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A Novel Multilayer Microstrip Antenna for Ultra Wideband Applications

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Abstract: *As wireless communication applications require more and more bandwidth, the demand for wideband antennas increases as well. For instance, the ultra wideband radio (UWB) utilizes the frequency band of 3.1-10.6 GHz .In this paper we introduce a new multilayer microstrip antenna for ultra wideband applications. In order to achieve suitable bandwidth, the antenna size is fine for mobile applications. The antenna is designed, optimized and simulated using Ansoft designer.*

***Keywords*:** Microstrip Antenna, Ultra wideband, Multilayer patches, Multiresonator

1 Introduction

Ultra Wideband Radio (UWB) is a potentially revolutionary approach to wireless communication in that it transmits and receives pulse based waveforms compressed in time rather than sinusoidal waveforms compressed in frequency [1]. This is contrary to the traditional convention of transmitting over a very narrow bandwidth of frequency, typical of standard narrowband systems such as 802.11a, b, and Bluetooth. This enables transmission over a wide swath of frequencies such that a very low power spectral density can be successfully received [2]. The recent allocation of the 3.1-10.6 GHz frequency spectrum by the Federal Communications Commission (FCC) for Ultra Wideband (UWB) radio applications has presented a myriad of exciting opportunities and challenges for antenna designers [3]. Pulsed UWB, by definition, refers to any radio or wireless device that uses narrow pulses (on the order of a few nanoseconds or less) for sensing and communication. This requires sufficient impedance matching, proper return loss and VSWR<2 throughout the entire bandwidth. In this paper a new low profile, small stacked multiresonator microstrip antenna is presented for UWB application. The bandwidth of a microstrip antenna increases with an increase in substrate thickness and decreases in the dielectric constant also, the bandwidth of the antenna increases when multiresonators are coupled in planar or stacked configurations. In this paper we use three patches placed in the bottom layer, and multiresonators taken on the top layers. One of the bottom patches is excited by a coaxial-fed.

2 Effect of Parasitic Patches

A patch placed close to the fed patch gets excited through the coupling between the patches [4-6]. Such a patch is known as a parasitic patch. If the resonance frequencies f_1 and f_2 of these two patches are close to each other, then broad bandwidth is obtained as shown in Figure1. The overall input VSWR will be the superposition of the responses of the two resonators resulting in a wide bandwidth [7, 8]. If the bandwidth is narrow for the individual patch, then the difference between f_1 and f_2 should be small as shown in Figure 1. If the bandwidth of the individual patch is large, then the difference in the two frequencies should be large to yield an overall wide bandwidth as shown in Figure2 [5].

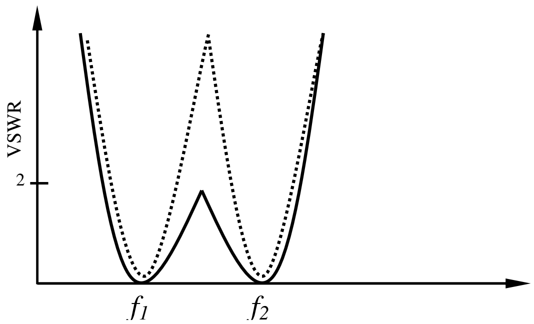

Fig. 1. VSWR plot of two coupled resonators having narrow bandwidth(. . .) individual resonators and(—) overall response

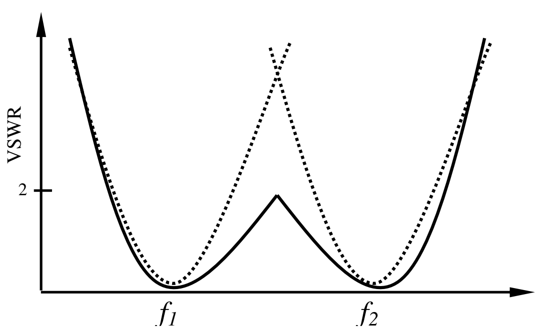

Fig. 2. VSWR plot of two coupled resonators having wide bandwidth (. . .) individual resonators and (—) overall response.

5 Multilayer Configurations

In the multilayer configuration, two or more patches on different layers of the dielectric substrate are stacked on each other. Based on the coupling mechanism, these configurations are categorized as electromagnetically coupled or aperture coupled MSA[1]s.

In the electromagnetically coupled MSA, one or more patches at the different dielectric layers are electromagnetically coupled to the feed line located at the bottom dielectric layer as shown in Figure 3. Alternatively, one of the patches is fed by a coaxial probe and the other patch is electromagnetically coupled. The patches can be fabricated on different substrates, and accordingly the patch dimensions are to be optimized so that the resonance frequencies of the patches are close to each other to yield broad BW. These two layers may be separated by either air gap or foam [8].

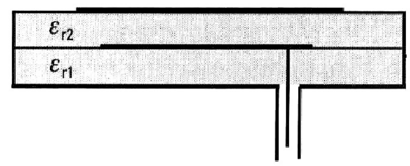

Fig. 3 Multilayer MSA

The multilayer broadband MSAs, unlike single layer configurations, show a very small degradation in radiation pattern over the complete VSWR BW. The drawback of these structures is the increased height; which is not desirable for conformal applications and increased back radiation. Planar and stacked multiresonators techniques are combined to yield a wide bandwidth with a higher gain. In this paper we use two different configurations for this type of antennas.

3 Antenna Design

As it is shown in Figure 4 planar and stacked multiresonators techniques are combined to yield a wide bandwidth with a higher gain [5].

