Low Profile Wide Band Balanced Antenna Design for Mobile Applications

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ABSTRACT

In this paper, wide band balanced antenna with enhanced bandwidth performance that covers the 850 to 3000 MHZ of Band, covering the GSM, UMTS, Bluetooth, GPS, & Wi-Fi applications is investigated[1-4]. This antenna was designed in HFSS which have low profile, linear phase and constant radiation pattern with proper return loss and resonant on multiple frequencies. This proposed antenna was then fabricated on substrate FR-4 Epoxy with dimensions 30 x 7 x 1.6 mm, and fed with planer wide band balun to calculate and measure the results.

General Terms

Wide band balance antennas, low profile antenna, unbalanced antenna , VSWR, radiation pattern, Return losses, 2D and 3d Polar / Radiation plots, prototyping, current distribution

Keywords

Low profile, balanced antenna, multi band / wide band antenna, VSWR, radiation pattern.

1. INTRODUCTION

As technology becomes more advanced, Antennas of hand held devices are fabricated near the ground plane with the different RLC components, which retards down the overall efficiency of the antenna. To overcome this problem balanced antenna technology was introduced to provide the reduction of current in the ground plane [6,7&11].

In the proposed designed, balanced currents only flow on the antenna element, thus dramatically reducing the effect of current flow on the ground plane (i.e. Chassis of any hand held devices)

In this paper a wide band [16,17&21] dipole antenna for mobile applications was designed and analyzed which is resonant on multiple frequencies (i.e. 850-300Mhz).

HFSS was used to design and calculate the results of the antenna on infinite sphere and to calculate the flow of current, gain , return loss and radiation parameters [5,6]. Deigned antenna was then fabricated on FR-4 Epoxy and the results were measured using network analyzer and Matlab to match the practical results with theoretical aspects [1].

2. DESIGNED ANTENNA

The designed antenna shown in figure 1(a) have a meandered rectangular patch is implemented on the FR-4 epoxy substrate. In balanced antenna design actually the mirror copy of the patch is implemented with is original one so that to cancel the current distribution in ground plane. So first, patch antenna was designed then copy its mirror image on the right side of the substrate.

The dimensions of the substrate are (30mm x 7mm x 1.6mm).The floating ground having dimensions (80 x 30) is used as reference mobile ground, shown in figure 1(a) &1(b).

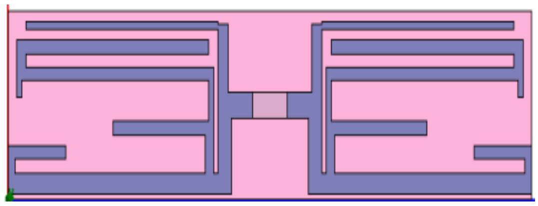

Figure 1 (a): designed balanced patch antenna

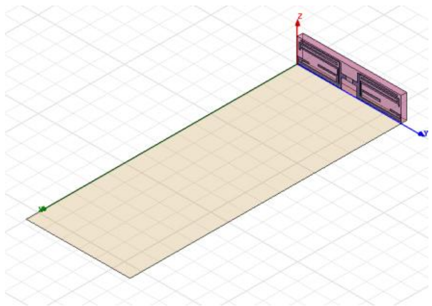

Figure 1 (b): Balanced patch antenna with ground

For feeding purpose, probe feeding technique is used. The antenna is fed with two different individual feed line inputs having same magnitude but opposite in phase.

Due to the multiple different path lengths the antenna is able to resonate at multiple frequency bands range. The lower path is controlling the lower frequency bands. The upper most path is controlling the higher frequency bands and the middle path is playing roll in the middle notch and the bandwidth of the antenna [19,20]. These prospects can be seen in results section.

3. RESULTS

In this section, the simulated return loss, radiation patterns and VSWR graph of the above implemented design are shown below:

3.1 Return Loss

In figure 2 the return loss[18] simulated in HFSS is shown.

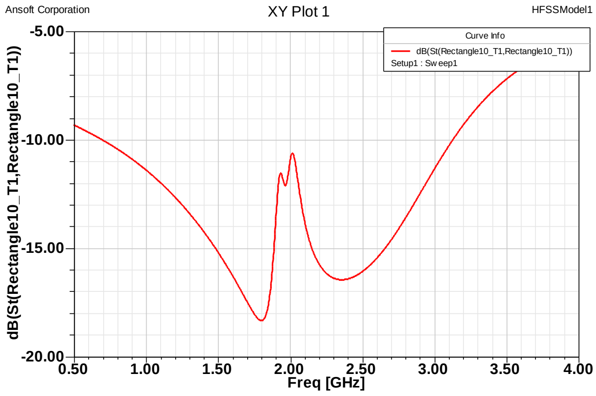

Figure 2: Return loss of proposed antenna

3.2 Radiation Patterns 2D

The 2D XY, YZ, ZX radiation pattern at different operating frequencies are shown in figure 3(a) to 3(e).

