Implementation of Octagonal and Hexagonal Microstrip Patch Antennas for UWB Applications

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Abstract—Ultra Wideband (UWB) communication systems have the advantages of very high bandwidth, fading minimization from multipath, and low power requirements. As per the standards of Federal Communications Commission (FCC), the UWB range is 3.1 GHz to 10.6 GHz. The Ultra Wideband (UWB) is rapidly advancing as a high data rate wireless communication technology. The Bandwidth of an antenna can be extended to high frequencies by adding an octagonal or hexagonal strip horizontally from the printed antenna and asymmetrically affix a conducting strip to the antenna.

The paper describes the design of antenna to enhance the bandwidth by increasing the size of the strip monopole by different geometries. The geometry of the wide Octagonal strip monopole is an Octagon of side ‘a=9mm’ where as for the wide Hexagon monopole is a Hexagon of side ‘a=10mm’. The strip is designed with a length of 23mm and gap ‘d=3mm’ between ground planes and strip for both the antenna geometries to achieve matching. The two printed monopole antennas are designed and etched onto an FR-4 epoxy substrate with an overall size of 45mm × 60mm ×1.6 mm. The proposed antennas is simulated by using Ansoft HFSS and tested by Vector Network Analyzer (E5071C) to obtain the results. The Hexagonal strip monopole is resonating at 5.5 GHz and UWB impedance bandwidth (S11 <-10 dB) ranges from 1.54 to 9.41GHz, while the Octagonal strip monopole is resonating at 5.5GHz and UWB impedance bandwidth (S11 <-10 dB) ranges from 1.3 to 5.65 GHz. The VSWR values for Hexagonal is 1.52:1 at 2.09GHz & for Octagonal it is 1.53:1 at 1.78GHz. The Bandwidth for Hexagonal is 7.87GHz, while for Octagonal is 4.35GHz.

Key words - Bandwidth Octagonal, Hexagonal, UWB, HFSS.

I.INTRODUCTION

The Federal Communications Commission (FCC) has declared that the Ultra-Wideband (UWB) frequencies (from 3.1 GHz to 10.6 GHz) by in 2002 [1]. Design of antenna for this new communications accepted has admiring accretion interest. Commercial UWB systems crave baby bargain antennas with Omni directional radiation patterns, ample bandwidth and non-dispersive behaviour [2]. These requirements makes UWB antenna architecture added complicated than acceptable narrow-band designs. An antenna is a key element for wireless communication as it transmits and/or receives electromagnetic waves [3]. During a decade, several antenna designs have been developed and their application depends on the physical parameters of its output. Due to recent trends of the communication system requirements in portable devices, it is necessary to design a light, compact, portable and an efficient antenna [4]. Several researchers are still developing optimum designs to abate the admeasurements and weight of multiband antennas while befitting acceptable performances [5–7]. An integrated antenna is among the one that is being preferred due to several practical applications, because of its light weight, small size, easy to fabrication and cheap realization. A small integrated antenna, also called as microstrip antennathat has significant applications in the area of wireless communication and is used for several microwave applications. Small chip antenna technology came into affluence in the backward 1970s but was able-bodied accustomed in 1980s. The architecture of microstrip antenna is simple as it requires a attenuate application on one ancillary of a dielectric substrate. The added ancillary of substrate has a even to the arena [8]. The application is about fabricated of administering actual like Copper or Gold and may be in any approximate shapes like rectangular, circular, triangular and egg-shaped or some added appearance [9]. For practical applications, the most common used microstrip patches are rectangular and circular patch antennas. In wireless communication, small integrated antennas are preferred than other
radiating systems, due to their ablaze weight, bargain size, low cost, accord and affluence of affiliation with advice accessories [10].

II. ANTENNA DESIGN SPECIFICATIONS

The geometry of the proposed dual-band antenna for UWB applications with its connected is depicted in Figure 1 and 2. The artifact of the proposed antenna is done application a accepted FR4 substrate, generally acclimated to accomplish printed ambit boards with array (h) of 1.6mm and permittivity of 4.4, which makes it simple and bargain to manufacture. The three capital ambit for the architecture of a microstrip Antennas are:

Resonant abundance (fr): The beating abundance of the antenna accept to be called appropriately. The Ultrawideband (UWB) advice systems accept the abundance ambit from3.1GHz to 10.6 GHz , appropriately the antenna advised accept to be able to accomplish in this abundance range. The beating abundance called for architecture is 5.5 GHz.

Dielectric connected of the substrate (εr): The dielectric actual called for our architecture is FR4 adhesive which has a dielectric connected of 4.4. A substrate with a top dielectric connected has been called back it reduces the ambit of the antenna.

• Acme of dielectric substrate (h): For the microstrip Patch antenna to be acclimated in wireless applications, it is capital that the antenna is not bulky. Hence, the acme of the dielectric substrate is called as 1.6 mm. Hence, the capital ambit for the architecture are:

  • fo = 5.5 GHz

  • εr = 4.4

  • h = 1.6 mm

Step 1: Calculation of the Able dielectric constant(εr):

Equation (1) gives the able dielectric constant as:

\[ \varepsilon_{\text{eff}} = \frac{\varepsilon_r + 1}{2}(1 + 0.3 \times h) \]

Step2: Calculation of the Length of Strip (Ls):

The length of the MicrostripAntenna given by the equation (2)

\[ L_s = \frac{0.42 \times c}{f_r \times \sqrt{\varepsilon_{\text{eff}}}} \]

Step 3: Calculation of the Width of Ground plane(Wg):

