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ANALYSIS OF THE CONNECTION SECTION BETWEEN K CONNECTOR AND MICROSTRIP WITH ELECTROMAGNETIC BANDGAP (EBG) STRUCTURE

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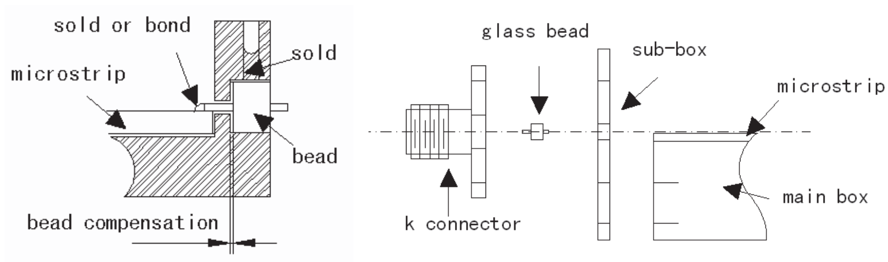
Abstract—For the application of K connector (K103F) at Ka-band, many problems exist, due to the complex method of installation. In this paper, the test fixture is simplified, and the performance of this section is improved with the Electromagnetic bandgap (EBG) structure. Simulation results are presented for the connection structure with EBG; plots of the input reflection of geometrical and physical parameters are reported and commented on.

1. INTRODUCTION

Electromagnetic bandgap (EBG) structures (1), which are also known as photonic bandgap (PBG) structures, have become popular due to their applications for suppression of unwanted electromagnetic mode transmission and radiation in the area of microwave and millimeter waves. Nowadays, The EBG structures are a subject of considerable interest for their important applications from the microwave region to the optical range, such as high-quality resonant cavities, filters, waveguides, planar reflectors and antenna substrates, and more (2-13).

In mm-wave frequency band, some functional modules are realized by plane structure of hybrid integration. And microstrip is the most common transmission line. Sometimes, a system is connected with waveguide by a transition, and the others are by the coaxial line, so K connector is used widely. It can be used from DC to 40 GHZ, but some problems would be arising at Ka-band: the insertion loss is much bigger; the reflection is much worse at some frequency points and the consistency of measurement is not good.

In this paper, the test fixture is modified, in order to simplify the equipment of K connector, and improve the performance of this



(a) (b)

Figure 1. (a) The detail of the test fixture given in the datasheet of Anritsu Company. (b) The method of installation in this paper.

section with the EBG structure.

The method of installation given in the datasheet of Anritsu (14) is showed in Fig. 1(a). The bead is fixed with the test fixture, and the structure of the box is complex, difficult to assemble. In this paper, the box is separated into main box and sub-box, the glass bead is fixed with the sub-box, and then they are fixed on the main box with screws. So we needn't disassemble the bead from box during the measurement. In this way, the proceeding of installation is simplified, and the consistency of measurement is improved.

The information about K connector in the datasheet of Anritsu: in 8 mm-wave frequency band, the reflection coefficient is about −12 dB at some frequency points. So the error of testing would be pulled in. In this paper, the EBG structure is used to improve the reflection coefficient. Firstly, the origin model without the EBG structure is simulated by HFSS. On the substrate Rogers 5880 (the relative permittivity is 2.2 and the height of substrate is 0.254 mm), the width of 50 Ohms microstrip is about 0.76mm. The simulation result is showed in Fig. 2, the reflection coefficient is much worse at the high-side frequency. The simulation results are found to be in good agreement with the measurement results, verifying the proposed configuration is correct.

In the following sections, the one-dimensional (1-D) printed periodic holes and two-dimension on the ground plane are researched separately, and the comparison of these structures is given.

2. SIMULATION AND ANALYSIS

For this application, the performance of this structure is simulated by the electromagnetic simulation software (HFSS). The basic structure

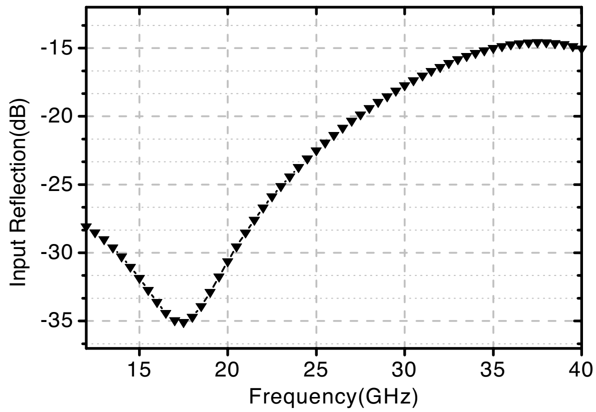


Figure 2. The result of the origin structure.

