21世纪高等学校规划教材

电子信息与通信工程专业英语

王立琦　王铭义　主编
孟娇茹　张　黎　副主编

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内 容 提 要

本书是21世纪高等学校规划教材。

全书分基础篇和提高篇两部分，共12章。基础篇包括电子学、信号与系统、数字信号处理、通信技术、计算机网络、英文专业文献的翻译共6章；提高篇包括移动电话、光纤通信、信息论与编码、数字图像处理、嵌入式系统、英文科技论文标题和摘要的写作共6章。本书内容涵盖了电子信息和通信工程专业的主要课程，每一章构成一个相对完整的专题，重点介绍基本概念、原理、方法与应用，每章后面附有专业词汇和难点注释。

本书可作为高等院校电子信息工程与通信工程专业本科生教学用书，也可供相关专业的工程技术人员学习和参考。

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前　言

电子信息与通信技术是目前发展最为迅速也是最为活跃的研究领域之一。随着我国国力的增强，对外交流日益广泛，迫切需求既懂得专业知识又具备专业英语综合运用能力的科研人员，因此对在校大学生英语水平的要求也越来越高。根据国家教委《大学英语教学大纲（修订版）》的规定，要通过四年不断线的学习提高学生的英语语言应用能力，因此专业英语是继大学公共英语之后理工科大学生的一门必修课程。

编者希望结合自己多年专业英语及其他专业课程教学实践中的经验体会，在力求通俗、简明、扼要和实用的指导思想下编写一本电子信息与通信工程专业英语教材，以期在有限的学时内培养学生专业英语阅读、翻译和写作的综合运用能力，全面提高英语素质。

全书由基础篇和提高篇两部分组成，授课教师可以根据需要及课时安排选讲或分学期讲授其中的内容。

本书的阅读材料均选自国外原版教材或技术网站，经适当编写而成，这样可以保证语言地道、用词规范。内容选取紧密结合电子信息与通信专业开设的课程，按专业知识体系结构编排，由浅入深，贯穿电子信息和通信工程专业的主要专业课程，包括电子学、信号与系统、数字信号处理、通信技术、计算机网络、移动电话、光纤通信、信息理论与编码、数字图像处理和嵌入式系统。考虑到大三的学生虽然已经具备了一定的英语语言基础，但是毕竟刚刚进入专业课程的学习，在具体内容的遴选上技术层面不要太深，否则学生读不懂，会失去学习兴趣，也给授课教师造成很大困难。课文的内容既对专业基础课和专业课进行必要的重复，尽量保证学生利用既有专业知识理解课文的内容，又有所拓宽和延伸，增强学生阅读兴趣，扩充专业词汇量，扩展和深化对本学科关键技术的认识。每篇课文后配有生词表和难句注释，旨在解决课文中的英语语言难点和专业知识难点，在一定程度上减轻学习负担。

在具备了一定阅读量的基础上，必须加以总结提炼，否则读得再多也只是内容的堆砌，而不是能力的提高。本书翻译部分独立成章，系统地介绍科技英语翻译的一般方法和技巧，通过学习学生可熟悉和掌握相关领域科技英语句法结构特点和常用表达方式，提高阅读和翻译专业英语资料的能力。

由于本科生在撰写毕业论文时必须给出英文标题和英文摘要，而学生这方面的能力相对薄弱，因此编者认为英文标题和摘要的写作应该纳入本科专业英语授课计划。所以本书将这一部分也独立成章，通过大量实例，详细讲解科技论文标题和摘要的写作要求及常用句型结构、表达方式，力求学以致用。

本教材的最主要特色是紧密结合专业课程，充分考虑学生的实际情况和教师授课的可操作性，阅读材料选材新颖，内容丰富，注重专业基础和关键技术，兼顾发展热点；翻译和写作部分系统性强，实用性强。

本书由哈尔滨商业大学王立琦、哈尔滨理工大学王铭义担任主编；黑龙江科技学院孟娇茹，东北林业大学张黎担任副主编；参加本书编写工作的还有哈尔滨商业大学张立志、于金涛和李云。其中，第2、5、12章由王立琦编写；第7、8章由王铭义编写；第6、10章由孟娇茹

