计算机系列教材

计算机新技术教程

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清华大学出版社

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内容简介

本书精选和提炼了目前计算机专业领域最新的研究成果和学术进展，内容取材广泛，难易适中，每单元各具特色。通过对文章中专业词汇、语法结构的介绍和分析，为读者将来在信息技术以及相关研究方向的英文资料的阅读、翻译和写作等能力提供了重要的支撑和保证。本书结合作者多年计算机教学和科研中的宝贵经验，以及与国外学术交流的体会总结，在保证本书专业知识领先的同时，更着重体现了内容的实用性和针对性。读者在提高专业英语读、写、译水平的同时，可通过本书及时地跟踪 IT 领域内的顶尖技术，把握学术上的研究热点，确立未来的学习和科研方向。

本书面向的读者是高校信息技术相关专业的本科生、大专生或是从事软、硬件开发及相关领域的工程技术人员，通过对每个单元中英文文献专题的引入、分析和解决问题的过程，培养和提高读者在专业英语方面的阅读、翻译和写作的综合能力。

图书在版编目(CIP)数据

计算机新技术教程：英文/汤晓兵，徐遵义主编. —北京：清华大学出版社，2016
计算机系列教材
ISBN 978-7-302-43410-8

Ⅰ. ①计…　Ⅱ. ①汤…　②徐…　Ⅲ. ①计算机技术—教材—英文　Ⅳ. ①TP3

中国版本图书馆 CIP 数据核字(2016)第 075218 号

责任编辑：白立军　李　晔
封面设计：常雪影
责任校对：时翠兰
责任印制：刘海龙

出版发行：清华大学出版社
网　　址：http://www.tup.com.cn，http://www.wqbook.com
地　　址：北京清华大学学研大厦 A 座　　**邮　　编**：100084
社 总 机：010-62770175　　**邮　　购**：010-62786544
投稿与读者服务：010-62776969，c-service@tup.tsinghua.edu.cn
质量反馈：010-62772015，zhiliang@tup.tsinghua.edu.cn
课件下载：http://www.tup.com.cn，010-62795954
印 装 者：北京嘉实印刷有限公司
经　　销：全国新华书店
开　　本：185mm×260mm　　**印　　张**：13　　**字　　数**：299 千字
版　　次：2016 年 8 月第 1 版　　**印　　次**：2016 年 8 月第 1 次印刷
印　　数：1～2000
定　　价：29.00 元

产品编号：068059-01

《计算机新技术教程》前言

本书在学习目标上有两个方面：一是从语言的角度来进行文章中英语的学习；二是对计算机专业领域相关知识的介绍，后者涵盖了从计算机的基本硬件和软件系统组成到计算机发展的前沿技术。在具体实施中，通过对这两个方面的交互渗透，在学好英语语义、语法的同时，让读者学习不同研究方向的计算机专业文献，对知识进行综合的学习和掌握，培养和提高读者在英文阅读、写作和翻译三个方面的专业英语综合学习和工作能力。

本书共分 12 个单元：第 1 单元硬件基础（Hardware），第 2 单元软件基础（Software），第 3 单元数据库（Database）为汤晓兵副教授编写，第 4 单元程序设计（Programming），第 5 单元办公计算（Office Computing），第 6 单元计算机网络（Networking）为徐遵义副教授编写，第 7 单元移动设备计算（Mobile Application）为赵洪銮副教授编写，第 8 单元网络开发（Web Development）为袁卫华讲师编写，第 9 单元计算机安全（Security）为王庆东高级工程师编写，第 10 单元网络服务（Web Services）为詹玲讲师编写，第 11 单元大数据（Big Data）为白彧助理研究员编写，第 12 单元云计算（Cloud Computing）为康喆讲师编写。汤晓兵、袁卫华和徐晓静编写了每单元后针对词汇、语法结构和单元综述的测试与练习。汤晓兵负责全书的统稿。

