高等学校专业英语教材

电子信息工程专业英语教程

(第5版)

Technical English Course for Electronic Information Engineering
(Fifth Edition)

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内 容 简 介

本书的主要目的是使读者掌握电子信息工程专业英语术语及用法，培养和提高读者阅读和翻译专业英语文献资料的能力。本书由10个主题单元组成，涵盖了电子信息领域的主要技术分支。主要内容包括电子器件、电子电路、电子系统组件、电子系统、现代数字设计、数字信号处理、语音和音频、图像和视频、嵌入式应用、电子仪器与测量等。每个主题单元由3篇课文、3篇阅读材料、课文词汇、课文注释和练习组成。每篇课文均有参考译文，书后附有练习参考答案、科技英语语音手册和词汇手册；全书配有电子教案、视频材料等教辅资源，通过华信教育资源网 www.hxedu.com.cn 免费提供给授课教师参考。

本书可作为电子信息工程专业的专业英语教材，也可供从事相关专业的工程技术人员参考使用。

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前　　言

电子信息工程是国内外飞速发展的工程领域之一。为了应对国际化竞争,大学生必须在学习阶段打下坚实的专业基础,发展全面的职业技能。“熟练运用专业英语、有效进行科技交流”是电子信息工程专业大学生的重要专业素养和必备职业技能。

为了提高学生的专业英语阅读写作能力、拓展学生对电子信息工程关键技术的认识、培养具备国际竞争力的技术人才,《电子信息工程专业英语教程(第 5 版)》[*Technical English Course for Electronic Information Engineering* (*Fifth Edition*)]充分吸收最新科技成果和英语教学成果,按照先进实用的选材原则和简明系统的组织原则,为电子信息工程专业大学生构建了一个提高英语水平和专业素养的平台。

本教程分为 10 个主题单元,涵盖了电子信息工程领域的主要技术分支。每个单元由 3 篇课文、3 篇阅读材料和一套单元练习组成。课文侧重展示基础理论和核心技术;阅读材料着力介绍历史沿革、实用技术和未来前景;单元练习采用完形填空、英汉互译、摘要写作的方式训练语言技能。

本教程各单元包含的具体技术内容如下:

1	电子器件	VLSI 技术、微处理器、存储器、数字时代、闪存、微控器
2	电子电路	运算放大器、低通滤波器、ADC、开关电容滤波器、DAC
3	电子系统组件	开关电源、时钟信号源、互连部件、PCB 技术、电源芯片、晶振
4	电子系统	移动电话系统、PC 系统、RFID 系统、GPS 系统、无线局域网
5	现代数字设计	FPGA、VHDL 语言、PLD 发展史、Verilog 语言、SoC
6	数字信号处理	DSP 基础、DSP 处理器、ASP 与 DSP、软件无线电、医学图像处理
7	语音和音频	高保真音频(CD)、音频压缩(MP3)、3G/4G/5G、声码器
8	图像和视频	数字图像、数码相机、电视信号、JPEG 标准、视频编码系统、视频格式
9	嵌入式应用	内核、设计语言、RTOS、ARM 处理器、嵌入式 OS
10	电子仪器与测量	信号源、示波器、逻辑分析仪、信号完整性、虚拟仪器

第 1～4 单元按照“器件”(device)→“电路”(circuit)→“系统”(system)的思路,全景展示了一个典型电子信息系统的构建过程。关于“器件”,我们选择了当今广泛应用的两种 VLSI 芯片——微处理器和存储器,它们是数字时代电子系统的核心。关于“电路”,我们选择了模拟电路的代表——运算放大器和滤波器,以及混合电路的代表——ADC 和 DAC,它们是数字时代电子系统的外围。众多功能电路可以构成“系统组件”(system component),我们选择了任何电子系统都离不开的“电源设备”(power supply)、“时钟信号源”(clock source)和“互连部件”(interconnects),它们分别相当于系统的“血液”“心脏”和“筋骨”。关于“系统”,我们选择了移动电话、个人计算机(PC)和全球定位系统(GPS)等。

第 5～6 单元聚焦两种数字电子系统核心的设计手段。一方面，可以利用 VHDL、Verilog 等硬件设计语言，在可编程的 FPGA 和 CPLD 芯片上，设计定制的数字电子系统核心。另一方面，可以利用汇编语言、C 语言等软件设计语言，在可编程的 DSP 芯片上，设计功能强大的信号处理核心。在工程实际中，这两种方式往往配合使用。

第 7～8 单元通过介绍 CD、MP3 等具体应用，展示了电子信息工程在音频、视频、图像等多媒体领域的发展成果，同时反映出多姿多彩的设计思路和理论成就。学习本单元，有助于激发学生的创新性思维。

第 9～10 单元面向工程实际，展示了嵌入式产品形成过程的主要方面——选择芯片、选择设计语言、选择操作系统，利用仪器进行测试、验证、故障排除等。关于“芯片”，我们选择了嵌入式领域广泛使用的 ARM。关于“语言”，我们介绍了汇编语言、C 语言、C++语言、Java 语言。关于“操作系统”，我们展示了“实时操作系统”（RTOS）和“嵌入式操作系统”（embedded OS）。关于“仪器测量”，我们选择了 3 件必备仪器——信号源、示波器、逻辑分析仪，并涉及了“信号完整性”（SI）问题和“虚拟仪器”（VI）应用。

在英语语言技能训练方面，本教程采用了 3 种方式——完形填空、英汉互译、摘要写作。进行“完形填空”练习，有助于雕琢语言细节——语法、词汇、固定搭配、专业术语、专业表达方法等。进行“英汉互译”练习，有助于明辨英汉语言差异、文化差异和思维方式差异，从而提高专业阅读、学术写作和科技交流的水平。进行“摘要写作”练习，有助于熟悉科技文体格式、用词特点和写作技巧，为将来写作科技论文打下良好基础。

任何语言能力的培养，必须在真实的场景中训练才会收到实效。在本教程中，各单元练习全部取材于国外大学教材、科技专著、国际会议论文、工程技术文档（芯片使用指南、用户手册、技术白皮书）、业内专家文章和著名公司网站等（详见参考资料），以期达到“利用英语学专业、通过专业练英语”的教学目标。

为了便于学生自学，本教程提供了课文参考译文、练习参考答案。此外，本教程在附录中还提供了“科技英语语音手册”和“科技英语词汇手册”。

为了便于教师授课及丰富课堂内容，本教程配有 PowerPoint 电子讲稿、阅读材料参考译文、模拟试卷及答案、视频材料及脚本等教辅资料。凡使用本教程作为教材的教师，均可登录电子工业出版社华信教育资源网（www.hxedu.com.cn）注册下载，或者电话联系 010-88254531 免费获得。

为方便读者学习，相关视频、试卷及生词短语/专业术语速查表等以二维码的形式给出，扫描下面二维码即可打开。

本教程自 2004 年 7 月出版第 1 版以来，受到了高校师生和工程技术人员的普遍认可和欢迎。这次修订是在前 4 版的基础上，充分采纳了每位读者的合理化建议，全面更新了技术内容和语言内容。希望最新版教程更加贴近教学、科研和工程实际。

由于作者水平所限，书中难免有纰漏和欠妥之处。本教程的读者反馈邮箱为 rzgwriting@163.com，欢迎各位读者不吝赐教！

编著者

使 用 说 明

学生自学建议

正式学习前，建议通读附录。对于没有系统学习过科技英语课程的学生，最好在学习本教程之前，将附录中的“科技英语语音手册”和“科技英语词汇手册”通读一遍。

全面理解核心学术词汇，准确记忆关键科技术语。面对海量英语词汇，必须要有选择。那些出现频率高、词义繁多、用法灵活的词汇是突破的重点。在专业英语学习中，有两类重点词汇——“核心学术词汇”(Core Academic Words)和“关键科技术语”(Key Technical Terms)。请分别参照课文词汇表的 New Words & Expressions 部分和 Technical Terms 部分。

泛读课文内容，聚焦英文表达技巧。在对照参考译文阅读课文的时候，不要仅限于明白大概意思就行了，要把主要精力集中于“这个中文意思，英文是怎么表达的”。在很多情况下，英文中有若干种表达方法。通过做笔记、摘抄和总结的办法，就可以不断地积累各种常用的英文表达技巧。

