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Analysis of Gain Improvement Techniques

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Abstract

A compact antenna is proposed and designed which is having high in-band selectivity. A via-fed monopole antenna is proposed with 'via' between radiator and ground plane. Different techniques have been used to make antenna with the frequency of operation 4.5 GHz. The different design techniques include are varying substrate thickness; using low dielectric substrate; using aperture coupling; and using Coplanar Waveguide. Further, the design need to be optimized to operate for the band 2.4-5.8 GHz with having ultra-wide band.

Keywords

Wideband, Via-fed, Impedance Bandwidth, Return Loss.

I. Introduction

As a result of expanding interest, the issue of rational use sharing and security of the radio range turned out to be essential. So the outcomes of the constrained radio range is the improvement of new advancements to build new technologies to increase the efficient use. Wide Band (WB) systems having wide data transmission range with low power spectral density and it is true that this increases efficiently the utilization of the radio frequencies. WB innovation depends on the utilization of exceptionally tight baseband technology based on the use of very narrow baseband pulses in the order of nanoseconds. These pulses result in spectral components covering a very wide bandwidth in the frequency domain. Because of this, WB can be utilized as a part of military applications that require low probability of detection. Other regular employments of WB are in radar and imaging advances. A WB definition was created as a signal with a fractional bandwidth greater than 0.2 or which occupies more than 500 MHz of spectrum which is defined as $2*(f_H-f_L) / (f_H+f_L)$ Where f_H and f_L are the upper and lower frequencies respectively measured at -10 dB below the peak emission point.

Wide Band, a remote interchanges innovation that can right now transmit information at velocities between 40 to 60 Mbps and in the long run up to 1 Gbps. WB transmits ultra-low power radio signs with short electrical heartbeats, frequently in the ps range. As a key part of the WB framework, a to a great degree broadband radio wire will be propelled in the recurrence range from 2.5–11 GHz, which has pulled in noteworthy exploration power in the late years. Difficulties of the practical WB recieving wire outline incorporate the WB exhibitions of the impedance coordinating and radiation security, the reduced appearance of the radio wire size and the low assembling cost for purchaser hardware applications. Over the assigned data transmission of WB framework, there are some other existing narrowband administrations that as of now possess frequencies in the WB band, for example, Wi-Fi. WB radio wire utilizes channels to stifle superfluous groups. In any case, utilizing channels without a doubt expand the intricacy of the WB framework and lead to increment in expense.

It is alluring to outline the WB reception apparatus with recurrence band of 2.5-3.5 GHz to minimize the potential obstructions between WB framework and narrowband frameworks. In this venture a smaller planar wideband reception apparatus with 2.5-3.5 GHz band attributes is examined. The recieving wire comprises of a slanted roundabout metal patch and a 50 Ω CPW transmission line. The proposed recieving wire has been effectively outlined and reproduced .The recreated come about additionally demonstrates stable radiation examples and consistent increase.

II. Literature Review

Wireless Communication innovation has altered our lives all through past few decades. Changed remote advancements like phones, Wi-Fi, Bluetooth, and so on that gives us the flexibility to talk with each other whenever and in anyplace. WB innovation has been utilized in the zones of radio identification and extending, detecting and military correspondences from the previous a quarter century however from the previous one decade inquiries about have a tendency to show interest towards making the WB extra fitting for computerized correspondence similarly with respect to the wellbeing applications. WB has been apace progressing as a promising high rate remote correspondence innovation.

The upsides of broadband region unit High Security since it has low normal transmission control that makes it evidence against recognition and interference. WB beats zone unit time-tweaked with codes unmistakable to each transmitter and recipient. WB beats even have Resistance to Interference. Some extra advantages incorporates durable Penetration capacity, less battery Power Consumption, High Performance in Multipath Channels.

The basic reception apparatus parameters important to deliver background information are Impedance Bandwidth measured by the characterization of both the VSWR and RL. The various other parameters are Directivity, Bandwidth, Gain, Polarization, Antenna power and Radiation Pattern.

III. Antenna Specifications

The given filter design given in this paper is named as Type-A [1].

