A New Methodology to Enable Parameterized Cell Transfer between Microwave CADs

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ABSTRACT—This paper presents a new methodology which provides easy layout data compatibility between microwave CADs (mw-CADs) or between an mw-CAD and a mask design CAD. With storing all parameters for representing parameterized cell (p-cell) into pattern- or attribute-text areas on GDS-II format, the methodology enables easy data transfer including p-cells between commercial mw-CADs, and promises time-saving design cycles for MMICs.

I. Introduction

Increasing demand for microwave applications including portable handsets, wireless access terminals, satellite communications, and collision avoidance automotive radar systems has driven the development of microwave CAD (mw-CAD) systems. In a recent commercial mw-CAD, a layout editor in addition to a microwave simulator is usually included as can be seen in Refs. [1]-[3]. Unlike a Si-LSI based CAD system, an mw-CAD is required to possess functions peculiar to microwave analog IC designs. These functions include the following.

(1) Pattern layout in consideration of EM interference
Given the significant affects of pattern layout to microwave IC performance due to EM (electro-magnetic) interference, mw-CAD systems must be provided with a pattern layout function in consideration of EM effects between interconnects in ICs. However, commercially available mw-CAD systems are not suitable because of their insufficient data handling capability and lack of extensibility to accommodate user-customized programs enabling design with EM effects.

(2) Data-conversion from pattern layout to photo mask data
Most mw-CAD systems lack the linkage between an mw-

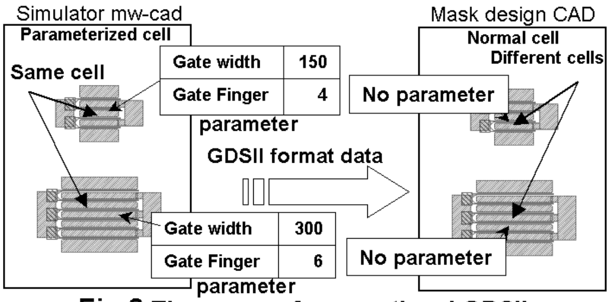

Fig.2 The usage of conventional GDSII

CAD and a mask design CAD like Cadence^{TM} Virtuoso. As a result of this, designers have been forced to conduct the time-consuming procedure shown in Fig. 1. After completing electrical design including rough pattern layout on a commercially available mw-CAD system, designers need to take the trouble to recreating photo-mask pat-

