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***Research paper***

# Dual Band Double Cross Monopole Antenna with Defected Ground Structure

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**Abstract**

A twofold band deceive monopole recieving wire is outlined with absconded ground structure. The planned radio wire is created on FR4 substrate of thickness 1.6 mm and dielectric consistent 4.4. the proposed reception apparatus is working in double band at 3 GHz (2.5-3.5 GHz with data transfer capacity of 1 GHz) and 9 GHz (8.5-9.5 GHz with transmission capacity of 1 GHz). The general measurement of this position of safety recieving wire is around 35x25x1.6 mm. Radio wire giving pinnacle pick up of in excess of 4.6 dB at 3 GHz and 3.86 dB at 9 GHz. The prototyped configuration was estimated with aniritsu combinational analyzer and the acquired outcomes are demonstrating great coordinating with reproduction results got from HFSS instrument.

***Keywords***: *Dual Band, Double Cross, Defected Ground, Monopole Antenna*

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## 1. Introduction

Double Band Radio wires have heaps of commonsense uses, for cell phones particularly. They work on two groups or frequencies, which are somewhat similar to radio stations, and can either work each one in turn or at the same time contingent upon the capacities of the individual gadget [1-4]. Double band reception apparatuses enable you to associate remotely in harder to achieve areas and are regularly utilized for gadgets, for example, cell or double band remote passageway [5-6].

The double band reception apparatuses chip away at two groups, one of which normal family unit machines likewise take a shot at. They can meddle with your network on other innovation now and again, however that can happen in any circumstance where there are various gadgets working immediately [7-8]. For some gadgets, double band recieving wires are a steady, simple approach to interface with the things you require. One approach to make a double band sharp edge recieving wire is to make an opening in a cutting edge reception apparatus that is not exactly or on the request of λ/10 with the goal that the lower recurrence does not 'see' the space (it is a general dependable guideline that the bother made by an intermittence not exactly λ/10 on a structure is irrelevant) [9-10].

The need for double band reception apparatuses is extraordinarily expanding these days. A few ways to deal with get double band printed dipole are introduced. U-molded openings and split-ring resonators have been connected in the dipole for double band application. In any case, there is an issue that the proportion between the working groups is constantly bigger than 2, i.e., the working groups could scarcely draw near. The double band radio wires with subjective recurrence proportion, particularly proportion littler than 2, are increasingly requested in remote administrations, e.g., route frameworks, remote neighborhood (WLAN) et cetera [11-13].

In this article a minimized double band recieving wire is intended to work at a large portion of the applications like Bluetooth, LTE, Wi-Fi, WiMAX and satellite correspondence applications. The outline angles as for the scientific plan and the applicable issues are talked about in the ensuing segments.

## 2. Antenna Geometry:

The composed reception apparatus comprising of betray fix with monopole structure. The opposite side of the substrate is influenced surrendered to ground by expelling certain part starting from the earliest stage. The upper bit of the fix comprising of cross formed transmitting component with more extensive measurement and lower bit of the emanating component comprising of restricted measurement. The plan of the monopole depends on the scientific detailing of rectangular fix as essential structure [14]. The powerful dielectric permittivity of the limited microstrip line is communicated as

$$\epsilon_{re} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \frac{\ln\left(\frac{\pi}{2}\right) + (1/\epsilon_r)\ln\left(\frac{4}{\pi}\right)}{\ln(8\,h/W)} \quad (1)$$

The wavelength of the signal propagating through a microstrip line is

$$\lambda_m = \frac{\lambda_0}{\sqrt{\epsilon_{re}}} \quad (2)$$

The characteristic impedance can be calculated from the equation 3 and 4.

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$$Z_{om} = \frac{\eta}{2\pi\sqrt{\epsilon_{re}}} \ln\left(\frac{8h}{W} + 0.25\frac{W}{h}\right) \quad \text{for w/h > 1} \quad (3)$$

$$Z_{om} = \frac{\eta}{\sqrt{\epsilon_{re}}}\left\{\frac{W}{h} + 1.393 + 0.667\ln\left(\frac{W}{h} + 1.444\right)\right\}^{-1} \quad \text{for w/h <1} \quad (4)$$

