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T-slot Broadband Rectangular Patch Antenna

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Abstract

A novel single layer single probe fed T-slot broadband rectangular patch antenna is reported in this article. A T-slot patch antenna gives an impedance bandwidth (-10dB return loss) of 25.23% with an average gain of about 7.43 dBi over the entire passband and peak gain of 9.88 dBi. It gives good radiation patterns in entire the pass band. The air substrate ($\varepsilon_r = 1$) is used for simulation and foam ($\varepsilon_r \approx 1$) is used to support patch for experimental purposed. The structures are easy to fabricate and radiation patterns are also much better and also close to conventional microstrip patch antenna patterns. Both simulated and measured results are presented.

Keywords: Broadband rectangular patch antenna, T-slot.

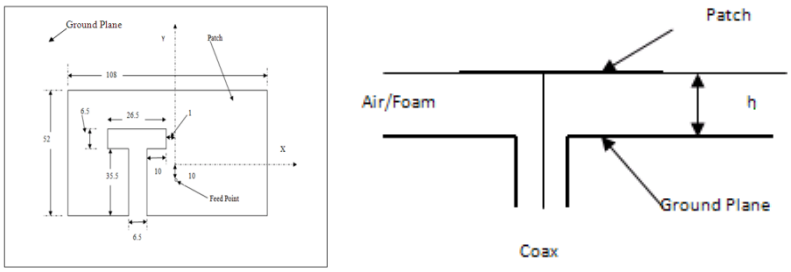
Introduction

Microstrip antennas have many advantages like thin profile, light weight, low cost, compatibility with integrated circuitry etc. It has tremendous applications in military, radar systems, mobile communications, global positioning system (GPS), remote sensing etc. The basic structure of microstrip antenna has very low impedance bandwidth of about 1-2% only. So, during the last two three decade extensive research is doing to improve the impedance bandwidth of microstrip antenna. Design of broadband patch antenna with thick air or foam substrate become quite popular owing due to their simple structure, easy to fabricate, thickness can be change easily

and good radiation characteristics over the wide operating bandwidth. Rectangular patch antenna having pair of slits had achieved impedance bandwidth of 24% and peak gain of 7.2 dBi had reported in [1]. A single U slot [2] has achieved impedance bandwidth upto 47% using thick probe, whereas double U slot using thick probe [3] it has achieved impedance bandwidth upto 44%. By using the method of stacking substrates, size of probe had been reduced [4], for which impedance bandwidth of 44.7% with peak gain of 10 dB and average gain of 3 dB had been reported. In this article T- slot broadband rectangular patch antenna with impedance bandwidth of 25.23% with average gain of about 7.43 dBi over the entire passband and peak gain of 9.88 dBi is presented. The radiation pattern is also much improved. The IE3D simulation software based on Method of Moments (MoM) is used for simulation and Agilent's E5071B ENA series Network Analyzer and Anritsu 37269D Vector Network Analyzer are used for measurements. In this article simulated and experimentally measured results are presented.

Antenna Design

The dimensions of the rectangular patch with T-slot antenna is 108 X 52 mm^2. The height (h) of air substrate between patch and ground plane is 7 mm. The dimension of the T-slot is as shown in the Figs. 1(a-c). The probe is fed at (X = 0, Y = -10 mm) from the patch centre. Antennas are fed with SMA coaxial probe of 50Ω characteristic impedance with inner conductor of radius 0.6 mm and foam ($\varepsilon_r \approx 1$) is used to support the patch. The antenna dimensions are obtained after optimization by simulation software. The ground plane size is taken to be about three times patch size for experimental purpose for realization of semi-infinite.



a. b.

c.

Figure 1: Antenna (dimensions are in mm) a. Top View b. Side View (h = 7 mm) c. Photograph of the Fabricated patch antenna.

Analysis and Results

For running simulation in IE3D, finite ground plane size is taken to be about three times patch size to have more matching result with experimental and also for realization of semi-infinite. The proposed patch antenna gives simulated impedance bandwidth of 22.54% (2.146 -2.692) GHz at centre frequency. Experimentally measured impedance bandwidth is 25.23% (2.06 -2.655) GHz at centre frequency (2.35 GHz). Its simulated average gain is about 7.43 dBi over the entire passband and peak gain of 9.88 dBi. The maximum directivity of 10.13 dBi and average directivity of about 8.61 dBi over the entire passband. All the simulated and measured results are as shown in Figs.2 (a-c).