翻译阅读材料，训练技术信息提取能力。作为将来的工程师，显然要具备从英文技术资料中提取关键信息的能力。本教程中的阅读材料包含了丰富的技术题材。如果对于某方面内容特别感兴趣，那么就可以尝试着翻译一下。这也是深入学习词汇、语法和文化的最好方式。

利用单元练习，进行自我测试。本教程中的单元练习，全部来自真实的技术资料，有利于学生测试自己真实的专业英语水平。

教师授课建议

根据教学实际情况，恰当选择精讲课文及段落。本教程的课文难度分为高、中、低三档，适用于各类型大学、各种水平学生的专业英语教学。课文的选材，既有高难度的科技专著、学术会议论文、技术手册，也有中等难度的大学教材、用户手册、技术白皮书，还有比较易懂的综述文章、科普读物。根据实际情况，教师要选择适合课堂教学的内容，作为精讲课文和精讲段落。其他课文和段落，可以安排学生课前预习或课后自学，也可以根本不去涉及。

利用英语学专业，通过专业练英语。专业英语课程实践性很强。在课堂上，教师不但要精讲，更要精练。一段精讲课文，既可以训练学生从中快速、准确提取技术信息的阅读能力，也可以训练学生撰写摘要、模仿造句、独立作文的能力。这种“阅读”→“分析”→“写作”的教学模式，被证明是非常成功的。

适时适量引入音频、视频，丰富课堂内容，激发学习兴趣。为了提高专业英语听说能力，可以在课堂教学中引入一定量的音、视频材料，并设法引导学生学会利用网络进行专业英语的听说读写交流。

强调科技英语阅读写作，提高科技交流职业技能。作为将来的工程师，阅读能力和写作能

力最为重要。在科技交流中，无论查询资料、进行设计，还是联系业务，都离不开阅读和写作。有效的科技交流，要求“准确”“快速”，而这种能力不经过专业训练是无法达到的。

扩展阅读建议

科技交流

[1] W.S.法依弗，K.E. 阿德金斯. 大学科技英语国际交流教程. 任治刚，译. 北京：电子工业出版社，2015.

[2] Charles W. Knisely，Karin I. Knisely. Engineering Communication. Cengage Learning，2014.

[3] Michael Alle. The Craft of Scientific Presentations：Critical Steps to Succeed and Critical Errors to Avoid (2nd Edition). Springer，2013.

论文写作

[1] John M. Swales，Christine Feak. Academic Writing for Graduate Students (3rd Edition). ELT，2012.

[2] R.A.戴，B.盖斯特尔. 科技论文写作与发表教程(第 8 版). 任治刚，译. 北京：电子工业出版社，2018.

词汇语法

[1] Alison Pohl，Nick Brieger. Technical English：Vocabulary and Grammar. Summertown Publishing，2002.

[2] Robert A. Day，Nancy Sakaduski. Scientific English：A Guide for Scientists and Other Professionals (3rd Edition). Greenwood，2011.

[3] Nigel A. Caplan. Grammar Choices for Graduate and Professional Writers. University of Michigan Press/ELT，2012.

教材选用建议

对于同时开设“电子信息工程专业英语”“通信工程专业英语”的学校，还可以选用《电子通信专业英语简明教程》(任治刚主编，电子工业出版社，2015)。该教程篇幅适中、内容简明，并专门设立“科技英语、学术写作和职场交流”部分。该教程也适合有志留学或深造的学生自修及国际化 IT 企业人士阅读。

对于“通信工程专业英语”感兴趣的读者，可以参照《通信工程专业英语教程》(任治刚主编，电子工业出版社，2016)。该教程题材广泛、内容实用、练习丰富，并提供“学术英语提要”“科技论文写作”等内容，可以满足读者在就业、深造或留学时的切实需求。

Contents

Unit 1

Electronic Devices

Lesson 1　VLSI Technology

One of the key inventions in the history of electronics[1], and in fact one of the most important inventions over period[2], was the transistor. It was invented by Bell Laboratories[3] in 1947. In short, a transistor is a device that conducts a variable amount of electricity through it, depending on how much electricity is input to it. In other words, it is a digital switch. However, unlike the vacuum tube, it is solid state. This means that it doesn't change its physical form as it switches. There are no moving parts in a transistor.

The advantages of the transistor over the vacuum tube[4] were enormous. Compared to the old technology, transistors were much smaller, faster, and cheaper to manufacture. They were also far more reliable and used much less power. The transistor is what started the evolution of the modern computer industry in motion.[5]

The transistor was originally a single, discrete device, which you could place individually into a circuit much like any other. Today, some special-purpose transistors are still used that way. What allowed the creation of modern processors was the invention of the integrated circuit[6], which is a group of transistors manufactured from a single piece of material and connected together internally, without extra wiring. Integrated circuits are also called ICs or chips.

A special material is used to make these integrated circuits. While most materials either insulate from electrical flow (air, glass, wood) or conduct electricity readily (metals, water), there are some that only conduct electricity a small amount, or only under certain conditions. These are called semiconductors. The most commonly used semiconductor is of course silicon.

By careful chemical composition and arrangement, it is possible to create a very small transistor directly on a layer of silicon, using various technologies to manipulate the material into the correct form. These transistors are small, fast and reliable, and use relatively little power. The first integrated circuit was invented in 1958 by Texas Instruments.[7] It contained just six transistors on a single semiconductor surface.

After the invention of the integrated circuit, it took very little time to realize the tremendous benefits of miniaturizing and integrating larger numbers of transistors into the same integrated circuit. More transistors (switches) were required in order to implement more complicated functions. Miniaturization was the key to integrating together large numbers of transistors while increasing hardware speed and keeping power consumption and space requirements manageable.

Large-scale integration (LSI) came to refer to the creation of integrated circuits that had previously been made from multiple discrete components. These devices typically contained hundreds of transistors. Early computers were made from many of these smaller ICs connected together on circuit boards.

As time progressed after the invention of LSI integrated circuits, the technology improved and chips became smaller, faster and cheaper. Building on the success of earlier integration efforts, engineers learned to pack more and more logic into a single circuit. This effort became known as very large-scale integration (VLSI). VLSI circuits can contain millions of transistors.

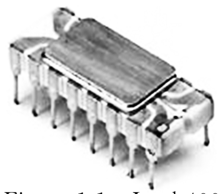

Figure 1.1 Intel 4004

Originally, the functions performed by a processor were implemented using several different logic chips. Intel[8] was the first company to incorporate all of these logic components into a single chip. This was the first microprocessor, the 4004 (see Figure 1.1), introduced by Intel in 1971. All of today's processors are (highly advanced!) descendants of this original[9] 4-bit CPU.

New Words & Expressions

invention [ɪn'venʃən] *n*. 发明
device [dɪ'vaɪs] *n*. 器件
conduct [kən'dʌkt] *vt*. 传导
variable ['veəriəbl] *adj*. 可变的
amount [ə'maʊnt] *n*. 数量
vacuum ['vækjʊəm] *n*. 真空
solid ['sɒlɪd] *adj*. 固体的
advantage [əd'vɑːntɪdʒ] *n*. 优势
enormous [ɪ'nɔːməs] *adj*. 巨大的
manufacture [ˌmænjʊ'fæktʃə] *vt*. 批量生产
reliable [rɪ'laɪəbl] *adj*. 可靠的
evolution [ˌevə'luʃən] *n*. 发展;演变
originally [ə'rɪdʒənəli] *adv*. 起初
individually [ˌɪndɪ'vɪdʒuəli] *adv*. 分别地
internally [ɪn'tɜːnəli] *adv*. 内部地
composition [ˌkɒmpə'zɪʃən] *n*. 合成
arrangement [ə'reɪndʒmənt] *n*. 排列
directly [daɪ'rektli] *adv*. 直接地
layer ['leɪə] *n*. 层
various ['veəriəs] *adj*. 多种不同的
manipulate [mə'nɪpjuleɪt] *vt*. 处理
contain [kən'teɪn] *vt*. 包含
surface ['sɜːfɪs] *n*. 表面
tremendous [trə'mendəs] *adj*. 巨大的
benefit ['benɪfɪt] *n*. 益处
miniaturize ['mɪnɪətʃəˌraɪz] *vt*. 使微型化
integrate ['ɪntɪgreɪt] *vt*. 集成
consumption [kən'sʌmpʃən] *n*. 消耗
requirement [rɪ'kwaɪəmənt] *n*. 需求
manageable ['mænɪdʒəbəl] *adj*. 可处理的
refer to ... 是指……
previously ['priːviəsli] *adv*. 此前
multiple ['mʌltɪpl] *adj*. 多个的
progress [prə'gres] *n*. 进步
implement ['ɪmplɪmənt] *vt*. 实现
incorporate [ɪn'kɔːpəreɪt] *vt*. 合并
introduce [ˌɪntrə'djuːs] *vt*. 推出
advanced [əd'vænst] *adj*. 先进的
descendant [dɪ'sendənt] *n*. 后代
original [ə'rɪdʒənəl] *adj*. 最初的