编写；第1、4章由张黎编写；第9章由张立志编写；第11章由于金涛编写；第3章由李云编写；全书由王立琦、王铭义负责统稿和校对。东北大学李晶皎教授、哈尔滨商业大学赵志杰教授担任本书主审，提出了许多宝贵的意见和建议。

由于作者水平有限，不足和疏漏之处在所难免，恳请专家和同行批评指正。

编　者

2009年3月

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基　础　篇

Chapter 1　Electronics

1.1　Electronic Devices and Types of Circuits

1.1.1　Electronic Devices

An electronic component is any physical entity in an electronic system whose intention is to affect the electrons or their associated fields in a desired manner consistent with the intended function of the electronic system. Components are generally intended to be in mutual electromechanical contact, usually by being soldered to a printed circuit board (PCB), to create an electronic circuit with a particular function (for example an amplifier, radio receiver, or oscillator). Components may be packaged singly or in more or less complex groups as integrated circuits. Some common electronic components are capacitors, resistors, diodes, transistors etc.

1. Capacitor

Circuit elements with specific values of capacitance are known as capacitors (Fig.1.1). Most of the capacitors in electronic circuits consist of two conducting plates with a small air gap or thin insulator between them. To increase the capacitance of such a parallel plate capacitor, we can make the area of the plates large and make the separation between them small.

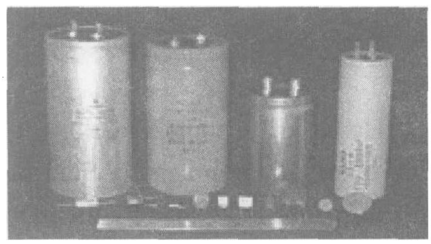

Fig.1.1　Various capacitors

It is often convenient to vary the capacitance in a circuit without removing the capacitor. The common variable capacitor is made of two sets of interleaved plates.[1] One set is immobile and the other set is attached to a shaft. If we rotate the shaft, we can effectively change the area of the plates so as to change the capacitance. Because the dielectric is air and it is necessary to make the separation between plates relatively large to assure that they do not touch, maximum capacitance values are limited to about 500 pF. In the fully unmeshed state, a 500pF variable capacitor may have a minimum capacitance of 10 pF or so. Mica trimmer capacitors use a mica dielectric. The separation between plates is adjusted with a screwdriver. They are commonly used where variation in capacitance is only occasionally necessary.

Capacitors follow the same law using the reciprocals. The total capacitance of capacitors in series is equal to the reciprocal of the sum of the reciprocals of their individual capacitances.

The working voltage of a series combination of identical capacitors is equal to the sum of voltage ratings of individual capacitors provided that equalizing resistors are used to ensure equal voltage division. This is all because of Ohm's law: $V = RI$.

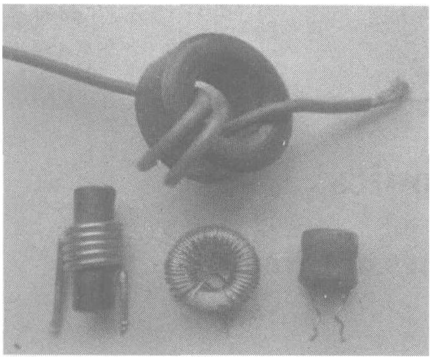

Fig.1.2 Some low-value inductors

2. Inductor

An inductor is a passive electrical component with significant inductance (Fig.1.2).

An "ideal inductor" has inductance, but no resistance or capacitance, and does not dissipate energy. A real inductor is equivalent to a combination of a significant ideal inductance, some resistance and capacitance, usually small. The resistance, a necessary property of a wire except at superconducting temperatures, may contribute significantly to the impedance, and may dissipate significant power. At some frequency, usually much higher than the working frequency, a real inductor behaves as a resonant circuit, and can cause parasitic oscillation.

