文 献 翻 译

EDA Technology

EDA (Electronics Design Automation) technology is that one kind arising at the historic moment with the development at full speed of the integrated circuit and computer technology is advanced, fast, effective electronic design automation tool. EDA tool regards hardware and software of the computer as the basic workbench, software package in common use of CAD that collect the data base, figure learning, picture theory and topological logic, computational mathematics, optimize theory, etc. multi-disciplinary latest achievement and develops. EDA is a development trend of the electronic designing technique, utilize EDA tool to replace a designer and finish most work in the electronic system design.

The implementation method of the digital system has been gone through from discrete component, SSI, MSI evolution at full speed to LSI, VLSI and UVISI too. In order to improve systematic dependability and common ability, the microprocessor and special-purpose integrated circuit (ASIC) have replaced the whole hardware LSI circuit in common use gradually. Can　program　the logic device (PLD) , especially can be programmed in the making that the logic device(FPLD) is applied to ASIC in a large amount at the scene. In the course of canning　program the development of the integrated circuit , the appearance of EDA technology has brought the revolutionary change that the electronic system is designed.

With the constant development of the micro-electric technique and computer technology，in the design work of electronic system related to fields, such as communication, national defense, spaceflight, industrial automation, instrument and apparatus, etc，the content of EDA technology is rising at the surprising speed , it has already nowadays become one of the front of the electronic technical development. This text has explained the basic conception and evolution of EDA technology at first, then introduce the essential feature of ESDA from several different respects, Analyse the workflow on two different levels of EDA technology emphatically finally, namely one grade of designs of circuit and system grade are designed，have introduced a kind of top-down high level electronic design method.

1. Preface

The human society has already entered into the highly developed information-based society, the development of the information-intensive society can not do without the progress of the electronic product. The modern electronic product has been presenting the

downward trend all the time at but the price while performance improves, complexity increases, and the paces of the model change are quicker and   quicker , the main reason which realizes this kind of progress is the development which produces the manufacturing technology and electronic designing technique. The former regards very small process technology as representatives, has already developed the deep sub-micro at present, can integrate several ten million transistors on the chip of several square centimeter . The latter's core is EDA technology. EDA refers to regarding computer as the workbench, have merged electronic CAD software package in common use that the latest achievement of application electric technology, computer technology, intelligent technology develops into , can carry on the design work of three respects auxiliary   mainly: IC designs, electronic circuit design and PCB are designed. Without the support of EDA technology, it is unimaginable that the design that wants to finish above-mentioned very large scale integration is made, conversely, produce manufacturing technology constant to progress and will put forward new request to EDA technology.

2．Development of EDA technology

EDA technology is following the development that the computer, integrated circuit, electronic system are designed, have gone through CAD (Computer Assist Design), auxiliary engineering design CAE of computer (Computer Assist Engineering Design) Three developing stages with design automation ESDA of electronic system (Electronic System Design Automation).

Review the development course of electronic designing technique in the past 30 years, can divide EDA technology into three stages .

The seventies of the 20th century, with hitting the appearance and application of the small- scale integrated circuit, traditional madding maps by hand and designed the printed circuit board and integrated circuit method has been already unable to meet and design the requests of the precision and efficiency, people begin high repeated miscellaneous work connect up and work and edit and replace with CAD tool that analyze such as Butut with two-dimensional level figure products design process. This has produced the first generation of EDA tools. Limited by computer workbench at that time, the design work that can be supported is limited and performance is worse

The seventies were CAD stage, people began to carry on the domain editor of IC and PCB overall arrangement to connect up auxiliary with the computer this stage, it is done by hand to

replace, has produced the concept of CAD .

The first individual computer platform of work station (Apollo) that appeared in the

eighties, has promoted the rapid development of EDA tool. For meet the electronic product in the scale and make the need that have, the second generation of EDA technology taking emulation of the computer and self routing as key technology has appeared. CAE tool with automatic integration capability has replaced some design work of the designer's. Characteristic its to regard software tool as core finish design, analyze, produce, every job of testing etc. of product development through software the. However, EDA tool that the majority proceeds from principle picture still can't meet the request that the complicated electronic system is designed, and the component figure specified is restricting optimization design.

