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Design of Broadband and Dual-band Monopole Antennas applicable in Various Wireless Fields

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Abstract

A wide-band monopole antenna is reported here. This antenna attributes a broad band-width ranging from 1.5 GHz to 7.2 GHz (76.31%) effectful for broad-band wireless application. The antenna comprises of a rectangular metal patch and an altered ground plane. This antenna is named as Antenna XX and is fed with 50 Ω transmission line. Now the antenna is suitably cut at the two corner sides of the metal patch near the feed line and also a rectangular portion of the metal patch has been removed to make the above said antenna perform as a dual band nature. This new geometry of the antenna is named as Antenna YY and provides double band of frequencies. Range of lower bandwidth is 1.7-3.2 GHz having 2.4 GHz middle frequency and range of upper bandwidth is 6.1-7.6 GHz with 6.9 GHz centre frequency. Accessible bandwidths for lower and upper band are 61.44% and 22% individually. The resultant two bands are effective for WLAN and C band applications. These two detailed antennas give monopole similar E-Plane and omnidirectional H-plane radiations patterns. These two antennas are designed and simulated by HFSS software.

Keywords: Monopole antenna, Wideband, Dual band, Wireless application

1. Introduction

With the advancement of wireless technology, monopole antennas become significant due to their simple construction, easy manufacture, easy fitting with little electronics hardware devices [1]. Other than these, they have fundamental beautiful feature of broad band-width. With some changing of geometry of monopole antenna, it becomes multiband nature moreover. Expansive broad band-width implies that it provides high information speed and low spectral coverage. They are also energy efficient [2].

Monopole antennas with various kinds of patch give wide-band feature. U-like antenna having slots on ground was accounted for wide band-width in [3]. A heart-shape antenna gives wide band-width by utilizing modified ground and non-uniform feed line helpful for imaging system [4]. A CPW fed antenna using loop in ground plane, expand the bandwidth was published in [5]. An elliptical antenna uses fractal design to broaden band-width (0.700-9 GHz) as informed in [6].

Many times, multiband antennas are accounted for WLAN, WiMAX, LTE etc. wireless fields. Numerous researchers are attempting to make antennas multi-band in nature.

An antenna put dual SRR to accomplish two bands effectful for WLAN and WiMAX published in [7]. A two-band mini sized antenna having L and fork like patches, was informed for LTE and Wireless LAN fields in [8]. In [9], crescent like CPW fed two bands antenna is presented for wireless technology. An antenna with DGS geometry was informed for IoT technology in [10]. Dual frequency has been achieved by putting resonating element and modified ground applied for WLAN in [11].

In this article, monopole antennas with just a reduced size of 40×30 mm2 is accounted for broadband, WLAN and C band applications. The reported antennas are modeled and simulated by HFSS software. Antenna XX gives broadband of 5.7 GHz and Antenna YY gives two bands. Both bands have equal -10 dB impedance bandwidth of 1.5 GHz.

2. Design of wide band and dual band antennas

The geometry and modeling of the two reported antennas are informed here. Both antennas are configured and simulated by HFSS software. FR4 substrate material is used to model the antennas. It has specifications like dielectric constant (εr) = 4.4, height (h) = 1.6 mm and loss tangent (δ) = .023. At first, a simple rectangular patch is modeled which has length X3=16 mm and width Y3= 15.5 mm. It consists of a shrink ground plane opposite side of the substrate with dimensions of X2= 18 mm and Y2= 30 mm. This initial antenna is termed as Antenna XX and is appeared in Figure.1. a. Graycolor shows ground plane, brown color shows patch and white color shows substrate. Now two square portions are cut away from bottom side of the patch just two sides of the feed line and a rectangular portion is removed from middle portion of the radiating patch as shown in Figure.1. b. This new configuration of the antenna is termed as Antenna YY and is shown in Figure.1. b. The dimensions of the removed metal portion is appeared in Figure.1. b and listed in Table. I. This antenna provides two wide band-widths. The evolution process from Antenna XX to Antenna YY is shown in Figure.1. c. This evolution process contains only one intermediate geometry to model Antenna YY from Antenna XX and is shown in Figure.1. c. Comparison of S11 parameters with respect to frequency for Antenna XX, intermediate geometry and Antenna YY are shown in Figure.1. d. Both configured antennas use microstrip feed line of length XF=20 mm and width YF=3.06 mm to achieve matching impedance. Substrate length (X1) and width (Y) are 40 mm and 30 mm respectively. The length and width of each parameter of the reported antennas are tabulated in the Table. I.

