Resistors-Loaded Substrate Integrated Waveguide Power Combiner/Divider

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***Abstract*—A resistors-loaded substrate integrated waveguide (SIW) power combiner/divider is reported. Two Riblet couplers are back-to-back merged, with one merged port acting as common port and the other degenerated. Hence, the proposed power combiner/divider consists of three operation branches and two isolated arms. Its structure symmetry ensures its equal-power-combining/dividing property. The two isolated arms are terminated by 50ohm lumped resistors to provide good isolation between the dividing branches, just as the isolated port of a coupler. Measured and simulated results of the fabricated prototype show good agreement with each other. Meanwhile, an isolation better than 16dB over 25% FBW is achieved, with the highest value over 30dB captured near central frequency.**

***Keywords*—Lumped resistor, power combiner/divider, substrate integrated waveguide (SIW)**

I. Introduction

Power divider is an indispensable component for the feeding network of array antenna systems. Particularly, for the microwave and millimeter wave applications, power dividers with low loss, high isolation and symmetrical structure are highly demanded. Meanwhile, substrate integrated waveguide (SIW) has provided a good way to realize high-performance microwave systems. Research has shown that SIW is usually more suitable for microwave applications beyond 10GHz than microstrip line due to the lower loss performance. And in the past decade, some SIW power dividers have been developed with three-port and multi-port blocks [1]-[4].

On the other hand, a six-port narrow-wall short-slot rectangular waveguide (RWG) coupler (Riblet type) has been reported in [5] for amplifiers' power combination application. To simplify the structure and improve phase balance, a five-port power divider is proposed in [6]. However, no SIW power divider with such structure has been reported. In this paper, a SIW power combiner/divider loaded with lumped resistors is reported. Section II and III simply talk about design and experimental results of the proposed work, respectively, with an eventually end as conclusions.

II. SIW Power Combiner/Divider with Lumped Resistor

Fig. 1 displays configuration of the proposed SIW power combiner/divider. Similar to the RWG case in [6], It consists of one common coupling section, three power combining/dividing branches and two isolated arms terminated by 50 ohm resistors. As depicted in [6] and [7], in the common coupling region of proposed SIW power combiner/divider, width and length of the common coupling region should be set reasonably. To learn the detailed property of the proposed SIW power combiner/divider more clearly, some electromagnetic simulations are carried out by using the ANSYS Electromagnetism Simulator. Fig. 2 shows the simulated output return loss and isolation with varied lengths of the microstrip line at the isolated arms, *Liso* (other dimensions are shown in the inset). As *Liso* becomes longer, the output return loss gets better and the operation frequency shifts lower. The isolation shows highest value with *Liso*=1mm around 15.8GHz, and the overall isolation performance improves as *Liso* increases.

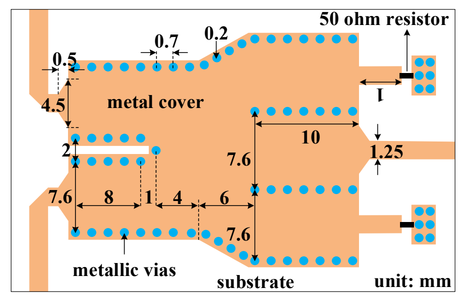

Fig. 1. Configuration of proposed SIW power combiner/divider.

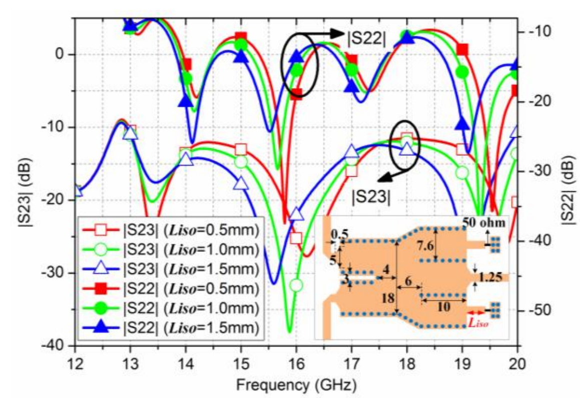

Fig. 2. Simulated output return loss and isolation with varied values of *Liso*.

