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Application Status of Left and Right Handed Transmission Lines in Power Dividers

Hui Yong Zeng[a], Zhong Wu Yu[b], Jian An[c], Bin Feng Zong[d],*

[a]*Air and Missile-Defence College, Air Force Engineering University, Xi'an 710051, China.*
[b]*Military Representative Office of PLA Stationed on 720 Factory, Nanjing 210038 , China*
[c]*Beijing Space Information Relay Transmission Technology Research Center, Beijing 102300, China.*
[d]*Unit 94710 of the PLA, Wuxi 214000, China.*

Abstract

The power splitter is an important device for applications such as microwave signal separation and array antenna feeding. After the emergence of the right and left hand transmission lines, most of the miniaturized power splitters are designed by utilizing the miniaturization characteristics of the left and right hand transmission lines. This paper summarizes the application of left and right hand transmission lines in the power splitter, and analyzes the advantages and disadvantages of different implementation methods.

Keywords: Left and right handed transmission line, power divider;

1. Introduction

The power splitter is an important device for applications such as microwave signal separation and array antenna feeding. Its performance directly affects the amplitude and phase relationship of the antenna. After the emergence of

* Corresponding author. Tel.: +86-18552097363; fax: +86-029-84789018.
E-mail address: hyzeng.1023@163.com

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the left and right hand transmission lines, the researchers designed a variety of power divider structures based on the left and right hand transmission lines. Most of the miniaturized power splitters are designed by utilizing the miniaturization characteristics of the right and left hand transmission lines.

A power splitter is a device commonly used in microwave passive systems that can distribute the energy of one input signal into multiple signal energy according to engineering requirements. Can be applied to phase shifters, power adapters, duplexers T-junctions and porous slot couplers, and can also be used for the distribution of IF signals in satellite receivers connected to antennas; in wireless communications, single solid-state devices The output power is limited as the frequency increases, and another method of using the power combiner can remedy this limitation. The reverse use of the power splitter can simultaneously combine several scattered energies to achieve high power output. There are many types of power splitters. According to the materials, common microwave power split devices have microstrip power split, waveguide splitter and substrate waveguide splitter; among them, the microstrip splitter is small in size, compact in structure and cost-effective. However, its bandwidth is narrow, power capacity is small, and insertion loss is large. The waveguide power divider is relatively large in size, but its excellent power and bandwidth characteristics make it widely used in microwave equipment such as broadband wireless communication, high-power transmitters, array antenna feed networks, phased array radars and power amplifiers. And there are also great applications in the millimeter wave band. In actual engineering use, we not only require the wide frequency band of the power splitter to improve our frequency band utilization, but also require the power splitter to have good reflection coefficient, isolation and consistency in all aspects. Measuring the pros and cons of a power splitter can be made up of many specified parameters. Here are a few of the commonly used ones: the reflectance of the input port of the power divider, the power amplitude balance between the output ports, the power capacity, the insertion loss, the isolation, the phase difference between the output ports, and the device size.

2. Analysis of the Implementation Method of Power Divider

The concept of the composite left-right hand transmission line fundamentally summarizes the dual natural properties of the left-hand transmission line and the right-hand transmission line in a clear and concise manner, and is widely considered to be a powerful example for studying left-hand material properties and developing left-handed devices. So far, the application of left-handed materials can be divided into three categories: (1) waveguide components: including polygonal strips, enhanced sideband devices, narrowband couplers, composite resonators, uniform power combiners, uniform power dividers, super Widescreen filters, agile distributed amplifiers, and pulse delay circuits. (2) Refracting wave system: including focusing lens, super-resolution imaging system, refracting telescope, etc. (3) Radiation wave equipment: including one-dimensional single-side passive leakage wave antenna and resonant antenna, one-dimensional polygonal mirror, two-dimensional active polygonal resonant antenna.

Literature [1] proposed a new type of Wilkinson power splitter based on the left and right hand transmission lines. The device uses the nonlinear dispersion characteristics of the left and right hand transmission lines, and uses the λ0/4 left and right hand transmission lines formed by LC components to replace the right hand transmission lines of the traditional power divider. The branch arm is constructed. The results show that the new power splitter can effectively increase the isolation bandwidth and reduce the size of the power splitter. The literature [2] designed the zero-phase shift left and right hand transmission lines according to the hyperbolic-linear dispersion relationship of the left and right hand transmission lines. A transmission line replaces the isolation network of the traditional power divider, which can effectively reduce the size of the entire power divider. The zero-phase-shift left and right hand transmission lines are used instead of the isolation network of the three-division power divider. As shown in Figure 1, the whole power is divided. The area of the device is reduced by 70% compared with the traditional power divider; in [3], based on the zero-order resonance characteristics of the left and right hand transmission lines, a 4-way microwave power splitter operating at 2.45 GHz is designed, and the power splitter is input in phase with the same phase. Power is distributed to each output port, and the output port position has no effect on power allocation. In the frequency range of 2.2 GHz to 2.65 GHz, the power difference of each output port of the power splitter is 1d. Within B, in the frequency range of 2.22GHz~2.56GHz, the phase difference of the output port is within 15°; in [4], the reverse open-loop resonator is embedded in the microstrip line, and a new type of left-right hand transmission line is designed and used for miniaturization. The design of the T-type power divider, as shown in Figure 2, is 75% smaller than that of the conventional power divider; the literature [5] uses a zero-phase-shift transmission line instead of the

traditional one-four-four-series power divider. The right-hand transmission line of the wavelength is designed to be a small-bandwidth one-four-four-series power splitter. The zero-phase shift line is realized by SMT components and microstrip lines. The comparison between the power splitter and the conventional structure is shown in Figure 3; the literature [6] adopts The left and right hand transmission line structure replaces the λ0/4 impedance conversion line of the conventional T-type power divider, and a small power divider is designed. As shown in FIG. 4, the size of the impedance conversion line is reduced by 70%.