在本书的编写过程中，得到了清华大学出版社的编辑以及刘祥昭老师的大力支持和帮助，在此对他们表示由衷的感谢。同时，感谢我的父母、妻子和双胞胎儿子们。在我编辑忙碌的时候，是他们的关心和爱护，支持着我集中精力、全力以赴地把书稿顺利完成。

由于编者水平有限，书中的缺点和不足难免，恳请读者指正。

编　者

目 录

Unit 1 Hardware—Microwave Integrated Circuits

This chapter covers the following topics:

- 1.1 Classification of Microwave Integrated Circuits
- 1.2 Microwave Circuits in a Communication System
- 1.3 Summary

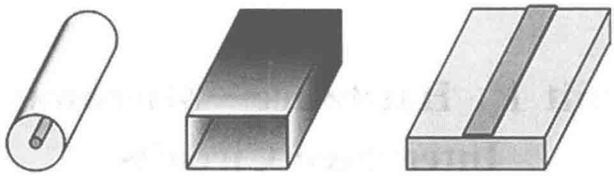
1.1 Classification of Microwave Integrated Circuits

An active microwave circuit can be defined as a circuit in which active and passive microwave devices such as resistors, capacitors, and inductors are interconnected by transmission lines. At low frequencies, the transmission lines are a simple connection; however, at microwave frequencies they are no longer just simple connections and their operation becomes a complicated distributed circuit element. As a result, a microwave integrated circuit's classification is based on the fabrication method of the transmission lines used for interconnection.

There are various types of transmission lines in microwave integrated circuits; some common examples are waveguides, coaxial, and microstrip lines. Figure 1.1 shows the transmission lines used in microwave circuits. Although there are special cases of microwave integrated circuits that are composed of coaxial lines and waveguides, in most cases the microwave integrated circuits are formed using planar transmission lines. Therefore, the content of this book is restricted to microwave integrated circuits formed using planar transmission lines, examples of which are microstrip, slot line, and co-planar waveguide (CPW), as shown in Figure 1.2. These planar transmission lines are frequently used in the large-scale production of microwave circuits and generally form the basic transmission lines for microwave circuits.

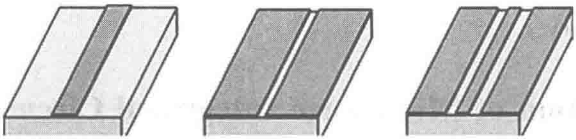
The implementation of planar transmission lines on substrates can be classified into two basic groups: *monolithic* and *hybrid integrated circuits*. In monolithic integration, the active and passive devices as well as the planar transmission lines are grown *in situ* on one planar substrate that is usually made from a semiconductor material called a wafer.

Figure 1.3 shows an example of monolithic integration. Figure 1.3(a) is a photograph of the top side of a wafer and Figure 1.3(b) shows a single monolithic



(a) (b) (c)

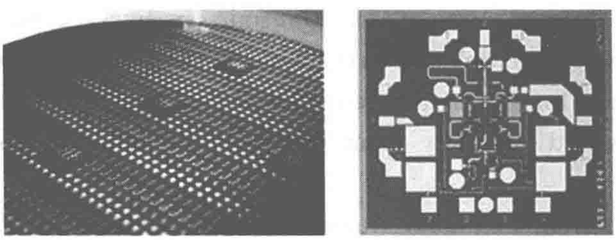
Figure 1.1 Some common transmission lines used in microwave circuits: (a) coaxial line, (b) rectangular waveguide, and (c) microstrip line.



(a) (b) (c)

Figure 1.2 Some common planar transmission lines used in microwave circuits: (a) microstrip, (b) slot line, and (c) CPW (co-planar waveguide).

microwave integrated circuit; the identical circuits are repeatedly produced on the wafer in Figure 1.3(a). The monolithic microwave integrated circuit in Figure 1.3(b) is found to contain active and passive devices, and planar transmission lines. The monolithic integration provides a compact sized circuit and eliminates a significant amount of assembly when building a component or a system. Especially because size is of critical importance in most recent RF systems, monolithic integration is frequently employed to provide a compact component. An advantage of monolithic integration is that it is well suited for large-scale production, which results in lower costs. A disadvantage is that monolithic integration takes a long time to develop and fabricate, and small-scale production results in highly prohibitive costs.



