微/电/子/制/造/技/术/系/列/丛/书

主　编　宋长发
副主编　文凤息　宋若翔

电子组装技术专业英语

DIANZI ZUZHUANG JISHU ZHUANYE YINGYU

国防工业出版社
National Defense Industry Press

微电子制造技术系列丛书

电子组装技术专业英语

主　编　宋长发
副主编　文凤息　宋若翔
参　编　罗源伟　李　鹏　唐　仪

国防工业出版社
·北京·

内 容 简 介

本教材按照生产企业电子组装工艺流程介绍了组装元器件、印制电路板、助焊剂、胶黏剂、焊料、清洗剂等材料的基本知识，介绍了电子组装生产线的组成、贴片机的基本结构和作用。简要介绍了焊接技术、清洗技术、检测技术等电子组装各工艺环节的工艺方法，生产过程中的静电防护技术等内容。

本教材适合作为应用型、技能型人才培养的大专院校（高职高专）应用电子类专业教材，也可作为电子组装专业技术培训用书，供从事电子组装工程技术人员参考。

图书在版编目(CIP)数据

电子组装技术专业英语/宋长发主编．—北京：国防工业出版社，2012.4

（微电子制造技术系列丛书）

ISBN 978-7-118-07952-4

Ⅰ.①电… Ⅱ.①宋… Ⅲ.①电子元件—组装—英语—高等学校—教材 Ⅳ.①H31

中国版本图书馆 CIP 数据核字(2012)第 047835 号

※

国防工业出版社出版发行

（北京市海淀区紫竹院南路 23 号 邮政编码 100048）

北京奥鑫印刷厂印刷

新华书店经售

*

开本 787×1092 1/16 **印张** 9½ **字数** 215 千字

2012 年 4 月第 1 版第 1 次印刷 **印数** 1—4000 册 **定价** 21.00 元

（本书如有印装错误，我社负责调换）

国防书店：(010)88540777 发行邮购：(010)88540776

发行传真：(010)88540755 发行业务：(010)88540717

前言

电子组装技术是应用型大专院校应用电子类专业重要的专业课程，也是电子信息、通信、电子制造等专业的选修课程。为了适应电子组装技术的高速发展和教学需要，编写了《电子组装技术专业英语》这本教材，本教材共 11 章，介绍了电子组装生产过程的基本内容和相关知识。

现代所有的电子产品，都是用电子组装技术来组装完成的。现代电子组装生产过程中，从生产管理到技术研究，从物料采购、保管、领用到生产线的具体加工，几乎都是用英语来下达指令，传递信息，进行管理。生产设备的工作界面也是英文界面，可以说，在电子组装行业内，不懂电子组装专业英语是不能胜任日常工作的。由于电子组装技术发展很快，社会对这方面的人才需求量也很大，为了培养更多的本专业人才满足社会的需要，配合教学的要求，编写了本教材。

本教材介绍了电子组装的材料、设备、工艺、管理等方面的内容，考虑到生产实际情况，对生产过程中的一些问题及其解决方法用表格的形式进行描述。学生通过学习本教材，更贴近生产实际，为将来学生零距离上岗奠定基础。

本教材对所选内容进行了仔细分析，将其中的生字词专门列于课文后面方便学生查阅学习，对课文中的难句进行了分析，旨在帮助学习者尽快掌握最基本的知识。本教材的另一个特点是对课文中最基础的内容给出了译文，读者通过英汉对照也能在最快的时间了解电子组装的工艺过程和英文表达方式。

本教材内容丰富、理论联系实际，按电子组装生产工艺流程安排相关章节，前后章节紧密联系又各自独立，有较强的实用性和指导性。本教材行文通俗易懂，图文并茂，有较好的可读性，各使用单位可根据课时情况选讲其中的相关内容。本教材也可作为电子组装专业技术培训教材和从事电子组装的工程技术人员参考。

