Dielectric resonator antenna for Short Range Wireless Communication Applications

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTER OF TECHNOLOGY

IN

TELEMATICS AND SIGNAL PROCESSING

BY

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Roll No. – 209EC1114

Department of Electronics and Communication Engineering

National Institute of TechnologyRourkela-769008

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Date: 20-05-2013

CERTIFICATE

This is to certify that this thesis entitled **“Dielectric resonator antenna for Short Range Wireless Communication Applications”** submitted by Mr. **MAHENDER P** , in partial fulfilment of the requirements for the award of Master of Technology Degree in Electronics and Communication Engineering with specialization in **“Telematics and Signal Processing”** during session 2011-13 at the National Institute of Technology, Rourkela (Deemed University) is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any degree or diploma.

Dr. S K Behera

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This project is by far the most significant accomplishment in my life and it would be impossible without people who supported me and believed in me.

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I want to thank all my teachers **Prof. S.K Patra**, **Prof. K. K. Mahapatra, Mr. Vivek Angadala** for providing a solid background for my studies and research thereafter. They have been great sources of inspiration to me and I thank them from the bottom of my heart.

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Last but not least I would like to thank my parents, who taught me the value of hard work by their own example. They rendered me enormous support during the whole tenure of my stay in NIT Rourkela.

Mahender P

ABSTRACT

Present scenario of communication, all wired ones replacing with wireless. So, to achieve efficient communication in wireless technology, efficient radiators required. One such efficient radiators is Dielectric resonator antenna. The extremely wide spectrum of 3.1 to 10.6 GHz with 15 bands of bandwidth greater than 500 MHz and power limit less than -41.3 dBm/MHz announced by FCC for Ultra wide band. The release of this Spectrum has rapidly increased the research in UWB technology for communications, radar imaging, and localization applications. Radio systems based on UWB technology offer opportunities for transmission of high data rate signals, coding for security and low probability of intercept, especially in multi user network applications . UWB communication systems have the promise of very high bandwidth, reduced fading from multipath in mobile communication and low power requirements. In general, UWB radio systems transmit and receive temporally short pulses without carriers or modulated short pulses with carriers. Carrier free UWB radio systems usually employ very short pulses in the order of sub nanosecond (ns) as opposed traditional communication schemes which send sinusoidal waves. DRA is one of the best antennas for UWB applications due to its attractive features like high radiation efficiency, low dissipation loss, small size, light weight, and low profile. Moreover, DRAs which possess a high degree of design flexibility, have emerged as an ideal candidate for wide band, high efficiency, and cost-effective applications. Second antenna is designed which resonates at 5.5 GHz which is suitable for 802.11a WLAN applications. The return loss of proposed antenna is -22.7dB at 5.5GHz. Third antenna is designed to resonate at two different frequencies one at 2.42 GHz and other at 9.13 GHz with dielectric constant of 10. The feeding mechanism used is CPW feeding. This CPW feeding structure has many useful characteristics like low radiation leakage, less dispersion, little dependency of the characteristics impedance on substrate height and unipolar configuration. Same antenna is fabricated with dielectric constant of 2.1 and measured the return loss, which is resonating at 3.5 GHz which can be used in WIMAX. The simulated and measured results shows that as the dielectric constant of DRA is increasing the resonant frequency shifts towards the lower frequency and as the dielectric constant is decreasing the resonant frequency is shifting towards higher frequency and the frequency of operation is also changing.

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PARENTS AND TEACHERS

CHAPTER

1

THESIS OVERVIEW

1.1 Introduction

Short range wireless communication such as WLAN and Ultra-Wideband (UWB) are becoming more popular within the market place and as a research area. They both enable users to exchange data and to connect telecommunications devices over a short range without the use of a “hard wired” connection. Antennas are an essential part of WLAN and Ultra-Wideband (UWB) devices with conflicting demands of small size and high antenna efficiency. Thus, the implementation of the exclusive small antennas with acceptable gain is highly desirable. In this thesis, three different compact antennas are proposed for use in UWB and WLAN.

With the use of wireless technology, the construction of a communication system is more convenient and cost effective, as there is no cable installation between the user devices and transmitters. Now days, wireless technology is inexpensive and mature enough to apply in short range communications, which are commonly used in portable devices, like remote control, wireless microphone, DECT cordless phone and wireless USB devices, etc. On the other hand, the environmental issue has become a hot topic that has made an impact into many areas, such as green electronic, green agriculture, green chemical industry and green wireless etc. Short-range wireless communication is classified as green wireless in as much as it exhibits characteristics like low power consumption, low RF radiation power, and low cost.

In recent years, some newer and more advanced wireless technologies have been developed or are under development, and include Bluetooth, ZigBee, Wi-Fi (802.11a, b, g) and Ultra-Wideband (UWB). These technologies deliver wire-like performance in an indoor wireless environment. A summary of the different characteristics for short-range wireless communication is shown in Table 1-1.

Standard	802.11	802.11a	802.11b	802.11g
Frequency(GHz)	2.45	5	2.4	2.4
Speed(Mbps)	0.72	54	11	54
Range	10m	50m	100m	100m
Applications	Bluetooth	WiFi(a)	WiFi(b)	WiFi(g)

Table 1-1 Summary of various short range wireless communications

Antennas are very important for these wireless technologies. Their antenna design has become a very hot research topic as antennas form the essential part of every wireless device. Without antennas, wireless signals cannot be radiated efficiently into free space thus making the device inoperable. The antenna size is directly related to the size of the devices. With the advent of system on chip, the size of the devices can be dominated by the size of the antenna, thus a device can now be made significantly smaller if the size of the antenna can be made small. In this thesis, three different antennas for UWB and WLAN are proposed.

1.2 Literature Review

For many years, the dielectric resonator has primarily been used in microwave circuits, such as oscillators and filters. If the shielding is removed and with the proper excitation to launch the appropriate mode, these same dielectric resonators can actually become efficient radiators. Furthermore, by lowering their dielectric constant, the radiation can be maintained over a relatively broad band of frequencies. Although open DRs were found to radiate many years ago , the idea of using the DR as an antenna had not been widely accepted until the original paper on the cylindrical dielectric resonator antenna (DRA) was published in 1983 by S.A. Long , M.W. McAllister and L.C.Shen.

In the early 1990s, emphasis was placed on realizing various feeding mechanisms to excite the DRAs and on applying various analytical or numerical techniques for determining the input impedance and Q-factor. Focus was mainly on individual elements. A significant amount of this characterization was carried out by two research teams: one was led by Kishk, Glisson , and Junker and the other by Luk and Leung. By the mid-1990s more attention was being given to linear and planar DRA arrays, ranging from simple two-element arrays, up to complex phased arrays .This period also saw the development of ferrite resonator antennas, DRAs operating at 40GHz, and DRAs with nearly 40% impedance bandwidth. Many of the recent advances were profiled by petosa et al.

Since the late 1990s more researchers have entered the field , and the yearly number of publications has grown. Emphasis has been on a compact designs to address the needs of portable wireless applications and on new DRA shapes or hybrid antennas for enhanced bandwidth performance to meet the requirements for emerging broadband or ultra-wideband systems.

1.3 SCOPE OF THIS PROJECT

The scope of this work is to design a DRA which can be used for UWB applications according to the Federal communication commission specifications. That is used the operating frequency band ranging from 3.1 to 10.6 GHz with the smaller possible distortion of the UWB pulse. On the other hand Inverted U-Shaped Dielectric Resonator Antenna for WLAN which operated at 5.5GHz and another Compact Dual Band Hemi Spherical Dielectric Resonator Antenna which resonates at two different frequencies one at 2.4 GHz and other at 9.10 GHz, are designed which can be used for wireless communication applications.

1.4 THESIS OUTLINE

The outline of this thesis is as follows

Chapter 2: It presents the basic characteristics of Dielectric Resonator antenna, the advantages and disadvantages of DRA, Feeding methods of DRA, Analytical Evaluation of DRA like frequency domain analysis and time domain analysis are present in this chapter.

Chapter 3: In this chapter the basics of antenna parameters such as Gain and directivity, polarization, input impedance, VSWR, bandwidth, Quality factor.

Chapter 4: This chapter describes H-Shaped UWB dielectric resonator Which covers the entire UWB band, the shape of DRA is H-Shape. The other parameters like Return loss, input impedance, gain performance parameters like path loss, group delay and time domain characteristics are described in this chapter.

Chapter 5: This chapter describes Inverted U shaped dielectric resonator antenna for wlan application. The other parameters like Return loss, gain, performance parameter i.e., path loss and radiation pattern are described in this chapter.

Chapter 6: This chapter describes compact dual band hemispherical dielectric resonator antenna. This antenna resonates at dual frequency one of this can be used for WLAN applications. The other parameters like Return loss, gain, current distribution, and radiation pattern are described in this chapter.

Chapter 7: This chapter describes the conclusion and future work.

CHAPTER

2

DIELECTRIC RESONATOR ANTENNA

2.1 Dielectric Resonator Antenna Theory

The dielectric resonator has primarily been used in microwave circuits, such as oscillators and filters. If the shielding is removed and with the proper excitation to launch the appropriate mode, these same dielectric resonators can actually become efficient radiators. Furthermore, by lowering their dielectric constant, the radiation can be maintained over a relatively broad band of frequencies. Various feeding mechanisms to excite the DRAs such as coaxial feed, slot aperture feed, Microstrip line feed, Coplanar wave guide feed. These DRAs can be easily coupled to integrated circuits. Since recent emphasis has been on a compact designs to address the needs of portable wireless applications and on new DRA shapes or hybrid antennas for enhanced bandwidth performance to meet the requirements for emerging broadband or ultra wideband systems.

2.2 Basic characteristics

Dielectric resonator antennas (DRA) possess some peculiar properties which render them very promising, especially for millimeter wave applications. Their high-radiation efficiency, bandwidth and polarization flexibility make them by far superior to conventional microstrip patch antennas (MPA). DRA are intrinsically immune to those surface wave power leakage and conductor loss problems, which plagues the MPA and reduces their efficiency. DRA consists of high dielectric constant materials, high quality factors and mounted on a grounded dielectric substrate of lower permittivity. DRA is fabricated from low-loss and high relative dielectric constant material of various shapes whose resonant frequencies are functions of the size, shape and permittivity of the material. DRA can be in a few geometries including cylindrical, rectangular, spherical, half-split cylindrical, disk, and hemispherical shaped. The DRAs have properties such as low phase noise, compact size, frequency stability with temperature, ease of integration with other hybrid MIC circuitries, simple construction and the ability to withstand harsh environments. The DRA has some interesting characteristics, like the small size, ease of fabrication; high radiation efficiency, increased bandwidth and low production cost. DRAs are very promising for applications in wireless communications.

DRAs offer several attractive features including:

- A wide range of dielectric constants can be used (ϵ_r= 10 – 100), that allowing the designer to have control over the physical size of the DRA and its bandwidth.
- The Size of DRA is proportional to λ0/√ ϵ_r , where λ0 is the free space wavelength at the resonant frequency, and ϵ_r is the dielectric constant of the material.
- DRAs can be designed to operate over a wide range of frequencies from 1.3 GHz to 40 GHz.
- High radiation efficiency (95%) due to the absence of conductor or surface wave losses.
- Several feeding mechanisms can be used (including slots, probes, microstrip lines, dielectric image guide, and coplanar waveguide lines) to efficiently excite DRAs.
- DRA can be excited by several modes, many of which radiate pattern similar to short electric or magnetic dipoles, producing either broadside or Omni directional radiation patterns for different coverage requirements.
- By selecting a dielectric material with low-loss characteristics, high-radiation efficiency can be maintained, even at millimeter-wave frequencies, due to an absence of surface waves and minimal conductor losses associated with the DRA.
- A Wide control over size and bandwidth

- A tight ϵ_r tolerance: ± 1- 5%,
- A high quality factor Q: up to 10000 (f = 10GHz)
- A Wide range of temperature coefficient of resonance frequency: (-12…+30) ppm/^{o}C
- A Tolerance ± 0.5; ±1.0; ±2.0 ppm/ ^{o}C.

