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An Ultra-Wideband Circularly Polarized Probe Based on Vivaldi Antenna

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Abstract

Abstract-Near-field antenna measurement has the advantages of high accuracy, good safety, and all-weather work, so it is widely used to test antennas. In this paper, a high-performance circularly polarized probe based on the vivaldi antenna is designed. We use a stripline T-type power splitter to evenly distribute the energy of the antenna port to the two feeds, ensuring that the amplitude and phase of the probe remain consistent when the probe is polarized. Its working frequency range is 0.55GHz-3.75GHz, and the axial ratio is lower than 3. The dielectric constant of the antenna dielectric plate is 2.65, and the antenna size is 325mm×304mm×2mm.

Keywords-Near field measurement, Vivaldi antenna, circular polarization.

Antenna Design

The structure of the traditional Vivaldi antenna, on both sides of the dielectric layer, the metal floor is etched with a gap structure (green) surrounded by gradual groove lines and a microstrip balun (yellow) for feeding. The gap structure includes exponential lines, transition groove lines and circular cavities. In order to obtain a wider bandwidth, choke slot loading is generally selected, which means that a rectangular, exponential or tree-shaped grid structure is loaded on the edge of the Vivaldi antenna radiating arm. This structure can reduce the fringe current and thereby reduce the fringe electric field. Strength to avoid unnecessary side radiation.

In this paper, the selected slot structure is shown in Figure 1. The Vivaldi antenna adopts a double feed point structure, and two Vivaldi antennas are connected in parallel in parallel. The exponential gradual rate of the two curves in the middle is different from the exponential gradual rate of the curves on both sides, which improves the original single and unbalanced feed structure. The slot line is composed of two different asymptotes. The two equations are:

$$Y_1(x) = \pm 0.5(Ws + g \times \exp(\ln((w - ws)/g) \times (x/L)))$$
$$Y_2(x) = \pm 0.5(Ws - g \times \exp(\ln(ws/g) \times (x/Ls))) \qquad (a)$$

