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Research paper

Micro strip antenna design for UWB with improved bandwidth

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Abstract

An UWB planar antenna is designed for bandwidth improvement using micro strip radiator. The radiator is designed with epoxy FR- 4 dielectric substrate. The geometry is of rectangular patch with semi round slot at each corner along with a rectangular slot in partial ground plane. The simulation bandwidth is 12.1 GHz and varies from 3.2 GHz to 15.3 GHz. The simulated result shows that the maximum gain achieves 5.4 dB at 14.3 GHz. The radiation characteristics are almost omnidirectional and dipole shape in H- and E- plane respectively. The simulation is carried out with HFSS simulator.

Keywords: *Micro Strip Patch; Partial Ground; UWB; Bandwidth Improvement.*

1. Introduction

The wireless communication systems are growing very fast for wide band antennas which are of great importance. For these systems, the radiators should satisfy higher gain with larger bandwidth. The UWB varies from 3.1 to 10.6 GHz, data rate between 110 to 200 Mbs and with highest radiated power -41.3 dBm/MHz which is approved by FCC in 2002 [1]. High-speed rate of data, small interference, reliable, inexpensive and less complexity are the main advantages of the UWB technology. The applications of UWB technology are in medicine imaging, radar and military communication. There are many different geometries have been designed for UWB patch antennas. They are triangular, elliptical and square [2-4]. In addition, many methods have been proposed to improve the impedance bandwidth such as by considering ground plane modification and other methods [5-7].

In this article, an UWB planar antenna is designed for bandwidth improvement of microstrip patch antenna. The antenna consists of epoxy FR- 4 dielectric substrate and rectangular patch with 50Ω impedance matching. The rectangular patch consists of semi round slot at each four corners and one rectangular slot in partial ground plane. The simulation bandwidth is 12.1 GHz varies from 3.2 GHz to 15.3 GHz. The simulated result shows that the maximum gain achieves 5.4 dB at 14.3 GHz. The radiation characteristics are almost omnidirectional and dipole shape in H- and E- plane respectively. HFSS simulator does the simulation. Section 2 is the UWB radiator configuration. Simulation results are explained in section 3. At last, conclusion is in section 4 with references.

Uwb Rectangular Microstrip Patch Radiator Configuration

Fig. 1 presents geometry of the intended rectangular microstrip patch antenna. The antenna consists of epoxy FR-4 dielectric substrate (dielectric constant (ε_r) 4.6 and loss tangent (tan δ) 0.02). All the dimensions are in millimetre. The size of dielectric substrate is width (W_{SUB}) = 29, length (L_{SUB}) = 32 and height (h) = 1.6; size of radiating element is width (W_P) = 13 and length (L_P) = 12.5; size of microstrip inset feed is width (w_f) = 2.65 and length (L_f) = 11.5; size of partial ground plane is width (W_G) = 29 mm and length (L_G) = 10.5.

For improvement of antenna impedance bandwidth, semi round slots are inserted at the four corners of the radiating element. The capacitive coupling between radiating element and partial ground plane is tuned due to insertion of semi round slots at the lower corners of the radiating element [8]. Again the inductive part of the radiator is tuned by inserting semi round slots at the upper corners of the radiating element. Hence, the capacitive coupling among the radiating element and partial ground plane is neutralized by this inductive part which achieves the pure resistive input impedance [9]. Again, to enhance the antenna impedance bandwidth of the radiator, one rectangular slot is inserted on the partial ground plane below the microstrip inset line feed. So, the capacitive effect is neutralized by this partial ground slot through the inductive nature of the metallic patch which achieves purely resistive input impedance [10]. The simulated return loss plot shows the better impedance matching. By adding one lower semi round slot the impedance bandwidth becomes wider rather than two. There is a small improvement of impedance bandwidth by adding one upper semi round slot comparing to without upper semi round slots over the whole frequency band.