The eighties were CAE stage. Compared with CAD, draw the function besides the pure figure , has increased the function of the circuit again and is designed and designed with the structure, and combine the two together through the electric connection network form, in order to realize engineering design, this is a concept of the auxiliary project of the computer. The main function of CAE is: The principle picture is input, logic emulation , the analysis of the circuit, the automatic overall arrangement is connected up, analyze after PCB

In the 1990s, the designer was from using the hardware to be developed and turned from one grade of electronic products of circuit to one grade of electronic product development of system to design the hardware progressively . ESDA tool is designed for the core with the system grade, including the systematic behavior grade describes that comprehensive with the structure grade, with test and prove systematic emulation system divide assign. The appearance of the third generation of EDA technology, the efficiency that the improvement system is designed greatly, dream of making the designer begin to realize that "the concept drive the project ". The designer has got rid of a large amount of auxiliary design work, concentrate energy on creative scheme and concept to conceive , thus improved efficiency of designing greatly, has shortened the research cycle of the products.

The 1990s were ESDA stage. Though CAD/CAE technology has made enormous success, has not liberated people completely from the strenuous design work out. In the course of designing entirely, automation and intelligent degree are also not high, various kinds of EDA software interfaces are various, learn and use difficult, and incompatible, influence and design to link up link directly. Because the above is insufficient, people begin to pursue the automation of carrying out whole design process.

3．The technology of EDA is formed

The essential feature of modern EDA technology is to adopt the high-level language

to describe, have one grade of emulation of system and integration capability. EDA target of technical research the whole course that electron design, have system grade, circuit grade and physics grades of each design of level. The category of technical research of EDA is quite extensive, develops and uses the angle to look from ASIC, include the following sub module : Design introduction sub module, set up and count data base sub module, analyze and prove sub module, comprehensive emulation sub module, overall arrangement connect up sub module etc..

EDA adopts the concurrent engineering and " top-down design method " mainly, then designs and starts with from the system, division and structure carrying on the function block-diagram on the top floor are designed, carries on emulation , corrects error first classily in the block-diagram , and describe with the hard wares, such as VHDL, Verilogy-HDL, ABEL etc. that the language describes the high-level systematic behavior, prove in system one grade , optimizes tools and produces the concrete net list in one grade of logical circuits of door synthetically with logic afterwards, it can be a printed circuit board or special-purpose integrated circuit that its corresponding physics is realized grade.

The experience of EDA tool is two great stages: Physics tool and logic tool. The actual physics question used for finishing of physics in the design of tool, for instance the overall arrangement of the chip, printed circuit board are connected up etc.. The logic tool is because of the logic of the net-list, cloth, transmit the concepts, such as time sequence etc., described at first that designs introduction in language by the picture editing machine of principle or the hardware, then utilize EDA system to finish being synthesized, course, such as emulation, optimizing etc., the structurization of net-list or VHDL, Virology -HDL turning into the physics tool finally and can be accepted is described. Now common EDA tools have logic, emulation, check analyze by tool, optimize /synthesis tool, etc.

At present, PLD has already become the main means that the modern digital system is designed. Traditional programming technology to insert and go on programming at programmable device PLD device, and " can be programmed the appearance of the logic device in the system " (ISP, namely In- System Programmable), has reached limit of the superiority full play of the programming device. ISP technology   directly among user design object system or circuit go on the technology of programming to PLD device at the board. Have broken the convention that PLD must be assembled after programming first of using, the programming after can assemble first , can also be programmed repeatedly after becoming the products. ISP allows user's programming " in the system " and revises logic, have provided for user and construct systematic ability and hardware upgrading ability again without revising the systematic hardware to design, make the hardware revised and

as convenient like the software revise , systematic dependability improves because of this.

