposes. Antenna is one type of transducer that converts electrical energy into the electromagnetic energy in form of electromagnetic waves [1]. These Monopole antennas combine the signals from multiple antennas in a way that mitigates multipath fading and maximize the output signal to-noise ratio. It can suddenly increase the performance of a communication system. In the past, most papers apply genetic algorithms for searching the minimum side lobe level of the antenna [3,8].In desired phase weights determined by the scan angle and array geometry, the amplitude weights ofelements are optimized by differential evolution algorithm to drive down the side-lobes.

In this project, a Monopole ultra wideband elliptical antenna array at the transmitter to synthesize an array pattern for minimizing the BER performance in a UWB communication system and To design & B.W. optimizations of UWB antenna. The electromagnetic software MWS-CST(Computer simulation technology simulator) is employed to perform the antenna design and optimization process.

KEYWORDS: UWB antenna, Bandwidth, CST Software, monopole antenna.

INTRODUCTION

This chapter describe about the introduction of design of UWB (Ultra wideband) antenna and performance analysis. Problem statement of project and objective of project that is to design, simulate and fabricate UWB antenna array operating at a resonant frequency range of 3-10 GHz.

Antennas are an integral part of everyday lives and are used for a multitude of purposes. Antenna is one type of transducer that converts electrical energy into the electromagnetic energy in form of electromagnetic waves [1]. All antennas operate on the same basic principles of electromagnetic theory formulated by James Clark Maxwell. The Maxwell put forth his unified theory of electricity & magnetism in 1873 in his book [2]. In now days the wireless system has become a part of human life. Most of the electrical and electronics equipment around are using the wireless system. Now a day's Compact microstrip antennas are getting more attention due to the increase in demands of small size antennas used in personal, commercial purposes and wireless applications. Wireless technology is the most rapidly growing area in the modern wireless communication. This offers customers the mobility to maneuver around inside a large insurance plan discipline and still be connected to the network. This supplies widely accelerated freedom and adaptability. For the house user, wireless has emerge as well known due to ease of set up, and area freedom. This being the case, portable antenna technology has grown along with mobile and cellular technologies. It is important to device have the proper antenna. The proper miniaturized antenna will improve transmission and reception, reduce power consumption, last longer and improve marketability of the communication device.[1]

Problem Statement
A Monopole antenna system combines multiple antenna elements with a signal processing capability to optimize its radiation and/or reception pattern automatically in response to the signal environment. Single band antenna supports only one or two frequency of wireless service. and these days more & more wireless std. are being supported by the devices so they employ several antennas for each standard.

- This leads to large space requirement in handheld devices.
- One foreseen associated problem with the antenna design for such devices is to cover 4G LTE bands while still covering DCS 1800, PCS1900,UMTS 2100,Wimax & WLAN/Bluetooth.
- Thus due to space constraints in mobile devices, covering multiple bands with a single antenna structure is the need of hour.

Objectives Of The Project

- ➢ To study different types of UWB antenna.
- ➢ To study different antenna parameters and selection of UWB antenna parameters.
- ➢ Modeling of antenna structure, Simulation and optimizing design parameters.
- ➢ To study Fabrication & testing of UWB antenna.
- ➢ To study Comparison & result validation.

Chapter Organizations
Chapter 1: In this chapter, Introduction of the ultra wideband antenna. Also this chapter includes the problem statement & objective of the project.
Chapter 2: In this chapter, The proposed solutions and design of an UWB monopole antenna is describes briefly.
Chapter 3: This chapter includes, performance analysis of monopole UWB antenna. Also describe output of design with parameters $S_{11,}$ VSWR, B.W., Radiation pattern.
Chapter 4: This chapter includes application of UWB monopole antenna how utilize in day to day life.
Chapter 5: This chapter includes conclusions based on project..

PROPOSED SOLUTIONS AND DESIGN
This chapter describes about methods used to component selection, feed selection, software used, design of conventional UWB monopole antenna.

Software used for Micro-strip antenna design
Microstrip antenna design software's are below used for simulation

- CST software
- HFSS software
- IE3D versions Zeland Software.

All these above software's used for microstrip antenna design and simulation purpose. These all software give good accuracy and set up time.Electromagnetic Simulation is an advanced technology to yield high accuracy in analysis and design of complicated RF printed circuit and microwave antennas, digital circuits with high speed operation and other electronic components.

