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A NOVEL ULTRA WIDE BAND YAGI MICROSTRIP ANTENNA FOR WIRELESS APPLICATIONS

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ABSTRACT

This paper presents an Ultra Wide Band Microstrip Yagi antenna with very good performance at four main operating frequencies (0.85, 2.4, 3.5 and 5.2) GHz. Numerical simulation results of our design show more than (-20 to -40) dB return loss at the bands of (0.85, 2.4, 3.5, 4.5 and 5.2) GHz and VSWR less than 1.7 at these frequencies. The simulation method based on finite element method (FEM) was applied by using HFSS simulator to obtain the optimized parameters in order to find the best design for this antenna. The antenna bands can be varied to be suitable for various wireless applications. Finally a fabrication to the final design has been implemented, and then a measurement performed to compare the actual results with those simulated. Measured return loss and VSWR of this antenna are presented to validate the results of simulation so that it give (0.85, 2.4, 2.75, 3.6, 4.2 and 5.3) GHz for the measured return loss results and the antenna VSWR ≤ 1.5 at (2.4, 3.5, 4.5 and 5.2) GHz.

Keywords: *Microstrip Yagi antenna, Wide Band, Ultra Wide Band.*

1. INTRODUCTION

These days numerous research activities are being pursued on the subject of wireless communications, which use the microwave or millimeter band [1, 2]. We have witnessed a tremendous growth of wireless communication links in recent years. Most wireless networks use omni-directional antennas [3]. However, in some applications we need directional antennas such as Log Periodic and Yagi-Uda antennas [4-7]. These types of antennas find their use in many applications such as industrial, medical, radar and wireless communications. The microstrip Yagi-Uda array consists of a driven microstrip antenna along with several parasitic microstrip antennas which are arranged on the same substrate surface in a way that the overall antenna characteristics are enhanced [8]. It is clear that in array applications, the effect of mutual coupling is usually undesirable, because it reduces the antenna gain, raises the side lobe level, etc.

However, in some applications mutual coupling enhances the antenna performance. For example, in the case of microstrip antenna, parasitic patches can be placed around a driven element to increase the gain of this single driven element by several decibels [9]. Also, it is interesting that parasitic patches with open circuit stubs can shape the beam of antenna so that it is tilted in a desired direction [10].

The first researcher who suggested the use of Yagi-Uda antenna design in microstrip structures was Huang in 1989 [11]. His proposed antenna consisted of four patches that were electromagnetically coupled to each other. That antenna had maximum gain of 8 dBi. After that, Huang and Densmor introduced a new microstrip Yagi-Uda antenna that had a maximum gain of 14 dBi but its use in some applications was problematic because of its low F/B ratio. The large size of this antenna was also the source of other difficulties [12]. Later, many methods were proposed. In [13], a new type of microstrip Yagi-Uda antenna was introduced which achieved high gain and high F/B ratio. However, this antenna was single band, working at 5.2GHz with return loss of 15 dB at this frequency. In this paper presents a design of Ultra Wide Band Microstrip Yagi antenna with very good gain. Simulated and measured results of our design show more than (-20 to -40) dB return loss the band of the fundamental resonant at (0.85, 2.4, 3.5, 4.5 and 5.2) GHz. The antenna VSWR ≤ 1.5 that make it to be suitable for various wireless applications.

2. ANTENNA DESIGN AND SIMULATION

Wide-band operations of antenna have presented to satisfy various wireless applications. In this section, we demonstrate the validity of our proposed designed antenna through simulated numerical analyses and then through the experimental results of fabricated antenna. Full wave analysis of the proposed antenna configurations were performed using Ansoft HFSS version-(8.0) [14] based on finite element method (FEM).

