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Analysis on Conservation of Energy in Microwave Power Synthesizer

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Abstract

Instead of using the traditional method of scattering matrix analysis, this paper uses a method similar to optical waveguide propagation. The basic theory of electromagnetic waves is used to analyze the amplitude and power of microwaves. Proved Conservation of energy is satisfied in microwave power synthesizer. Meanwhile, explained the different electromagnetic wave propagation phenomenon between divider and synthesizer.

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1. Introduction

In recent years, with the rapid development of microwave communication, radar application system and electronic countermeasure technology, there is an increasing demand for the output power and bandwidth of the microwave transmitting system are becoming higher and higher¹. Therefore, figuring out how to achieve the maximum power output in the broadband is always one of the hot research issues in microwave and millimeter wave communication and electronic warfare system².

At present, the power amplifier used in engineering is divided into two types: one is the electric vacuum device, such as a traveling wave tube power amplifier³. The other one is Solid-state devices⁴. The solid-state device is small in size, good in stability, low in power supply voltage, and can be mass produced at low cost⁵. However, due to the limitations of voltage breakdown and heat dissipation of semiconductor materials, the output power of the corresponding solid-state device is far less than that of the vacuum electronic device⁶.

So, it is widely used that multiple solid-state devices combined to obtain higher output power. Therefore, the synthesis power technology is a key to microwave millimeter wave communication system⁷.

The core components of power synthesis are power synthesizer (divider)⁸. It is used to be analyzed by scattering theory⁹. Which makes the physical concept is not very clear, especially when it comes on the amplitude variation, electromagnetic wave superposition and energy distribution. This paper analyzes the mode of the electromagnetic wave, with the basic electromagnetic wave transmission theory, to get the energy before and after the power synthesizer (divider), verified whether the conservation of energy is satisfied in power synthesizer (divider).

2. Y-type power synthesizer (divider)

To make the problem much easy and clear, take the Y-type microstrip line power synthesizer to illustrate the problem, as shown in Figure 1. In the microstrip line circuit, the transmission microwave can be treated as TEM mode⁹.

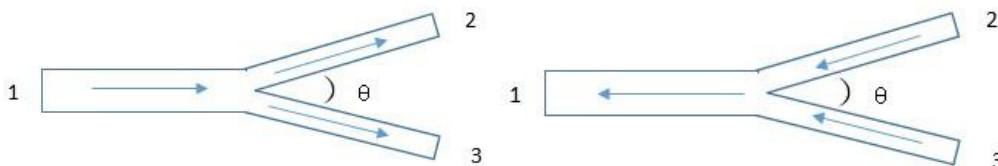


Fig.1 Y-type synthesizer (a) divider; (b) Synthesizer

3. Zero angle power synthesizer

To obtain a concise physical concept, we found a simple model which assuming the synthesizer's angle θ is 0 and created a coordinate system like Fig. 2. The junction point of the three channels as the origin of the coordinate and X axis perpendicular to the paper(Y-Z plane).

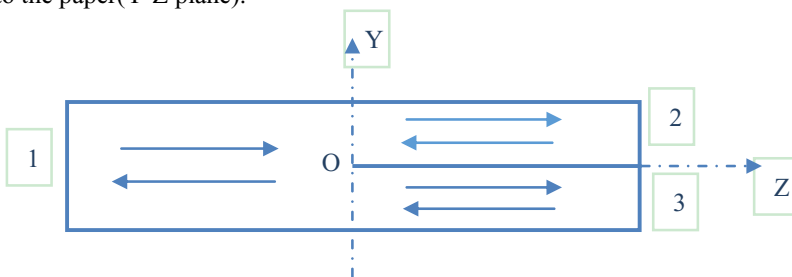


Fig.2 Zero angle Y-type synthesizer

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