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Application Status of Left and Right Handed Transmission Lines in Dual/Multi-Band Antenna Units

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Abstract

The advent of dual/multi-band antennas has met the need for diversification of modern wireless communication functions. The left and right hand transmission lines have positive, zero and negative order resonant frequencies, and based on this characteristic, dual/multiple frequency antennas can be realized. This paper summarizes the application of the left and right hand transmission lines in the dual/multi-frequency antenna unit.

Keywords: Left and right hand transmission line, dual/multi-frequency antenna;

1. Introduction

In recent years, the rapid development of wireless communication systems has made the antenna for receiving and transmitting wireless signals a qualitative leap. In this development process, antennas have become more and

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more widely used, such as smart home systems; wearable wireless communication devices; smart mobile devices, and the rapid growth of the number of wireless communication users and the development and use of different communication frequency ranges. The above applications make antenna research continue to move toward broadband, dual-band and even multi-band. At the same time, the development of portable communication devices requires that the size of the antenna be as small as possible. Microstrip antennas have the advantages of low profile, small size, easy integration and easy implementation of multi-frequency. They are a vital member of the antenna family and have become one of the hotspots of current research. However, the bandwidth of the microstrip antenna is too narrow to meet the needs of some specific occasions. It is necessary to solve the problem that the bandwidth of the microstrip antenna is narrow and used in different frequency bands.

At present, the ways to achieve dual or multi-frequency antennas are:

(1) A single patch. Slotting on the surface of the patch, changing the field distribution of the various natural modes of the patch or using different feeding methods to excite several natural modes of the antenna, thereby achieving dual or multi-frequency.

(2) Single layer and multiple patch structures. Each shape-sized patch has its own resonant frequency, which can be used to form a double resonance using patches of different resonant frequencies, or a multi-spot resonant microstrip antenna.

(3) Multi-layer structure. A plurality of resonators are formed using a multilayer antenna structure to generate a plurality of resonant frequencies.

The emergence of dual/multi-band antennas satisfies the demand for diversification of modern wireless communication functions. The traditional methods of implementing dual/multi-frequency are mainly to use double-fed lines and change the shape of patch antennas. These methods generally have the disadvantages of different radiation patterns and low radiation efficiency, and are large in size. Since the right and left hand transmission lines have positive, zero, and negative order resonance frequencies, dual/multiple frequency antennas can be realized.

2. Analysis of Implementation Method of Dual/multi-Frequency Antenna Unit

In [1], a dual-frequency zero-order resonant antenna composed of low-band and high-band zero-order resonant antennas is proposed based on the left-right hand transmission line. The resonant frequencies are at 0.86 GHz and 1.8 GHz, respectively, and the measurement results of radiation efficiency are 53%. And 41%, and achieved omnidirectional radiation, the disadvantage is that the bandwidth is narrow; the literature [2] based on the left and right hand transmission line structure by etching the flat pattern on both sides of the substrate designed dual-band antenna, the structure does not need to add vias and sets The total component can easily realize the excitation of the microstrip line. The designed dual-band antenna can realize the negative order frequency of 0.373GHz and the positive-order resonance of 0.817GHz, and has omnidirectional radiation characteristics and miniaturization characteristics; A dual-frequency circularly polarized loop antenna is designed by using the left and right hand transmission lines composed of interdigitated capacitors and shunt inductors. The two frequency bands have similar radiation patterns and have good axial radiation characteristics. The operating frequencies are 1.768GHz~1.776 respectively. GHz and 3.868GHz~4.007GHz; the literature [4] proposed a small dual-frequency left-handed material antenna array, which has the characteristics of small size and high radiation efficiency; the literature [5] utilizes left and right hand transmission The multi-frequency antenna is designed for the zero-order and negative-order resonance of the line structure. The 6-cell left-hand transmission line structure can resonate in the -2 order, -1 order, 0th order and multiple positive-order frequencies, and its radiation effect in multiple frequency bands.

It can be equivalent to a magnetic current around the patch, the antenna has a low-profile vertical polarization characteristic; the literature [6] proposed a double-layer medium left and right hand transmission line, and used it to design a dual-frequency antenna, the antenna is composed of 4 left and right hand transmission line units, as shown in Figure 1, the antennas resonate at 1.06 GHz and 2.12 GHz respectively; the literature [7] proposes a new concept of left-handed materials, periodically embedding metal open rings in ordinary media, making conventional media The characteristics have changed, with left-hand effect and right-hand effect, and then the antenna is designed with the newly synthesized medium as the base. The antenna resonance is at the two frequencies of 0.49 GHz and 2.48 GHz, and the matching characteristics are good; the literature [8] proposed A dual left-hand transmission line unit based on a ground defect structure, the unit includes two right-hand regions and one left-hand region, so that the

multi-frequency characteristic is more prominent, and the antenna structure is as shown in FIG. 2, the antenna The secondary resonances are in the -1st order, 0th order and +1st order, and the corresponding resonant frequencies are 2.57GHz, 3.72GHz and 4.64GHz respectively; the literature [9] proposes a dual-frequency antenna based on the left and right hand phase shifting lines, as shown in Fig. 3. As shown, due to the large size reduction of the left-handed material, the size of the phase shifting line is only 0.212λ0, thereby reducing the size of the antenna; the literature [10] studied the resonant mode of the left and right hand transmission lines based on the substrate integrated waveguide structure, In the method of etching the interdigitated gap on the front surface of the substrate integrated waveguide, a series capacitor is obtained, and the short-circuiting pin of the substrate constitutes a parallel inductor. Based on the left-right hand transmission line, a slot antenna with a terminal short circuit and an open terminal is respectively designed, as shown in FIG. 4, the antenna is shown in FIG. It can work in the -1st order, 0th order and +1st order resonant modes, and is suitable for multi-frequency communication systems.