Requirements

1. CST MWS Software
2. Printed Circuit Board Laboratory
3. Vector Network Analyzer

In order to take full advantage of the benefits to be obtained by using multiple antennas place in a mobile for mobile communications, it is necessary to use an antenna array which is both compact and also has low mutual coupling between ports. Generally these requirements are conflicting and to achieve them simultaneously is the subject of much research. The demand for higher data rates in wireless communications due to extensive use of multimedia applications and video streaming is always on the rise. Antenna array technology have emerged as an extension of an antenna for high receiver gain, increased data rates, larger network throughput (channel capacity), spectral efficiency, multipath fading and improve reliability through antenna diversity. The parameters that decide the performance of such antenna are the spacing between the elements, geometry, radiation pattern of an element, area of the aperture and number of antenna parameters.

Micro strip patch element shape

In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape as shown in Figure 2.1. Every shape has its own characteristics but square, rectangular, and circular are the most common configurations because of their easier analysis and fabrication [10].

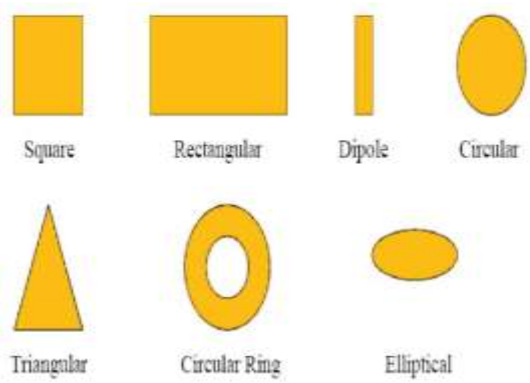


Figure 2.1: Common shapes of microstrip patch elements

Feed Techniques

Microstrip patch antennas can be fed by a variety of methods. These methods can be classified into two categories-contacting and non-contacting.

Micro strip Line Feed

In this type of feed technique, a conducting strip is connected directly to the edge of the Microstrip patch as shown in Figure 2.2.

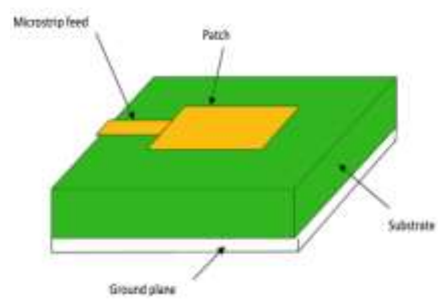


Figure 2.2: Microstrip line feed.

The conducting strip is smaller in width as compared to the patch and this variety of feed arrangement has the abilities that the feed can also be etched on the identical substrate to provide a planar structure.

Proposed Solution

(1) By adding new slots & CMT-EBG will be incorporated in order to reduce the mutual coupling, this may also reduce the size of an antenna and increase the bandwidth.

(2) With the new slots cut on the ground plane, the bandwidth can be expanded to 9.33 GHz (1.67–11GHz).The bandwidth of the monopole slot UWB antenna etched the CMT-EBG on both sides of the microstrip-fed line is broadened to 9.47 GHz (1.53–11 GHz) with the GPS covered.

Design of Conventional Microstrip Patch Antenna

The antenna used in this project is a rectangular patch printed on a substrate as shown in Figure3.3.The patch antenna is having attractive features such as low profile, lightweight, easy to fabricate and conformity to mounting post. However the disadvantage of the patch antenna includes the narrow bandwidth, low gain and directivity. In order to obtain the patch antenna with desired working frequency, the following formula is used to obtain the suitable parameter [11].

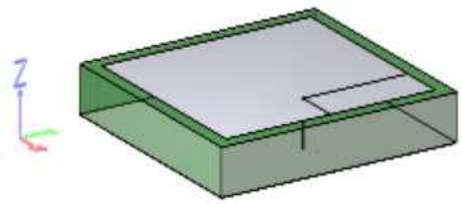


Figure: 2.3 Conventional microstrip patch antenna

The width (w) of the patch can be calculated as:

$$w = \frac{c}{2f\sqrt{\frac{(\varepsilon_r+1)}{2}}} \qquad 2.1$$

With '*c'* is the free space velocity of light, '*f'* is the frequency of operation, 'ε_r'is the dielectric constant and *h* is the height of the dielectric substrate. The effective dielectric constant (ε_{reff}) can be determined by