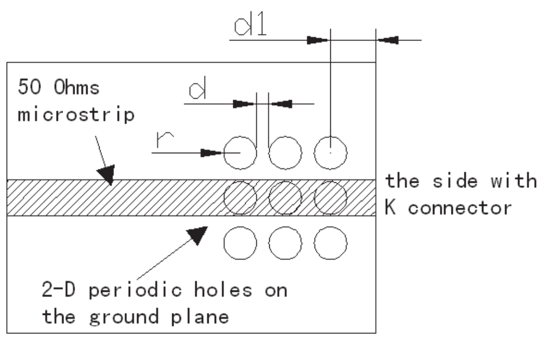
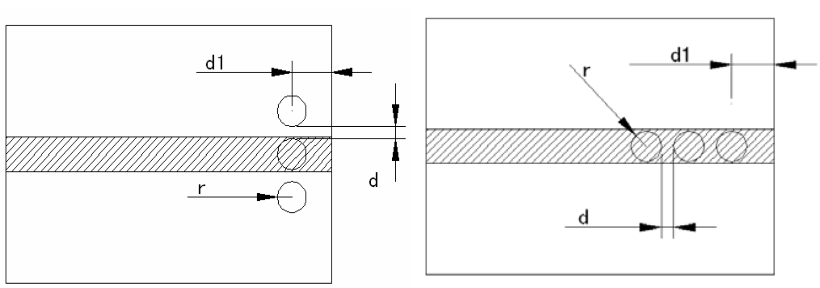
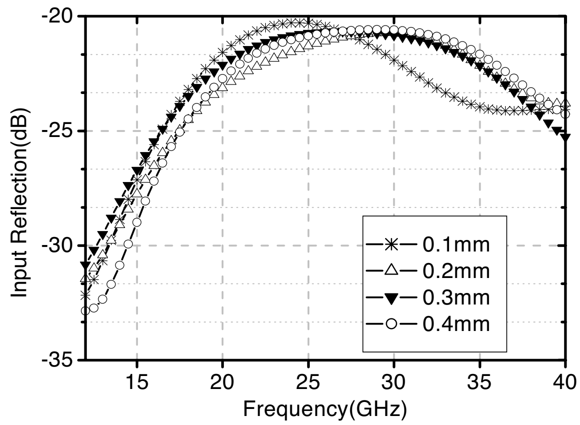


Figure 3. The basic structure of this section with the EBG structure.

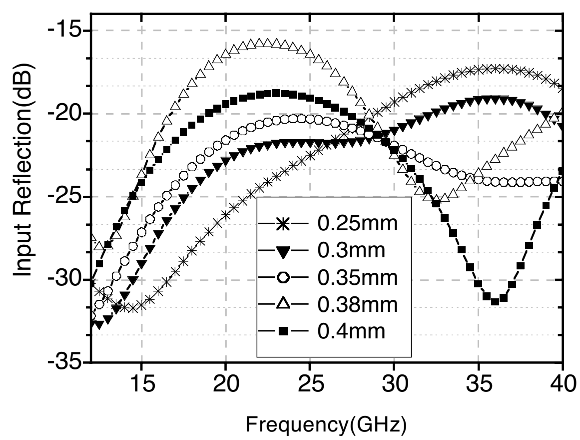


(a) (b)

Figure 4. The connection section with 1-D EBG structure. (a) The holes are vertical to the microstrip; (b) The holes are parallel to the microstrip.



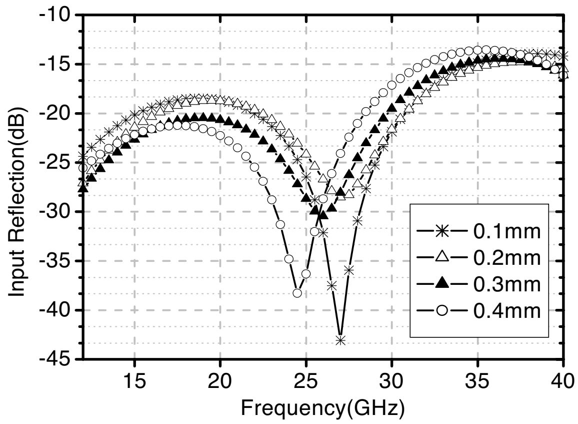
(a)



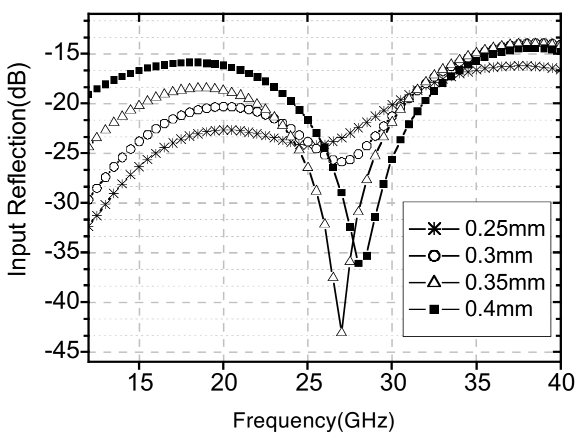
(b)

Figure 5. Full-wave simulations of this structure (the holes are vertical to the microstrip). (a) Different values of d with $r = 0.35$ mm; (b) Different values of r with $d = 0.1$ mm.

of EBG is showed in Figure 4, using the substrate of Rogers 5880, r is the radius of the holes and d is the distance between the holes. Where $d1 = 0.2$ mm, the width of microstrip is 0.76 mm, simulate the magnitude of S_{11} for different values of r and d.