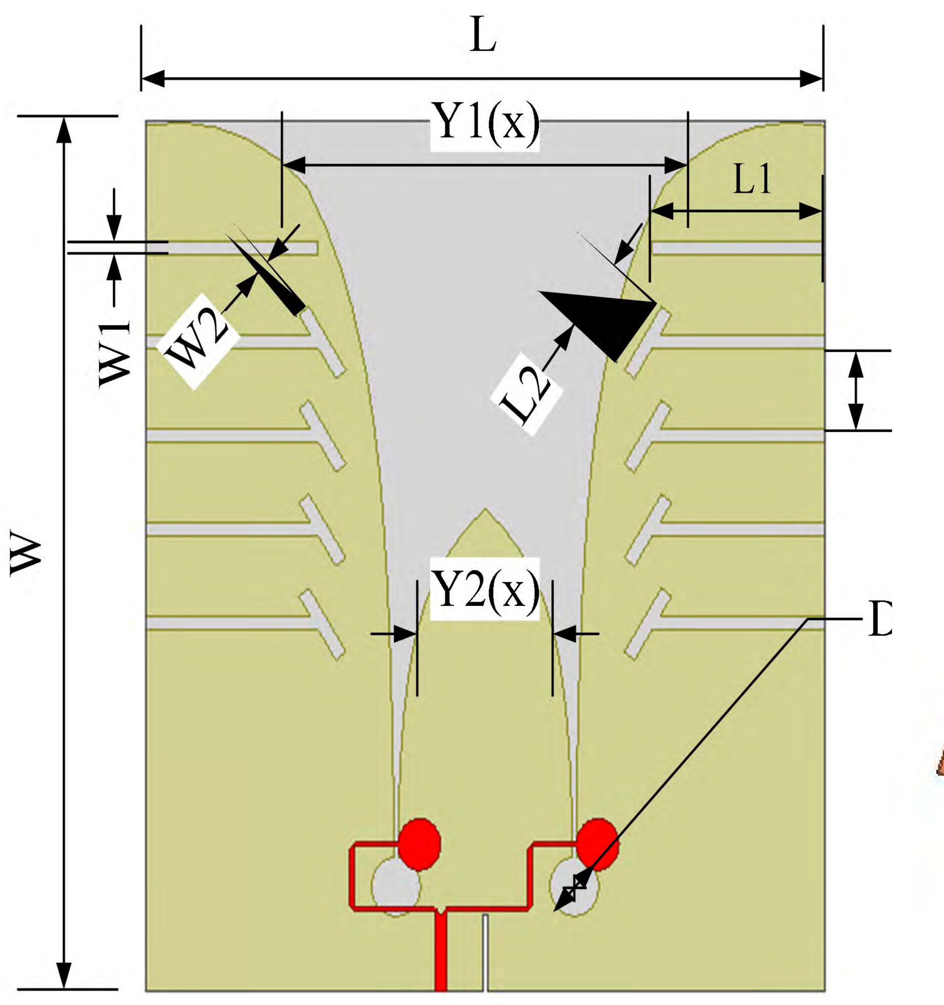


Fig.1. Slot structure

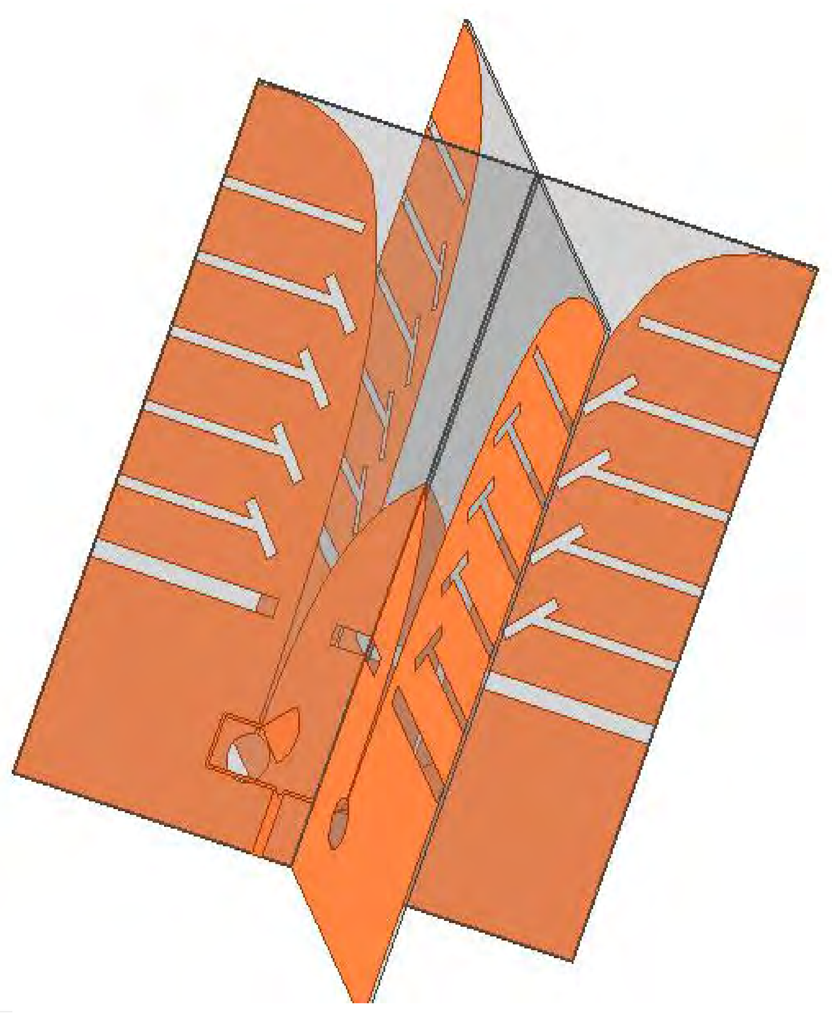


Fig.2. 3D View

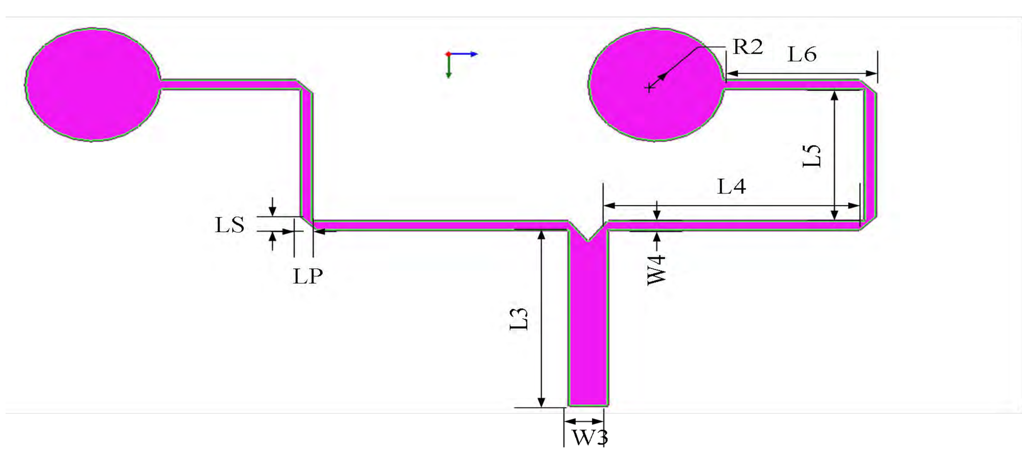


Fig.3. T-type power divider and feed structure

The simulation software we selecte is HFSS 18, through parameter optimization, and finally all sizes are selected: W=325mm, L=304.5mm,D=30mm,DR=22mm,W3=5.52mm,L3=26mm,LL=4.5mm,L4=36.38mm,LP=LS=2.31mm,L5=22.46mm,L6=20mm, Ws=40mm, g=0.9mm, Ls=60mm.

Simulated Results

The simulation software we selecte is HFSS 18, and get the final result. Figure 4 shows the return loss of the two ports of the probe. It can be seen from Figure 4 that the normal working area of the probe is 0.55GHz-3.75GHz. In the entire working frequency band, we have selected some frequency points. Figure 5 shows the Axial Ratio corresponding to these frequency points, it shows that the overall axis ratio is lower than 3dB, and the Axial Ratio performance is good. Also, we have selected the gain of some frequency points, and shown in Figure 6, the gain of each frequency point exceeds 7dB.