本教材由桂林电子科技大学宋长发副教授主编，文凤息对课文中的难点做了分析并给出部分课文内容的译文，桂林电子科技大学信息科技学院宋若翔编写第一章和第九章并进行文字与图片的处理及资料汇集工作，罗源伟、李鹏、唐仪参与编辑，本书参考并引用了一些出版发行的文献资料和在网络上公开登载的相关内容，其中大多数列入了参考文献之中，还有一些未找到原作者和出处。在此向所有本书引用资料的原作者表示感谢！由于编者水平有限，时间仓促，教材中不足之处在所难免，恳请广大读者提出宝贵意见。

编 者

2012 年 3 月

Contents

Unit One

Introduction

Over the past few years, electronic products, and especially those which fall within the category of Consumer Electronics, have been significantly reduced in physical size and weight. Products such as cellular telephones, lap-top computers, pagers, camcorders, etc. , have been reduced by as much as 3/4 of their original introductory size and weight. The most significant contributing factor to this reduction has been the inclusion of fine pitch, Surface Mount (SM) components. The larger, thicker and heavier leaded Through-Hole (TH) packages consumed far too much power, too much space and contributed significantly to the total weight of the final product. Product manufacturers were listening when the customer said: Make it smaller, lighter and less expensive.

A second phase to this continued reduction in package size and weight is currently being experienced. A new family of sub-miniature surface mounted packages known under the industry's generic name of Chip Scale Packages (CSP) have recently been introduced. CSP size components are currently the basis of a new series of consumer products. CSP components are currently being supplied in two package configuration, both of which will be a maximum of 1.2 × of the die size. One incorporates planar or bumped pad interconnections on the peripheral of the package underside. The other package is in the form of a reduced scale ball grid array either in a partially or fully populated I/O condition.

The increasing availability of the CSP significantly impacts the ability of product designers to design hand-held products of a size and weight not previously possible. The new CSP allows a higher density of components to be placed into an increasingly smaller portion of an existing Printed Circuit Board (PCB), or that the PCB may be reduced with an accompanying reduction in product size, weight and cost.

CSP incorporating high I/O dies, along with discrete passive components are currently used in the design of the palm-sized camcorders. As a residual benefit, with components in closer proximity the signal propagation time is reduced thus producing a series of faster circuits. Accompanying the benefits of smaller size, reduced weight, higher density and increased performance, the individual Methods, Technologies and Tech-

niques used to assemble PCB assemblies have been impacted.

Surface Mount Technology (SMT) is a method for constructing electronic circuits in which the Sarface Mounted Components (SMC) are mounted directly onto the surface of Printed Circuit Boards (PCB). Electronic devices made like this are called surface mount devices or SMDs. In the industry it has largely replaced the through-hole technology construction method of fitting components with wire leads into holes in the circuit board.

An SMT component is usually smaller than its through-hole counterpart because it has either smaller leads or no leads at all. It may have short pins or leads of various styles, flat contacts, a matrix of solder balls (BGAs, Ball Grid Arrays), or terminations on the body of the component.

【参考译文】

引 言

过去几年中，电子产品，特别是不断更新换代的消费类电子产品，其外形尺寸和重量已有显著缩小。诸如手机、笔记本式计算机、寻呼机、便携式摄像机等电子产品，较之最初产品形式，其尺寸和重量已缩减了近 3/4。导致电子产品尺寸和重量缩减的最重要因素是细间距表面组装元器件的应用。相比较而言，体积更大、厚度和重量更大的有引脚通孔组件会消耗更多能量、占据更大空间，最终会显著增加终端产品总重量。电子产品制造者不断面临消费者对电子产品需求的呼声：小型化、轻型化和低成本。

在元器件封装尺寸及重量持续缩减的形势下，另一种封装技术正迅速发展。最近被引入的这类用于表面组装的新型超小封装结构的业内通用名称是芯片尺寸封装（CSP）。CSP 元件是当前一系列新型消费类电子产品的发展基础。当前应用的 CSP 元件具有两种封装结构，但每种封装结构的外形尺寸均不大于相应裸芯片尺寸的 1.2 倍。一种 CSP 封装结构底部四周分布有平面引脚互连焊盘或凸点互连焊盘。另一类封装结构则是部分封装尺寸或整体 I/O 尺寸缩小化的球栅阵列封装结构。