When the characteristic impedance of the microstrip line is known then to find the width of the strip

$$\frac{W}{h} = \frac{2}{\pi}\left\{\frac{60\pi^2}{Z_{om}\sqrt{\epsilon_r}} - 1 - \ln\left(\frac{120\pi^2}{Z_{om}\sqrt{\epsilon_r}} - 1\right) + \frac{\epsilon_r - 1}{2\epsilon_r}\left[\ln\left(\frac{60\pi^2}{Z_{om}\sqrt{\epsilon_r}} - 1\right) + 0.39 - \frac{0.61}{\epsilon_r}\right]\right\} \quad (5)$$

This expression will give the effective length of the radiating patch.

$$f_r = \frac{1}{2L_e\sqrt{\epsilon_{re}}\sqrt{\epsilon_0\,\mu_0}}\sqrt{\frac{2}{\epsilon_r + 1}} \quad (6)$$

For an efficient radiator, the optimized width is given as

$$W = \frac{1}{2f_r\sqrt{\epsilon_0\,\mu_0}}\sqrt{\frac{2}{\epsilon_r + 1}} \quad (7)$$

The length of the patch can be determined by

$$L = \frac{1}{2f_r\sqrt{\epsilon_{re}}\sqrt{\epsilon_0\,\mu_0}} - 2\Delta L \quad (8)$$

Here '$f_r$' is the resonating frequency. Fig 1 shows the dimensional view of the antenna front side and back side. The equivalent circuit is also presented here for the designed antenna model. Table 1 providing all the dimensions for the antenna parameters.

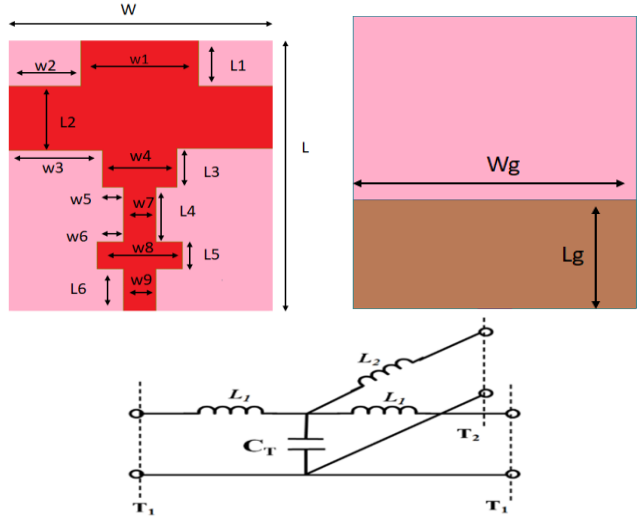



**Fig 1.** Antenna Geometry, (a) Front View, (b) Back View, (c) Equivalent circuit

**Table 1.** Antenna Dimensions

| S. No | Parameter | Dimension in mm | S. No | Parameter | Dimension in mm |
|---|---|---|---|---|---|
| 1 | W | 25 | 9 | L1 | 6 |
| 2 | L | 35 | 10 | L2 | 8 |
| 3 | W1 | 20 | 11 | L3 | 5 |
| 4 | W2 | 5 | 12 | L4 | 8 |
| 5 | W3 | 9 | 13 | L5 | 3.5 |
| 6 | W4 | 7 | 14 | L6 | 4.5 |
| 7 | W5 | 2 | 15 | Lg | 13 |
| 8 | W6 | 2.5 | 16 | Wg | 25 |

## 3. Results and Analysis:

This section presents the simulated and measured results of the proposed antenna with respect to reflection coefficient, VSWR, input impedance, radiation pattern and current distributions. The fig 2 shows the frequency Vs reflection coefficient and VSWR plot. The proposed antenna operating in two bands at 3 GHz and 9 GHz with bandwidth of 1 GHz at each band. The reflection coefficient less than -10 dB and VSWR 2:1 in those operating bands.

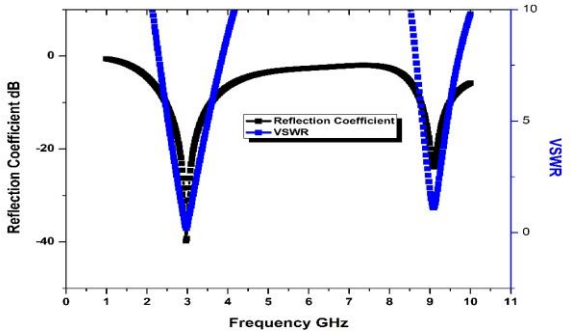



**Fig 2.** Reflection Coefficient, VSWR Vs Frequency

The input impedance of the antenna is presented in Fig 3 with respect to smith chart. The impedance of the antenna is nearer to 50 ohms at both operating bands.

