International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 13, Issue 1 [January. 2024] PP: 199-204

A Compact Coaxial Fed Metamaterial Microstrip Meander Slot Antenna for Wireless Applications

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Abstract- *Nowadays, the emergent wireless communication has become very important and antennas are the vital of wireless communication. Users demand to have small size of device that can be brought anywhere without the use of wire and to fulfil the demand, small size of antenna is needed. In this research work microstrip antenna is used because of its numerous advantages. It is light weight; low cost and easy to integrate with impressed circuits.Microstrip antenna fulfil all these requirements.*

In this present research work, a novel design and analysis of compact coaxial fed meander slot microstrip antenna for the wireless application is presented which achieves easier design and wider antenna bandwidth. The shape of proposed antenna will provide the multiband operation which is required for the wireless application including Fixed Mobile, WLAN, WiMAX and other applications.

The antenna is designed on a ground plane with dimension 40 × 36 on which a substrate of FR4 dielectric material with relative permittivity of 4.4 and loss tangent of 0.002 with thickness 1.6 is placed. A rectangular patch with dimension 25x23 is placed over substrate which has four meander shaped slots to achieve multiband operation in 2.1 GHz (2.086-2.114 GHz), 2.4 GHz (2.398–2.439 GHz) and 3.4 GHz (3.44-3.48 GHz), 4.7GHz (4.741-4.794 GHz) with return loss <-10dB and respective VSWR < 2.Meander line structure is used that allows antenna design with small size.The performance of antenna design based on the no of turns in meander slots and position of meander slots.

Keywords*- VSWR , FEM, HPBW, Permittivity, Width of Patch Antenna, Radiation Resistance*

Date of Submission: 19-01-2024 Date of acceptance: 02-02-2024

I. INTRODUCTION

In wireless communications technology, Meander slot antenna has many applications where low-profile and high efficiency is considered. The slot has many type of structure or design like meander, tapered, angular etc according to the application used and it is generally made on some conducting substance like copper or gold. The Slot antenna has a thin profile, flexible shape, easy in fabrication consisting circular and linear polarization and spurious radiation. The ratio of frequency depends on the number of slots; their position and the slot length. The lowest frequency ratio arises from the radiation edge of patch. That is the maximum loading effect of slot which occurs at the position, where maximum magnetic field exists. Loading effect increases the length of slot. Substrate parameters such as dielectric constants and height of substrate can be varied to get different return loss values and ultimately rise in impedance bandwidth. Bandwidth of antenna can be improved by decreasing the value of dielectric constant of the substrate. A compact meander type slot antenna reduced 56% size [9].

The meander slot element consists of horizontal and vertical slot so it formed a series of sets of right angled bends. The polarization of the antenna depends on radiations from the bend. There should be proper space between bends, since if the bends are too close to each other, then cross coupling will be more, which in result will affects the purity regarding polarization of the resulting radiation pattern. In another case the spacing is limited due to the space array grid and also the purity regarding polarization of the radiated field will vary according to the spacing between the bends. The electrical small antenna is defined as the largest dimension of the antenna is no more than one tenth of a wavelength.

The design of meander Slot antenna is a set of vertical and horizontal slot. Combination of vertical and horizontal Slot forms turns. Number of turns increases efficiency increases. In case of meander slot if meander spacing is increased resonant frequency decreases. At the same meander separation increase resonant frequency decreases. In general, horizontal slots of the meander slot antenna provide inductance effects, while vertical slots exhibit capacitive characteristics [10]. Thus, the resonant frequency can be regulated by controlling the meander slot‟s lengths

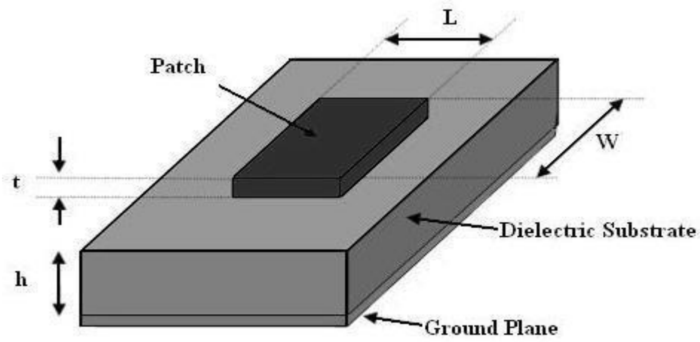

Figure 1: Cross-section of Microstrip Antenna with radiating field

This research work proposes an antenna which is designed in order to enhance the characteristics of the proposed antenna. The proposed antenna is designed on FR-4 substrate and is demonstrated to achieve a multi frequency with wide bandwidth. The simulation is done on CST
MWS STUDIO v10.