2. Simulation rresults

The simulation S_{11} plot of the intended radiator is given in Fig. 2. It shows that the intended radiator achieves impedance bandwidth 12.1 GHz varies from 3.2 GHz to 15.3 GHz. The optimized dimensions of the proposed antenna are r_1 = r_2= r_3= r_4= 2.5 mm, w_1 = 10 mm and w_2 = 7 mm. The optimized size of the rectangular slot on the partial ground plane is w = 4 mm, L= 0.85 mm and L_1= 2 mm.

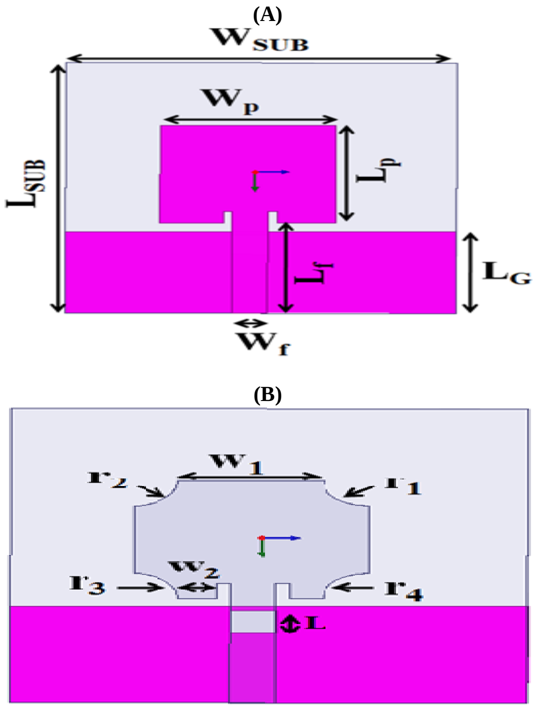

Fig. 1: The Intended Radiator (A) Front Side (without Modification) (B) Rear Side (Final Design).

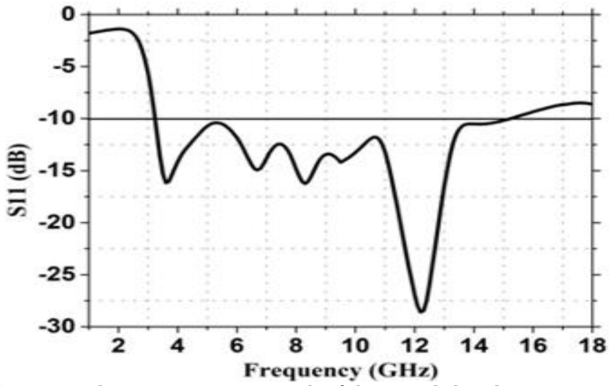

Fig. 2: Simulation Return Loss Graph of the Intended Radiator as in Fig. 1.

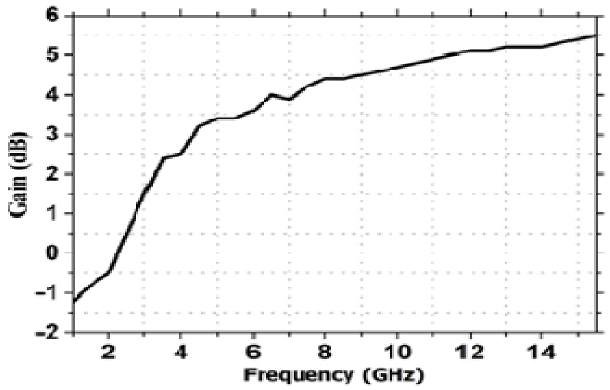

Fig. 3: Simulated Gain of the Intended Radiator (B) in Fig. 1 (B).

Fig. 3 presents the simulation gain of proposed antenna. It clears that gain increases with increase in frequency and the maximum gain reaches at 14.3 GHz, which is 5.4 dB. Fig. 4 shows the simulation radiation characteristics of the intended radiator at different resonant frequencies such as at 3.5 GHz, 6.7 GHz, 8.3 GHz and 12.3 GHz respectively. The H- (XZ) plane is at φ = 90 deg. and θ varies from 0 -180 deg whereas the E- (YZ) plane is at φ = 0 deg and θ varies from 0 -180 deg. The H- plane radiation characteristics are almost omnidirectional at lower frequencies. The E- plane radiation patterns are almost that of dipole radiator. As the frequency increases, the number of side lobes arises may be because of excitement of higher order modes.