不断增加的 CSP 芯片可用性显著影响着电子产品设计者，所设计的手持产品尺寸和重量不再局限于先前水平。新型 CSP 芯片应用使得在尺寸缩小的 PCB 表面安装更大密度的元器件成为可能，或使得 PCB 尺寸随产品尺寸、重量和成本降低而减小成为现实。

集成了多 I/O 引脚裸芯片和分立无源元件的 CSP 封装目前已应用于设计掌上便携式摄像机。CSP 的另外一个优势是所产生的信号传递速度大大减小并因此产生了一系列速度更快的电路。CSP 具有小型化、轻型化和更高密度和更高性能等优势，其应用于组装 PCB 组件的方法、技术和工艺已产生了广泛的影响。

表面贴装技术（SMT）是一种构建电子电路的方法，即把表面贴装元件直接安装到印制电路板的表面。这样的电子器件称为表面贴装器件。在行业里，表面贴装技术已基本上取代了通孔工艺里的将插装元器件通过引线孔安装到电路板的方法。一个 SMT 元件通常小于通孔技术的对应元件，因为它是短引线或无引线元器件，它的引脚较短。如平面接触、球形阵列、器件端子等各种引线形式。

1.1 Printed circuit assembly

Printed Circuit Boards and Automated Electronics Assembly have come far since the early 1960s. New applications (用途) keep pushing the edge for smaller areas, lighter products, faster speeds, and more bandwidth. A proliferation of packages and new materials has helped revolutionize new machine development. In the electronics market, characterized by ever-shorter product development, intense global competition, and rapidly evolving technology, understanding the assembly equipment and processes is necessary as a means to ensure survival. This chapter will cover major assembly types, accuracy definitions and considerations, network communications, and some key machine selection criteria. Electronics assemblies can be grouped into three major categories:

(1) Through-hole.

(2) Surface-mount.

(3) Mixed-technology (which can be any combination of through-hole, surface-mount, odd- form, or bare-die assembly).

Practicality picture of Printed Circuit Board assembly as shown in Figure 1-1.

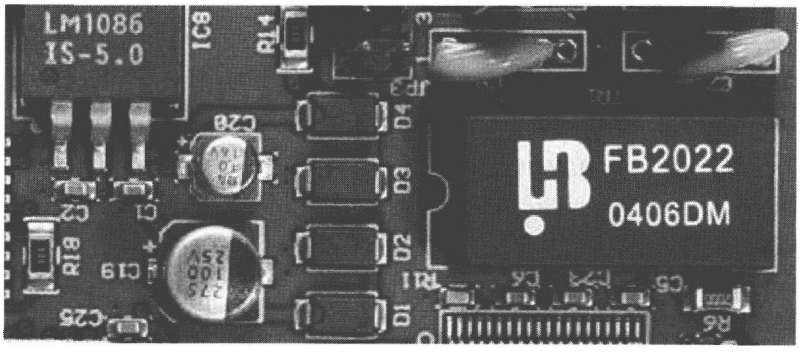

Figure 1-1 Printed Circuit Board Assembly

Through-hole is still very much alive and new machines are still being introduced in the new millennium, but the total volumes continue to shrink. Surface mount has become the work- horse, and new developments include new machine types, several line configurations, and a dependency on network communications. Globalization is also driving the need for multilingual applications and user-friendly interfaces. Odd-form components are being automated more and more to keep up with line throughput and act times. Bare-die, including flip-chip, assemblies are growing at a faster rate than the overall electronic assemblies. To complicate things further, several applications actually require mixed-technologies, which puts a heavier burden on the equipment manufacturers.