II. Methodology

First of all, antenna system will be reviewed, focusing on meander line and slotted antenna through variety kind of sources and references such as journals, books and through internet. Variety types of antenna will be designed, for instance microstrip patch antenna, microstrip meander line antenna, microstrip slot antenna, and slotted meander line antenna by using CST Studio Suite 2010. After that all 4 designed antenna will be simulated to observe the antenna parameters such as return loss, bandwidth, gain and directivity. Report writing will be done to record all the results and discussions. Figure 1.2 below shows the overall flow of this project.

Figure 2: Project Flow Chart

III. LITERATURE OVERVIEW

The idea of designing of the microstrip antennas arises due to the enhancement in technology and the devices those works on microwave frequency from the hand held cellular phones to the satellites for wireless communication. They are widely used because of their many advantages, such as the low profile, light weight, and conformity. Researchers have made many efforts to configure the microstrip antenna to make enhancement in bandwidth to work efficiently in desirable in modern wireless communications and reduction in the losses occurred during transmission and reception. With the rapid development of wireless communications, wide-band antennas have attracted many researchers‟ attentionNumerous researchers have proposed different analytical and numerical methods to examine the electromagnetic behaviour of the microstrip antenna; therefore, various approximate methods for designing the microstrip meander slot antenna are documented in the survey.

These methods are classified as either analytical or numerical. As the subject has exceptionally large number of research papers, so only the pertinent pioneering works are referred hereProposed an H-shape meandered microstrip patch antenna designed for multiband application. The proposed patch has a compact in size and suitable for wireless applications in L-band, S-band, C-band and X-band Communications. To achieve desire results, HFSS simulation software has been used

Proposed two antenna designs for dual and wide band operation in wireless systems. First design is realized with a tapered meander slot with micro-strip feed to allocate operation at frequency bands 1.8 and 2.4 GHz. The two resonant frequencies are controlled by the distance of the meander slot width and the microstrip line termination from the slot. The second design is accomplished by the use of a coplanar patch-slot antenna fed by a coplanar waveguide (CPW). The second design is easily tuned to operate at 2.45 and 5.75GHz. By make variations in patch dimensions the operating frequency is controlled. For this analysis, Advanced Design System (ADS) is used which is based on the method of moment (MoM) technique.

Coaxial-Fed Meander Slot Antenna Design

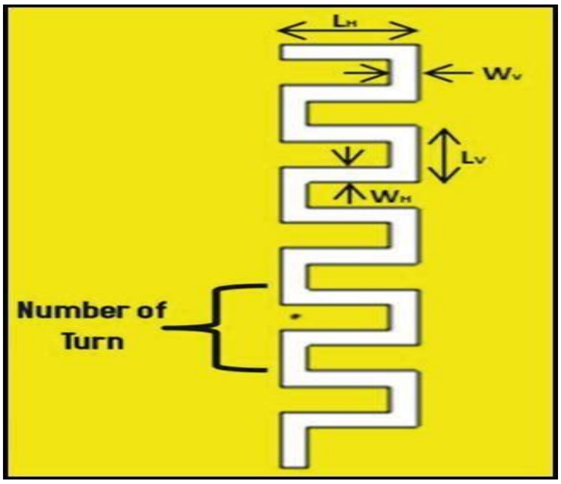

Figure 3: Design parameter of meander slot antenna

a compact wideband meander slot antenna design is proposed for wireless applications including WLAN and WiMAX. The antenna consists of a coaxial feed line, a substrate, and a rectangular patch on which four Meander slots are etched. The Meander slots are able to achieve multiband frequencies. The parameters of the meander slot antenna that are used in all the three designs consists of the width of horizontal line W_H, length of horizontal line L_H, width of vertical line W_V, length of vertical line L_V and the number of turn, N. For all designed structure, the width of the vertical and horizontal lines is fixed to 1mm and length of the vertical and horizontal lines is fixed to 3mm.