The antenna has three rectangular patches at the bottom and two patches on the top layers exciting the bottom patch by coaxial feed. The two top patches are the same in size but the two patches beside the exited patch are different in size.

Only the bottom patch is fed and the other patches electromagnetically coupled as shown in Figure 5.

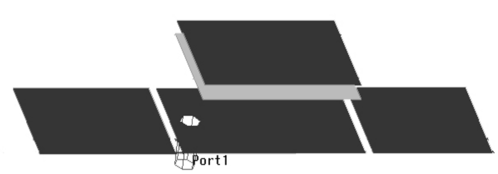

Fig. 4 The geometry of the antenna

In Figure 5 the top view and in Figure 6 the side view of the antenna are shown. The patch on the bottom layer is shown in dotted lines and the patches on the top layer are shown in solid lines.

[1] Microstrip antenna

Because of the multilayer configuration of the antenna and its especial structure the number of parameters that are to be optimized is increased. Referring to the antenna geometry from Figures 3 and 4, the dimensions of the antenna are presented in Table 1.

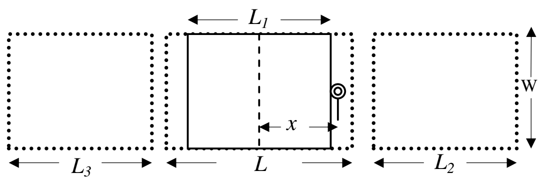

Fig. 5 top view of the antenna

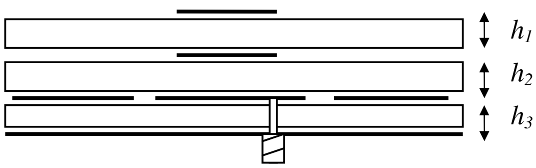

Fig. 6 side view of the antenna

3.1.1 Simulation Results

The antenna is designed, optimized and simulated using Ansoft designer software. The bandwidth obtained for the antenna is 3.25 GHz. The radiation is in the broad side direction, and the variation in the pattern is very small over the entire bandwidth. At 4.3 GHz, the gain is 7.5 dB. As shown in figures 7-9 the bandwidth and return loss are proper for ultra wideband applications and antenna dimensions are suitable for mobile devices.

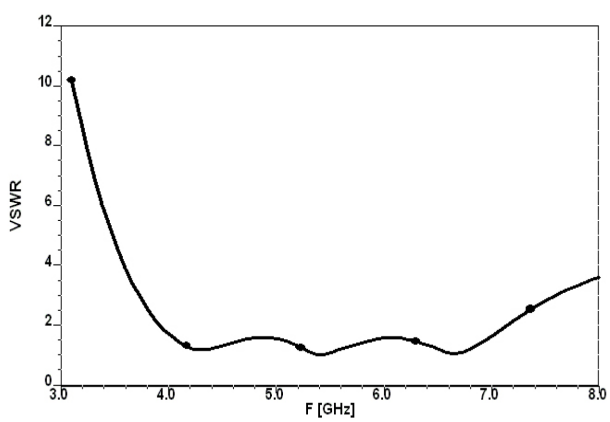

Fig. 7 VSWR plot of antenna

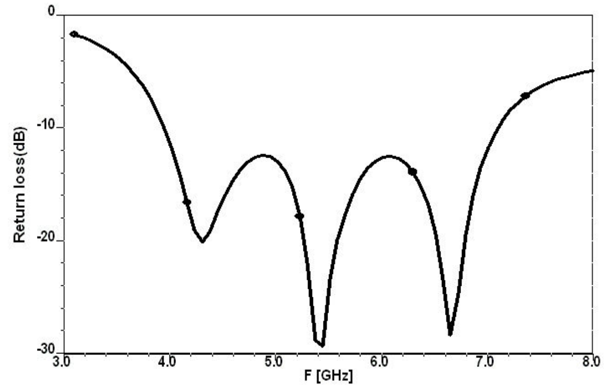

Fig. 8 Return loss plot of antenna

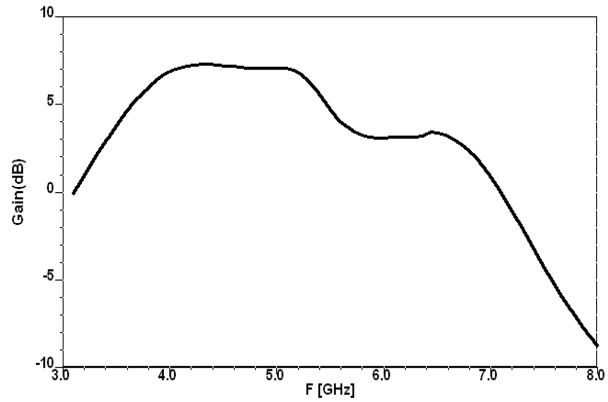

Fig. 9 Gain plot of antenna

5 Conclusions

In this paper, a new small microstrip antenna for ultra wideband applications is designed, optimized simulated. There was a great success in finding a suitable structure for mobile applications. Also obtaining bandwidth about 50% and maximum gain about 7.5 dB shows that this structure can be mentioned as a useful design for ultra wideband products. However acquired results show that the antenna design and structure need more refinement in order to achieve the ultimate design with a smaller physical profile and better performance.

Table 1
Dimensions of the Antenna

L	L_1	L_2	L_3	W	h_1	h_2	h_3	ε_{r1}	ε_{r2}	ε_{r3}
18mm	15.4mm	13.4mm	11.7mm	10.8mm	1.2mm	5mm	4mm	2.1mm	2.1mm	2.1mm

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