Technical Terms

electronics [ˌɪlekˈtrɒnɪks] *n*. 电子学
transistor [trænˈsɪstə] *n*. 晶体管
electricity [ˌɪlekˈtrɪsəti] *n*. 电
digital [ˈdɪdʒɪtəl] *adj*. 数字的
switch [swɪtʃ] *n*. 开关
power [ˈpaʊə] *n*. 功率
discrete [dɪsˈkriːt] *adj*. 分立的
circuit [ˈsɜːkɪt] *n*. 电路
chip [tʃɪp] *n*. 芯片
insulate [ˈɪnsjuleɪt] *vt*. 绝缘
semiconductor [ˌsemɪkənˈdʌktə] *n*. 半导体
silicon [ˈsɪlɪkən] *n*. 硅
miniaturization [ˈmɪnɪətʃəˌraɪˈzeɪʃən] *n*. 缩微化
component [kəmˈpəʊnənt] *n*. 元器件;组件;部件
logic [ˈlɒdʒɪk] *n*. 逻辑
microprocessor [maɪkrəʊˈprəʊsesə] *n*. 微处理器
solid state 固态
power consumption 功耗
circuit board 电路板
IC *abbr*. integrated circuit 集成电路
LSI *abbr*. large-scale integration 大规模集成
VLSI *abbr*. very large-scale integration 超大规模集成
CPU *abbr*. central processing unit 中央处理器

Notes

1. electronics 可译作"电子学""电子技术"或"电子线路""电子设备"。例如,"镉是电子工业有毒废物"(Cadmium is a toxic waste product of *electronics* industry)。后缀-cs 表示"学术",如"美学"(aesthetics)、"伦理学"(ethics)、"经济学"(economics)。
2. period 可指"一段时间",如"在四天之内"(over a *period* of four days)"此项研究为期六个月"(The study will be carried out over a six-month *period*)。介词 over 可表示时间或空间的跨越,如"此图展示了过去 20 年来 Y 随 X 变化的情况"(This figure shows how Y varied in relationship with X *over* the last 20 years)。
3. Bell Laboratories(又称 Bell Labs)是贝尔实验室(www.bell-labs.com),总部位于美国新泽西州的默里山(Murray Hill, New Jersey)。1947 年 12 月 23 日,该实验室的 Bill Shockley、Walter Brattain 和 John Bardee 发明了晶体管。

4. The advantages of Y over X 结构表示"Y 相对于 X 的优势"。advantage 常见搭配有 a big/great/major advantage、the main advantage、have an advantage 和 the advantage of *sth*.。
5. 此句为强调结构,使用 what 表语从句强调主语(the transistor)。
6. 此句为强调结构,使用 what 主语从句强调表语(the invention of the integrated circuit)。
7. Texas Instruments 是指德州仪器公司(www.ti.com),总部位于美国得克萨斯州的达拉斯(Dallas, Texas)。1958 年,该公司的 Jack Kilby 发明了第一片集成电路。
8. Intel 是指英特尔公司(www.intel.com),其总部位于美国加利福尼亚州的圣克拉拉(Santa Clara, California)。1968 年,Robert Noyce 和 Gordon Moore 创建英特尔公司。
9. original 源自 origin(起点),意为"最初的",如"原计划"(*original* plan)、"原始特征"(*original* features)、"将讨论返回到开始的话题"(steer the discussion to the *original* topic)。

Lesson 2 Memory Devices

Memories can be made in mechanical, magnetic, optical, biological and electronic technologies. Examples of magnetic memories are tapes, floppy disks, hard drives and ferroelectric[1] RAMs. Examples of optical memories are CD-ROMs, rewrittable CDs. Electronic memory is used extensively in computer equipment since it is the fastest available. All electronic memory today can be in separate IC format, module format, or can be part of an IC as a macro-function or cell. Table 1.1 is an overview of some electronic memories.

Table 1.1 Overview of Common Electronic Memory Devices

Type	Properties	Writtable	Non-volatile	Speed	Cost
Flip-flop	One-bit register. Used as basic building blocks in digital circuits.	Yes	No	Ultra fast	Very high
Register	Set of flip-flops holding a byte, word or long word. Used in complex chips such as CPUs.	Yes	No	Ultra fast	Very high
SRAM	Array of flip-flops that is addressable. Used for temporary storage of data or cache[2].	Yes	No	Very fast	High
DRAM	Array of storage cells which is addressable. Used for main computing data storage.	Yes	No	Fast	Moderate
ROM	Array of hard-wired cells that is addressable. Programming done at time of chip manufacture.	No	Yes	Very fast	Low
EEPROM	Electrically erasable programmable ROM. Number of write cycles is limited.	Yes	Yes	Low	High

Flip-flop

A flip-flop is basically a bi-state circuit in which either a 0 or 1 state can resides. Because of its simplicity, the flip-flop is extremely fast. As a basic element, the flip-flop is used in digital circuits and ICs. A flip-flop will lose its state when the supply voltage is removed. Therefore, it is volatile.

Register

A register is a set of flip-flops in parallel. Typically a register is 8, 16, 32 or 64 bits wide. Often a register is used to hold data, address pointers, etc. A register is volatile and very fast just like the flip-flop.

SRAM (static random access memory)

An SRAM is an array of addressable flip-flops. The array can be configured as such that the data comes out in 1-bit, 4-bit, 8-bit, and etc. SRAM is simple, fast and volatile just like the flip-flop, its basic memory cell. SRAM can be found on microcontroller boards (either on or off the CPU chip), where the amount of memory required is small and it will not pay off to build the extra interface circuitry for DRAMs. In addition, SRAM is often used as cache because of its high speed.

SRAM comes in many speed classes, ranging from several ns for cache applications to 200ns for low power applications. SRAM exists in both bipolar and MOS technology. CMOS[3] technology boasts the highest density and the lowest power consumption. Fast cache memory can be constructed in BiCMOS technology, a hybrid technology that uses bipolar transistors for extra drive. The fastest SRAM memories are available in emitter coupled logic (ECL) bipolar technology. Because of the high power consumption, the memory size is limited in this technology.

A special case of SRAM memory is content addressable memory (CAM)[4]. In this technology, the memory consists of an array of flip-flops, in which each row is connected to a data comparator. The memory is addressed by presenting[5] data to it (not an address!). All comparators will then check simultaneously[6] if their corresponding RAM register holds the same data. The CAM will respond with the address of the row (register) corresponding to the original data. The main application for this technology is fast lookup tables. These are often used in network routers.

DRAM (dynamic random access memory)

The word "dynamic" indicates that the data is not held in a flip-flop but rather in a storage cell. The data in a storage cell must be refreshed (read out and re-written) regularly because of leakage. The refresh time interval is usually 4 to 64 ms. The storage cell only requires one capacitor and one transistor, whereas[7] a flip-flop connected in an array requires 6 transistors. In trench capacitor memory technology, which is used in all modern DRAMs, the transistor is constructed above the capacitor so that the space on chip is ultimately minimized. For this reason, DRAM technology has a lower cost per bit than SRAM technology. The disadvantage of the extra circuitry required for refreshing is easily offset by the lower price per bit when using large memory sizes.

DRAM memory is, just like SRAM memory constructed as an array of memory cells. A major difference between SRAM and DRAM, however, lies in the addressing technique. With an SRAM, an address needs to be presented and the chip will respond with presenting the data of the memory cell at the output, or accepting the data at the input and write it into the addressed cell. With DRAM technology, this simple approach is impossible since addressing a row of data without rewriting it will destruct all data in the row because of the dynamic nature.