Table. 1: Parameters (in mm) of the reported antennas

X1	X2	X3	X4	X5	XF
40	18	16	8	3	20
Y1	Y2	Y3	Y4	Y5	YF
30	30	15.5	1.5	3	3.06

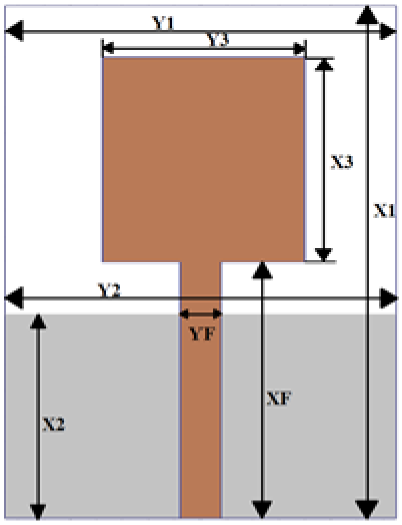


Figure.1. a: Antenna XX

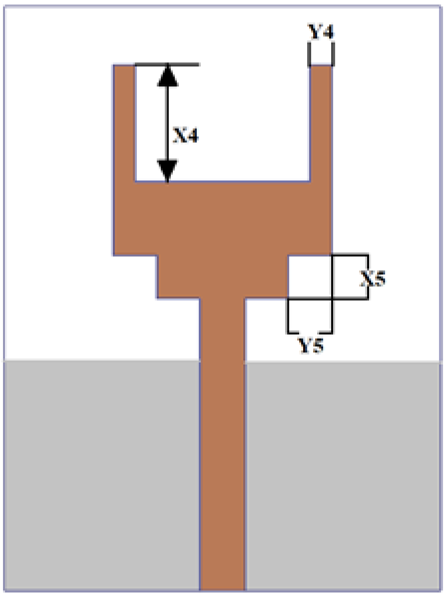
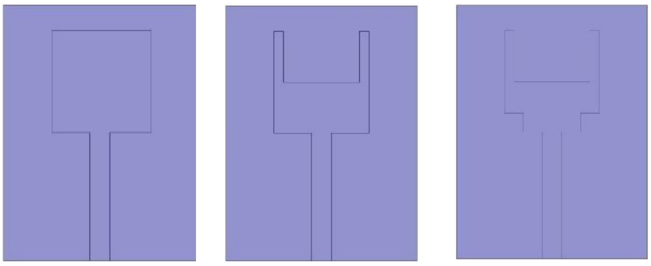


Figure.1. b: Antenna YY



Antenna XX **Intermediate stage** **Antenna YY**

Figure.1. c: Evolution process of Antenna YY

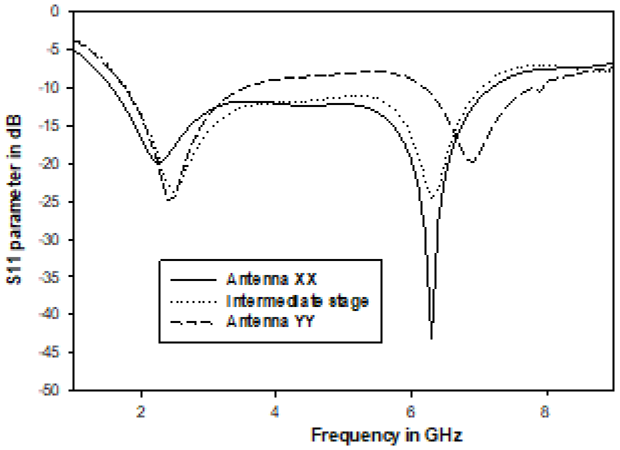


Figure.1. d: Comparison of S11 parameters for evolution process of Antenna YY

3. Results (Simulated) Of Antennas

This section contains simulated results of the reported antennas. Antenna XX provides wide -10 dB impedance bandwidth ranges from 1.5 to7.2 GHz with 76.31% of bandwidth. Maximum reflection co-efficient reaches at -43.17 dB at 6.3 GHz. Antenna YY provides two wide bands. One ranges from 1.7 to 3.2 GHz with 2.4 GHz central frequency. Other band ranges from 6.1 GHz to 7.6 GHz with 6.9 GHz central frequency. Accessible percentage bandwidths for first band and second band are 61.44 % and 22% respectively. Maximum reflection co-efficient reaches -25 dB for the first band and -20 dB for the second band. The plot of S11 parameters for both Antenna XX and Antenna YY are shown in Figure.2. Normalized E-H plane radiation patterns at three different frequencies (2.3 GHz, 4.4 GHz and 6.3 GHz) of Antenna XX are appeared in Figure.3. a, Figure.3. b and Figure.3. c. Almost monopole alike radiation patterns are obtained. Figure.4 shows the surface current of Antenna XX at 2.3 GHz, 4.4 GHz and 6.3 GHz. Maximum current occurs at bottom portion of the feed line for 2.3 GHz, maximum current occurs at entire feed line and bottom portion of the metal patch for 4.4 GHz and for 6.9 GHz, maximum current takes place along with the feed line. Normalized E-H patterns of Antenna YY are shown in Figure.5. a and Figure.5. b. Figure.5. a shows radiation patterns at 2.4 GHz for Antenna YY and Figure.5. b shows radiation patterns at 6.9 GHz for Antenna YY. Surface currents at 2.4 GHz and 6.9 GHz for Antenna YY are shown in Figure.6. Maximum current occurs at the feed line at 2.4 GHz and 6.9 GHz for Antenna YY.