4. Development trend of EDA technology

With the introduction of Intel Company Pentium processor, the listing of FPGA of hundreds of thousands pieces of scale of company, such as Xilinx etc., and extensive chip group and application of the high-speed, high density printed circuit board, EDA technology is in emulation , time sequence analysis, integrated circuit test automatically, high-speed printed circuit board design and expansion of operating platform etc. face the new enormous challenge. These are developments trend in the future of EDA technology of new generation. In the face of the electronic product market that nowadays develops at full speed, the designer needs more practical, swifter EDA tool, use unified integrated design environment, change traditional mentality of designing, concentrate on and get and design and conceive energy, the scheme compares and looks for the respects, such as optimization design etc., develop the of good performance electronic product with first-class quality at fastest speed. Of new generation EDA technology towards powerful simple to learn while being easy, the direction easy to use will be developed.

5. Essential feature of ESDA technology

ESDA representatives are nowadays the newest developing direction of electronic designing technique, its essential feature is: The designer divides with the function conceptual design to the whole system according to the " top-down design method ", the key circuit of the system is realized with one or several slices of special-purposes integrated circuit (ASIC), then adopt the hardware to describe that the language (HDL) is finished the systematic behavior grade and designed, produce the final goal device through comprehensive device and adapter finally. The electronic design method known as high level of such a design   method, will also do the introduction of deepening in 4.2 in concrete procedure. Now introduce several concepts related to ESDA essential feature.

5.1 the" Top-Down" design method

10 years ago, chose the standard integrated circuit to construct out a new system " Bottom-Up" in basic train of thought that the electron is designed, such a design method build Pyramid like one brick one, it lows with high costs efficiency have to be but also easy to make mistakes.

Design the brand-new design method to provide for us a kind of "   Top-Down " in high level, designing starting with from the system at first in these kind of design method, division and structure carrying on the function block-diagram on the top floor are designed. Carries on emulation , corrects error first classy in the block-diagram , and describe with

the hardware that the language describes the high-level systematic behavior, prove in system one grade. Then by optimizing tools and produce the concrete net-list of pieces of circuit synthetically, it can be a printed circuit board or special-purpose integrated circuit that its corresponding physics is realized grade. Because the main emulation designed and debugging the course to finish on high level, this not merely helps to find the mistake on the structure design in early days, avoid the waste of the design work, and has reduced the work load of logic function emulation , has improved success rate designed.

5.2   The designing of ASIC

The complexity of the modern electronic product is strengthened day by day, a electronic system may be formed by integrated circuit on a small scale of several tens of thousands of, this has brought volume largely, the consumption is great, problem with bad dependability , the effective method to solve this problem is to adopt ASIC (Application Specific Integrated Circuits) chip to be designed. ASIC can be divided into according to the difference of design methods: Customize ASIC all, half customize ASIC, programmable ASIC (called and can program the logic device too).

When design and customize ASIC chip completely, the designer wants to define the geometric figure of all transistors and rule of craft on the chip, design result transfer to IC producer close membrane make and finish finally. The advantage is: The chip can obtain optimum performance, namely area utilization ratio high, fast, low power dissipation . The shortcoming is: Development period is long, costly, only suitable for the product development in enormous quantities.

Half customize ASIC domain of chip design method to some extent different, divide into door array design law and standard unit design law, these two kinds of methods are both binding character design methods, its main purpose is simplified and designed, shorten construction period by sacrificing the performance of the chip as the cost. Can program   logic chip and above-mentioned difference of covering the membrane ASIC to lie in : The designer can fire out one's own chip in the laboratory after finishing the domain design, needn't have the participation of IC producer, has shortened development period greatly .