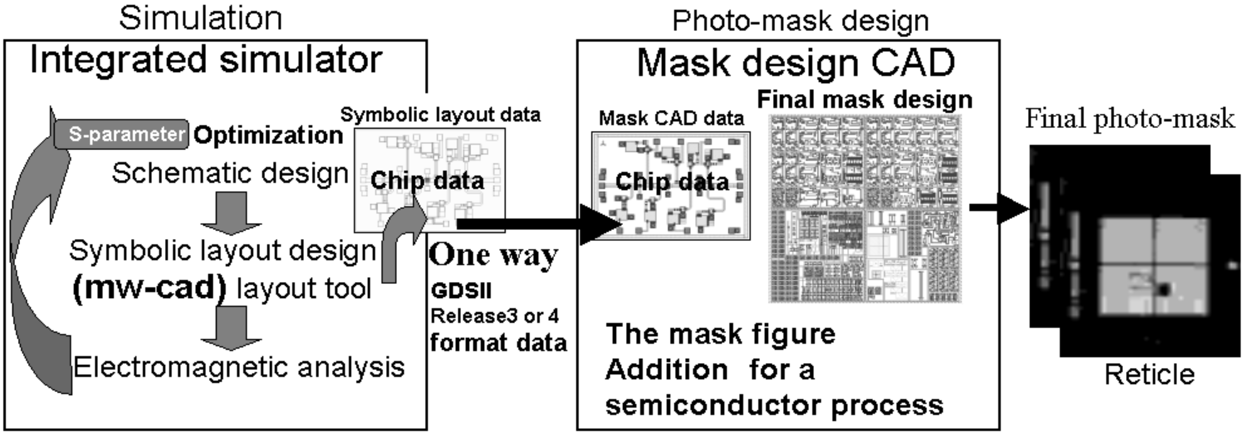

Fig.1 Conventional MMIC design flow

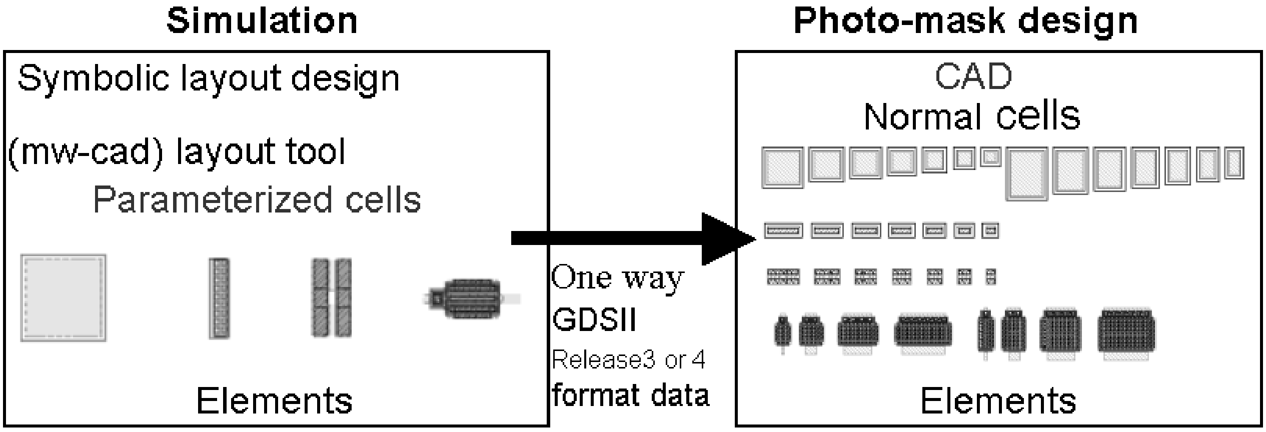

Fig.3 Conventional usage of GDSII

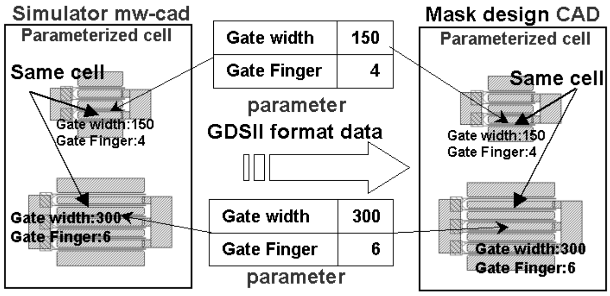

Fig.4 The usage of conventional GDSII

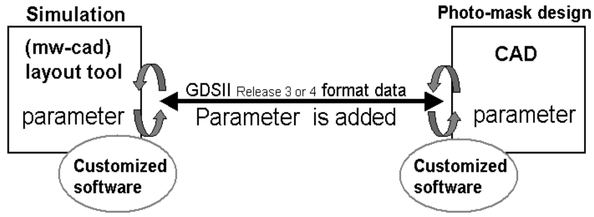

Fig.5 This work system architecture

tern layout on a Si-based mask design CAD.

There is another difficulty arising from the lack of this data conversion. That is unavailability of p-cells (parameterized cells) data transfer when using widely used GDS-II. In the data transfer from mw-CAD to a photo-mask CAD, only GDS-II formatted figure information, not including p-cells, is transferred from a commercial mw-CAD to a mask design CAD (see Fig.2). Figure 3 shows an example of disadvantages for traditional MMIC design data conversion from the mw-CAD and the mask design CAD. The unavailability of p-cells has given enormous burden on designers and also caused inefficiency in designing microwave circuits. This paper is to present easy-to-conduct, considerably effective solutions for the above problems in mw-CAD systems.

