A Ka Band Coupled Line Directional Coupler Based on the CPW Technology

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Abstract

A coupled line directional coupler based on the coplanar waveguide (CPW) configuration is proposed in this work. The coupled line directional coupler is one of the most common couplers. They can be implemented using coaxial and planar technologies, such as the stripline and microstrip line. The stripline and microstrip line can no longer complete the task at the high frequency portion due to losses. The high frequency band is where CPW performs better than striplines and microstrip lines. The proposed coupler works at a high frequency band (27-32 GHz), it will be used in the intelligent life evaluation system for high reliability of system semiconductors for high-speed 5G.

Ⅰ. Introduction

In microwave systems, directional couplers are frequently utilized for power distribution. The creation of such passive components has drawn ongoing, persistent interest ever since the infancy of microwave engineering. The development of transmission lines, including rectangular waveguides and planar structures, has been deeply linked to this. Technologies of stripline and microstrip line provided significant benefits because to their compactness, planarity, and affordable manufacture. Many early proposals for microwave integrated circuits included directional couplers and the possibility to integrate them with active components. Many directional couplers were redesigned as a result, and new types of circuit structures, such as branch-line hybrid and coupled line directional coupler, were also developed. In microwave and millimeter-wave systems, the branch-line [1] and coupled line coupler [2] are both commonly employed. Compared with the branch-line coupler, the coupled line coupler has a wider bandwidth.

The expanding market needs to engage more because of technological advancement. The stripline and microstrip line can no longer complete the task at the high frequency portion due to losses. A few novel technologies are being gradually researched, for example, the coplanar waveguide (CPW). The high frequency band is where CPW performs better than striplines and microstrip lines. CPW circuits [3] are frequently employed in the microstrip form division from RF to millimeter wave bands, and grounded CPW have a strong ground structure and lower losses in the high frequency band. For designs in the millimeter wave, as well as in the 100 GHz band and beyond, this may give benefits and stability. A – 20dB coupled line directional coupler based on the CPW configuration are introduced in this work. CPW technology are used to achieve a good performance at a high frequency (27-32 GHz). The proposed coupler is designed to apply in the intelligent life evaluation system for high reliability of system semiconductors for high-speed 5G.

Ⅱ. Method

One of the most common forms of directional coupler is the coupled line directional coupler. Figure 1 shows a single section coupled line directional coupler. The part between ports 1 and 2 is known as the main line, and ports 3 and 4 are known as the coupler line. The power on the coupled line flows in the opposite direction to that on the main line. The symbols in Figure 1 are completely arbitrary because the directional coupler is a linear device. Thus, any port of the coupler can be used as the input port, which would result in the directly connected port being the through port, while the adjacent port being the coupled port, the diagonal port becoming the isolation port.

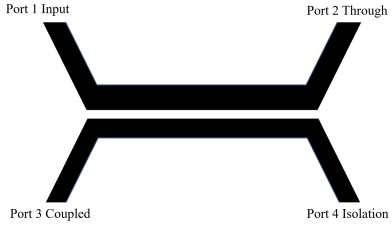

Figure 1. A single section coupled line directional coupler.

A CPW is an electrical planar transmission line which can be fabricated by using the printed circuit board technology to transmit microwave frequency signals. On a smaller scale, CPW transmission lines are frequently used in monolithic microwave integrated circuits. A conventional CPW consists of a single conductive track printed on a dielectric substrate and a pair of return conductors that are located on either side of the track. All three conductors are on the same side of the substrate and are therefore coplanar. There is a small gap between the return conductor and the central track that has a constant width along the length of the line. Away from the central conductor, the return conductor typically extends to an indeterminate but large distance, so that each conductor is conceptually a semi-infinite plane.

The CPW supporting the conductor, also known as the grounded CPW (CPWG), is a common variant in which the ground plane covers the entire backside of the substrate, as shown in Figure 2. In a grounded coplanar waveguide, a small spacing between the top ground conductor and the signal conductor achieves a low impedance of the circuit, and the impedance of the circuit can be changed by adjusting this spacing. As the spacing between the ground and signal conductors increases, the impedance also increases. When the spacing between the top ground conductor and signal conductor of the grounded coplanar waveguide increases, the effect of the ground conductor on the circuit decreases.

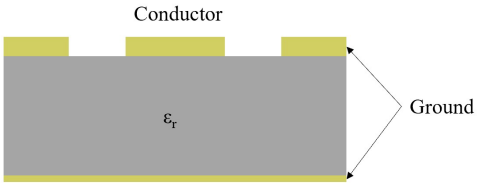

Figure 2. The geometry of CPWG.

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