
Filtered Vivaldi Module

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CONFIDENTIAL

Tuesday 13th August, 2024

Abstract

This primer outlines the specifications and features of compact Vivaldi antenna which has an integrated low pass filter which aims to provide a unified hardware solution for all regulatory regions.

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1 General Description

The differential Vivaldi antenna module is designed to offer a straightforward, modular integration for a variety of Ultra-Wideband (UWB) applications. This updated innovative design incorporates a compact low-pass filter within the antenna module itself, allowing users to achieve certification across different regulatory regions with a single hardware.

The RF front-end features a differential low-pass filter that connects directly to the dual Vivaldi antenna, as depicted in Fig. 1. When excited differentially, the system functions as a unified differential antenna, showcasing a dipole-like radiation pattern and linear polarization. This balanced circuit design enables direct connection to the SR1020 radio chip's output pins (RFN-RFP) without the need for a balun. The module is constructed on a 4-layer FR4 PCB, characterized by a relative permittivity of 4.4 and a total thickness of 0.98mm as shown in Fig. 2.

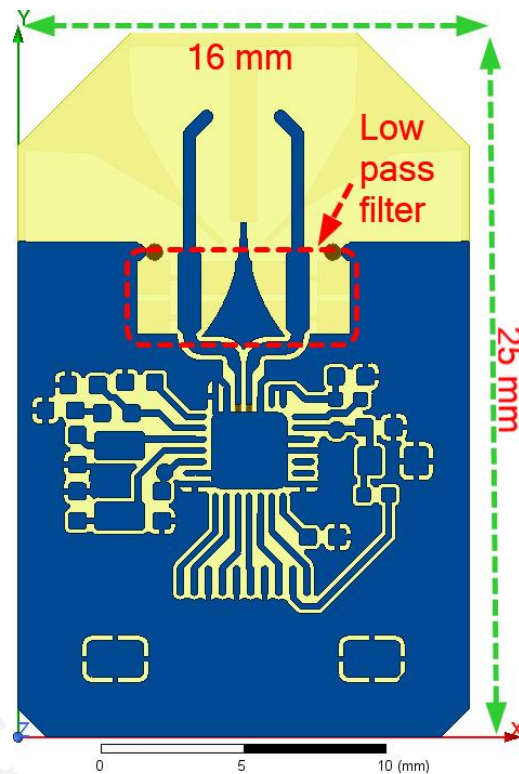


Figure 1: Filtered Vivaldi antenna module.

Material	Layer	Thickness	Dielectric	Gerber	Er
	Top Overlay			GTO	
Surface Material	Top Solder	0.01mm	Solder Resist	GTS	
Copper	Top Layer	0.04mm		GTL	
Prepreg		0.11mm	PP-006		4.4
CF-004	Layer 1	0.04mm		G1	
		0.60mm	FR-4		3.96
CF-004	Layer 2	0.04mm		G2	
Prepreg		0.11mm	PP-006		4.29
Copper	Bottom Layer	0.04mm		GBL	
Surface Material	Bottom Solder	0.01mm	Solder Resist	GBS	
	Bottom Overlay			GBO	
Total thickness: 0.98mm					

Figure 2: Multi layer stackup.

2 Simulated Performance

The simulated differential S_{11} of the RF front-end is presented in Fig. 3. As it can be observed, the -10 dB impedance cutoff is at about 6.1 GHz for this module.

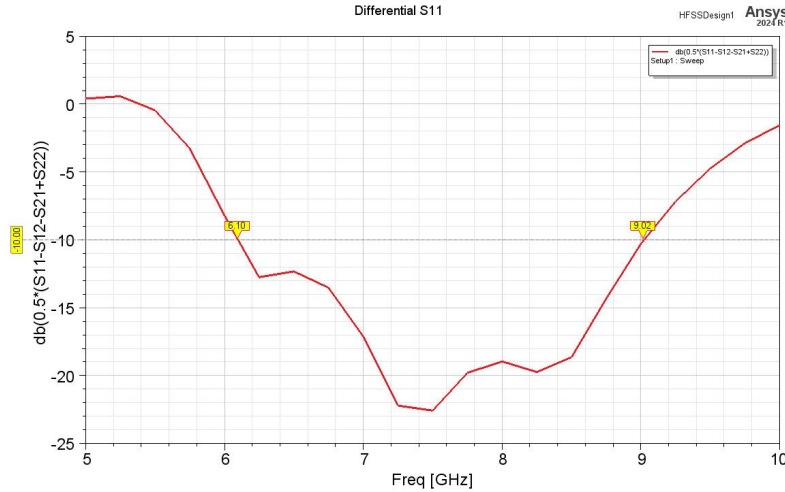


Figure 3: Simulated S_{11} result of the RF front-end.

