THE PMOS REFERENCE LIBRARY
FOR THE RIT CALMA CAD SYSTEM

by

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ABSTRACT

A reference library of PMOS structures was created on the Calma CAD system. The library contains NAND, NOR, Inverter, alignment marks, and contact pads. The referrence library may be accessed by the users of the system to assist them with their design projects. The cells have been previously studied and fabricated at RIT's department of microelectronic engineering [1].

INTRODUCTION

A Calma GDS II system is an interactive graphics design system developed specifically to handle input, manipulation, checking, and output of very large scale integrated masks. The system uses a 32-bit minicomputer by Data General, called Eclipse, as its basis of operation. The computer features memory mapping and floating point unit, giving fast response and high system throughput in computational applications. The system also features a 300-megabyte disk storage module for the drawings [2]. These and some other features of the system, such as the on-screen menus, make Calma an ideal tool for the design layouts of chips and complicated circuits of 300 or more components.

The software package currently used for creating layouts is called Integrated Circuit Editor (ICE.) Ice resides on RIT's VAX system and is accessed through graphics terminals on a time sharing basis. It is a relatively easy tool to learn. Students who are first introduced to circuit design and layout, might find ICE an ideal layout tool. The Microelectronics department plans on continuing the use of ICE as the layout tool for cases where large number of users are involved and cases where the project size is small. However, for cases where designs are more complicated and the number of components is large, the use of ICE becomes impractical. For such cases, Calma GDS II provides a faster and easier design technique.

A reference library of structures can provide the users of the system with standard cells that they are able to use in their designs. By choosing to do so, the designer will be saving himself time in working toward his complex design,

without having to start from scratch.

One well established technology is 10 micron PMOS using projection alignment and silver halide masks. In the microelectronics industry, NMOS technology is common because the greater mobility of electrons permits smaller channels and higher frequency response. However, PMOS rather than NMOS, is used at RIT because of the undesired contribution of the non ideal factors involved in processing of our circuits. This causes a negative shift in the threshold voltage of a transistor. In the case of an enhancement mode NMOS, the shift causes the threshold voltage of the transistor to be negative. This is similar to depletion mode NMOS with Vt<0, where a negative voltage is needed in order to turn off the device. Therefore, the NMOS transistors fabricated at RIT are already on at zero applied potential. The fact that an ideal PMOS transistor has a negative threshold voltage makes the contribution of the negative shift less significant (the polarity does not change.) [3,4]

A PMOS reference library on the Calma system was created in order to initiate the use of Calma as a layout tool. The reference library contains the simple logic gates--i.e. Inverter, NOR and NAND gates--necessary for the creation of PMOS digital circuits. Other logic gates and devices can be created by combining these units in specific arrangements. For instance, an AND gate is created by connecting an inverter to the output of a NAND gate. Similar approach is taken in the creation of logic gates such as NORs and ORs. Multiplexors, decoders, and counters, just to name a few, can be created through metalization patterning of arrays of logic gates.

Also included in the reference library are contact pads and alignment marks. Alignment marks ensure the correct alignment of production masks. Contact pads provide for easy access of ports for testing purposes.

EXPERIMENT

The GDS II "self-study course" by Calma [5] provided information necessary for learning to operate the system. Seven tapes and the manual for the GDS II introduced the commands and the system functions that were needed for this project.

The PMOS cells created for the Calma reference library have been previously simulated and characterized by Robert Pearson [1]. The width-to-length ratios of each transistor involved in the designs of the gates previously mentioned are discussed by Mr. Pearson, and their significance in the rise and fall time of the signals are mentioned.

In all designs, the minimal 10-micron design rules were observed [6]. In addition, the size of the logic gates were kept about the same for all of them so that they can be easily placed in the designers' arrangements. Power and ground terminals are made available at the top and bottom of the cells, and the input and output terminals are provided at the sides of the cells.

RESULTS / DISCUSSION

The collection of structures in the PMOS reference library consists of a saturated enhancement mode load inverter, Nor and Nand gates, alignment marks for all four layers--diffusion, thin oxide, contact cuts, metal,--and two versions of contact pads for chips of 1900 x 1900 um2 size. The schematic and layouts of these structures are shown on the following page.

A designer may use the contents of the library by attaching the reference library to his personal library. To do so, he would issue the following commands

	OPENREF1 <CR>
computer will respond	REFERENCE LIBRARY 1 NAME:
the user responds	PMOSLIB <CR>

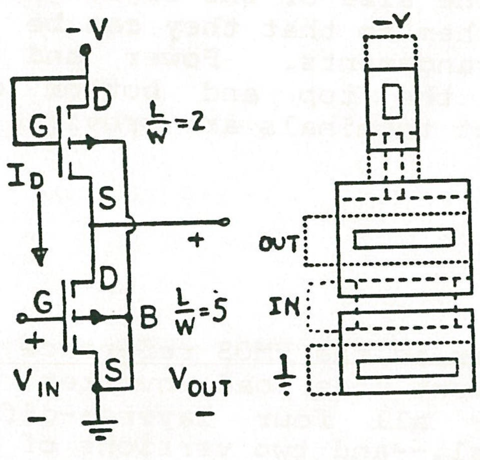
Once the reference library is attached,the designer may use the contents of the library from his own personal directory without having to permanently store its contents.

Upon completion of work, the designer may detach the reference library from his personal library by entering the command OPENREF1 one more time with no name attached and hitting the carriage return.