Compared to the other antennas, the proposed antenna not only achieves multiband simultaneously, but also has a rather simple structure that is easy to fabricate. Meanwhile, the measured results represent that the antenna shows a good multiband characteristic to satisfy the requirement of WLAN, WiMAX and other wireless applications.

Antenna Design

Based on the background of the researches above, a simple and compact Coaxial fed Meander slot antenna for 2.1 GHz (2.086-2.114 GHz), 2.4 GHz (2.398–2.439 GHz) and 3.4 GHz (3.44-3.48 GHz), 4.7 GHz (4.741-4.794 GHz) is designed and simulated. The operations are achieved by etching four Meander shaped slots on rectangular metal radiating patch of dimensions 25 X 23 X 0.035 mm^3.

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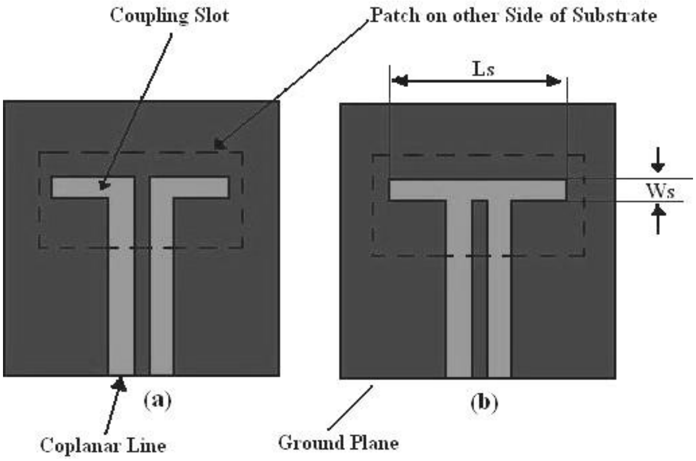

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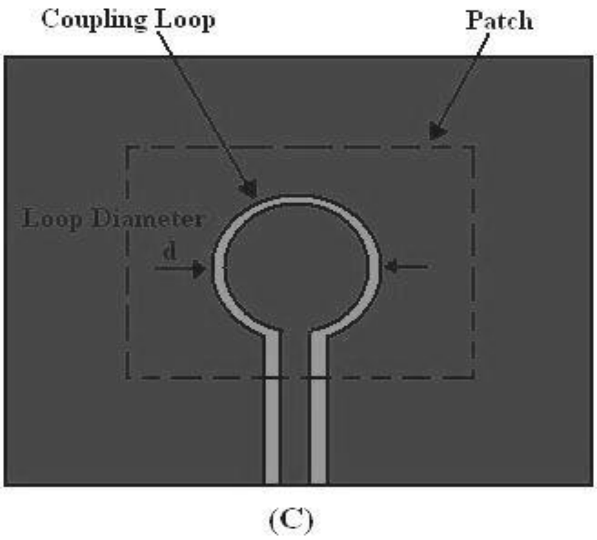

Coplanar waveguide feed of the microstrip patch antenna. (a) Inductive coupling by splitting the coupling slot into two by the CPW, (b) Capacitive coupling between the patch and the slot and (c) Coupling through an annular slot to reduce backward radiation from the slot.