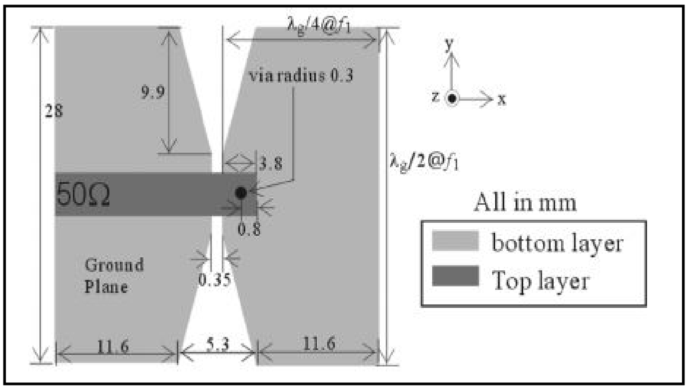
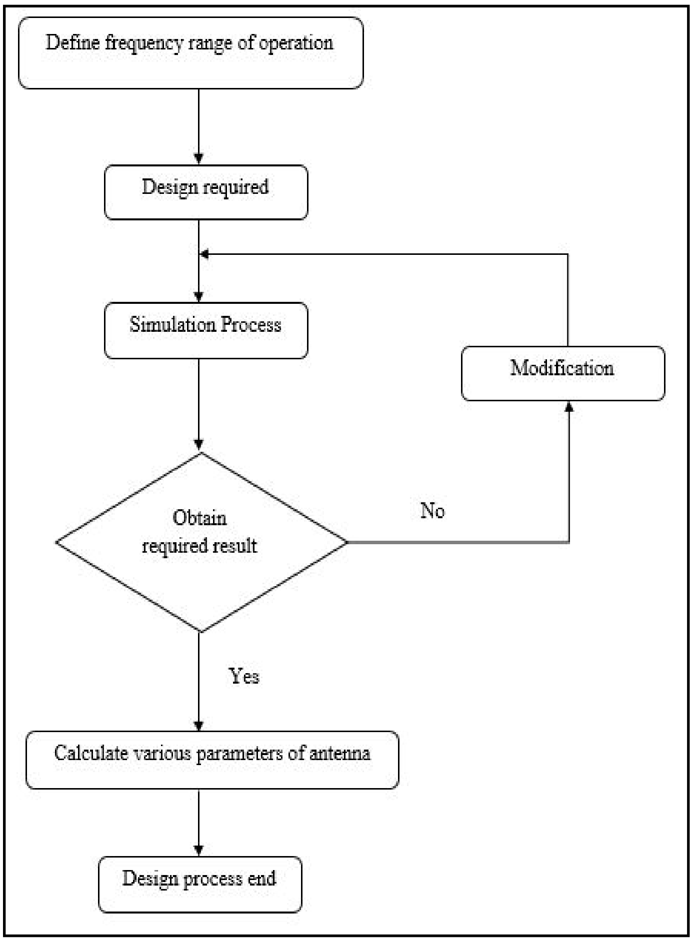


Fig. 1: Antenna Layout with dimensions

It was designed on low cost two sided PCB. The radiator and ground plane of the micro-strip line feeding line form a pair of tapered shape on the bottom layer of the PCB.The tapered shape provide a wideband matching of antenna to achieve good return loss within the UWB band.The top layer is a 50-ohm feeding line connected to the radiator on the bottom through via.The antenna given are designed with dielectric constant of 2.55, substrate thickness of 0.8mm, and loss tangent of 0.003 and the frequency used is 4.5 GHz. Figure 1 shows the design for antenna with dimensions.

IV. Design Methodology:



V. Simulation Results

The antenna is designed and simulated using HFSS, a 3-D model simulation tool for EM structures design and simulation.

Antenna Design

The Type-A antenna with the given specifications is designed and is shown in Figure 2. The various physical parameters are as:
X-axis = 28.5 mm, Y-axis = 28 mm.
Stripline Length = 16.9 mm,
Stripline Width = 2.26 mm.
Via radius = 0.3 mm.
Dielectric Constant = 2.55.
Substrate Thickness = 0.8 mm.

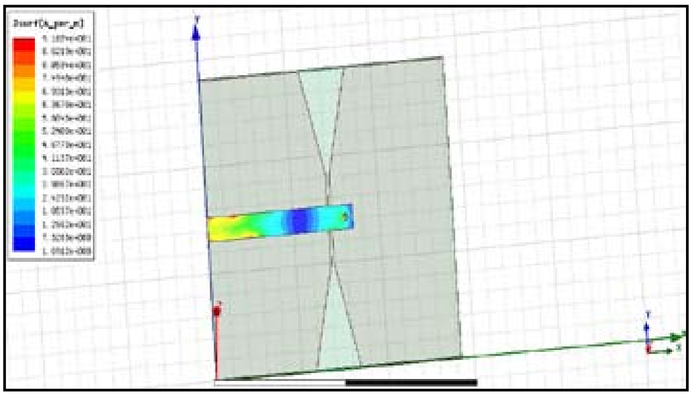
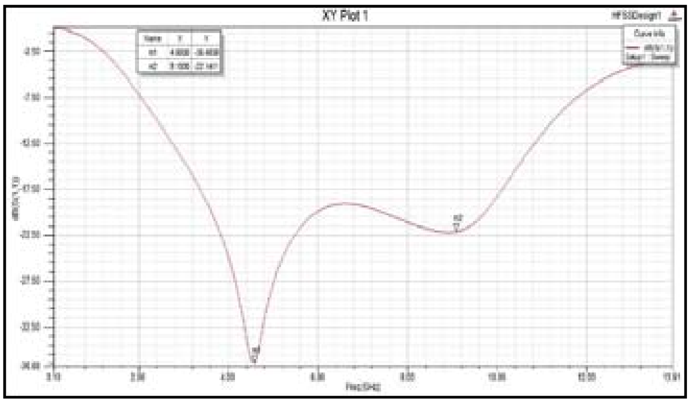