The efficiency of the antenna's radiation is determined by calculating the ratio of the power radiated by the antenna to the power received at its input, as shown in Fig. 4. This method is particularly precise as it accounts for any impedance mismatches and the insertion losses from the feed lines and filter. The combined radiation efficiency and filter insertion loss stay under 1.5 dB across the relevant frequency range.

Fig. 5 illustrates the peak realized gain of the antenna, reaching a maximum of approximately 1.8 dB at 9 GHz, including losses.

These figures also demonstrate the antenna's filtering capability, effectively rejecting signals below 6 GHz and above 10.5 GHz. This selective filtering ensures meeting certification requirements for out of band emissions.

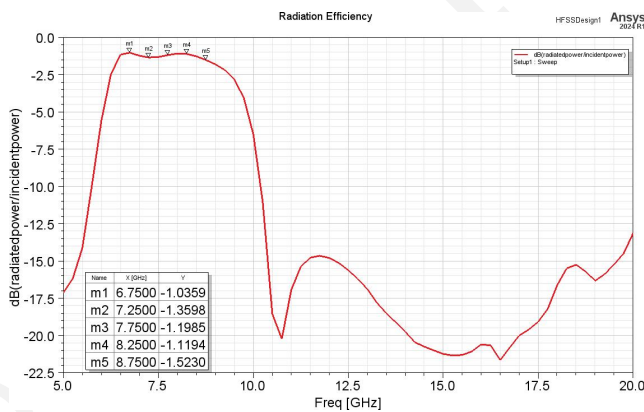


Figure 4: Radiation efficiency of the Vivaldi dongle antenna.

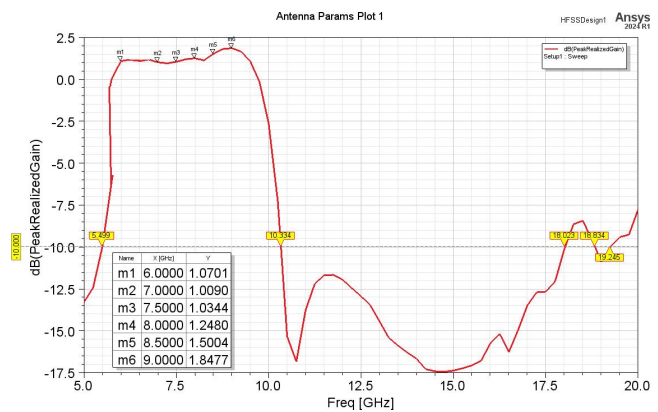


Figure 5: Peak realized gain of the Vivaldi dongle antenna.

3 Simulated Radiation Patterns

The radiation pattern of the module is plotted for the XY, XZ, and YZ cuts from 6.0 to 9.0 GHz in Fig. 6-8. It has to be noted that these patterns have been obtained from free space simulation. The radiation pattern of the antenna will be different in a specific product and will be affected by the elements around it.

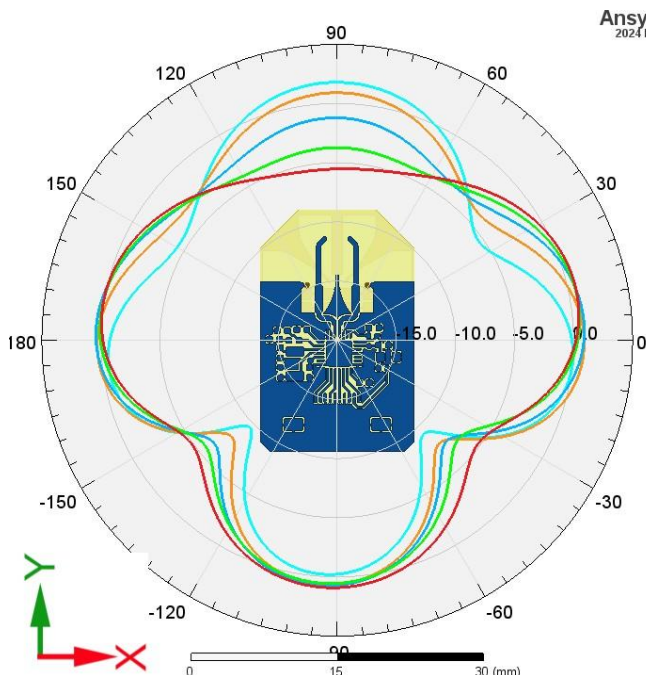


Figure 6: Realized gain (dB) (xy-plane).