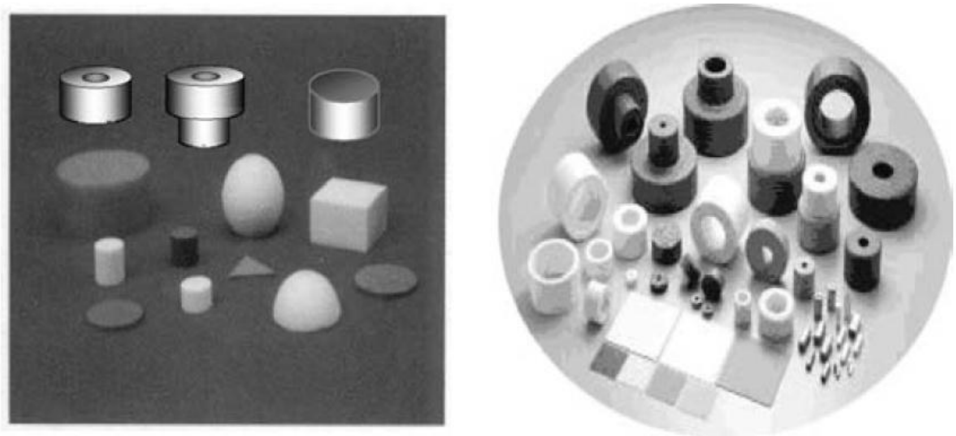


Fig. 2.1 DRAs of various shapes (cylindrical, rectangular, hemispherical, low-profile circular-disk, low-profile triangular)

2.3 ADVANTAGES

In the past few years, extensive studies on the DRA have been focused on resonators of various shapes, the feeding techniques, and bandwidth enhancement methods. Specific features of DRAs have made them suitable for a variety of applications specially millimeter wave (MMW) applications. DRAs can be easily coupled to almost all types of transmission lines. They can be integrated easily with MMIC circuits. In MMW applications conductor loss of metallic antennas become severe and the antenna efficiency decreases significantly, conversely the only loss for a DRA is that due to the imperfect material of the DRA which can be very small in practice. Therefore DRAs have high radiation efficiency. In comparison to microstrip antennas, DRAs have wider impedance bandwidths. For a typical DRA with dielectric constant of 10 the impedance bandwidth of 10% can be achieved. Avoidance of surface waves is another attractive advantage of DRAs over microstrip antennas. Single DRAs of different shapes has been possible, including rectangular, cylindrical, hemispherical, triangular, conical, etc. Among these different shapes cylindrical and rectangular are the most common and the rectangular has the advantage of having one more degree of freedom for design purposes. There are a variety of feed configurations, which electromagnetic fields can be coupled to DRAs. Most common feed arrangements are microstrip aperture coupling, direct microstrip coupling, probe coupling and conformal strip coupling. Among these feed configurations, aperture coupling is more suitable for MMW applications. In aperture coupling configuration, since the DRA is placed on the ground plane of the microstripfeed, Figure 2.1 DRAs of various shapes (cylindrical, rectangular, hemispherical, low-profile circular-disk, low-profile triangular) parasitic radiation from the microstrip line is avoided. Isolation of the feed network from the radiating element is another advantage of the aperture coupling method.

Dielectric resonator antennas (DRAs) have been extensively used for numerous applications since they have many attractive characteristics such as low profile, light weight, low cost, and inherently wide bandwidth. They could be used for numerous applications as both individual elements and in an array environment. In addition, wide bandwidth, low cost, low dissipation loss at high frequency, and high radiation efficiency are the inherent advantages of DRAs over conventional patch antennas. Compared with Microstrip antennas, which suffer from higher conduction loss and surface waves in antenna array applications, DRAs have high radiation efficiency and high power handling capability due to lack of metallic loss. Unlike the microstrip antenna, DRA does not support surface waves if placed on a ground plane directly. In recent years, DRAs have been considered as potential antennas for mobile phone applications. A general problem in the miniaturization of RF resonators used in filters and small antennas is decrease of efficiency, due to conductor losses. In DRAs, lower conductor losses, compared to those in typical metal antennas such as microstrip patches can be expected because DRAs have fewer metal parts. Thus, DRAs are good potential alternatives, especially when very small antenna elements are needed. In addition, they can be easily incorporated into microwave integrated circuits because they can be fabricated directly on the printed circuit board (PCB) of the phone. Specific features of DRAs have made them suitable for a variety of applications specially MMW applications. DRAs have small size and low cost. They can be easily coupled to almost all types of transmission lines.

Dielectric resonator antennas have several advantages compared to conventional microwave antennas, and therefore many applications cover the broad frequency range. Some of the principal advantages of dielectric resonator antennas compared to conventional microstrip antennas are:

- DRA has a much wide impendence bandwidth than microstrip antenna because it radiates through the whole antenna surface except ground port while microstrip antenna radiate only through two narrow radiation slots.
- Higher efficiency.
- Avoidance of surface waves is another attractive advantage of DRAs over microstrip antennas
- However, dielectric resonator antennas have some advantages:
- Light weight, low volume, and low profile configuration, which can be made conformal;

- DRA has high degree of flexibility and versatility, allowing for designs to suit a wide range of physical or electrical requirements of varied communication applications.
- High radiation efficiency
- High dielectric strength and higher power handling capacity
- In DRA, various shapes of resonators can be used (rectangular, cylindrical, hemispherical, etc.) that allow flexibility in design.
- Several feeding mechanisms can be used (probes, slots, microstrip lines, dielectric image guides, and coplanar waveguide lines) to efficiently excite DRAs, making them amenable to integration with various existing technologies.

2.4Feeding Methods

There are several techniques available to feed or transmit electromagnetic energy to a dielectric resonator antenna. The five most popular feeding methods are the coaxial probe, slot aperture, microstrip line, co-planar coupling and dielectric image guide.

2.4.1 Coaxial Feed

The Coaxial feed or probe feed is a very common technique used for feeding dielectric resonator antennas as shown in figure 2.2. In this method, the probe can either be placed adjacent to the DRA or can be embedded within it. The amount of coupling can be enhanced by adjusting the probe height and the DRA location. In DRA, various modes can be excited depending on the location of the probe. For the probe located adjacent to the DRA, the magnetic fields of the TE11δ mode of the rectangular DRA are excited and radiate like a horizontal magnetic dipole. For a probe located in the center of a cylindrical DRA, the TE011 mode is excited and radiating like a vertical dipole. Another benefit of using probe coupling is that one can couple directly into a 50Ω system, without the requirement for a matching network. Probes are suitable at lower frequencies where aperture coupling may not be applied due to the large size of the slot required.

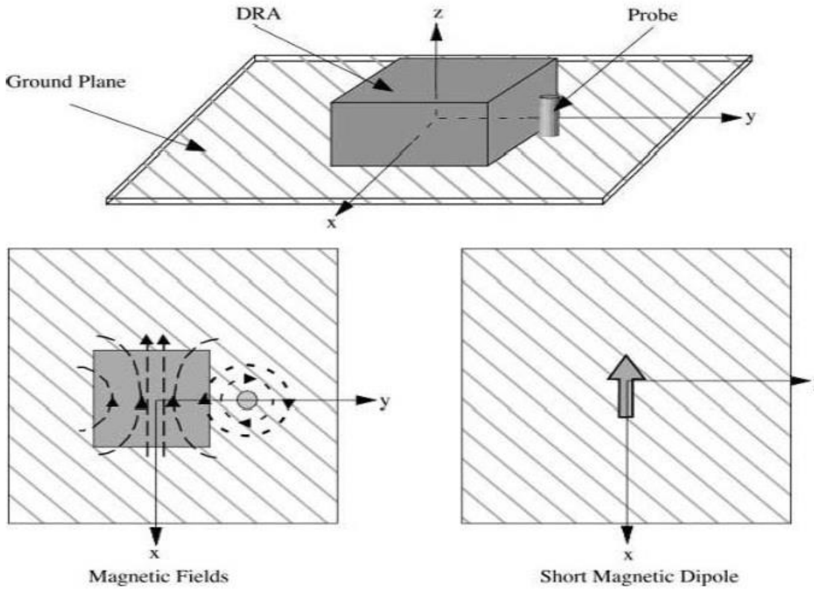


Fig. 2.2 Probe-fed Dielectric resonator antennas

2.4.2 Slot Aperture

In slot aperture method, a DRA is exciting through an aperture in the ground plane upon which it is placed. Aperture coupling is applicable to DRAs of any shapes such as rectangular, cylindrical or hemispherical. The aperture works like a magnetic current running parallel to the size of the slot, which excites the magnetic fields in the DRA. The aperture consists of a slot cut in a ground plane and fed by a microstrip line below the ground plane. For avoiding spurious radiation, feed network is located below the ground plane. Moreover, slot coupling is an attractive technique for integrating DRAs with printed feed structures. The coupling level can be changed by moving the DRA with respect to the slot. Generally, a high dielectric material is used for the substrate and a thick, low dielectric constant material is used for the top dielectric resonator patch to optimize radiation from the antenna. The main drawback of this feed technique is that it is problematic to fabricate due to multiple layers, which also increases the antenna thickness. This feeding method also provides narrow bandwidth (up to 21%) .

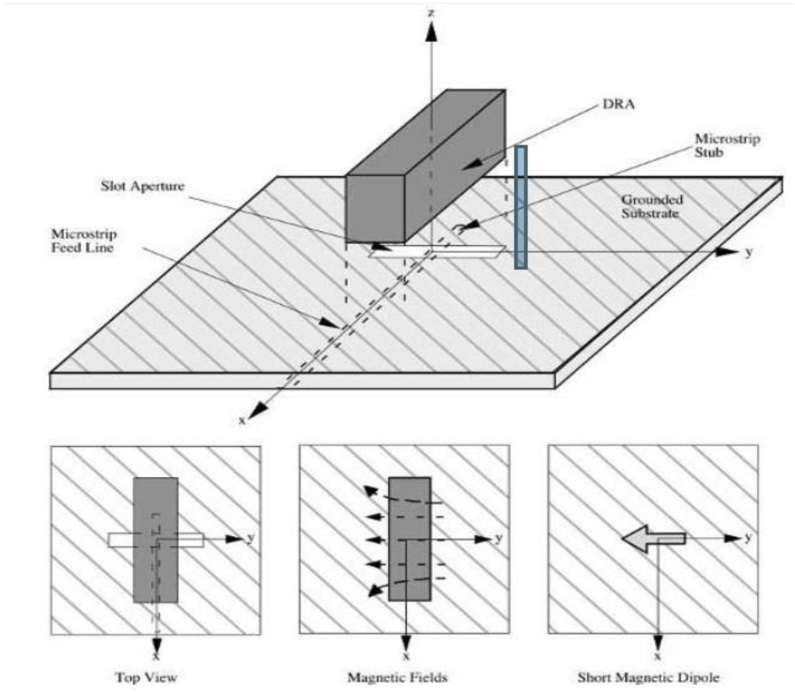


Fig. 2.3 Slot-fed Dielectric resonator antennas

2.4.3 Microstrip Line Feed

In this type of feed technique, a conducting strip is connected directly to the edge of the patch as shown in figure 2.4. A common method for coupling to dielectric resonators in microwave circuits is by proximity coupling to microstrip lines. Microstrip coupling will excite the magnetic fields in the DRA to create the short horizontal magnetic dipole mode. The level of coupling can be changed by the lateral location of the DRA with respect to the microstrip line and on the relative permittivity of the DRA .

In DRAs, the amount of coupling is generally quite small for requiring wide bandwidth. Microstrip lines can be used as a series feed for a linear array of DRAs. This is an easy feeding technique, since it offers ease of fabrication and simplicity in modeling along with impedance matching. However as the thickness of the dielectric substrate being used, rises, surface waves and spurious feed radiation also rises, which hampers the bandwidth of the antenna. One drawback of this method is that the polarization of the array is analyzed by the orientation of the microstrip line such as the direction of the magnetic fields in the DRA will be parallel to the microstrip line.

