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Design and Fabrication of Meander Line Antennas for WLAN and Dual Band Applications

M. Vinodh Kumar, K. Pruthvi Raj, Md. Amina Tabassum, G. Ramya, V. Priyanka

Abstract **- A 2.4-GHz WLAN meander-line antenna and A Dual band meander line antenna are designed and simulated. The HFSS 3-D EM simulator is employed for design simulation. The prototypes of simulated antenna is realized on an FR-4 PCB substrate. The results are verified using Vector Network Analyzer ENA 5071C. In both Simulation and Design the measured VSWR is less than 2 from 2.4 to 2.5 GHz for the WLAN MLA and for Dual band MLA at frequencies 3.1GHz and 5.1GHz.**

Keywords **- Microstrip Antenna, Meander-Line Antenna (MLA), VSWR, Network Analyzer, WLAN.**

I. INTRODUCTION

In recent years, the wireless communication business has expanded greatly [1], [2]. Wireless systems such as WLAN have been popular .With development of communication equipment, control and security devices are commonly used such as Bluetooth. As we know, in these systems the antenna is an important part of devices that determines system size and performance.

Having a Dual band response is the other key factor for meander line antennas. As wireless communication systems are becoming more and more flexible and even a less expensive than today cable based systems, equipment working in these systems requires a low profile, dual band and wide band antennas. Meander line antennas, which has small size, wideband and ability to operate in dual band frequency is suitable choice for applications in Communications.

This paper presents a 2.4-GHz meander-line printed antenna for WLAN applications [3] and another Dual band meander-line antenna at frequencies 3.1 and 5.1 GHz for wireless applications. The HFSS 3-D EM simulator is used for design simulation. The simulated antennas are fabricated on a double-sided FR-4 printed circuit board for experimental measurements. The antenna plots and different measurements are presented.

A useful way to make the conventional linear wire antennas shorter is to bend a wire according to some geometrical configurations, such as the structure of the mender line [4], [5]. Fig. 1 shows the illustration of a printed meander-line antenna for the WLAN card. The ground plane to emulate the RF board is about 40 X 32 mm and the space for the printed meander-line antenna is about 21 mm. It is noted that the selection of the space for the antenna and ground printed in the backside is the same with ones of a practical case. WLAN MLA and Dual Band MLA are fabricated using FR-4 epoxy substrate whose thickness is 1.6mm and dielectric constant ε_r (relative permittivity) 4.4 and were tested using two port - Agilent Vector.

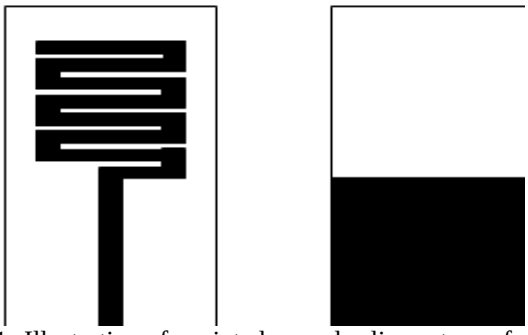

Fig.1. Illustration of a printed meander-line antenna for the WLAN applications (a) Front plane and (b) ground plane.

Network Analyzer ENA5071C (300 KHz-14 GHz) and all the results were noted and this paper presents all these Results.

II. ANTENNA DESIGN

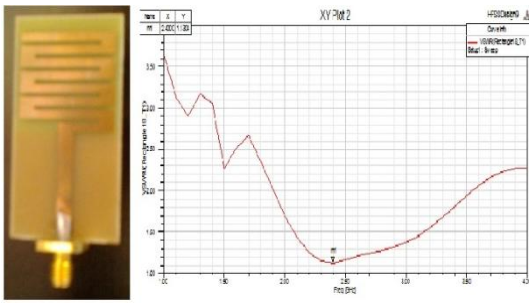

Fig.2. Photograph of a realized WLAN meander line antenna on a FR-4 substrate and measured antenna input VSWR on HFSS software.

