Low-Profile H Slot Multiband Antenna for WLAN/Wi-MAX Application

Siddharth Vashisth, Sparsh Singhal, and Chandan

Abstract This paper presents a microstrip antenna that gives multiband when we use a microstrip feeding at the input of the antenna. The proposed antenna is made up of FR-4 substrate. The multiband that we obtained is used for different modern applications and also we get a different range of frequencies at each band. Here, the bandwidth is also satisfactory as we required and also return loss obtained is less than 10 dB as per the requirement. In this paper, various rectangular patch antenna arrays are designed for the application of WLAN (wireless local area network) at 2.4 GHz. The single patch antenna is designed using probe feeding technique. Arrays of 2 × 1 are also designed using the edge feeding technique.

Keywords Low profile antenna · FR-4 Substrate and probe feed technique

1 Introduction

Today's world is characterised by wireless communication and it is being served as one of the biggest contributions of technology to mankind. A wireless communication system uses the free space as the communication channel instead of wires and cables. Here the electrical signals from the transmitter need to be converted into the EM signals for propagation through free space and then the EM signals received by the receiver need to be converted back into electrical signals. The transducer which converts electrical signals to EM signals and vice versa at the transmitter and receiver side, respectively, is called antenna. Hence antenna is playing a vital component in a wireless communication system. Since the wireless devices are becoming more and more compact on one side and increase in the number of applications in a single device such as Wi-Fi, WiMax, Bluetooth, GPS, 5G, etc. [5]. There are some designs

S. Vashisth (✉) · S. Singhal · Chandan
Department of Electronics and Communication Engineering, Meerut Institute of Engineering and Technology, Meerut, India
e-mail: siddharth.vashisth.ec.2017@miet.ac.in

S. Singhal
e-mail: sparsh.singhal.ec.2017@miet.ac.in

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containing different shapes like U shaped, T shaped etc. [6, 7]. Parasatic radiation elements of different sizes and stacked patch antenna result in thicker antenna [4]. On the other side, there is a need for antenna design, which is compact in size, light in weight, lower in cost and supports multiple frequency band operation [8]. All the above-mentioned needs are fulfilled by the microstrip patch antenna.

2 Antenna Design

The diagram of the antenna structure is shown in Fig. 1. The values of the parameters are also enlisted in Table 1. The antenna is made on a cost-effective FR-4 epoxy substrate of thickness 1.6 mm. There are three monopoles having different lengths, microstrip feed line. In the typical design procedure of the microstrip antenna, the desired resonant frequency, thickness and dielectric constant of the substrate are known or selected initially. In this design of rectangular microstrip antenna, FR4

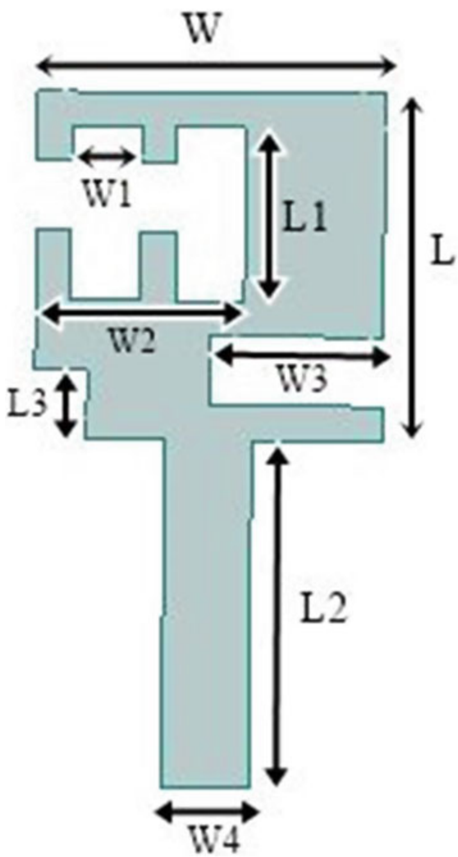


Fig. 1 Geometry of the proposed antenna

Table 1 Dimensions of the proposed antenna (in mm)