Fig. 2 : Designed Antenna

Result



As the design is made for 4.5 GHz frequency it will resonate at 4.5 and 9 GHz giving return loss of -36.48 dB and -22.14 dB respectively.The gain obtained is 1.43 dB and the given gain for the design at 4.5 GHz is 1.6 dB [1].
The gain obtained from the Type-A antenna is less, so design optimization is done in order to improve gain.

Optimization Techniques:

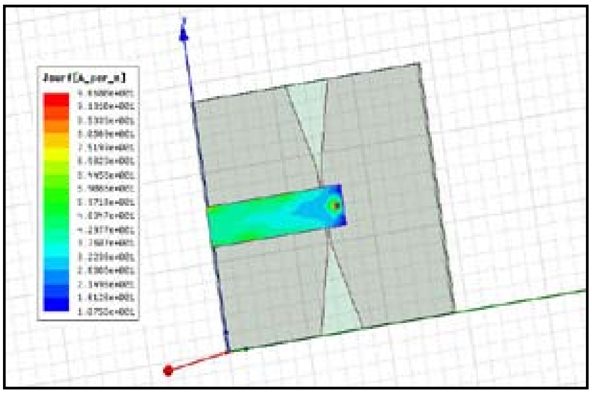
The various techniques involved for gain improvement includes:

- Varying the height of the substrate.
- Using reflector planes.
- Thick substrate with low dielectric constant.
- Insertion of air gap between top and bottom plane of antenna.
- Antenna loaded with metamaterial structure has the capability to increase the gain and reduce the return loss as its dielectric constant reduces because of the structure.

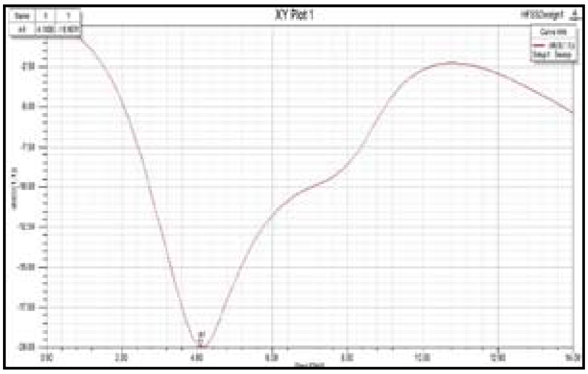
Antenna design using gain improvement techniques are as:

- **Varying Substrate height:** The effect of varying substrate height is supposed to be seen on the gain that by increasing substrate height keeping relative permittivity constant, gain will increase. Also, the effect on physical dimensions of antenna is that the width of the stripline will change in order to match impedance.

Design



Result Obtained:



The antenna resonates at 4.1 GHz.The return loss obtained from the design is -19.96 dB which gives the gain of 1.88 dB. The further optimization of antenna gives the return loss of -21.09 dB with gain of 2.64 dB.So, we can say that increasing the height of substrate while keeping relative permittivity constant, gain will increase.

The design is also simulated for air as substrate by taking the air gap as 0.8 mm and 1.6 mm which will give return loss at -15.08 dB and -19.07 dB respectively at 4.5 GHz. The relative permittivity for air used is 1.0006 and the width of the stripline for 0.8 mm gap is 3.92 mm and for that of 1.6 mm gap is 7.85 mm.

Comparison table for various designs

Design Type	Parameters	Return Loss (dB)	Peak Gain (dB)
Base Paper Design	L = 16.9 mm W = 2.26 mm Substrate thickness = 0.8 mm Relative Permittivity = 2.55	-34.85 at 4.5 GHz	1.38
Varied Substrate Thickness	L = 16.9 mm W = 4.52 mm Substrate thickness = 1.6 mm Relative Permittivity = 2.55	-21.09 at 4.1 GHz	2.64
Air substrate	L = 16.9 mm W = 3.92 mm Substrate thickness = 0.8 mm Relative Permittivity = 1.0006	-15.08 at 4.5 GHz	1.24
Air substrate with increased thickness	L = 16.9 mm W = 7.85 mm Substrate thickness = 1.6mm Relative Permittivity = 2.55	-19.07 at 4.5 GHz	1.29

VI. Conclusions

The main objective of this work is to make a wireless antenna and to analyze various gain enhancement techniques. In this paper, we used increased thickness and low dielectric substrate, which will verify the techniques mentioned. Also the effect of varying thickness can be seen on the width of the strip line structure.

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