Probe Feed E-Shaped Patch Antenna at 4.87 GHz

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***Abstract*—In this paper, E-shape microstrip patch antenna for wireless communication is designed, simulated, built and tested. The operating frequencies of antenna are 2.97 GHz and 4.85 GHz, the substrate FR4 is used for proposed antenna with dielectric constant 4.01 and 1.7mm thickness. Two parallel slots are cut to perturb the surface current path to achieve dual resonance. The E-shape has return loss of -28 dB and -14.03 dB at operating frequencies 2.97 GHz and 4.85 GHz respectively. Designing and simulation of this antenna has been done by the help of Sonnet Software. This antenna is fed by a co-axial probe feeding. In this paper, the effects of length difference among antenna legs has been studied.**

Keywords*—*Co-axial feed antenna, compact wireless antenna, E-shaped antenna, microstrip patch antenna, patch antenna, U slot antenna.

I. INTRODUCTION

In the recent world, the demand for low weight, cheap, low profile and efficient antennas is increasing microstrip patch antenna and are more popular for meeting these requirement in several applications. The main problem encountered with these such kind of patch antennas is high value of return loss and smaller impedance bandwidth, but theses problem can be solved by using some new designing approaches [1].

The microstrip patch antenna offers the advantages of low profile, ease of fabrication, and compatibility with integrated circuit technology. They can be designed to operate over a large range of frequencies (1- 40 GHz) and easily combine to form linear or planar arrays [2].

The current wireless communication systems have to fulfill the demands such as high data rates, increased capacity, high quality, and high reliability for different applications. Multiple-input-multiple-output (MIMO) systems provide the suitable technology for these requirements without the necessity of additional bandwidth or transmit power by spreading multiple antennas, with sufficient element spacing, the correct number of elements, and appropriate array geometry or topology [3–5].

A microstrip patch antenna is type of antennas that offers a low profile, i.e., thin and easily manufacture ability, which provides great advantages over traditional. An E-shaped patch antenna is easily formed by cutting two slots from a rectangular shape. By cutting the slots from a patch, gain, return loss and bandwidth of microstrip antenna can be improved. The increased development of wireless communications, the urgency to design low volume, compact, low profile planar configuration and wideband multi-frequency planar antennas become highly desirable. Narrow bandwidth is a serious limitation of these microstrip patch antennas. Different techniques are used to overcome this narrow bandwidth limitation. These techniques include increasing the thickness of the dielectric substrate, decreasing dielectric constant and using parasitic patches [6].

For the E-shaped patch antenna, two parallel slots are incorporated to introduce a second resonant mode, resulting in a dual band antenna. If the feed point is located at the tip of the center arm as in [6–8], the second resonant mode will be introduced at a lower frequency than the fundamental resonant mode [7].

Various methods have been studied and analyzed for suppression of mutual coupling and improvement of the isolation between the antennas, including the neutralization technique [9, 10], using electromagnetic band gap (EBG) structures [11–13] or etching slots or slits from the ground and forming defected ground structures (DGSs) [14, 15]. In neutralization technique, an additional coupling is introduced by connecting the two antennas with a thin metal strip. This additional coupling cancels out the coupling between the antennas by properly adjusting the length of the metal strip, and the isolation between the two input ports can be significantly enhanced. In the DGS method, even if the DGS adds an extra degree of freedom in the design, the removal of the metal strip from the PEC or some portions of the substrate require precise micromachining techniques, and otherwise, performance degradation can occur. Also, the DGS itself is a slot antenna, which causes an increase in back lobe radiation [16].

Research on microstrip antenna in the 21st century aims at size reduction, increasing gain, wide bandwidth, multiple functionality and system-level integration. Significant research work has been reported on increasing the gain and bandwidth of microstrip antennas [6-8]. In this paper, an attempt has been

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made to design a single band microstrip antenna without any geometrical complexities [8].

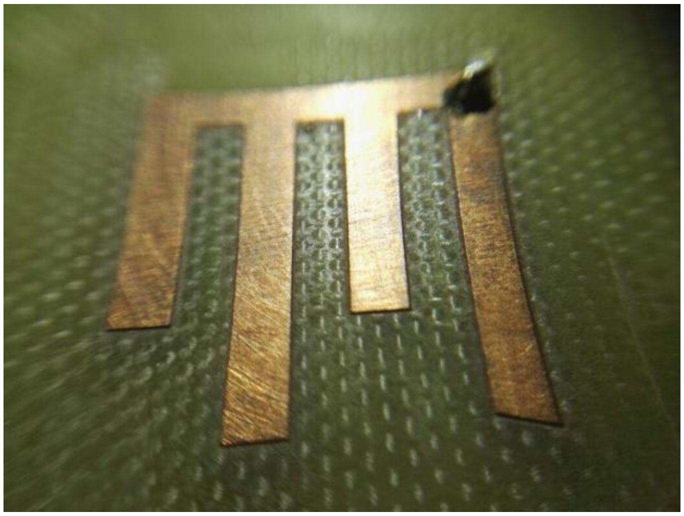

Fig. 1. Top view of the fabricated circular antenna.

