Coplanar Wave Guide inverted L Patch Antenna For Ultra Wide Band Applications

Authors
S. Davi¹, Dr.K.Ramanjaneyulu²
1. Student, M. Tech, Department of Electronics, PVP SIDDHARTHA
2. Professor, Phd, Department of Electronics, PVP SIDDHARTHA

ABSTRACT
In this paper, simulation and fabrication of inverted L patch antenna is presented. The antenna is designed for ultra wideband (UWB) applications. The ground is vertically extended toward two sides of the single radiator and thereby space around the radiator is effectively used. The antenna is designed to have return loss parameter value of -10dB with a size of 25*25*1.6 mm³. Simulation result shows that the designed antenna achieves good impedance matching over an operating bandwidth of 3.1 -19.5 GHz.

INTRODUCTION
Ultra-wideband (UWB) technology [1]-[2] has been identified as an attractive solution for certain biomedical sensing applications [3] due to safety, no requirement for physical contact with the subject, the extraction of real-time functional information and relatively low cost. Prominent biomedical applications of UWB include heart-rate sensing [4], tumour detection [5] and speech sensing [6].

One of the challenging tasks in UWB antenna design is the achieving of wide impedance bandwidth while still maintaining high radiation efficiency where UWB antennas are required to attain a fractional bandwidth that is greater than 100%. Also, high radiation efficiency and stability are required for UWB applications [7]. Other challenges of the UWB antenna design include the compact size of the antenna and low manufacturing cost. In UWB speech sensing application [6], the UWB antenna is attached to a helmet which will be worn by a subject and therefore the antenna should be lightweight. The requirements suggest that a planar structure [8]–[10] is attractive for the speech sensing application.

A Novel coplanar waveguide (CPW)-fed compact UWB micro strip antenna [11] is proposed and designed. The proposed antenna possesses a method to minimize the monopole antenna by loading of inverted L-strip over the conventional radiator patch antenna to lower the height of the antenna. The proposed structure is shown in Fig. 1.
ANTENNA DESIGN

The micro strip antenna bandwidth is not very broad because it has only one resonance. To design a UWB antenna, two or more resonant parts with each one operating at its own resonance is required and the overlapping of these multiple resonances may lead to multiband or broadband performance. Therefore, this design is chosen to generate two or more resonant bands for achieving ultra wide bandwidth. In this design, a Coplanar Wave guide transmission line is used. The CPW consists of a single conducting track printed onto a dielectric substrate together with a pair of conductors. All the three conductors are on the same side of the substrate. The substrate in this design is FR4 with dielectric constant of 4.4 and thickness is 1.6 mm.

The two grounds were etched on the same plane of the monopole as shown in Fig. 1. This design is introduced to obtain ultra wideband accompanied with good impedance matching over the entire operating band. The basis of the monopole radiator is a rectangular patch which has the dimensions of length Lp3 and width Wp3 and is protruded with two inverted L-shaped strips from the patch’s upper two sides. Each of the two strips comprises both the vertical and horizontal strips with dimensions of Lp2*Wp2 and Lp1*Wp1 respectively. As for the ground plane, unlike the general use of a solid rectangular plane for a micro strip-fed monopole antenna, ground planes are embedded from the patch’s left and right sides on the same plane to provide the CPW feed. The overall size of the antenna is 25*25*1.6 mm$^3$ and each of the embedded grounds has a vertical section of 25 mm as well as a horizontal section. The radiator is surrounded by a metal ground for reducing the antenna area. The small gap between the radiator and the ground plane is a major factor to cause strong capacitive coupling. The detailed dimensions of the proposed ultra wideband antenna are listed in Table I.

TABLE I  Design parameters of the proposed compact inverted L- strip UWB microstrip antenna shown in fig.1
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<thead>
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<th>Parameters</th>
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<th>$L_{p3}$</th>
<th>$L_{g1}$</th>
<th>$L_{g2}$</th>
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<td>5</td>
<td>10.6</td>
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<td>1</td>
<td>3</td>
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</table>

**Fig 2:** Design of the Proposed UWB microstrip Antenna

**Fig 3:** Simulated return loss against frequency of the proposed UWB antenna

**Fig 4:** Simulated VSWR against frequency of the proposed UWB antenna

**Fig 5:** Simulated two dimensional radiation pattern of the proposed UWB antenna
A. Variation of inverted L-strip parameter L_{P1}:

Fig.6 shows the simulated results of the proposed antenna with inverted L-strip length L_{P1} from 3 to 6mm. It can be seen that the S-parameter magnitude < -10dB increases greatly as L_{P1} increases from 3 to 6mm and decreases as L_{P1} increases further. There is a mismatch of the impedance of the radiating patch and the input impedance at the middle frequencies of UWB. Therefore, it is decided to take L_{P1}=5mm as the optimum of UWB band.

![Simulated return loss against frequency for the proposed UWB antenna with various L_{P1}; other parameters are same as listed in table 1.](image1)

**Fig 6:** Simulated return loss against frequency for the proposed UWB antenna with various L_{P1}; other parameters are same as listed in table 1.

B. Variation of inverted L-strip parameter L_{P3}:

Fig.7 shows the simulated results of the proposed antenna with inverted L-strip length L_{P3} from 6.3mm to 6.8mm. It can be seen that the VSWR < 2 bandwidth of the antenna increases as L_{P3} value increases. There is a mismatch of the impedance of the radiating patch and the input impedance at the middle frequencies of UWB. Therefore, it is decided to take L_{P3}=6.5mm as the optimum of UWB band.

![Simulated VSWR against frequency for the proposed UWB antenna with various L_{P3}; other parameters are same as listed in table 1.](image2)

**Fig 7:** Simulated VSWR against frequency for the proposed UWB antenna with various L_{P3}; other parameters are same as listed in table 1.

EXPERIMENTAL RESULT

Fig.8 shows the photograph of the UWB antenna. A network analyzer is used to measure the return loss of the proposed antenna. The design of the simulated antenna is shown in Fig. 2. This UWB antenna was fabricated and printed on a 1.6-mm-thick FR-4 substrate with permittivity of 4.4 and a loss tangent of 0.024. The CST microwave studio software is used to numerically investigate and optimize the proposed antenna.
configuration. The Fig. 3 shows the simulated return loss of the proposed antenna with the optimized parameters as listed in Table I. Fig. 4 shows the VSWR of the proposed antenna and fig. 5 shows the radiation pattern of the proposed antenna. Obviously, the simulation results show ultra wide bandwidth from 3.1 to 19.5 GHz.

**Fig 8:** Photograph of the fabricated UWB antenna

**Fig 9:** Measured result of the fabricated UWB antenna

**Fig 10:** Return loss parameter of the simulated and measured result.

**CONCLUSION**

A novel CPW-fed compact inverted L strip antenna is designed and simulated. The simulated return loss and VSWR covers the frequency range from 3.1-19.5 GHz (16.4 GHz Bandwidth). The measured results of
return loss parameter are applicable for the whole ultra wide bandwidth with good impedance matching characteristics. The designed antenna is the best suitable for UWB applications.

REFERENCES