All Dimensions in mm	
L	10
L1	5
L2	10
L3	2
W	10
W1	2
W2	6
W3	5
W4	2.5

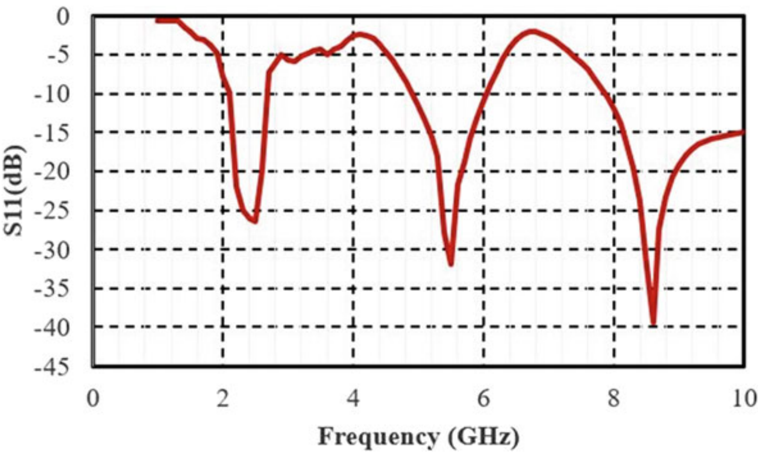


Fig. 2 Return loss of the proposed antenna

dielectric material (εr = 4.4) with dielectric loss tangent of 0.02 is selected at the substrate with 1.6 mm height.

The antenna has shown −26.44 dB return loss at 2.4 GHz, −31.93 dB return loss at 5.5 GHz and −39.41 dB return loss at 8.6 GHz resonant frequency and obtained bandwidth is 2.4 GHz, 5.45 GHz and 8.56 GHz, which is shown in Fig. 2. At the resonant frequency, antenna radiates maximum power.

3 Results and Discussion

Figure 1 shows the simulated prototype of our proposed antenna, which consists of a compact size of 50 mm, 115.7 mm and 1.6 mm. The antenna has shown −26.20dB return loss at 2.4GHz, −31.97dB return loss at 5.5GHz and −39.61dB return loss at 8.6GHz resonant frequency and obtained bandwidth is 2.45GHz, 5.85GHz and 8.55GHz, which is shown in Fig. 2. At the resonant frequency, antenna radiates maximum power. Antennas play a vital role in the field of wireless communications. Some of them are parabolic reflectors, slot antennas, patch antennas and folded dipole antennas. Each one of the antennas is superior in its own characteristics, design and applications. We can state antennas are one of the most essential things in wireless communication without which the world could not have imagined the present day of technology.

In Fig. 3a, we have designed a patch in which three slots are cut and we have obtained the results as shown in the figure. In the above step, we get a single band only between 8 and 9 and we are working for triple band so it is of no use for us now so we have to do further slot additions in our design.

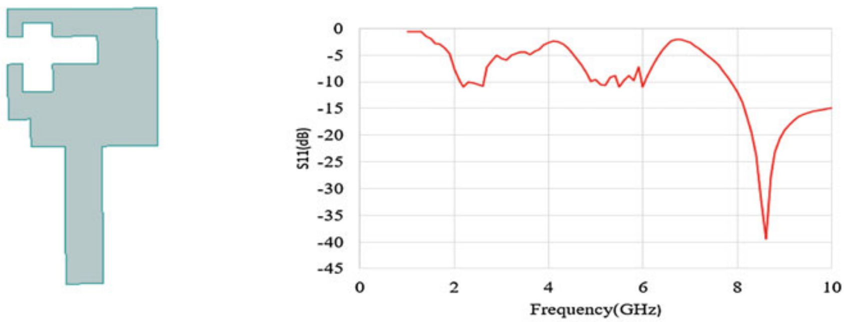
In Fig. 3b, we have done some modifications to improve our result so we have added one more slot to achieve our result so that we can get triple band. After adding a slot, we have received another band, which is not for our final result so we have to do further modifications.

In Fig. 3c, when we cut one more slot then we have achieved our result, which is triple band. This time we get usable frequency bands with usable application at different frequencies. Return loss should be less than −10 dB for acceptable operation. The antenna has −12.55 dB return loss at 2.4 GHz, −38.17 dB return loss at 3.9 GHz and −28.61 dB return loss at 5.6 GHz (Table 2).

