A Printed Planar Helix Antenna*

Aneesh Chowdary Kommalapati[1], Chen Zhao[1],
Sheel Aditya[1]*, and Ciersiang Chua[2]
[1]School of Electrical and Electronic Engineering
Nanyang Technological University, Singapore
[2]CST South East Asia Pte. Ltd.
*esaditya@ntu.edu.sg

Abstract: The conventional circular helix antenna offers broadband circularly polarized radiation but is difficult to fabricate using printed-circuit techniques. This presentation describes a broadband, circularly polarized, planar helix antenna operating at X-band that is fabricated using printed circuit techniques. For a design with 5 turns, the results of the simulations are as follows: over a frequency range of 8.3 - 11.7 GHz, S11 is less than -10 dB, directivity ranges from 11.7 - 12.6 dBi, and the axial ratio ranges from 0.68 - 3.3 dB. The design is fabricated and the measurement results match the simulation results reasonably well.

Keywords: Circularly polarized antenna, helix, microfabrication, planar helix.

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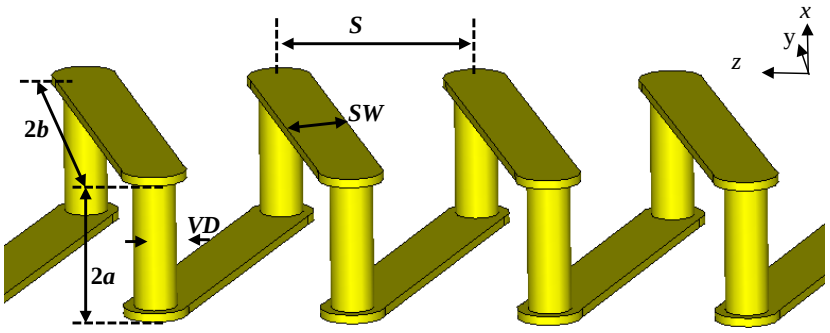
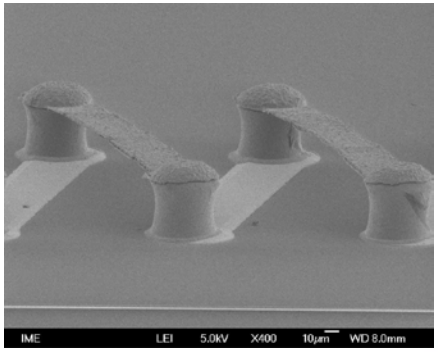
Introduction

- **The conventional circular helix [1]-[3] is difficult to fabricate using printed-circuit or microfabrication techniques**
- **Printed-circuit techniques are important for miniaturization as well as low-cost mass-production**
- **Microfabrication techniques become important at high frequencies of operation where the dimensions become small [4]**
- **The planar helix with straight edge connections (PH-SEC) can be printed as well as microfabricated; it also retains the broadband feature of the conventional circular helix [5]-[7]**



Perspective view of the planar helix with straight-edge connections [5]



Microfabricated planar helix at W-band [7]

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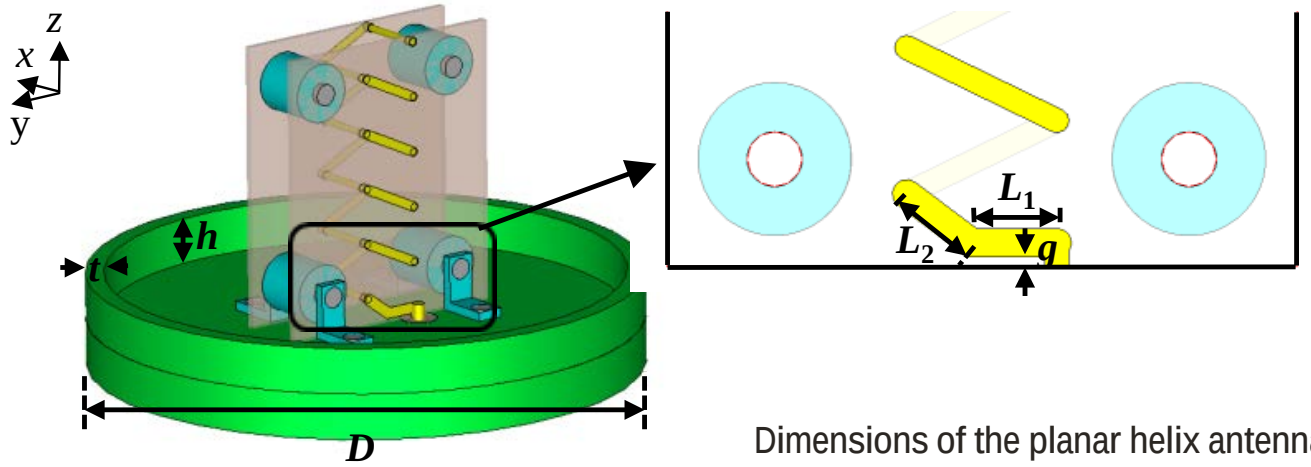
Configuration of the planar helix antenna



Perspective view of the planar helix antenna

Guidelines for initial design:

- **3/4 < C/λ < 4/3**
- **12 < α <14 °**
- **S = λ/4**

C: circumference **α: pitch angle**
S: spacing **Centre frequency: 10 GHz**

Dimensions of the planar helix antenna with a centre frequency of 10 GHz (symbols are explained in figs.)