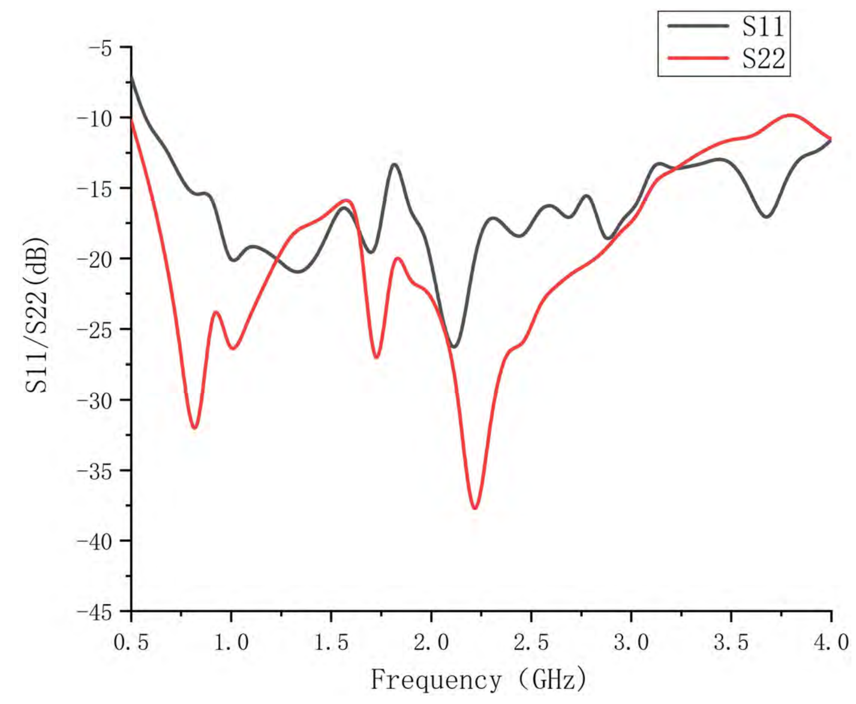


Fig.4. S-parameters of the antenna

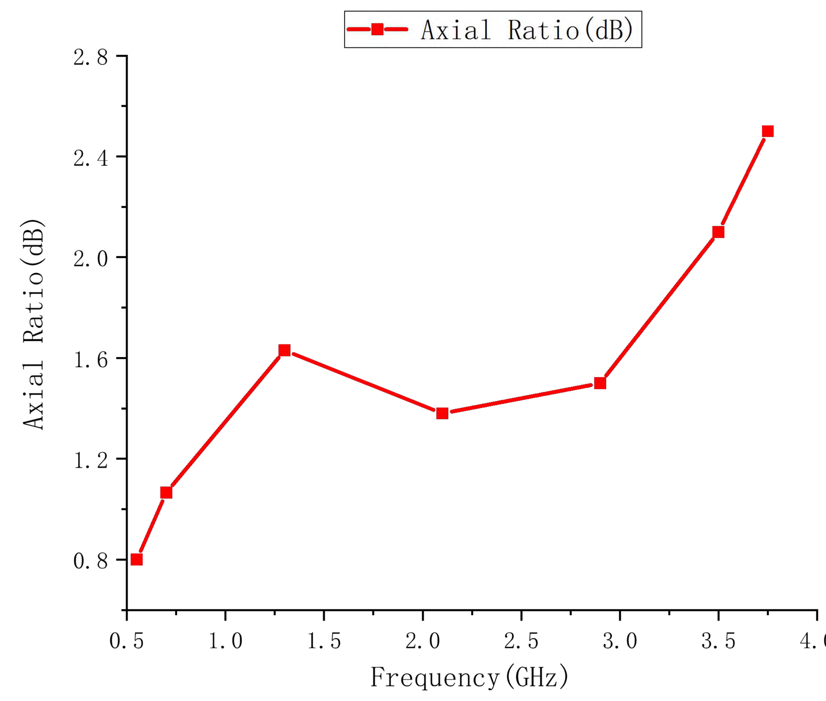
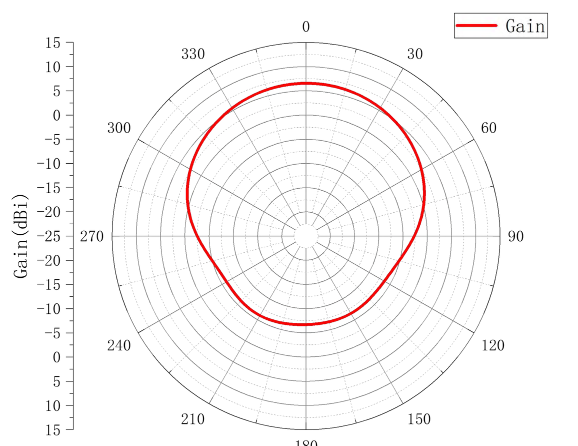
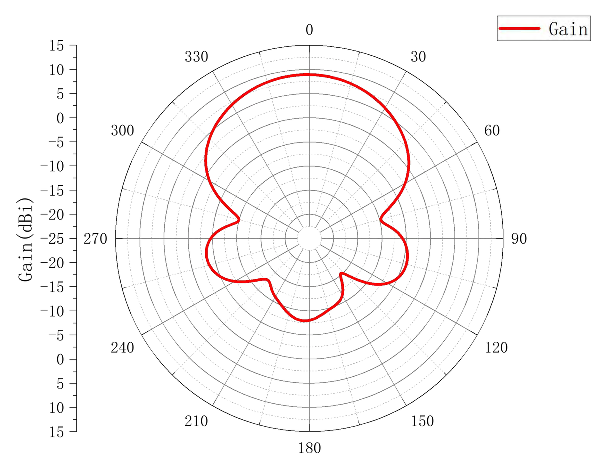