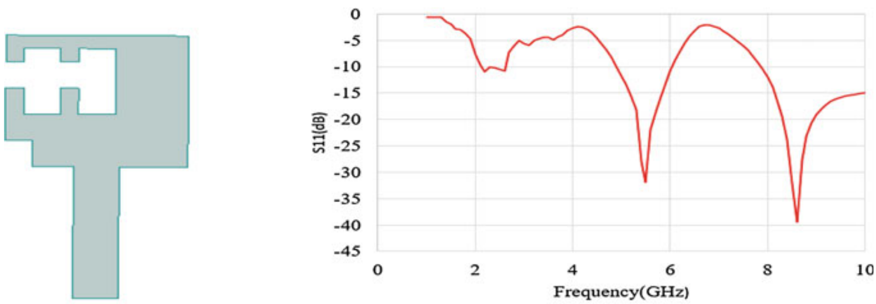
We have a frequency versus gain graph, which shows the gain for the proposed antenna design at two different frequencies (Figs. 4, 5, 6, 7 and 8).

4 Conclusion

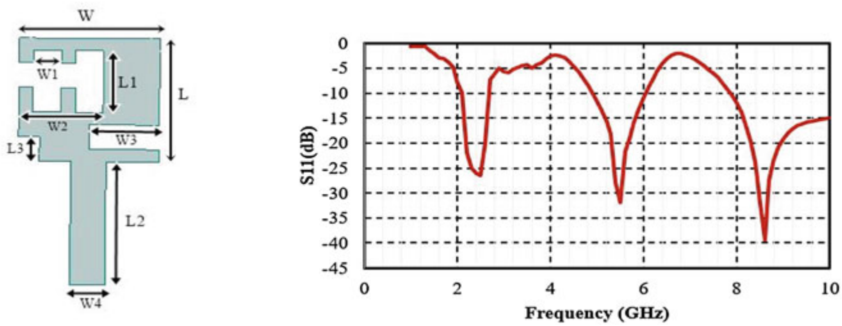
Low-profile H slotted antenna for different wireless applications is investigated and successfully simulated in this paper. The antenna has shown −26.20 dB return loss at 2.4 GHz, −31.97 dB return loss at 5.5 GHz and −39.61 dB return loss at 8.6 GHz resonant frequency and obtained bandwidth is 2.45 GHz, 5.85 GHz and 8.55 GHz at the maximum radiated power.



(a)



(b)



(c)

Fig. 3 Step modification of antenna

Table 2 Comparison of the proposed antenna with reference antenna

Ref	Number of band	Compact size of patch
[3]	2	70.5 mm × 87 mm
[13]	2	8.9 cm × 6.4 cm
Proposed antenna	3	20 mm × 10 mm