ROM (read only memory)

ROMs are also called mask[8]-ROMs or mask programmed ROMs. This is because a ROM needs to be programmed by setting its cells to either 0 or 1 at the time of manufacture. Usually the 0 or 1 is formed by the presence or absence of an aluminum line. This aluminum pattern is defined by a lithographic mask used in one of the last steps of manufacture. Therefore these devices are often called mask-ROMs.

The advantage of ROM is that it can be manufactured at the lowest price in high volumes. Another advantage in some applications is that it is impossible to alter the data once the chips are made, and that no further programming and testing are required. On the other hand, if the data or code must be changed this can be a small disaster. The rest of the chips will end in the dustbin and new chips will have to be made.

EEPROM (electrically erasable programmable ROM)

This means that the chip can be programmed like an EPROM, but can be erased electrically. As a result, no UV source is required. EEPROMs can be erased on a byte-by-byte basis.

New Words & Expressions

mechanical [mɪˈkænɪkəl] *adj*. 机械的
extensively [ɪkˈstensɪvli] *adv*. 大量地;广泛地
available [əˈveɪləbl] *adj*. 可获得的;可用的
format [ˈfɔːmæt] *n*. 格式
module [ˈmɒdʒul] *n*. 模块;功能块
property [ˈprɒpəti] *n*. 特性
volatile [ˈvɒlətaɪl] *adj*. 易失的
array [əˈreɪ] *n*. 阵列
temporary [ˈtempərəri] *adj*. 临时的
moderate [ˈmɒdərət] *adj*. 中等的
simplicity [sɪmˈplɪsəti] *n*. 简易性
parallel [ˈpærəlel] *adj*. 并行的
static [ˈstætɪk] *adj*. 静态的
simultaneously [saɪməlˈteɪniəsli] *adv*. 同时地
corresponding [ˌkɒrɪˈspɒndɪŋ] *adj*. 相应的
respond [rɪˈspɒnd] *vi*. 响应
original [əˈrɪdʒənəl] *adj*. 最初的
dynamic [daɪˈnæmɪk] *adj*. 动态的
indicate [ˈɪndɪkeɪt] *vt*. 标明
regularly [ˈregjələli] *adv*. 定期地
whereas [weəˈæz] *conj*. 然而
ultimately [ˈʌltɪmətli] *adv*. 最终
minimize [ˈmɪnɪmaɪz] *vt*. 减至最低
disadvantage [ˌdɪsədˈvæntɪdʒ] *n*. 缺点;劣势
offset [ˈɒfˌset] *vt*. 抵消;弥补
major [ˈmeɪdʒə] *adj*. 主要的;重要的

random [ˈrændəm] *adj*. 随机的
access [ˈækses] *n*. 访问
configure [kənˈfɪgə] *vt*. 配置
rangingfrom ... to ... 从……变化到……
hybrid [ˈhaɪbrɪd] *adj*. 混合的
consist of ... 由……组成
technique [tekˈniːk] *n*. 技术
approach [əˈprəʊtʃ] *n*. 方法
presence [ˈprezəns] *n*. 存在；出现
absence [ˈæbsəns] *n*. 不存在；缺乏
aluminium [ˌæljuːˈmɪnjəm] *n*. 铝
on a ... basis 按照……方式

Technical Terms

memory [ˈmeməri] *n*. 存储器
magnetic [mægˈnetɪk] *adj*. 有磁性的
optical [ˈɒptɪkəl] *adj*. 光学的
ferroelectric [ˌferəʊɪˈlektrɪk] *adj*. 铁电的
register [ˈredʒɪstə] *n*. 寄存器
cache [kæʃ] *n*. 高速缓存
erasable [ɪˈreɪzəbl] *adj*. 可擦除的
programmable [ˈprəʊgræməbl] *adj*. 可编程的
microcontroller [maɪkrəkənˈtrəʊlə] *n*. 微控器
interface [ˈɪntəˌfeɪs] *n*. 接口
circuitry [ˈsɜːkɪtri] *n*. 电路
bipolar [baɪˈpəʊlə] *adj*. 双极性的
density [ˈdensəti] *n*. 密度
drive [draɪv] *n*. 驱动器
comparator [kəmˈpærətə] *n*. 比较器
router [ˈruːtə] *n*. 路由器
refresh [rɪˈfreʃ] *vt*. 刷新
leakage [ˈliːkɪdʒ] *n*. 泄漏
interval [ˈɪntəvəl] *n*. 间歇
capacitor [kəˈpæsɪtə] *n*. 电容器
lithographic [ˌlɪθəˈgræfɪk] *adj*. 平版印刷的
source [sɔːs] *n*. 信号源
flip flop 触发器
digital circuit 数字电路
address pointer 地址指针
lookup table 查找表
network router 网络路由器
trench capacitor 沟道式电容器
SRAM *abbr*. static random access memory 静态随机存取存储器
DRAM *abbr*. dynamic random access memory 动态随机存取存储器
CMOS *abbr*. complementary metal oxide semiconductor 互补金属氧化物半导体

ECL *abbr*. emitter coupled logic　射极耦合逻辑

CAM [kæm] *abbr*. content addressable memory　内容寻址存储器

EEPROM [ˈiːprɒm] *abbr*. electrically erasable Programmable ROM　电可擦除可编程只读存储器

UV *abbr*. ultraviolet　紫外线

Notes

1. “铁电”(ferroelectric)现象是指:当在某些材料上施加超过特定强度的电场时,该材料就在一个方向上极化或改变原来的极化方向。只要不受干扰,这种极化状态就一直保持下去。
2. “高速缓存”(cache)用于存储频繁使用的或近期使用的数据,从而提高数据存取速度。高速缓存分为两类:处理器中的内部缓存(内存缓存)和主板上的外部缓存(磁盘缓存)。
3. CMOS 集成电路的输出由一个 N 型 MOSFET 和一个 P 型 MOSFET 串联而成。因为 N 型 MOSFET 和 P 型 MOSFET 相互补偿,所以使用“互补”(compementary)来说明它。
4. “内容寻址存储器”(CAM)用于实现高速查找表,其容量要明显小于 DRAM 或 SRAM。
5. 作动词时,present 意为“展示”“呈现”。作形容词时,present 意为“出现的”“存在的”;其名词形式为 presence。absent 是 present 的反义词,其名词形式为 absence。
6. simultaneously 源自形容词 simultaneous。以-aneous 结尾的常用形容词还有 spontaneous(“自发的”)和 instantaneous(“立即的”)。例如,“这种液体自发燃烧”(The liquid *spontaneously* ignited)“立即反应”(an *instantaneous* response/reply/reaction)。
7. whereas 用来连接对比句,可译作“而……”。例如,“旧方法很复杂,而新方法很简单”(The old system was complicated, *whereas* the new system is very simple)。
8. mask 可译作“掩模”“掩码”或“掩蔽”。此处是指芯片制造过程中的掩模。

Lesson 3　Microprocessors

A microprocessor is a complete computation engine that is fabricated on a single chip.[1] The first microprocessor was the Intel 4004, introduced in 1971. The 4004 was not very powerful — all it could do was add and subtract, and it could only do that 4 bits at a time. But it was amazing that everything was on one chip. Prior[2] to the 4004, engineers built computers either from collections of chips or from discrete components. The 4004 powered one of the first portable electronic calculators.

The first microprocessor to make it into a home computer was the Intel 8080, a complete 8-bit computer on one chip, introduced in 1974. The first microprocessor to make a realsplash in the market was the Intel 8088, introduced in 1979 and incorporated into the IBM PC. The PC market moved from the 8088 to the 80286 to the 80386 to the 80486 to the Pentium to the

Pentium Ⅱ to the Pentium Ⅲ to the Pentium 4. All of these microprocessors are made by Intel and all of them are improvements on the basic design of the 8088. The Pentium 4 can execute any piece of code that ran on the original 8088, but it does it about 5,000 times faster! Table 1.2 shows the differences between the different processors that Intel has introduced over the years.