In practice, inductors are usually implemented by some sort of coiled conductive winding which may surround a ferromagnetic core. Large inductors used at low frequencies may have thousands of turns around an iron core; however at very high frequencies even a straight piece of wire (i.e., with turns and core reduced to zero) has significant inductance.

Inductors follow the same law, in that the total inductance of non-coupled inductors in series is equal to the sum of their individual inductances:

$$L_{\text{total}} = L_1 + L_2 + \cdots + L_n \tag{1.1}$$

However, in some situations it is difficult to prevent adjacent inductors from influencing each other, as the magnetic field of one device couples with the windings of its neighbours. This influence is defined by the mutual inductance M. For example, if you have two inductors in series, there are two possible equivalent inductances depending on how the magnetic fields of both inductors influence each other.

When there are more than two inductors, the mutual inductance between each of them and the way the coils influence each other complicates the calculation. For a larger number of coils the total combined inductance is given by the sum of all mutual inductances between the various coils including the mutual inductance of each given coil with itself, which we term self-inductance or simply inductance. For three coils, there are six mutual inductances M_{12}, M_{13}, M_{23}, M_{21}, M_{31} and M_{32}. There are also the three self-inductances of the three coils: M_{11}, M_{22} and M_{33}.

Therefore:

$$L_{\text{total}} = (M_{11} + M_{22} + M_{33}) + (M_{12} + M_{13} + M_{23}) + (M_{21} + M_{31} + M_{32}) \tag{1.2}$$

By reciprocity $M_{ij} = M_{ji}$ so that the last two groups can be combined. The first three terms represent the sum of the self-inductances of the various coils. The formula is easily extended to any number of series coils with mutual coupling. The method can be used to find the self-inductance of large coils of wire of any cross-sectional shape by computing the sum of the mutual inductance of each turn of wire in the coil with every other turn since in such a coil all turns are in series.

3. Resistor

A resistor (Fig.1.3) is a two-terminal electronic component that opposes an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's law: $V = IR$. The electrical resistance R is equal to the voltage drop V across the resistor divided by the current I through the resistor. Resistors are used as part of electrical networks and electronic circuits.

To find the total resistance of all the components in series circuit, add the individual resistances of each component: $R_{total} = R_1 + R_2 + \cdots R_n$, for components in series with resistances R_1, R_2, etc. To find the current I, use Ohm's law: $I = \frac{V}{R_{total}}$.

To find the voltage across a component with resistance R_i, use Ohm's law again:where I is the current, as calculated above. The components divide the voltage according to their resistances, so, in the case of two resistors.

4. Transistor

In electronics, a transistor (Fig.1.4) is a semiconductor device commonly used to amplify or switch electronic signals. A transistor is made of a solid piece of a semiconductor material, with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the controlled current can be much larger than the controlling current, the transistor provides amplification of a signal. The transistor is the fundamental building block of modern electronic devices, and is used in radio, telephone, computer and other electronic systems. Some transistors are packaged individually but most are found in integrated circuits.

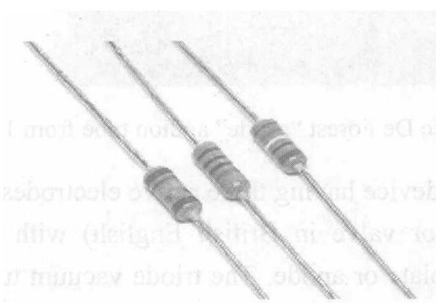

Fig.1.3 Three resistors

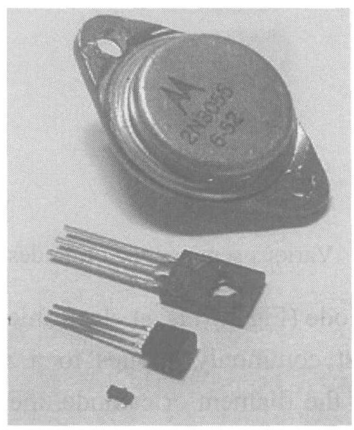

Fig.1.4 Assorted discrete transistors

(1) Diode

In electronics, a diode (Fig.1.5) is a two-terminal device (thermionic diodes may also have one or two ancillary terminals for a heater).