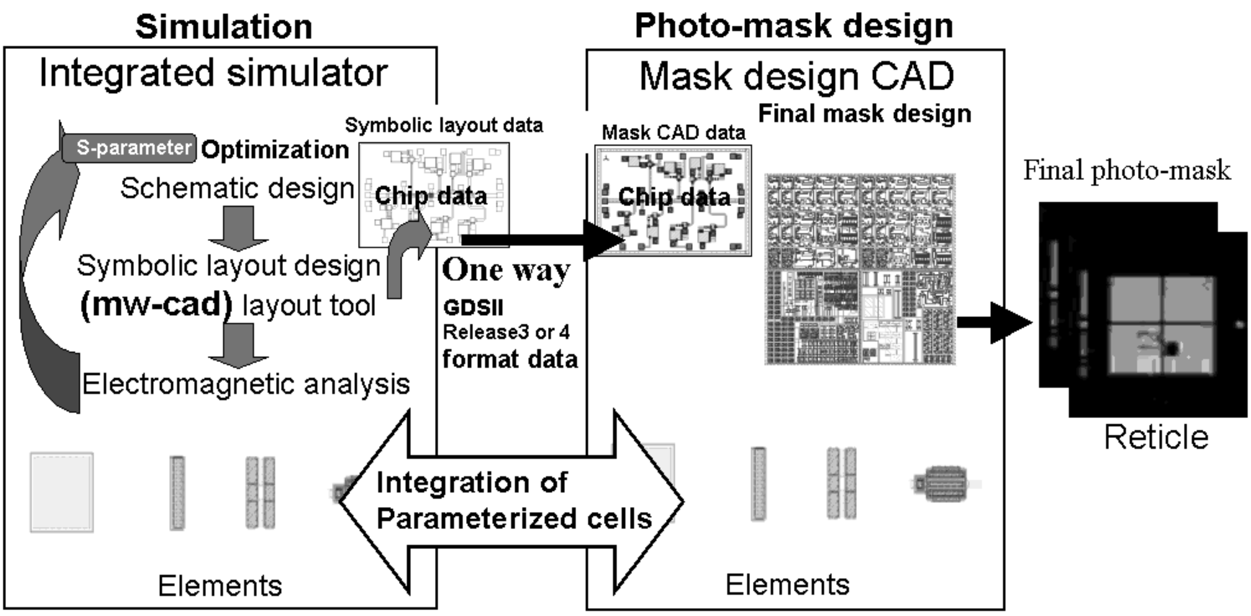

Fig.6 This work MMIC design flow

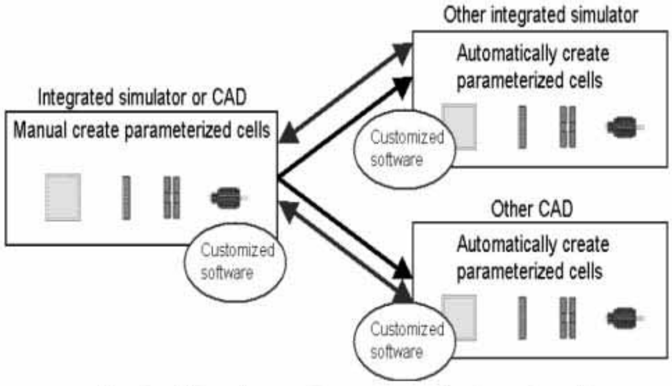

Fig.7 Sharing of parameterized cells

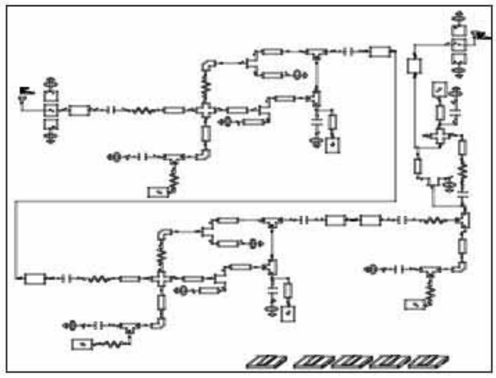

Fig.8 X-Band LNA schematic

II. Proposed Methodology

To address the technical issues mentioned in the previous section, we have proposed a new methodology, which provides easy layout data compatibility between mw-CADs or between an mw-CAD and a mask design CAD. This methodology features the utilization of pattern- or attribute-text data area in GDS-II format in order to enable the p-cell data transfer between the mw-CADs or between the mw-CAD and mask design CAD, as shown in Fig 4. These text data areas (2048 characters / element) are large enough to store parameters necessary for representing p-cells. This way of storing parameter information of the p-cells in these data areas makes the p-cell data transfer possible while using traditional GDS-II format data [4]. All needed to translate the p-cell data into the mw-CAD or mask design CAD is to make small translation programs, as shown in Fig 5, either by designers or mw-CAD vendors.

Figure 6 shows the new MMIC design flow with our proposed methodology. By transferring p-cell parameters together with GDS-II format layout data, the p-cell information can be transferred bi-directionally between the mw-CADs and mask design CAD via the translation programs customized on the mw-CADs and mask design CAD. As can be seen in Fig. 7, electrical design including p-cell layout on the mw-CAD leads to easy translation from layout design on the mw-CAD to that on the mask design CAD. The p-cell transfer also gives us an easy management for basic cells, because each basic cell is commonly used in various CADs. Consequently, a design cycle from electrical design to tape-out is shortened outstandingly. Moreover, the proposed methodology allows the designers to simulate and draw a circuit schematic and its layout data on several different kinds of commercial mw-CADs, because a common p-cell can be used on mw-CADs. Hence, the designers can change the mw-CADs easily according to their purpose of the simulations: S-parameter simulation, harmonic balance simulation, sys-

