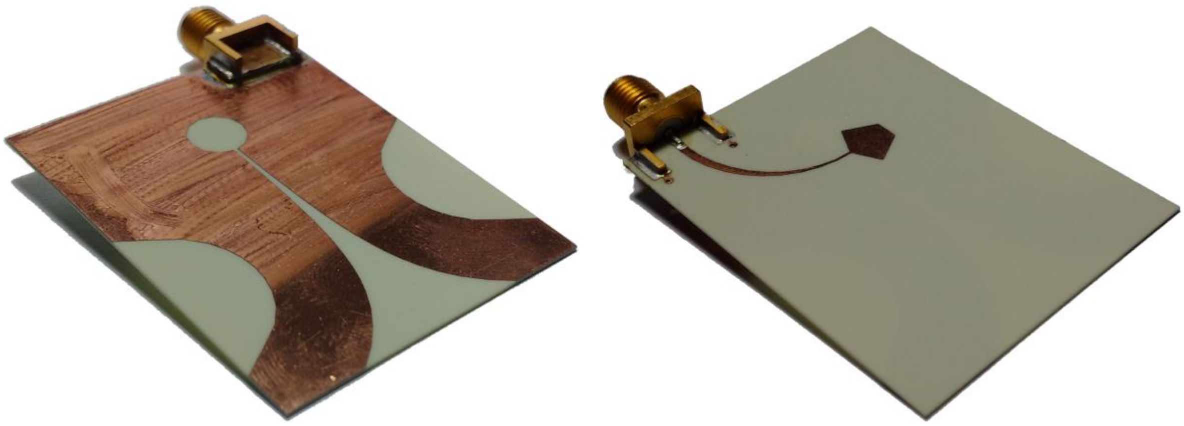
Lime Microsystems Limited

Surrey Technology Centre
Occam Road
The Surrey Research Park
Guildford, Surrey GU2 7YG
United Kingdom

Tel: +44 (0) 1483 685 063
e-mail: enquiries@limemicro.com

Vivaldi Antenna



Document version: 1.0
Document revision: 0

Contents

1

Introduction

This document presents the design, simulation results and preliminary measurement results of the wideband Vivaldi antenna.
A Vivaldi antenna, also known as a tapered slot antenna.

2

Antenna Design

2.1 Specifications

The antenna should cover the frequencies 10 GHz and 5.5 GHz with 100 MHz bandwidth around these centre frequencies. The reflections coefficient, S11, should be lower than -10 dB, or VSWR $\leq$ 2.0.
The antenna should have standard SMA connector, placed near the corner of the plate in line with the main radiation direction.
The substrate is Rogers RO4350B of the thickness 20 mils, i.e., 0.5 mm, with relative permittivity 3.6 and loss tangent 0.0032.

2.2 Electromagnetic Model

Figure 2.1 and Figure 2.2 show the top and bottom view of the antenna, respectively. The metallic pars are cyan, and the dielectric (substrate) is red.
The antenna is in the bottom layer, while the feeding tapered microstrip with optimized (radial) stub is at the top layer. The antenna will be fed by SMA connector placed at the beginning of the tapered bended microstrip line.
The calculated reflection coefficient in the frequency range from 1 GHz to 15 GHz is shown in Figure 2.3. The antenna covers the frequencies 5.5 GHz and 10 GHz, but also has reflection coefficient below -10 dB in the frequency range 3.5 GHz to 14 GHz.
The calculated 3-D radiation pattern at 5.5 GHz is shown in Fig. 6, and at 10 GHz in Fig. 7. The maximum gain, in the main radiation direction, is 5.2 dBi at 5.5 GHz and 7.7 dBi at 10 GHz. Note that due to the manufacturing tolerances, and the connector transition it is expected to lose up to 1 dBi in the radiation, and about 2 dB for the reflection coefficient.