II. DESIGN STEPS

The size of the antenna is 17.0 × 18.0mm. Substrate material is FR- 4 and the thickness of it is 1 mm (εr = 4.01, dielectric loss tangent = 0.0018). The thickness of air is taken as 3 times of the thickness of the FR-4, (3 mm). Top view of the fabricated and measured antenna is shown in Fig. 1.

III. SIMULATION AND PARAMETRIC STUDY

Analyses were performed using Sonnet software [17]. The frequency range is between 1 - 10 GHz. In two different frequency values, -10dB or lower magnitude values were obtained. When the magnitude of S11 is -15.35 dB, gain is +7.27 dB at 2.97 GHz. In second analysis, frequency was 4.87 GHz and S11 was -12.65 dB and gain is +8.86 dB. Results are provided in Table I. When compared with the first antenna, the size of the antenna is changed from 15.0 × 16.8 mm to 17.0 × 18.0 mm. Also change the port position. In Fig. 2, gain-frequency graph is shown and +8.79 gain is found at 4.85 GHz. In Fig. 3, S11 graph is shown and at 4.85 GHz, -14.03 dB magnitude was found. A prototype of this antenna is tested by using an HP8720D network analyzer. Fig. 3 shows the comparison between simulated and measured S-parameters' results of the proposed antenna. It is noticed that there are some difference between the simulation and measurement results. These differences can be considered acceptable as long as its effect on the resonant frequency is not high and the frequency band does not shift much. The discrepancies are mostly due to the insertion loss of SMA connectors, surrounding environment that influences on wave reflection, or the fabrication tolerances.

IV. CONCLUSION

In this work, E type patch antenna was designed, simulated and fabricated. Compared to the first analysis, in the second analysis there was an increase in the gain value. So, when the frequency is at 2.97 GHz, S11 is -15.35 dB and the gain value is found as +7.27 dB. In the second analysis when the frequency is at 4.85 GHz, S11 is -14.03 dB and the gain is found as +8.79 dB. By adjusting antenna leg lengths, it is possible to achieve different resonance frequencies and gain. Two different analyses were compared in this article. We are also in the process of measuring the fabricated antenna for further studies on single band operations.

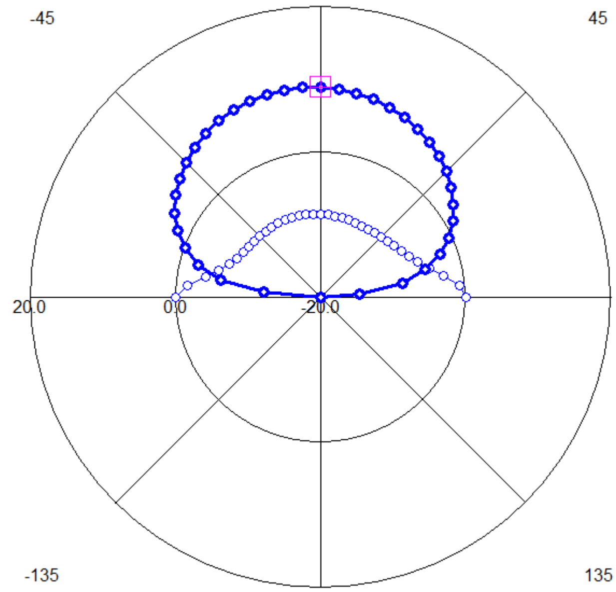

Fig. 2. Radiation pattern at 4.85 GHz.

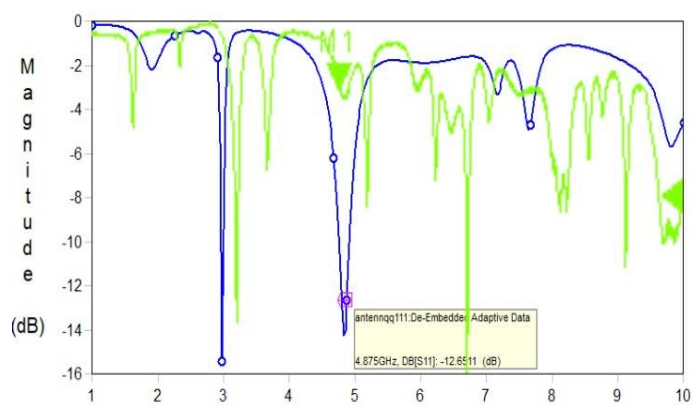

Fig. 3. Input match (S11).

TABLE I. RESULTS AND COMPARISONS

Frequency	S11	Gain
4.87 GHz	-12.65 dB	8.86 dB
2.97 GHz	-15.35 dB	7.27 dB
4.0 GHz	-0.92 dB	6.91 dB
6.22 GHz	-1.80 dB	4.93 dB

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