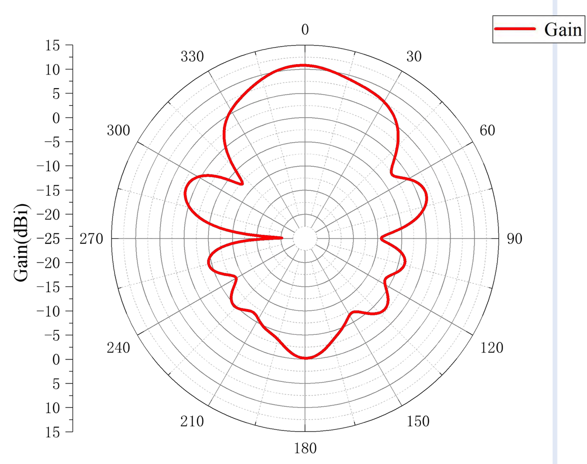
Fig.5. Axial Ratio plot



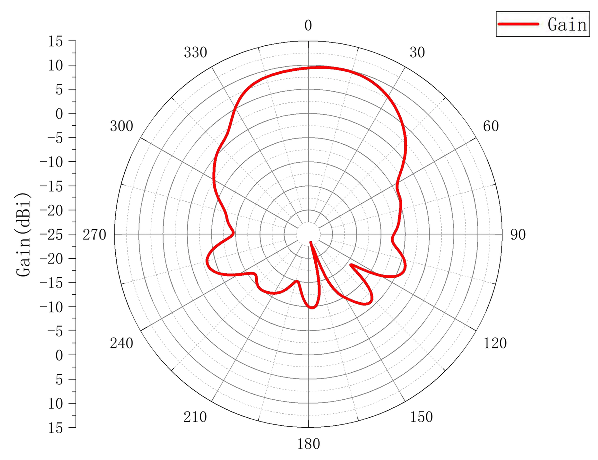
Freq.=0.7GH



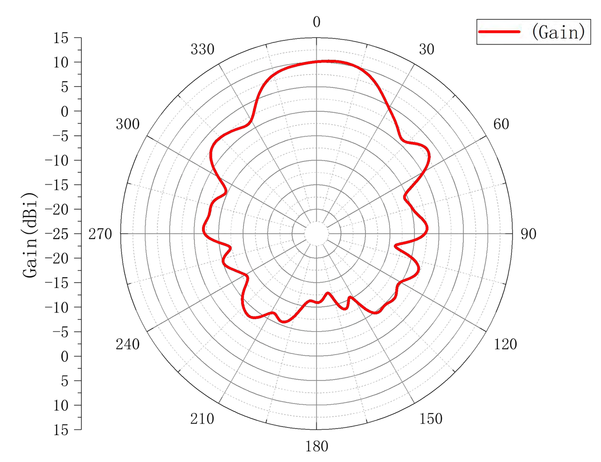
Freq.=1.3GH



Freq.=2.1GH



Freq.=2.9GH



Freq.=3.5GH

Fig.6. Radiation pattern at frequency

Conclusion

In this paper, the antenna slot adopts the form of two Vivaldi antennas in parallel in parallel, and at the same time rectangular slot, which effectively improves the current distribution and increases the gain, so that the antenna can work normally at 0.55GHz-3.75GHz. The overall gain is above 7dB, and the highest can reach 10.2dB. And the entire frequency band, the Axial Ratio is lower than 3dB, which has strong practicability.

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