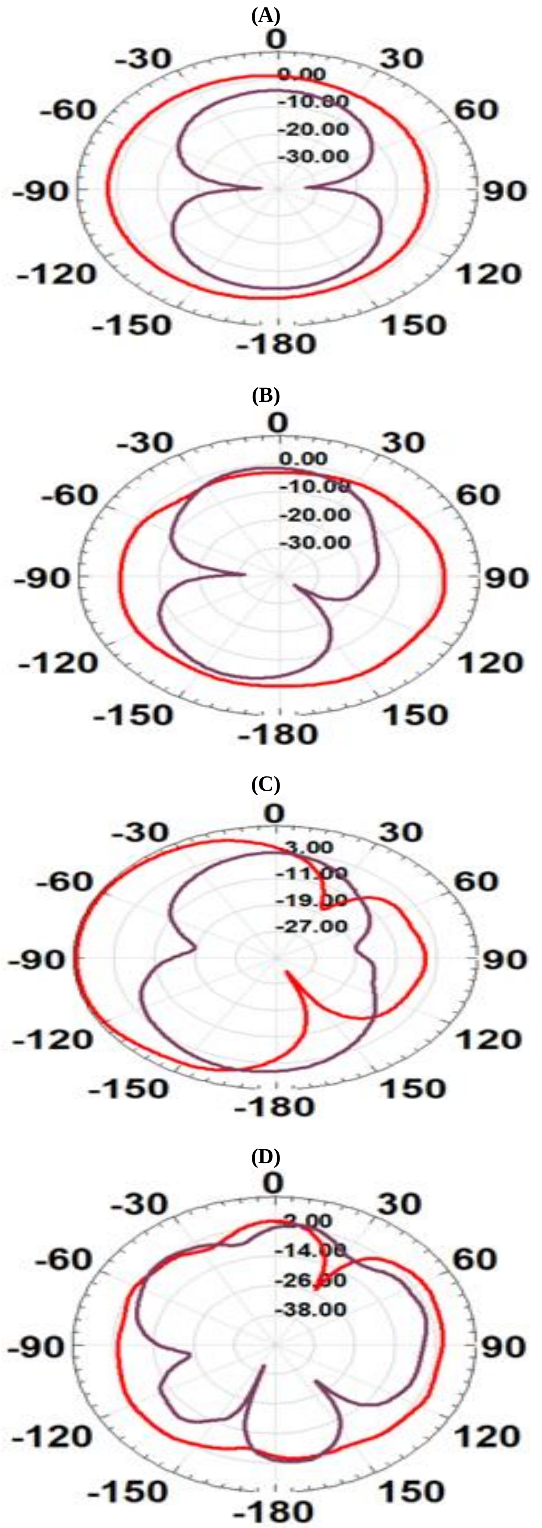

Fig. 4: Simulation Radiation Pattern of the Intended Radiator at Different Resonant Frequencies (A) 3.5 (B) 6.7 (C) 8.3 (D) 12.3 Ghz Respectively, H-Plane and E- plane.

3. Conclusion

The UWB antenna for bandwidth enhancement of microstrip patch radiator is designed using HFSS software. The radiator satisfies the UWB system requirements. The proposed UWB radiator consists of rectangular radiating element with 50Ω microstrip inset feed line and partial ground plane. For improvement of impedance matching the semi, round cuts are introduced in the four corners of the patch. Again, for improvement of impedance bandwidth, a rectangular slot is inserted in the partial ground plane, which is below to the inset feed line. The impedance bandwidth of the intended radiator is 12.1 GHz varies from 3.2 GHz to 15.3 GHz with good impedance matching. The H- plane radiation charactristics are almost omnidirectional and that of E- plane is dipole in shape.

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