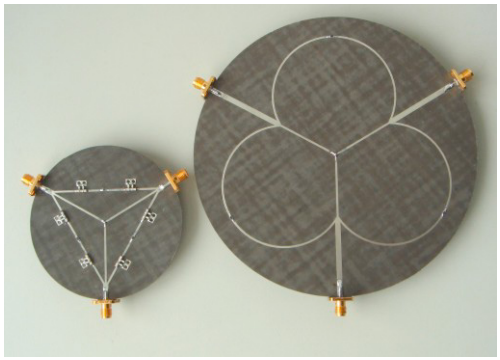

Fig. 1 Small power splitter reported in [2]

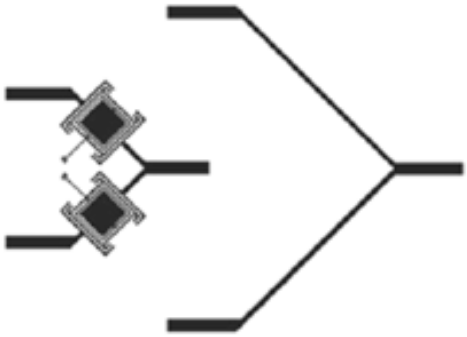

Fig. 2 Small power splitter reported in [4]

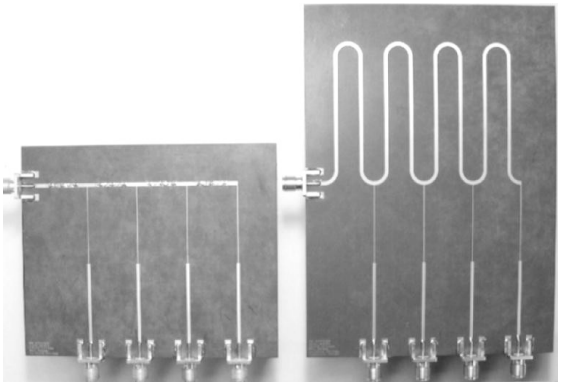

Fig. 3 Small power splitter reported in [5]

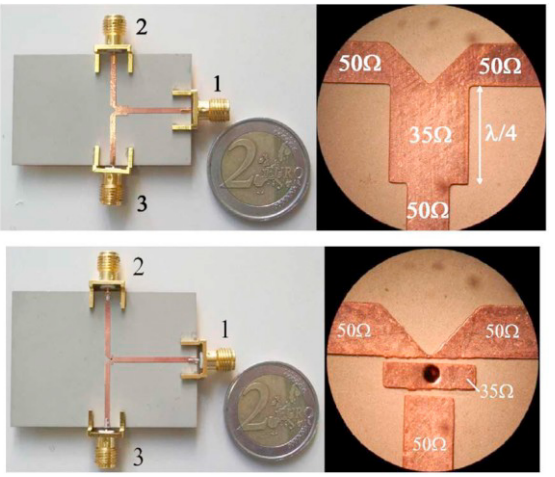

Fig. 4 Small power splitter reported in [6]

3. Conclusion

The function of the feeder system is to ensure that the amplitude and phase of each antenna unit in the antenna array are distributed as needed. Therefore, the merits of the feeder system are the key factors affecting the overall performance of the antenna array. Power dividers are a very important passive component in microwave passive components. Applications are extensive, including communications, radar, electronic countermeasures, electronic reconnaissance, navigation, surveillance and weapon guidance systems. In circuits such as antennas, power amplifiers, and phase shifters, the power splitter can be used to distribute or combine signals multiple times. The power splitter is an important part of the feeder system of the antenna. This paper summarizes the application of left and right hand transmission lines in the power splitter, and analyzes the advantages and disadvantages of different implementation methods.

4. Acknowledgement

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5. References

1. Ling Ti, Zou Yongzhuo, Lin Zhili et al. Design of Wilkinson Power Splitter Based on Left-Hand Transmission Line[J]. Journal of Microwaves, 2007, 23(5): 26~28
2. An Jian, Wang Guangming, Zhang Chenxin et al. Design of miniaturized power divider based on composite left and right hand transmission lines[J]. Journal of Microwaves, 2008, 24(6): 72~74
3. Fan Rudong, Liu Changjun. A Novel Series Power Splitter Based on CRLH-TL Zero-Order Resonance Characteristics[J]. Chinese Journal of Engineering Design, 2008, 15(3): 213~215
4. M. Gil, J. Bonache and F. Martín. Synthesis and applications of new left handed microstrip lines with complementary split-ring resonators etched on the signal strip [J]. IET Microwave, Antennas & Propagation, 2008, 2(4):324~330
5. M. A. Antoniades and G. V. Eleftheriades. A broadband series power divider using zero-degree metamaterial phase-shifting lines [J]. IEEE Microwave and Wireless Component Letters, 2005, 15(11):808~810
6. E. Saenz, A. Cantora, I. Ederra, et al. A metamaterial T-junction power divider [J]. IEEE Microwave and Wireless Component Letters, 2007, 17(3):172~174