(a)



(b)

Figure 6. Full-wave simulations of this structure (the holes are parallel to the microstrip). (a) Different values of d with $r = 0.35\,\text{mm}$; (b) Different values of r with $d = 0.1\,\text{mm}$.

2.1. 1D EBG Structure

For the 1D EBG structure, three holes are etched on the ground plane. And change the electromagnetic field's distribution in the substrate, to improve the performance of this structure in 8mm-wave frequency band.

The first case study is the holes are vertical to the microstrip, as shown in Fig. 4(a).

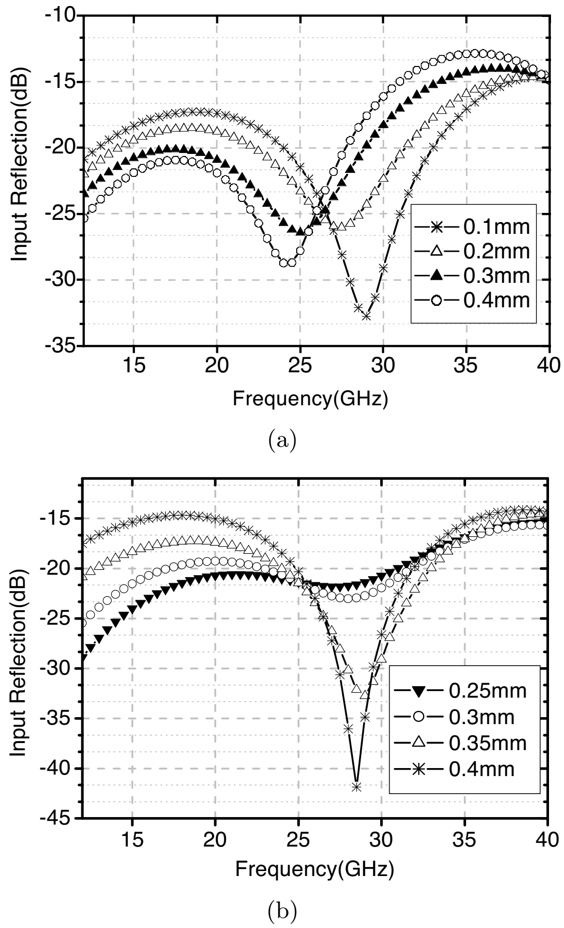


Figure 7. Full-wave simulations of this structure (2-D EBG structure). (a) Different values of d with $r = 0.35\,\text{mm}$; (b) Different values of r with $d = 0.1\,\text{mm}$.

This structure is simulated with HFSS. Firstly, let $r = 0.35\,\text{mm}$, and adjust d from 0.1 mm to 0.4 mm, the results are shown in Fig. 5(a), it can be show that they have little difference, it means that the holes of the two sides have little effect here, the hole just under the main transmission line has the main influence for the performance of this section. And we can get a much better input reflection by adjusting the value of r at Ka band.

Then, let $d = 0.1\,\text{mm}$, r is varied from 0.25 mm to 0.4 mm. The results are shown in Fig. 5(b). It shows that we can improve the reflection by change the value of r in the frequency band of K, Ka respectively.

The second case study is the holes are parallel to the microstrip, as showed in Fig. 4(b). In the same way, we also get two plots, as showed in Figs. 6(a), (b). The same conclusion can be made as the first case. As we all know, the electromagnetic field scatter under the strip, so the holes under the strip is much more sensitively than others.

2.2. 2-D EBG Structure

For 2-D EBG structure, the simulation model is show in Fig. 2(b). We can get two plots in the same way, as showed in Figs. 7(a), (b). The center frequency is adjusted by changing the value of d. These two plots are similar with Fig. 6. The reason is the holes of two sides have little effect to the whole structure, just be same with the first case of 1-D.

3. CONCLUSION

In this paper, for the application of K connector at Ka band, two ways are given to improve the performance of this connecting structure. Firstly, the test fixture is separated into main box and sub-box, the bead is welded with the sub-box, and then fixed on the main box with screws. In this way, the test fixture is simplified, and changing the substrate is realized without disassembling the bead from box. So the consistency of measurement is improved.

The second way is base on the EBG structure. The simulation results given in the paper show that the performance is improved with the EBG structure, and a much better reflection coefficient is got by adjusting the value of r and d at one special frequency band needed.

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