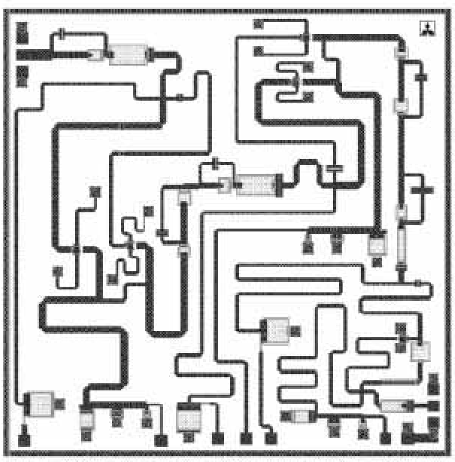

Fig.9 X-Band mw-cad layout

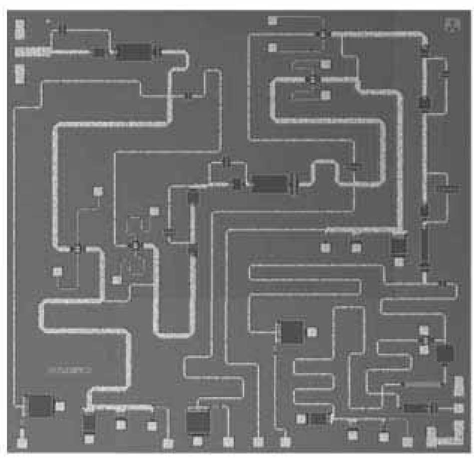

Fig.10 X-Band LNA chip microphotograph

tem simulation, electromagnetic field simulation, and so on. Our proposed methodology enables easy data transfer including p-cells providing drastically shorter design cycles for microwave circuit designs. This method can be applied to any kind of CAD because the programs utilize only built-in functions disclosed by CAD system vendors.

III. Application of Proposed Methodology to MMIC fabrication

To verify the effectiveness of our proposed methodology, we customized a commercial mw-CAD and a mask design CAD and then designed and fabricated an broadband LNA MMIC. Microwave Office^{TM} (MW Office) was chosen as an mw-CAD, and Cadence Virtuoso^{TM} as a layout editor for mask data. A p-cell translation program was added to MW-Office in corporation with AWR, Inc, then we added a p-cell translation program written in Skill^{TM} language to Virtuoso. Figures. 8 and 9 show the LNA schematic and its layout. In electrical design including p-cell layout design, S parameter and electromagnetic field analysis was implemented to satisfy the target specification on the mw-CADs. The chip microphotograph and main electrical characteristics are shown in Figs. 10 and 11. Figure 12 shows the X -band LNA reticle mask layout.

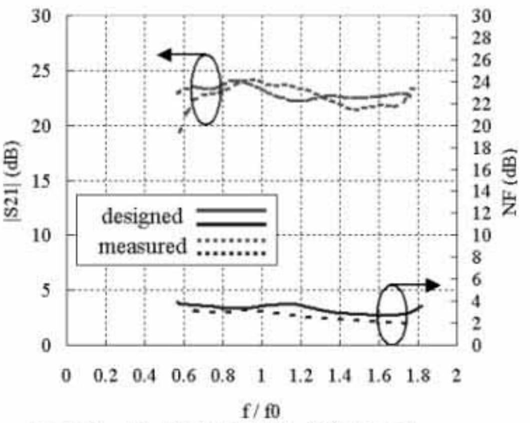

Fig.11 X-Band LNA S21 and noise figure

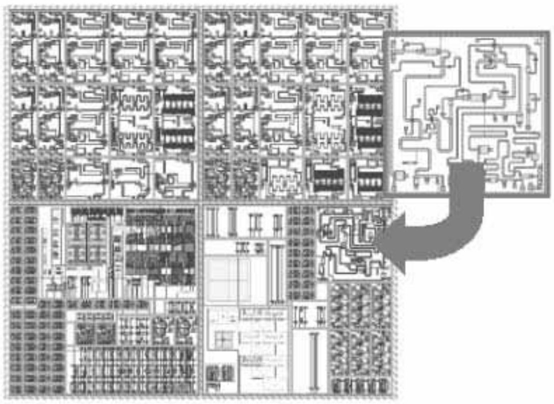

Fig.12 X-Band LNA reticle mask layout

Thanks to the proposed methodology, it took about one week, a half of traditional design cycle, to complete this design including mask layout.

IV. Conclusion

We have demonstrated the new methodology which provides easy layout data compatibility between mw-CADs or between an mw-CAD and a mask design CAD. By storing p-cell parameters into pattern- or attribute- text areas on GDS-II format, the proposed methodology enables easy data transfer including p-cells between commercial mw-CADs, and promises time-saving design cycles for MMICs.

References

[1] Ansoft Corporation Serenade8.71 User manual.
[2] Applied Wave Research, Inc. Microwave office 5.53 User manual.
[3] Cadence Design Systems, Inc. IC Tools – Release4.3.4 Design Framework II User manual.
[4] US patent, pending.