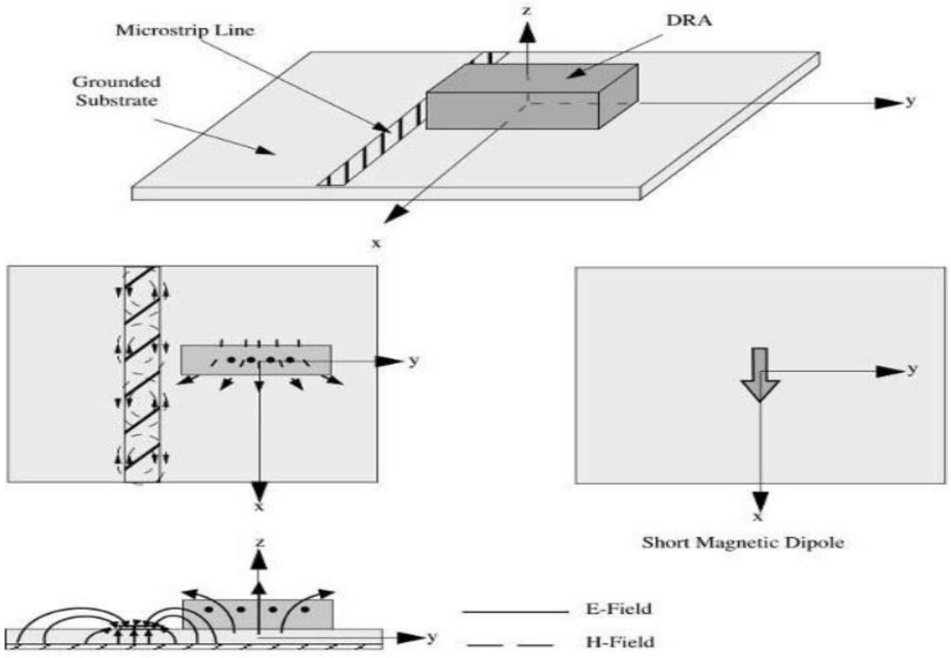


Fig. 2.4 Microstrip-fed DRA

In DRAs, the amount of coupling is generally quite small for requiring wide bandwidth. Microstrip lines can be used as a series feed for a linear array of DRAs. This is an easy feeding technique, since it offers ease of fabrication and simplicity in modeling along with impedance matching. However as the thickness of the dielectric substrate being used, rises, surface waves and spurious feed radiation also rises, which hampers the bandwidth of the antenna. One drawback of this method is that the polarization of the array is analyzed by the orientation of the microstrip line such as the direction of the magnetic fields in the DRA will be parallel to the microstripline .

2.4.4 Co-Planar waveguide Feed

The Co- planar feed is a very common technique used for coupling in dielectric resonator antennas. Here, figure 2.5 shows a cylindrical DRA coupled to a co-planar loop. The coupling level can be adjusted by locating the DRA over the loop.

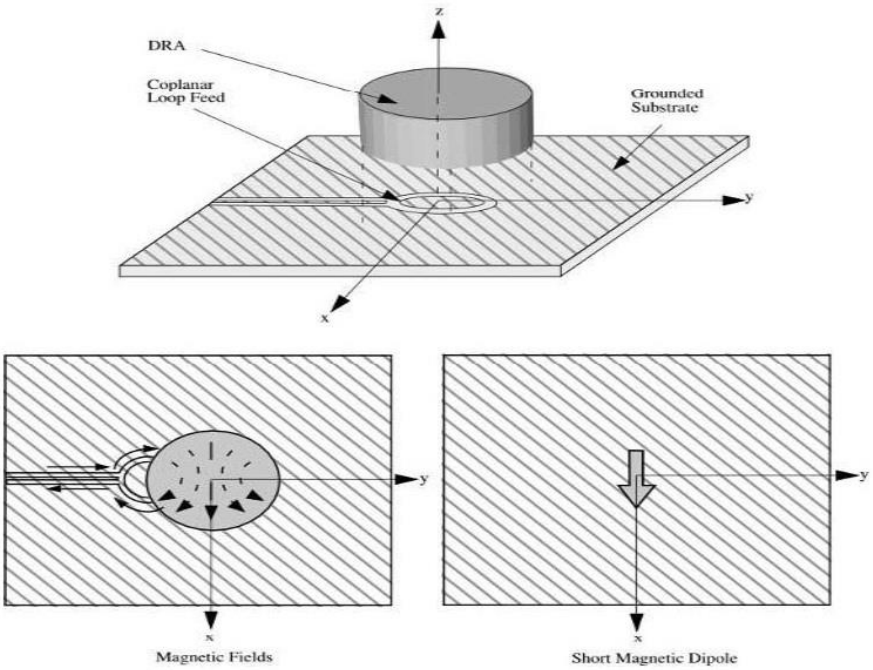


Fig. 2.5 Co-planar loop-fed DRA

The coupling behavior of the co-planar loop is similar to coaxial probe, but the loop offers the advantage of being non-obtrusive. By moving the loop from the edge of the DRA to the center, one can couple into either the HE11δ mode or the TE011 mode of the cylindrical DRA.

2.4.5 Dielectric Image Guide

Dielectric image guide is another attractive coupling technique in DRAs, as shown in figure 2.6. Dielectric image guides offer advantages over microstrip at millimeter–wave frequencies since they do not suffer as severely from conductor losses. As with microstriplines, the amount of coupling to the DRA is generally quite small, especially for DRAs with Slower permittivity values, although it may be possible to increase the coupling by operating the guide closer to the cut-off frequency. The dielectric image guide is thus best utilized as a series feed to a linear array of DRAs.

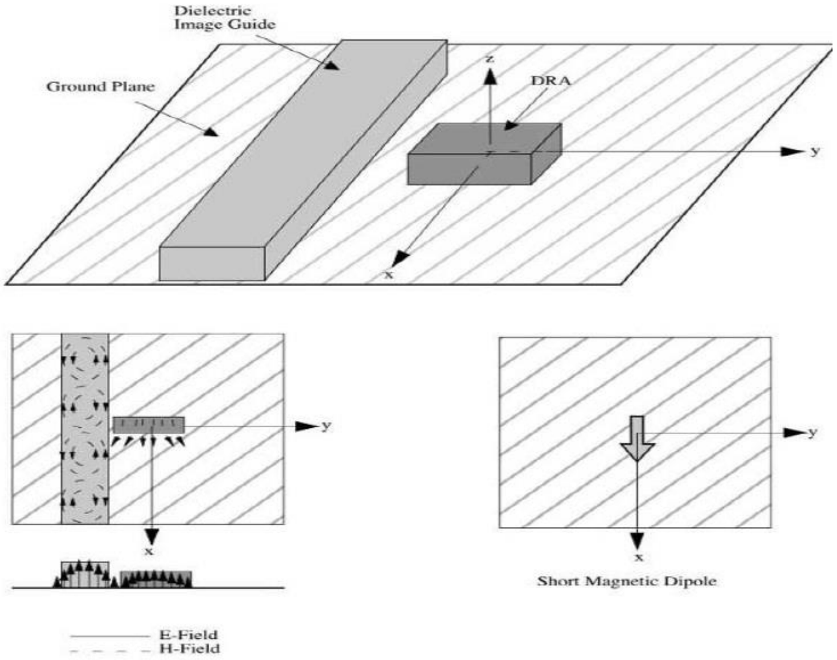


Fig. 2.6 Dielectric image guide-fed DRA

2.5 Analytical Evaluation of Dielectric Resonator Antenna

In designing, input impedance is the important parameter which is a feed to excite the DRA. Input impedance as a function of frequency is to determine the bandwidth of operation and for matching the antenna to the circuit. Unfortunately, there are no simple closed-form expressions for predicting the input impedance of the DRA when excited by a particular feed and rigorous analytical. Here, some of the techniques that have been used to predict the input impedance for DRAs excited by the various feed.

2.5.1 Green's function analysis

For a probe-fed DRA, the input impedance (Z_{in}) can be determined using the following equation:

$$Z_{in} = \frac{-1}{I_O^2} \int (E.J_S) ds \qquad (2.1)$$

E= Electric fields of the DRA

J_s = Applied source current density on the probe

I_O = Magnitude of the current on the probe

The electric fields of the DRA depend on the source excitation and determined by using:

$$\int (E.J_S) ds \qquad (2.2)$$

Here, G represents Green‘s function for the DRA. By using some simple assumptions about a single-mode operation and the currents on the probe, the Green‘s function for a hemispherical DRA was first derived and was then used to predict the input impedance of the probe-fed DRA operating in the TE111 mode. This technique was also applied to a probe–fed hemispherical DRA operating in the TM101 mode. The input impedance of conformal strip feeds and aperture feeds can also be analyzed using Green‘s function. The advantage to this technique is the relatively fast computation time required to obtain the input impedance. It is useful method for analysing the effects of altering probe dimensions and probe location and can be used for optimizing the input impedance. The main drawback is its limitation only to hemispherical DRA geometries. For other DRA shapes, different analytical techniques are required.

2.5.2 Numerical methods for analyzing DRAs

Numerical methods for analyzing DRAs can be categorized into two groups, frequency domain technique and time domain technique. Each category offers advantages for particular antenna geometries.

2.5.3 Frequency domain analysis

Two common frequency domain techniques that have been used to analyze DRAs are the method of moments (MOM) and the finite element method (FEM). The MOM was first developed for wire or metal antennas of arbitrary shape, but can be extended to include dielectric materials by introducing equivalent currents. The MOM involves discrediting the antenna into a number of small segments and solving for a set of unknown coefficient representing the current on one segment due to a known incident field. Analysis of DRAs is not limited to a hemispherical shape, and the technique can be used to also analyses simple cylindrical and rectangular DRA shapes. Determining the DRA input impedance using the MOM technique will require more computer memory and time than applying Green‘s function. Thus, MOM technique is not convenient tool for optimizing the DRA performance. MOM is used to investigate the effect of the air gaps and calculate internal field pattern of various modes of cylindrical DRAs.

The FEM (Finite element method) can be used to analyses DRAs of arbitrary shape. Similar to the MOM, it involves a discretization of the geometry but whereas in the MOM only the DRA and the ground plane require segmentation , in the FEM the entire volume surrounding the DRA must also be discretized, thereby increasing the computational size of the problem. The advantage of the FEM is that it does not require the formulation of equivalent currents and can thus be readily applied to arbitrary shapes. Another advantage of the FEM is its availability as commercial software where graphical user interfaces are provided to simplify the geometrical definition of the problem. FEM is used to determine the effects of a finite ground plane on the radiation pattern of a DRA.

2.5.4 Time domain analysis

There are two time domain techniques that have been applied to analyzing DRAs are the finite difference time domain (FDTD) method and the transmission line method (TLM). These techniques require the entire volume around the DRA to be discretized and thus can be memory and time intensive. In it, wideband pulse used to excite the DRA, and by transforming the solution into the frequency domain, the input impedance can be determined over a wide frequency range. For frequency domain techniques, the problem would have to be re simulated at every frequency of interest and obtaining the impedance response over a broad frequency range could be very time consuming. With the frequency domain methods, the time domain methods are good tools for analyzing the performance of a given DRA geometry, but are less useful for optimizing the performance of DRAs. FDTD is used to calculate circular polarization patterns of cross-shaped DRAs and input impedance of slot-fed rectangular DRA. Transmission line method used to calculate input impedance of microstrip-fed multi-segment DRAs.

CHAPTER

3

ANTENNA PARAMETER

3.1 Gain and directivity

The gain of an antenna is the radiation intensity in a given direction divided by the radiation intensity that would be obtained if the antenna radiated all of the power delivered equally to all directions. The definition of gain requires the concept of an isotropic radiator; that is, one that radiates the same power in all directions. An isotropic antenna, however, is just a concept, because all practical antennas must have some directional properties. Nevertheless, the isotropic antenna is very important as a reference. It has a gain of unity (g = 1 or G = 0 dB) in all directions, since all of the power delivered to it is radiated equally well in all directions.

Although the isotopes are a fundamental reference for antenna gain, another commonly used reference is the dipole. In this case the gain of an ideal (lossless) half wavelength dipole is used. Its gain is 1.64 (G = 2.15 dB) relative to an isotropic radiator.

The gain of an antenna is usually expressed in decibels (dB). When the gain is referenced to the isotropic radiator, the units are expressed as dBi; but when referenced to the half-wave dipole, the units are expressed as dBd. The relationship between these units is

$$\mathrm{G_{dBd}G_{dBd}} = \mathrm{G_{dBi}G_{dBi}} - 2.15\ \mathrm{dBidB} \qquad (3.1)$$

Directivity is the same as gain, but with one difference. It does not include the effects of power lost (inefficiency) in the antenna. If an antenna were lossless (100 % efficient), then the gain and directivity (in a given direction) would be the same.

3.2 Antenna Polarization

The term polarization has several meanings. In a strict sense, it is the orientation of the electric field vector E at some point in space. If the E-field vector retains its orientation at each point in space, then the polarization is linear; if it rotates as the wave travels in space, then the polarization is circular or elliptical. In most cases, the radiated-wave polarization is linear and either vertical or horizontal. At sufficiently large distances from an antenna, beyond 10 wavelengths, the radiated, far-field wave is a plane wave.