Looking at the physical layout of our proposed antenna in the shown figure.1, one would see that it is comprised of multiple elements working together to provide a wide bandwidth of usable frequencies. The active (radiating or receiving radiation) portion of the antenna effectively shifts with frequency as one stage becomes 'more resonant' than the next. The lowest operating frequency is determined by the longest element and the highest operating frequency is set by the shortest element. As the frequency of the transmission (or reception) increases, the active region of the antenna shifts forward to the shorter 1/2 λ dipole elements or vice versa as the frequency decreases. Obviously the 'secret' for proper operation must lie in the length and spacing of the antenna elements. These and other factors must be carefully chosen to cover the desired frequency range for the antennas' application. One of the main design features that make the PCB Yagi antenna simple to use is the partially folded driven element. This patented configuration allows you to directly attach a coaxial cable feed to the microstrip transmission line on the board without having to use a matching network. Your hook-up couldn't be any easier Just solder on your 50 Ω coaxial feed lines.

3. SIMULATION RESULTS

A. RETURN LOSS

Numerical simulation return loss results of our design performed using Ansoft HFSS, and they show more than (-20 to -40) dB return loss at the bands of (0.85, 2.4, 3.5, 4.5 and 5.2) GHz as shown in figure 2.

B. VSWR

Also VSWR simulation return of our design performed, at the bands of (0.85, 2.4, 3.5, 4.5 and 5.2) GHz and they show less than 1.7 at these frequencies.

C. RADIATION PATTARNS

Simulated results of the E_total radiation patterns of the proposed antenna are presented, the results include solutions at different frequencies band 2.4GHz, 3.5GHz and 5.2 GHz respectively as shown in figure 7, 8 and 9.

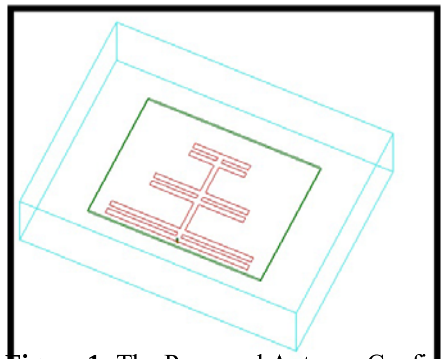

Figure.1: The Proposed Antenna Configuration

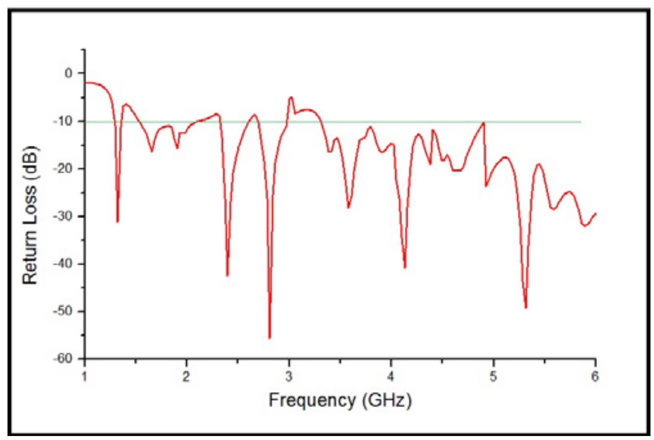

Figure.2: Simulated Result of the Return Loss for the Proposed Antenna

4. MEASURD RESULTS

The new ultra wide band microstrip yagi antenna was fabricated and tested as shown in figure 3(a). The simulated and measured return loss is shown in Figure 4. The fundamental resonant mode is at (0.85, 2.4, 3.5, 4.5 and 5.2) GHz for the simulated results and (0.85, 2.4, 2.75, 3.6, 4.2 and 5.3) GHz for the measured results. The measured Smith chart of the antenna is shown in Figure 5. And measured antenna VSWR results ≤ 1.5 at (2.4, 3.5, 4.5 and 5.2) GHz as shown in figure 6.