Diodes have two active electrodes between which the signal of interest may flow, and most are used for their unidirectional electric current property. The varicap diode is used as an electrically adjustable capacitor.

The directionality of current flow most diodes exhibit is sometimes generically called the rectifying property. The most common function of a diode is to allow an electric current to pass in one direction (called the forward biased condition) and to block it in the opposite direction (the reverse biased condition). Thus, the diode can be thought of as an electronic version of a check valve.

Real diodes do not display such a perfect on-off directionality but have a more complex non-linear electrical characteristic, which depends on the particular type of diode technology. Diodes also have many other functions in which they are not designed to operate in this on-off manner.

Early diodes included “cat’s whisker” and vacuum tube devices (also called thermionic valves). Today the most common diodes are made from semiconductor materials such as silicon or germanium.

(2) Triode

The original three-element device was patented in 1908 by Lee De Forest who developed it from his original two-element 1906 Audion.

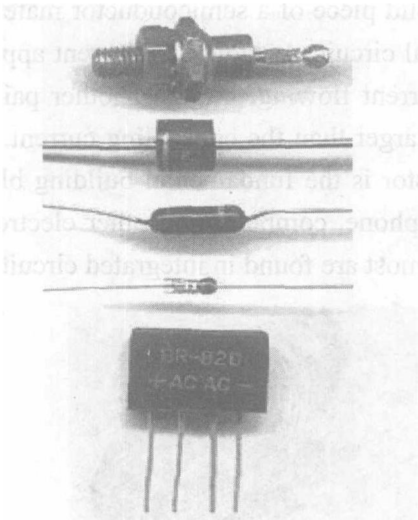

Fig.1.5 Various semiconductor diodes

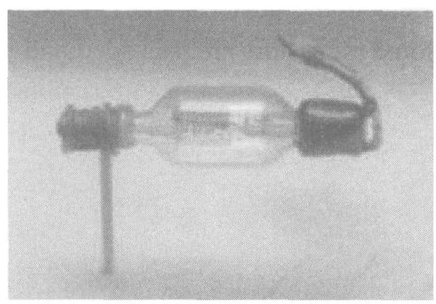

Fig.1.6 Lee De Forest “triode” audion tube from 1908

A triode (Fig.1.6) is an electronic amplification device having three active electrodes. The term most commonly applies to a vacuum tube (or valve in British English) with three elements: the filament or cathode, the grid, and the plate or anode. The triode vacuum tube is often viewed as the first electrical amplification device, although the relay (which contained mechanical parts) is usually viewed, in a broad sense, as the first actual electrical amplifier.

Although triodes are now largely obsolete in consumer electronics, having been replaced by the transistor, triodes continue to be used in certain high-end and professional audio applications, as well as in microphone preamplifiers and electric guitar amplifiers.

Some guitarists routinely drive their amplifiers to the point of saturation, in order to produce a desired distortion tone. Many people prefer the sound of triodes in such an application, since the distortion of a tube amplifier, which has a "soft" saturation characteristic, can be more pleasing to the ear than that of a typical solid-state amplifier, which is linear up to the limits of its supply voltage and then clips abruptly. However, this typically only applied to the power stage of a tube amplifier.

5. Transformer

A transformer (Fig.1.7) is a device that transfers electrical energy from one circuit to another through inductively coupled electrical conductors. A changing current in the first circuit (the primary) creates a changing magnetic field; in turn, this magnetic field induces a changing voltage in the second circuit (the secondary). By adding a load to the secondary circuit, one can make current flow in the transformer, thus transferring energy from one circuit to the other.

The secondary induced voltage V_S, of an ideal transformer, is scaled from the primary V_P by a factor equal to the ratio of the number of turns of wire in their respective windings.

By appropriate selection of the numbers of turns, a transformer thus allows an alternating voltage to be stepped up—by making N_S more than N_P—or stepped down, by making it less.

Transformers are some of the most efficient electrical "machines", with some large units able to transfer 99.75% of their input power to their output. Transformers come in a range of sizes from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used to interconnect portions of national power grids. All operate with the same basic principles, although the range of designs is wide.

