Design and Simulation of a Dual Polarized High Performance Antenna Element for Mobile Communication Base Station

Oko-oboh, Akhere Angus, Umayah, Erhiega N., Okhaifoh, Joseph Ebosetale

***Abstract*—A Dual Polarized Microstrip antenna array element for mobile telecommunication base station has a good potential for low cost base station antenna design for wireless communication. The result shows that there is increase capacity, besides; fading mitigation is put to check. The use of this type of design eliminates signal transception and result in polarization diversity and estimations.**

***Index Terms*— Dual polarized, base station, low cost, fading mitigation, polarization diversity.**

I. INTRODUCTION

Ideally, base station antenna in wireless communication would have broadband performance, small aperture, high gain, low side lobe levels and requires stable and appropriate beamwidth for cell sector design. In addition, it should have low voltage standing wave ratio, adequate power handling capacity, assembly and manufacturing must be easy [1],[2]. Increasingly, cost is a major factor, especially for application in emerging technology in global market. In existing design, the use of other types of antenna design e.g for the parabolic reflectors in parabolic antenna elements design result to coupled stacked patches, which however leading to good performance, but difficult to achieved the required cost targets due to high cost printed circuit boards. Various designs of dual polarized in journal articles and magazines has their merits and their short comings. For instance, the folded dipole metal broadband dual polarized antenna element shows a narrow bandwidth as frequency decreases, with antenna dimensions increasing in proportion, There is also the demerit of cross element and offset tuned dual band although, it has excellent gain performance and excellent radiation pattern [3]. The dual-ring circularly polarized micro strip patch array using hybrid feed has a well behaved radiation pattern and moderate high gain but has the demerit of a very poor isolation [4].

In this design, a gain of 7dBi under a frequency range of 1.9-2.17GHz (3 G Band) gives a low profile and high isolation between the dual polarized ports equal to or greater than 30dB, conformal configuration, low volume, light weight, low cost, compatibility with integrated circuits and a compact antenna system.

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The dual polarized high performance microstrip antenna in figure 1 is a single patch microstrip type. It consists of a rectangular substrate with a parasitic element deployed above it. Such antennas have very small Voltage Standing Wave Ratio (VSWR), narrow bandwidth of about 0.7% to 1.5% but for high frequency performance, high power capacity, minimum reflection and resistance matching, the VSWR must be increased [5].

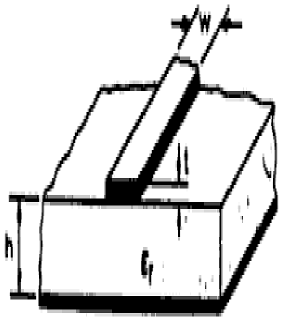

Fig. 1: Sketch of Dual Polarised Antenna

Hence a parasitic element was deployed above the driven patch element as shown figure 1. The parasitic element increases the capacitance of the driven element thereby increasing the bandwidth of the antenna system. The separation between the driven element and the parasitic element contributes to the VSWR bandwidth as well as the gain of the antenna and thus stacked patch antennas are popular choice in wireless communication and feed arrays for reflector antennas [1], [6].

II. THEORY AND DESIGN

Transmission line model approach was used and an addition of suspended patches for improved bandwidth gives minimum reflection with VSWR to match a given system at a given resistance [7],[8]. The dual polarization microstrip antenna was designed from the single polarized version in figure 2 and the simulation result and smith chart is as shown in figures 3a and 3b.