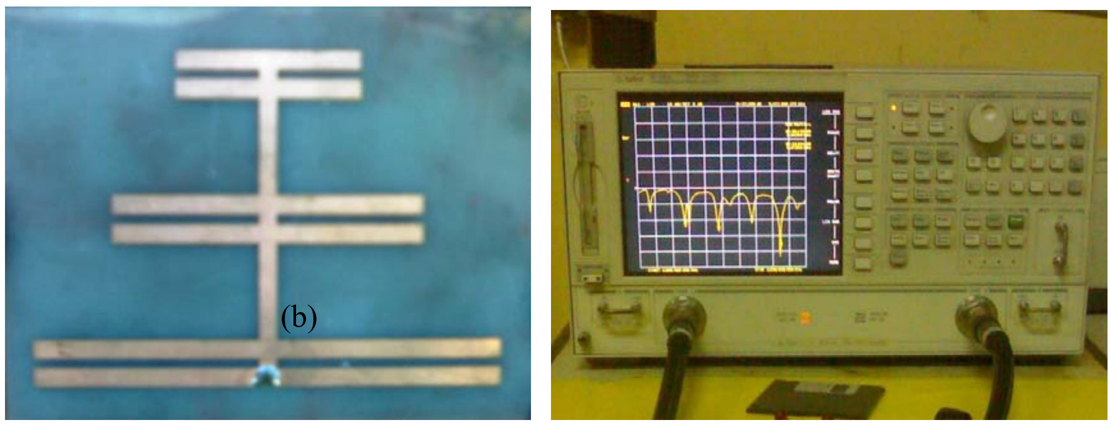

Figure.3: (a) The Proposed Fabricated Antenna
(b) Measured Result of the Return Loss for the Proposed Antenna

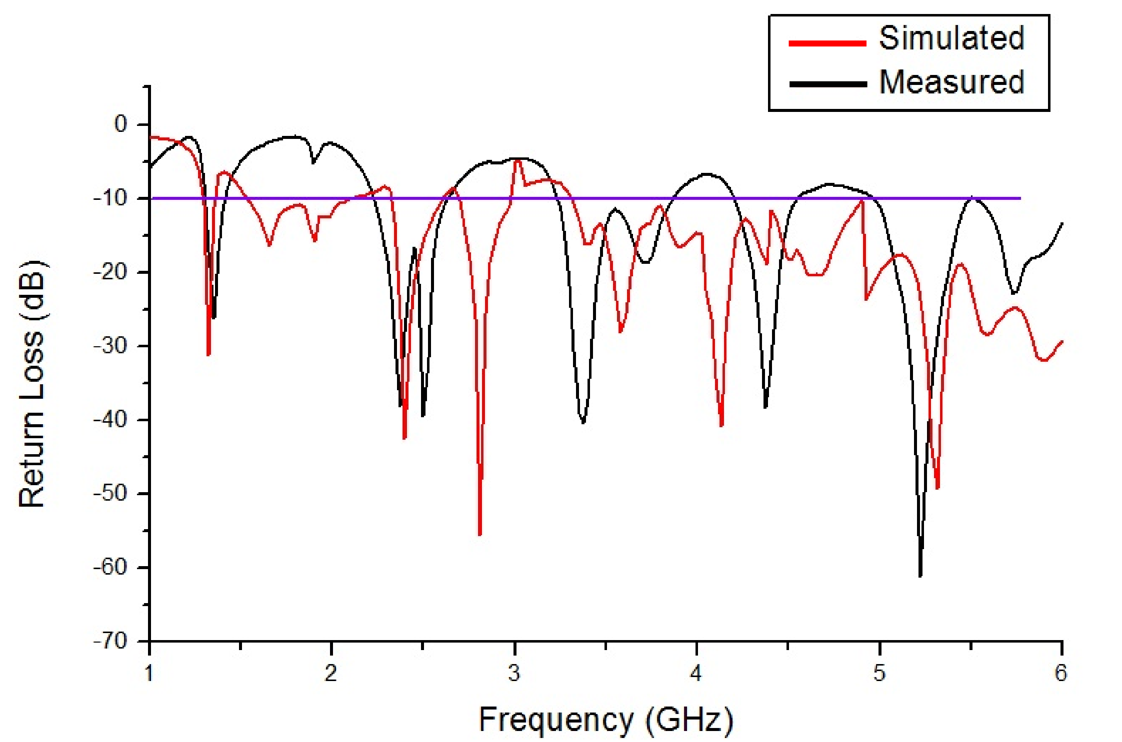

Figure.4: Simulated and Measured Result of the Return Loss for the Proposed Antenna

