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Application Status of Left and Right Handed Transmission Lines in Broadband Antenna Units

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Abstract

In recent years, high standards and strict requirements have been put forward on the structure and performance of antennas, especially bandwidth, gain and directivity have become the most important performance indicators of antennas. How to broaden bandwidth has become a hot topic. The left and right hand transmission line structure has the advantages of low loss, frequency bandwidth, small size and easy fabrication, and is more suitable for the design of a wideband antenna. This paper summarizes the application of the left and right hand transmission lines in the broadband antenna unit.

Keywords: Left and right hand transmission line, broadband antenna unit;

1. Introduction

Antennas are one of the essential devices in military and civilian radio systems such as radio, radio, navigation, and radar. A device that transmits and receives electromagnetic signals in a radio system is called an antenna. The

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antenna mainly performs energy conversion: when transmitting, the energy transmitted by the transmitter through the transmission line is converted into electromagnetic wave to be radiated outward; when receiving, the specific electromagnetic wave in the space is converted into energy capable of propagating in the transmission line, and then transmitted to the receiving line by the transmission line. machine. The antenna can be regarded as a converter between the guided electromagnetic wave and the spatial electromagnetic wave.

The rapid development of various intelligent wireless communication devices, especially portable wireless communication devices and smart homes, has integrated various wireless communication standards into one system. In order to meet the requirements, it is required to be the core unit for receiving and transmitting signals--microstrip antennas can have the following features: small size, light weight, simple structure, frequency bandwidth, working in dual-frequency or even multi-band and easy to use in integrated circuits. Therefore, the demand for miniaturized broadband and dual-frequency microstrip antennas is becoming more and more common.

There are several ways to broaden the antenna band:

(1) Reduce the quality factor of the antenna Q

There are many parameters to be considered in the antenna design, but the most susceptible to the frequency is the impedance. It can be considered that the bandwidth of the linearly polarized microstrip antenna is mainly limited by its impedance bandwidth. The microstrip antenna is actually a resonator. To broaden the microstrip antenna band, it is necessary to reduce the Q value of the antenna equivalent resonant circuit. The relative dielectric constant of the antenna dielectric substrate and the like can be lowered by increasing the thickness h of the antenna.

(2) Add parasitic patches using electromagnetic coupling

In order to increase the bandwidth of the antenna, it is possible to try to change the equivalent resonant circuit of the antenna. For example, add a parasitic patch, which may or may not be coplanar with the patch. This approach allows the microstrip antenna to form a double-tuned characteristic that produces two very close resonant frequencies, effectively increasing the bandwidth of the microstrip antenna; however, it also increases the size of the antenna. Another method is to use electromagnetic coupling to feed, which can also increase the bandwidth of the antenna.

(3) Additional impedance matching network

Since the main influence on the antenna bandwidth is the impedance matching problem of the microstrip antenna, the additional impedance matching network can also effectively improve its bandwidth. For example, using a simple double-branch matching technique can increase the bandwidth of the antenna by a factor of two.

The left-handed material of the metal resonant structure generally exhibits left-handed characteristics only at the resonant frequency, and has the disadvantages of large loss and narrow frequency band, which limits its application in wide-band antennas; and the left-right hand transmission line structure has low loss, frequency bandwidth, and small size, and easy to make, etc., more suitable for the design of broadband antennas.

2. Analysis of the Implementation Method of Broadband Antenna Unit

The study of left-handed materials involves many fields such as materials science, solid physics, electromagnetics and optics. It is a research hotspot in today's academic world. The composite left-right hand transmission line—an important branch of left-handed materials has received great attention from the academic community. . The concept of the composite right and left hand transmission line not only enriches the traditional transmission line theory, but more importantly opens the door to the dispersion control characteristics of human free control transmission lines, which has deeply changed the design concept of traditional microwave devices.

Block left-handed materials based on SRRs and their derived structures often have shortcomings such as narrow bandwidth and large losses. These shortcomings lead to a long way to go before the practical phase of such structures. However, the CRLH structure based on the transmission line overcomes the shortcomings of the block left-handed material and is more practical. The nonlinear dispersion relation of CRLH transmission line and its phase constant can be arbitrarily selected in the real field, so that it has some characteristics that are not available in traditional transmission lines when it is applied in the microwave field, such as wideband, dual band, miniaturization, and zero phase. Shift and zero-order resonance, etc.

Literature [1] proposed a small broadband antenna based on the double resonance theory. The antenna consists of two parts of the left and right hand transmission lines, and five spiral inductors are loaded around each part of the