Table 1.2 Intel x86 microprocessors

Name	Date	Transistors	Microns[3]	Clock speed	Data width[4]	MIPS[5]
8080	1974	6,000	6	2 MHz	8 bit	0.64
8088	1979	29,000	3	5 MHz	16 bit/8-bit bus	0.33
80286	1982	134,000	1.5	6 MHz	16 bit	1
80386	1985	275,000	1.5	16 MHz	32 bit	5
80486	1989	1,200,000	1	25 MHz	32 bit	20
Pentium	1993	3,100,000	0.8	60 MHz	32 bit/64-bit bus	100
Pentium Ⅱ	1997	7,500,000	0.35	233 MHz	32 bit/64-bit bus	～300
Pentium Ⅲ	1999	9,500,000	0.25	450 MHz	32 bit/64-bit bus	～510
Pentium 4	2000	42,000,000	0.18	1.5 GHz	32 bit/64-bit bus	～1,700
Pentium 4 "Prescott"	2004	125,000,000	0.09	3.6 GHz	32 bit/64-bit bus	～7,000

From this table you can see that, in general, there is a relationship between clock speed and MIPS. The maximum clock speed is a function[6] of the manufacturing process and delays within the chip. There is also a relationship between the number of transistors and MIPS. For example, the 8088 clocked at 5 MHz but only executed at 0.33 MIPS (about one instruction per 15 clock cycles). Modern processors can often execute at a rate of two instructions per clock cycle. That improvement is directly related to the number of transistors on the chip.

Inside a Microprocessor

A microprocessor executes a collection of machine instructions that tell the processor what to do. Based on the instructions, a microprocessor does three basic things:

- Using its ALU (Arithmetic/Logic Unit), a microprocessor can perform mathematical operations like addition, subtraction, multiplication and division. Modern microprocessors contain complete floating point processors that can perform extremely sophisticated operations on large floating point numbers.
- A microprocessor can move data from one memory location to another.
- A microprocessor can make decisions and jump to a new set of instructions based on those decisions.

There may be very sophisticated things that a microprocessor does, but those are its three basic activities. Figure 1.2 shows an extremely simple microprocessor capable of doing[7] those three things. This microprocessor has an address bus that sends an address to memory, a data bus that can send data to memory or receive data from memory, an RD (read) and WR (write) line to tell the memory whether it wants to set or get the addressed location, a clock line that lets a clock pulse sequence the processor and a reset[8] line that resets the program counter to zero (or whatever) and restarts execution. And let's assume that both the address and data buses are 8 bits wide here.

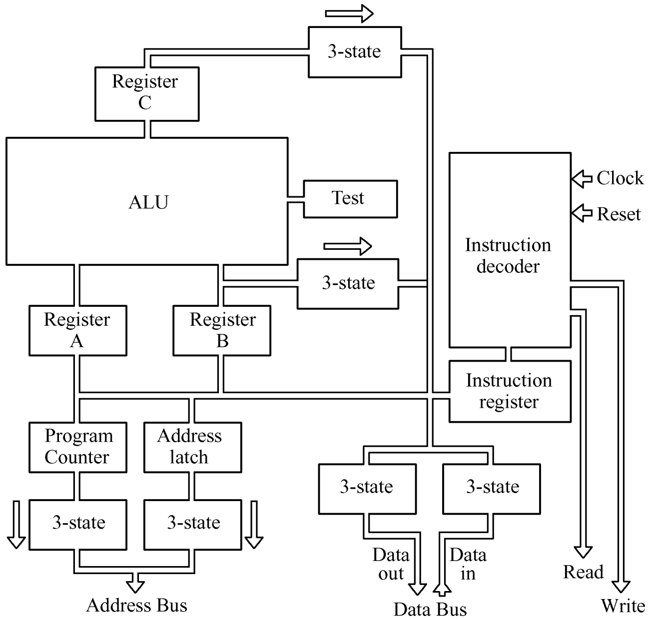

Figure 1.2 A simple microprocessor

Here are the components of this simple microprocessor:

- Registers A, B and C are simply latches made out of flip-flops.
- The address latch is just like registers A, B and C.
- The program counter is a latch with the extra ability to increment by 1 when told to do so, and also to reset to zero when told to do so.
- The ALU could be as simple as an 8-bit adder, or it might be able to add, subtract, multiply and divide 8-bit values. Let's assume the latter here.
- The test register is a special latch that can hold values from comparisons performed in the ALU. An ALU can normally compare two numbers and determine if they are equal, if one is greater than the other, etc. The test register can also normally hold a carry bit from the last stage of the adder. It stores these values in flip-flops and then the instruction decoder can use the values to make decisions.
- There are six boxes marked "3-State" in the diagram. These are tri-state buffers[9]. A tri-state buffer can pass a 1, a 0 or it can essentially disconnect its output. A tri-state buffer allows multiple outputs to connect to a wire, but only one of them to actually drive a 1 or a 0 onto the line.
- The instruction register and instruction decoder are responsible for controlling all of the other components.

Although they are not shown in this diagram, there would be control lines from the instruction decoder that would:

1. Tell the A register to latch the value currently on the data bus
2. Tell the B register to latch the value currently on the data bus
3. Tell the C register to latch the value currently on the data bus
4. Tell the program counter register to latch the value currently on the data bus
5. Tell the address register to latch the value currently on the data bus
6. Tell the instruction register to latch the value currently on the data bus
7. Tell the program counter to increment
8. Tell the program counter to reset to zero
9. Activate any of the six tri-state buffers (six separate lines)
10. Tell the ALU what operation to perform
11. Tell the test register to latch the ALU's test bits
12. Activate the RD line
13. Activate the WR line

Coming into the instruction decoder are the bits from the test register and the clock line, as well as the bits from the instruction register.

RAM and ROM

The address and data buses, as well as the RD and WR lines connect either to RAM or ROM — generally both. In our sample microprocessor, we have an address bus 8 bits wide and a data bus 8 bits wide. That means that the microprocessor can address (2^8) 256 bytes of memory, and it can read or write 8 bits of the memory at a time. Let's assume that this simple microprocessor has 128 bytes of ROM starting at address 0 and 128 bytes of RAM starting at address 128.

ROM stands for read-only memory. A ROM chip is programmed with apermanent collection of pre-set bytes. The address bus tells the ROM chip which byte to get and place on the data bus. When the RD line changes state, the ROM chip presents the selected byte onto the data bus.

RAM stands for random-access memory. RAM contains bytes of information, and the microprocessor can read or write to those bytes depending on whether the RD or WR line issignaled. One problem with today's RAM chips is that they forget everything once the power goes off. That is why the computer needs ROM.

By the way, nearly all computers contain some amount of ROM (it is possible to create a simple computer that contains no RAM — many microcontrollers do this by placing a handful of RAM bytes on the processor chip itself — but generally impossible to create one that contains no ROM). On a PC, the ROM is called the BIOS (basic input/output system). When the microprocessor starts, it begins executing instructions it finds in the BIOS. The BIOS instructions do things like test the hardware in the machine, and then it goes to the hard disk to fetch the boot sector. This boot sector is another small program, and the BIOS stores it in

RAM after reading it off the disk. The microprocessor then begins executing the boot sector's instructions from RAM. The boot sector program will tell the microprocessor to fetch something else from the hard disk into RAM, which the microprocessor then executes, and so on. This is how the microprocessor loads and executes the entire operating system.

Microprocessor Instructions

Even the incredibly simple microprocessor shown here will have a fairly large set of instructions that it can perform. The collection of instructions is implemented as bit patterns, each one of which has a different meaning when loaded into the instruction register. Humans are not particularly good at remembering bit patterns, so a set of short words are defined to represent the different bit patterns. This collection of words is called the assembly language of the processor. An assembler can translate the words into their bit patterns very easily, and then the output of the assembler is placed in memory for the microprocessor to execute. If you use C language programming, a C compiler will translates the C code into assembly language.

So now the question is, "How do all of these instructions look in ROM?" Each of these assembly language instructions must be represented by a binary number. These numbers are known as opcodes. The instruction decoder needs to turn each of the opcodes into a set of signals that drive the different components inside the microprocessor. Let's take the ADD instruction as an example and look at what it needs to do:

1. During the first clock cycle, we need to actually load the instruction. Therefore the instruction decoder needs to:
   1) activate the tri-state buffer for the program counter
   2) activate the RD line
   3) activate the data-in tri-state buffer
   4) latch the instruction into the instruction register
2. During the second clock cycle, the ADD instruction is decoded. It needs to do very little:
   1) set the operation of the ALU to addition
   2) latch the output of the ALU into the C register
3. During the third clock cycle, the program counter is incremented (in theory this could be overlapped into the second clock cycle).