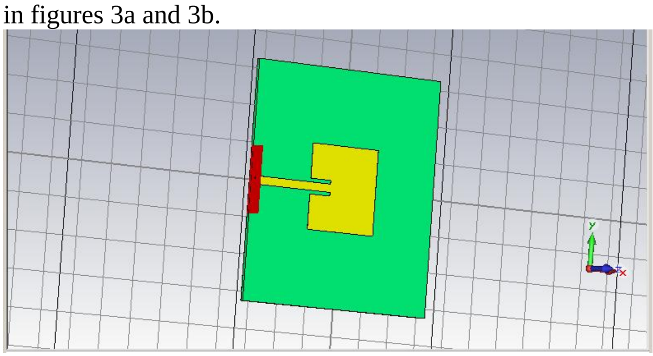

Fig. 2: Computer Simulation Technology Design of Dual Polarized Antenna

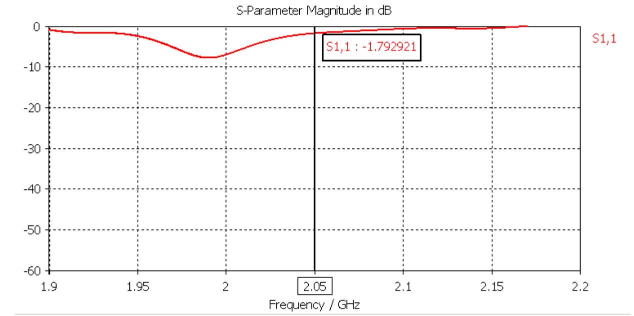

Fig 3a: Simulation Result of Dual Polarized Antenna

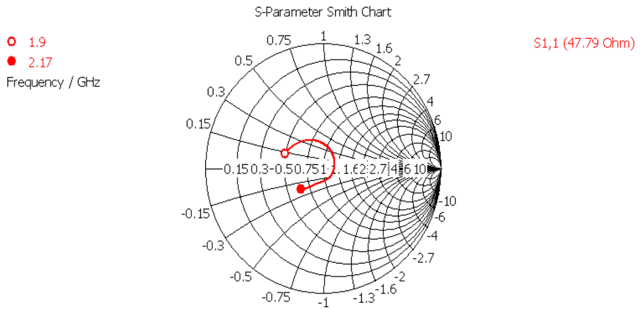

Fig. 4c: Smith Chart Dual Polarize Antenna with T-junction Splitter

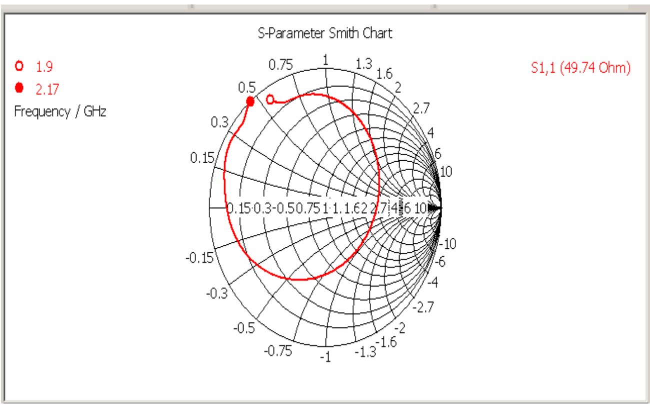

Fig 3b: Smith chart diagram of Dual Polarized antenna

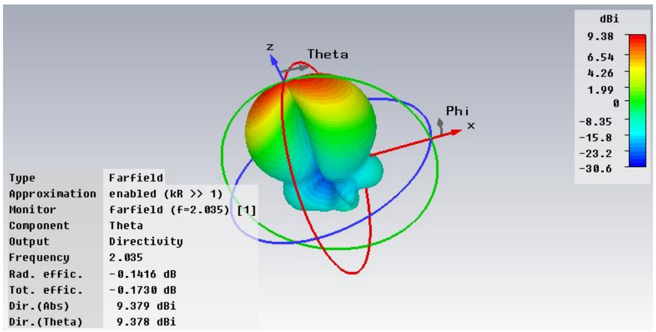

Fig. 4d: Radiation pattern 3D with T-junction splitter

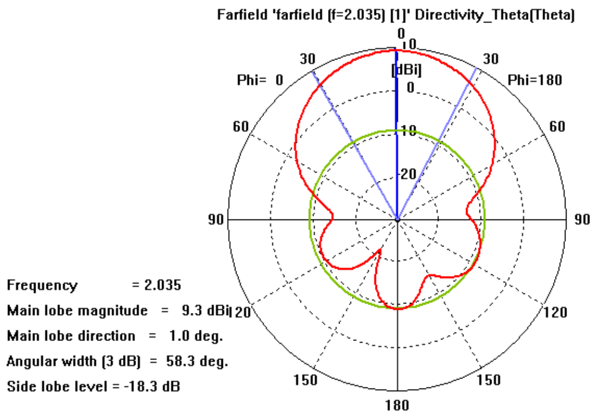

Fig. 4e: Radiation pattern 3D with T-junction splitter

However, with the single polarized version and a T-junction splitter in fig 4a, the simulation and the smith chart result is as shown in Figure 4b and 4c respectively.