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r + 1}{2}\left[1 + 12\frac{h}{w}\right]^{\frac{-1}{2}} \qquad 2.2$$

The actual length of patch (*L*) is calculated by

$$L = L_{eff} - 2\Delta L \qquad 2.3$$

Whereas, the effective length of the patch (*Leff*) and the length extension (*ΔL*) can be determine respectively using

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{reff}}} \qquad 2.4$$

$$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)\left(\frac{w}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{w}{h} + 0.8\right)} \qquad 2.5$$

Finally, the ground plane parameters of the patch antenna can be calculated as

$$L_g = 6h + L \qquad 2.6$$

$$W_g = 6h + W \qquad 2.7$$

We can find the return loss of the device connected to port 2.

$$\text{ReturnLoss:}20\log(S_{11}) \qquad 2.8$$

OR

$$\text{Return Loss: } 20\log 10\frac{VSWR+1}{VSWR-1} \qquad 2.9$$

Design of UWB Monopole Antenna

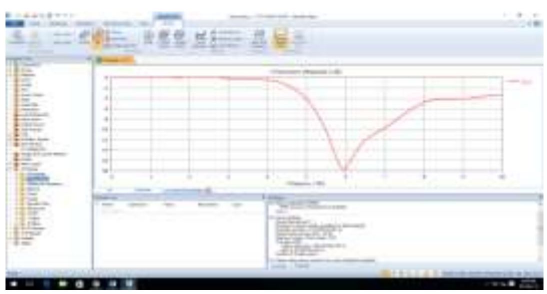
Ultra Wideband (UWB) technology is an excellent candidate for a low vigour, low cost, high data rate, and brief rang wireless verbal exchange process. According to the Federal Communication Commission (FCC), UWB signal is defined as a signal having fractional bandwidth greater than 20% of the center frequency [3].These Monopole antennas combine the signals from multiple antennas in a way that mitigates multipath fading and maximize the output signal to-noise ratio. It can rapidly increases the performance of a communication system. In the past, most papers apply genetic algorithms for searching the minimum side lobe level of the antenna [4].In preferred segment weights decided via the scan attitude and array geometry, the amplitude weights of factors are optimized by way of differential evolution algorithm to pressure down the side-lobes. However, this pattern are not able to guarantee to acquire the minimum BER performance. In this paper, we propose a Monopole ultra wideband circular antenna array at the transmitter to synthesize an array pattern for minimizing the BER performance in a UWB communication system.

The original monopole antenna has bandwidth of 9.27 GHz (1.73–11 GHz).It covers UMTS2000, PCS1900, TD-SCDMA, WiMAX, WLAN 802.11b/g or Bluetooth, LTE, and UWB frequency range. Here by cutting two new slots on the ground plane, the antenna can expand its bandwidth to 9.33 GHz (1.67–11 GHz) that is available at extra DCS1800 services, DVB-H services. The bandwidth of the antenna with conventional musharoom-type electromagnetic band-gap (CMT-EBG) embedded on both sides of a 50Ω microstrip line can be enhanced to 9.47 GHz (1.53–11 GHz) covered the extra GPS [6].

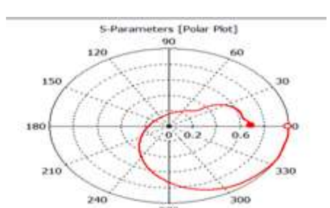
PERFORMANCE ANALYSIS

This chapter shows design of patch with different dimensions, shapes and varying the frequency on finite ground. Chapter also describe output of design with parameters S_{11}, VSWR, B.W., Radiation pattern and comparison of result.

It will show the design solver run successfully.



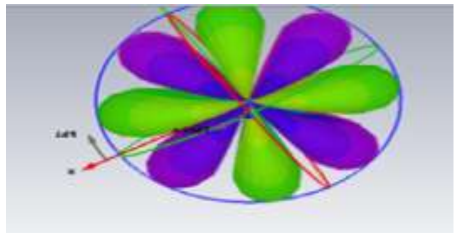
In this graph we see the S Parameters magnitude in dB Vs. frequency in GHz to get result of antenna.