3.3 Input impedance

There are three different kinds of impedance relevant to antennas. One is the terminal impedance of the antenna, another is the characteristic impedance of a transmission line, and the third is wave impedance. Terminal impedance is defined as the ratio of voltage to current at the connections of the antenna (the point where the transmission line is connected). The complex form of Ohm's law defines impedance as the ratio of voltage across a device to the current flowing through it.

The most efficient coupling of energy between an antenna and its transmission line occurs when the characteristic impedance of the transmission line and the terminal impedance of the antenna are the same and have no reactive component. When this is the case, the antenna is considered to be matched to the line. Matching usually requires that the antenna be designed so that it has terminal impedance of about 50 ohms or 75 ohms to match the common values of available coaxial cable.

3.4 Voltage Standing Wave Ratio

The standing wave ratio (SWR), also known as the voltage standing wave ratio (VSWR), is not strictly an antenna characteristic, but is used to describe the performance of an antenna when attached to a transmission line. It is a measure of how well the antenna terminal impedance is matched to the characteristic impedance of the transmission line. Specifically, the VSWR is the ratio of the maximum to the minimum RF voltage along the transmission line. The maxima and minima along the lines are caused by partial reinforcement and cancellation of a forward moving RF signal on the transmission line and its reflection from the antenna terminals.

If the antenna terminal impedance exhibits no reactive (imaginary) part and the resistive (real) part is equal to the characteristic impedance of the transmission line, then the antenna and transmission line are said to be matched. It indicates that none of the RF signal sent to the antenna will be reflected at its terminals. There is no standing wave on the transmission line and the VSWR has a value of one. However, if the antenna and transmission line are not matched, then some fraction of the RF signal sent to the antenna is reflected back along the transmission line. This causes a standing wave, characterized by maxima and minima, to exist on the line. In this case, the VSWR has a value greater than one. The VSWR is easily measured with a device and VSWR of 1.5 is considered excellent, while values of 1.5 to 2.0 is considered good, and values higher than 2.0 may be unacceptable.

3.5 Bandwidth

The bandwidth of an antenna is defined as the range of frequency within the performance of the antenna. In other words, characteristics of antenna (gain, radiation pattern, terminal impedance) have acceptable values within the bandwidth limits. For most antennas, gain and radiation pattern do not change as rapidly with frequency as the terminal impedance does. Since the transmission line characteristic impedance hardly changes with frequency, VSWR is a useful, practical way to describe the effects of terminal impedance and to specify an antenna's bandwidth.

For broadband antennas, the bandwidth is usually expressed as the ratio of the upper to lower frequencies of acceptable operation. However, for narrowband antennas, the bandwidth is expressed as a percentage of the bandwidth.

3.6 Quality factor

The quality factor is a figure-of-merit that representative of the antenna losses. Typically there are radiation, conduction, dielectric and surface wave losses.

$$\frac{1}{Q_t} = \frac{1}{Q_{rad}} + \frac{1}{Q_c} + \frac{1}{Q_d} + \frac{1}{Q_{sc}} \qquad (3.2)$$

Q_t: Total quality of factor

Q_{rad}: Quality factor due to radiation losses

Q_c: Quality factor due to conduction losses

Q_{dm}: Quality factor due to dielectric losses

Q_{sc}:quality factor due to surface wave

The quality factor, bandwidth and efficiency are antenna figures-of-merit, which are interrelated, and there is no complete freedom to independently optimize each one.

For very thin substrates h $<<\lambda_0$ of arbitrary shapes including rectangular, there approximate formulas to represent the quality factors of the various losses.

These can be expressed as

$$Qc = h\sqrt{\pi f \mu \sigma} \qquad (3.3)$$

$$\mathrm{Q_d} = \frac{1}{\tan\delta\delta} \qquad (3.4)$$

$$Q_{rad} = \frac{2\omega\varepsilon}{hG_t/_l} \qquad (3.5)$$

Where tan δ is the loss tangent of the substrate material, σ is the conductivity of the conductors associated with the patch and ground plane, G_t/l is the total conductance per unit length of the radiating aperture.

CHAPTER

4

H-Shaped UWB Dielectric Resonator Antenna

4.1 INTRODUCTION

The extremely wide spectrum of 3.1 to 10.6 GHz with 15 bands of bandwidth greater than 500 MHz and power limit less than -41.3 dBm/MHz announced by FCC for Ultra wide band. The release of this Spectrum has rapidly increased the research in UWB technology for communications, radar imaging, and localization applications. Radio systems based on UWB technology offer opportunities for transmission of high data rate signals, coding for security and low probability of intercept, especially in multi user network applications . UWB communication systems have the promise of very high bandwidth, reduced fading from multipath in mobile communication and low power requirements. In general, UWB radio systems transmit and receive temporally short pulses without carriers or modulated short pulses with carriers. Carrier free UWB radio systems usually employ very short pulses in the order of sub nanosecond (ns) as opposed traditional communication schemes which send sinusoidal waves. Antenna plays a major role in UWB applications because these antennas have to transmit short duration pulses without any pulse spread and as accurately as possible.DRA is one of the best antennas for UWB applications due to its attractive features like high radiation efficiency, low dissipation loss, small size, light weight, and low profile. Moreover, DRAs which possess a high degree of design flexibility, have emerged as an ideal candidate for wide band, high efficiency, and cost-effective applications. Recently more and more Ultra wideband antenna designs have been proposed especially Stacking of two DRAs, DRAs separated by wall, Antenna mounted on a vertical ground plane.

4.2 GEOMETRY OF ANTENNA

The size of DRA is 14mm length and 16.3 mm width and 6 mm thickness with dielectric onstant 10.2, and it is placed on 26 × 28 mm^2 substrate with dielectric constant 1.06 and thickness of 0.7 mm. The ground plane is partially printed below the substrate. The size of ground plane is 26 × 11.7 mm^2 on one side and a printed probe extends from the Microstrip line of the same width that ends with the 50Ω line after certain length. The other parameters are F_{L1} = 5 mm, FL2 =14.1 mm, FW1=1.9 mm, F_{W2} =1 mm. A slot of 10 mm × 3.5 mm is made in the ground in order to cover lower frequencies in the ultra-wide band.

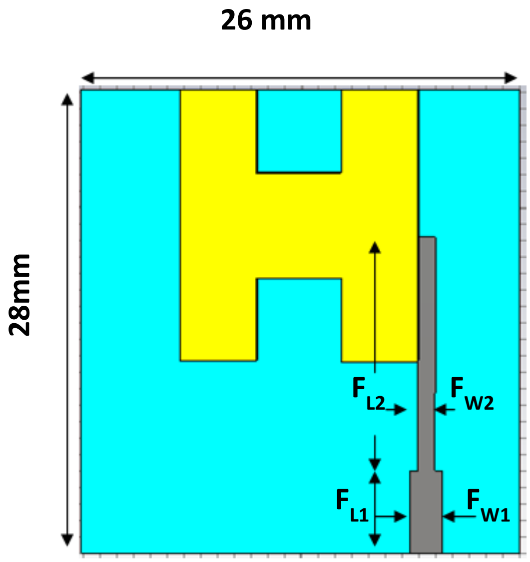


Fig. 4.1 Geometry of H-Shaped UWB DRA

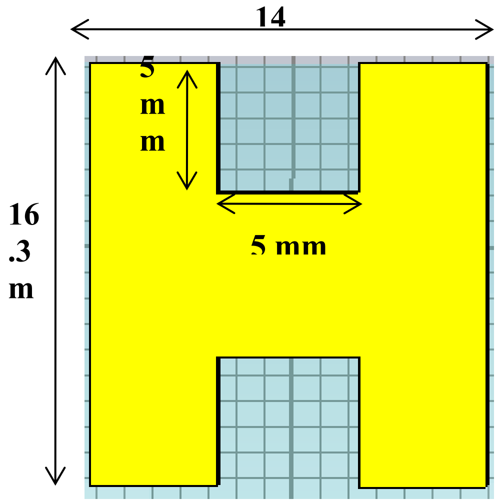


Fig. 4.2 Geometry of H-Shaped DRA

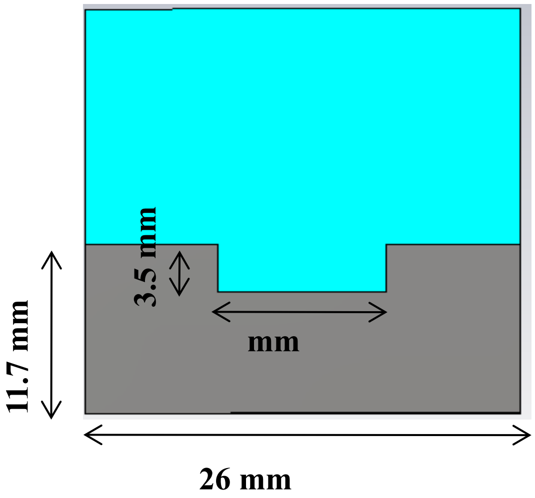


Fig. 4.3 Geometry of Ground plane

4.3 SIMULATED SETUP AND RESULTS

4.3.1 Simulation Setup

The commercial 3D full wave electromagnetic (EM) simulation software CST Microwave studio is used for simulation. It analyzes 3D and multilayer structures of general shapes. It has been widely used in the design of MICs, RFICs, patch antennas, wire antennas, and other RF/wireless antennas. It can be used to calculate Return loss plot, VSWR, current distributions, radiation patterns etc.

4.3.2 Return loss and Antenna Bandwidth

As described in chapter three, the bandwidth can be calculated from the return loss (RL) plot. The bandwidth of the antenna is said to be those range of frequencies over which the return loss is less than -10dB, which is equivalent to 2:1 VSWR. It was observed from many trials of simulations by changing the size of feed line it is observed it was approximately covering the UWB Fig.4.4, later the applying slot on the ground plane UWB is totally covered.Fig.4.5 Compares return loss with and without ground slot. With ground slot total ultra wide band is covered. The slot in the ground plane is affecting the lower frequencies.

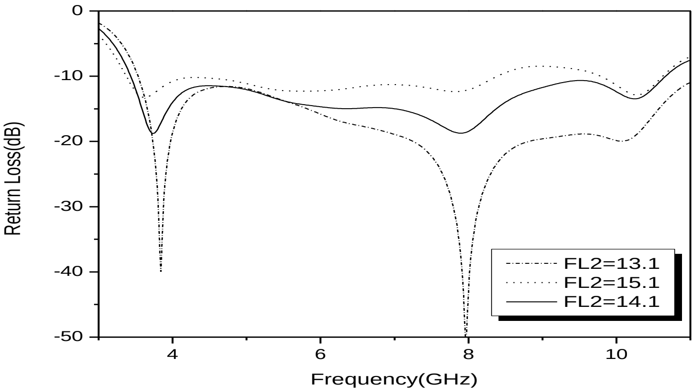


Fig.4.4. Return Loss for various feed lengths.

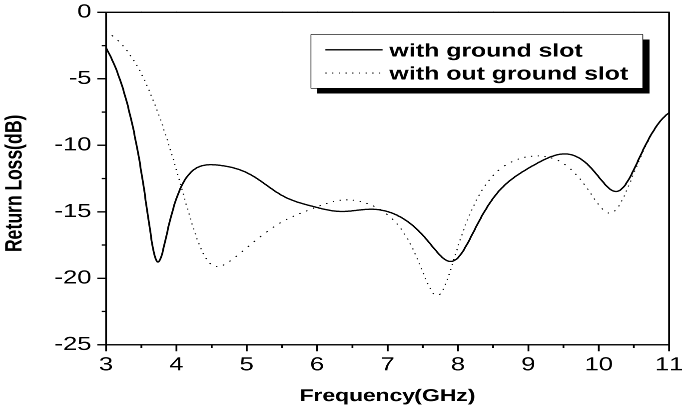


Fig.4.5 Variation of Return Loss with and without ground slot.