Can program the logic device since the seventies , has gone through PAL, GAL, CPLD, FPGA several developing stages, among them CPLD/FPGA has belonged to the high density and can program the logic device , the integrated level has already been up to 2 million doors slice at present, it close integrated level high advantage, ASIC of membrane, and can program logic device design and produce convenient characteristic combine together, especially suited to the sample developing short run product

development, enable products and list at fastest speed, and when the market expands , it can very easy to transfer to and cover membrane ASIC realize, so develop the risk but greatly reduced .

5.3 The hardware describes languages

The hardware describes that the language (HDL-Hardware Description Language) is a kind of computer language used for designing the electronic system of the hardware, it describe the logic function of the electronic system, circuit structure and connects the form in programming way of software, describe with traditional door grade that the way compares, it is more suitable for the design of the extensive system. Such as one addition device of 32, utilize figure input software need 500 introduction to 1000 door, and utilize VHDL language to only need to write a line of A −B +C, and VHDL language readability is strong, apt to revise and find the mistake. The early hardware described languages, was developed by different EDA manufacturers such as ABEL-HDL, AHDL, not compatible each other, and does not support designing at many levels , translation should be finished artificially among the levels. In order to overcome the above defect, the American Ministry of National Defence put out VHDL (Very High Speed IC Hardware Description Language) language formally in 1985, IEEE adopted VHDL and described the standard of languages (IEEE STD-1076) for the hardware in 1987.

VHDL whether one omni-directional hardware describe language, including systematic behavior grade, register transmit grade and logic gate one magnitude of a lot of design levels, support the mixing and describing of three kinds of description forms of the structure, dataflow, behavior, so VHDL nearly covers the functions of describing the language of various kinds of hard wares in the past, whole top-down or the bottom-up circuit design process can be finished with VHDL. In addition, VHDL also has the following advantages :

The wide range of VHDL describes the core that ability makes it become high level and is designed, has brought the designer's focus of work up to the realization and debugging of the systematic function, less energy is used in physics to realize to only need flowers

VHDL can describe with the succinct and clear code that controls the logic design complicatedly, flexible and convenient, but also easy to design the exchange, save of the result and put in an position.

The design of VHDL does not depend on the specific device , has facilitated the conversion of the craft .

VHDL is a standard language, support for numerous EDA manufacturers , so the

transplanting is good.

5.4 Systematic frame structure

EDA systematic frame structure (Framework) is a set of norms of disposing and use EDA software package, present main EDA system all set up frame structure, for instance Design Framework of Cadence Company, Falcon Framework of Mentor Company etc., these frame structure is all in accordance with the unified technical standard that international CFI organization (CAD Framework Initiative) make . Framework can carry on optimization grouping of the tool software from different EDA manufacturers , integrates it under a unified environment of easy management, and still support and realize the transmission and sharing of information in the course of whole product development between the tasks, between the designers, this is a realization foundation of a co-current engineering and Top-Down design method.

6. Conclusion

EDA technology whether electron design a revolution of field, at developing stage of high speed at present, there are new EDA tools every year to come out, the application level of EDA technology of our country lags behind the developed country for a long time, so, the masses of electronic engineering personnel should master this advanced technology as soon as possible , this improve design need of efficiency is of our country electronics industry survive at world market even more, strive and need that develop unexpectedly.

EDA 技术

EDA(Electronics Design Automation 电子设计自动化)技术是随着集成电路和计算机技术的飞速发展应运而生的一种高级、快速、有效的电子设计自动化工具。EDA 工具是以计算机的硬件和软件为基本工作平台，集数据库、图形学、图论与拓扑逻辑、计算数学、优化理论等多学科最新成果研制的计算机辅助设计通用软件包。EDA 是电子设计技术的发展趋势，利用 EDA 工具可以代替设计者完成电子系统设计中的大部分工作。

数字系统的实现方法也经历了由分立元件、SSI、MSI 到 LSI、VLSI 以及 UVISI 的飞速发展过程。为了提高系统的可靠性与通用性，微处理器和专用集成电路(ASIC)逐渐取代了通用全硬件 LSI 电路。可编程逻辑器件(PLD)，尤其是现场可编程逻辑器件(FPLD)被大量地应用在 ASIC 的制作中。在可编程集成电路的开发过程中，EDA 技术的出现带来了电子系统设计的革命性变化。