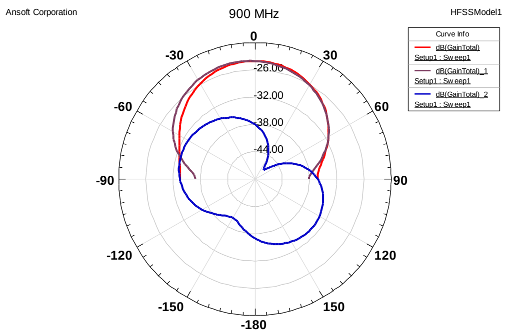

Figure 3(a): 2D Radiation pattern at 900 MHz

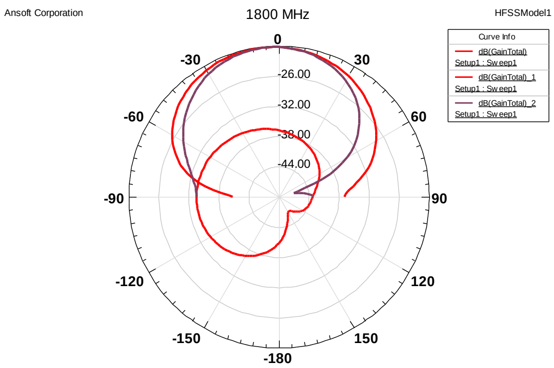

Figure 3(b): 2D Radiation pattern at 1800 MHz

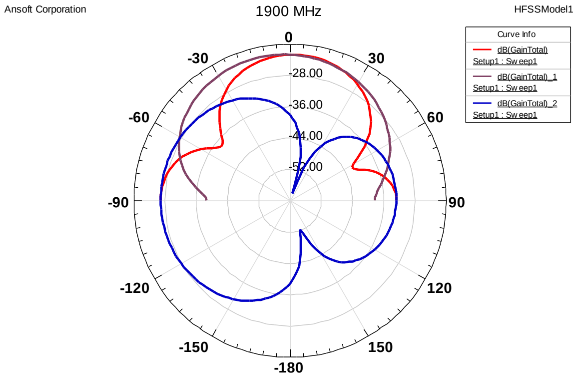

Figure 3(c): 2D Radiation pattern at 1900 MHz

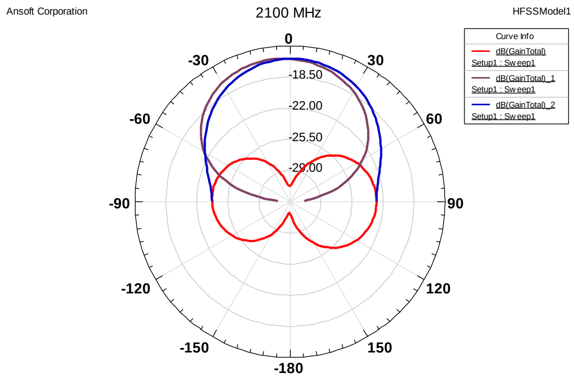

Figure 3(d): 2D Radiation pattern at 2100 MHz

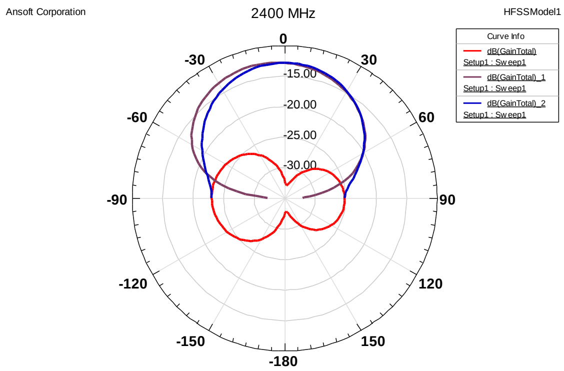

Figure 3(e): 2D Radiation pattern at 2400 MHz

3.3 VSWR

Ideally, VSWR is equal to unity in case of no transmission line mismatch. For low gain mobile terminal antennas $\rho \leq 2$ and $\rho \leq 3$ [16].

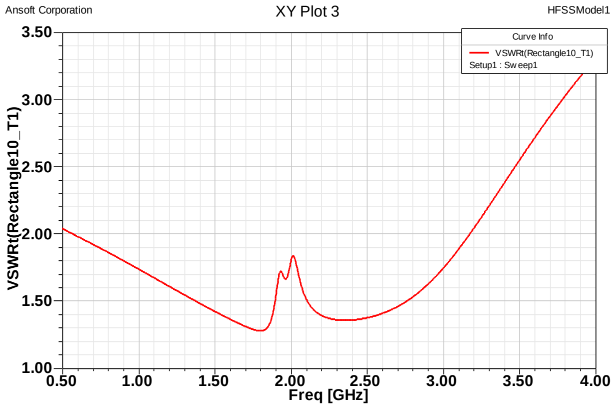

Figure 4: Showing VSWR characteristic of final antenna i.e. less than 2 for the operating region

3.4 3D Polar Plots

The 3D polar patterns at different operating frequencies are shown in figure 5(a) to 5(e).