【参考译文】

自 20 世纪 60 年代初出现印制电路板和自动化电子组装，新用途面向面积小、质量

轻、生产速度快、频带宽。新封装形式和新材料的发展推动了新机器革命性的发展。在电子市场，其特点是面对越来越短的产品开发时间，激烈的全球竞争，迅速发展的技术，了解组装设备和工艺是确保企业生存的一种必要手段。本节将介绍大规模组装设备的类型、精度和需要考虑的事项、网络通信，以及一些关键机械选择标准。电子组装大致可分为三大类：

（1）通孔安装；

（2）表面贴装；

（3）混合（组装）技术（可任意组合的通孔安装，表面贴装，电路形式，或裸芯片组装）。

电路板组装实物图如图 1-1 所示。

通孔技术仍是十分流行的，将来也会有新的机器引进，但通孔组装机器总的容量也将继续压缩。表面贴装技术已成为主要技术，而新的发展包括新的机械、一些线路的配置，以及相关的网络通信。全球化也需要多种语言的应用和友好的用户界面。越来越多的自动化单一元器件跟上生产量和操作时间。裸板组装包括倒装芯片比任何其他电子组装产品的增长速度都快。对未来来说，这是复杂的，还有一些需要应用混合技术，这使得设备制造商的负担更重了。

1.2 Assembly techniques

Components are to be placed on the printed circuit board which has flat, usually tin-lead, silver, or gold plated copper pads without holes, called solder pads Solder paste , a sticky mixture of flux and tiny solder particles, which is first applied to all the solder pads with a stainless steel or nickel stencil using a screen printing process. After screen printing, the boards then proceed to the pick-and-place machines, the pick-and-place machines are shown in Figure 1-2.

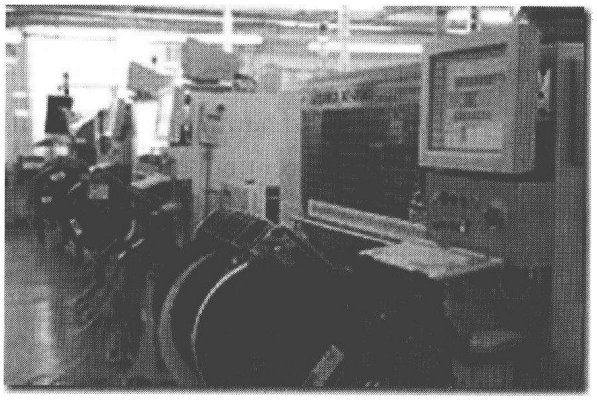

Figure 1-2 The pick-and-place machines on the production lin

They are placed on a conveyor belt. The components to be placed on the boards are usually delivered to the production line in either paper/plastic tapes wound on reels or

plastic tubes. Some large integrated circuits are delivered in static-free trays. Numerical control pick-and-place machines remove the parts from the tapes, tubes or trays and place them on the PCB , see Figure 1-3.

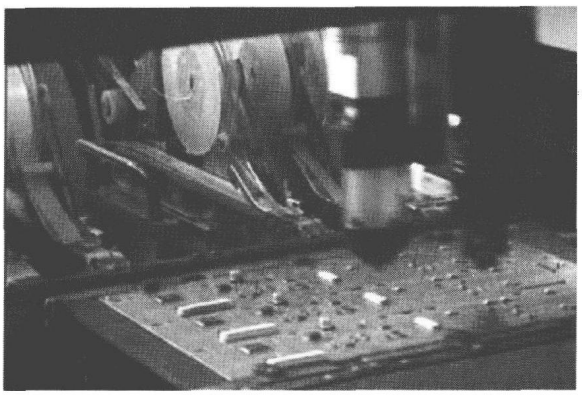

Figure 1-3 Place components on the PCB

【参考译文】

贴片元件需要放在平整的电路板上，通常电路板上的布线需要镀锡、镀银、镀金，电路板上焊盘的底层上镀铜，没有孔。用不锈钢板或镍板做成的网板。将一种由焊剂和很小颗粒的焊料购成的很黏的混合物，通过模板印刷，将其印到焊盘上，模印之后，电路板随着传送带进入贴装机中，板上的元器件通常是被输送进入生产线之前放在塑料或纸卷成盘状的粘带上或塑料管中，一些大型的集成电路放在不受静电干扰的盘子中，数字控制的贴片机运动到纸带或管子或托盘放置元器件地方取件放置到电路板的指定位置。