随着微电子技术和计算机技术的不断发展，在涉及通信、国防、航天、工业自动化、仪器仪表等领域的电子系统设计工作中，EDA 技术的含量正以惊人的速度上升，它已成为当今电子技术发展的前沿之一。本文首先阐述了 EDA 技术的基本概念和发展过程，然后从几个不同的方面介绍 ESDA 的基本特征，最后着重分析 EDA 技术在两个不同层次上的工作流程，即电路级设计和系统级设计，引入了一种自顶向下的高层次电子设计方法。

1 前言

人类社会已进入到高度发达的信息化社会,信息社会的发展离不开电子产品的进步。现代电子产品在性能提高、复杂度增大的同时，价格却一直呈下降趋势，而且产品更新换代的步伐也越来越快，实现这种进步的主要原因就是生产制造技术和电子设计技术的发展。前者以微细加工技术为代表，目前已进展到深亚微米阶段，可以在几平方厘米的芯片上集成数千万个晶体管;后者的核心就是 EDA 技术。EDA 是指以计算机为工作平台，融合了应用电子技术、计算机技术、智能化技术最新成果而研制成的电子 CAD 通用软件包，主要能辅助进行三方面的设计工作 IC 设计,电子电路设计以及 PCB 设计。没有 EDA 技术的支持，想要完成上述超大规模集成电路的设计制造是不可想象的，反过来，生产制造技术的不断进步又必将对 EDA 技术提出新的要求。

2 EDA 技术的发展与回顾

EDA 技术伴随着计算机、集成电路、电子系统设计的发展，经历了计算机辅助设计 CAD(Computer Assist Design) 、计算机辅助工程设计 CAE(Computer Assist Engineering Design)和电子系统设计自动化 ESDA(Electronic System Design Automation)三个发展阶段。

回顾近 30 年电子设计技术的发展历程，可将 EDA 技术分为三个阶段。

20 世纪 70 年代，随着中小规模集成电路的出现和应用，传统的手工制图设计印刷电路板和集成电路的方法已无法满足设计精度和效率的要求，人们开始将产品设计过程中

高重复性的繁杂劳动如布图布线工作用二维平面图形编辑与分析的 CAD 工具代替。这就产生了第一代 EDA 工具。受当时计算机工作平台的制约，能支持的设计工作有限且性能比较差。

70 年代为 CAD 阶段，这一阶段人们开始用计算机辅助进行 IC 版图编辑和 PCB 布局布线，取代了手工操作，产生了计算机辅助设计的概念。

80 年代出现的第一个个人工作站(Apollo)计算机平台，推动了 EDA 工具的迅速发展。为了适应电子产品在规模和制作上的需要，出现了以计算机仿真和自动布线为核心技术的第二代 EDA 技术。具有自动综合能力的 CAE 工具代替了设计师的部分设计工作。其特点是以软件工具为核心通过这些软件完成产品开发的设计、分析、生产、测试等各项工作。但是，大部分从原理图出发的 EDA 工具仍然不能适应复杂电子系统设计的要求，而且具体化的元件图形制约着优化设计。

80 年代为 CAE 阶段，与 CAD 相比，除了纯粹的图形绘制功能外，又增加了电路功能设计和结构设计，并且通过电气连接网络表将两者结合在一起，以实现工程设计，这就是计算机辅助工程的概念。CAE 的主要功能是：原理图输入，逻辑仿真，电路分析，自动布局布线，PCB 后分析。