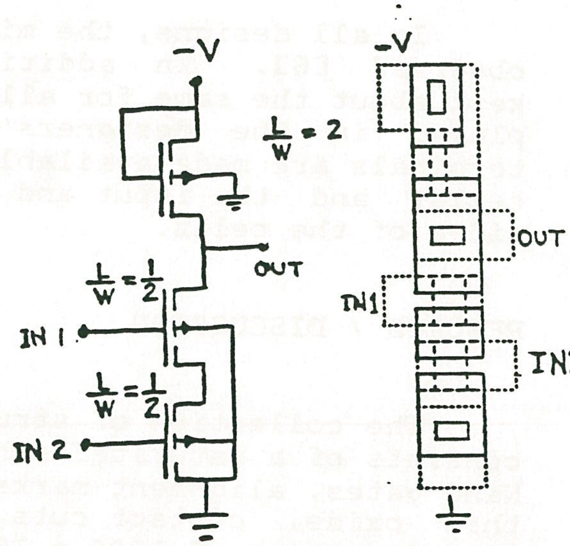
In order to keep consistant with the designs of the PMOS library, the designer should assign the following layers to the four corresponding PMOS layers:

Diffusion:	Layer #1
Thin Oxide:	Layer #2
Contact cuts:	Layer #3
Metal:	Layer #4

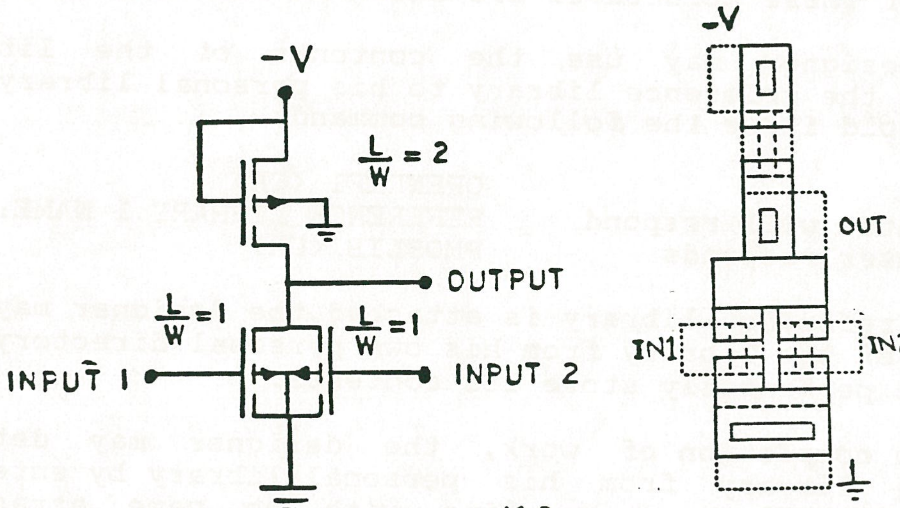
The user must be aware that unless specified by him, the system will automatically assign "0" to the layer number. Colors and shadings may be assigned to each layer according to the designer's preferences. These, unlike the layer number identifications, are not permenant and may be changed at any time without effecting the compatability of the two libraries--the personal and the reference libraries.



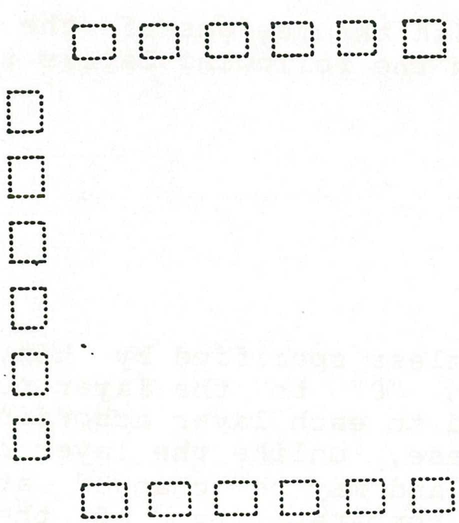
INVERTER



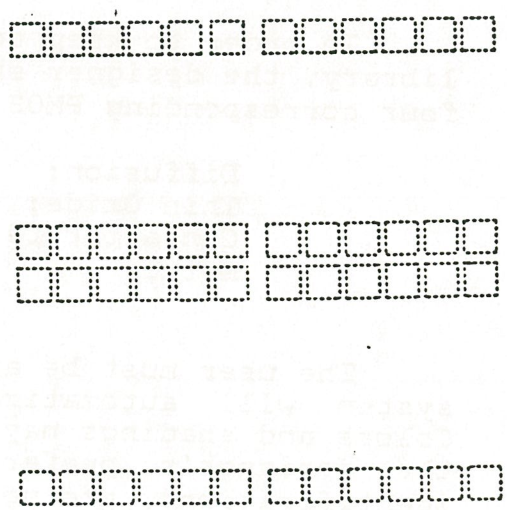
NAND



NOR



"PADS"



"DOUBLEPADS"

The user of the reference library also has the flexibility of modifying the overall size of a structure to fit his needs. Calma allows for the magnification of the structures without changing the proportions of the individual elements with respect to one another. For more information on this topic, the reder may refer to the revised version of the user manual by J. F. Wenzel [7].

CONCLUSIONS

The creation of the PMOS reference library on the Calma system gives the department of microelectronic engineering a starting point for using Calma as alayout tool. The elements believed to be most essential for a library of this type were created. However, this does not mean that the collection is complete. Future design work can be performed to increase the contents of this library to include more complex structures.

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REFERENCES

1. "PMOS Digital Structures," Robert Pearson, May 1986.
2. "Calma CHIPS GDS II Product Specification," release 4.0, 1982.
3. Robert Pearson, Microelectronics lecture notes, Summer quarter 1986.
4. David Pearlman, Electronics II lecture notes (revised edition,) May 1985.
5. "The GDS II self-study course" by Calma.
6. ICE user manual, compiled by the RIT microelectronic department, 1985.
7. "Calma System CAD user Manual," J. F. Wenzel, Senior Research Project, Nov. 22 1986.