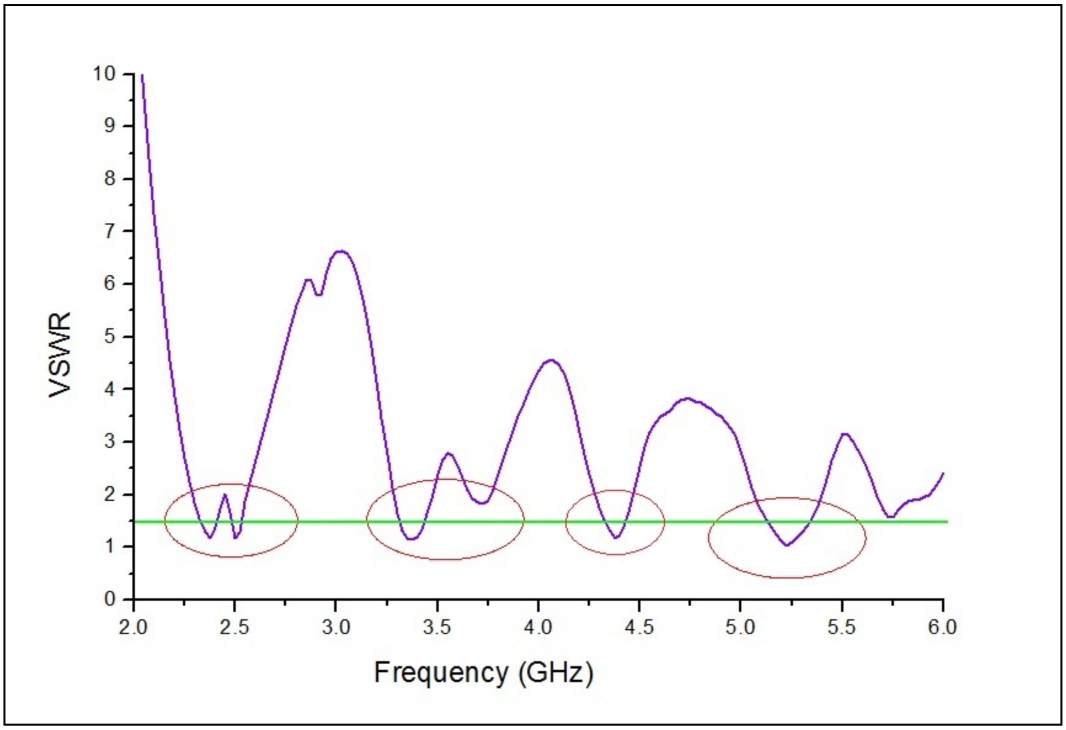

Figure.5: Measured Result of VSWR of the Proposed Antenna

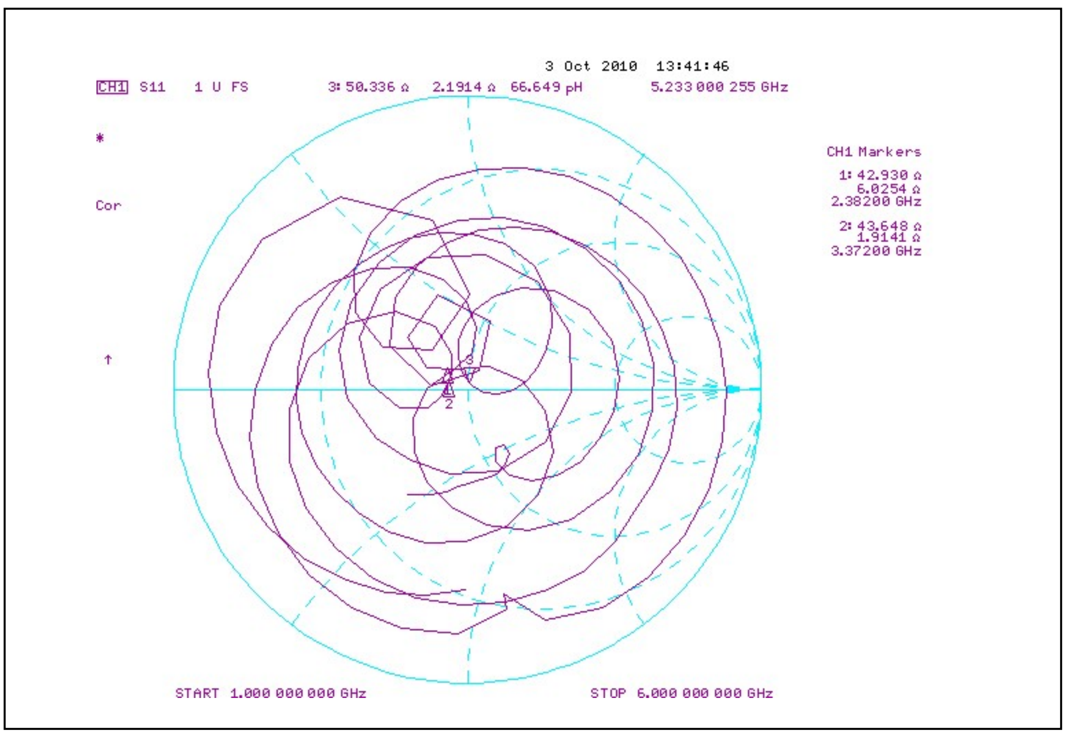