90 年代，设计师逐步从使用硬件转向设计硬件，从电路级电子产品开发转向系统级电子产品开发。ESDA 工具是以系统级设计为核心，包括系统行为级描述与结构级综合，系统仿真与测试验证，系统划分与指标分配，系统决策与文件生成等一整套的电子系统设计自动化工具。第三代 EDA 技术的出现，极大地提高了系统设计的效率，使设计师开始实现"概念驱动工程"的梦想。设计师摆脱了大量的辅助设计工作，把精力集中于创造性的方案与概念构思上，从而极大地提高了设计效率，缩短了产品的研制周期。

90 年代为 ESDA 阶段。尽管 CAD/CAE 技术取得了巨大的成功，但并没有把人从繁重的设计工作中彻底解放出来。在整个设计过程中，自动化和智能化程度还不高，各种 EDA 软件界面千差万别，学习使用困难，并且互不兼容，直接影响到设计环节间的衔接。基于以上不足，人们开始追求贯彻整个设计过程的自动化，这就是 ESDA 即电子系统设计自动化。

3 EDA 的技术构成

现代 EDA 技术的基本特征是采用高级语言描述，具有系统级仿真和综合能力。EDA 技术研究的对象是电子设计的全过程，有系统级、电路级和物理级各个层次的设计。EDA 技术研究的范畴相当广泛，从 ASIC 开发与应用角度看，包含以下子模块：设计输入子模块、设计数据库子模块、分析验证子模块、综合仿真子模块、布局布线子模块等。

EDA 主要采用并行工程和"自顶向下"的设计方法，然后从系统设计入手，在顶层进行功能方框图的划分和结构设计，在方框图一级进行仿真、纠错，并用 VHDL、Verilog-HDL、ABEL 等硬件描述语言对高层次的系统行为进行描述，在系统一级进行验

证，最后再用逻辑综合优化工具生成具体的门级逻辑电路的网表，其对应的物理实现级可以是印刷电路板或专用集成电路。

EDA 工具的发展经历了两个大的阶段：物理工具和逻辑工具。物理工具用来完成设计中的实际物理问题，如芯片布局、印刷电路板布线等。逻辑工具是基于网表、布尔逻辑、传输时序等概念，首先由原理图编辑器或硬件描述语言进行设计输入，然后利用 EDA 系统完成综合、仿真、优化等过程，最后生成物理工具可以接受的网表或 VHDL、Verilog-HDL 的结构化描述。现在常见的 EDA 工具有逻辑器、仿真器、检查/分析工具、优化/综合工具等。

目前，PLD 已成为现代数字系统设计的主要手段。传统的编程技术是将 PLD 器件插在编程器上进行编程，而"在系统可编程"(ISP，即 In-System Programmable)逻辑器件的问世，将可编程器件的优越性发挥到了极致。ISP 技术就是直接在用户设计目标系统中或线路板上对 PLD 器件进行编程的技术。打破了使用 PLD 必先编程后装配的惯例，可以先装配后编程，成为产品后还可反复编程。ISP 允许用户"在系统中" 编程和修改逻辑，给使用者提供了在不修改系统硬件设计的条件下重构系统的能力和硬件升级能力，使硬件修改变得像软件修改一样方便，系统的可靠性因此而提高。

4 EDA 技术的发展趋势

随着 Intel 公司 Pentium 处理器的推出，Xilinx 等公司几十万门规模的 FPGA 的上市，以及大规模的芯片组和高速、高密度印刷电路板的应用，EDA 技术在仿真、时序分析、集成电路自动测试、高速印刷电路板设计及操作平台的扩展等方面都面临着新的巨大的挑战。这些就是新一代 EDA 技术未来发展的趋势。面对当今飞速发展的电子产品市场，设计师需要更加实用、快捷的 EDA 工具，使用统一的集成化设计环境，改变传统设计思路，将精力集中到设计构思、方案比较和寻找优化设计等方面，以最快的速度开发出性能优良、质量一流的电子产品。新一代 EDA 技术将向着功能强大、简单易学、使用方便的方向发展。