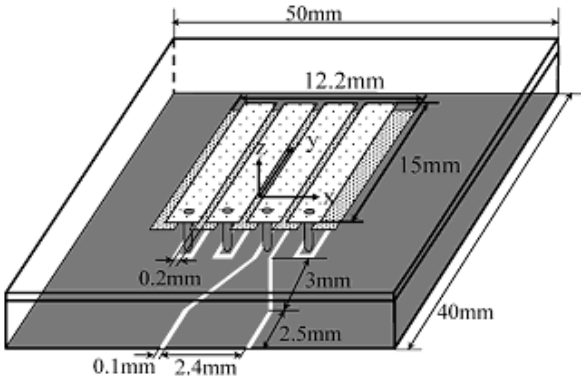

Fig. 1 Dual frequency antenna reported in [6]

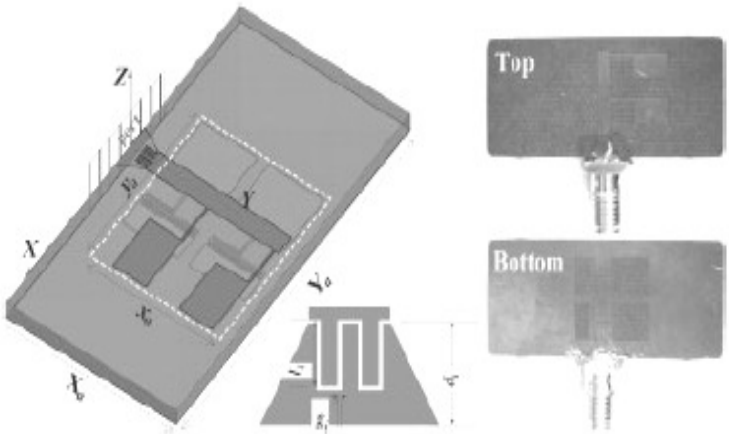

Fig. 2 Multi-frequency antenna reported in [8]

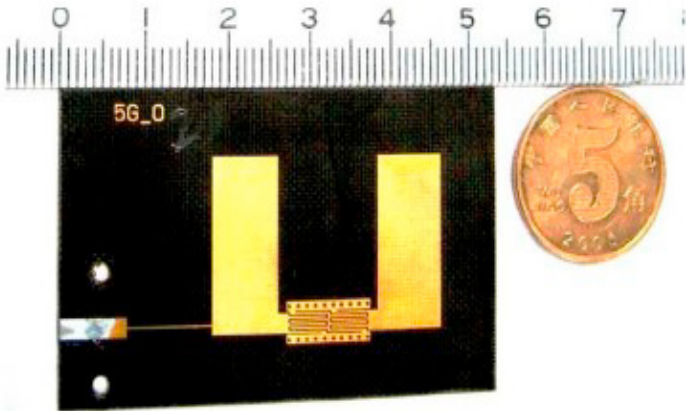

Fig. 3 Dual frequency antenna reported in [9]

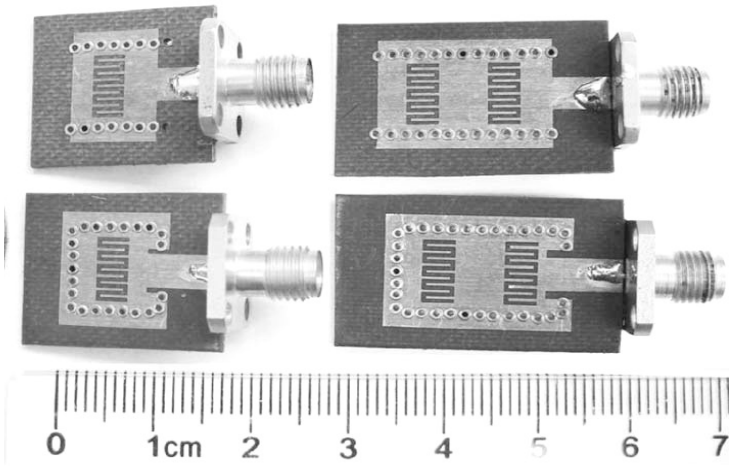

Fig. 4 Multi-frequency antenna reported in [10]

3. Conclusion

With the development of wireless communication technology, many frequency bands have become blocked. In order to increase the utilization of the number of channels, the wireless communication device is required to be able to switch between different frequency bands, or to be able to work on multiple frequency bands simultaneously. Then it is required to work as an antenna in the system in dual or multi-band. The traditional method of implementing a dual/multi-frequency antenna is mainly to use a double feed line and change the shape of the patch antenna. These methods generally have the disadvantages of different radiation patterns and low radiation efficiency, and are large in size. The left and right hand transmission lines have positive, zero and negative order resonant frequencies, and based on this characteristic, dual/multiple frequency antennas can be realized. This paper summarizes the application of the left and right hand transmission lines in the dual/multi-frequency antenna unit, and analyzes the advantages and disadvantages of different implementation methods.

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