Extended Abstracts of the 2007 International Conference on Solid State Devices and Materials, Tsukuba, 2007, pp. 500-501

P-5-11

A Compact Balanced Filter on Thin Film Substrate for mmWave application

Chan-Sei Yoo[1,2], Ji-Min Maeng[1], Sang-Sub Song[1], Hee-Seok Lee[3], Woo-Sung Lee[2], Nam-Kee Kang[2], and Kwang-Seok Seo[1]

[1]Seoul National University. School of Electrical Engineering and Computer Science
San 56-1 Shillim-dong, Kwanak-gu, Seoul 151-742, Korea
[2]Electronic Materials & Packaging Research Center, Korea Electronict Technology Institute
#68 Yatap-dong, Bundang-gu, Seongnam-sei, Gyeonggi-do 463-816, Korea
Phone: +82-31-789-7217 E-mail: ychs@keti.re.kr
[3]Interconnect Product & Technology System LSI Division, Samsung Electronics CO., LTD.
San #24 Nongseo-ri, Giheung-eup, Yongin-si, Gyeonggi-do 449-711, Korea

1. Introduction

Recently, the demand for broadband microwave and millimeter wave communication systems has been rapidly increasing. Especially, 60 GHz band frequency resources are being allocated on a global basis for short-range applications such as wireless local area network, wireless home link and intelligent transport systems[1]. Keeping pace with this trend, many kinds of researches on passives for 60 GHz band are being performed vigorously like in [2].

In this work, the novel balanced filter structure was suggested. The balanced filter consists of band pass filter and balun for power dividing and phase shifting. And the suggested balanced filter was evaluated on Si substrate by the thin film technology(MCM-D), so that can be integrated with the active chipset by using BEOL(Back end of line) process

2. Fabrication

Fig. 1 shows the cross section of MCM-D substrate used for the evaluation for the suggested balanced filter circuit, which consists of lossy silicon substrate, two benzocyclobutene(BCB) layers, three Au-metal layers and silicon bumps for power and heat handling. Especially, by using the ground bumps, the connections from top layer to ground plane were realized effectively without high aspect ratio vias. In the system evaluation using the suggested substrate, the active chipset can be attached on the ground bumps by BGA for flip-chip technology.

3. Band Pass Filter Design

In the design of band pass filter, the 2nd order circuit with J-inverter was used[3]. For the evaluation of the parallel resonant tank circuit, just one transmission line which was terminated to ground in one side and open ended with loading capacitor in other side. The circuit and structure are shown in Fig. 2 and Fig. 3 respectively. The length of the resonator can be reduced below quarter wave length and the operating frequency can be adjusted easily by controlling the size of the loading capacitors. The response of the suggested filter is shown in Fig. 4. The insertion loss is 1.6 dB in passband(55~64 GHz) and the return loss is larger than 20 dB. The resulting size is 0.7 x 0.3 mm^2.

4. BALUN Design

The balun is a passive device that converts balanced signal to unbalanced one and vice versa. Which means that the power of the unbalanced signal should be divided by half and the phase difference between balanced signals be 180°. In this work, the lumped parameterized circuit was used instead of distributed one to minimize the dimension of balun[4]. The suggested circuit and structure are shown in Fig. 5 and Fig. 6, respectively. The dimension of balun can be reduced by using lumped components, the resulting size is 0.3 x 0.6 mm^2. The measure response is shown in Fig. 7. The insertion loss is 0.5 dB and phase difference is 178.5°.

5. Balanced Filter Design

The balanced filter was evaluated by connecting the band pass filter and the balun effectively as shown in Fig. 8. The power imbalance and the phase imbalance are ± 1 dB, and ± 1° in passband(55~64 GHz), respectively. The dimension of the evaluated balanced filter is 0.7 x 0.9 mm^2.

The response of the balanced filter is shown in Fig. 9.

6. Conclusions

The balanced filter that consists of band pass filter and balun was suggested and realized on thin film substrate by MCM-D technology. The power imbalance and the phase imbalance are ± 1 dB, and ± 1° in passband(55~64 GHz), respectively. The dimension of the evaluated balanced filter is 0.7 x 0.9 mm^2. The suggested balanced filter can be integrated with the active chipset by using BEOL process.

References

[1] K. TAKAHASHI et al., IEICE Trans. Electron Vol. E84-C. No. 10 (2001) p1506.
[2] Y. SATO et al., IEICE Trans. Electron Vol. E86-C. No. 8 (2003) p1621.
[3] C. Yoo et al., European Microwave Conf. Proceeding (2006) p114.
[4] D. Lew et al., Microwave Symposium Digest (1999) p1893.