Every instruction can be broken down as a set of sequenced operations like these that manipulate the components of the microprocessor in the proper order. Some instructions, like this ADD instruction, might take two or three clock cycles. Others might take five or six clock cycles.

Microprocessor Performance

The number of transistors available has a huge effect on the performance of a processor. As seen earlier, a typical instruction in a processor like an 8088 took 15 clock cycles to execute. Because of the design of the multiplier, it took approximately 80 cycles just to do one 16-bit multiplication on the 8088. With more transistors, much more powerful multipliers capable of single-cycle speeds become possible.

More transistors also allow for a technology called pipelining. In a pipelined architecture, instruction execution overlaps. So even though it might take five clock cycles to execute each instruction, there can be five instructions in various stages of execution simultaneously. That way it looks like one instruction completes every clock cycle.

Many modern processors have multiple instruction decoders, each with its own pipeline. This allows for multiple instruction streams, which means that more than one instruction can complete during each clock cycle. This technique can be quite complex to implement, so it takes lots of transistors.

The trend in processor design has been toward full 32-bit ALUs with fast floating point processors built in and pipelined execution with multiple instruction streams. There has also been a tendency toward special instructions that make certain operations particularly efficient. There has also been the addition of hardware virtual memory support and L1 caching on the processor chip. All of these trends push up the transistor count, leading to the multi-million transistor powerhouses available today. These processors can execute about one billion instructions per second!

The newest thing in processor design is 64-bit ALUs. Sixty-four-bit processors have been with us since 1992, and in the 21st century they have started to become mainstream. Both Intel and AMD have introduced 64-bit chips. Sixty-four-bit processors have 64-bit ALUs, 64-bit registers, 64-bit buses and so on.

New Words & Expressions

computation [ˌkɒmpjəˈteɪʃən] *n*. 计算
fabricate [ˈfæbrɪkeɪt] *vt*. 构造
at a time　一次
improvement [ɪmˈpruːvmənt] *n*. 改进
in general　大体上
relationship [rɪˈleɪʃənʃɪp] *n*. 关系;联系
maximum [ˈmæksɪməm] *adj*. 最大的
at a rate of...　以……的速率
related to ...　与……相关
a collection of ...　一批……
Based on...,...　依据……,……
sophisticated [səˈfɪstɪˌkeɪtɪd] *adj*. 复杂巧妙的
assume [əˈsjuːm] *vt*. 假定
increment [ˈɪŋkrɪmənt] *n*. 增量;增加
stand for ...　代表……
permanent [ˈpəːmənənt] *adj*. 永久的
implement [ˈɪmplɪmənt] *vt*. 实现;实施
define [dɪˈfaɪn] *vt*. 定义
represent [ˌreprɪˈzent] *vt*. 代表;表示
overlap [ˌəʊvəˈlæp] *vt*. 重叠
manipulate [məˈnɪpjəˌleɪt] *vt*. 操纵;使用
in the proper order　按照正确顺序
has a huge effect on ...　对……产生巨大影响
performance [pəˈfɔːməns] *n*. 性能
As seen earlier, ...　如前所见,……
approximately [əˈprɒksɪmətli] *adv*. 大约
allow for ...　考虑到……
architecture [ˈɑːkɪˌtektʃə] *n*. 体系结构

comparison [kəm'pærɪsən] *n*. 比较;对比
normally ['nɔːməli] *adv*. 通常
diagram ['daɪəgræm] *n*. 示意图
essentially [ɪ'senʃəli] *adv*. 基本上
responsible for ... 负责……
currently['kʌrəntli] *adv*. 当前;时下
simultaneously [ˌsaɪməl'teɪniəsli] *adv*. 同时地
trend [trend] *n*. 趋势;动态
tendency['tendənsi] *n*. 趋向;偏好
efficient [ɪ'fɪʃənt] *adj*. 高效的
virtual ['vɜːtʃʊəl] *adj*. 虚拟的
mainstream ['meɪnˌstriːm] *n*. 主流

Technical Terms

microprocessor [maɪkrəʊ'prəʊsesə] *n*. 微处理器
execute ['eksɪˌkjuːt] *vt*. 执行
micron ['maɪkrɒn] *n*. 微米;10^{-6}米
instruction [ɪn'strʌkʃən] *n*. 指令
addition [ə'dɪʃən] *n*. 加法
subtraction [səb'trækʃən] *n*. 减法
multiplication [ˌmʌltəplɪ'keɪʃən] *n*. 乘法
division [dɪ'vɪʒən] *n*. 除法
pulse [pʌls] *n*. 脉冲
sequence ['siːkwəns] *n*. 序列
counter ['kaʊntə] *n*. 计数器
decoder [diː'kəʊdə] *n*. 译码器
buffer ['bʌfə] *n*. 缓存器
activate ['æktɪveɪt] *vt*. 激活
assembler [ə'semblə] *n*. 汇编器
compiler [kəm'paɪlə] *n*. 编译器
multiplier ['mʌltɪˌplaɪə] *n*. 乘法器
pipelining ['paɪpˌlaɪnɪŋ] *n*. 流水线技术
discrete component 分立元件
machine instruction 机器指令
floating point processor 浮点处理器
memory location 存储器位置
program counter 程序计数器
address latch 地址锁存器
test register 测试寄存器
carry bit 进位位
instruction decoder 地址译码器
boot sector 引导扇区
operating system 操作系统
bit pattern 比特模式;位模式

assembly language　汇编语言
binary number　二进制数
clock cycle　时钟周期
virtual memory　虚拟内存
MIPS [mɪps] *abbr*. million instructions per second　每秒百万条指令数
ALU *abbr*. arithmetic/logic unit　算术逻辑单元
ROM [rɒm] *abbr*. read-only memory　只读存储器
RAM [ræm] *abbr*. random access memory　随机存取存储器
BIOS [ˈbaɪɒs] *abbr*. basic input/output system　基本输入/输出系统
opcode [ˈɒpkəʊd] *abbr*. operation code　操作码

Notes

1. 此句涉及如何进行术语定义。正式定义采用完整句子形式给出该术语的名称、类属和特征。正式定义可分为四种类型：(1)"组成型"(A resistor is a device that *is composed of a highly resistive material designed to have a definite amount of resistance.*)；(2)"类比型"(A resistor is a device that *absorbs electric energy very much like a damping device used in door opener to absorb mechanical energy or in cars for shock absorption* .)；(3)"对比型"(A resistor is a device *used for dissipating energy, unlike a capacitor that is used for storing electric energy.*)；(4)"功能型"(A resistor is a device *used in circuits to limit and create opposition to current flow or provide voltage drop.*)。除"正式定义"外，还有"非正式定义"(在括号中以单词或短语的形式给出该术语的近义词等最简信息)和"扩展定义"(在正式定义的基础上扩充几段有关历史背景、应用领域、组成部件、图形描述、基本原理、实例展示或术语比照等方面的内容)。简单术语仅需"非正式定义"，复杂术语则要进行"正式定义"或"扩展定义"。
2. prior 可表示时间上"更早的"或作用上"更重要的"，如"预先通知"(*prior* notice)、"事先安排"(*prior* arrangement)、"事先书面许可"(*prior* written consent)等。短语 prior to sth.表示在某个时间之前或者在某个事件之前。此句可译为"在 4004 出现之前，工程师要用一组芯片或一组分立部件构建计算机"。
3. "微米"(micron)用于度量芯片内最小线宽。其值越小，芯片内集成的晶体管就越多。
4. "数据宽度"(data width)，这里是指 ALU 字长。一般而言，外部数据总线宽度和 ALU 数据宽度相同。但是，也存在例外情况。例如，8088 ALU 为 16 bit，其外部数据总线为 8 bit。又如，Pentium ALU 为 32 bit，其外部数据总线为 64 bit。
5. "每秒百万条指令数"(MIPS)是表征微处理器性能的指标之一。鉴于现代微处理器的种类繁多、结构各异，MIPS 指标能反映出来的信息是粗略的。
6. 在数学中，function 表示"函数"，如"三角函数"(trigonometric *function*)等。Y is a function of X 可译作"Y 是 X 的函数"，在这里可译作"Y 取决于 X"。
7. be capable of (doing)*sth*.用于表示人、机构或器物的能力，如"十级风能够掀翻屋顶"(A force ten wind *is capable of* blowing the roofs off houses.)。而 be able to do *sth*.只用