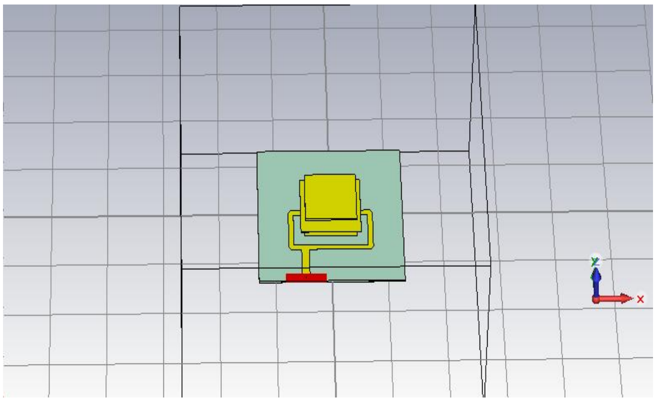

Fig. 4a: Addition of a T-junction splitter

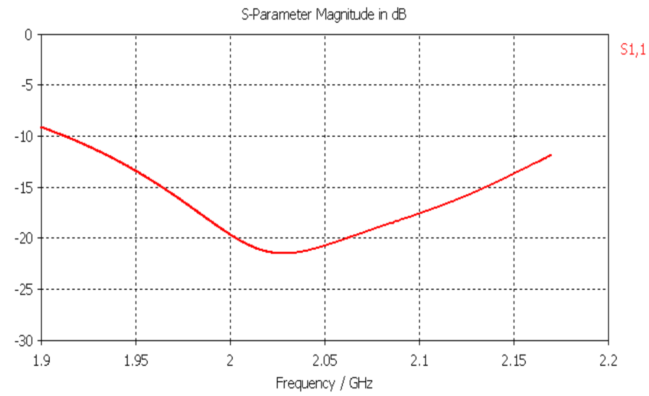

Fig. 4b: Dual Polarized Antenna with T-junction splitter

For the dual polarization antenna, a second substrate was added together with another T junction splitter as in figure 5a. This gives rise to a balanced excitation [9]. Simulation results are shown in figure 5b and figure 5c. The smith chart for S11 and S22 are also depicted in Figure 5d and Figure 5e.

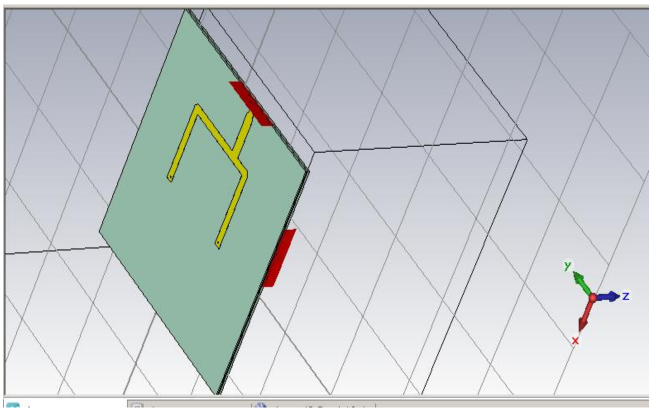

Fig. 5a: Dual Polarized Microstrip Antenna with another T-junction Splitter

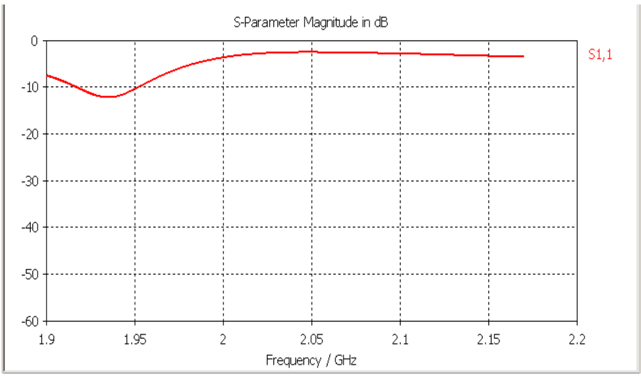

Fig. 5b: S11-Simulation Result of Dual polarized Microstrip Antenna with a Second T-junction Splitter