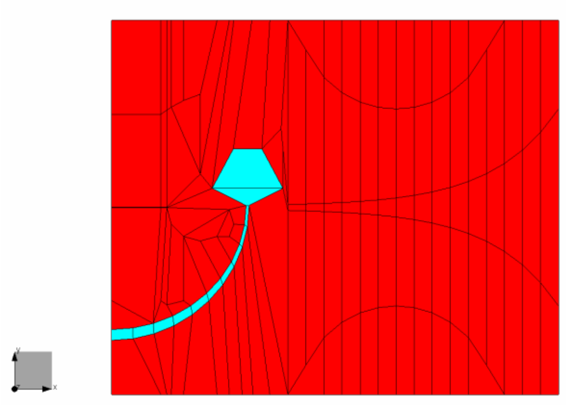


Figure 2.1: Antenna Top View

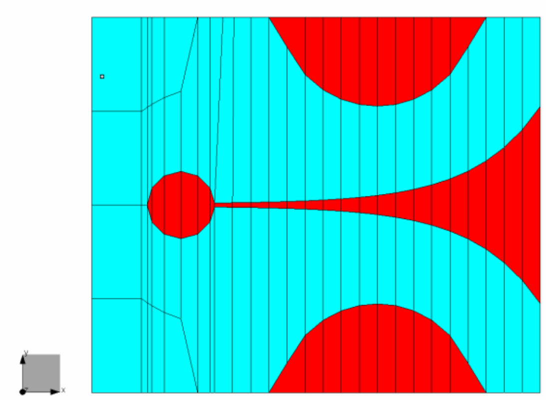


Figure 2.2: Antenna Bottom View

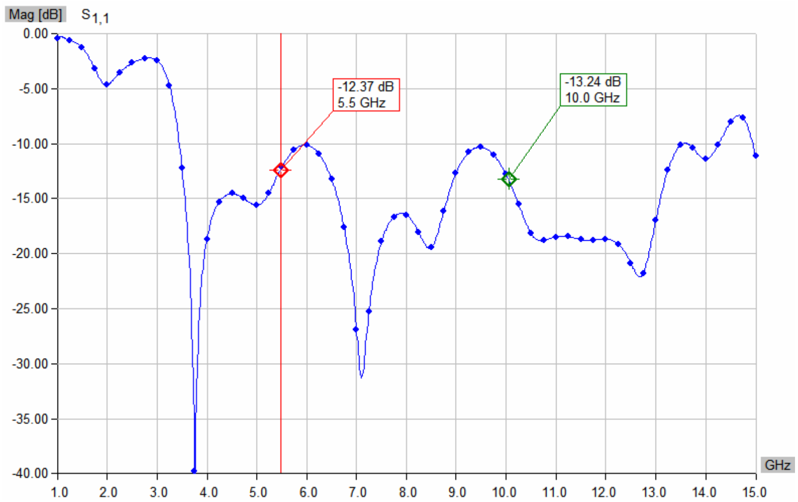


Figure 2.3: Calculated Reflection Coefficient

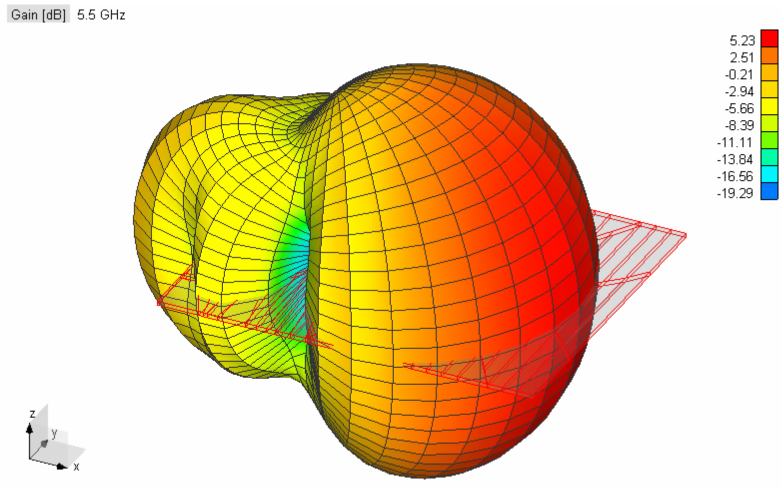


Figure 2.4: Calculated 3-D radiation pattern of the designed Vivaldi antenna at 5.5 GHz