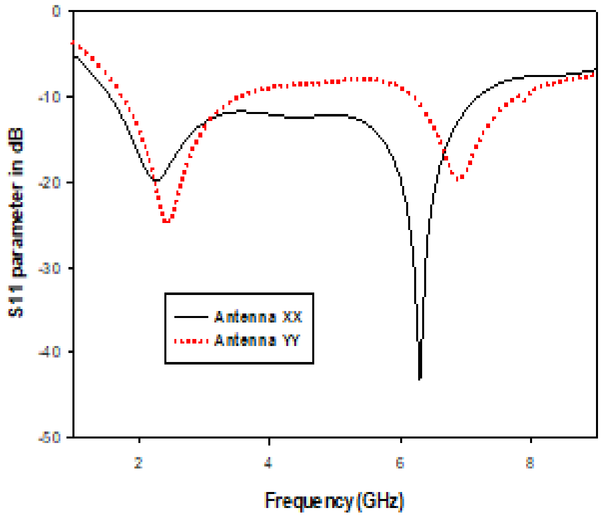


Figure.2: S11 parameter plot

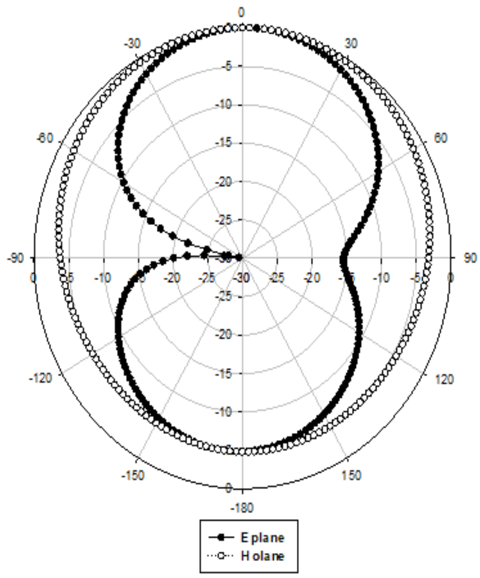


Figure.3. a: Normalized radiation patterns at 2.3 GHz for Antenna XX

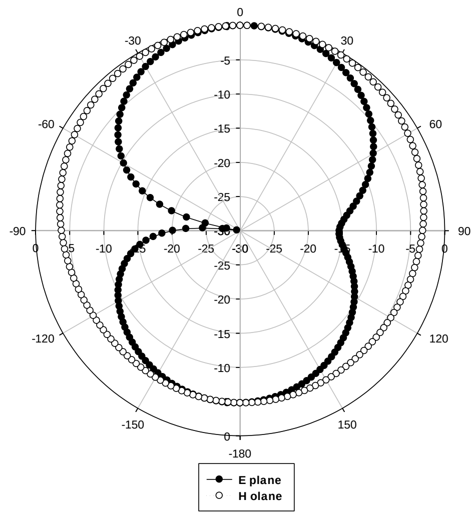


Figure.3. b: Normalized radiation patterns at 4.4 GHz for Antenna XX

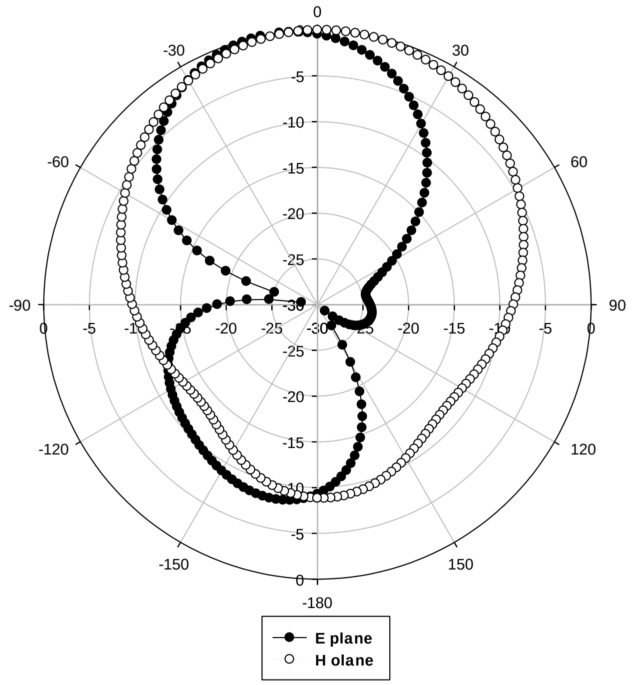
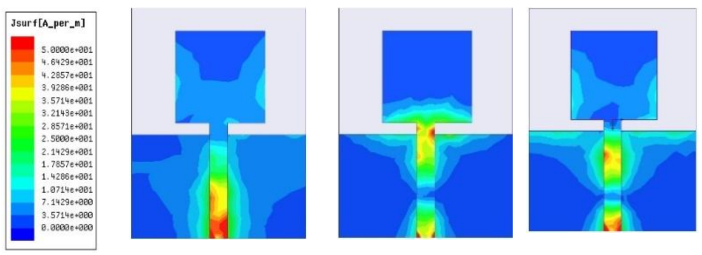


Figure.3. c: Normalized radiation patterns at 6.3 GHz for Antenna XX



(a) 2.3 GHz (b) 4.4 GHz (c) 6.3 GHz

Figure.4: Surface current of Antenna XX

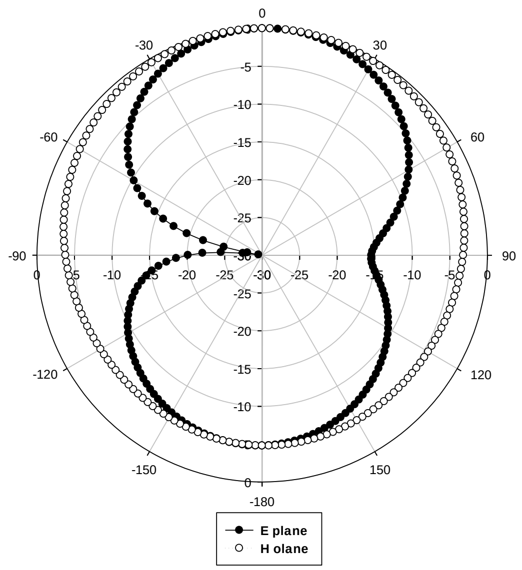


Figure.5. a: Normalized radiation patterns at 2.4 GHz for Antenna YY

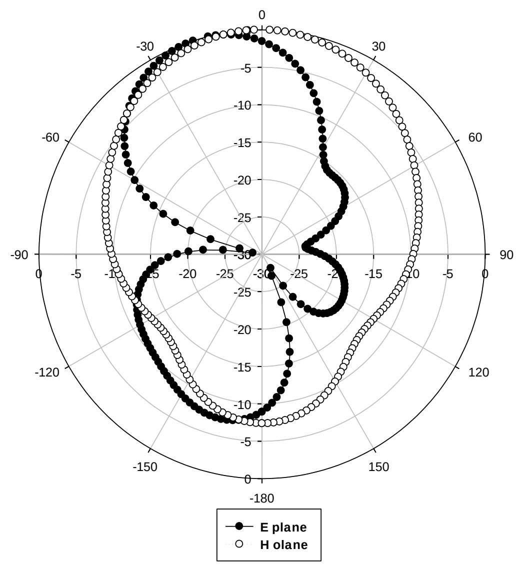
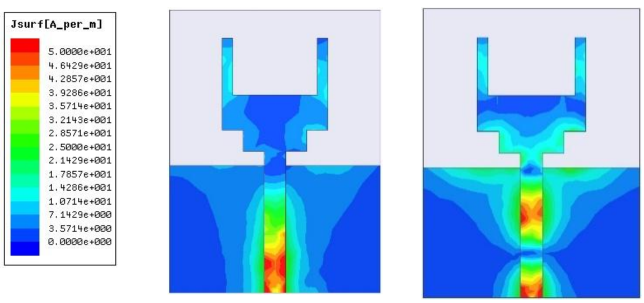


Figure.5. b: Normalized radiation patterns at 6.9 GHz for Antenna YY



(a) 2.4 GHz (b) 6.9 GHz

Figure.6: Surface current of Antenna YY

Conclusions

In this work, two monopole antennas are reported. Rectangular monopole antenna provides wide band-width of 5.7 GHz. Two types of metal cut have been introduced on the metal patch of the rectangular monopole antenna to obtain two bands. Two bands, each of 1.5 GHz have been achieved. Antennas are simple in design and small in volume. They are applicable in broadband and dual band (WLAN and C) applications. Antennas have been designed in HFSS Software and simulated results are presented. The tested results verification is in progress and will be informed in future.

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