The width of the ground plane can be calculated by the equation (3)

\[ W_g = \frac{1.38 \times c}{f_r \times \sqrt{\varepsilon_{\text{eff}}}} \]

Step 4: Calculation of the Length of Ground plane(Lg):

Here the length of the ground plane is obtained by equation (4)

\[ L_g = \frac{0.36 \times c}{f_r \times \sqrt{\varepsilon_{\text{eff}}}} \]

Step 5: Calculation of the Resonant Frequency (fr):

Resonant frequency (fr) is given by the equation (5),

\[ f_r = 3 + \frac{2}{\sqrt{\varepsilon_{\text{ref}}}} \left[ \frac{21}{L_s} + \frac{65}{W_g} + \frac{18}{L_g} - 3 \right] \]

By using the Design Equations the dimensions of strip monopole antenna are having the values of a=10 mm for Hexagonal and a=9 mm for Octagonal antennas and Wg=45mm, Lg=20mm, D=3mm, H=9mm, A=1.6mm, εr= 4.44

i) Octagonal microstrip antenna Design Process

The geometry of proposed finite ground coplanar waveguide (CPW) fed dual-band Octagonal monopole antenna is Shown in Figure 1. The antenna structure is chosen to be a rectangular patch element with dimensions of width W and length L, and with a vertical spacing of ‘h’ away from the ground plane. A conventional CPW fed line designed with a gapof distancea ‘d’ between the signal strip and the coplanar ground plane is used for exciting the radiating patch element. Two finite ground planes with the same size of width Wg and length Lg, are situated symmetrically on each side of the CPW feeding line. The Table.1 shows the dimensions of the proposed Octagonal antenna.
Table 1. Dimensions of the proposed octagonal strip monopole antenna

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Parameters</th>
<th>Dimensions</th>
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<tbody>
<tr>
<td>Substrate</td>
<td>W</td>
<td>60mm</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>45mm</td>
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<tr>
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<td>h</td>
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<td></td>
<td>(\varepsilon_r)</td>
<td>4.38mm</td>
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<tr>
<td>Ground plane</td>
<td>(W_g)</td>
<td>45mm</td>
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<td></td>
<td>(L_g)</td>
<td>20mm</td>
</tr>
<tr>
<td>Antenna</td>
<td>D</td>
<td>3mm</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>9mm</td>
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i) Octagonal microstrip antenna Design Process
The geometry of the proposed bound arena coplanar beachcomber adviser (CPW) fed dual-band Hexagonal monopole antenna apparent in fig2. The proposed antenna was bogus on FR4 substrate with dielectric connected 4.4 and array 1.6 mm.

The Table 2 shows the ambit of the proposed Hexagonal antenna

<table>
<thead>
<tr>
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<td></td>
<td>(L_g)</td>
<td>20mm</td>
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<tr>
<td>Antenna</td>
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<td>1mm</td>
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<td></td>
<td>a</td>
<td>10mm</td>
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Table 2. Dimensions of the proposed hexagonal strip antenna

III. RESULTS

Prototypes of the Octagonal and Hexagonal shape antennas are simulated constructed and tested. The proposed antenna are simulated using HFSS, Fig. 1, 2 shows the simulated antennas

Figure 1: HFSS modal of octagonal antenna

Figure 2: HFSS modal of Hexagonal antenna

A. Octagonal strip Monopole Antenna
The performance of the Octagonal shape antenna has been investigated by using HFSS. The Figures 3, 4 shows the apish acknowledgment accident, VSWR and Figure 5, 6 shows the activated acknowledgment accident, VSWR and the Figure 7 shows the radiation arrangement of the band monopole antenna from the frequency 1.9 GHz to 9.4 GHz.

Fig3. Return loss curve for wide octagonal strip monopole antenna using HFSS

Fig4. VSWR curve for wide octagonal strip monopole antenna using HFSS
Figure 5: Return loss curve for wide octagonal strip monopole antenna using vector network Analyzer network.

Figure 6. VSWR curve for wide octagonal strip monopole antenna using vector network Analyzer network.
B. Hexagonal strip Monopole Antenna

The performance of the Hexagonal shape antenna has been investigated by using HFSS. The figures 8, 9, and 10 show the return loss, VSWR, and radiation pattern of the hexagonal strip monopole antenna from 1.34 GHz to 5.65 GHz.

Fig. 10 shows the return loss curve for wide hexagonal strip monopole antenna using HFSS.
The proposed work is mainly useful to operate the antenna at a particular band of frequencies. The Hexagonal and Octagonal shaped antennas have been built and simulated using the Ansoft HFSS and the practical results are obtained by testing the fabricated antennas on Vector Network Analyzer (E5071C). The Hexagonal band monopole is resonating at 5.5 GHz and UWB impedance bandwidth (S11 < -10 dB) ranges from 1.54 to 9.41 GHz, is observed in simulation result whereas in practical results observed at 2.4 GHz to 8.7 GHz. While the Octagonal band monopole is resonating at 5.5 GHz and UWB impedance bandwidth (S11 < -10 dB) ranges from 1.3 to 5.65 GHz, is observed in simulation result whereas in practical results observed in steps of 3 bands 1.8 GHz-3 GHz, 4 GHz-6 GHz and 7 GHz-9 GHz. The VSWR values for Hexagonal is 1.52:1 at 2.09 GHz & for Octagonal it is 1.53:1 at 1.78 GHz. The Bandwidth for Hexagonal is 7.87 GHz, while for Octagonal is 4.35 GHz. The proposed antennas provide about Omni-directional radiation characteristics with abstinence accretion and ability which is acceptable for the next bearing ultra-wideband applications.

REFERENCES