Figure.6: Measured Result of Smith Chart of the Proposed Antenna

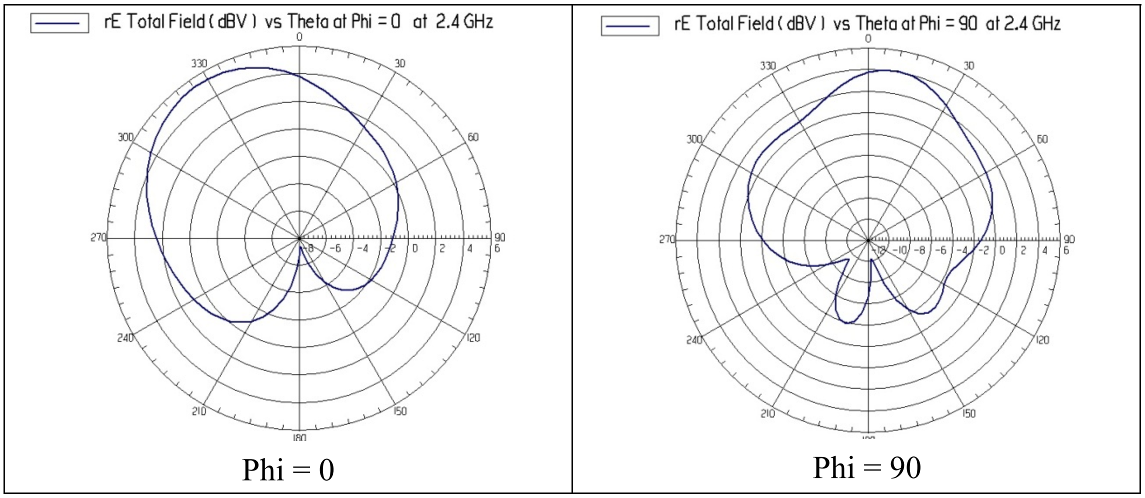

Figure.7: E_Total vs Theta Solved at the Frequency 2.4 (GHz)