Vocabularies and Phrases

accuracy *n.* 精确
assembly *n.* 装配，组装
Assembly Techniques 组装技术
Ball Grid Array (BGA) 球形栅格列阵
bandwidth *n.* 带宽
bare-die assembly 裸芯片组装
category *n.* 种类
component *n.* 元件
configuration *n.* 配置
counterpart *n.* 对等物
conveyor belt 传输带
criteria *n.* 标准
device *n.* 器件
flat contacts *n.* 平面接触
flip-chip assembly 倒装芯片装配
flux *n.* 助熔剂
globalization *n.* 全球化
interface *n.* 界面
IC (integrated circuits) 集成电路
line configuration *n.* 生产线配置
mount *n.* 组装
mixed-technology 混合组装技术
matrix *n.* 矩阵
millennium *n.* 千年
multilingual *a.* 多种语言的
nickel *n.* 镍
Printed Circuit Board (PCB) 印制电路板
Printed Circuit

Assembly (PCA)		印制电路装	solder	*n.*	焊接剂
proliferation	*n.*	扩散	solder pad		焊盘
pick-and-place		拾取	solder paste		锡膏
shrink	*v.*	缩小	screen	*n.*	模板
stencil	*n.*	印制模型板	static-free	*a.*	防静电的
Surface Mounted Technology (SMT)		表面组装技术	Through-hole Technology		通孔技术
Surface Mounted Components (SMC)		表面安装元件	a conveyor belt		传送带
Surface Mounted Devices (SMD)		表面贴装器件	termination	*n.*	终结

〈难句分析〉

(1) Surface Mount Technology (SMT) is a method for constructing electronic circuits in which the Surface Mounted components (SMC) are mounted directly onto the surface of Printed Circuit Boards (PCB) .

分析：for constructing electronic circuits 作 method 的定语，in which the Surface Mounted Components (SMC) are mounted directly onto the surface of Printed Circuit Boards (PCB) 是 method 的定语从句。

(2) Components are to be placed on the printed circuit board which has flat, usually tin-lead, silver, or gold plated copper pads without holes, called solder pads. With a stainless steel or nickel stencil using ascreen printing process.

分析：Which has flat, usually…作 the printed circuit board 的定语从句。

1.3 SMT design and assembly

Once circuit design is complete, substrate design and fabrication, most commonly of a Printed Circuit Board (PCB), enters the process. Generally, PCB assembly configurations using Surface Mount Devices (SMD) are classified as shown in Figure 1-4 .

Type I-only SMDs are used, typically on both sides of the board. No through-hole components are used. Top and bottom may contain both large and small active and passive SMDs. This type board uses reflow soldering only.

【参考译文】

一旦电路设计完成，就进入了基板设计和制造过程，也就是通常所说的 PCB 制作。通常，采用表面组装元器件组装的 PCB 组装结构如图 1-4 所示。

类型Ⅰ——仅采用表面组装元器件，在两侧均有表面组装元器件分布的印制电路板。不使用通孔插装元器件。顶部和底部同时含有大尺寸或小尺寸有源或无源表面组装元器件。该类型电路板采用再流焊方式完成焊接。

TypeⅡ—a double-sided board, with SMDs on both sides. The top side may have all sizes of active and passive SMDs, as well as through-hole components, while the bot-

tom side carries passive SMDs and small active components such as transistors. This type board requires both reflow and wave soldering, and will require placement of bottom side SMDs in adhesive.

