MINIATURIZED UWB ANTENNA STRUCTURE FOR MICROWAVE RADAR SYSTEM

Hridesh Kumar Verma[1], Dr. Praveen Kumar Maduri[2], Deepanshu Bhargava[3], Gaurav Yadav[4], Himanshu Pandey[5]
[1, 2,3,4,5] Department of Electronics and Instrumentation
Galgotias College of Engineering and Technology, Greater Noida-201306

Abstract- A compact microstrip line-fed ultra wide band (UWB) antenna is presented. The proposed antenna is fabricated onto an inexpensive GML 1000 substrate with an overall dimension of 30 X 32 mm^2.The experiment shows that the proposed antenna achieves good impedance matching constant gain, stable radiation patterns over an operating bandwidth of 3.1 – 10.7 GHz , which covers the entire UWB. The nearly stable radiation pattern with a maximum gain of 4.7 dBi makes the proposed antenna suitable for being used in UWB communication applications.

Introduction

The admiral benefits of wireless lifestyle have led to in a huge demand for advanced wireless communication. The quick strengthened growth of the wireless communication market is expected to continue in the future since the claim of all wireless services is increasing. New wireless generation systems endeavour to provide high data rates as well as a wide range of applications of video and data to the portable users while supplying as many users as possible. However, this trend is limited by available resources like spectrum, power and co-existence of wireless devices. Thus innovative technologies that can co-exist with devices operating on the crowded bands, are required to overcome the limited bandwidth and provide high data rates. [1]

In February 2002, federal communications commission (FCC) released a wide new unlicensed spectral band of 7.5 GHz for the commercial operation of ultra wideband technology.[2] Since then, UWB has been considered as one of the most promising wireless technologies to revolutionize high data rate transmission. UWB technology has offered unique advantages not achievable by conventional narrowband technology. These advantages are low power consumption, high speed transmission, immunity to multi path propagation, and simple hardware configuration. [3]

UWB communication techniques have attracted a great deal of interest both in the academia and industry in the past few years because of high merit of their advantages. All wireless systems and applications including UWB ones need a mean of transferring energy or signal from the apparatus to free space in the form of electromagnetic waves or vice versa which is an antenna. It has been recognised as a critical element of the successful design of any wireless device. Since the wireless systems are highly dependent on their antenna characteristics. Based on that, UWB antennas have been an important and active area of research and have presented antenna engineers with major design challenges.

UWB offers as an attractive solution to a wide variety of applications. UWB has the potential for very high data rates using very low power at very limited range. It makes UWB became part of the wireless world which includes broadband wireless, radar communications, high speed WPAN, wireless sensor networks, wireless telemetry, and telemedicine. Also due to the excellent time resolution and accurate ranging capability of UWB, it can be used in positioning and tracking applications such as radar imaging systems, ground penetration radars, surveillance systems and medical imaging. For many applications, such as ground penetrating radars, high data rate short range wireless local area networks, ultra wideband (UWB) short pulse radars and UWB channel sounding, UWB directional or Omni-directional antenna is required.

Some considerations should be taken while designing the UWB antenna. According to the FCC's definition, a suitable UWB antenna should provide an absolute bandwidth no less than 500 MHz. This is the minimum bandwidth but generally the UWB antenna should operate over the entire 3.1-10.6 GHz frequency range. The UWB antenna performance is required to be consistent over the whole equipped band. Ideally, antenna radiation patterns, gains and impedance matching should be stable across the entire band. High radiation efficiency is required because any unwarranted losses incurred by the antenna could affect the functionality of the system. A suitable antenna should be physically compact and preferably planar to be compatible to the UWB unit.

Antenna Configuration

The proposed antenna has simple geometry. The proposed antenna is designed on GML1000 substrate of thickness 0.762, with relative permittivity 3.2. The characteristics impedance of the microstrip line is taken as 50Ω.

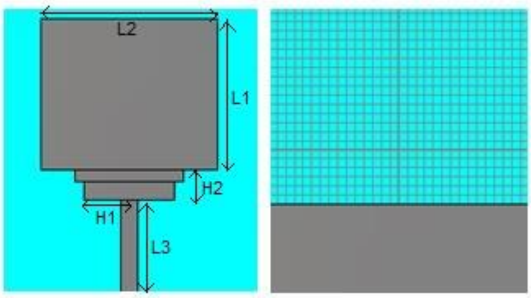

Figure 1 Proposed Antenna (a) Front View (b) Back View

Dimension	Size (in mm)
L1	16.6
L2	19.46
L3	10.5
H1	5
H2	3.2

Table 1: Table showing dimension and size of proposed antenna

The slot in the ground plane has strong coupling to the feeding structure. Therefore, by properly selecting the slot shape and tuning stub, good impedance bandwidth and radiation characteristics can be achieved. The overall dimension of the proposed antenna is 30 X 32 mm^2. The sizes of different dimensions are mentioned in table 1. The ground of the proposed antenna is of dimension 30 X 10 mm^2.

Results and Analysis

The results are simulated on **CST MICROWAVE STUDIO^{TM} SUITE 2010.** The experiment shows that the proposed antenna achieves good impedance matching constant gain, stable radiation patterns over an operating bandwidth of 3.1 –10.7 GHz , which covers the entire UWB.

Input Impedance

The input impedance characteristic of the proposed antenna is given in Fig. 2. Fig. 2 shows a graph between frequency (in GHz) and S parameter S_{11} magnitude (in dBi). Two dominant nulls are observed in the characteristics. Despite being compact in size, the antenna still achieved wideband width to cover the entire UWB.