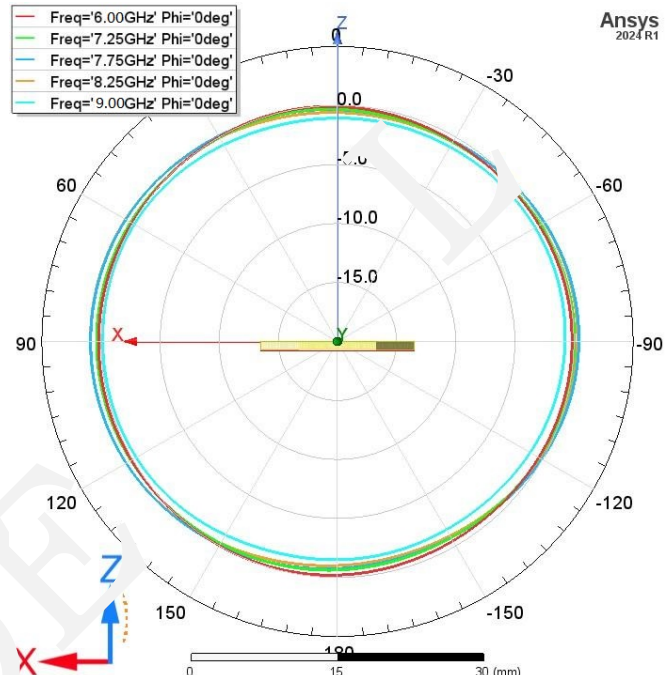


Figure 7: Realized gain (dB) (xz-plane).

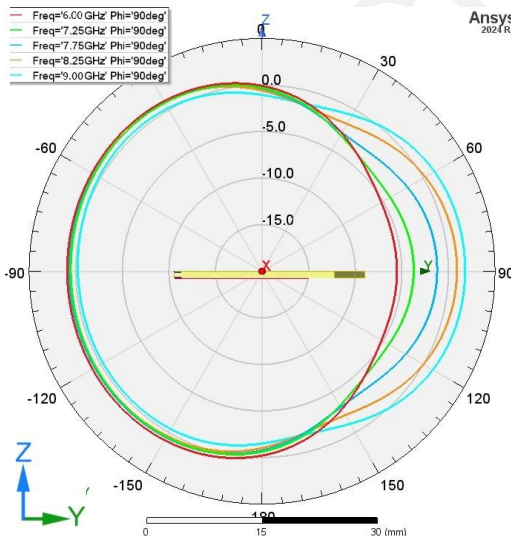


Figure 8: Realized gain (dB) (yz-plane).

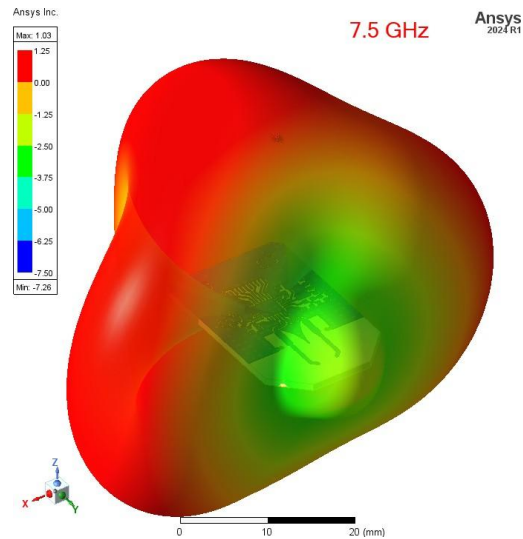


Figure 9: 3D radiation pattern at 7.5 GHz.

Frequency (G)	Peak Gain(dB)
6.0	1.0701
7.0	1.0090
7.5	1.0344
8.0	1.2480
8.5	1.5004
9.0	1.8477(max)

Antenna Specification

Antenna type	PCB antenna
Frequency range	6.0G-9G
MAX. Gain	1.84dB
Impedance	50 Ohm