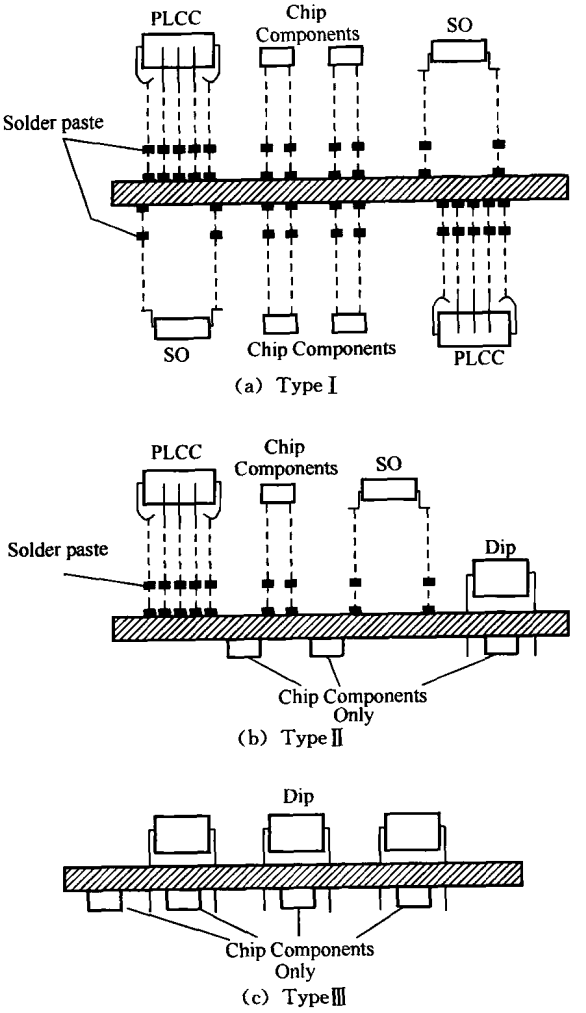

Figure 1-4 SMT circuit boards

【参考译文】

类型Ⅱ——两侧都含有表面组装元器件的双面印制电路板。顶部含有各种尺寸的有源或无源表面组装元器件和通孔插装元器件；而底侧仅含有无源表面组装元器件和如三极管等较小尺寸有源元器件。该类型电路板需要分别采用再流焊和波峰焊，并且底部表面组装元器件焊接时需采用胶黏剂辅助贴装。

Type Ⅲ — top side has only through-hole components, which may be active and/or passive, while the bottom side has passive and small active SMDs. This type board uses wave soldering only, and also requires placement of the bottom-side SMDs in adhesive.

【参考译文】

类型Ⅲ—— 顶部只含有有源或无源通孔插装元器件，而底部则含有无源表面组装

元器件和小尺寸有源表面组装元器件。该类型基板仅采用波峰焊完成焊接，但底侧表面组装元器件焊接时需采用胶黏剂辅助贴装。

Vocabularies and Phrases

adhesive	*n.* 胶黏剂	Components	插装元件
fabrication	*n.* 制造	reflow soldering	再流焊
transistors	*n.* 晶体管	substrate design	基板设计
Through-hole		wave soldering	波峰焊

Reading material

SMT Design, Assembly, and Test Overview

It should be noted that with the ongoing increase in usage of various techniques to place IC dice directly on circuit boards, Type Ⅲ in some articles means a mix of packaged SMT ICs and bare die on the same board.

A Type I bare board will first have solder paste applied to the component pads on the board. Once solder paste has been deposited, active and passive parts are placed in the paste. For prototype and low-volume lines this can be done with manually guided X-Y tables using vacuum needles to hold the components, while in medium and high-volume lines automated placement equipment is used. This equipment will pick parts from reels, sticks, or trays, then place the components at the appropriate pad locations on the board, hence the term "pick and place" equipment.

After all parts are placed in the solder paste, the entire assembly enters a reflow oven to raise the temperature of the assembly high enough to reflow the solder paste and create acceptable solder joints at the component lead/pad transitions. Reflow ovens most commonly use convection and IR heat sources to heat the assembly above the point of solder liquidus, which for 63/37 tin-lead eutectic solder is 183℃. Due to the much higher thermal conductivity of the solder paste compared to the IC body, reflow soldering temperatures are reached at the leads/pads before the IC chip itself reaches damaging temperatures. The board is inverted and the process repeated.