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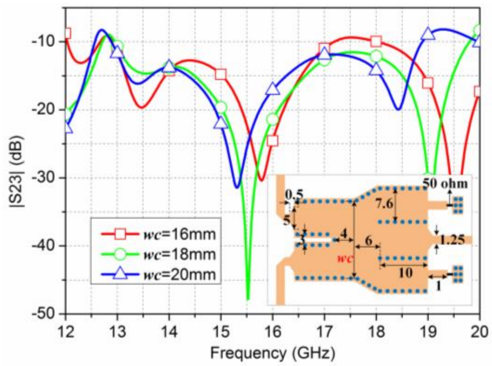
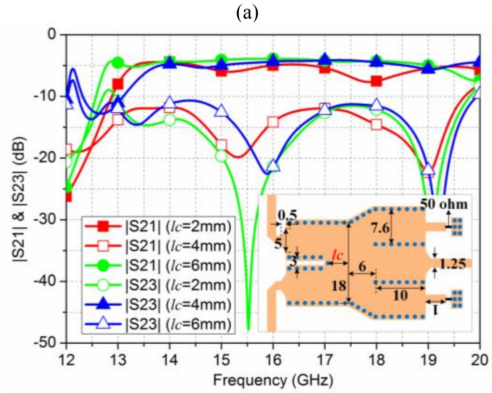


(a)



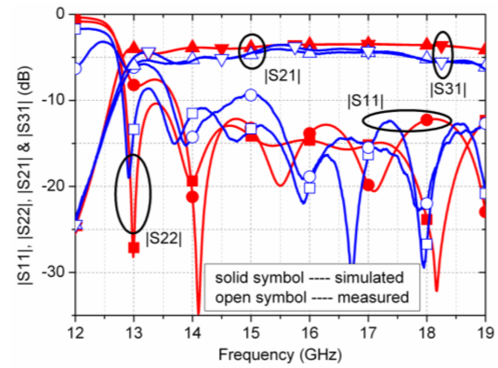
(b)

Fig. 3. Simulated isolation with (a) varied values of *wc*, and (b) varied values of *lc*, with other geometrical parameters shown in the inset.

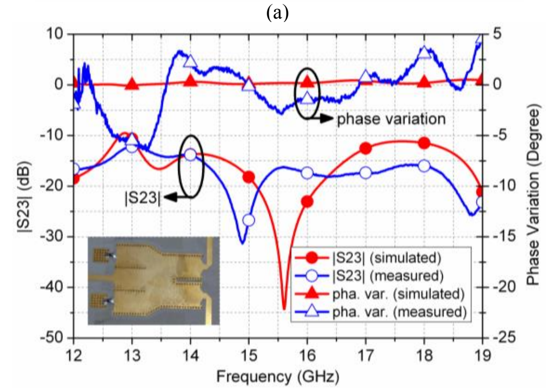
Simulated isolations with varied width and length of the common coupling region are given in Fig. 3 (other geometrical parameters are shown in the insets). It can be obtained from Fig. 3 that both width (*wc*) and length (*lc*) of the coupling region should be proper to optimize isolation. And a proper *lc* is helpful to achieve lower transmission loss. Finally, the power combiner/divider is simulated by using the same simulator mentioned above, with the optimized dimensions shown in Fig. 1.

III. Experimental Results

To prove the practical performance of the proposed power combiner/divider, a RT/duroid 6002 substrate with relative permittivity of 2.94, dielectric loss tangent of 0.0013 and thickness of 0.508mm is used for fabrication. Two 0805 thin film chip resistors are soldered at the isolated ports for termination [8]. Fig. 3 shows comparison between measured and simulated results, with photograph of the fabricated prototype shown in the inset. In the frequency range from 14GHz to 18GHz (FBW=25%), insertion losses are about 4.8±0.5dB. The input return loss is better than 12dB, while the output one is over 9.5dB (most part over 12.5dB). The phase variation is less than ±3 degree over 13.5-19GHz. The measured isolation is better than 16dB from 14GHz to 19GHz, showing better broadband performance than the simulation. The highest value of isolation is over 30dB at 15GHz, about 600MHz lower-shifting and 15dB worse than the simulated one. This is mainly caused by the inaccuracy in soldering of the lumped resistors.



(a)



(b)

Fig. 4. Measured and simulated (a) return losses and insertion losses, and (b) isolation and phase variation.

IV. Conclusions

A resistors-loaded in-phase SIW power combiner/divider with equal-dividing-ratio is implemented and measured. Good performance is captured according to the measured results. A FBW of 25% with isolation over 16dB is achieved. Based on its measurement, the proposed SIW power combiner/divider is promising for array antennas' feeding network applications.

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