6. Relay

A relay (Fig.1.8) is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. It was invented by Joseph Henry in 1835. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier.

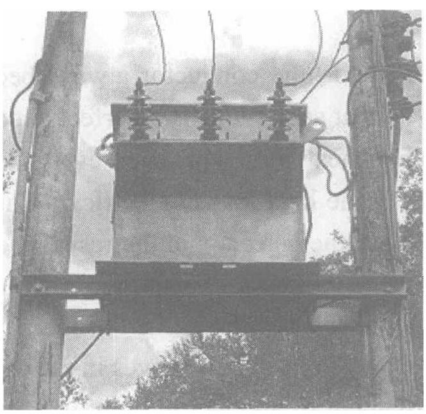

Fig.1.7 Three-phase pole-mounted step-down transformer

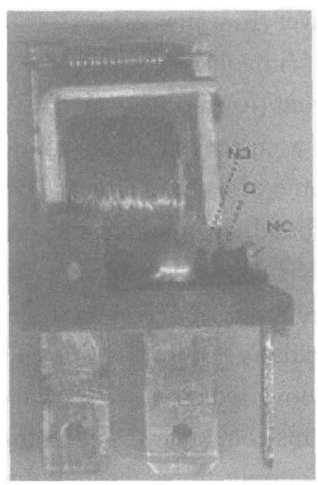

Fig.1.8 Automotive style miniature relay

1.1.2 Types of Circuits

1. Some Laws and Formulas about Circuits

In any circuit where the only opposition to the flow of electrons is resistance, there is a definite relationship between the values of voltage, current, and resistance. This relationship was discovered by George Simon Ohm in 1827. It is known as Ohm's law.

According to the Ohm's law: the voltage necessary to force a given amount of current through a circuit is equal to the product of the current and resistance of the circuit. If E means voltage (in volts), I means current (in amperes), and R means resistance (in ohms), then Ohm's law can be expressed by these mathematical formulas:

$$E = IR, I = E/R, R = E/I \tag{1.3}$$

By using the Ohm's law formulas, the value of any one of the three electrical quantities in a circuit (voltage, current, and resistance) can be found if the values of the other two quantities are known.

Kirchhoff's 1st law: The algebraic sum of the currents at any junction of conductors is zero. In other words, the sum of the currents flowing towards a junction is equal to the sum of the currents flowing away from the junction. This statement was announced by Kirchhoff in 1847.

Kirchhoff's 2nd law: In any closed circuit the algebraic sum of the potential drops in the various parts of the circuit is equal to the electromotive force acting round the circuit.

Electric pressure, by itself can do no work. A battery develops an emf. But if no load is connected across it, no electrical work is accomplished. When a conductor is connected across a source of the emf, a current of electrons is developed. The current represents movement. The product of the pressure and the movement (volts and amperes) does accomplish work. The unit of measurement of the rate of doing work, or the unit of measurement of power, is watt (W): 1V causing 1A to flow in a 1Ω resistor produces 1W of power. In formula form:

P: power (in watts, W)

E: emf (in volts, V)

I: current (in amperes, A)

When a current of electrons flows through a conductor, the conductor always becomes warmer. Some of the power in the circuit is converted to heat and is lost. If a perfect conductor could be found, it would carry current without such a heat loss. However even the best conductor has some resistance, so there will always be some heat loss in electric circuit. The main factors in the conversion of electric power to heat are the current and the resistance. The power formula is $P = I^2R$. Not all power in electricity is converted into heat. In a radio, some power is converted into sound waves, but some heat will be developed in the radio in the process of this conversion. With transmitters, power is changed into radio waves in the air.

When current flows through the resistance-wire filament of an electric light, the filament becomes so hot that it glows brightly. The wire is hot and is radiating heat energy, but it is also radiating energy in the form of light. The power formula will give the total amount of power being consumed.

The basic unit of measurement of power is the watt. For smaller quantities, the milliwatt, or 0.001W, may be used. For larger quantities, the kilowatt or 1000W may be used.