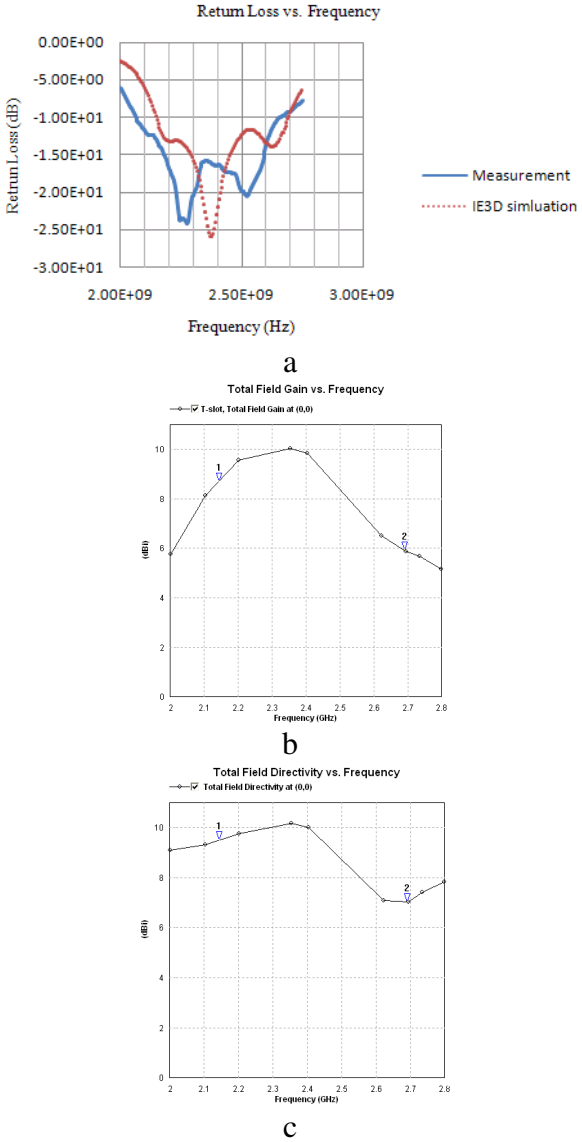
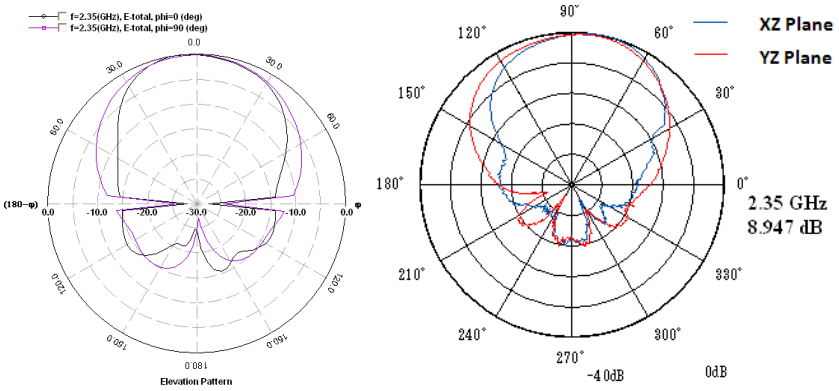


Figure 2: a. Return loss vs Frequency graph b. Gain vs Frequency graph c. Directivity vs Frequency graph.

The simulated radiation patterns at centre frequency (2.35 GHz) with half power beamwidth (-3dB beamwidth) of E-total are 52^0 and 63.6^0 at phi 0^0 and 90^0 respectively shown in Fig. 3(a). The measured radiation patterns at centre frequency (2.35 GHz) is shown in Fig. 3(b).



a b

Figure 3: a. Simulated radiation patterns at centre frequency (2.35 GHz). b. Measured radiation patterns at centre frequency (2.35 GHz).

The current distribution on patch and ground plane are shown in Fig. 4 at centre frequency 2.35 GHz.

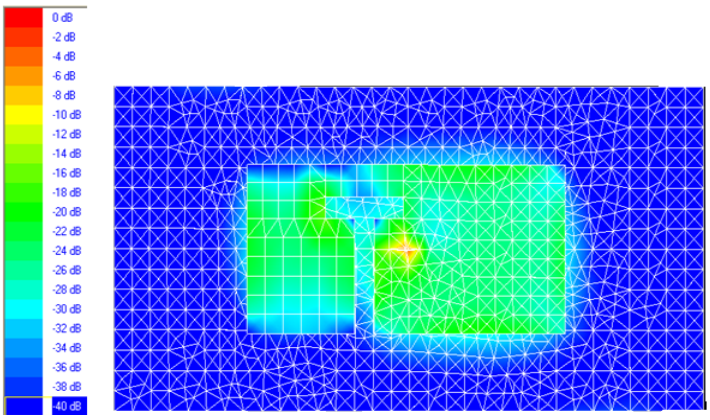


Figure 4: Current distribution on Patch and ground plane at 2.35 GHz.

Conclusion

The T-slot rectangular patch antenna gives wideband impedance bandwidth (25.23%) with good average gain of about 7.43 dBi over the entire passband and peak gain of 9.88 dBi. This type of T-slot is a new concept with more compact in size. The

radiation patterns are also much improved. This structure are easy to fabricate and simple. Our designed antenna has many advantages in terms of gain, impedance bandwidth, height, radiation characteristics etc.

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