Frequency/GHZ

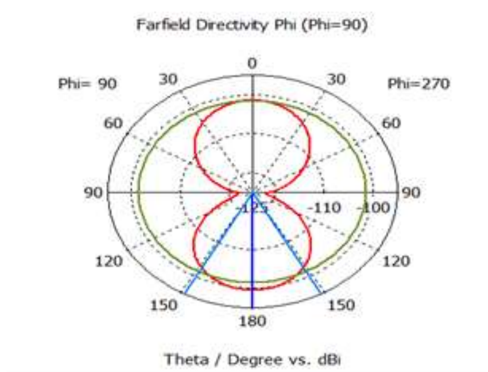
- 0
- 10

Here we see linear polar plot which shows graph of frequency range from 0 to 10 GHz.



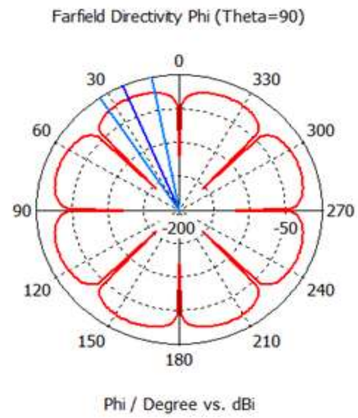
Here we can check phi phases and other many analysis options such as Axial Ratio, Theta, Theta Phase etc.

Type	Far field
Approximation	enabled (kR >> 1)
Monitor	Far field (f=5)
Component	Phi phase
Output	Direcivity
Dir.(phi)	-21.00 dBi
Frequency	5



Here we have to select polar option for polar analysis. Also we see the polar plot and observe the following readings.

Frequency	5
Main lobe magnitude	-99.8 dB
Main lobe direction	180.0 deg
Angular width (3 dB)	56.1 deg
Side lobe level	-1.6 dB



Here we view far field directivity select constant theta option for performance analysis. and observe reading as followes:

Frequency	5
Main lobe magnitude	-20.9 dB
Main lobe direction	23.0 deg.
Angular width (3 dB)	22.5 deg.

MERITS

- Light weight and low quantity
- Low profile planar configuration which can be effectively made conformal to host surface.
- Low fabrication rate, consequently may also be manufactured in large quantities.
- Helps both, linear as well as circular polarization.
- Can also be conveniently built-in with microwave integrated circuits (MICs).
- Ability of dual and triple frequency operations.
- Automatically robust when established on rigid surfaces.

APPLICATION OF UWB MONOPOLE ANTENNA

Ground penetrating radar (1MHz- 10GHz)

UWB technology is also appropriate for detection of unknown or known small and shallow objects buried underground. A new application of UWB ground penetrating radar (GPR) is reported in this project for the detection of buried gas pipelines. The UWB GPR is used to draw a map of buried gas pipelines by connecting a global positioning system (GPS) to the GPR. [12] [13].

- Multi-frequency operation Bluetooth, WLAN, GPS (Global positioning system), Wi-MAX applications [6]
- Satellite services (8GHz to 10GHz) Satellite communication the ultra-wide bandwidth antenna used for high frequency applications [12].
- Military Applications

UWB technology is very useful for military application. Because a very short duration pulse implies a large band, the power is spread over numerous frequencies instead of being concentrated. The resultant power spectral density is very low and the probability of detection and interception is very low. In the field of high power UWB technology (electromagnetic detection) for military application, an impulse UWB radar have the following features: [12]

- Ability to detect through obstacles and in dense media;
- Improvement of the radar range resolution;

- ➢ Improved clutter rejection;
- ➢ Improved detection of low flying targets;
- ➢ Improved detection of (stealth or not) target;
- ➢ Improved recognition (or even identification) of targets;
- ➢ Target imagery made possible, using a Synthetic Aperture Radar mode (SAR)
- Medical Application

In medical applications, non-invasive imaging with UWB makes it possible to get very accurate in-body information from patient. UWB radar is much safer than X-ray due to the great difference in the emission power levels.[12]

CONCLUSIONS

In this report, a theoretical survey on UWB antenna is done. The Selection of antenna parameters like B.W.,VSWR, efficiency, radiation pattern of the antenna. UWB antenna has low profile, small size & low manufacturing cost, hence the UWB antenna has been found to be significant demand for wireless applications.The designed multiband antenna is very sensitive to changes in dimension of the structure including the ground plane. Ground plane of the antenna is used as a radiator resulting in overall size reduction & improvement in the operating bandwidth. Well suited for high speed, short range WPAN.

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