4.3.3 Input Impedance

The input impedance of the proposed antenna is nearly 50 ohms in almost entire range of frequencies of UWB which is shown in the Fig. 4.6

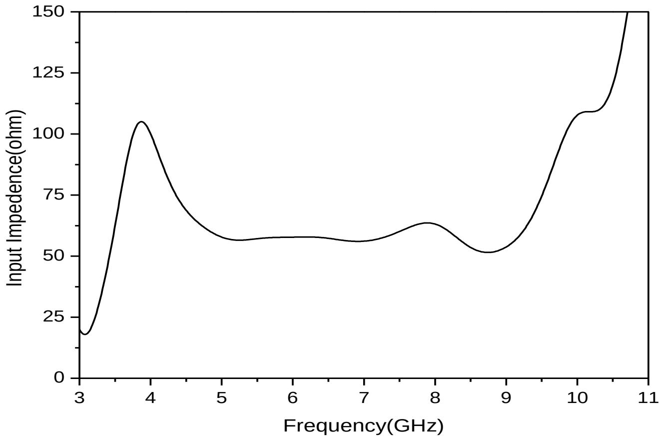


Fig.4.6. Input impedance of the proposed antenna.

4.3.4 Gain vs. Frequency Plot

In the H-Shaped UWB DRA the gain is well above 2dB for the entire Ultra wide band range.

Fig 4.7 shows the gain Vs. Frequency of the proposed antenna.

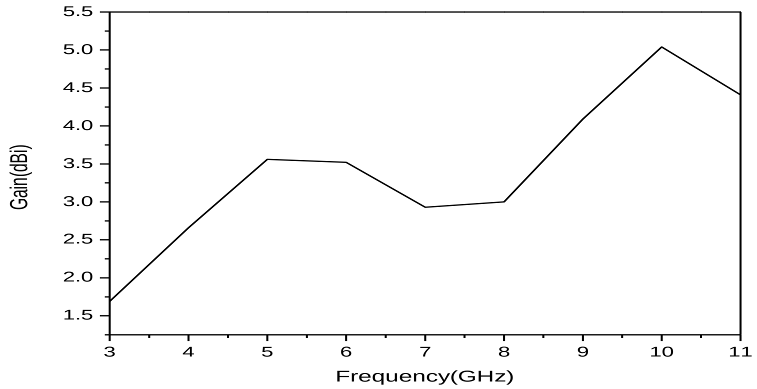


Fig. 4.7 Gain of the proposed antenna

4.3.5 Performance parameters of antenna

The performance of antenna is measured using two properties. They are Path loss and Group delay. The dispersion properties of the proposed antenna are presented in the Fig 4.8(a), 4.8(b). The path loss indicates the propagation performance. If this is not constant and its variation becomes large, the propagation performance between the transmitting and receiving UWB antennas are affected adversely and pulse communication becomes impossible. We show that the path loss varies almost constant when the two antennas are face to face and slightly distorted when they are side by side. The Group delay indicating the pulse distortion is important in UWB radio technology because it transforms the digital coding information into the impulse signals whose pulse duration is less than 1 ns. From Fig. 4.8(c) it is clear that the variation of the Group delay is less than 1ns in the operating frequency band. From the results we can expect that the characteristic of far field phase is linear in UWB frequency band and pulse communication will be possible.

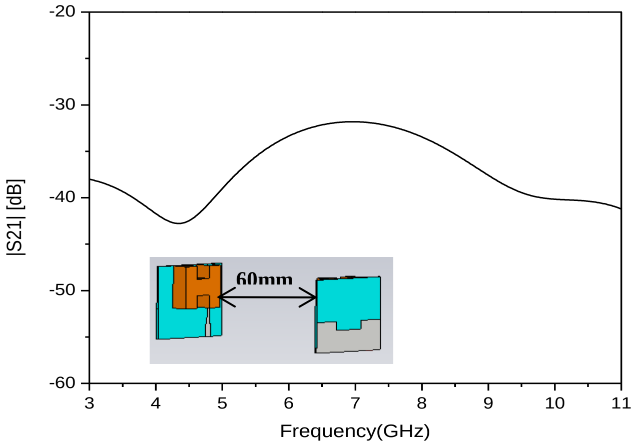


Fig.4.8 (a)

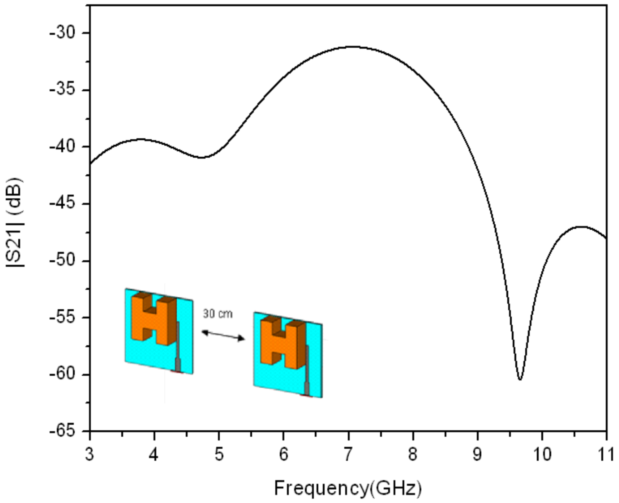


Fig.4.8 (b)

Fig. 4.8 Path loss of antenna (a) Face to Face (b) Side by Side.

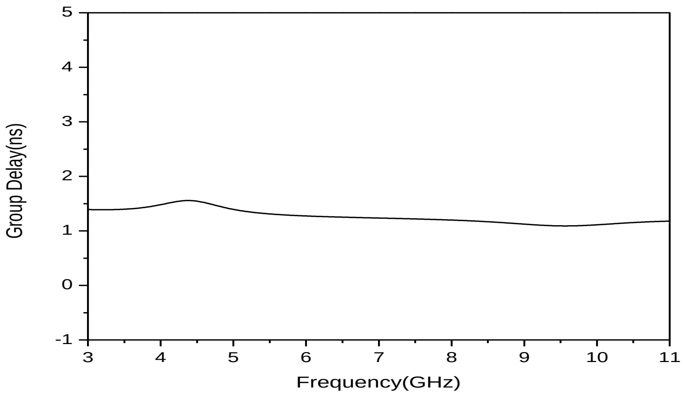


Fig. 4.8.1 Group delay of proposed antenna

4.3.6 TIME DOMAIN CHARACTERISTICS

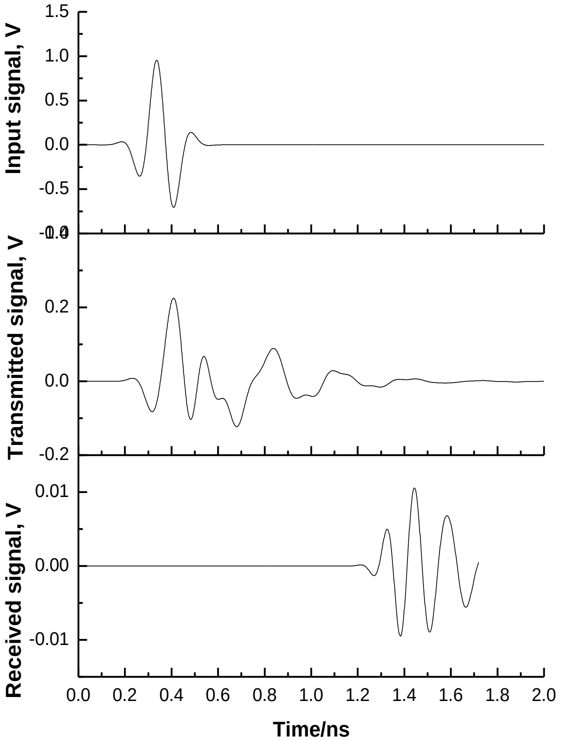


Fig.4.9 Input, Transmitted and Received signals.

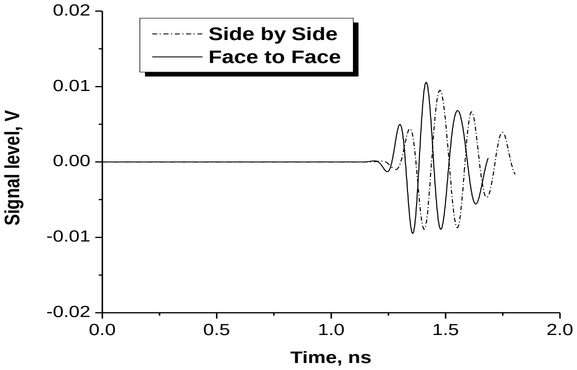


Fig.4.10. Received signals when antennas Face to Face and Side by Side

TX/RX setup	ρ
Antennas placed face to face	0.87
Antennas placed side by side	0.82

Table 4.1 correlation factor for the TX/RX setup

In addition to the distortion characteristics in frequency domain, it is necessary to consider the transmitted and received signals in the time domain. Fig. 8 shows the input and transmitted signals of first antenna and received signal at the second antenna when they are placed face to face at 30 cm apart. The received signals at the second antenna when they are placed face to face and side by side are shown in Fig. 4.9. A very slight difference between the received signals is observed. The amplitude of received signal when they are placed side by side is slightly less and there is small time delay in the received signal compared to antennas when they are placed face to face.

For evaluating the waveform distortion, a well-known parameter named correlation factor was calculated between the input signal at the transmitting antenna terminal and far-field electric field intensity signal. The correlation factor is given by

$$\rho = \max_{\tau}\left\{\frac{\int S_1(t)S_2(t-\tau)dt}{\sqrt{\int {S_1}^2(t)dt}\sqrt{\int {S_2}^2(t)dt}}\right\} \qquad (4.1)$$

Where $s_1(t)$ and $s_2(t)$ are transmitted and received signals respectively. If the correlation factor is unity then the received signal is same as transmitted signal but amplitude is less because of path loss but if the correlation factor is less than unity then the received signal is deviated from the transmitted signal. The transmitted and received signals are obtained from the port signals in the CST Microwave studio and correlation factor is calculated from the equation. From the obtained correlation factor shown in Table we can say, the antenna is suitable for UWB systems.

CONCLUSION

Dielectric resonator antenna for UWB has been designed. The antenna simulations shows indicated the best results in the gain and return loss. The path loss is almost constant when two antennas are placed face to face and slightly distorted when placed side by side and the variation of the Group delay is less than 1ns, in the operating frequency band. From the results we can expect that the characteristic of far field phase is linear in UWB frequency band and pulse communication will be possible.

CHAPTER

5

Inverted U-Shaped Dielectric Resonator Antenna for WLAN

5.1 INTRODUCTION

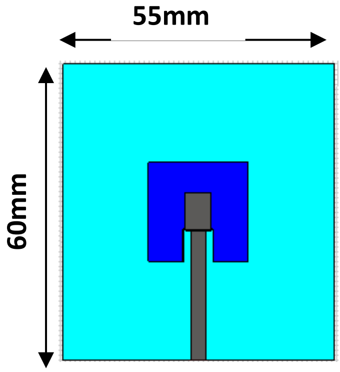
Rapid progress in wireless communication promises to replace wired communication in the near future in which antenna plays a more important role. The dielectric resonator antennas (DRAs), could be used for such applications due to their advantages including high radiation efficiency, flexible feed arrangement, simple geometry, proximity detuning and DRAs are not susceptible to tolerance errors as Microstrip antennas, especially at high frequencies. High – radiation efficiency, bandwidth and polarization flexibility make them by far superior to conventional Microstrip patch antennas. DRAs are intrinsically immune to those surface wave power leakage and conductor loss problems, which effects the Microstrip patch antenna and reduces their efficiency. The resonant frequencies of a DRA are predominantly determined by its size and shape, relative permittivity of the material ε_r, and the selected mode of operation. DRAs can be excited using probe, Microstripline, microstripslot, and coplanar waveguide coupling. DRAs frequently available in rectangular, cylindrical, and hemispherical geometries. Rectangular DRAs offer more design flexibility since two of the three of its dimensions can be varied independently for a fixed resonant frequency and known constant of the material. DRAs with high permittivity materials were used for W-LAN applications.

In this chapter an inverted U-shape antenna with Microstrip feed line and studied the performance of the antenna at various heights of rectangular patch at the center of Dielectric resonator. The proposed antenna is suitable for 802.11a WLAN which is resonating at 5.5 GHz.

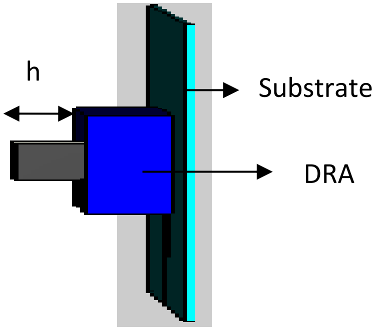
5.2 GEOMETRY OF ANTENNA

The proposed DRA consists of a dielectric resonator (DR) and a substrate with an area of 55mm X 60mm. The substrate selected is Rogers RT6002 with a thickness of 0.762mm and relative permittivity of 2.94 (εr).The dielectric resonators selected is Rogers TMM10i with a thickness 5.238mm and a dielectric permittivity ε_{rd}=9.2 . The area of DR is 20 mm × 20 mm with a slot of 7 mm 6.5 mm at the bottom side.

