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IC MASK DESIGN USING MICROCOMPUTERS

The problems of the custom designed integrated circuits are described. The possibility to design the integrated circuits using popular microcomputers is shown. Four versions of the computer aided programs for IC mask design are presented. Using those programs it is possible to design integrated circuits at the other places than IC producer. In this case the data ready to control pattern generator are prepared off site.

1. INTRODUCTION

Progress in IC technology allows for the fabrication of a custom designed integrated circuit. The number of specialized engineers for IC design is very limited and significant grow in the number of new integrated circuits is possible only when all electronic engineers will have access to the IC design facilities. With the fixed technology process the different mask set is the only various input for different integrated circuits. Those mask are produced by pattern generator controlled by computer. Therefore practically in order to design and produce new integrated circuit it is necessary to supply the IC producer with proper data to generate mask set. This task can be performed at any place if there are an access to the computer and to the proper software. The main purpose of this work was to investigate possibility of use microcomputers to design integrated circuits by customers.

2. CHARACTERIZATION OF CUSTOM DESIGNED INTEGRATED CIRCUITS

There are few approaches for custom designed integrated circuits. Most of them are based on the principle that various specialized integrated circuit can be fabricated by changes of the last metalization process only. In this process it is possible to connect all elements of the circuit accordingly to the customer demand. This approach is standard in custom designed analog IC and also in one approach for digital IC known as "gate array". It should be underlined that design process is aided very much with a computer. To design

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specialized integrated circuit usually it is not necessary to proceed the design process on the lowest level, where circurt should be build of single transistors in custom analog IC, or to be build of the single gate in case of "gate array" approach. Practically the IC design is limited to system construction from large blocks. In case of custom designed analog IC the ready subcircuits can be taken from computer memory and placed on the transistor-resistor array. In case of digital IC from computer library the predesigned digital subcircuits are taken where many basic gates exist. In above examples the only last metalization process is different from one circuit to the other. The information which has to be stored in the computer memory about predesigned subcircuits is related to the last interconnection layer. This approach for the custom designed IC has few drawbacks. One is that surface of the chip is not use very efficiently, other are the longer connection and higher parasitics.

Other approach for custom designed IC is known as "standard cell". In this case the subcircuits are optimally predesigned in shape of rectangulars with the same width. Much better results can be achieved because designer is not restricted to the last layer and he is free to design all integrated subcircuit structure. Process of custom design is therefore limited to proper placement rectangular subcircuits in columns on the chip and to interconnect each other. Rest of the designing task is carried on by the computer which use subcircuit data with information about all mask levels. Standard cell approach require therefore more computer power than the approach described previously.

Host complex approach is the fully custom designed integrated circuit. In this case surface of the chip can be use optimally. Of course the designer may use library of subcircuits, but he can place this subcircuit in any point on the chip. Also he is free to route the connection. This approach require more time but better results can be obtained. In this paper the possibility of using microcomputer for fully custom IC designed is discussed.

3. HICROCOMPUTER PROGRAHS FOR IC HASK DESIGH

Computing power of the microcomputers increases rapidly in recent years. Additional advantage of microcomputers is its graphics ability. Also it is possible to realize hard copies with graphics printers. Two best known computers systems were considered: 8-bit microcomputers working under CPH and 16-bit microcomputers working under HS DOS.

In case of the CPH most of the computers do not have the screen graphics ability and the design pattern has to be send frequently to the printer. Some CPH microcomputers as Amstrad or Kaypro 10 have high resolution graphics. The other disadvantage of 8-bit computers is the limitation of direct memory access to 64 kB only. Developed program HASK for CPH systems allows to design integrated circuits with 350 rectangular mask patterns. Using RAM-disk the size of the designed

circuit can be much large, and it may consist up to 4000 rectangular patterns. This is possible with advanced overlay programing structure. Program allows to insert the circuit fragments from the disk libraries, also simple transformations are possible. Version of the HASK program for 16-bit computers has been also developed. This version is much more friendly because fragments of the designed circuits can be observed on the screen. In the new HASK2 program developed in OBREUS by A.Petrykowski the circuit data can be entered to the program both by numbers form keyboard and by the moving cursor on the screen. Host advanced program PED developed by Sz.Skup and B.Wilamowski has advanced graphics and it allows inserting, deleting and moving patterns between screen and library. Also various type of transformations and scaling are possible. Hard copy of the designed mask can be produced on various graphical printers and on the plotter. Output data has form which directly control pattern generator. With PED program the integrated circuits up to 40000 rectangular pattern can be designed. When hard disk is used the maximum circuit size is practically unlimited.

4. CONCLUSION

From the analysis of the ability of microcomputers it can be concluded that it is possible to design fully custom type integrated circuits with more than 1000 transistors. In case of hierarchical approach the complexity of circuits can be much large. Therefore using popular microcomputers as IBM XT it is possible to design quite complex integrated circuits far from the IC producer. Some simple integrated circuits had been already designed at Technical University of Gdansk and fabricated in OBREUS Torun. Future of such "off site" design depends also on the proper device and subcircuit modeling and on the access to special computer programs for simulation and analysis of electronic circuits.