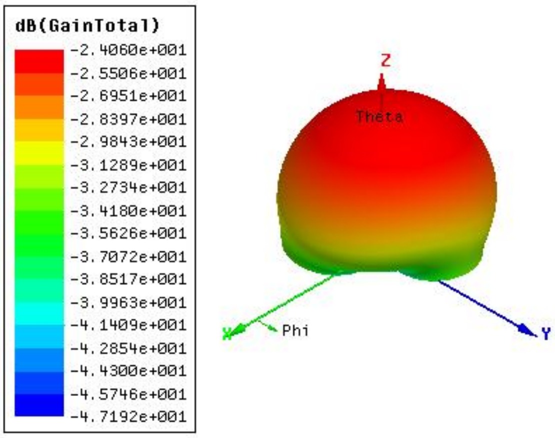

Figure 5(a): 3D polar pattern at 900 MHz

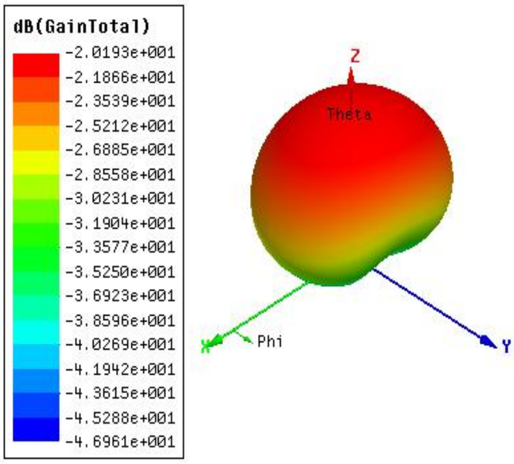

Figure 5(b): 3D polar pattern at 1800 MHz

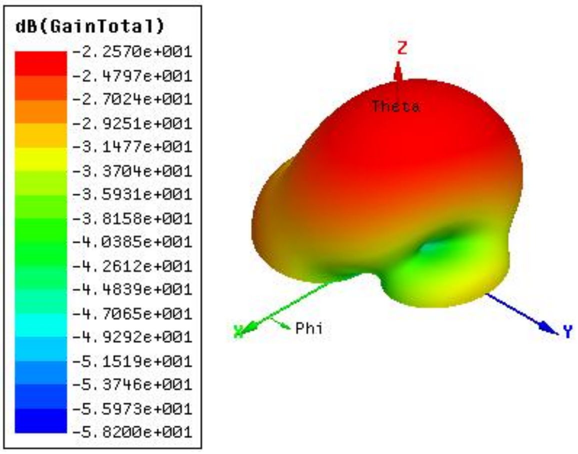

Figure 5(c): 3D polar pattern at 1900 MHz

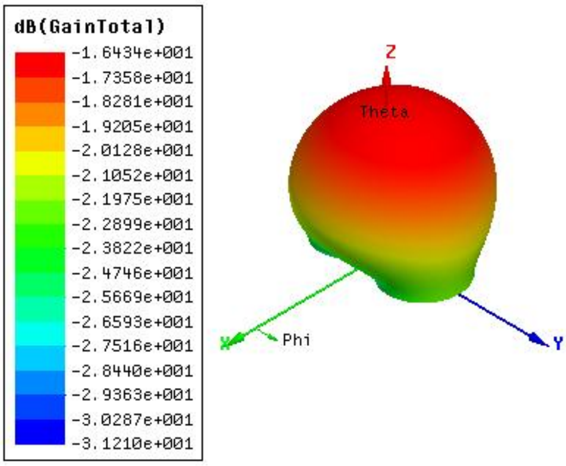

Figure 5(d): 3D polar pattern at 2100 MHz

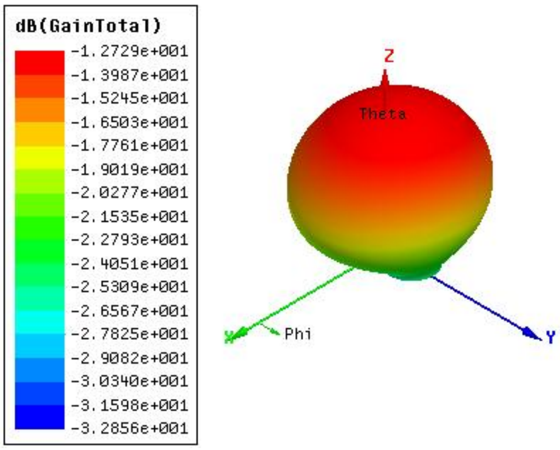

Figure 5(e): 3D polar pattern at 2400 MHz

4 CURRENT DISTRIBUTION

The magnitude of the current over the patch designed is shown in figure 6. It is one of the most important factors to radiate the patch of antenna [8]. A good current distribution will result in good radiation.