于表示人的能力，如“她能应对此项工作吗？”（Will she *be able to* cope with the work?）。此外，be capable of (doing) *sth*. 还可以表示“可能性”，(the) capability to do *sth*.则表示“做……的能力”。

8. “复位”(reset)是指“使系统状态处于指定的初始值”。
9. “三态缓存器”(tri-state buffer)用来控制向总线输出信号。当控制位有效时，输入信号通过三态缓存器向总线输出；当控制位无效时，三态缓存器输出端呈现高阻状态（记作Z)，即不向总线输出任何信号。

Exercises

1. Fill in the blanks with proper words, phrases or clauses.

(1)The microprocessor is the central ________(部件)of the PC.________(你做的全部工作)on your computer is performed directly or ________ by the processor. Obviously, it is one of the most important components of the PC, ________(如果不是)the most important. It is also, scientifically, not only one of the most ________(令人惊奇的)parts of the PC, but one of the most amazing ________ (器件)in the world of technology.

The processor ________(扮演重要的角色)in the following important ________(方面)of your computer system.

Performance: The processor is probably the most important single ________(决定性的因素) of system performance in the PC. ________ other components also play a key role in determining performance, the processor's capabilities ________ (控制) the maximum performance of a system. The other devices only allow the processor to ________(达到它的全部潜能).

Software Support: Newer, faster processors ________ the use of the latest software. ________ addition, new processors ________ the Pentium with MMX Technology, enable the use of specialized software not usable on earlier machines.

Reliability and Stability: The quality of the processor is one factor that determines ________(系统运行的可靠性). While most processors are very ________(可靠的), some are not. This also depends ________(在某种程度上)on the age of the processor and how much energy it ________(消耗).

Energy Consumption and Cooling: Originally processors consumed relatively little power compared ________ other system devices. Newer processors can consume ________(大量的) power. Power consumption has an impact ________ everything from cooling method selection to overall system reliability.

Motherboard Support: The processor you decide to use in your system will be a ________(主要的) determining factor in what sort of chipset you must use, and hence what motherboard you buy. The motherboard ________(反过来)dictates many facets of your system's capabilities and performance.

(2)Flash memory is a ________(固态的)storage device — everything is ________(电子

的). Flash memory provides a ________(非易失的), reliable, low power, low cost, ________(高密度)storage device for programmable ________(代码和数据), ________ it extremely useful in the ________(嵌入式)marketplace. The most noticeable attribute ________ the flash part is its ________ to retain data without the need for power or battery ________(备份).

________(从开发者的角度看), it may be important to store data ________ it can be retrieved at a later time, so they use flash memory. (However, flash memory isn't the only method to accomplish the ________(离线的)storage of data.)

The disadvantage of flash memory is ________ it is very difficult to program. Care must be ________ when reading and writing, ________ there are special procedures which need to be performed in order to get the data on the part. ________ (因为)the characteristics of the part, it is impossible to write and then immediately overwrite data. In order to write new data to flash existing data must be ________ first. The erase process must be done using large blocks of memory. ________ just erasing a portion of the part, you must erase entire sections. This cumbersome process of read/erase/write can get very complicated when there are ________(重复的)write operations being performed.

Another aspect of flash memory ________(必须要考虑的)is its life expectancy: Continuous erasing can ________ (对……产生破坏性的影响) a flash part. ________(对任一给定的闪存), there is a limit ________ the total number of erase operations that may be performed on a particular erase sector before it becomes unreliable ________ damaged.

Despite the complications, there are many advantages to flash memory, so why don't we just use flash memory for everything? The cost per megabyte for a hard disk is cheaper, and the capacity is much greater.

2. Translate the following passages into Chinese or English.

(1) Many of the products and services in modern society are based upon the work of electrical engineers and computer scientists. The tremendous reduction over the last decade in the cost of digital electronic devices has led to an explosive growth in the use of computers and computation. At the same time, our increased understanding of computer science has made possible the development of new software systems of increased power, sophistication, and flexibility.

(2) In November 1971, Intel introduced the world's first commercial microprocessor, the 4004, invented by three Intel engineers. Primitive by today's standards, it contained a mere 2,300 transistors and performed about 60, 000 calculations in a second. Today, the microprocessor is the most complex mass-produced product ever, with millions of transistors performing hundreds of millions of calculations each second.

(3) Microprocessors are the brains of your personal computer. Here on this tiny silicon chip are millions of switches and pathways that help your computer make important decisions and perform helpful tasks. And microprocessors don't just think for computers — you might find a processor in many other everyday items like your telephone or car.

(4) Memory is the component of a computer (and an embedded system) that is used to

store and retain information. There is always a need to store information in an embedded application, so there will always be some type of memory in the design. Many types of memory are available, thus there are many choices for embedded customers.

(5) Memory can be split into two main categories: volatile and non-volatile. Volatile memory loses its content when the system is powered off. Most types of RAM fall into this category. Non-volatile memory does not lose its data when the system or device is turned off.

(6) 现代电子系统数字化程度越来越高，复杂程度也极高。要是没有超大规模芯片技术，这是无法想象的。现代电子系统太复杂了，其设计原理很像大型软件系统设计。在许多方面，计算机科学和电子系统设计需要相同的背景知识。而作为一个不断扩展的工程领域，现代电子系统设计也离不开计算机辅助设计。

(7) 芯片是一小片嵌入了集成电路的半导体材料。芯片的典型尺寸不超过 1 平方英寸，却能包含几百万只晶体管。芯片类型丰富，例如，CPU 芯片包含一个完整的处理单元；而存储芯片包含空白的存储单元。

(8) 微处理器是一片包含 CPU 的硅片。区分微处理器的基本特征有三个：指令集、带宽和时钟速度。

(9) “使用闪存、不用硬盘”的原因有几个。闪存的速度更快、没有噪声、重量更轻、尺寸更小，也不存在可动部件。

(10) 在计算机系统中，存储器是用来运行程序、存储数据的部件。随机存取存储器芯片构成了主存储器。存储器的可用容量决定了运行程序的大小以及能否一次运行多个程序。主存储器暂时存储数据。一旦关闭计算机，数据就丢失了。它不同于内部只读存储器、外部存储器，后者的数据存储时间要长久。只读存储器包含计算机的核心程序。总之，任何以机器可读方式存储数据的设备都可称为“存储器”。

3. Writing tasks

Summary: Write an abstract for *Lesson* 1 *VLSI Technology* within 150～200 words.

Composition: Write an essay about some kind of electronic devices which you are familiar with.

Reading Materials

Passage 1 The Digital Age

The Birth of Digital Age

During the middle of the 20^{th} century, mathematicians and engineers discovered a process for converting most physical quantities found in the world (such as sound waves, light intensity, forces, voltage, current, or charge) to numbers or digits. This discovery should not be surprising, since scientists had been using mathematics to describe the physical world for centuries. This remarkable, yet simple, discovery was the mathematical foundation that gave birth to the digital age. There are many advantages to "digitizing" analog quantities. For example:

1. Numbers are much less sensitive to physical problems caused by the physical nature of the device used to store or manipulate them.
2. Numbers are easier to store than an equivalent physical "amount" of something.
3. Numbers can be moved through space, using electronic, optical, or acoustic means.

Still a Long Way to Go

Unfortunately, there was a major problem in building new digital devices when they were first conceived. Engineers just didn't have the right parts to build new digital systems. Not to be deterred, engineers working during the first half of the 20th century tried the smart and reasonable thing: They attempted to use readily available vacuum tubes as basic digital building blocks. Following this approach, in 1945, engineers successfully produced the first digital computer, called the ENIAC (see Figure 1.3). It was built out of more than 17,000 vacuum tubes, weighed 30 tons, and filled a 30-by-50-foot room. Just think of the heat produced by 17,000 light-bulbs all burning in the same room!