A rectangular patch is placed in between the inverted U-shaped patch with the dimensions 5.2 mm × 7 mm × 10mm as a feeding mechanism, which is connected with a 50 Ω Microstrip line. The Microstrip line is printed on one side of substrate with dimensions 3 mm × 30 mm and ground is below substrate. The rectangular patch- feed mechanism gives good coupling between the patch and DR.



(a)



(b)

Fig. 5.1. Geometry of proposed DR antenna. (a) Top-view (b) Side-view

5.3 SIMULATION SETUP AND RESULTS

5.3.1 Simulation Setup

The commercial 3D full wave electromagnetic (EM) simulation software CST Microwave studio is used for simulation. It analyzes 3D and multilayer structures of general shapes. It has been widely used in the design of MICs, RFICs, patch antennas, wire antennas, and other RF/wireless antennas. It can be used to calculate and Return loss plot, VSWR, current distributions, radiation patterns etc.

5.3.2 Return loss and Antenna Bandwidth

As described in chapter three, the bandwidth can be calculated from the return loss (RL) plot. The bandwidth of the antenna is said to be those range of frequencies over which the return loss is less than -10dB, which is equivalent to 2:1 VSWR. The height of rectangular patch for coupling is varied 2 mm to 10 mm and parametric study is performed which is giving the optimum result of resonating frequency 5.5GHz, return loss of -22.7dB at 10mm. When the height of the rectangular feed is changing the resonant frequency is changing and it is moving from right to left and the return loss is also increasing. Fig.5.2 Shows the simulated return loss which is about -22.7dB at 5.5GHz.

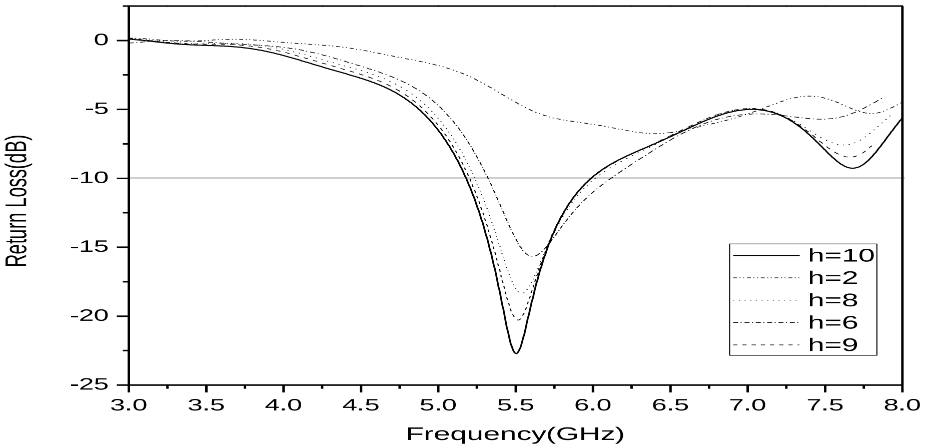


Fig. 5.2. Return Loss for various h values.

5.3.3 Gain vs. Frequency Plot

The gain of antenna is well above 6dBi in the frequency range. Fig 5.3 shows the gain Vs. Frequency of the proposed antenna.

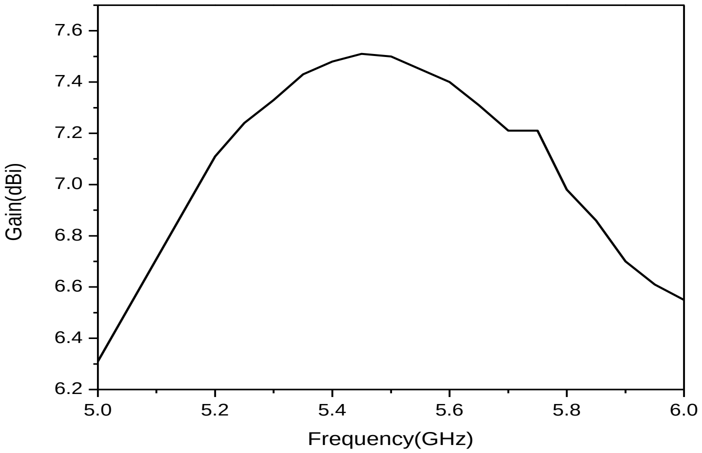
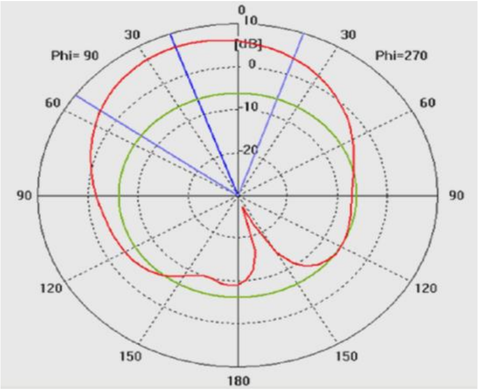


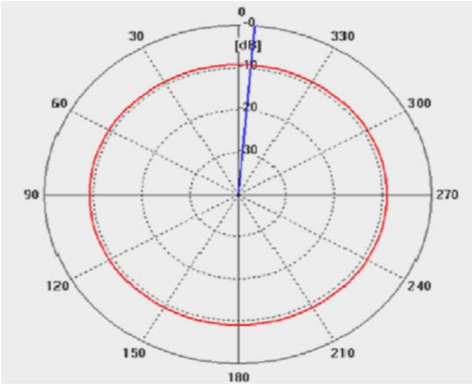
Fig.5.3. *Simulated Gain of the proposed Antenna.*

5.3.4 Radiation pattern plot

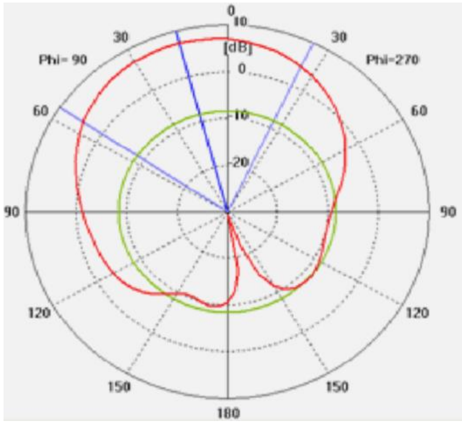
The simulated far field radiation pattern at 5.2 GHz, 5.5 GHz, 6 GHz are shown in Fig.5.4. From the H-plane which is shown in Fig. 5.4(b) we can say that the antenna radiates omnidirectional. The antenna radiates in the broadside direction.



(a)


0
-0
30
330
[dB]
-10
60
-20
300
-30
90
270
120
240
150
210
180

(b)


0
10
30
[dB]
30
Phi= 90
Phi=270
0
60
60
-10
-20
90
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120
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150
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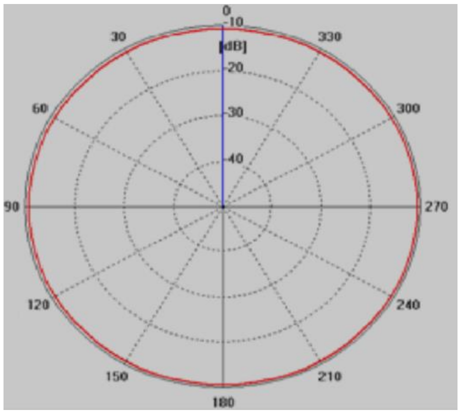
(c)


0
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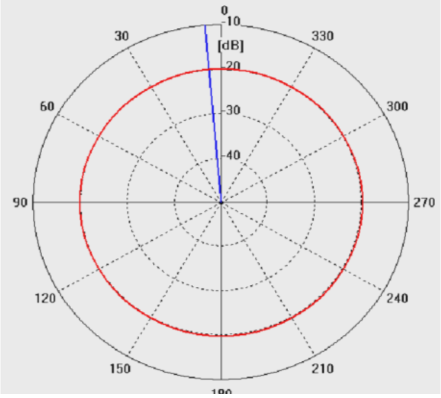
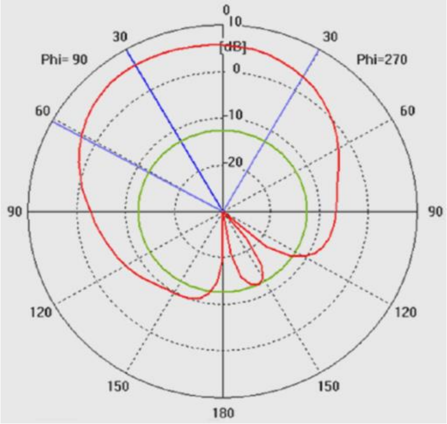
(d)



(e)



(f)

Fig. 5.4. Radiation patterns of proposed antenna (a) E-plane at 5.2 GHz. (b) H-plane at 5.2 GHz (c) E-plane at 5.5 GHz (d) H-plane at 5.5 GHz (e) E-plane at 6 GHz (f) H-plane at 6 GHz.

5.3.5 Performance parameter of antenna

The path loss indicates the propagation performance. If this is not constant and its variation becomes large, the propagation performance between the transmitting and receiving WLAN antennas become bad and the pulse communication becomes impossible. From the Fig. 5.5. we can show that the path loss varies almost constantly in the desired operating frequency range.

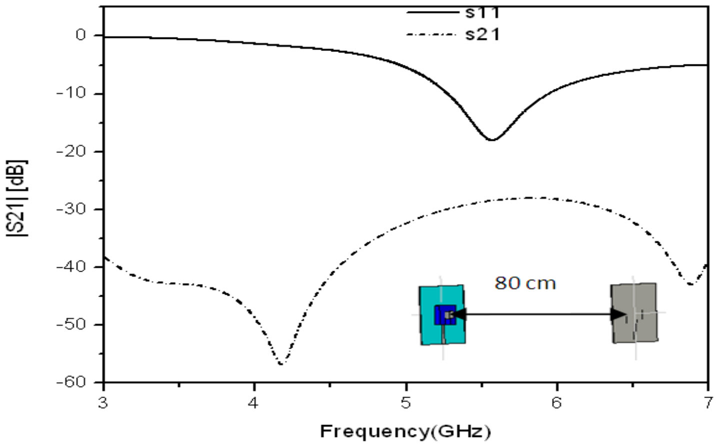


Fig. 5.5. Dispersion property of proposed antenna (Path loss)

CONCLUSION

Dielectric resonator antenna for WLAN which operates at 5.5GHz is designed. A microstrip feed line with a rectangular patch which has input impedance of 50 Ω is used for matching. The rectangular patch- feed mechanism gives good coupling between the patch and DR. The antenna simulations shows indicated the best results in the gain which is above 6dBi in the range of 5-6GHz band and return loss is -22.7dB at 5.5GHz and the radiation pattern is showing that this antenna can be used as Omni directional antenna.

CHAPTER

6

Compact Dual Band Hemi Spherical Dielectric Resonator Antenna

6.1 INTRODUCTION

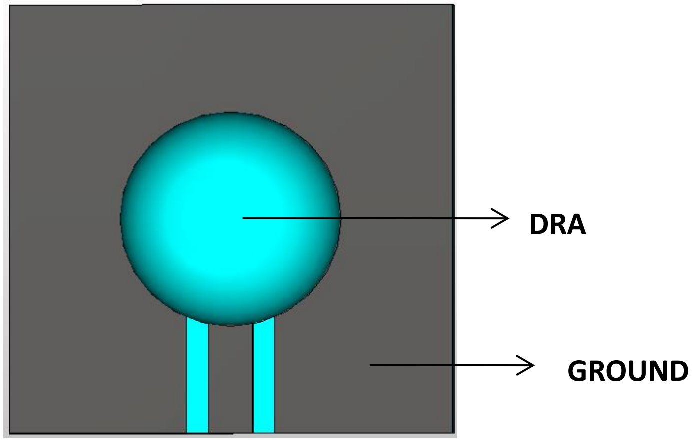
Dual or multi frequency operation is highly desirable in modern wireless communication systems. If a single dielectric resonator antenna (DRA) can support multi frequencies then the need for multi single frequency antenna is not necessary. Applications requiring different frequency bands can be operated simultaneously with one radiating element. This reduces the circuit size and leads to compact systems. The dielectric resonator antenna has many attractive features like wide bandwidths, low dissipation loss at high frequencies, high radiation efficiency due to the absence of conductors and surface wave losses, high permittivity, light weight and ease of excitation.

