A Compact Microstrip Patch Antenna for X-Band

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Outline

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Introduction

- A compact rectangular microstrip patch antenna is introduced in this paper. The input match and the gain of the antenna at the center frequency of 8.52 GHz, is respectively 45dB and 5dB. A 1.6mm thick FR4 material is used as the substrate for this work.
- The antenna might be used in applications of microwave devices in X-Band including satellite communications, radars, terrestrial broadbands, space communications, amateur radios, and molecular rotational spectroscopy.

Design Steps & Simulation Results

- Figure 1 has the top view of the antenna. The antenna is built on a 1.6mm thick FR4 substrate. The dielectric constant is $\varepsilon_r = 4.4$ for this material.

- The size of the antenna is 16 x 12 mm. Dimensions of the feeding line of the antenna is 4 x 16 mm.

Design Steps & Simulation Results

The design is simulated from 1 GHz to 11 GHz. The S11 of the design is shown in Figure 2 where one can see that the design has a return loss of about 45 dB at 8.52 GHz.

Design Steps & Simulation Results

As you can see from the radiation pattern of the antenna shown in Figure 3, the main beam has two intermediate patterns of 5 dB at $\theta = \pm 60^{\theta}$. The cross polarization level is a little bit high around -3.87 dB.

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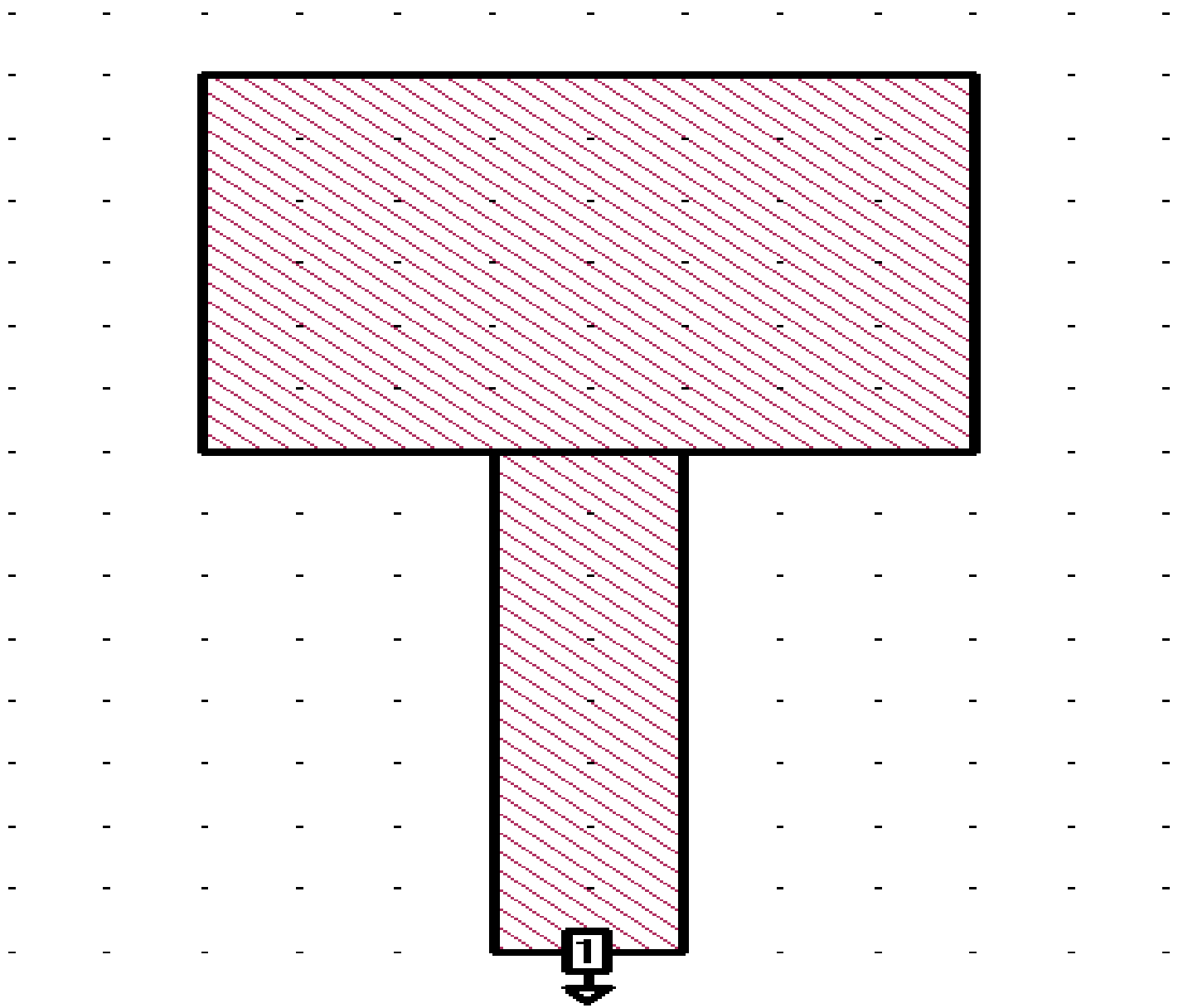