5 ESDA 技术的基本特征

ESDA 代表了当今电子设计技术的最新发展方向，它的基本特征是：设计人员按照"自顶向下"的设计方法，对整个系统进行方案设计和功能划分，系统的关键电路用一片或几片专用集成电路（ASIC）实现，然后采用硬件描述语言（HDL）完成系统行为级设计，最后通过综合器和适配器生成最终的目标器件。这样的设计方法被称为高层次的电子设计方法，具体流程还将在 4.2 节中做深入介绍。下面介绍与 ESDA 基本特征有关的几个概念。

5.1 "自顶向下"的设计方法

10 年前，电子设计的基本思路还是选择标准集成电路"自底向上"（Bottom-Up）地构造出一个新的系统，这样的设计方法就如同一砖一瓦地建造金字塔，不仅效率低、成

本高而且还容易出错。

高层次设计给我们提供了一种"Top-Down"的全新的设计方法，这种设计方法首先从系统设计入手，在顶层进行功能方框图的划分和结构设计。在方框图一级进行仿真、纠错，并用硬件描述语言对高层次的系统行为进行描述，在系统一级进行验证。然后用综合优化工具生成具体门电路的网表，其对应的物理实现级可以是印刷电路板或专用集成电路。由于设计的主要仿真和调试过程是在高层次上完成的，这不仅有利于早期发现结构设计上的错误，避免设计工作的浪费，而且也减少了逻辑功能仿真的工作量，提高了设计的一次成功率。

5.2 ASIC 设计

现代电子产品的复杂度日益加深，一个电子系统可能由数万个中小规模集成电路构成，这就带来了体积大、功耗大、可靠性差的问题，解决这一问题的有效方法就是采用ASIC(Application Specific Integrated Circuits)芯片进行设计。ASIC 按照设计方法的不同可分为：全定制 ASIC，半定制 ASIC，可编程 ASIC（也称为可编程逻辑器件）。

设计全定制 ASIC 芯片时，设计师要定义芯片上所有晶体管的几何图形和工艺规则，最后将设计结果交由 IC 厂家掩膜制造完成。优点是：芯片可以获得最优的性能，即面积利用率高、速度快、功耗低。缺点是 开发周期长，费用高，只适合大批量产品开发。

半定制 ASIC 芯片的版图设计方法有所不同，分为门阵列设计法和标准单元设计法，这两种方法都是约束性的设计方法，其主要目的就是简化设计，以牺牲芯片性能为代价来缩短开发时间。

可编程逻辑芯片与上述掩膜 ASIC 的不同之处在于：设计人员完成版图设计后，在实验室内就可以烧制出自己的芯片，无须 IC 厂家的参与，大大缩短了开发周期。

可编程逻辑器件自七十年代以来，经历了 PAL、GAL、CPLD、FPGA 几个发展阶段，其中 CPLD/FPGA 属高密度可编程逻辑器件，目前集成度已高达 200 万门/片，它将掩膜ASIC 集成度高的优点和可编程逻辑器件设计生产方便的特点结合在一起，特别适合于样品研制或小批量产品开发，使产品能以最快的速度上市，而当市场扩大时，它可以很容易的转由掩膜 ASIC 实现，因此开发风险也大为降低。

上述 ASIC 芯片，尤其是 CPLD/FPGA 器件，已成为现代高层次电子设计方法的实现载体。

5.3 硬件描述语言

硬件描述语言（HDL-Hardware Description Language）是一种用于设计硬件电子系统的计算机语言，它用软件编程的方式来描述电子系统的逻辑功能、电路结构和连接形式，与传统的门级描述方式相比，它更适合大规模系统的设计。例如一个 32 位的加法器，利用图形输入软件需要输入 500 至 1000 个门，而利用 VHDL 语言只需要书写一行 A=B+C即可，而且 VHDL 语言可读性强，易于修改和发现错误。早期的硬件描述语言，如ABEL-HDL、AHDL，是由不同的 EDA 厂商开发的，互相不兼容，而且不支持多层次设计，