HYBRID DRA has attracted attention due to their dual band and wide band operation with increasing antenna size. The hybrid structure is a combination of DRA and another radiating resonator of feeding structure. These two radiating resonators are stacked tightly in order to get dual frequency of operation or wide band. The different types of feeding applied to DRA can be probe feeding, Microstrip line feeding, slot feeding, CPW feeding. The CPW fed slot arrangement offer more flexibility and is directly compatible with different mounting surfaces. The CPW feeding structure has many useful characteristics like low radiation leakage, less dispersion, little dependence of the characteristics impedance on substrate height and uniplanar configuration. There are two types of coupling mechanism for CPW fed line one is inductive coupling and the other is capacitive coupling. They also allow easy mounting and integration with other microwave integrated circuits and RF frequency devices.

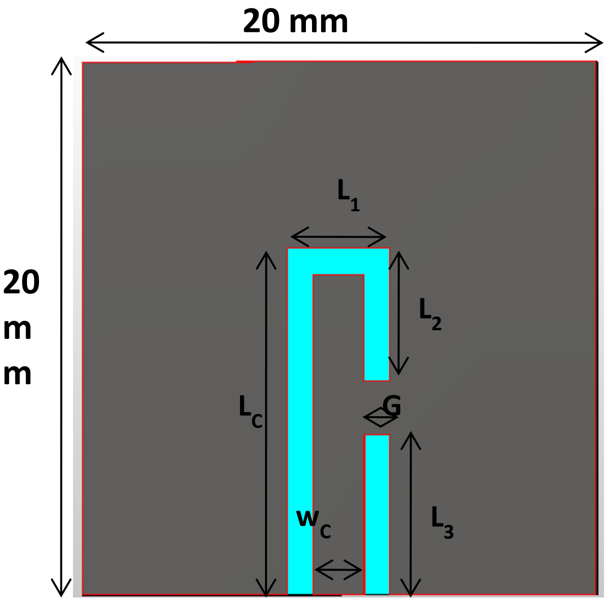
A compact hemispherical dielectric resonator antenna fed with CPW inductive slot which acts as one of the resonator is designed and simulated. The proposed antenna operates at dual frequency one at 2.4GHz which can be used for WLAN for IEEE 802.11 standard and other resonator is at 9.10GHz. The proposed antenna is very compact with good gain and can be used in mobile communication systems, WLAN dongles etc.

6.2 GEOMETRY OF ANTENNA

The proposed hemispherical DRA is shown in the fig. 6.1. It consists of a hemispherical DRA fed with CPW inductive slot. The ground of size 20mm × 20mm is printed on a FR4 substrate of thickness 1.6 mm and the dielectric constant 4.2. The hemispherical DRA has the radius R=5mm and dielectric constant 10 is properly placed over the ground with feeding structure in order to obtain dual frequency. The inverted L– shaped inductive slot resonates at approximately half wave length ($L_1+L_2+2R-2S\approx\lambda_g/2$) where $\lambda_g$is the guided wave length of the slot with Dielectric Resonator (DR) placed on it. The rest of the antenna parameters are shown in Fig.6.1 (b). L_c=13mm, L_1=4mm, L_2=4mm, L_3=6mm, G=1mm, W_c=2mm, S=2.



(a)



(b)

Fig.6.1. Proposed antenna (a) Front view (b) Feed geometry

6.3 SIMULATION SETUP AND RESULTS

6.3.1 Simulation Setup

The commercial 3D full wave electromagnetic (EM) simulation software CST Microwave studio is used for simulation. It analyzes 3D and multilayer structures of general shapes. It has been widely used in the design of MICs, RFICs, patch antennas, wire antennas, and other RF/wireless antennas. It can be used to calculate and Return loss plot, VSWR, current distributions, radiation patterns etc.

6.3.2 Return loss and Antenna Bandwidth

As described in chapter three, the bandwidth can be calculated from the return loss (RL) plot. The bandwidth of the antenna is said to be those range of frequencies over which the return loss is less than -10dB, which is equivalent to 2:1 VSWR. Several structures of feeding design was considered found changing the length of L2 and L3 and found that this feed design is optimum .The proposed antenna resonates at the dual frequency. The lower band is due to the CPW inductive slot while the higher band is due to the DR. The simulated lower band achieves impedance bandwidth of 18.63% (for S_{11}<-10 dB) from the Return loss graph shown in the Fig. 6.2. Ranging from 2.2 to 2.65 GHz with center frequency at 2.42GHz and the higher band achieves band width of 7% with center frequency at 9.13 GHz.

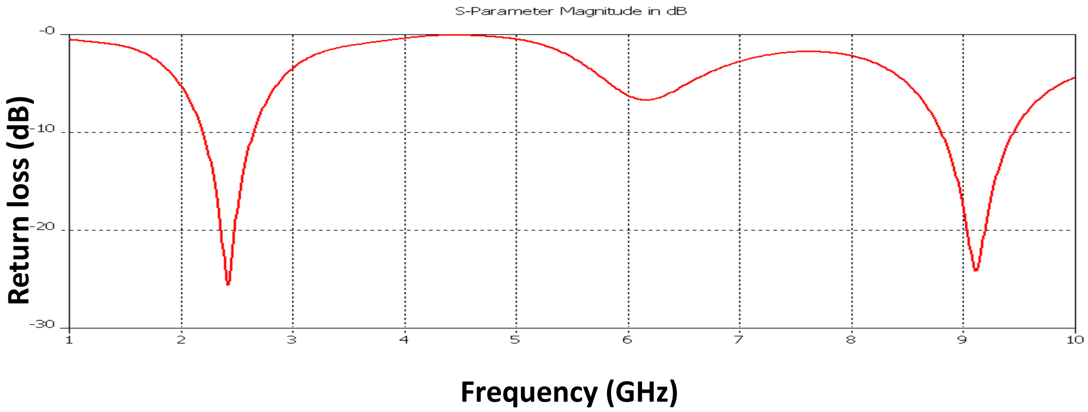
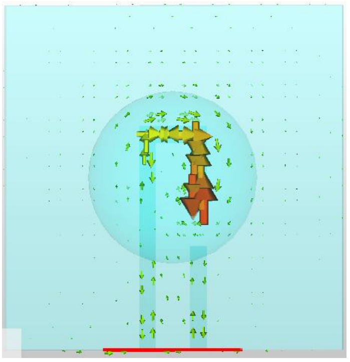


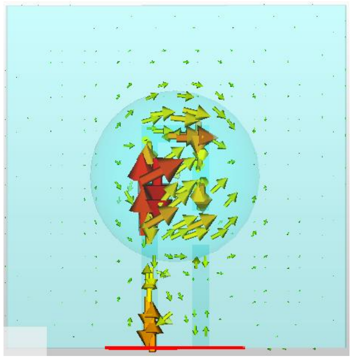
Fig.6.2. Simulated Return loss of the proposed antenna

6.3.3 Current distribution in the antenna

The current distribution shown in the Fig.6.3. Shows that at 2.4GHz total current is distributed across the inductive slot and the slot resonates at that frequency at 9GHz the current is totally distributed across the DR thus it gives the higher resonant frequency and dual is obtained.



(a)



(b)

Fig 6.3. Current distribution at (a) 2.4GHz (b) 9GHz

6.3.4 Gain vs. Frequency Plot

The gain vs. frequency graph shown in the Fig. 6.4. Shows that the gain at 2.4GHz is 2.36dBi and 9GHz it is 5.91dBi.

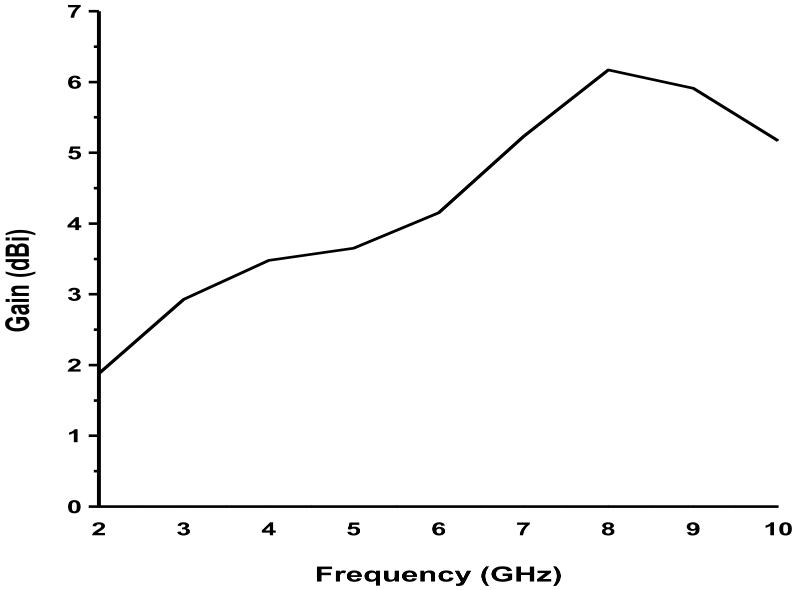
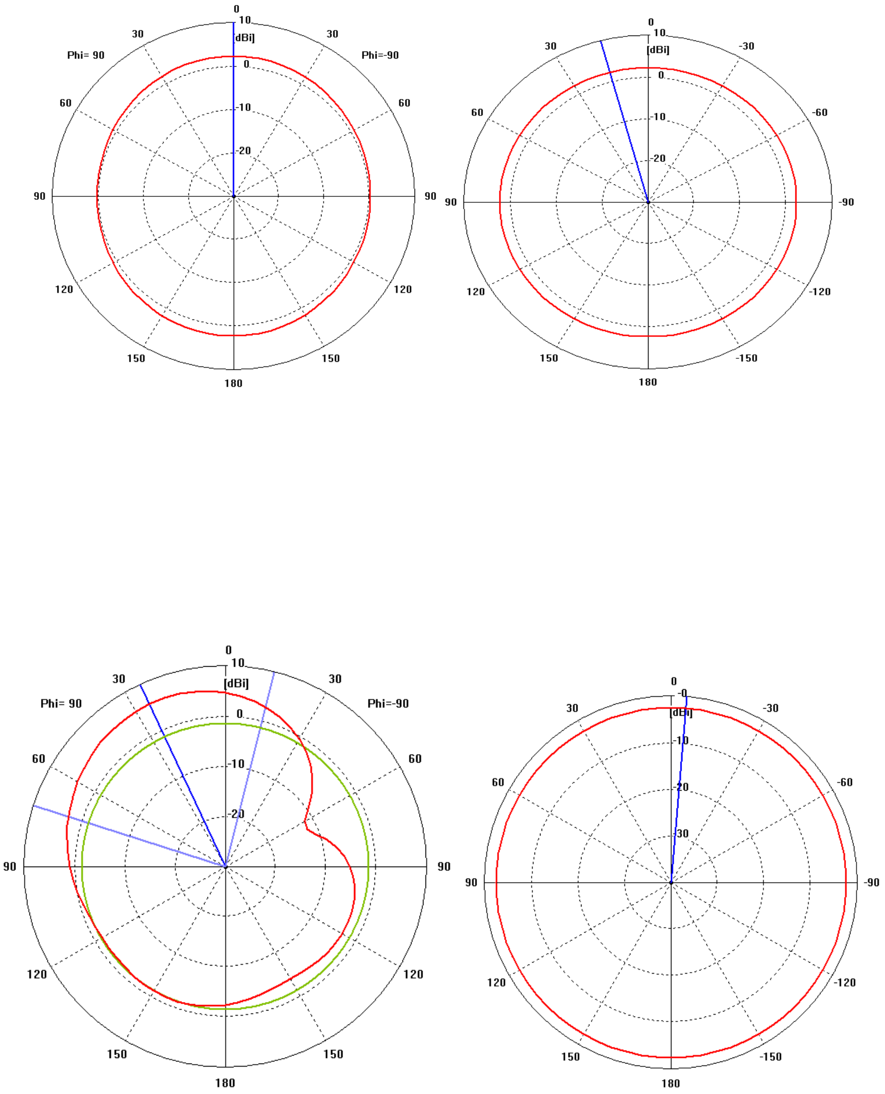


Fig.6.4 Simulated gain of the proposed antenna.