(a) (b)

Figure 1.3 Monolithic integration: (a) a wafer and (b) a monolithic microwave integrated circuit on the wafer.

Hybrid integration is a fabrication method in which the transmission lines are implemented by conductor patterns on a selected substrate with either *printing* or *etching*, and active and passive devices are assembled on the patterned substrate by either soldering or wire bonding. When implementing transmission lines by conductor patterns on a substrate, careful consideration must be given to the substrate material and the conductor material for the transmission lines because these materials can have significant effects on the characteristics of transmission lines. Hybrid integration is thus classified into three types based on the method by which the lines are formed on the substrate: a *printed circuit board* (PCB), a *thick-film* substrate, and a *thin-film* substrate.

Figure 1.4 shows an example of how connection lines are formed on a PCB substrate. Both sides of the dielectric material are attached with copper cladding that is then etched to obtain the desired conductor patterns. For PCB substrate materials, epoxy fiberglass (FR4), teflon, and duroid are widely used. FR4 substrate (a kind of epoxy fiberglass) can be used from lower frequencies to approximately 4 GHz, while teflon or duroid can be used up to the millimeter wave frequencies, depending on their formation. Generally, all these materials lend themselves to soldering while wire bonding for an integrated circuit assembly is typically not widely used. Furthermore, compared with other methods that will be explained later, a PCB can result in lower costs; its fabrication is easy and requires less time to produce. In addition, production on a small scale is possible without the use of expensive assembly machines; it is easy to fix and could also be used in large-scale production, and is thus widely used.

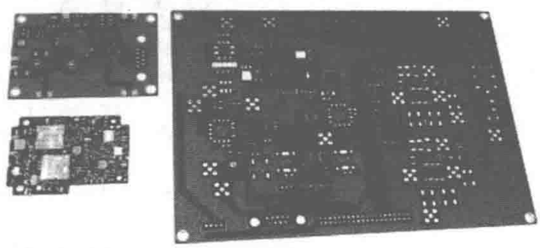


Figure 1.4 A photograph of epoxy fiberglass PCBs.

The PCBs on the left are for the X-band and 2 GHz frequency synthesizers using the phase locked loop. The PCB on the right is for the VHF automatic identification system, which has a similar block diagram shown in Figure 1.7. The power amplifier is implemented in a separate block.

Thick-film substrates are produced by screen-printing techniques in which conductor patterns are formed by pushing conductive paste on a ceramic substrate through a patterned screen and then firing printed conductor patterns. The substrate is called thick film because the patterns formed by such techniques are generally much thicker than those formed using thin-film techniques. As a benefit of using screen-printing techniques, multiple screen printings are possible. Dielectric or resistor patterns can also be formed by similar screen-printing techniques using dielectric or resistor pastes. Using an appropriate order of multiple screen printings, it is also possible to form capacitors and resistors on the ceramic substrate. Since the ceramic substrate is more tolerant of heat, it is easy to assemble active devices in the form of chips. On the other hand, considering the lines and patterns formed by this process, the pattern accuracy of thick film is somewhat inferior compared to that of thin film. The costs and development time, on a case-by-case basis, are somewhere between those of the PCB and thin-film processes. Recently, however, the integration based on thick-film technology has become rare because its cost and pattern accuracy are between the PCB and thin-film technology, while thick film is widely used to build multifunction components. A typical example is the package based on LTCC (low-temperature co-fired ceramics) technology Figure 1. 5 Multilayer ceramics and structuring are possible in LTCC technologies. Figure 1. 5 shows a photograph of thick-film patterned substrates fabricated using the thick-film process.