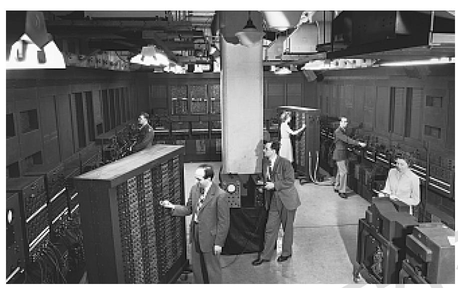
Figure 1.3 The first digital computer — ENIAC

While primitive by today's standards, the ENIAC was a major advance in engineering and technology. Never before in human history could we do math so fast and so accurately. While the ENIAC opened up new digital horizons for society, these first computers were so large and so expensive that only governments and the largest of companies could ever hope to own or even use one.

The Transistor Replaced the Vacuum Tube

What the digital age needed was a truly digital component that could replace the vacuum tube. It would have to run fast, use much less power than the vacuum tube, and, most importantly, be small and inexpensive. Fortunately, in 1947 engineers at AT&T's Bell Laboratories developed that component, called the transistor. Its creation changed the world for ever. Bill Shockley, Walter Brattain, and John Bardeen won the Nobel Prize in 1956 for their joint discovery and development of the transistor, which, within a few decades, had completely replaced the vacuum tube in nearly every piece of technology.

Now, engineers could unleash their imaginations to create smaller, portable devices that could run on the relatively small amounts of energy contained in batteries and were rugged in normal use. For this reason, many people believe that the transistor is the most important invention of the 20^{th} century. Just look around you today to see the nearly infinite array of small gadgets and pieces of technology built from transistors.

The Integrated Circuit (IC)

As engineers designed devices for more complex tasks, such as in robotics or medicine, the resulting systems required ever more transistors. This push for more transistors made the devices large and hard to wire together. The next critical step forward into the digital age was the ability to put many transistors onto a single small part that could be used for these increasingly complex tasks. Jack Kilby accomplished this remarkable feat in 1958 at Texas Instruments when he invented the integrated circuit, or IC, as shown in Figure 1.4(a). For this discovery, Kilby was awarded the 2000 Nobel Prize in physics. This groundbreaking invention was coined the "integrated circuit" because it cleverly integrated many parts, typically transistors, into a single small package like that shown in Figure 1.4(b).

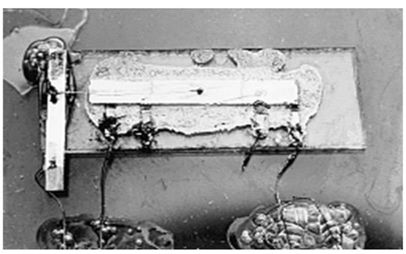

Figure 1.4(a) The first integrated circuit

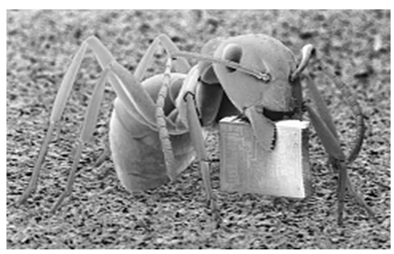

Figure 1.4(b) A modern integrated circuit

With the invention of the IC, engineers were able to undertake more complicated designs, because they now had modern digital parts that could do significantly more complicated math on the newly digitized version of the real analog world. Interestingly, the integrated circuit has become so pervasive in devices from computers to anti-lock brakes that it is difficult to find individual transistors in modern technology today — they are now all part of integrated circuits.

Questions:

1. What advantages does the digital technology have?
2. Which are the building blocks of ENIAC, vacuum tubes or transistors?
3. What does the term *gadget* mean in this article?

4. Why is the transistor regarded as the 20^{th} century's most important invention?

5. What does the acronym IC stand for in electronics?

Passage 2 Flash Memory

Electronic memory comes in a variety of forms to serve a variety of purposes. Flash memory is used for easy and fast information storage in such devices asdigital cameras and home video game consoles. It is used more as a hard drive than as RAM. In fact, flash memory is considered a solid state storage device. Solid state means that there are no moving parts—everything is electronic instead of mechanical. Flash memory is a type of EEPROM chip. It has a grid of columns and rows with a cell that has two transistors at each intersection. The two transistors are separated from each other by a thin oxide layer. One of the transistors is known as a floating gate, and the other one is the control gate. The floating gate's only link to the row, or wordline, is through the control gate. As long as this link is in place, the cell has a value of 1. To change the value to a 0 requires a curious process called Fowler-Nordheim tunneling.

Tunneling is used toalter the placement of electrons in the floating gate. An electrical charge, usually 10 to 13 volts, is applied to the floating gate. The charge comes from the column, or bitline, enters the floating gate and drains to a ground.

This charge causes the floating-gate transistor to act like an electron gun. The excited electrons are pushed through and trapped on other side of the thin oxide layer, giving it a negative charge. These negatively charged electrons act as a barrier between the control gate and the floating gate. A special device called a cell sensor monitors the level of the charge passing through the floating gate. If the flow through the gate is greater than 50 percent of the charge, it has a value of 1. When the charge passing through drops below the 50-percent threshold, the value changes to 0. A blank EEPROM has all of the gates fully open, giving each cell a value of 1.

The electrons in the cells of a Flash-memory chip can be returned tonormal ("1") by the application of an electric field, a higher-voltage charge. Flash memory uses in-circuit wiring to apply the electric field either to the entire chip or to predetermined sections known as blocks. This erases the targeted area of the chip, which can then be rewritten. Flash memory works much faster than traditional EEPROMs because instead of erasing one byte at a time, it erases a block or the entire chip, and then rewrites it.

Although standards are flourishing, there are many Flash-memory products that are completely proprietary in nature. But it is good to know that as electronic components become increasingly interchangeable and learn to communicate with each other, standardized removable memory will allow you to keep your world close at hand.

Questions:

1. What does the author mean by saying *It is used more as a hard drive than as RAM*?

2. What does the term *solid state device* refer to?

3. Which is the normal state in a Flash-memory chip, "1" or "0"?

4. How does flash memory manage to work faster than traditional EEPROMs?

5. What's the difference between a flash memory and a flash RAM?

Passage 3 Microcontrollers

Microcontrollers are special purpose computers, which do one thing well. If a computer matches a majority of these characteristics, then you can call it a microcontroller:

- Microcontrollers are "embedded" inside some other device (often a consumer product) so that they can control the features or actions of the product.
- Microcontrollers are dedicated to one task and run one specific program. The program is stored in ROM and generally does not change.
- Microcontrollers are often low-power devices. A desktop computer is almost always plugged into a wall socket and might consume 50 watts of electricity. A battery-operated microcontroller might consume 50 milliwatts.
- A microcontroller has a dedicated input device and often (but not always) has a small LED or LCD display for output. For example, the microcontroller inside a TV takes input from the remote control and displays output on the TV screen. The controller controls the channel selector, the speaker system and certain adjustments on the picture tube electronics such as tint and brightness.
- A microcontroller is often small and low cost. The components are chosen to minimize size and to be as inexpensive as possible.
- A microcontroller is often, but not always, ruggedized in some way.

The microcontroller controlling a car's engine, for example, has to work in temperature extremes that a normal computer generally cannot handle. A car's microcontroller in Alaska has to work fine in -30 degree F (−34℃) weather, while the same microcontroller in Nevada might be operating at 120 degrees F (49℃).

The actual processor used to implement a microcontroller can vary widely. In many products, such as microwave ovens, the demand on the CPU is fairly low and price is an important consideration. In these cases, manufacturers turn to dedicated microcontroller chips-chips that were originally designed to be low-cost, small, low-power, embedded CPUs. The Motorola 6811 and Intel 8051 are both good examples of such chips. There is also a line of popular controllers called "PIC microcontrollers" created by a company called Microchip. By today's standards, these CPUs are incredibly minimalistic; but they are extremely inexpensive when purchased in large quantities and can often meet the needs of a device's designer with just one chip.

Questions:

1. How is a microcontroller defined?

2. What functions does the microcontroller inside a TV perform?

3. Why does a microcontroller often require being ruggedized in some way?

4. What kinds of products are dedicated microcontroller chips often applied to?

5. What does the acronym LED mean in this article?