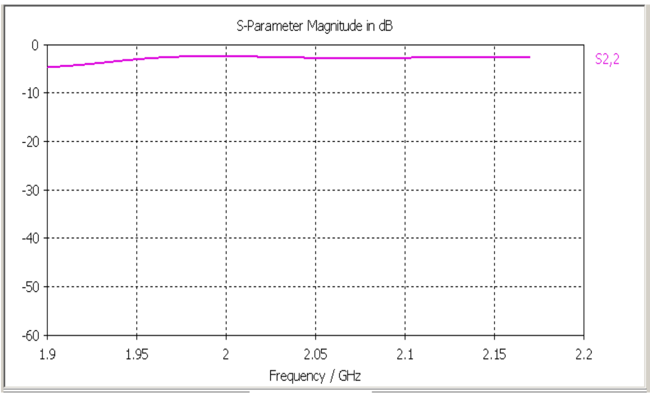

Fig. 5c S22-Dual polarized Microstrip Antenna

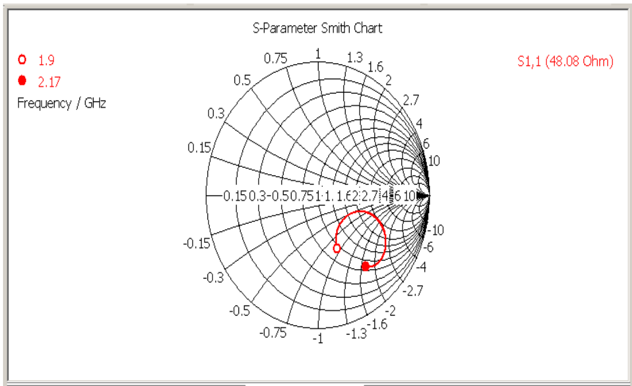

Fig. 5d: S11-Smith Chart for Dual Polarized Antenna with a Second T-junction Splitter

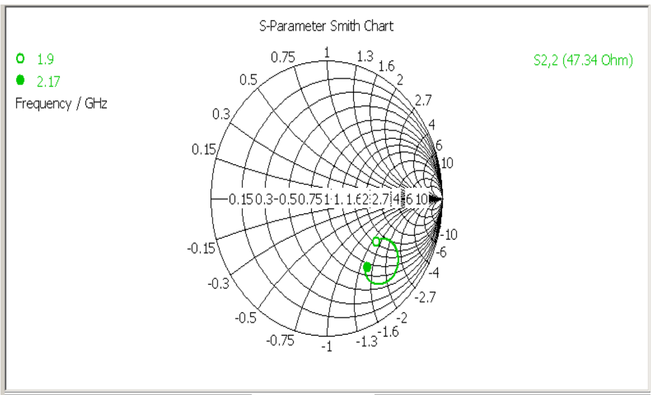

Fig. 5e: Smith Chart result for S22 of a Dual Polarized Microstrip Antenna with the second T-junction Splitter.

Impedance matching stub was added to both feed in the Dual polarized version in figure 6a to increase the VSWR and the simulation result for S11 and S22 showing return loss and isolation for S12 and S21 [7], [8]. The smith chart for S11 and S22 and the radiation pattern for 3D and Polar are all depicted in figures 6b, 6c, 6d, 6e, 6f, 6g, 6h and 6i .