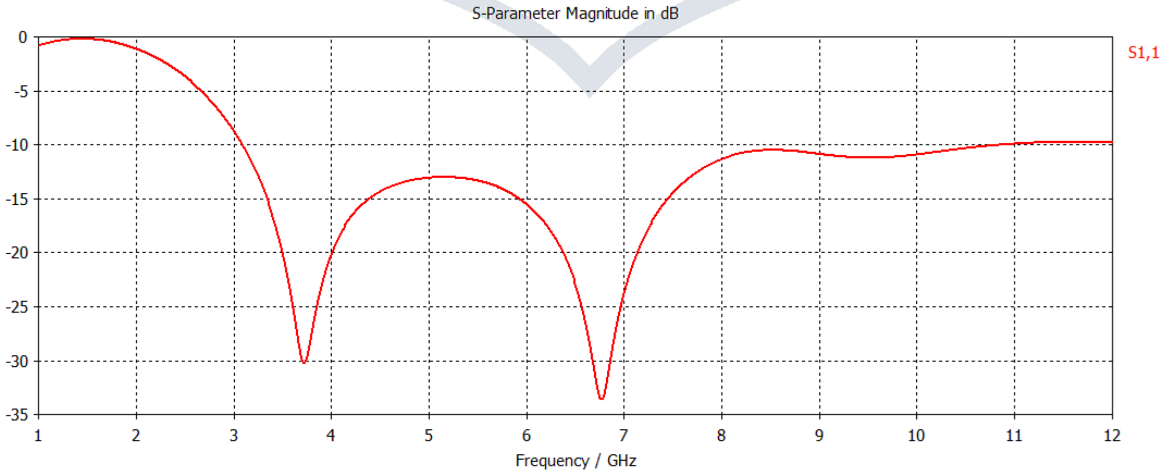

Figure 2 S_{11} vs Frequency graph RETURN LOSS S_{11} RESULT

Radiation Pattern

The measured normalized radiation pattern in the E-plane and H-plane are shown in Fig.3. The toroidal-like pattern is almost omnidirectional at the measured frequencies in the E-plane, while it exhibits nulls in the H-plane. The patterns show little variation with frequency.

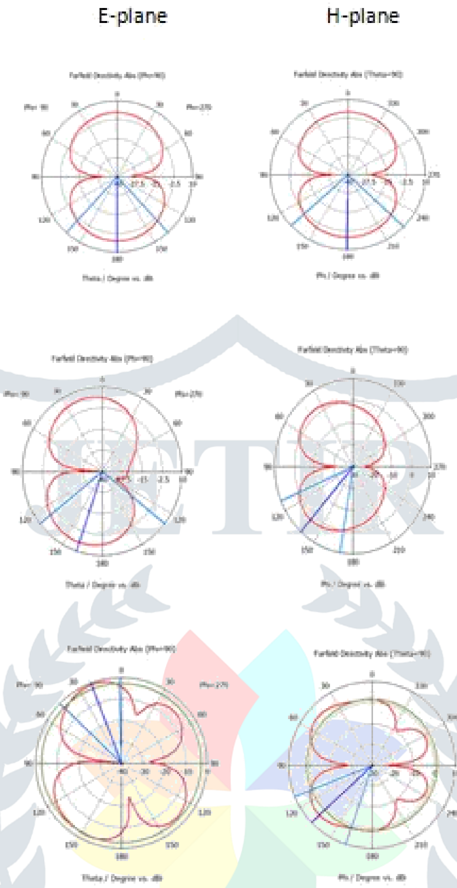

Figure 3 Radiation Pattern of proposed antenna at three different frequencies. (a) 3 GHz (b) 6.5 GHz (c) 10 GHz

Frequency	Plane	Main Lobe Magnitude	Main Lobe Direction	Angle Width (3 dBi)
3 GHz	E-plane	2.3 dBi	180 deg.	84.6 deg.
	H-plane	1.4 dBi	179 deg.	93.6 deg.
6.5 GHz	E-plane	4.3 dBi	161 deg.	103.3 deg.
	H-plane	2.4 dBi	138 deg.	57.3 deg.
10 GHz	E-plane	-0.8 dBi	21 deg.	44.2 deg.
	H-plane	4.7 dBi	133 deg.	49.3 deg.

Table 2: Table showing main lobe magnitude, main lobe direction and Angle width

The radiation pattern is calculated for three different frequencies at 3 GHz, 6.5 GHz and 10 GHz. It can be observed that at the low frequency of 3 GHz, the radiation pattern in the -plane is omnidirectional with low cross-polarization values. At a higher frequency of 6.5 GHz, the radiation pattern is still approximately Omni directional. At a higher frequency of 10 GHz, the radiation patterns become directional with some nulls due to the excitation of higher-order current mode. The nulls observed in both E and H planes may also be due to the fact that the microstrip feed line is directly printed below the ground plane.

CONCLUSION

A compact microstrip line-fed ultra wideband antenna has been proposed. The proposed antenna is fabricated onto an inexpensive GML 1000 substrate with an overall dimension of 30 X 32 mm^2. The simulation on CST MICROWAVE STUDIO^{TM}

SUITE 2010 shows that the proposed antenna achieves good impedance matching constant gain, stable radiation patterns over an operating bandwidth of 3.1 –10.7 GHz , which covers the entire UWB. The nearly stable radiation pattern with a maximum gain of 4.7 dBi makes the proposed antenna suitable for being used in UWB communication applications.

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