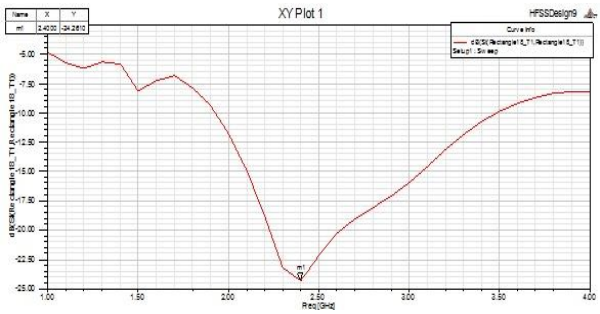

Fig.3.Return loss (s_{11}) curve of WLAN antenna designed on HFSS software

The substrate is the FR-4 PCB. The meander shape, with the height of the feed element is 40mm and thickness of the feed is 4 mm. The width and gap of the meander-line antenna are 2 and 1 mm respectively, but width of meander line antenna is 4mm at the edges. Length of each segment in the meander line antenna is 26mm and this antenna is operated to resonate at 2.4-GHz band. Fig. 1

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also shows the simulated antenna structure in both the planes. Fig. 2 shows the photograph of a realized antenna on a 62× 32 mm FR-4 substrate and VSWR measure of antenna. Fig. 3 Shows the VSWR attained on the HFSS where as the Fig. 5 is the VSWR curve that was verified over the Agilent Vector Network Analyzer With the realized antenna. The return loss of the designed antenna is plotted over the HFSS software that is shown in Fig 3, where as the return loss curve obtained over the Agilent Vector Network is shown in Fig 6. Polar plot and Smith chart are also plotted that is shown in Fig. 4 (Simulated) and the Designed plots are verified in Fig. 7

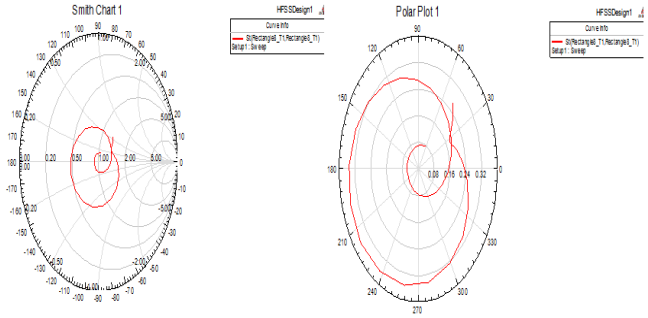

Fig.4.Smith chart and Polar plots of the WLAN antenna in HFSS software

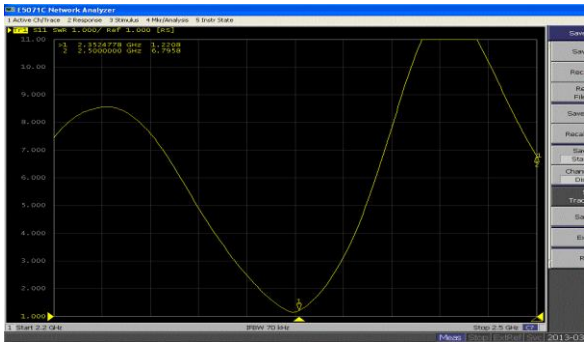

Fig.5. the VSWR plot obtained on the Vector Network Analyzer for the WLAN antenna.

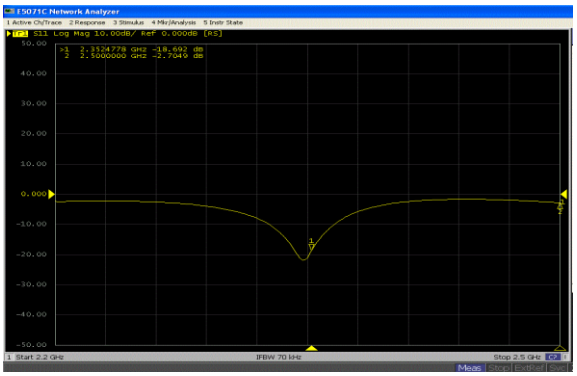

Fig.6. the Return loss plot obtained on the Vector Network Analyzer for the WLAN antenna.

Fig. 8 shows the illustration of a printed meander-line antenna for the dual band applications. The ground plane to emulate the RF board is about 40 X 30 mm and the space for the printed meander-line antenna is about 8 mm. It is noted that the selection of the space for the antenna and ground printed in the backside is the same with ones of a practical case. It is a similar antenna with a single vertical segment such that it resonates at frequencies 3.1 and 5.1 GHz

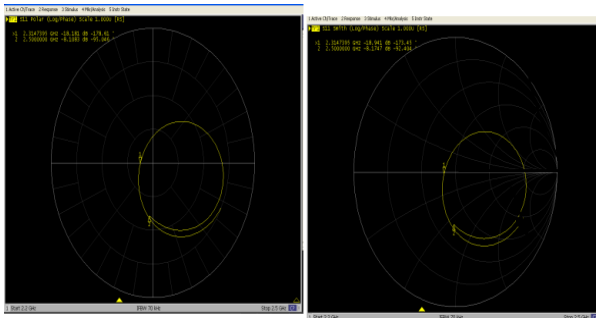

Fig. 7.Smith chart and Polar plots of the WLAN antenna in Network Analyzer.