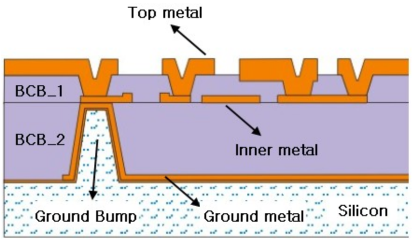


Fig. 1　Cross-section of MCM-D Substrate

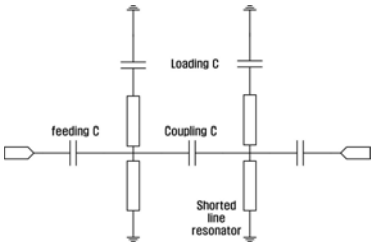


Fig. 2.　The Circuit of the suggested band pass filter

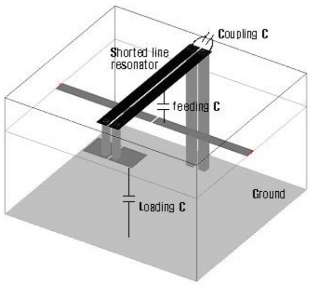


Fig. 3.　The Structure of the suggested band pass filter

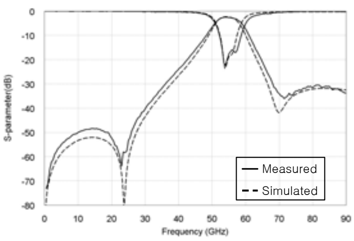


Fig. 4.　The Response of the suggested band pass filter

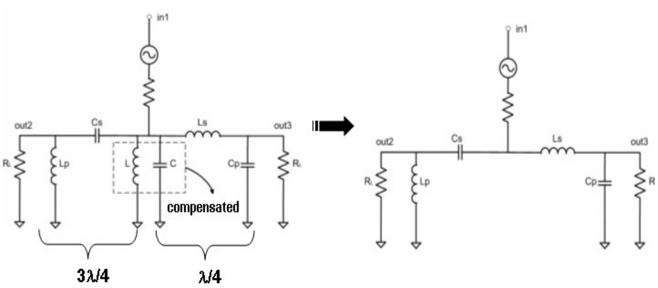


Fig. 5.　The Circuit of the suggested balun

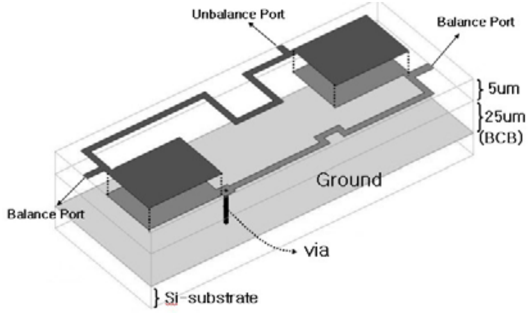
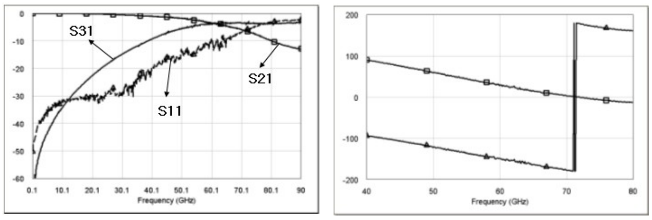


Fig. 6.　The Structure of the suggested balun



(a) Power　　　　　　　　　　(b) Phase

Fig. 7.　The Measured Response of balun

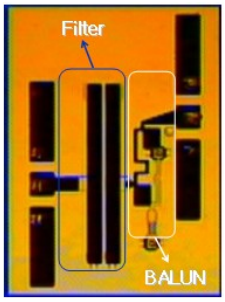
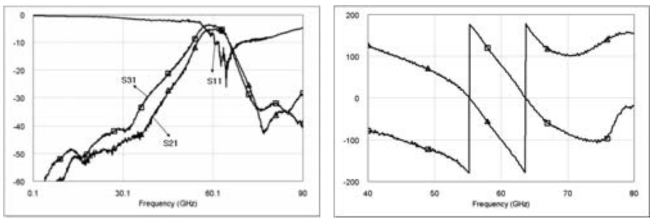


Fig. 8.　The actual shape of the suggested balanced filter



(a) Power　　　　　　　　　　(b) Phase

Fig. 9.　The Measured Response of balanced filter