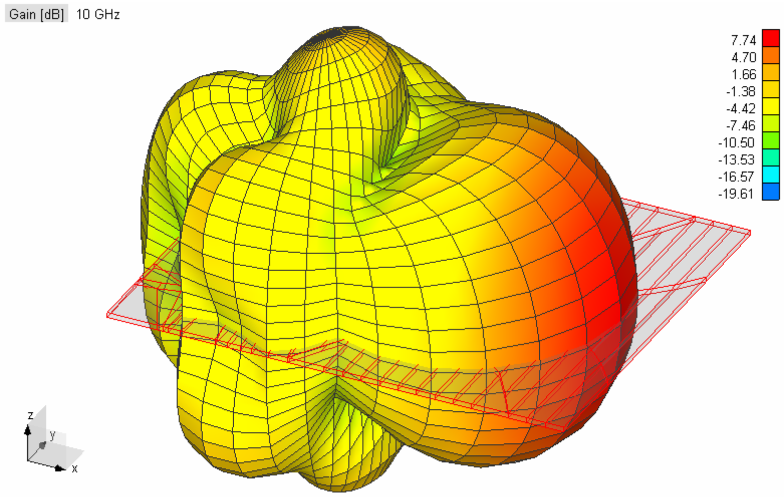


Figure 2.5: Calculated 3-D radiation pattern of the designed Vivaldi antenna at 10 GHz

2.3 PCB Design and Connector Layout

Starting from the 3-D model, exactly the same footprint is transferred to PCB, as it is shown in Figure 2.6. The two vias should be metalized. The final antenna dimensions are approximately 48 mm by 38 mm.

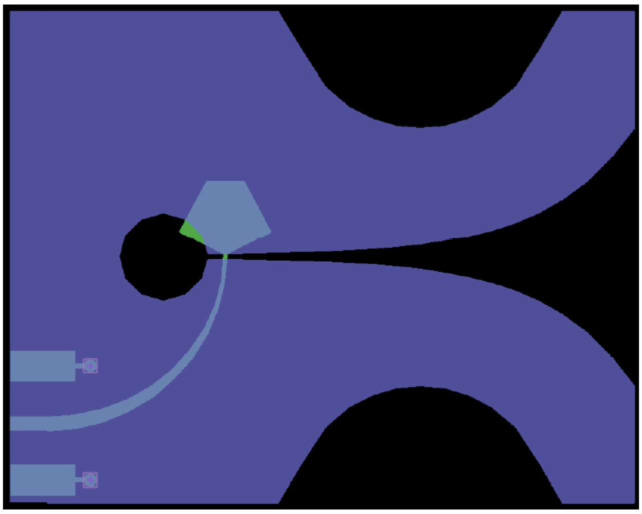


Figure 2.6: Final gerber files

3

Prototype Measurements

Antenna prototype is presented in Figure 3.1.

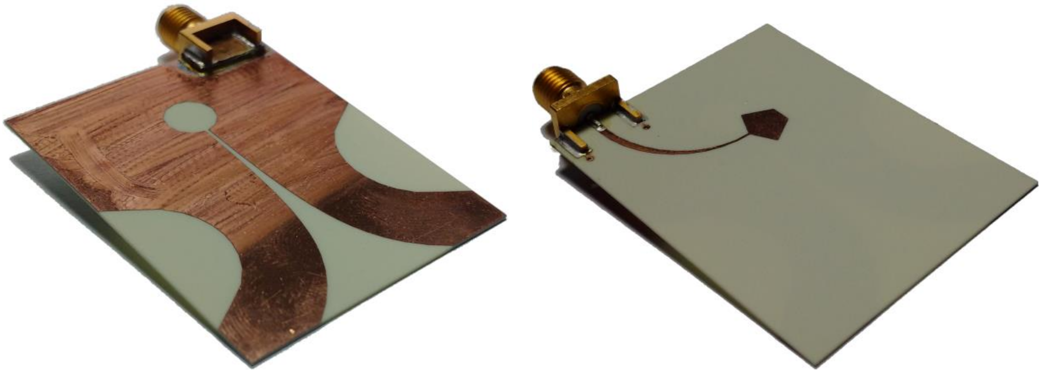


Figure 3.1: Antenna Prototype

In order to estimate the antenna gain, two identical antennas were positioned at 1 m distance, and the loss was measured for relative angles between -90º and 90º.
In order to obtain the estimated antenna gain, free space loss at the measured frequency was accounted for. Results are presented in Table 3.1.

