International Journal of Smart Sensor and Adhoc Network

Volume 2 | Issue 1 Article 12

October 2011

An Overview on Properties, Parameter Consideration And Design of Meandering Antenna

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Abstract -Meander line antenna (MLA) is an electrically small antenna. Electrically small antennas pose several performance related issues such as narrow bandwidth, high VSWR, low gain and high cross polarization levels. In this paper overview on properties, parameter consideration and design of MLA is proposed. The proposed antenna is designed for USB based application. The antenna performance parameters are optimized to achieve reasonably wide impedance bandwidth, high gain, VSWR < 2 and an omni directional radiation pattern. Moreover, the current distribution and the effect of the ground plane size on the altered MLA are discussed in this paper.

Index Terms—*Meander Line,VSWR, polarization,USB.*

I. INTRODUCTION

Now a day's due to rapid changes in wireless communication technologies, there is tremendous increase in data rate and at same time reduction in antenna size and weight is demanded. There are varieties of techniques to reduce the size of microstrip antennas: use of high permittivity substrates [1], shorting pins [2], and meander line. Inserting suitable slots in radiating patch is also a common technique in reducing the dimensions of patch antenna. The slots introduce parasitic capacitances which tend to reduce the resonant frequency of the antenna .For wireless communications applications such as USB Dongle, radio frequency identification tags, Bluetooth headset, Mobile phone Mean dear line antenna is convincing solution [3]. Meander line antenna is one type of the micro strip antennas. The meander line antenna was proposed by Rashed and Tai for reduce the resonant length [4]. Meandering the patch increases the path over which the surface current flows and that eventually results in lowering of the resonant frequency than the straight wire antenna of same dimensions.

This paper presents an overview on properties, parameter consideration and design printed meander antennas in the ISM band by providing a good initial geometrical configuration of the antenna. This article has been divided into four sections. Section II describes in detail properties of meander line. Section III describes meander line design. The structure of proposed antenna discuss in section IV. The results obtained from our proposed antenna are listed and discussed in Section V. Finally concluding remarks are presented in Section VI.

II. PROPERTIES OF MEANDER LINE

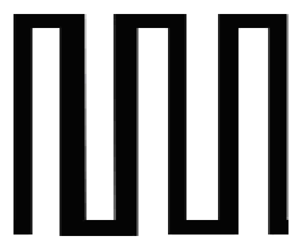


Fig.1 Meander Line Structure

The electrical small antenna defines as the largest dimension of the antenna is no more than one-tenth of a wavelength [5]. Meander antenna is electrically small antenna .The design of meander line antenna is a set of horizontal and vertical lines. Combination of horizontal and vertical lines forms turns. Number of turns increases efficiency increases. In case of meander line if meander spacing is increase resonant frequency decreases. At the same meander separation increase resonant frequency decreases [6]. A meander antenna is an extension of the basic folded antenna and frequencies much lower than resonances of a single element antenna of equal length. Radiation efficiency of meander line antenna is good as compare to conventional half and quarter wavelength antennas. Antenna size reduction factor β depends primarily on the number of meander elements per wavelength and spacing of element widths of the rectangular loops [7].

The meander line element consists of vertical and horizontal line so it formed a series of sets of right angled bends. The polarization of antenna depends on radiations from the bend. The spacing between two bends is very vital, where if the bends are too close to each other, then cross coupling will be more, which affects the polarization purity of the resultant radiation pattern. In other case the spacing is limited due to the available array grid space and also the polarization of the radiated field will vary with the spacing between the bends, and the spacing between the micro strip lines [8]. The width of etch (line etch on PCB) is used here is 0.5 mm.

Planar meander line antenna with added quarter sfera parasitic element at the both side of the meander can produce double beam radiation pattern at frequencies much lower than resonances of a single-element antenna of equal length [9].

A planar meander line monopole antenna element is the most suitable choice for the MIMO antenna system.

III. MEANDER LINE DESIGN

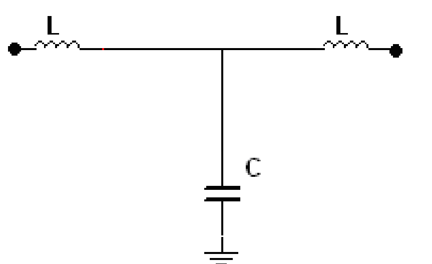


Fig.2 Lumped equivalent model of meander

The meander line antenna acts as a resonant LC circuit. The vertical elements act as the inductor, horizontal elements act as capacitor. The horizontal lines lie in the short length of the PCB while the vertical lines are placed along the long length of the PCB. The meander line configuration of the monopole allows reducing the occupied space of the antenna element to less than $0.1\lambda_0$ in each dimension.

The lumped inductance and capacitance are calculated as follows:

Lumped inductance $L_A = \frac{Ll}{2}$

Lumped capacitance $C_B = Cl$

Where L inductance per unit length is, C is capacitance per unit length and l is length of line segment [10].

Total length of antenna is given by

$$N \times S = \lambda / 10$$

Where N number of turns, S is spacing between two meander lines

The characteristic impedance of each meander section given as:

$$Z_o = 276 \log\left(\frac{2S}{d}\right)$$

Where d is the monopole wire diameter.