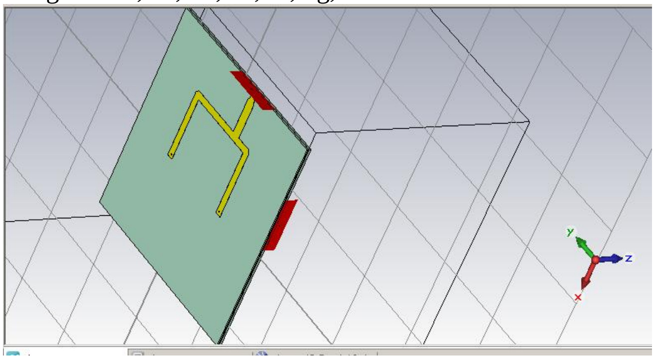

Fig. 6a: Dual Polarised Microstrip Antenna with Impedance matching Stub

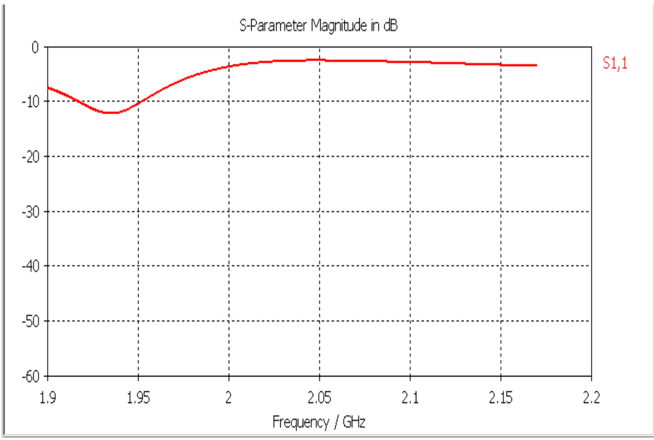

Fig. 6b: S11 Simulation Result of Dual Polarised Microstrip Antenna with Impedance matching Stub

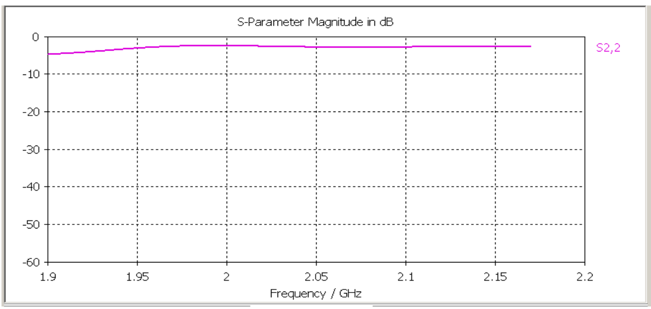

Fig. 6c: S22 Simulation Result of Dual Polarised Microstrip Antenna with Impedance matching stub

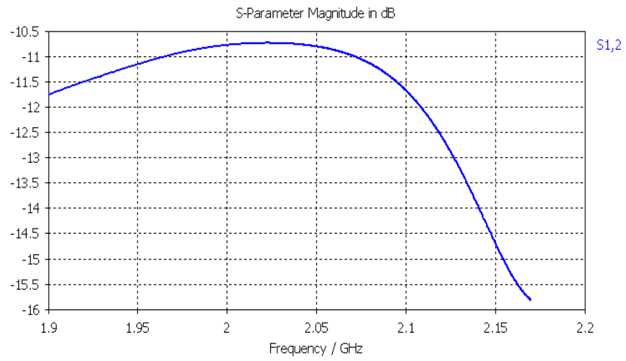

Fig. 6d: S12 Simulation Result of Dual Polarised Microstrip Antenna with Impedance matching stub

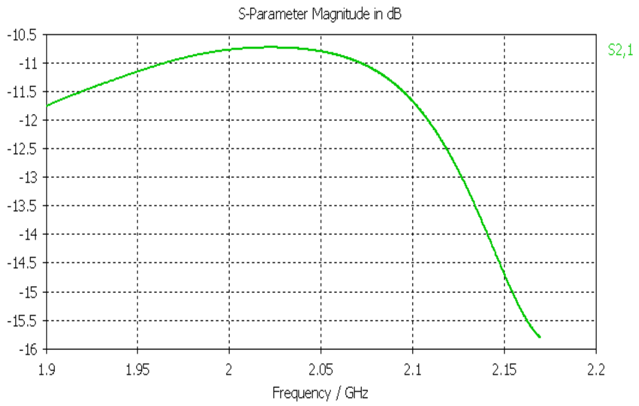

Fig. 6e: S21 Simulation Result of Dual Polarised Microstrip Antenna with Impedance matching stub

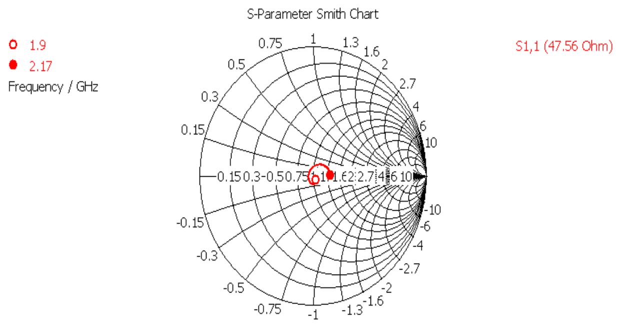

Fig. 6f: S11 Smith chart Result of Dual Polarised Microstrip Antenna with Impedance matching