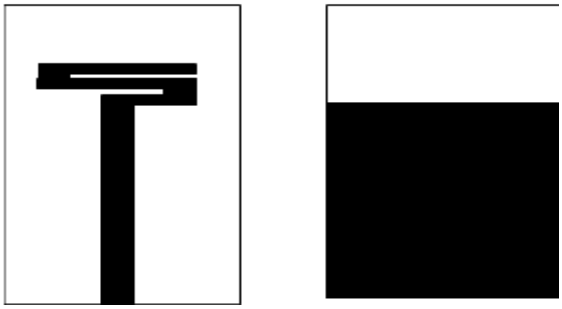

Fig.8. Illustration of a dual band meander-line antenna for wireless applications (a) Front plane and (b) ground plane.

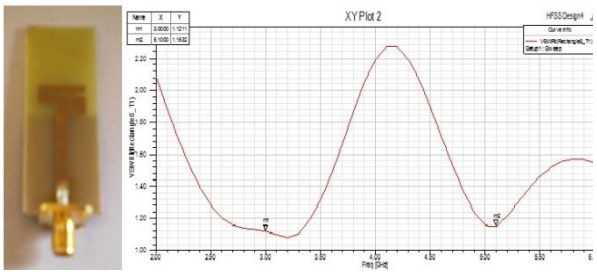

Fig.9. Photograph of a realized dual band meander line antenna on a FR-4 substrate and measured antenna input VSWR on HFSS software.

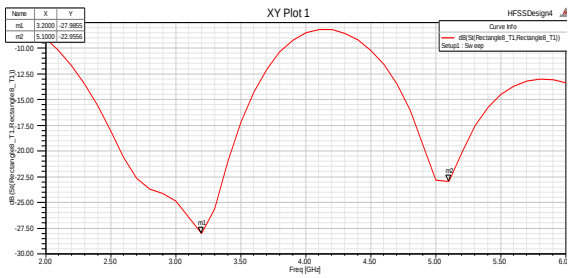

Fig.10. Return loss (s_{11}) curve of dual band MLA designed on HFSS software

The substrate is the FR-4 PCB. The meander shape, with the height of the feed element is 40mm and thickness of the feed is 4 mm. The width and gap of the meander-line antenna are 2 and 1 mm respectively, but width of meander line antenna is 4mm at the edges. Length of each segment in the meander line antenna is 25mm and this antenna is operated to resonate at frequencies 3.1 and 5.1

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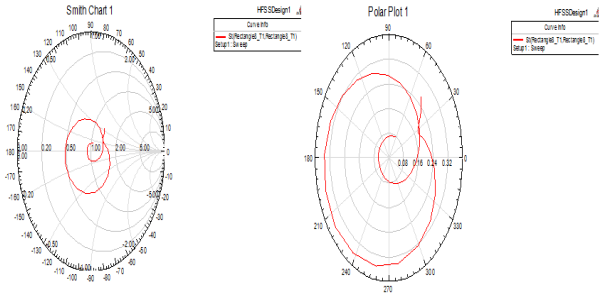

Fig. 11.Smith chart and Polar plots of the dual band MLA in HFSS software

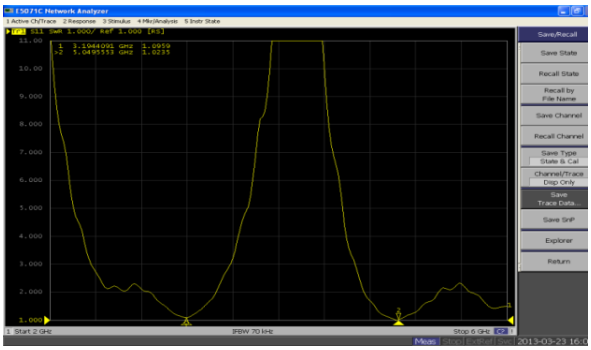

Fig.12.The VSWR plot obtained on the Vector Network Analyzer for the dual band antenna

GHz. Fig. 8 also shows the simulated antenna structure in both the planes. Fig. 9 shows the photograph of a realized antenna on a FR-4 substrate and VSWR measure of antenna. The VSWR and Return loss curves in both HFSS 3D simulator and vector network analyzer are presented in this paper for both the designed and fabricated antenna. The VSWR obtained is in between 1 to 2 for the frequencies 3.1 GHz and 5.1 GHz. Fig. 9 Shows the VSWR of the designed antenna in HFSS software where as it is verified using ENA5071C (VNA)and the VSWR plot is shown in Fig. 12. The return losses of the antenna are shown in Figs 10 and 13 respectively in HFSS software and on Vector Network Analyzer (VNA). Polar plot and Smith chart are also plotted that is shown in Fig.11 and the plots verified are shown in Fig.14.