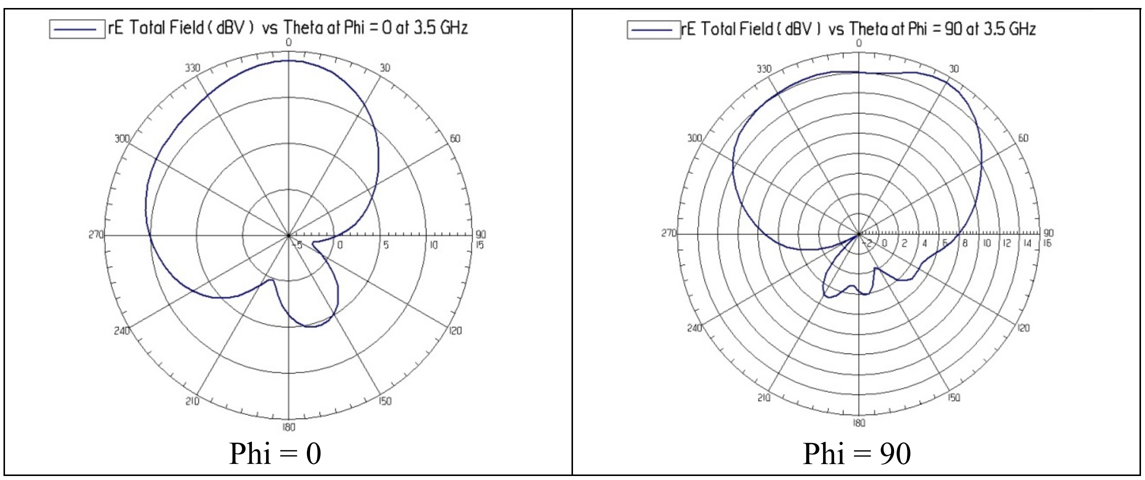

Figure.8: E_Total vs Theta Solved at the Frequency 3.5 (GHz)

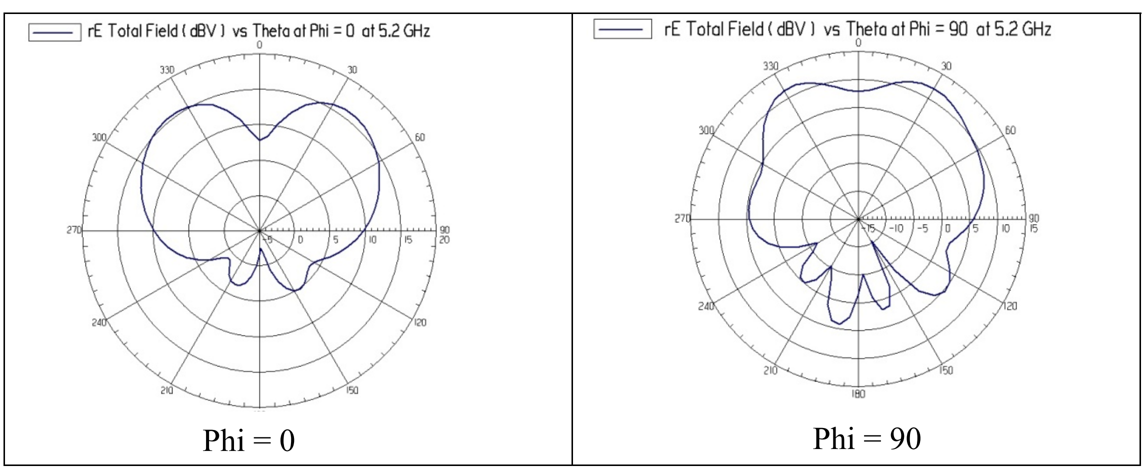

Figure.9: E_Total vs Theta Solved at the Frequency 5.2(GHz)

5. CONCLUSION

An Ultra Wide Band Microstrip Yagi antenna is presented. Numerical simulation and measured results of our design show more than (-20 to -40) dB return loss at the bands of (0.85, 2.4, 3.5, 4.5 and 5.2) GHz and VSWR less than 1.7 at these frequencies.. Finally a fabrication to the final design has been implemented, and then a measurement performed to compare the actual results with those simulated. Measured return loss and VSWR of this antenna are presented to validate the results of simulation so that it give (0.85, 2.4, 2.75, 3.6, 4.2 and 5.3) GHz for the measured return loss results and the antenna VSWR ≤ 1.5 at (2.4, 3.5, 4.5 and 5.2) GHz.

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