Crossing Transmission Line Modeling Using Two-port Measurements

Korkut Kaan Tokgoz, Lim Kimsrun, Seitarou Kawai, Kenichi Okada and Akira Matsuzawa

Tokyo Institute of Technology, Department of Physical Electronics
2-12-1-S3-27, Oookayama, Meguro-ku, Tokyo, 152-8552, Japan, E-mail: korkut@ssc.pe.titech.ac.jp

1. Introduction

CMOS technology is the best candidate for the unlicensed band at 60 GHz frequency [1]. A CMOS TRX to work thoroughly at these frequencies, one should have well-known device models beforehand, some of which have more than two-ports. Unfortunately, four-port measurements up to 110 GHz, dynamic range values are small, which affects the accuracies [2]; thus four-port device modeling would be a hard task. Having in mind on these issues, in this work, a crossing transmission line (TL), a four-port device, is modeled using two-port measurement data.

2. Structure and Method

The crossing TL structure is too small for measurement without crosstalk. Hence, four Test Element Groups (TEGs) are constructed each of which having six crossing TLs with two different orientations having two ports of each terminated with known loads as open circuited and short circuited TLs, and for the other two ports TLs added between them (Fig. 1). It is important to note that all TLs other than crossing TL have already been characterized [3]. TEGs are manufactured with 65 nm CMOS process. For the model construction, two measurement results are used at the same time from two different TEGs, shown in Fig. 1(a), and (b), respectively. For verification, measurements of TEGs, shown in Fig. 1(c), and (d), are compared with the extracted model.

3. Results and Lumped Equivalent Model

The lumped equivalent model of crossings is, also presented in Fig. 1. The values of the lumped components are optimized and the results are given in Table 1. The magnitude and phase comparisons of S_{21} for model and measurements are provided in Fig. 2(a)-(b) for the model extraction stage comparisons and Fig. 2(c)-(d) for the verification stage comparisons. One can observe that the model results are well matched up to 110 GHz.

4. Conclusion

An approach to model a four-port device with two-port measurements is presented. The results for both model extractions and verification cases are well matched up to 110 GHz.

TABLE 1: LUMPED COMPONENT VALUES FOR MODEL

L_{UP}	2.86 pH	L_{LW}	2.13 pH	C_1	2.05 fF
R_{UP}	0.18 Ω	R_{LW}	0.27 Ω	C_2	0.05 fF
C_{UP}	105 fF	C_{LW}	175 fF	C_{COUP}	1.64 fF

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References

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[2]Agilent Technologies, Network Analyzers' Data Sheets http://www.home.agilent.com/agilent/, *Last visited: 2013.05.11*

[3] N. Li, *et al., IEICE,* 2010, p. 431

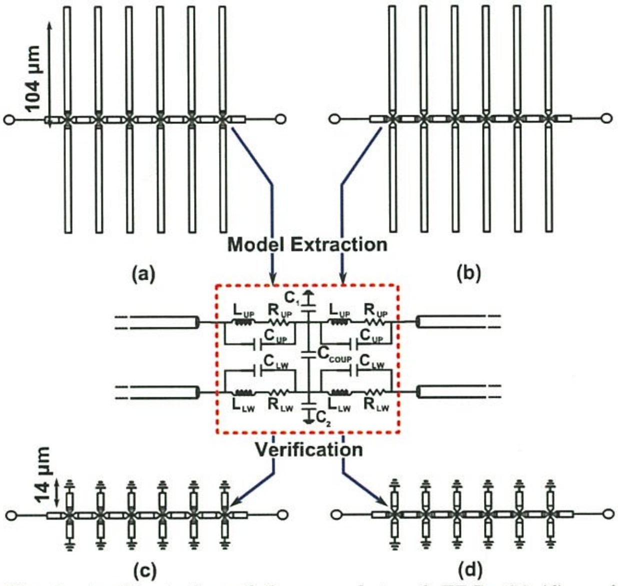

Fig. 1. An illustration of the manufactured TEGs (a)-(d), and crossing TL model extraction and validation flow, and the lumped equivalent model of the crossings (middle).

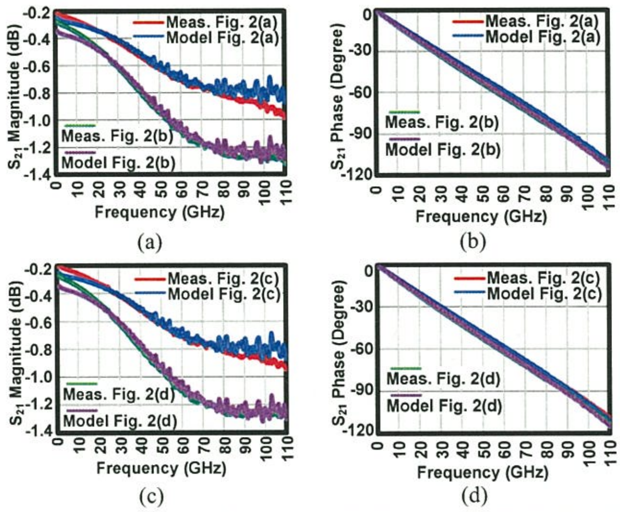

Fig. 2. S_{21} comparison between measurements and extracted models for four different TEGs used for model extraction (a), (b) and verification (c), (d).