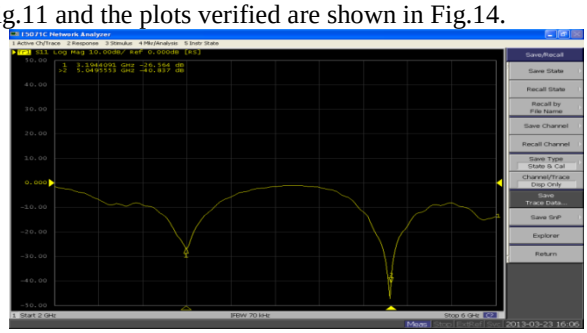

Fig.13. the Return loss plot obtained on the Vector Network Analyzer for the dual band antenna

As mentioned, the meander-line antennas is connected with Agilent vector network analyzer so that the different measurements of the antenna can be obtained and can be compared with the results obtained with the software.

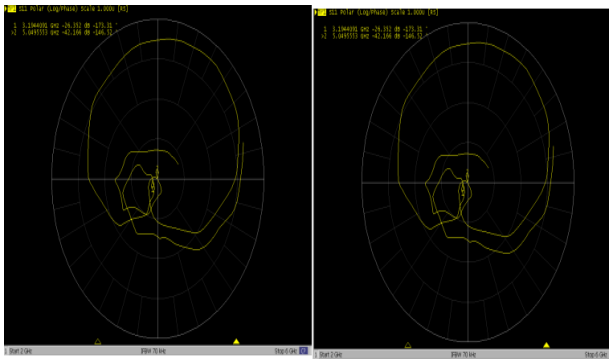

Fig.14. Smith chart and Polar plots of the dual band antenna in HFSS software

III. CONCLUSIONS

Classic meander line antenna has good properties such as, small, low profile, simple and cheap [6]. These nice features make meander line antenna very popular and usable in many aspect of communication systems Especially in WLAN and Dual band Applications [7]. As wireless communication systems are becoming more and more flexible and even a less expensive than today cable based systems, equipment working in these systems requires a low profile, dual band and wide band antennas [8].

From the Results it is observed that for the dual band antenna The Frequencies that are accessible are 3.1 GHz and 5.1 GHz. The Return loss curves in both Software and Hardware are almost same. VSWR is between 1 and 2 at these Frequencies .The Polar Plot and Smith Chart in both Hardware and Software also similar. For Single band Meander line antenna the frequency accessible is 2.4 GHz and as it is an unlicensed frequency it can be used in

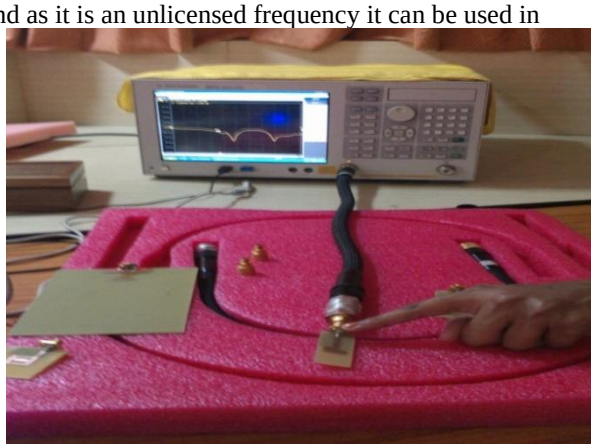

Fig.15.The dual band antenna connected with Vector network analyzer for investigating the results

Wireless applications especially used in Wireless LAN and Bluetooth. The VSWR at 2.4 GHz is between 1to 1.5 which stands for a very less VSWR (Voltage Standing Wave Ratio) hence the losses are negligible and a very idle communication can be built through this antenna. The Other Parameters of this antenna are also good and similar in both Software and Hardware Verification.MLA's has low efficiency [9] but designing carefully can make them efficient.

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