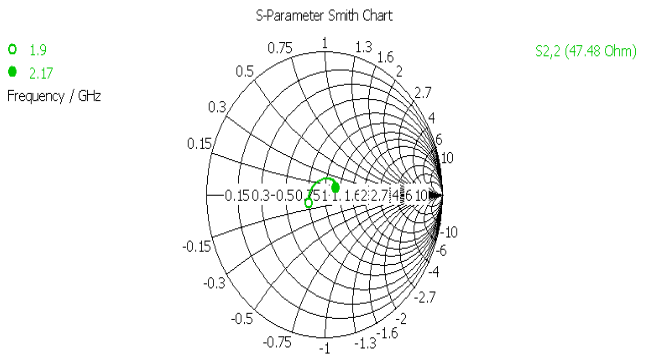

Fig. 6g: S22 Smith chart Result of Dual Polarised Microstrip Antenna with Impedance matching stub

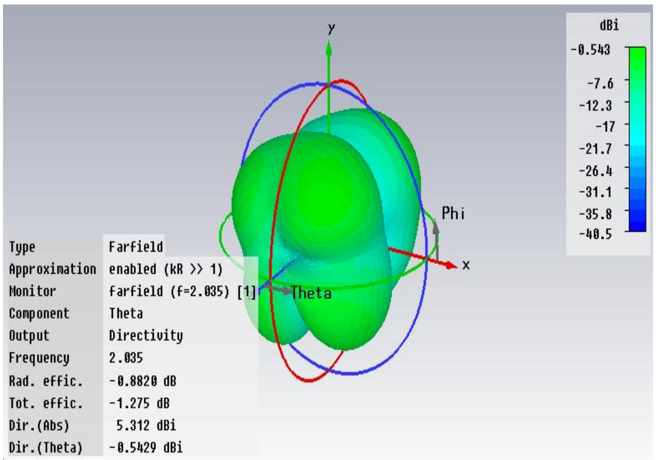

Fig. 6h: Radiation Pattern(3D) of a Dual Polarized Microstrip Antenna with Impedance Matching Stub

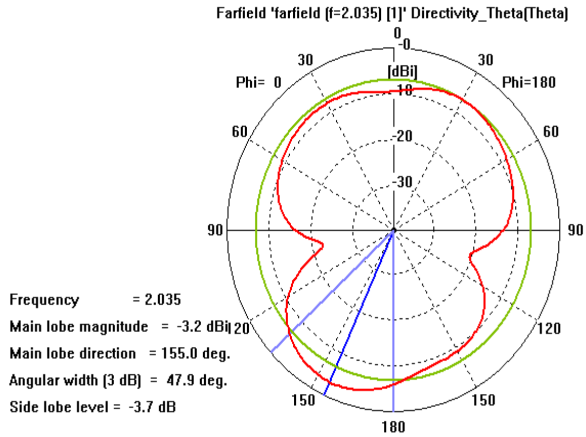

Fig. 6i: Radiation Pattern (Polar) of a Dual Polarized Microstrip Antenna with Impedance Matching Stub

III. EXPERIMENTAL RESULTS

The result in Figure 6h and 6i shows a low side lobe, excellent radiation pattern, low cross polarization, low profile and high isolation between the dual polarized ports equal to or greater than 30dB, conformal configuration, low volume, light weight, low cost, compatibility with integrated circuits and consequently, resultant compact antenna system.

IV. CONCLUSION

A novel balanced feed dual polarized microstrip antenna has been presented. Excellent VSWR performance overfull 3G band was demonstrated. Overall the programme illustrate the design and simulation of a dual polarized high performance microstrip antenna with $+45^0/-45^0$ slant linear used in mobile telecommunication base station. Excellent port to port isolation has been achieved from the systematic design. Beside, good antenna radiation pattern, return loss, low cross polarization and gain indicate that low cost antenna with polarization diversity, compactable with integrated circuit has excellent performance and cost benefits.

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