If mixed-technology Type Ⅱ is being produced, the board will then be inverted, an adhesive will be dispensed at the centroid of each SMD, parts placed, the adhesive cured, the assembly re-righted, through-hole components mounted, and the circuit assembly will then be wave-soldered which will create acceptable solder joints for both the through-hole components and bottom-side SMDs.

A Type Ⅲ board will first be inverted, adhesive dispensed, SMDs placed on the bottom-side of the board, the adhesive cured, the board re-righted, through-hole components placed, and the entire assembly wave soldered. It is imperative to note that only passive components and small active SMDs can be successfully bottom-side wave-sold-

ered without considerable experience on the part of the design team and the board assembly facility. It must also be noted that successful wave soldering of SMDs requires a dual-wave machine with one turbulent wave and one laminar wave.

It is common for a manufacturer of through-hole boards to convert first to a Type Ⅱ or Type Ⅲ substrate design before going to an all-SMD Type I design. This is especially true if amortization of through-hole insertion and wave-soldering equipment is necessary. Many factors contribute to the reality that most boards are mixed- technology Type Ⅱ or Type Ⅲ boards. While most components are available in SMT packages, through-hole connectors are still commonly used for the additional strength the through-hole soldering process provides, and high-power devices such as three-terminal regulators are still commonly through-hole due to off-board heat-sinking demands. Both of these issues are actively being addressed by manufacturers and solutions exist which allow Type I boards with connectors and power devices.

Again, it is imperative that all members of the design, build, and test teams be involved from the design stage. Today's complex board designs mean that it is entirely possible to exceed the ability to adequately test a board if the test is not designed-in, or to robustly manufacture the board if in-line inspections and handling are not adequately considered. Robustness of both test and manufacturing are only assured with full involvement of all parties to overall board design and production.

It cannot be overemphasized that the speed with which packaging issues are moving requires anyone involved in SMT board or assembly issues to stay current and continue to learn about the processes. Subscribe to one or more of the industry-oriented journals noted in the "Further Information" section at the end of this Chapter, obtain any IC industry references, and purchase several SMT reference books.

Vocabularies and Phrases

a dual-wave machine	双波机	insertion	*n.* 插入
amortization	*n.* 分配	invert	*v.* 翻转
a screen printing process	模板印锡膏	laminar wave	层波
centroid	*n.* 中心	overemphasize	*v.* 过分强调
conductivity	*n.* 传导性	turbulent wave	湍流波
convection	*n.* 对流	Vacuum Needle	真空吸嘴
convert	*v.* 转换	pick part	拾取
deposite	*v.* 放置	power devices	功率器件
dispense	*v.* 分配	prototype	*n.* 样机
facility	*n.* 设施	reels	*n.* 带式包装
imperative	*a.* 必须的	robustly	*ad.* 强烈地
IR heat	红外热	robustness	*n.* 强壮
		sticks	棒式包装

subscribe	*v.* 定期订阅	three-terminal regulators	三端稳压
SMT Design SMT	设计	trays	*n.* 盘式包装
thermal	*a.* 热的		

1.4 PCB assembly flows

1. Through-hole technology

Insert leaded packages on side A　A 面插装元件

↓

Wave solder the leads on side B　B 面进行波峰焊

↓

Aqueous clean PCP　清洗

↓

Inspect & rework PCB　检测或返修

↓

Test PCB　测试

2. Mixed technologies

Side A　A 面

↓

Attach SMT components　贴上贴片元件

↓

Reflow solder paste　再流焊

↓

Insert leaded packages on side A　A 面插装元件

↓

Reverse PCB to side B　翻板到 B 面

↓

Apply adhesive　涂胶黏剂

↓

Attach passive SMT components　贴上无源元件

↓

Cure adhesive　烘干硬化（固化）

↓

Reverse PCB to side #1　翻板

↓

Wave solder leaded and SMT　波峰焊

↓

Components　贴装元件

↓