This coupling arrangement is somewhat similar to the aperture coupling the only difference between the two is that the slot in the ground plane is fed by a microstrip line in aperture- coupled microstrip antennas. Experimental investigations of CPW excitation are reported as the 10-dB return loss bandwidth was found to be 2.8% for capacitive coupling, and 3.5% for inductive coupling at about 5 GHz on a substrate with $\varepsilon r = 2.2$ and $h = 1.58$ mm

IV. Result

The proposed antenna is simulated by CST MW simulator, and meander slot antenna resonates at 2.1 GHz with return loss -20.282 dB, 2.4 GHz with return loss -22.318 dB, 3.4 GHz with return loss -14.951 dB and 4.7 GHz with return loss -14.598 dB with VSWR < 2 in all above frequency ranges. The resonance frequency bands are lies in between the frequency band designated for Fixed Mobile, WLAN, WiMAX and Fixed Satellite (Space- to-Earth) wireless applications systems respectively

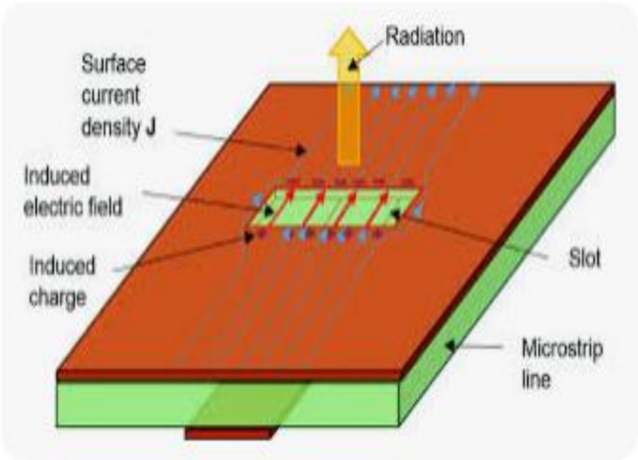

Figure 4: Coaxial feed proposed compact meander slot antenna

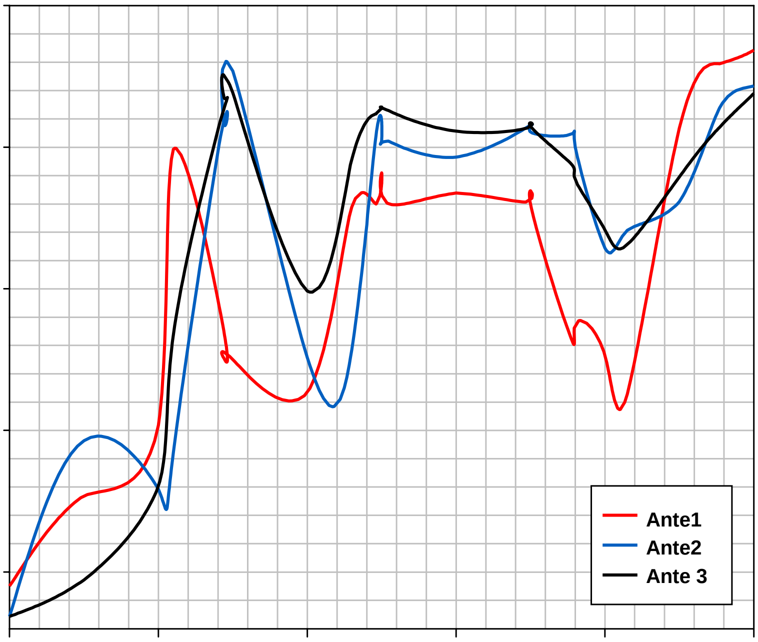

Figure 5: Plot between Gain and Frequency

This section describes the performance of antenna designs in terms of gain with respect to frequency. The gain performance of the Antenna Design 3 is moderate between frequency range 2.0 GHz to 2.6 GHz and from frequency range 2.6 GHz to 4.6 GHz the gain of antenna 3 is higher than the other two antenna designs and further antenna 3 has moderate gain from 4.6 GHz to 6.4 GHz. All these values show that the Antenna Design 3 has better performance in all the antenna design.

V. CONCLUSION

The meander slot antenna resonates at 2.1 GHz with return loss -20.282 dB, 2.4 GHz with return loss -22.318 dB, 3.4 GHz with return loss -14.951 dB and 4.7 GHz with return loss -14.598 dB. The resonance frequency bands lies in between the frequency band designated for Fixed Mobile, WLAN, WiMAX and Fixed Satellite (Space-to-Earth) wireless applications systems respectively. This antenna yields a good impedance bandwidth and return loss in the following frequency ranges. The stable radiation patterns and constant gain are also obtained

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