transmission line to adjust its working frequency. The antenna structure is shown in Figure 1. The antenna bandwidth reaches 0.1 GHz; the literature [2] proposes a microstrip antenna with a broadband miniaturized left and right hand transmission line structure. The upper layer of the substrate has four left and right hand transmission line structures, and two parallel metal plates are introduced between the through hole and the floor. To reduce the value of the shunt capacitance, because the bandwidth will increase as the value of the shunt capacitance decreases, this structure can significantly increase the bandwidth of the antenna; the literature [3] uses the new two-dimensional left and right hand transmission line to design ultra-wideband, high A gained rectangular microstrip patch antenna consisting of a triangular band gap etched on a metal patch and a cross-band line etched on the ground. The antenna bandwidth is increased from 0.2 GHz to 3 GHz and the radiation efficiency is exceeded. 98%; the literature [4] uses the left and right hand transmission line theory to design two new ultra-wideband antennas, one is a circular structure, its frequency band coverage is 2.63GHz~8.55GHz, another It is a rectangular structure with a bandwidth exceeding 2 GHz and high radiation efficiency. This type of antenna is suitable for high-speed short-distance wireless communication systems, such as wireless personal area network systems. The literature [5] designed a spiral shape. The left and right hand transmission line UWB antenna has a bandwidth of up to 2.2 GHz and a relative bandwidth of 25.3%. In [6], the 0th and -1st order resonances of the left and right hand transmission lines are close, and a broadband antenna is designed. As shown in Fig. 2, the antenna bandwidth is reached. 20.3%.

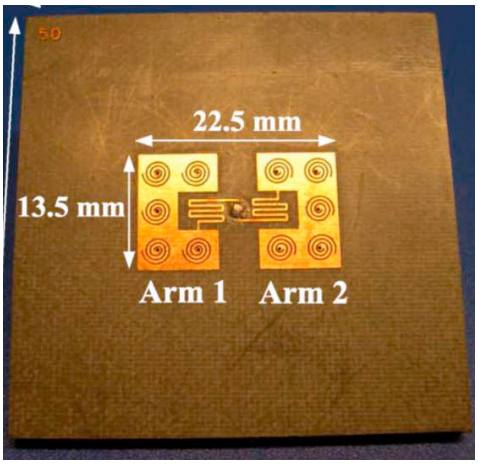

Fig. 1 Broadband antenna reported in [1]

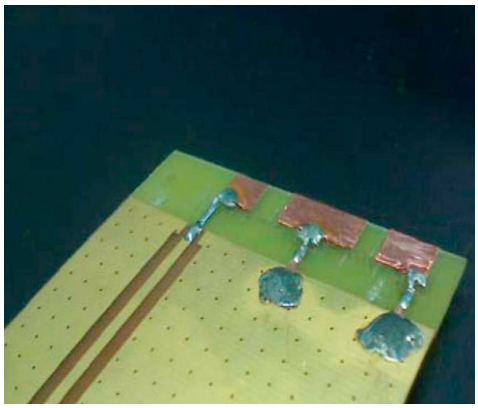

Fig. 2 Broadband antenna reported in [6]

3. Conclusion

Transmission line theory, also known as one-dimensional distributed parameter circuit theory, is the theoretical basis for microwave circuit design and calculation. Transmission line theory plays a bridge between circuit theory and electromagnetic field theory, and is also very important in microwave network analysis. The transmission line equation is the basic equation of the transmission line theory. It is a differential equation describing the variation law of voltage and current on the transmission line and their relationship. The CRLH transmission line is a new concept that is both connected and different from traditional transmission lines. The nonlinear dispersion relationship of the CRLH transmission line and its phase constant can be arbitrarily selected in the real field, making it have characteristics not found in conventional transmission lines. With the gradual improvement of the degree of social informatization and the increasingly scientific and intelligent life of people, the application of wireless communication technology has been integrated into all aspects of our lives. As a key part of the wireless communication system, the antenna plays an important role in the operation of the entire system. Bandwidth, gain and directionality have become the most important performance indicators for antennas. How to broaden bandwidth and increase gain has become a hot topic. The left and right hand transmission line structure has the advantages of low loss, frequency bandwidth, small size and easy fabrication, and is more suitable for the design of a wideband antenna. This paper summarizes the application of the left and right hand transmission lines in the broadband antenna unit, and analyzes the advantages and disadvantages of different implementation methods.

4. Acknowledgement

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5. References

1. 1. J. Zhu and G. V. Eleftheriades. A compact transmission line metamaterial antenna with extended bandwidth [J]. IEEE Antennas Wireless Propagation Letters, 2009, 8:295~298.
2. 2. M. A. W. Nordin, E. H. E. Raouf and A. A. Yussuf. Bandwidth enhancement of a compact antenna based on the composite right/left-handed (CRLH) transmission-line (TL) [A]. Proceedings of 3rd European Conference on Antennas and Propagation [C], Berlin, 2009:3582.
3. 3. L. W. Li, Y. N. Li and J. R. Mosig. Design of a novel rectangular patch antenna with planar metamaterial patterned substrate [A]. Proceedings of International Workshop on Antenna Technology: Small Antennas and Novel Metamaterials [C], Chiba, 2008:123.
4. 4. W. Huang, N. Xu, V. Pathak, et al. Composite right-left handed metamaterial ultra-wideband antenna [A]. Proceedings of IEEE Antenna Technology [C], Santa Monica, CA, 2009:1.
5. 5. Z. S. Duan, S. B. Qu, J. Q. Zhang, et al. A compact low - profile wideband omnidirectional microstrip patch loading composite right/left-handed transmission line [A]. Proceedings of International Workshop on Metamaterials [C], Nanjing, 2008:312.
6. 6. J. K. Ji, G. H. Kim and W. M. Seong. Bandwidth enhancement of metamaterial antennas based on composite right/left-handed transmission line [J]. IEEE Antennas Wireless Propagation Letters, 2010, 9:36~39.