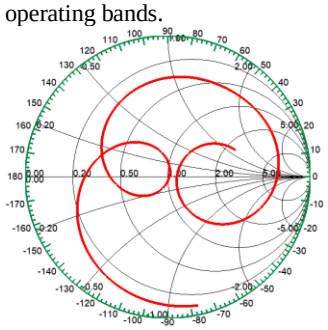
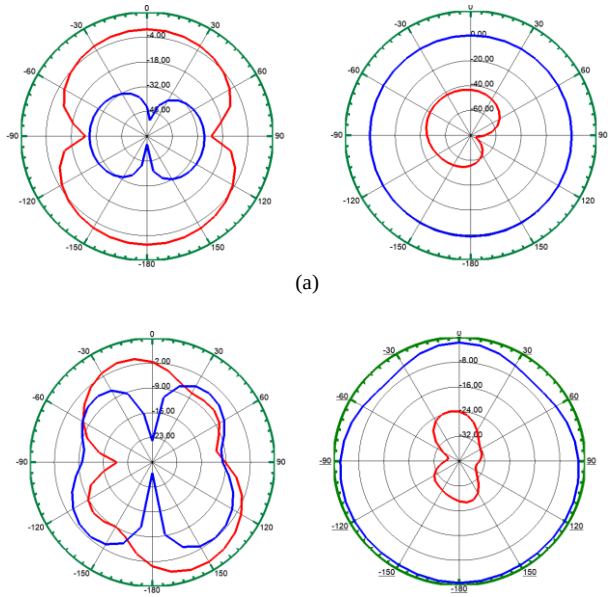


**Fig 3.** Impedance Measurement by Smith Chart

There are two zones where signals crumple and transmit from the radio wire. They are known as the close field and far field. The separation that reception apparatus inductance has on the transmitted flag is straightforwardly relative to recieving wire tallness and the measurements of the wave. The radiation example of the reception apparatus will give the total picture in regards to its radiation attributes in two noteworthy planes of height and azimuthal. Fig 4 shows the radiation example of the recieving wire in E and H-plane for 3 GHz and 9 GHz. The E-plane radiation example of the radio wire is looking like monopole like radiation at 3 GHz and mandate design at 9 GHz. In H-plane reception apparatus is demonstrating omni directional example in co-polarization and low cross polarization.



(a)

(b)

**Fig 4.** Radiation Pattern in E and H-Fields, (a) At 3 GHz, (b) At 9 GHz

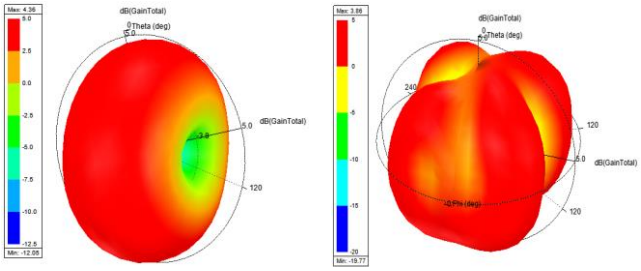
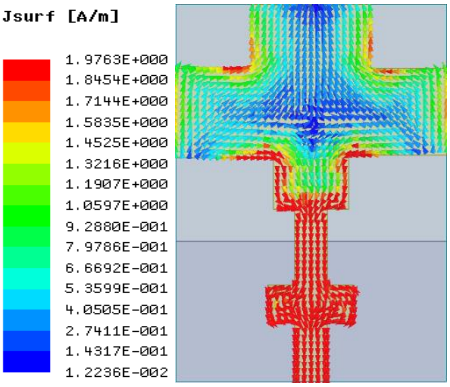


**Fig 5.** 3D Gain Plots at 3 GHz and 9 GHz

The three-dimensional radiation pattern can be observed from Fig 5. The monopole like pattern and the directive pattern at two operating bands can be observed from the above patterns. The surface current distribution over the antenna structure can be observed from the Fig 6. The current distribution is more at feed point over the surface of the patch element. The antenna current distribution in 6(b) having equal magnitude but orientation in opposite direction on the patch. This will lead to cancellation of radiation on that location.