Table 3.1: Estimated antenna gain

Relative Angle [º]	Measured Loss @ 5.5 GHz [dB]	Measured Loss @ 10 GHz [dB]	Antenna Gain @ 5.5 GHz [dB]	Antenna Gain @ 10 GHz [dB]
-90	-49.5	-43.8	-9.9	0.1
-80	-48	-45.2	-8.4	-1.3
-70	-43.1	-37.7	-3.5	6.2
-60	-43	-45	-3.4	-1.1
-50	-37.7	-44.5	1.9	-0.6
-40	-36.6	-42.7	3.0	1.2
-30	-36.6	-39.2	3.0	4.7
-20	-33.2	-38.3	6.4	5.6
-10	-32.7	-36.5	6.9	7.4
0	-32	-35.3	7.6	8.6

10	-32.6	-36.75	7.0	7.1
20	-35.4	-36.3	4.2	7.6
30	-37.3	-40.34	2.3	3.5
40	-37	-41.2	2.6	2.7
50	-39.2	-45.6	0.4	-1.7
60	-40.7	-43.3	-1.1	0.6
70	-50.5	-43.3	-10.9	0.6
80	-48	-46.4	-8.4	-2.5
90	-57.5	-46.3	-17.9	-2.4

Estimated gains are illustrated in Figure 3.2.

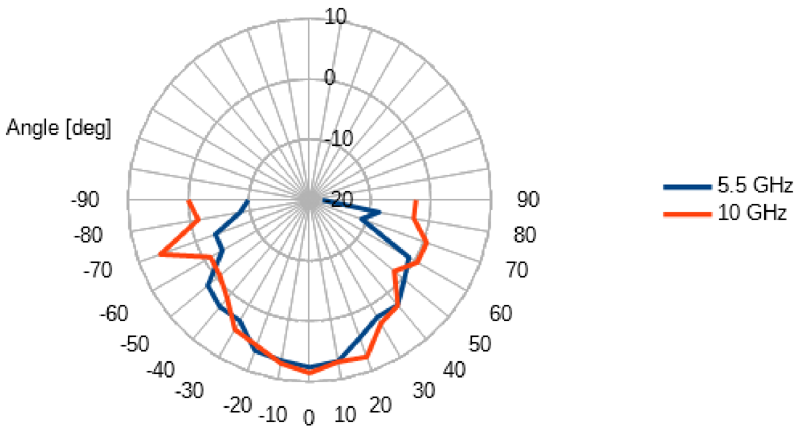


Figure 3.2: Preliminary measurements - Gain in horizontal plane from -90º to 90º

Measured reflection coefficient for two antenna prototype samples are presented in Figure 3.3.

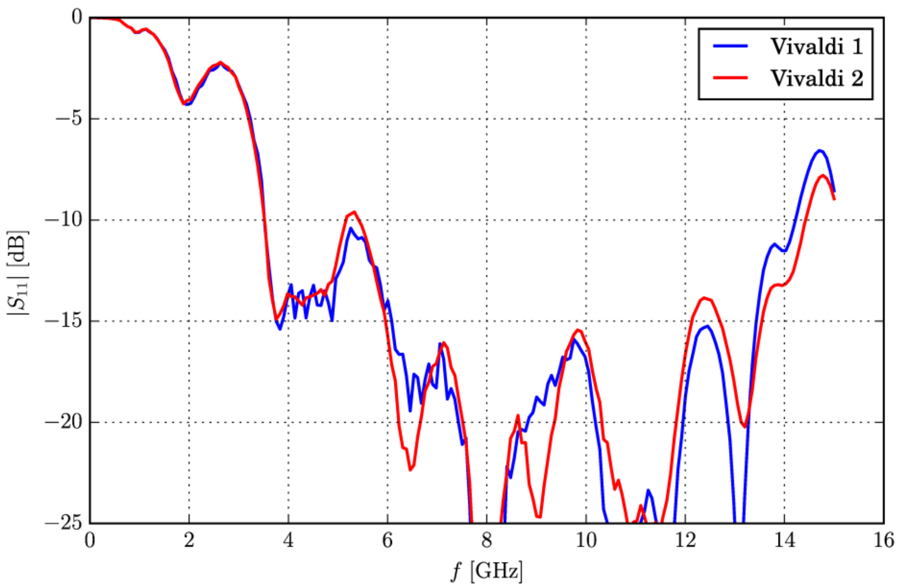


Figure 3.3: Measured reflection coefficient for two samples