Actually, power, by the formula $P = EI$, implies time, since the ampere I in the formula is a coulomb per second. An ampere can be expressed as

Q: electron quantity (in coulombs, C)

T: time (in seconds, s)

I: current (in amperes, A)

If power equals volts times amperes equals Q/T, then power must equal volts times Q/T. In formula form:

$$P = EI = EQ/T \tag{1.4}$$

This formula tells us power is equal to volts times coulombs per second.

2. Series Circuits

If several electric components, such as resistors, are connected so that the current is the same in every one, the components are said to be in a series circuit. Consider the simple series circuit comprising the battery and three resisters. The current I results in a potential difference between the terminals of each resistor. That is:

$$V_1 = R_1 I\ ,\quad V_2 = R_2 I\ ,\quad V_3 = R_3 I \tag{1.5}$$

Clearly, the sum of these voltages is equal to the battery emf, or

$$V = V_1 + V_2 + V_3 \tag{1.6}$$

The equation above states that the algebraic sum of the potential differences around any complete circuit is equal to zero.

The equivalent resistance of any number of resistors connected in series equals the sum of their individual resistances.

A useful circuit based on the series connection of resistors is the potential divider with many taps. The division of the potential V among the various taps depends upon the magnitudes of the resistances in the potential divider.[2] Obviously, if the series resistors are replaced by a potentiometer, the output voltage may be set at any desired fraction of V.

3. Parallel Circuits

If two or more components are connected in parallel they have the same potential difference (voltage) across their ends. The potential differences across the components are the same in magnitude, and they also have identical polarities. Hence, the same voltage is applicable to all circuit components connected in parallel. The total current I is the sum of the currents through the individual components, in accordance with Kirchhoff's circuit laws. The current in each individual resistor is found by Ohm's law. Factoring out the voltage gives:

$$I_{\text{total}} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}\right) \tag{1.7}$$

4. Series-parallel Resistor Circuits

Not all circuits are simple series or parallel arrangements. Many are combinations of parallel resistors connected in series with other resistors or combined with other parallel groups. These can only be described as series-parallel circuits.

The simplest approach to analyze a series-parallel circuit is to resolve each purely series group into its single equivalent resistance and to resolve each parallel group of resistors into its equivalent resistance. The process is repeated as many times as necessary.

As in all types of circuits, open-circuit and short-circuit conditions affect the currents and voltage drops throughout the circuit.

Series-parallel resistor circuits consist of combinations of series-connected and parallel-connected resistors.

The circuit currents vary from branch to branch, and the component voltage drops depend on the branch currents and on the component resistance.[3] The supply current depends on the supply voltage and on the circuit resistance offered to the voltage source.

5. Analog Circuits

Most analog electronic appliances, such as radio receivers, are constructed from combinations of a few types of basic circuits. Analog circuits use a continuous range of voltage as opposed to discrete levels as in digital circuits. The number of different analog circuits so far devised is huge, especially because a "circuit" can be defined as anything from a single component, to systems containing thousands of components.

Analog circuits are sometimes called linear circuits although many non-linear effects are used in analog circuits such as mixers, modulators, etc. Good examples of analog circuits include vacuum tube and transistor amplifiers, operational amplifiers and oscillators.

Some analog circuitry these days may use digital or even microprocessor techniques to improve upon the basic performance of the circuit. This type of circuit is usually called "mixed signal" .

Sometimes it may be difficult to differentiate between analog and digital circuits as they have elements of both linear and non-linear operation. An example is the comparator which takes in a continuous range of voltage but puts out only one of two levels as in a digital circuit. Similarly, an overdriven transistor amplifier can take on the characteristics of a controlled switch having essentially two levels of output.

6. Digital Circuits

Digital circuits are electric circuits based on a number of discrete voltage levels. Digital circuits are the most common physical representation of Boolean algebra and are the basis of all digital computers. To most engineers, the terms "digital circuit", "digital system" and "logic" are interchangeable in the context of digital circuits. In most cases the number of different states of a node is two, represented by two voltage levels labeled "Low" (0) and "High" (1). Often "Low" will be near zero volts and "High" will be at a higher level depending on the supply voltage in use.