Fig. 1. Top view of the antenna

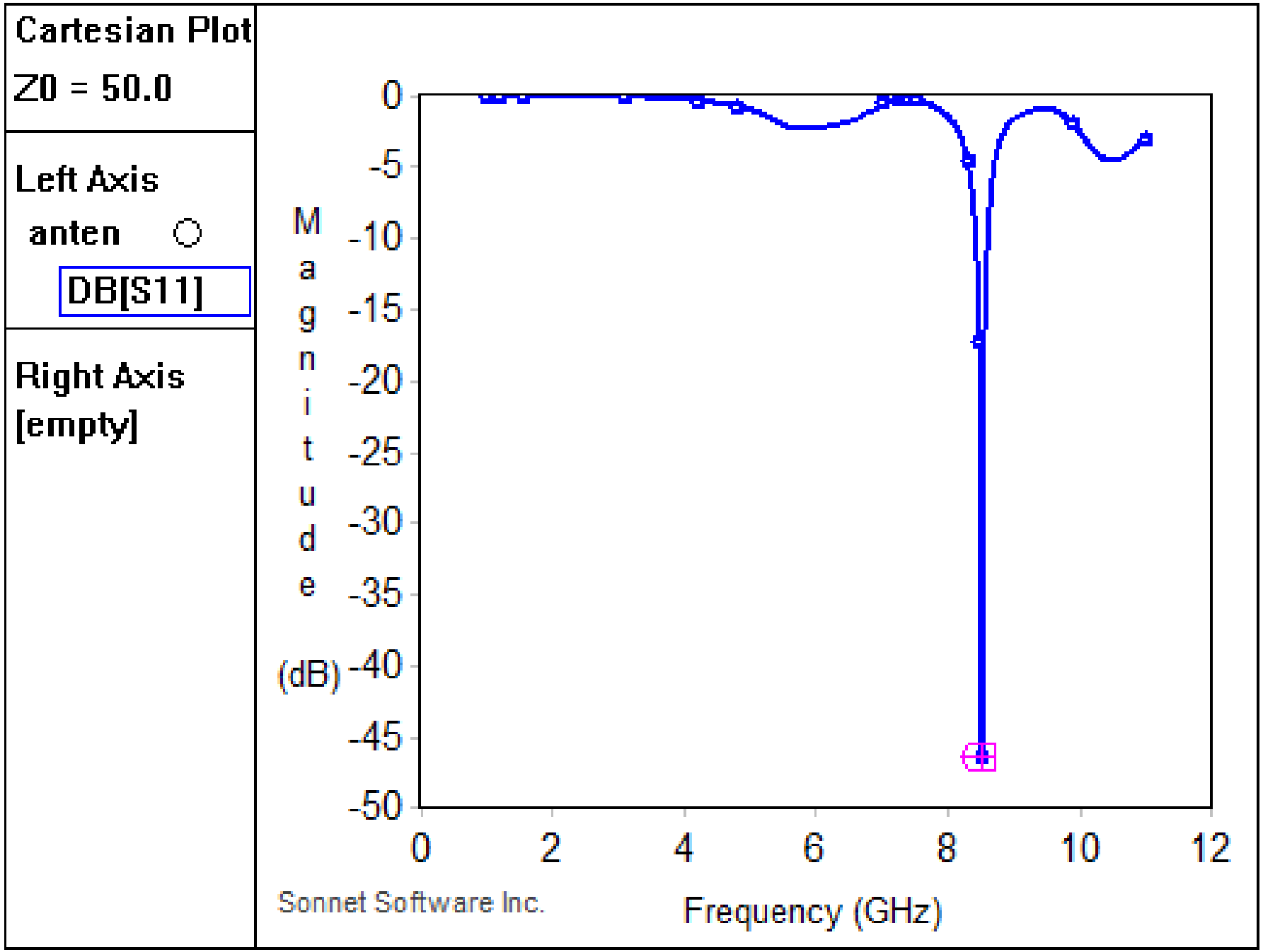

Fig. 2. S11 of the antenna

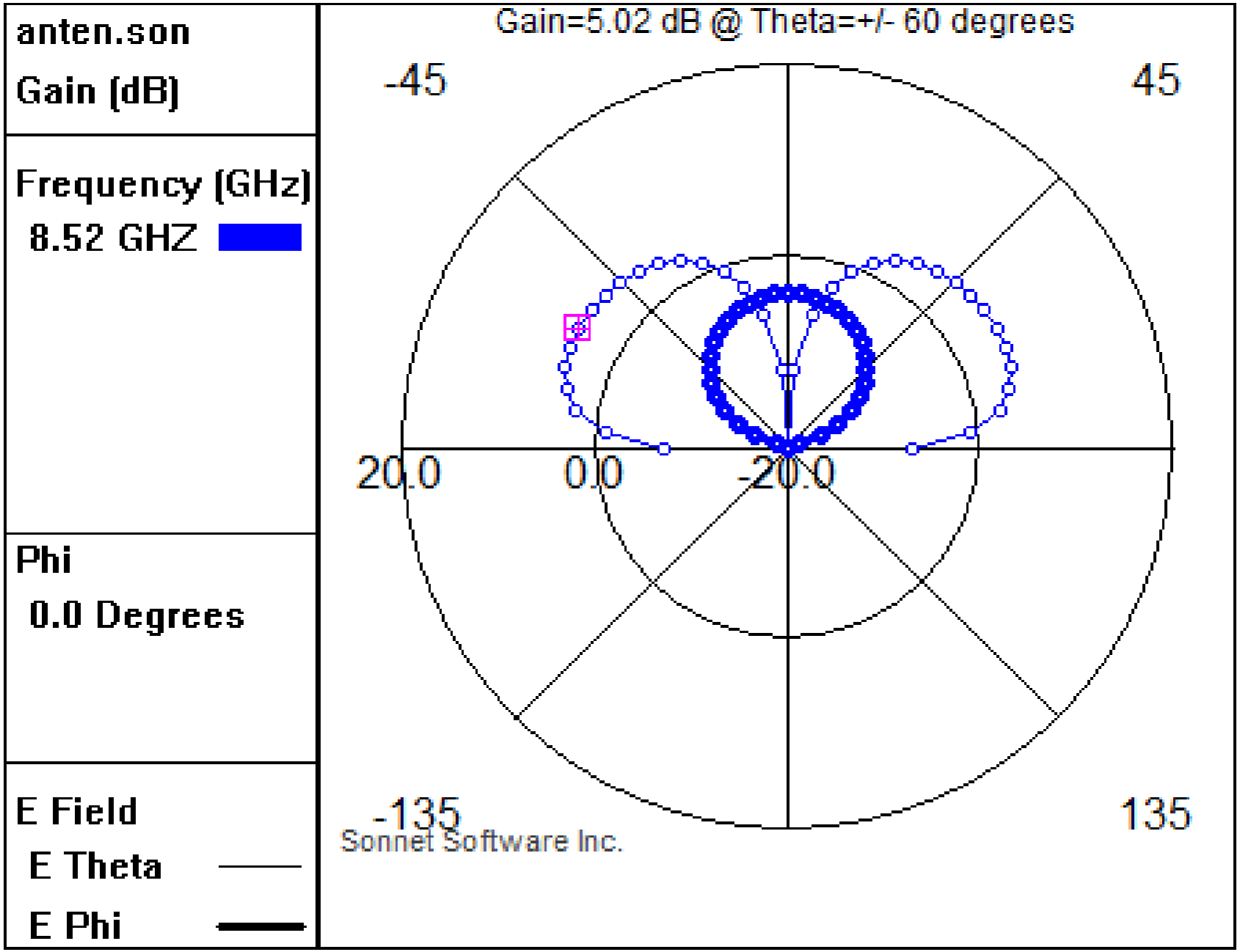

Fig.3. 3D View of the antenna

Parametric Study

In order to see the fabrication tolerances of the dielectric substrate, a parametric study is conducted by changing the dielectric thickness and dielectric constant.

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TABLE I. CHANGING THE DIELECTRIC CONSTANT

ε_r	[S11] (dB)	Gain (dB)	Frequency (GHz)
4.45	-37.80	4.99	8.48
4.43	-33.19	4.97	8.50
4.40	-45.01	5.00	8.52
4.37	-30.42	4.92	8.54
1.55	-32.35	5.01	8.58

TABLE II. CHANGING THE DIELECTRIC THICKNESS

Dielectric thickness (mm)	[S11] (dB)	Gain (dB)	Frequency (GHz)
1.65	-29.42	4.98	8.50
1.63	-33.19	4.97	8.50
1.60	- 45.01	5.00	8.52
1.57	-39.07	5.04	8.54
1.55	-28.82	5.02	8.54

CONCLUSION

In this paper, a rectangular microstrip patch antenna was designed and simulated by using a planar 3D electromagnetic simulation tool, called Sonnet Suites. The designed antenna has a very good return loss performance according to the simulation. The return loss of the antenna is 45 dB. The electric field θ polarized gain is 5 dB and the frequency is 8.52 GHz. In this work, it is also shown how manufacturing tolerances associated with material thickness and dielectric constant may affect the performance of the antenna. An antenna with this performance can be used in applications of microwave devices in X-Band.

ACKNOWLEDGEMENT

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AUDIENCE QUESTIONS

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