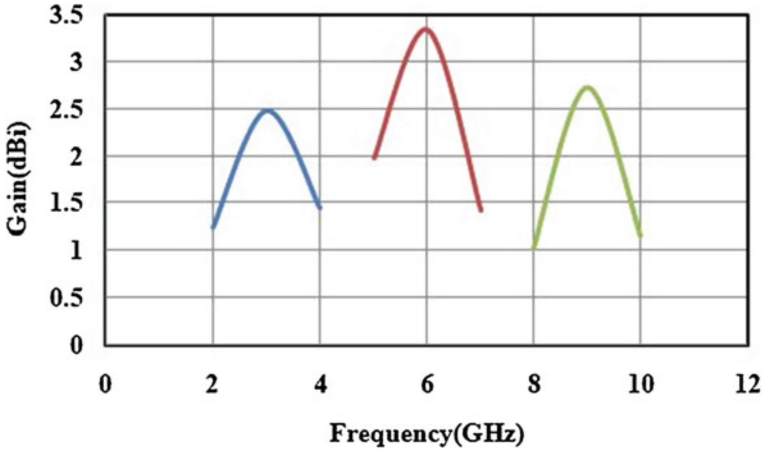


Fig. 4 Gain curve of the proposed antenna

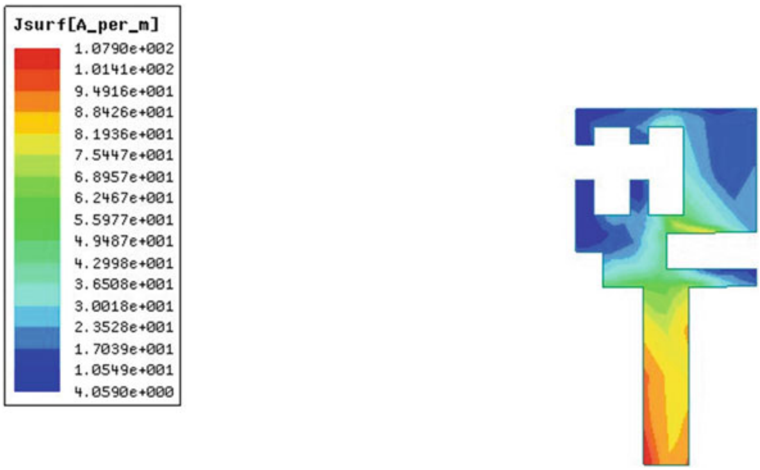
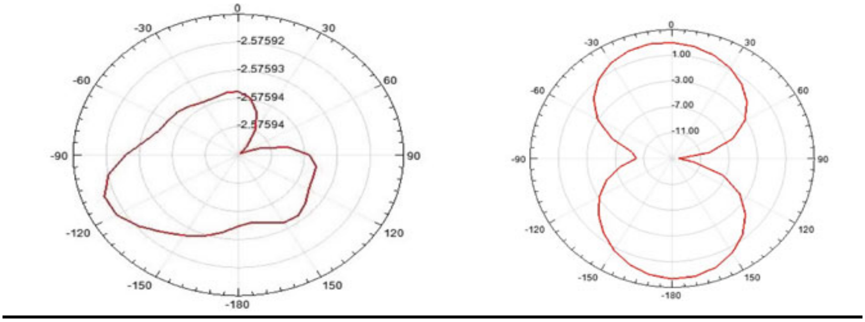


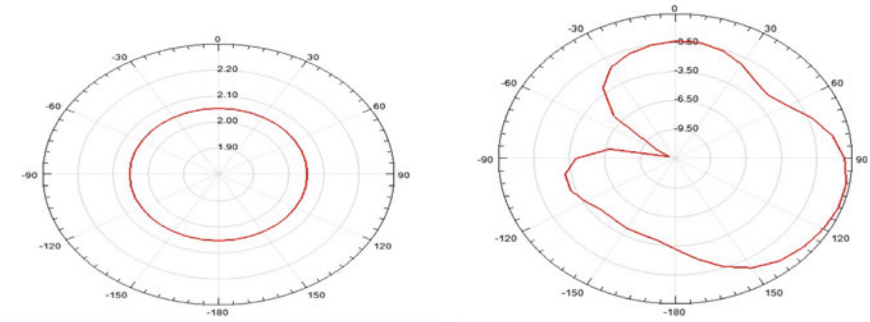
Fig. 5 Current distribution pattern at 2.4 GHz

Fig. 6 Current distribution pattern at 5.5 GHz

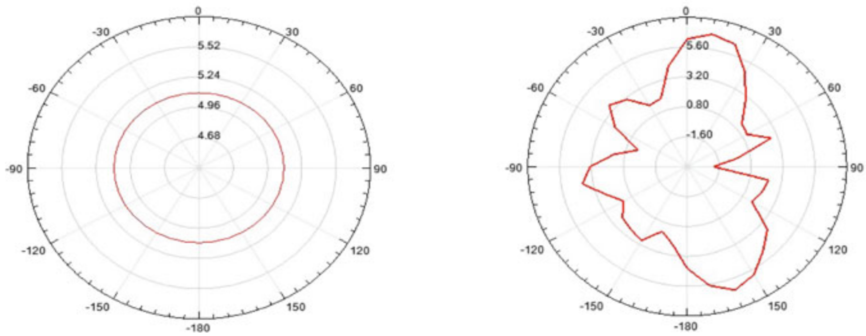
Fig. 7 Current distribution pattern at 8.6 GHz



(a) At 2.4GHz



(b) At 5.5GHz



(c) At 8.6GHz

Fig. 8 Radiation pattern at different frequencies

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