Parameter	Dimension (mm)
$2a$	8.03
$2b$	6.27
S	6.11
VD	0.8
SW	1
L_1	2.9
L_2	3.2
g	0.4
t	2
h	5
D	60

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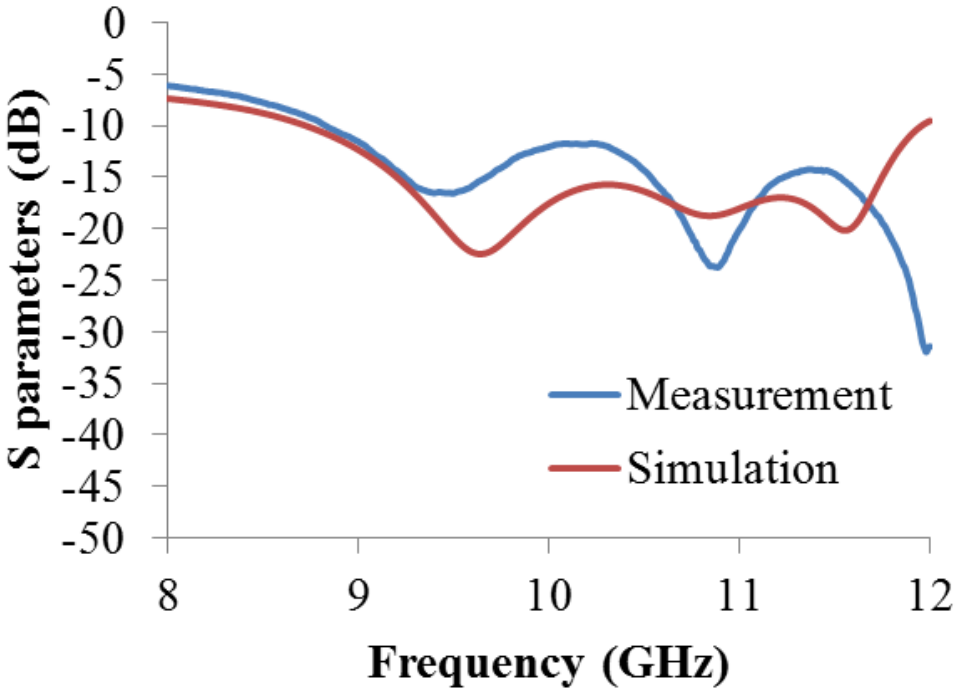
Reflection Coefficient S_{11}



- **Simulated S_{11} is less than -10 dB from 8.3-11.7 GHz**
- **Measured S_{11} is below -10 dB from 8.6-12 GHz**
- **The simulations match well with measured results**

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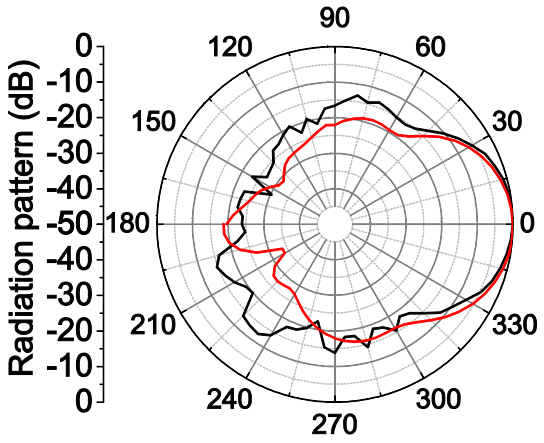
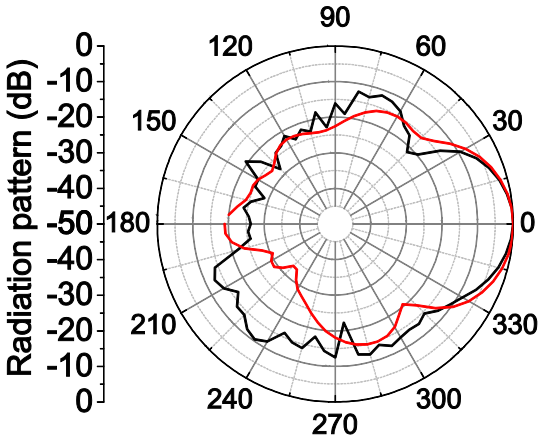
Radiation Patterns