6.3.5 Radiation pattern plot

The radiation patterns at 2, 4 and 9 GHz are shown in the Fig.4. the patterns in the E-plane are near Omni directional when compared to the conventional dipole antenna because the asymmetric DR loading on the CPW inductive slot. The proposed antenna radiates a maximum in the broad side direction at both the frequencies.



E-Plane ***H-Plane***

Fig.6.5. Radiation pattern at 2.4 GHz and 9GHz.

6.4 PRACTICAL ANTENNA

When the same above proposed antenna is designed with dielectric constant of 2.1 the resonant frequency is shifted to 3.6GHz

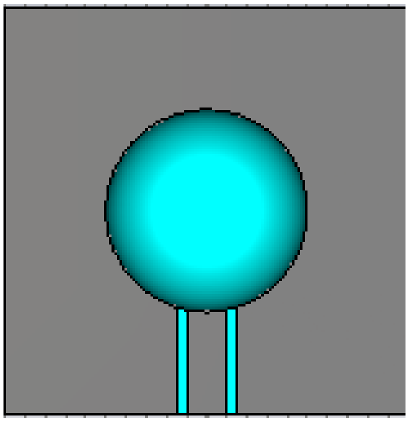


Fig.6.6 Practical antenna with dielectric constant 2.1

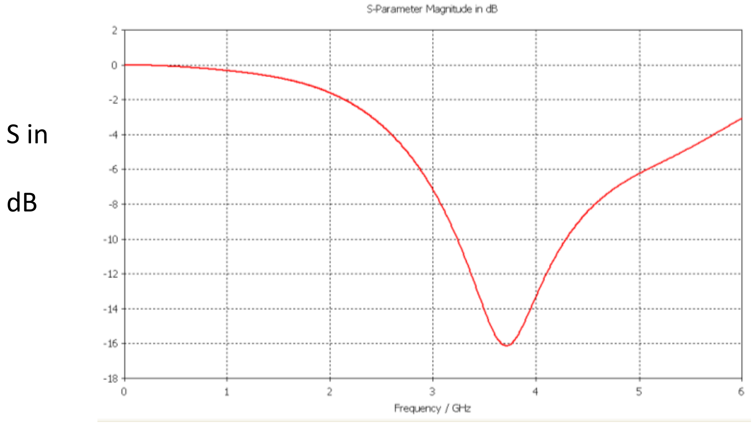


Fig. 6.6.1 simulated Return loss

For practical purpose when hemispherical DRA is replaced with square DRA for ease of fabrication with dimensions 5mm x 5mmthe resonant frequency is showing as 3.6GHz as per the return loss graph. Which means that shape of DRA is not effecting the resonant frequency , only the dielectric constant has major effect on the resonant frequency.i.e., when dielectric constant is 10 resonant frequency is 2.42 GHz an when it is lower to 2.1 the resonant frequency shifted to higher frequency at 3.6GHz.

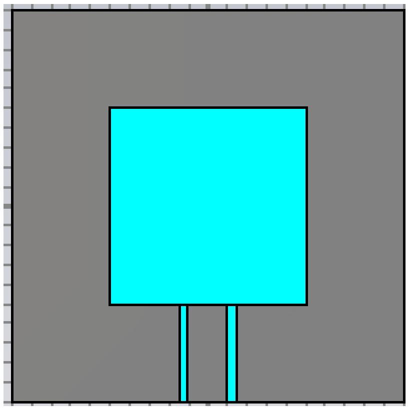


Fig.6.7 Practical antenna with dielectric constant 2.1 and square DRA

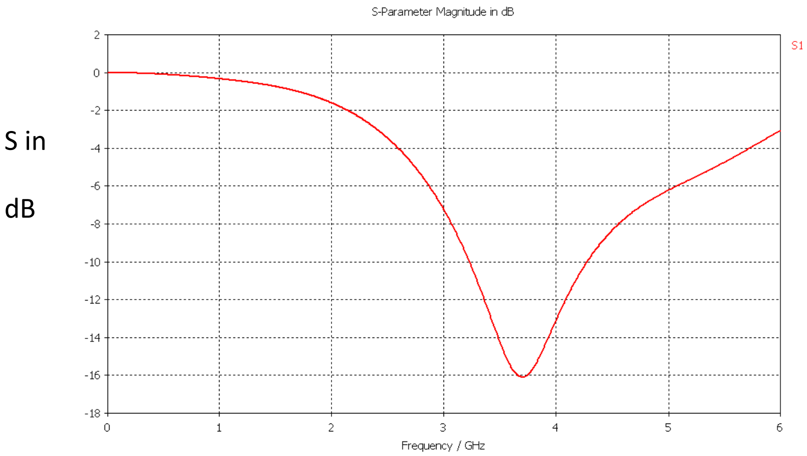


Fig. 6.7.1 simulated Return loss

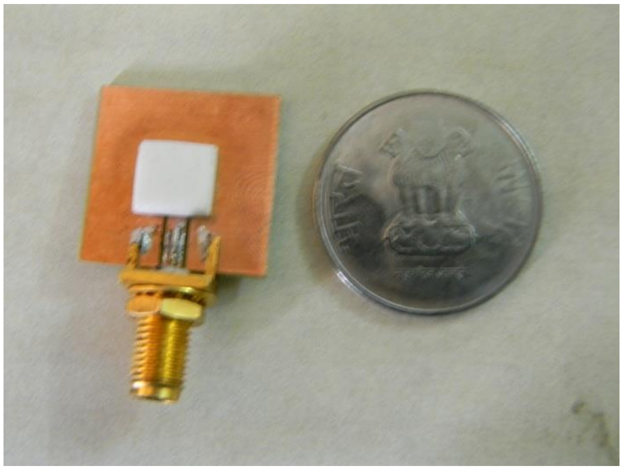
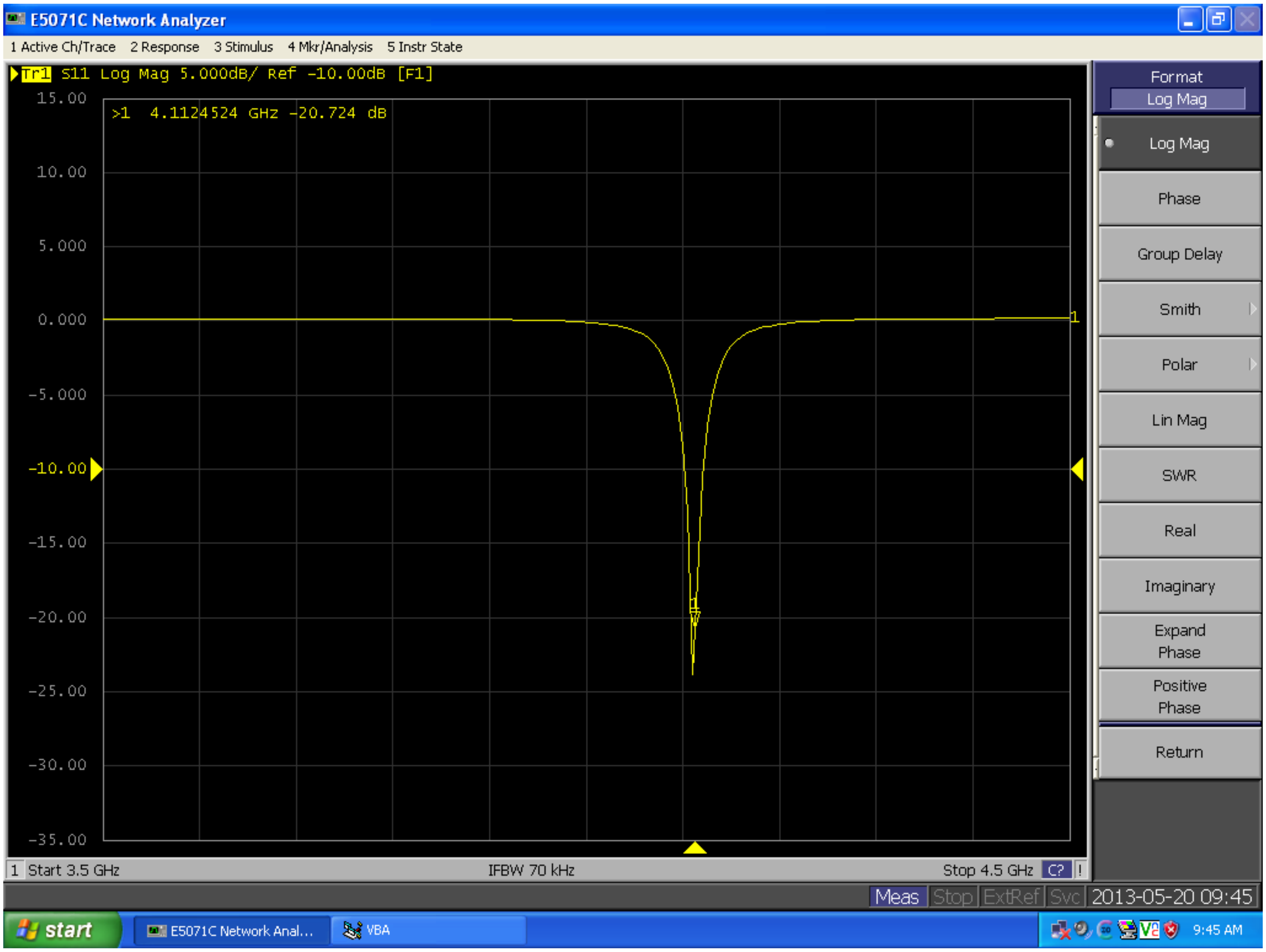


Fig. 6.7.2 Fabricated antenna


Tr1 S11 Log Mag 5.000dB/ Ref -10.00dB [F1]

>1 4.1124524 GHz -20.724 dB

1 Start 3.5 GHz IFBW 70 kHz Stop 4.5 GHz

Meas Stop ExtRef Svc 2013-05-20 09:45

Fig. 6.7.3 Measured return loss

CONCLUSION

Compact hemispherical DRA with dielectric constant of 10 was designed and simulated. Due to advantages of CPW feeding like low radiation leakages, less dispersion, this CPW feeding is used for this antenna. This antenna resonates at two different frequencies one at 2.42GHz and other at 9.13GHz. The proposed antenna is fabricated with dielectric constant of

2.1 and DRA with square shape and measured return loss shows that due to lesser dielectric constant the resonant frequency is shifted to 3.6GHZ which is used for WiMAX.

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSION

In these thesis three different dielectric resonator antennas for short range wireless communication application has been designed. Ultra-wide band (UWB) and WLAN are popular research and commercial topics for short range wireless communication.

In chapter 4 dielectric resonator antenna for UWB has been designed. The antenna simulations shows indicated the best results in the gain and return loss. The path loss is almost constant when two antennas are placed face to face and slightly distorted when placed side by side and the variation of the Group delay is less than 1ns. in the operating frequency band. From the results we can expect that the characteristic of far field phase is linear in UWB frequency band and pulse communication will be possible.

In chapter 5 dielectric resonator antenna for WLAN which operates at 5.5GHz is designed. A microstrip feed line with a rectangular patch which has input impedance of 50 Ω is used for matching.The rectangular patch- feed mechanism gives good coupling between the patch and DR.The antenna simulations shows indicated the best results in the gain which is above 6dBi in the range of 5-6GHz band and return loss is -22.7dB at 5.5GHz and the radiationpattern is showing that this antenna can be used as Omni directional antenna.

In chapter 6 compact hemispherical DRA with dielectric constant of 10 was designed and simulated. Due to advantages of CPW feeding like low radiation leakages, less dispersion, this CPW feeding is used for this antenna. This antenna resonates at two different frequencies one at 2.42GHz and other at 9.13GHz. The proposed antenna is fabricated with dielectric constant of 2.1 and DRA with square shape and measured return loss shows that due to lesser dielectric constant the resonant frequency is shifted to 3.6GHZ which is used for WiMAX.

FUTURE SCOPE

Fabrication of UWB antenna with dielectric constant 10.2 and measurement is to be done. While designing UWB antenna time domain characteristics, path loss and group delay is to be considered. For other applications like WLAN higher the dielectric constant lower the resonant frequency, as dielectric constant is reduced the resonant frequency shifts to higher frequencies.

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