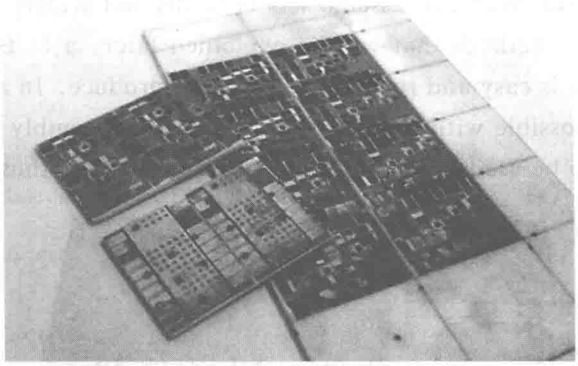


Figure 1.5 A photograph of substrates fabricated by the thick-film process.

The thin-film technique is very widely used in the fabrication of microwave circuits for military and microwave communication systems. In the case of the thin-film process, a similar ceramic substrate material used in thick film is employed, but compared to the thick-film substrate, a fine surface-finish substrate is used. The most widely used substrate is 99% alumina (Al_2O_3). Other substrates such as fused silica, quartz, and so on are possible for conductor-pattern generation based on thin-film technologies. The pattern formation on the substrate is created with a photolithographic process that can produce fine tracks of conductor patterns similar to those in a semiconductor process. Since the thin-film substrate is also alumina as in the case of a thick-film substrate, the assembly of semiconductor chips using wire bonding is possible. Thin film compared with PCB and thick film is more expensive, and due to the requirement of fine tracks, a mask fabrication is necessary and the process generally takes longer. Passive components such as resistors and air-bridge capacitors can be implemented using this process. In addition, integrated circuits produced by the thin-film process require special wire bonders and microwelding equipment for assembly. Compared to the monolithic integration process, the thin-film process tends to be cheaper in terms of cost, but compared to MMIC, the assembled circuit using the thin-film patterned substrate is difficult to characterize precisely because of unknown or poorly described parasitic circuit elements associated with the assembly methods such as wire bonding and die attach. Before the emergence of MMICs (monolithic microwave integrated circuits), thin-film technology was the conventional method for building microwave-integrated circuits (MICs). Figure 1.6 is a photograph of thin-film circuits fabricated with the thin-film technique.

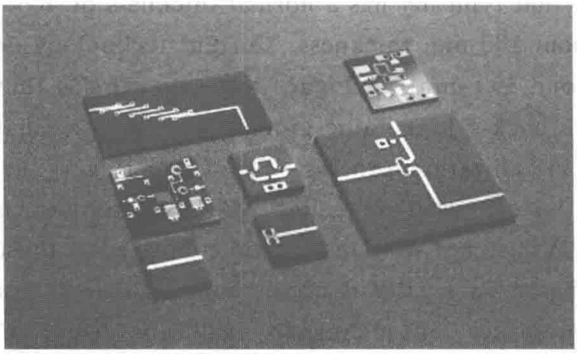


Figure 1.6 A photograph of substrates produced by the thin-film process.

From top left to bottom right, they are filter, phase shifter, power amplifier, path-switching circuit by assembly, power divider, and 50 Ω lines.

The choice of integration method depends on the application and situation, taking into account several factors mentioned previously, such as the operating frequency of the integrated circuit, the types of semiconductor components (chip or packaged), the forms of the passive components, large-scale fabrication costs, and method of assembly. These factors should all be considered when selecting the optimum method of integration. Table 1.1 provides a comparison of the hybrid integrations described previously.

Table 1.1 Comparison of hybrid integration

Technology	Cost	Fabrication Time	Pattern Accuracy	Assembly
PCB	Low	Short	Low	Soldering
Thick film	Middle	Middle	Low	Soldering and wire bonding
Thin film	High	Long	Fine	Soldering and wire bonding