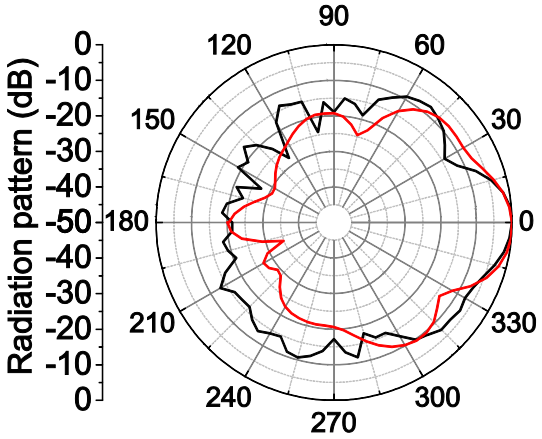


(a)



(b)

Measured (black curve) and simulated (red curve) radiation patterns for the overall field in the yz-plane:
(a) 9 GHz, (b) 10 GHz, (c) 11 GHz



(c)

- **The measured shape and beam width of the main lobe matches simulations well**
- **The difference in the side lobe levels may be attributed to fabrication errors**

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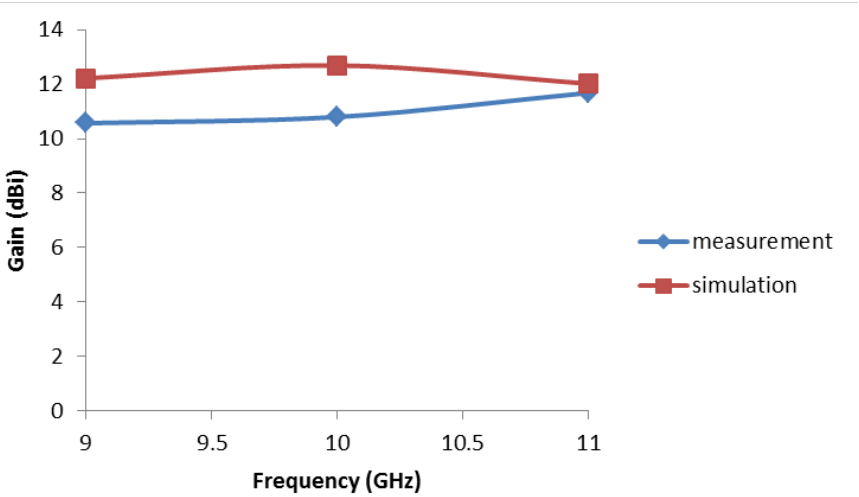
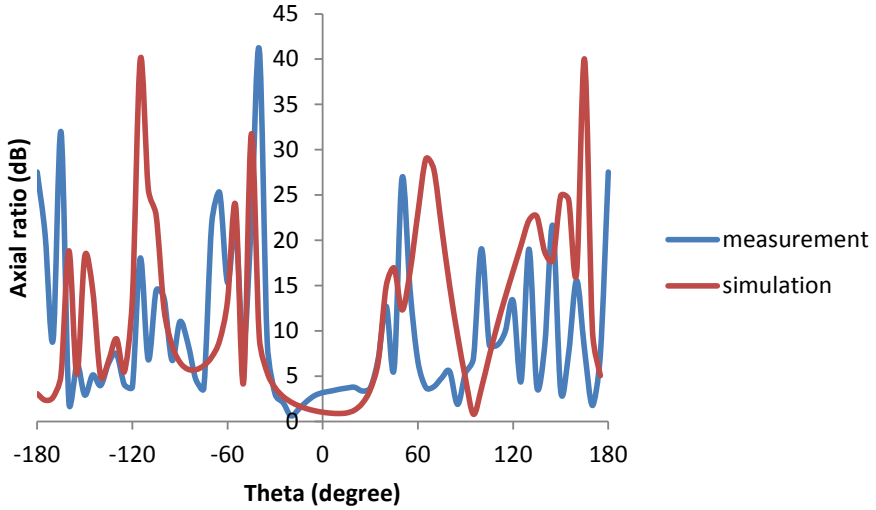
Gain and Axial Ratio



Measured and simulated gain



Measured and simulated axial ratio at 10 GHz

- The reduction in the measured gain may be attributed to the loss at the solder junctions and the 'straight-edge connections'
- The angular range for -3 dB axial ratio is around 55° (simulated as well as measured)

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Conclusion

- The design and simulation results for a planar helix antenna have been presented.
- The design is demonstrated at X-band frequencies and it is shown that this antenna can achieve circular polarization over a broad range of frequencies and angles.
- The effect of variations in dimensional parameters on S_{11}, axial ratio, directivity and side lobe level has been studied.
- The antenna has been fabricated using printed-circuit techniques. The measured $S_{11,}$ radiation pattern, and axial ratio results match well the simulation results.
- The planar helix antenna has the potential to operate at millimeter-wave frequencies due to its compatibility with printed-circuit and microfabrication techniques.

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