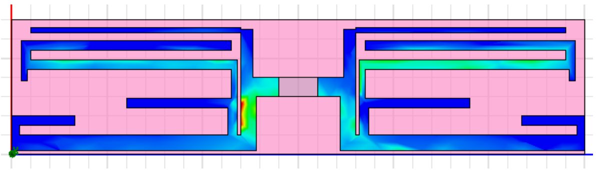

Figure 6: The current distribution along the patch

5 PROTO TYPE

A prototype of the balanced patch antenna with the dimensions optimized above is fabricated.

In this fabrication Single sided copper layered substrate is used and Ferric chloride solution is used for etching the copper patch on the substrate. SMA Connectors is soldered to the antenna patches using connecting wire [9], And a single layer sheet having dimensions of 80X30mm used to ground the antenna. As shown in below figures 7(a) and 7 (b).

Figure 7(a): Fabricated Balanced Antenna

Figure 7(b): The proto type design of the antenna with ground Plane.

Results of the fabricated Antenna are then measured by network analyzer and optimize the extracted results on Matlab with the theoretical aspects as shown in given below in figures 8(a) and 8(b).

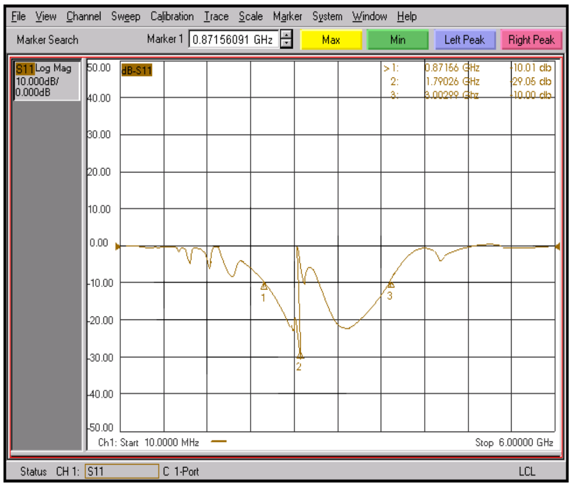

Figure 8(a): Return loss of the antenna on Network analyzer.

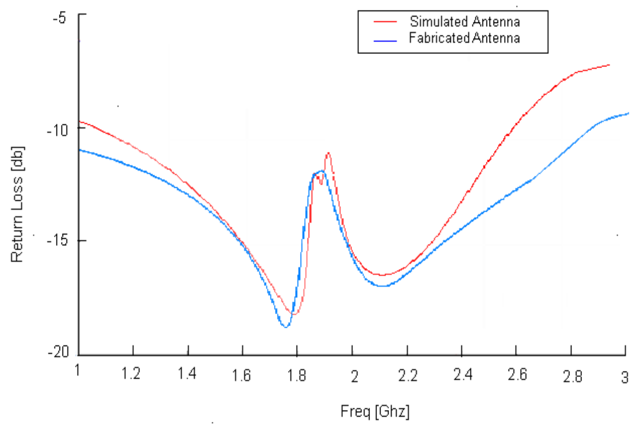

Figure 8(a): Return loss plotted on Matlab

The data files from HFSS and Network analyzer are imported to Matlab to optimize the results of fabricated and simulated antenna, The difference in the fabricated and simulated antenna can be seen clearly from the above picture, as the s11 Parameter [18] of fabricated antenna are slightly shifted to left side from the reference S11 parameter of simulated antenna because the feeding cables are not perfectly matched and also there are some losses of SMA connectors, But still it will resonate on pre-described frequency band [14,15].

6. CONCLUSION

Patch antennas are very important for modern applications, but mostly the unbalanced antennas are used which usually retard down its efficiency in some manner when fabricated near to the ground plane. The basic aim of this paper is to make low profile balanced antenna that can work efficiently on mobile applications [12,13] working from 850-3000 MHz of frequency bands.

The main idea of designing such an antenna is that, it will resonant on different frequencies for different applications in such a manner that it can retain its efficiency when it fabricated near to ground plane [6].

The problem was solved by proposing a balanced patch on the FR-4 substrate, in order to retains its efficiency and reduction of current in lumped (R,L & C) elements. Now, it is able to provide a suitable amount of bandwidth which is applicable for the mentioned mobile applications [6,10 &11].

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