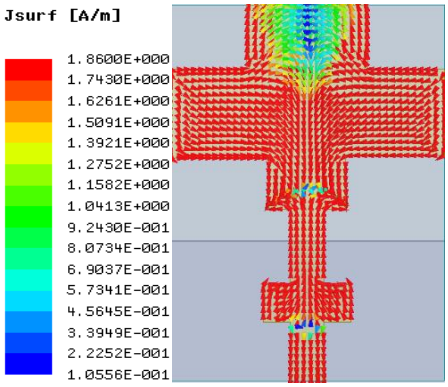




**Fig 6.** Current distribution plot, (a) At 3 GHz, (b) At 9 GHZ

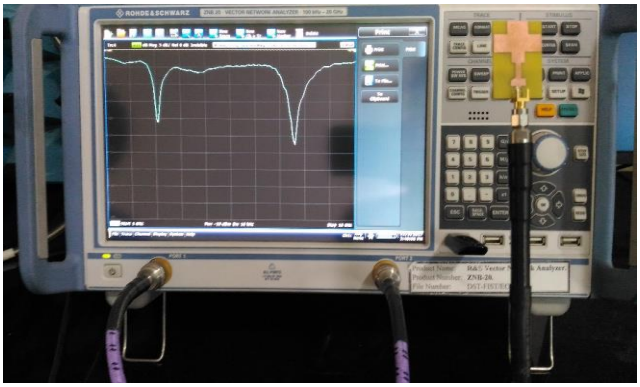


**Fig 7.** Measurement on ZNB 20 VNA

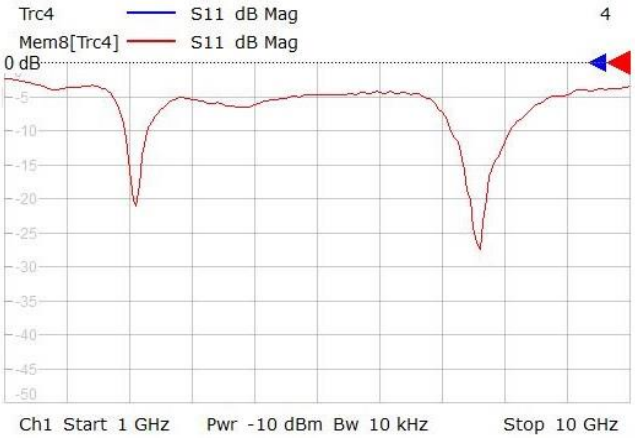



**Fig 8.** Measured Reflection Coefficient

The measurement results of the antenna on ZNB 20 vector network analyzer is presented in Fig 7. The $S_{11}$ result of the antenna with dual band characteristics can be observed here in Fig 8 also along with the network analyzer screen shot.




**Fig 9.** Measured Impedance

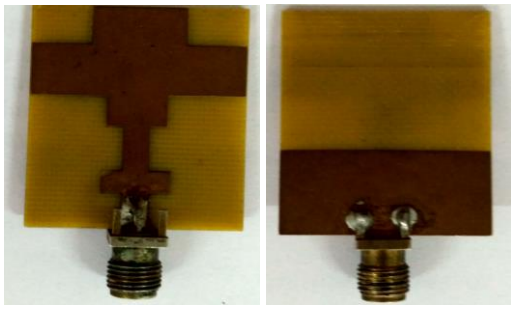


**Fig 10.** Fabricated Antenna Model

The impedance characteristics of the are presented in Fig 9. Antenna measurement results are in good agreement with the simulation results. Fig 10 shows the fabricated antenna model top and bottom view for reference.

## 4. Conclusion

The proposed radio wire show is minimized in nature with measurement of 35x25x1.6 mm on business FR4 substrate material. The composed recieving wire working in two groups at 3 GHz and 9 GHz with great impedance data transmission and radiation attributes. The model is covering the greater part of the application groups like Bluetooth, LTE, Wi-Fi and satellite correspondences. The proposed demonstrate indicating omni directional example in H-plane with low cross polarization and monopole like example in E-plane. A pinnacle acknowledged pick up of 4.6 dB at 3 GHz and 3.86 dB at 9 GHz is achieved from the present model. The deliberate outcomes on Vector arrange analyzer is furnishing phenomenal relationship with recreation results.

## 5. Acknowledgements:

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