IV. STRUCTURE OF AN ANTENNA

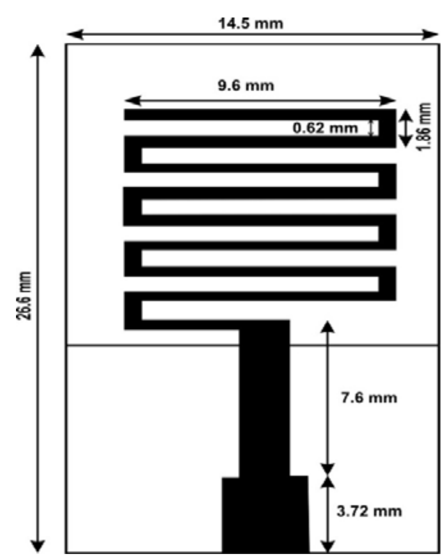


Fig.2 Proposed antenna structure

The MLA is created using meander line and shaped ground as shown in Figure 2; on rectangular FR4 substrate. Height of the substrate is 1.59 mm with relative permittivity 4.4 and ground of size 13.33 mm x 10.04 mm. The total USB dongle PCB area is typically about 14.5mm×26.6 mm where the antenna area. Quarter Wave Transformer is used for impedance matching purpose.

V. RESULTS AND DISCUSSION

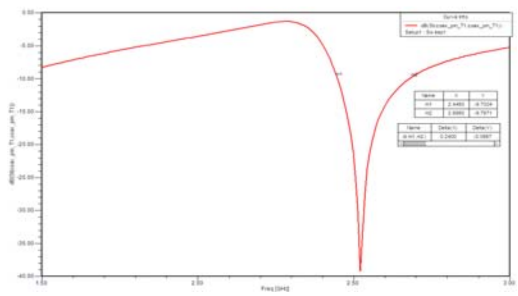


Fig.3 Simulated return loss for proposed MLA antenna

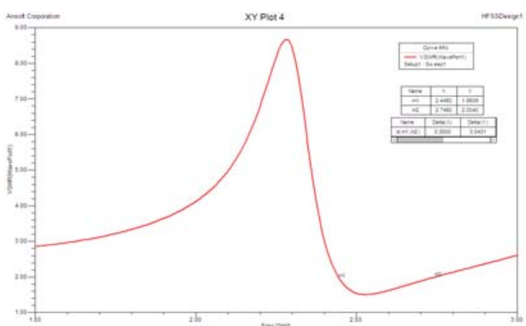


Fig.4 Simulated VSWR for proposed MLA antenna

This section presents the simulated results of modified MLA. HFSS has been used to simulate the antenna for several performance parameters such as impedance bandwidth, radiation patterns and VSWR. The parametric study of the antennas reveals the band behavior. The antenna is designed to operate on 2.5 GHz ISM band. Fig. 3illustrates the S11 of MLA; where it shows a return loss of -39.1 dB for the operation on 2.5 GHz. The impedance bandwidth calculated at -10 dB scale for this band is 240 MHz.

The simulated current distribution on the Surface of MLA is presented in Fig.3. In small antennas, the ground plane plays a major part in radiation. As a consequence of the change in ground plane size, shift in the resonant frequencies has been noticed. The current distribution on the ground plane and its effect on the resonant frequencies were also observed during simulation.

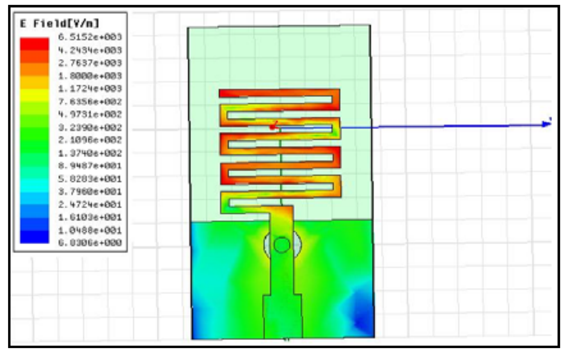
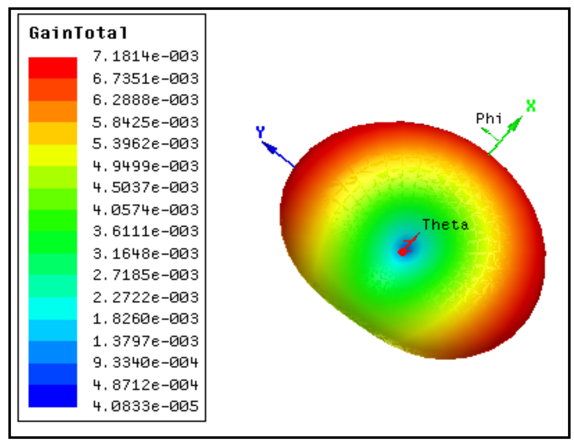
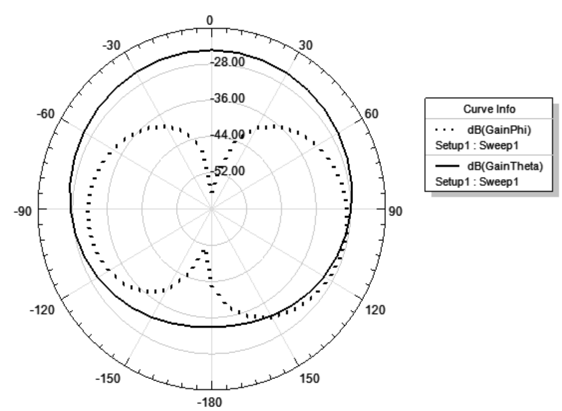


Fig.5 Surface current distribution on MLA at 2.5 GHz



(a)



(b)

Fig.6 Radiation Pattern of Proposed antenna

Fig.7 Photo of the fabricated antenna without connector

VI. CONCLUSION

In this work, design of a compact single element planar antenna system operating in the ISM frequency band was presented. Due to size reduction proposed antenna useful for wireless communication. The antenna system operates in the 2.44GHz - 2.68GHz frequency band with a bandwidth is 240 MHz .Return loss is –39.1 dB is obtained. The proposed research work is suitable for USB application.

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