Computers, electronic clocks, and programmable logic controllers (used to control industrial processes) are constructed of digital circuits. Digital signal processors are another example.

Building-blocks:

- Logic gates
- Adders
- Binary Multipliers
- Flip-Flops
- Counters
- Registers
- Multiplexers
- Schmitt triggers

Highly integrated devices:

- Microprocessors
- Microcontrollers
- Application-Specific Integrated Circuit(ASIC)
- Digital Signal Processor (DSP)
- Field-Programmable Gate Array (FPGA)

7. Tuning Circuits

The process of selecting the carrier wave of a desired station is referred to as tuning. This may be accomplished by adjusting one or more components of a series tuned circuit so that its resonant frequency will be equal to that of the desired carrier wave. The impedance of the series tuned circuit at resonance will be at its minimum value; therefore, the current in the series tuned circuit produced by the desired station adjustment will be at its maximum value.

Selecting a desired signal is only one of three important functions performed by the tuning circuit. In addition, it must reject all undesired signals, and in many instances it also increases the voltage of the desired signal before passing it on to the following circuit. The ability of a radio receiver to accomplish each of its three functions is known as its sensitivity, selectivity and fidelity.[4] Although the terms and definitions presented here refer to radio receivers, they apply to tuning circuits in general as well as to all other forms of communication systems.

Sensitivity is a measure of the ability of a radio receiver to reproduce, with satisfactory volume, weak signals received by the antenna.[5]

Selectivity is a measure of the ability of a radio receiver to reproduce the signal of one desired station and to exclude the signals from all others.

Fidelity is a measure of the ability of a radio receiver to reproduce faithfully all the frequencies present in the original signal.

8. Integrated Circuits

In electronics, an integrated circuit (also known as IC, microcircuit, microchip, silicon chip, or chip) is a miniaturized electronic circuit (consisting mainly of transistor, diodes, capacitors, resistors, semiconductor devices, as well as passive components) that has been manufactured in the surface of a thin substrate of semiconductor material. The integrated circuit is sometimes called an IC. It is so called because all of the circuit elements are bonded together rather than separately wired to each other after being manufactured. Integrated circuits are used in almost all electronic equipments in use today and have revolutionized the world of electronics.

A hybrid integrated circuit is a miniaturized electronic circuit constructed of individual semiconductor devices, as well as passive components, bonded to a substrate or circuit board.

The electrically interconnected components that make up an IC are called integrated elements. If an integrated circuit includes only one type of components, such as only diodes or resistors, it is said to be an assembly or set of components.

The principle of integrated circuit elements lies in the following. A great number of "set" are produced simultaneously on a wafer. Each set contains all the components such as transistors, diodes and resistors which are interconnected with short fine metallic stripes deposited on the wafer surface.[6] They make up a functional block. Each ICs of components is a ready integrated circuit. All ICs are regularly distributed on the wafer surface.

ICs can be classified by function into two: circuits to be applied in digital systems and those to be applied in linear systems. The digital ICs are employed mostly in computers, electronic counters, frequency synthesizers and digital instruments. And the analog, or linear ICs operate over a continuous range, and include such devices as operational amplifiers.

The invention of the IC is a great revolution in the electronic industry. Sharp size, weight reductions are possible with these techniques; and more importantly, high reliability, excellent functional performance, low cost and low power dissipation can be achieved.[7] ICs are widely used in the electronic industry.

New Words and Expressions

printed circuit board 印刷电路板
parallel plate capacitor 平板电容器
screwdriver ['skru:draivə] n. 螺丝刀，起子，改锥
dielectric [daii'lektrik] n. 电介质，绝缘体
trimmer ['trimə] n. 微调电容器
terminal ['tə:minl] n. 终端，末端
perfect conductor 理想导体
equivalent resistance 等效电阻
magnetic field 磁场
diode ['daiəud] n. 二极管
triode ['traiəud] n. 三极（真空）管
series circuit 串联电路
parallel circuit 并联电路
tuning circuit 调谐电路